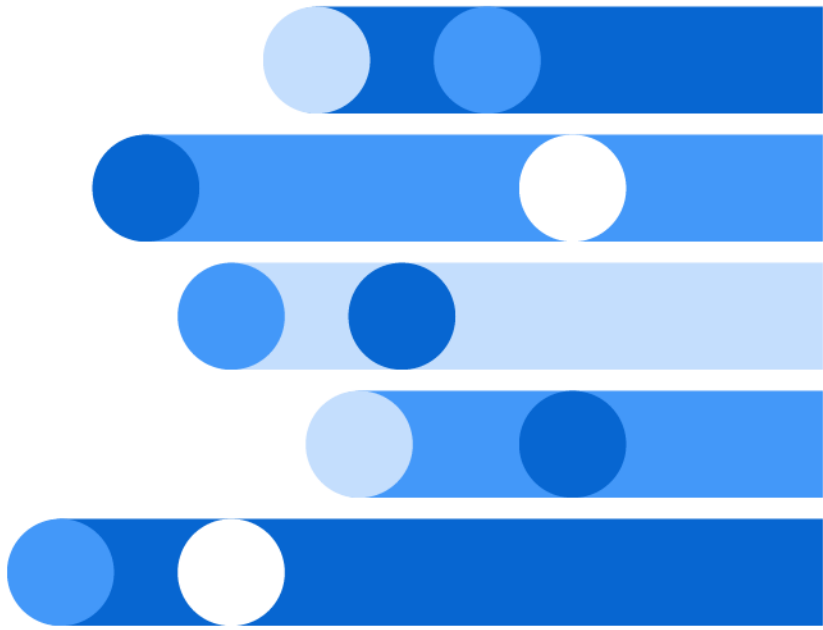
SAS® Data and AI Studio: Working with Flows

2026.07*



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SAS® Documentation
July 7, 2026

The correct bibliographic citation for this manual is as follows: SAS Institute Inc. 2026. *SAS® Data and AI Studio: Working with Flows*. Cary, NC: SAS Institute Inc.

SAS® Data and AI Studio: Working with Flows

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1

Introduction to Flows

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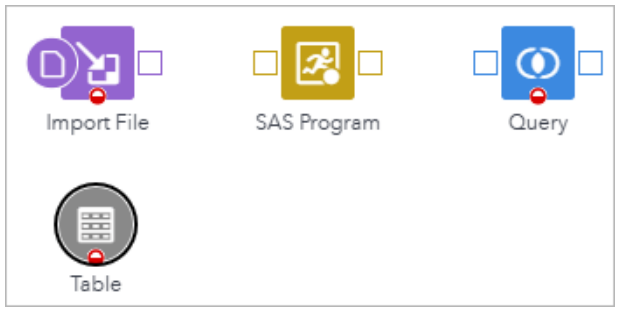
What Is a Flow?

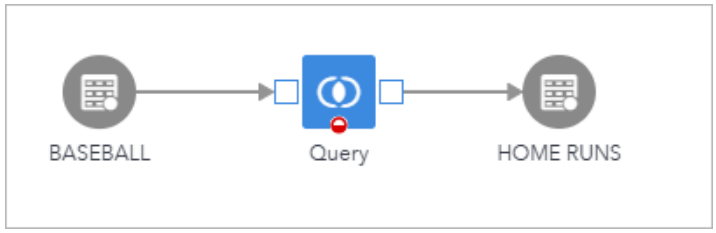
A *flow* is a sequence of operations on data. Data and operations are represented inSAS Data and AI Studio by steps that you can access from the **Steps** section of the navigation pane. Each step in a flow is represented by a node on the flow canvas.

The nodes on this flow canvas represent some of the steps that are available in SAS Data and AI Studio.



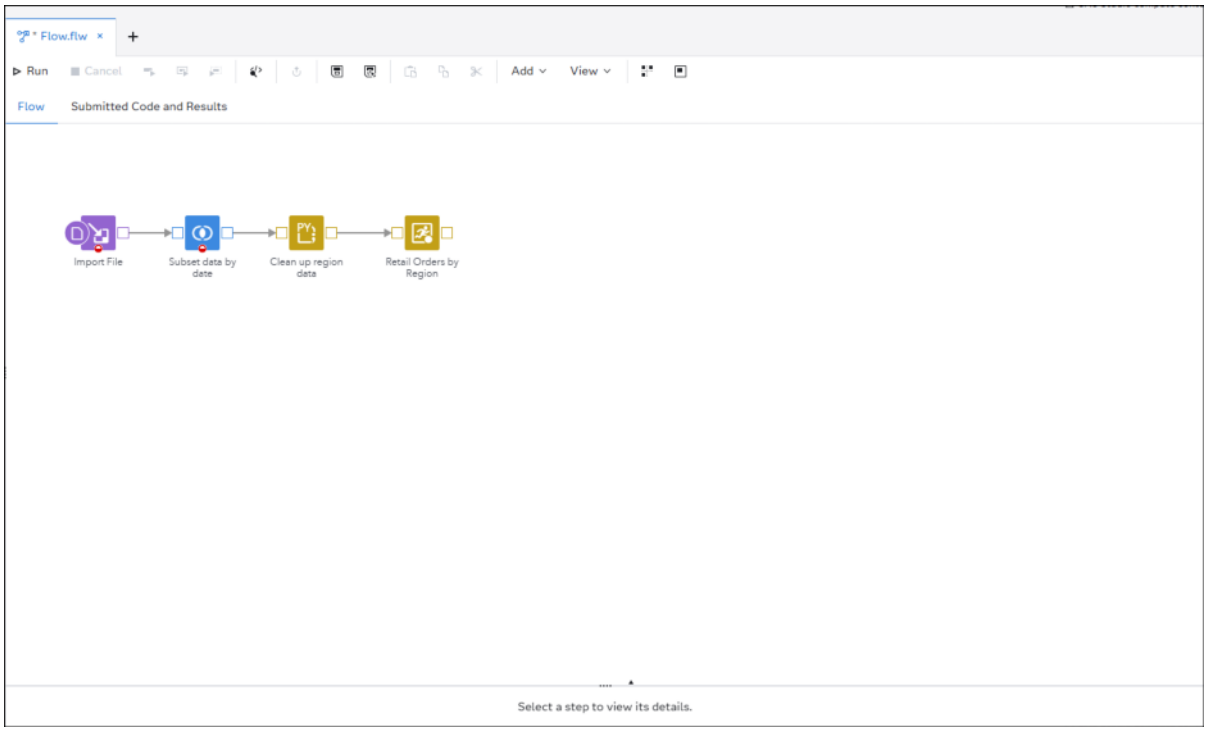
A flow can include a series of nodes in which the output of one node is the input to another node. As you build a flow, SAS Data and AI Studio automatically generates SAS code for each node. You can use flows to prepare data for reporting and analysis.

This example uses the Table and Query steps to create a flow that analyzes baseball data.



- BASEBALL is a Table node that provides the input data to the query.
- Query is a Query node that selects the number of home runs for each player in the BASEBALL table.
- HOME RUNS is a Table node that specifies the output table for the query.

You can also use a flow to combine different technologies in a single workflow. For example, you can create a flow that uses the Import step to convert an external .csv file to a SAS table, the Query step to subset the data, the Python Program step to cleanse the data, and the SAS Program step to create a report.

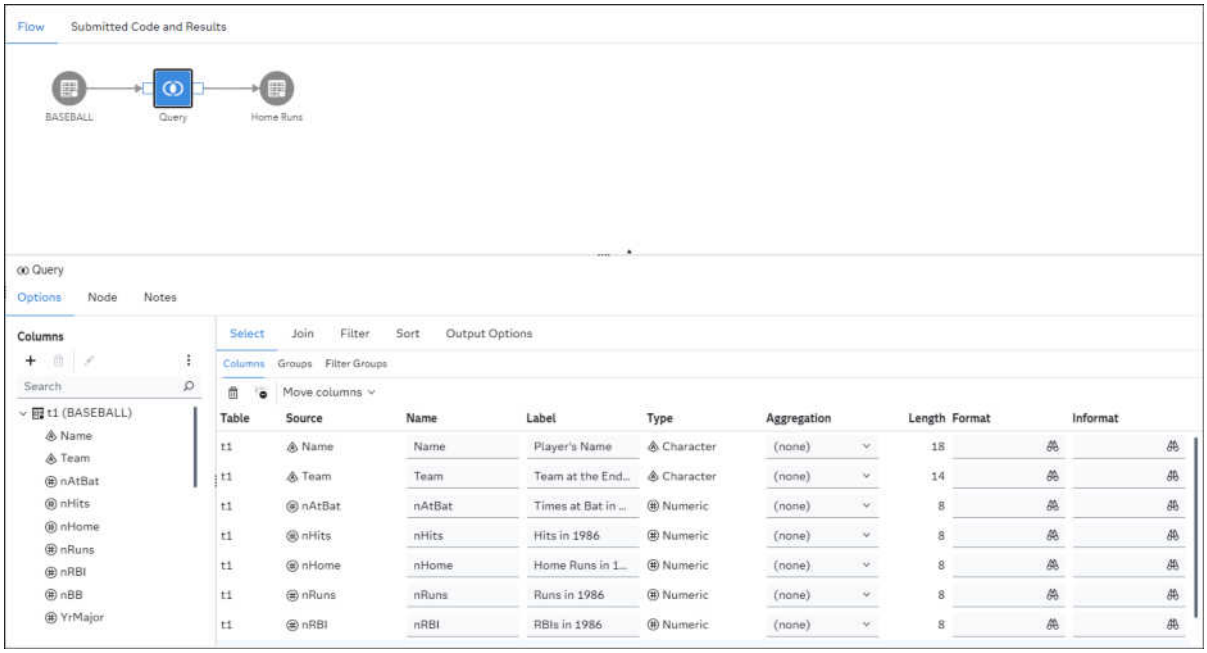


The types of steps that you can add to a flow are listed in the **Steps** section of the navigation pane. For more information, see "What Types of Steps Can I Add to a Flow?" on page 11.

Understanding the Flow Tab

About the Flow Tab

The flow functionality is available from the **Flow** tab.



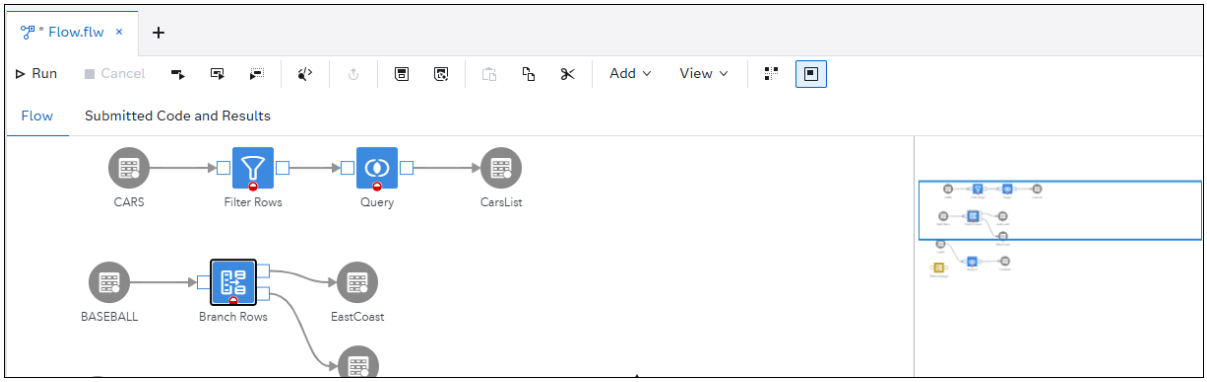
The Flow tab has two areas:

- The flow canvas enables you to build the sequence of nodes and manage the flow as a whole. You can use the **Submitted Code and Results** tab to view the code and log that SAS Data and AI Studio automatically generates as you build the flow. The **Submitted Code and Results** tab also displays any results and output data that are generated when you run a node.
- The node details under the canvas enable you to manage the attributes of a selected node in the flow, including node options and node properties. If you select a node on the flow canvas, the details for that node appear under the flow. You can specify various options that define the behavior of the selected node. You must specify a minimum set of options for each node in the flow in order to run the flow successfully.

Using the Overview Map

You can use the overview map to view your entire flow in a small window on the flow canvas. This feature is useful when you have a large, complex flow that you must scroll to view. Drag the rectangle on the map to move the view vertically and horizontally.

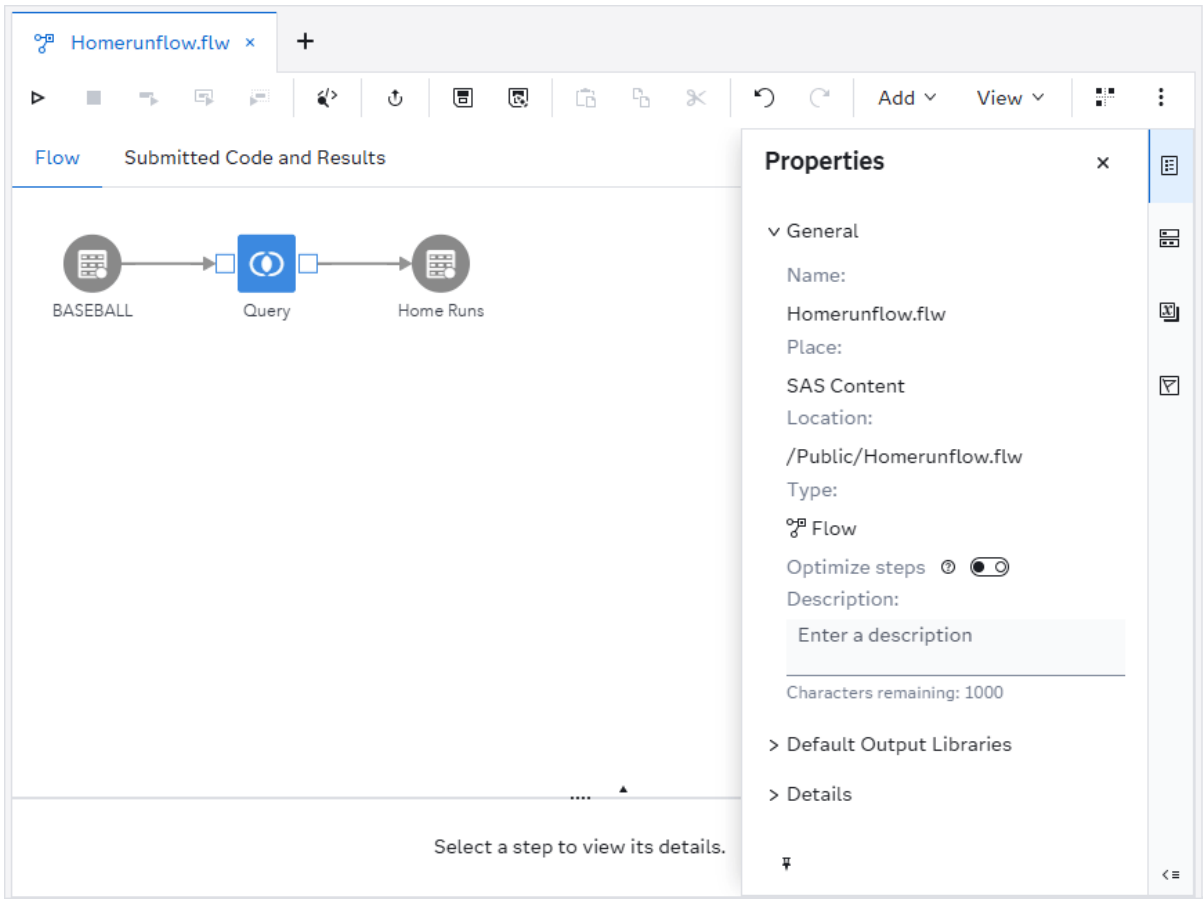
To toggle the overview map on and off, click ▣ on the flow toolbar.



Viewing Flow Properties

By default, the flow properties are collapsed on the right side of the canvas. When you expand the Properties pane, you can edit the Description property to specify information about the flow. You can also select options to optimize steps in the flow and change the default output library location for the flow.

Note: The flow description cannot exceed 1000 characters.



You can display, collapse, and pin the Properties pane:

- To display the Properties pane when it is collapsed, click .
- To collapse the Properties pane, click .
- To pin the Properties pane so that it remains visible when you scroll the flow horizontally, click . The Properties pane is pinned by default when it is displayed. If you do not pin the Properties pane, some nodes on the right side of the flow canvas might not be visible.

You can optimize the performance of your flow by combining the code generation of adjacent nodes so that the table that is associated with the output port of the first node is not created. For more information, see "Optimizing Steps in a Flow" on page 1353.

You can use the **Default output library for intermediate tables** property to change the default output library for temporary tables in the current flow:

- **Application default** uses the default library that is specified for the application. The default library is determined by the **Default output library for intermediate tables** application preference. For more information, see "Specifying Tables Settings" in *SAS Data and AI Studio: User's Guide*.
- **Output library location** uses the library that you specify.

Adding a Note to a Flow

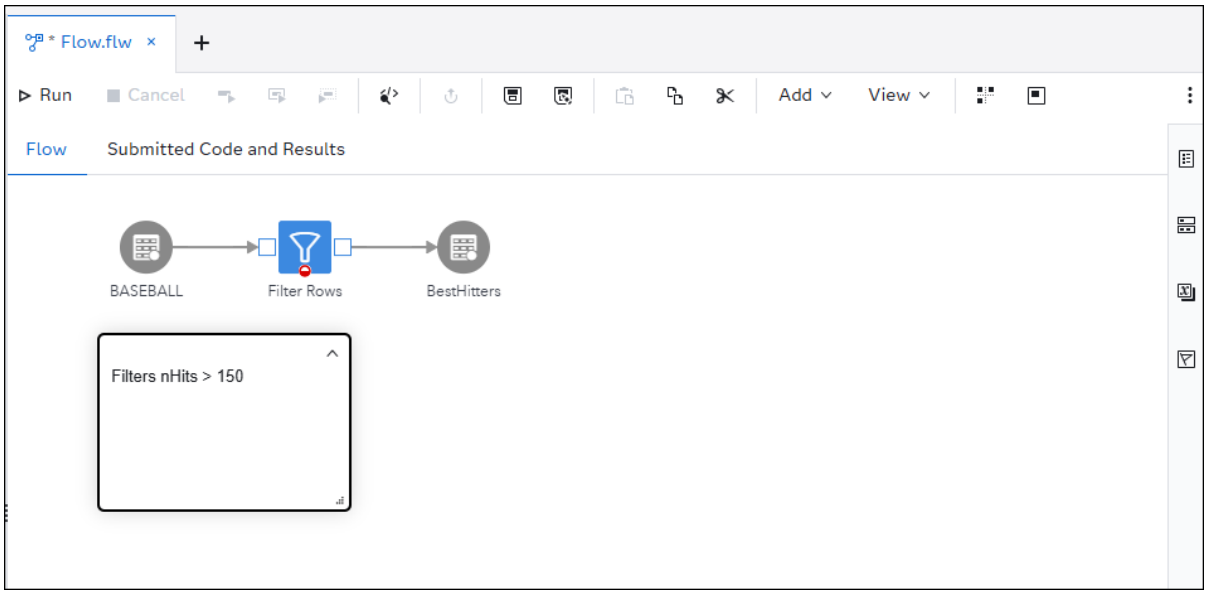
You can annotate your flow by adding notes to the flow canvas. Notes that are added to the flow are not associated with a specific node. You can position the notes anywhere in the flow, and you can cut, copy, and paste notes within and between flows.

To add a note to a flow:

1 On the flow toolbar, click **Add** ⇨ **Notes**.

2 Enter the text of the note in the note box.

Note: To delete a note, right-click the note and select **Delete**.



You can collapse and expand a note in a flow:

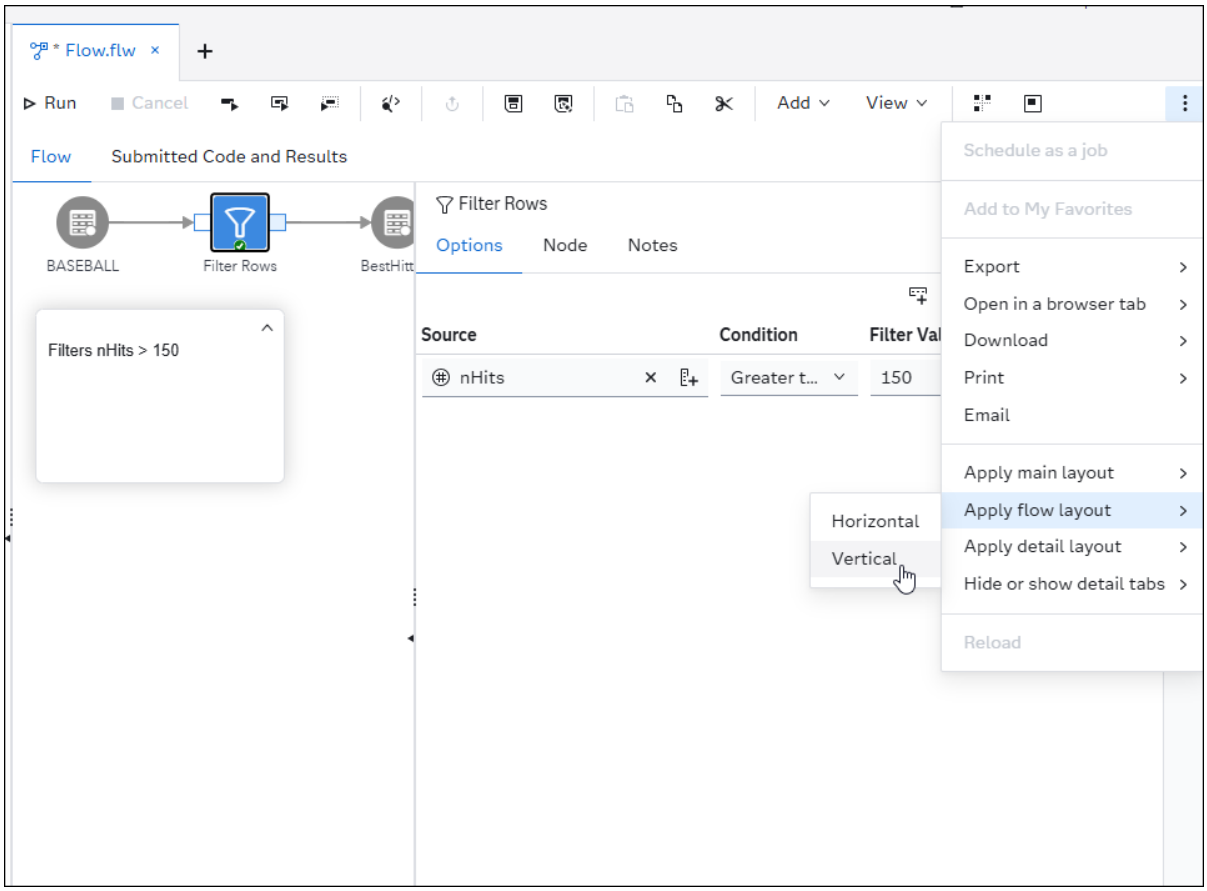
- To collapse a note in the flow, click ^ in the upper right corner of the note.
- To expand a collapsed note, double-click the note.

Customizing the Flow Tab

You can change the layout of the default flow tabs so that the **Submitted Code and Results** tab is displayed separately from the **Flow** and **Generated Code** tabs. You can also choose to display the preview tabs horizontally or vertically.

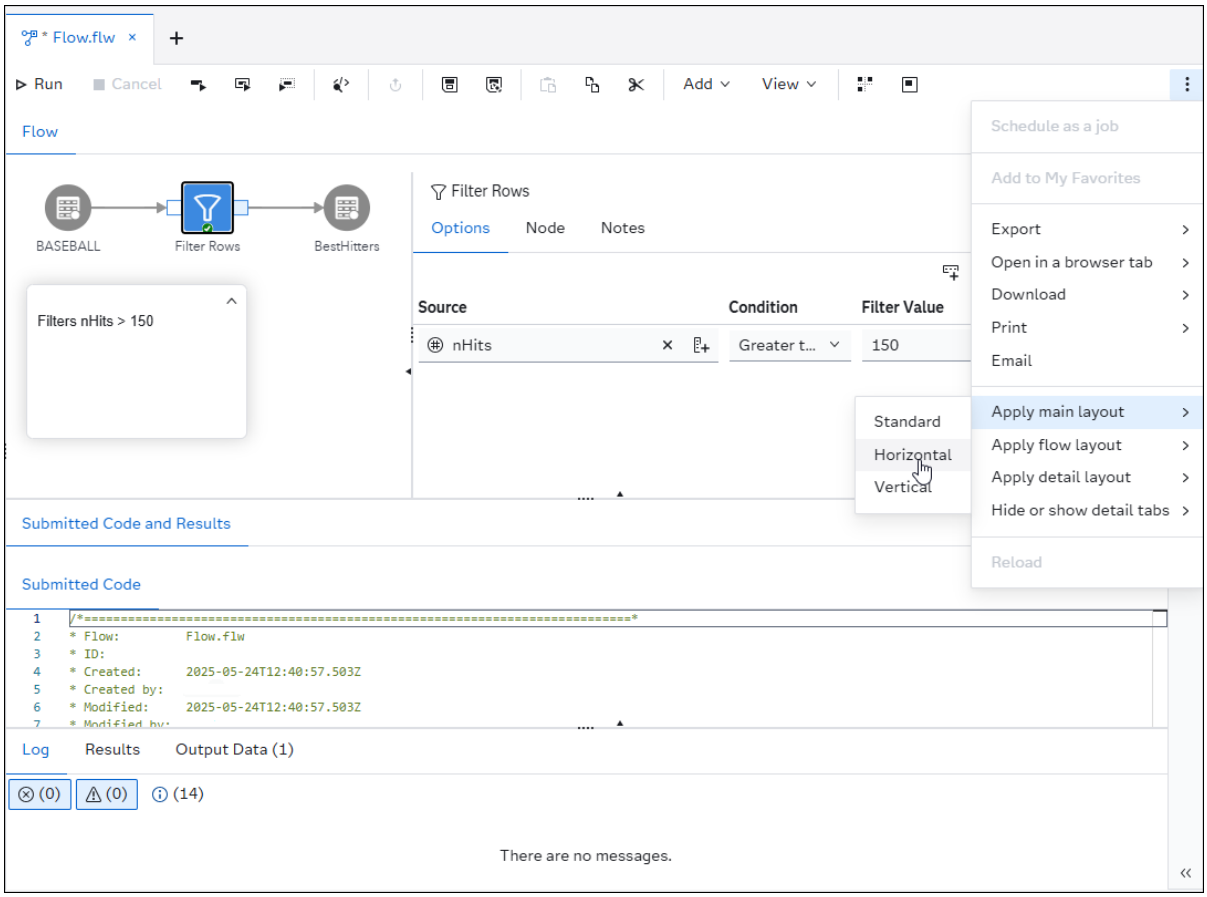
To change the layout of the default flow tabs:

- On the flow toolbar, click ⋮ and select **Apply flow layout**. Select the layout that you want to use.



To change the main layout:

- On the flow toolbar, click ⋮ and select **Apply main layout**. Select the layout that you want to use.



Creating a Flow

You can create a flow in these ways:

- On the **Start Page** tab, click **Build a flow**.
- From the SAS Data and AI Studio menu, select **New** ⇨ **Flow**.

Opening a Flow

Flows can be saved to a SAS Server or SAS Content. Flows are saved as *.flw files. To open a saved flow, navigate to the appropriate folder in the **SAS Server** or **SAS Content** sections in the navigation pane and perform one of these actions:

- Double-click a flow to open it.
- Right-click a flow and select **Open**.

- Select a flow and drag it to an open space next to any open tab in the work area. Release the flow to open it.

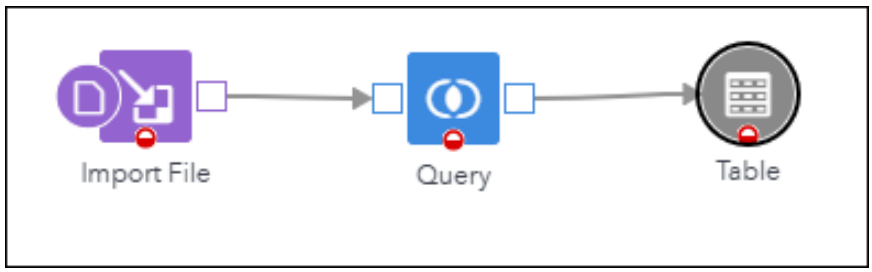
Understanding Steps and Nodes

About Steps and Flow Nodes

SAS Data and AI Studio is shipped with many predefined steps that include queries and data transformations. Steps are represented as nodes in a flow. Flows are built from a sequence of data and operational nodes, which you can connect in order to specify the order of execution.

Data steps, such as the File and Table steps, represent data in a flow. Operational steps, such as the Import, Query, and SAS Program steps, represent operations that can be performed on data. The File and Table steps are not considered operational steps.

You can add steps to a flow as placeholders in order to create the structure of your flow, and then specify the attributes and content of the nodes later. For example, you could create a flow with placeholders for an Import step, a Query step, and a SAS Table step. When you are ready, you can specify the external file and output table that you want to use as well as the options for the Import and Query nodes.



You can also add saved files to a flow from different sections of the navigation pane. Each node can have input and output ports, depending on the node type.

TIP You can move individual nodes by dragging them around the flow canvas. To move multiple nodes as a group, use your mouse pointer to draw a box around the nodes that you want to move. The nodes in the box are selected. Click one of the selected nodes to drag the entire group to another location on the flow canvas.

What Types of Steps Can I Add to a Flow?

The types of steps that you can add to a flow are listed in the **Steps** section of the navigation pane. The steps are organized into categories that indicate the function that they perform. Here are the basic steps that are available in SAS Data and AI Studio:

- Export - exports data to an external file.
- Import - converts an external file to a SAS data set.
- Table - references a SAS data set from a SAS library.
- Python Program - enables you to write a new Python program or open a saved Python program.
- SAS Program - enables you to write a new SAS program or open a saved SAS program or snippet.
- Query - extracts data from one or more tables according to criteria that you specify.
- Sort - enables you to order your data by the values of one or more columns.

You can use the node details under the flow canvas to specify the attributes and content of the node. Every node has a Node tab, which you can use to specify a name and description of the node.

For a complete list of the steps that are available in each license of SAS Data and AI Studio, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Note: Not all steps are available in all licenses of SAS Data and AI Studio.

Adding Steps to a Flow

When you have a flow open in the work area, you can use the **Steps** section of the navigation pane to add steps to a flow. You can also click **Add** on the flow toolbar to add some of the most frequently used steps to a flow.

To add one or more saved files to a flow, expand the **SAS Server** or **SAS Content** section of the navigation pane and drag the appropriate files to the flow canvas. You can add the following types of saved files to a flow:

- SAS program files (*.sas)
- Python program files (*.py)
- Comma-separated values files (*.csv)
- Delimited files (*.tsv, *.tab, or *.dlm)

- Text files (*.txt)
- Flow files (*.flw)

Note: The subflow feature is available only if your site licenses SAS Data and AI Studio Advanced. For more information, see "About Subflows" on page 59.

You cannot add *.sas7bdat, *.ctm, *.ctk, *.ctl, or *.cqy files to a flow.

Identifying Updated Steps in a Flow

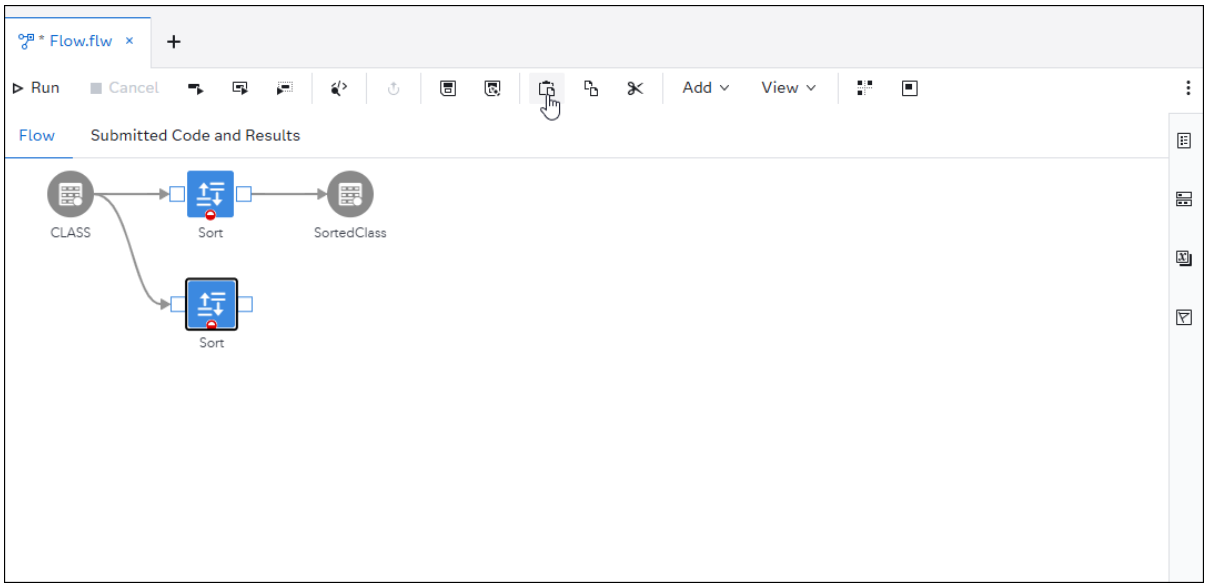
If a SAS step in your flow has been updated, SAS Data and AI Studio automatically displays a message at the top of the workspace. On the node for each updated step, SAS Data and AI Studio displays a warning icon, so you know which steps have been updated. For specific information about what was changed, contact the step author.

To continue, simply dismiss this message. No further action is needed.

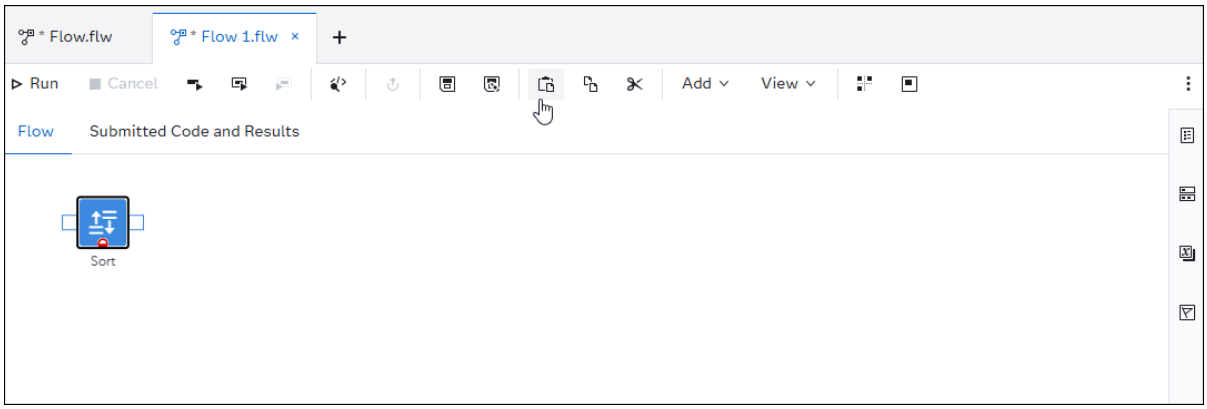
Cutting, Copying, and Pasting Nodes

You can cut, copy, and paste one or more nodes within a flow. You can also cut, copy, and paste nodes between flows. When you cut or copy nodes, the properties and values that are associated with the nodes are retained.

When you copy and paste an operational node within a flow, any connections to the input port of the original node are automatically created to the input port of the pasted node. You must manually re-create any connections from the output port of the pasted node.



When you copy and paste an operational node into a different flow, connections are not automatically created unless you have also selected and copied the connected nodes. The pasted node displays an error state until you add the required connections and update the node options as necessary.



To copy one or more nodes, select the nodes that you want to copy from the flow canvas and click .

To cut one or more nodes, select the nodes that you want to cut from the flow canvas. Right-click a selected node and select **Cut**.

To paste the nodes, open the flow into which you want to paste the nodes and click .

> **TIP** SAS Data and AI Studio can auto-arrange the nodes in your flow by repositioning nodes, ports, and connections into a logical arrangement. You can modify any changes SAS Data and AI Studio makes by manually updating the flow. To auto-arrange the nodes in the flow, click on the toolbar.

Connecting Nodes

Nodes are joined by connections to either the node itself or to a port on the node.

Depending on the node type, you can drag a node to the flow canvas, drop it on another node, and automatically create a connection between the nodes. The tip on your mouse pointer changes to indicate valid locations in which you can insert the node in the flow, connect the node to the input port of another node, or connect the node to the output port of another node.

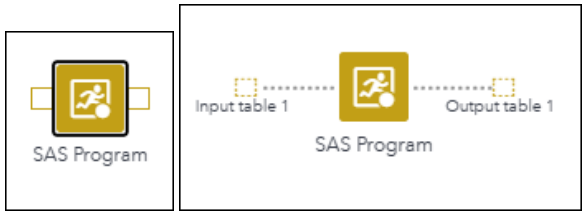
For example, you can drag a Table node and connect it to either the input or output port of a Query node, or you can drag an external .csv file from the **SAS Content** section of the navigation pane and connect it to the input port of an Import node.

TIP SAS Data and AI Studio can auto-arrange the nodes in your flow by repositioning nodes, ports, and connections into a logical arrangement. You can modify any changes SAS Data and AI Studio makes by manually updating the flow. To auto-arrange the nodes in the flow, click on the toolbar.

Expanding and Collapsing Node Ports

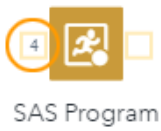
Some node types, such as SAS Program, Query, and Import, can contain one or more input and output ports. Ports represent either an input source or an output target for connecting data with nodes.

By default, ports are collapsed. To expand or collapse a port, right-click the port and select **Expand** or **Collapse**. You can expand or collapse all ports by clicking **View** on the toolbar and selecting **Expand all ports** or **Collapse all ports**.

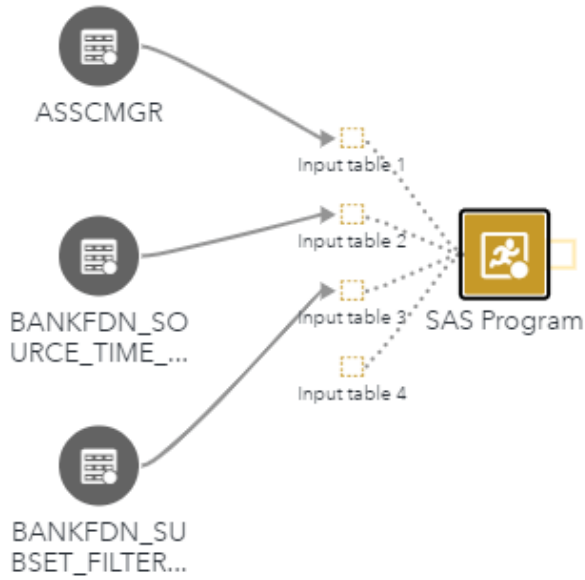


You can assign source data to an input port by connecting another node to the input port. Depending on the node type, input can be either data or the output from another node.

When you connect nodes, SAS Data and AI Studio automatically adds ports to a node as they are needed. Not all node types support multiple input ports. You can also manually add input and output ports to some node types by right-clicking the node and selecting **Add input port** or **Add output port**. When a node has more than two ports, they are displayed as a single port with the number of ports noted.



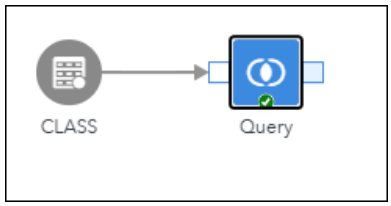
When a node has multiple input ports, the ports automatically expand when you create a connection.



Note: When a node has multiple output ports, you must first expand the ports before creating a connection to another node.

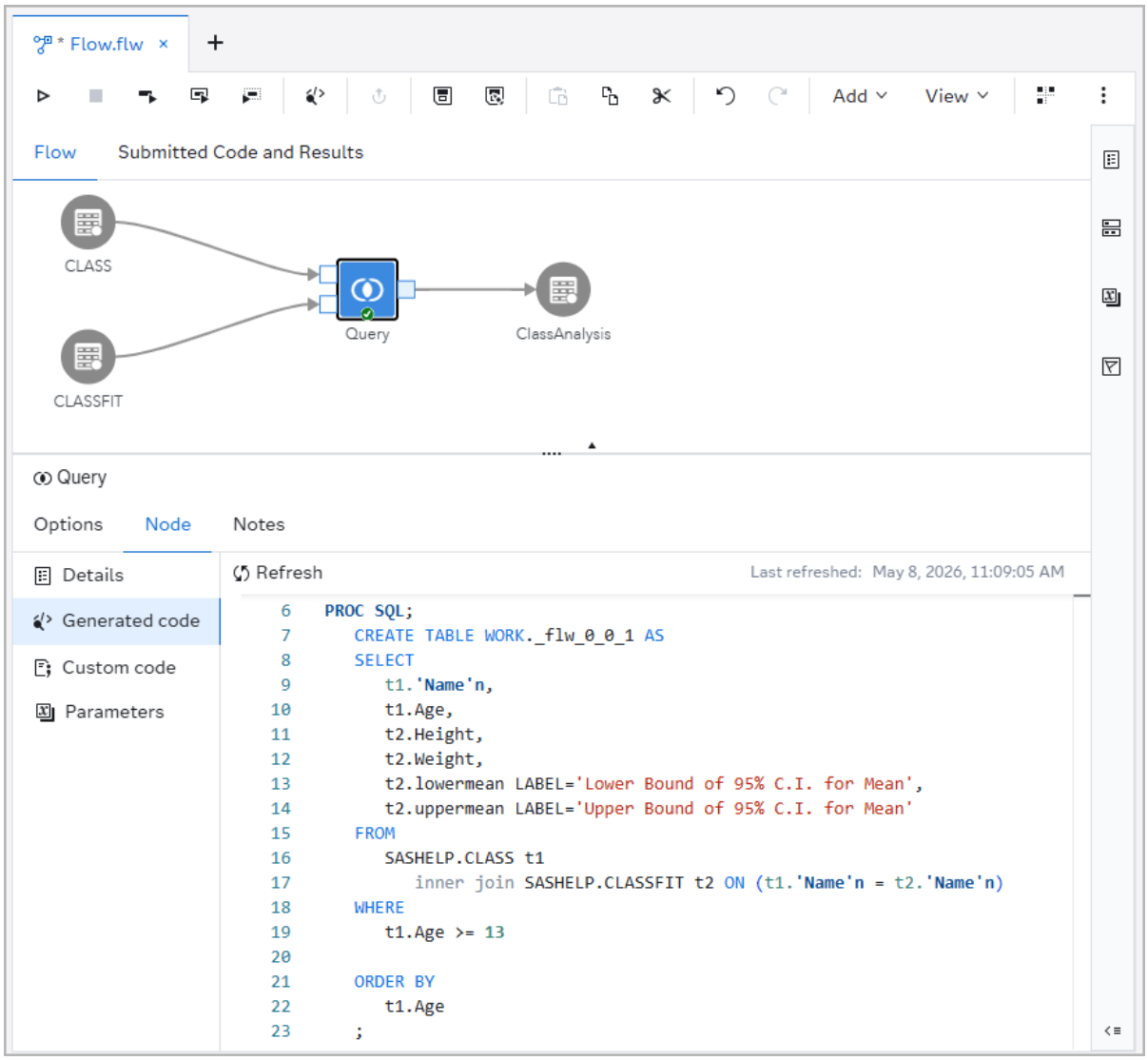
By default, output ports represent tables in the Work library. To specify a location for the data, add a Table node to the flow and connect the node to the output port. An empty output port indicates that there is no data available in the port.

When a node has run successfully and data is available from the output node, the node is displayed as filled in.



Viewing Generated Code for a Step

You can view the code that is generated for an individual step in a flow by using the Node tab in the node details.



To view the generated code for a step:

1 Click the appropriate node on the flow canvas.

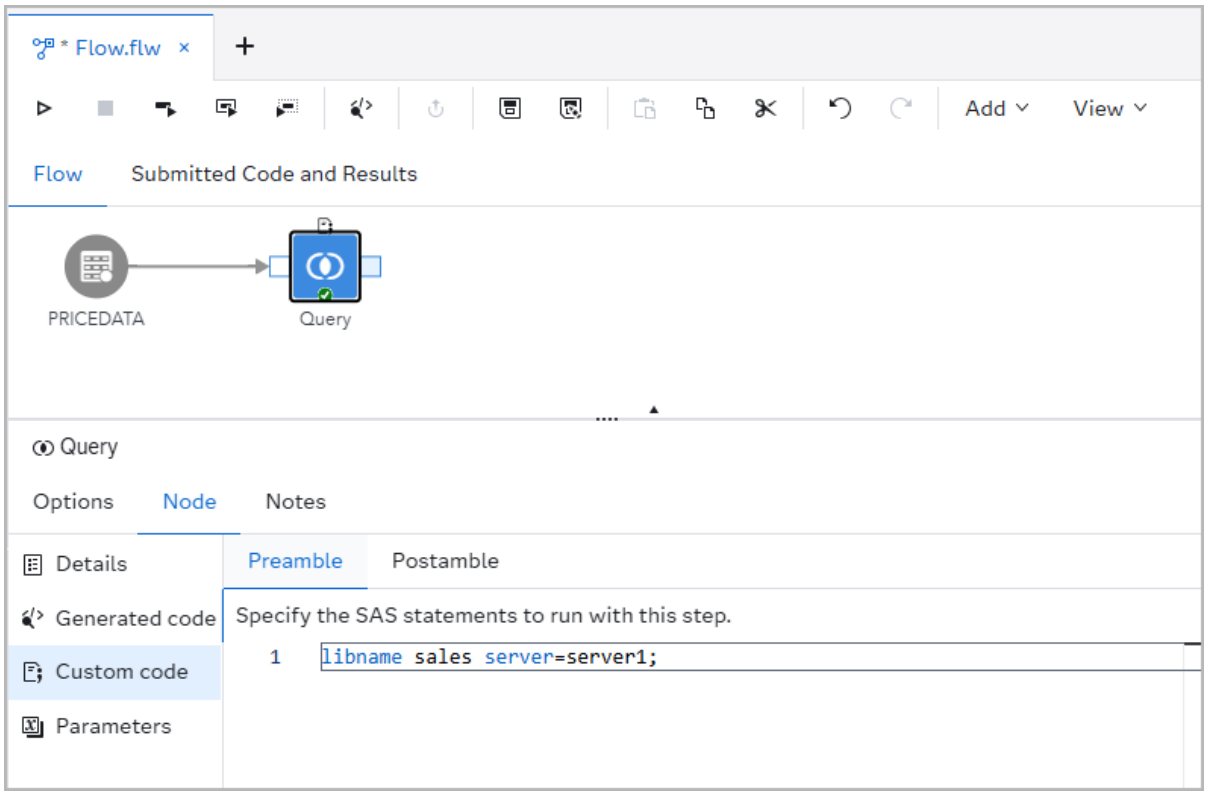
2 Click the **Node** tab in the node details area, and then click **Generated code**.

Note: If you have made changes to the node options since the code was initially generated, you must click **Refresh** to update the generated code.

Adding Preamble and Postamble Code to a Flow Node

You can add custom SAS code to run before and after a node in a flow by using the Node tab in the node details. When you add code to a node, a code icon is displayed with the node on the flow canvas.

Note: If you have selected the **Optimize steps** option, nodes that have custom code associated with them are not included in the optimization. Nodes without custom code are still optimized, even when the flow also contains nodes with custom code.



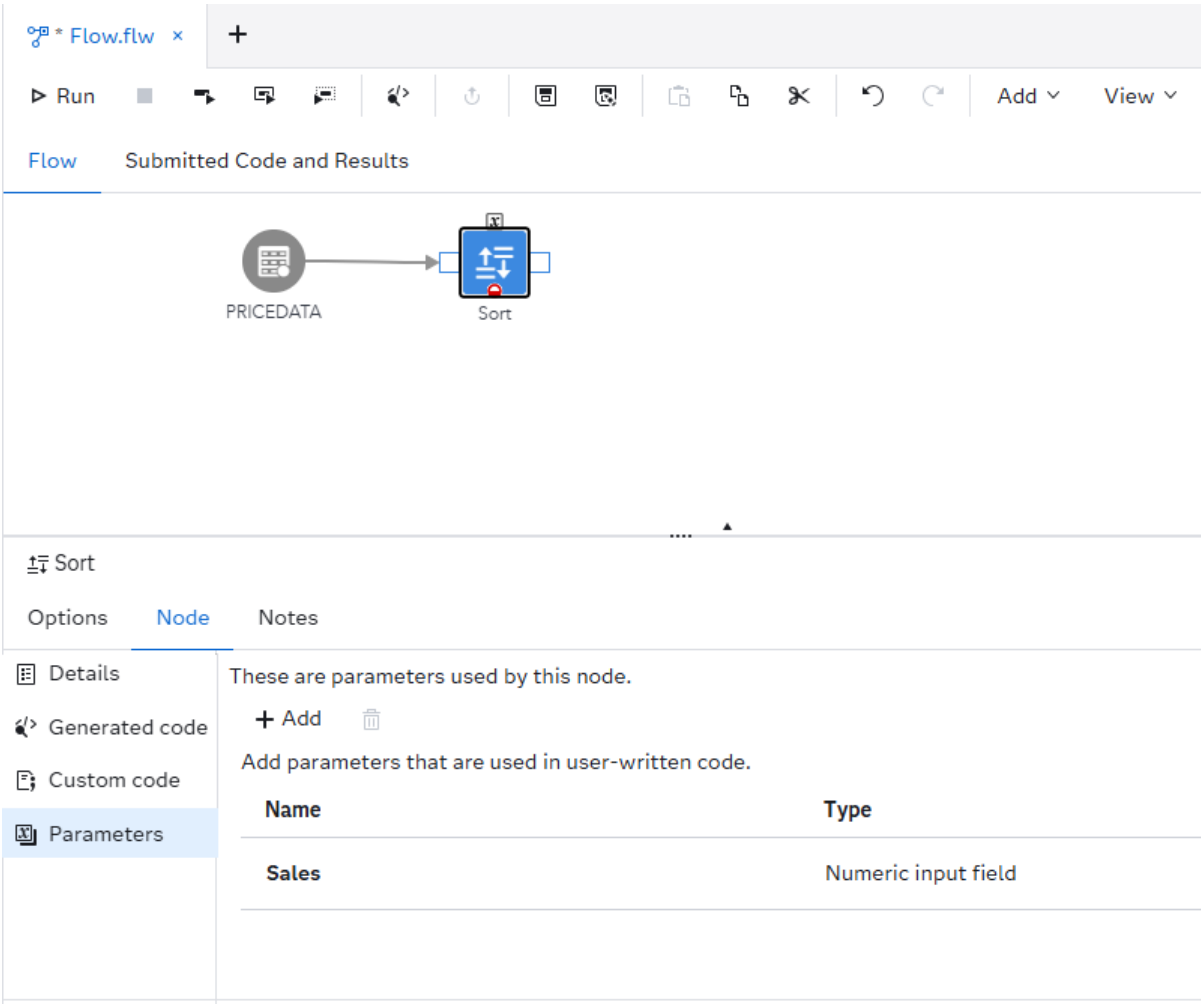
To add custom code to a node:

1. Click the appropriate node on the flow canvas.
2. Click the **Node** tab in the node details area, and then click **Custom code**.

   Click the **Preamble** or **Postamble** tab and enter the code. The custom code window includes the features of the SAS code editor.

Adding Parameters to a Flow Node

You can add a parameter to a specific node in the flow by using the Parameters tab in the node details. When you add a parameter to a node, the parameter icon is displayed with the node on the flow canvas.



To add a parameter to a node:

1 Click the appropriate node on the flow canvas.

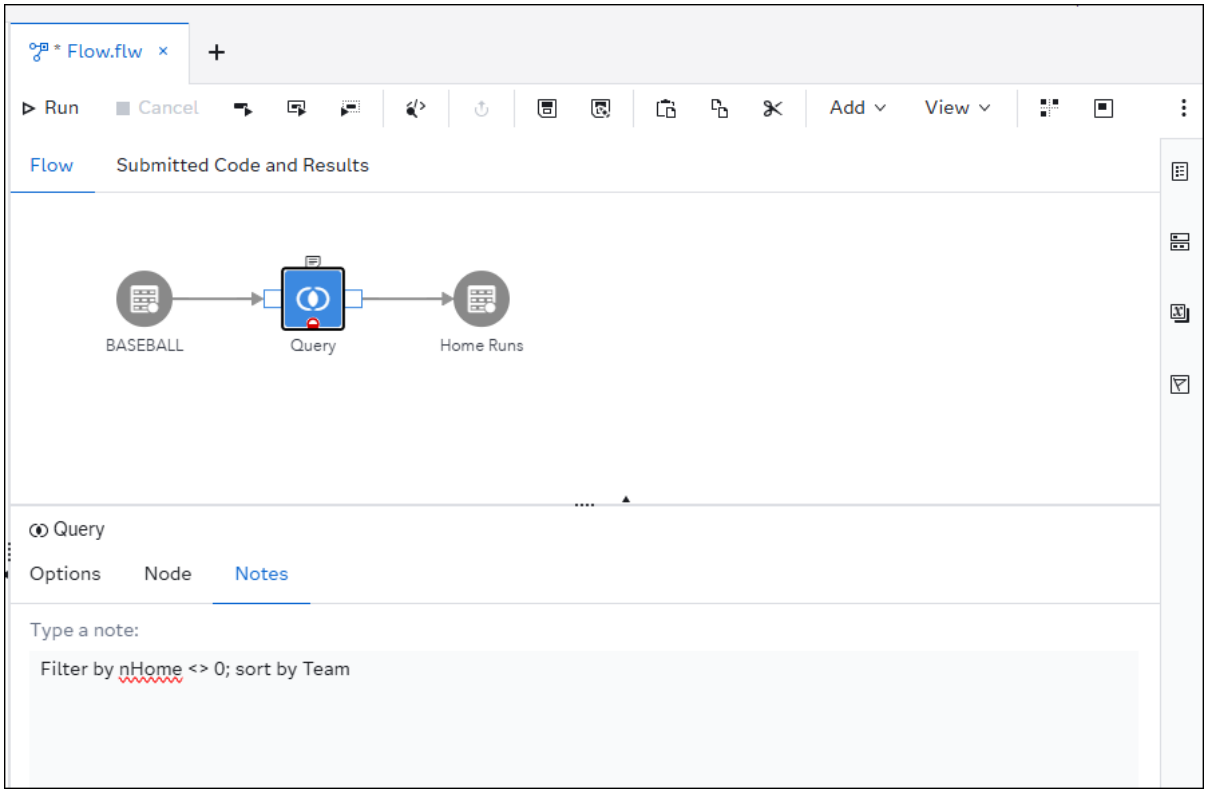
2 Click the **Node** tab in the node details area and then click **Parameters**.

3 Click **Add**. Select the parameter to use and click **OK**.

For more information, see "Creating a Parameter" on page 39.

Adding Notes to a Flow Node

You can add notes to a specific node in a flow by using the Note tab in the node details. When you add a note to a node, a note icon is displayed with the node on the flow canvas.



To add a note to a node:

1 Click the appropriate node on the flow canvas.

2 Click the **Notes** tab in the node details area and enter the note text.

You can edit a note in these ways:

- Click the **Notes** tab in the node details area and update the note text.
- Click the note icon on the flow canvas to expand the note text, and then double-click the note text box. Enter your changes in the note text box. Click anywhere on the flow canvas to save your changes.

To expand a node note, single-click the note icon.

To collapse a node note, click ^ in the upper right corner of the note.

To remove a note from a node, delete the text in the note.

Using Undo and Redo in a Flow

You can undo and redo actions that affect the flow canvas, including adding and deleting nodes, ports, connections, and swimlanes. You can also undo and redo any manual or automatic reordering of nodes in the flow.

To undo or redo an action on the flow canvas:

- Click or in the flow toolbar.
- Press Ctrl+Z or Ctrl+Y.

2

Working with Data in a Flow

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About the Table Node

Table nodes are used to reference SAS data sets in SAS libraries, CAS tables in CAS libraries, or DBMS tables in DBMS libraries. You can use table nodes as input and output for operational nodes.

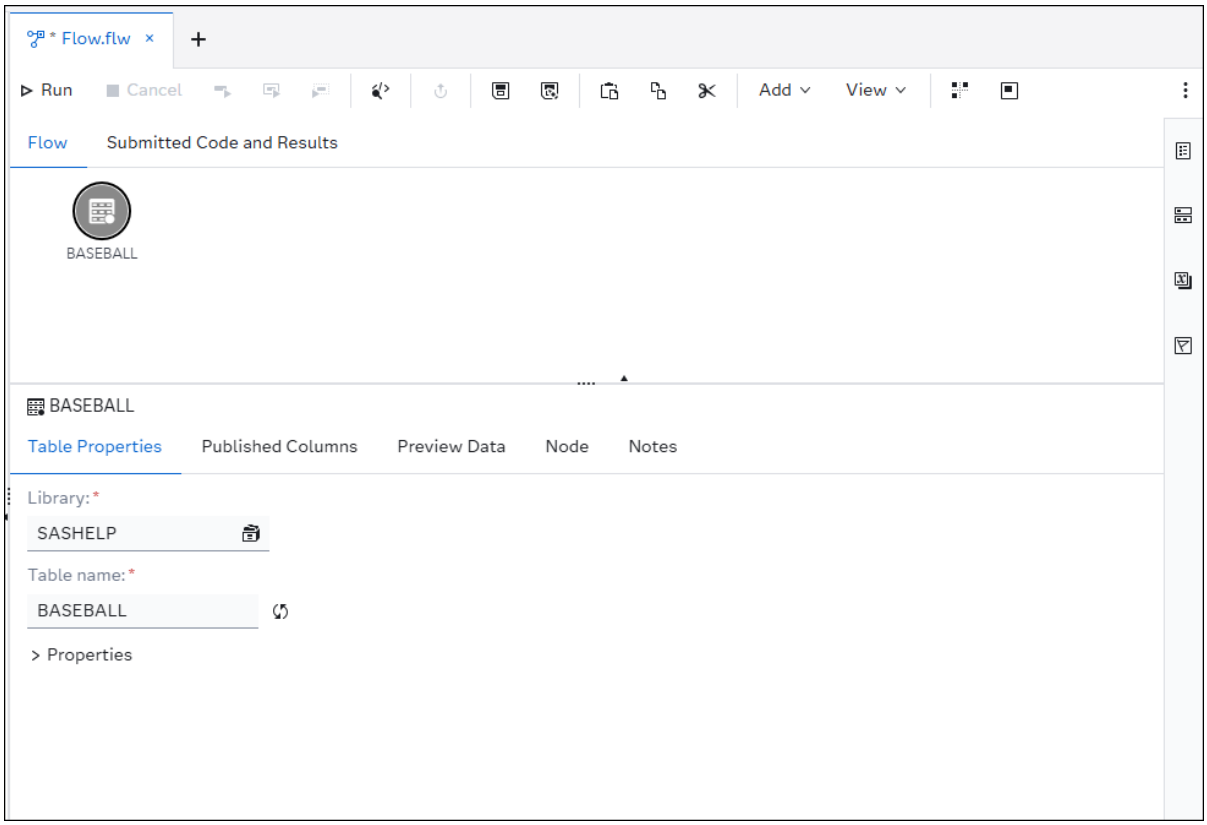
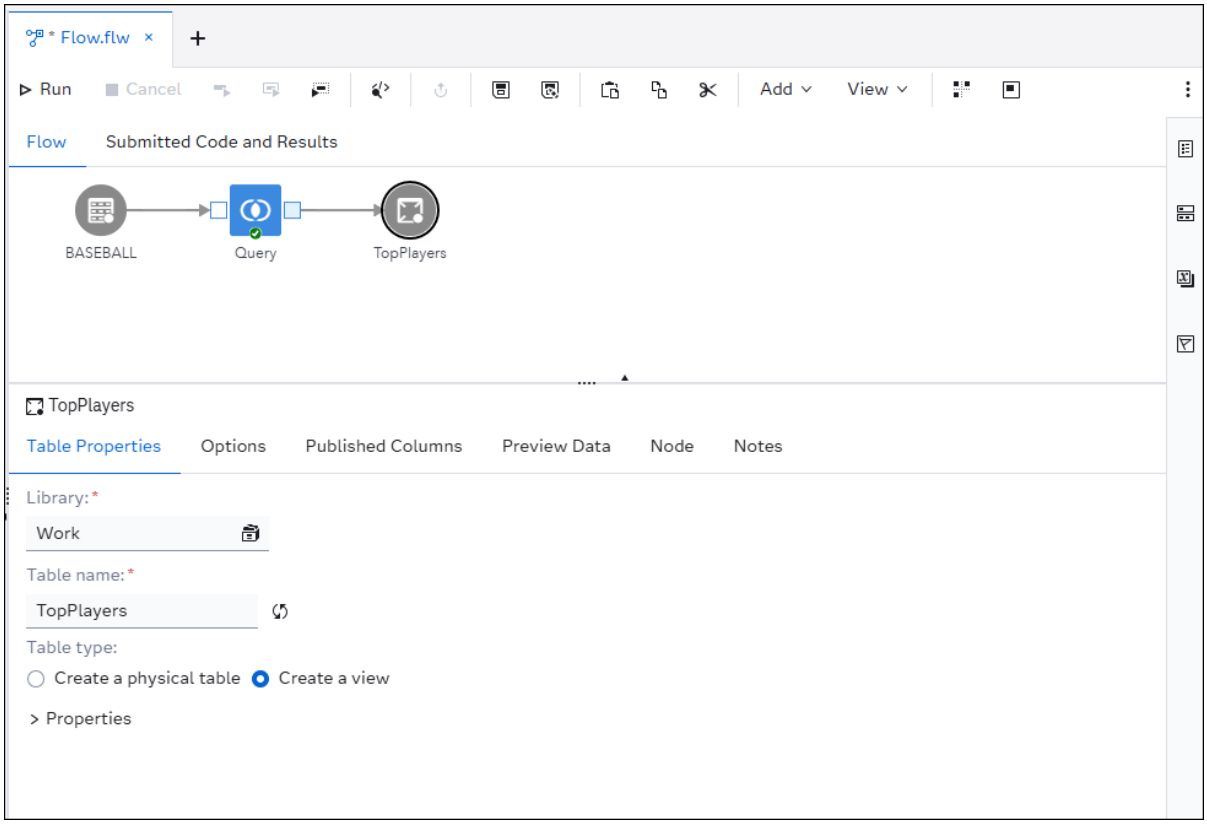


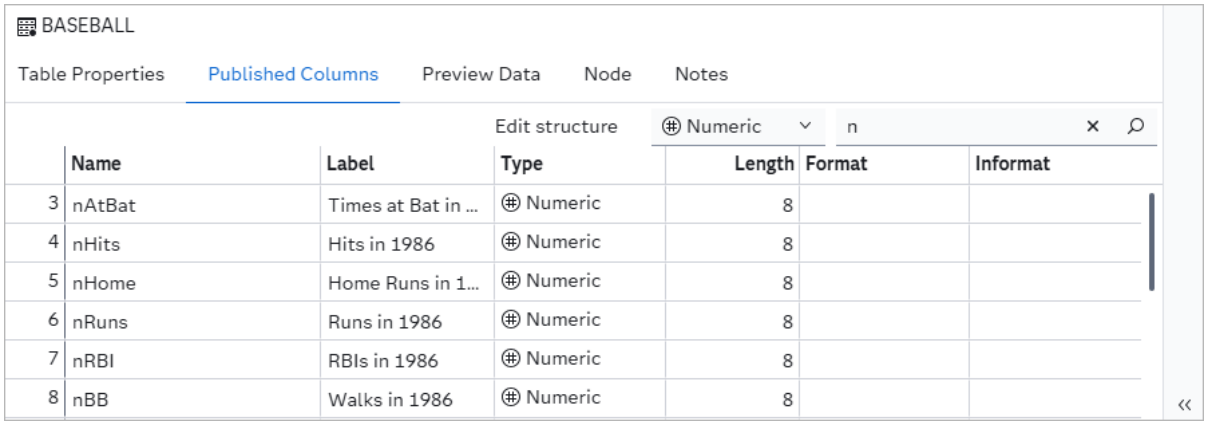
Table nodes can also reference data views. A view is a stored query that generates a result set when you access the view. Views do not store data. A view is a virtual table and can be used like a table.

Note: You can create a view by connecting a Table node to the output port of a Query node. The Query node must use PROC SQL to generate the results as a view. For more information, see "Query" on page 123.

To generate a view, click the Table node on the flow canvas, and then click the **Table Properties** tab. Select **Create a view**.



The column structure of the table or view is displayed on the Published Columns tab of the node details.



You can use the Published Columns tab for these tasks:

- To filter the columns on the tab by character or numeric data types, click the filter drop-down list and select **Character** or **Numeric**. You can also enter search criteria for the Name and Label columns in the search box. The example above shows the Baseball table filtered by numeric columns that include *n* in the Name or Label columns.
- To add or delete columns or to change the properties of an existing column, click **Edit structure**. To exit edit mode and reset the column structure to the structure of the table that is specified on the Table Properties tab, click **Edit structure** again. Any changes that you have made to the column structure are overwritten.

TIP You can use the **Edit structure** option to copy the column structure of an existing table to a new table.

1. Click the table node to which you want to copy a new column structure, and then click the **Table Properties** tab.

   Note: Before you can copy the column structure of an existing table, you must specify a library and table name for the new table (for example, Work.NewTable).

2. Change the values of the **Library** and **Table name** fields to match the library and table names of the table whose structure you want to copy (for example, Sashelp.Class).
3. Click the **Published Columns** tab, and then click **Edit structure**. You can add, delete, or edit columns, if necessary.
4. Click the **Table Properties** tab again and change the values of the **Library** and **Table name** fields back to the values of the original table (for example, Work.NewTable).

You can view the data in the table or view on the Preview Data tab. The Preview Data tab interface is very similar to the interface for the stand-alone table viewer. For more information, see "About the Table Viewer" in *SAS Data and AI Studio: User's Guide* and other topics in the "Working with Data" chapter.

Specifying Advanced Output Table Options

You can specify additional options to apply when an output table is created or when data is updated or inserted in the table. Often, the additional options are used to improve performance. The advanced table options can be applied to tables in these situations:

- Table node that is connected to the output port of an operational node – advanced options for a Table node can include options that are associated with creating a table. For example, you could use additional options to specify a label, specify how observations in the output table are compressed, or you could create single and composite indexes for a SAS output table.

  Note: The advanced output table options are not available if the Table node is connected to the output port of a SAS Program, Python Program, Insert Rows, Execute Decisions, or custom step node.

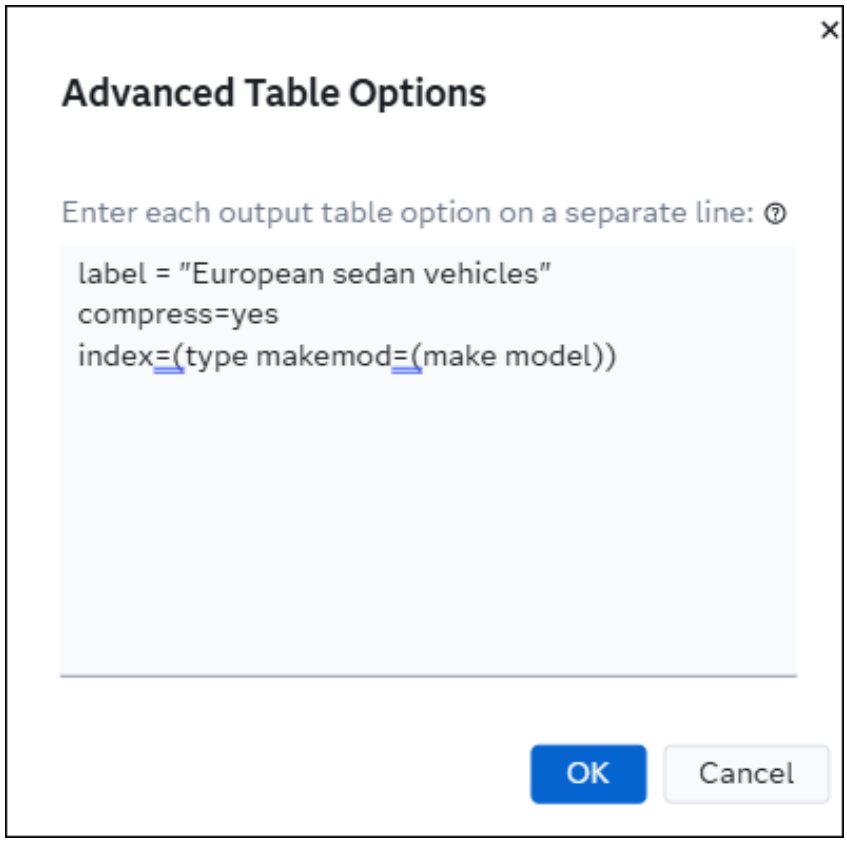
- Target table that is defined in the node details of an operational node – advanced options for the target table in an operational node can include options that are associated with the operations performed by the node on the table. For example, in a Load Table node, you could use options that are associated with inserting and updating data in a table, such as options to specify the number of rows to insert or to specify whether to use a DBMS-specific bulk-load facility.

To specify advanced table options:

1 If you are specifying options for a Table node, click the output table in the flow, and then click the **Table Properties** tab.

   If you are specifying options for the target table in an operational node, click the operational node and then click the **Options** tab.

2 Click **Advanced table options**. Enter each option on a separate line. This example shows options for a Table node.



The syntax for the advanced options can vary depending on the code that is generated for the step. In most cases, the output options should be data set options, but some steps require CASL table parameters or FedSQL table options. You must include any quotation marks that are required for string values. You can find more information about options here:

- SAS data set options
- CASL table parameters
- FedSQL table options

Note: This is an option for advanced users. It is recommended that you avoid using any options that might change the column metadata, such as DROP=, KEEP=, or RENAME=. If you use options that change the column metadata, you can generate syntactically valid code that can cause errors in downstream nodes. If you need to subset columns in the table or change column names or labels, you should use an additional step such as Manage Columns.

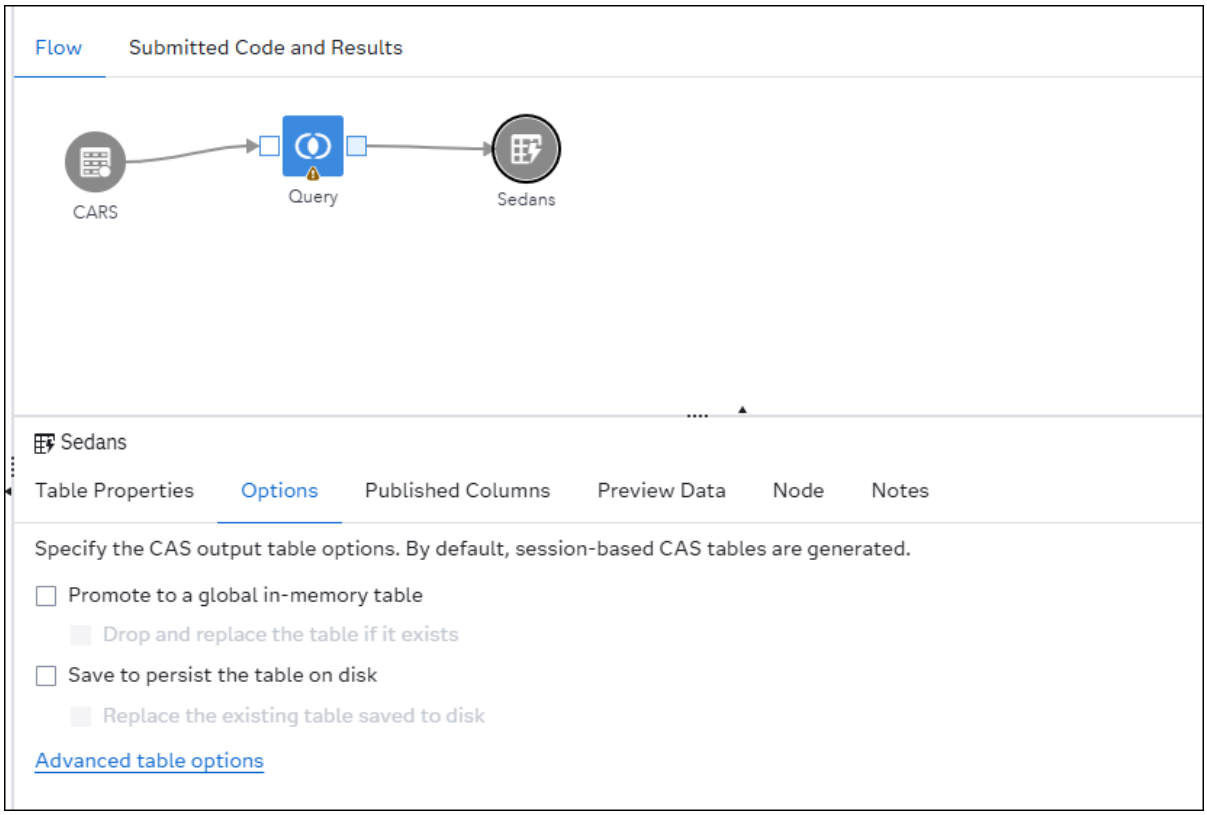
Setting Options for CAS Output Data

If you are running an operational node that creates CAS output data, you can specify whether the table is a session-scope table or a global-scope table, and you can save the table to the CAS server. You can also specify additional options to apply when the table is created or updated.

Note: The output table options are not available if the table node is connected to the output port of a SAS Program, Python Program, Insert Rows, or custom step node.

To specify CAS output table options:

1 Click the output table in the flow, and then click the **Options** tab.



2 Select from the following options:

- **Promote to a global in-memory table** - creates a global-scope table that can be viewed by other sessions. Global-scope tables persist after the current CAS session is terminated. If you want to automatically replace an existing global-scope table of the same name, select **Drop and replace the table if it exists**. If you do not create a global-scope table, a session-scope table is created. A session-scope table can be viewed only by your current CAS session and is dropped when the session ends. Session-scope tables are created by default.
- **Save to persist the table on disk** - saves the table to the CAS server as a SASHDAT file. If you want to automatically replace an existing table of the same name, select **Replace existing table saved to disk**.

3 To specify additional options to apply when the table is created or updated, click **Advanced table options** and enter each option on a separate line. For more information, see "Specifying Advanced Output Table Options" on page 24.

Exporting Data to an External File

To export data in a flow:

1 Click the **Steps** section of the navigation pane.

2 Expand the **Data (Input and Output)** folder and double-click the **Export** step to add an Export node to the flow.

3 Connect the input port of the Export node to a data source, such as a Table node or another node that creates an output table, such as a Query node or an Import node. For more information, see "Connecting Nodes" on page 13.

4 Select the Export node to specify options for the output file, including the name and location of the file:

- **File location**: specifies the name and location of the exported file. The file extension determines the format of the exported file.
  - To download the file, click . Depending on your browser settings, the file might open in a viewer.
  - To view the raw data, click .

    Note: This option is not available for Microsoft Excel files.
- **File type** - the values for this option are determined by the file extension.
- **Delimiter**

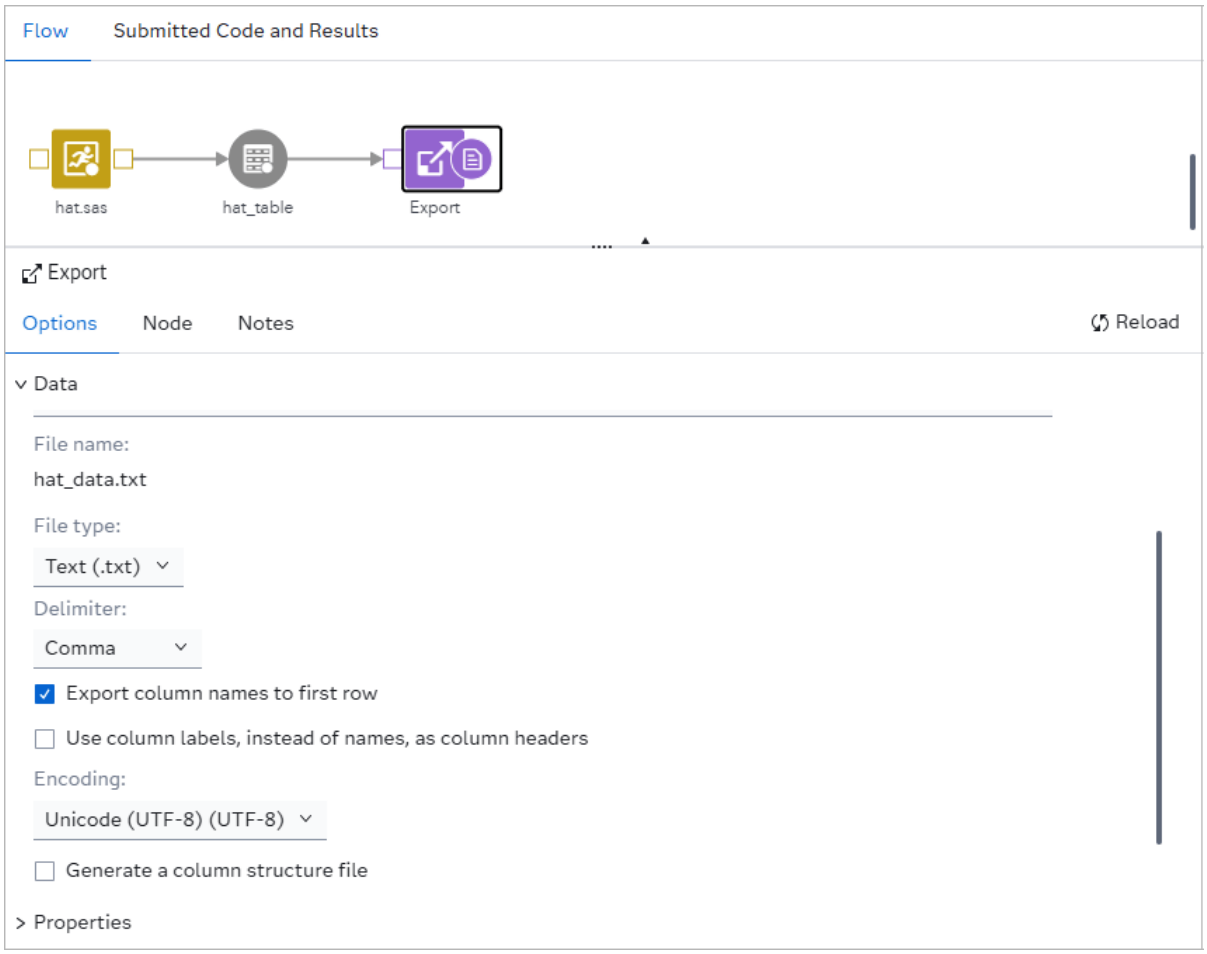
Note: The delimiter can be a single 7-bit character, Tab, '^[@A-Z]', or one of [file://, /0, /a, /b, /t, /v, /f]\\, \0, \a, \b, \t, \v, \f. Multi-byte UTF-8 characters are not valid.

- **Export column names to first row** - adds the column names as the first row of the exported file. This option is not available for fixed-width files.
- **Use column labels, instead of names, as column headers** - uses column labels instead of the column names as the column headers in the exported file. This option is not available for fixed-width files.
- **Encoding**
- **Generate a column structure file** - generates a CSV file that contains the column structure metadata for the exported file. The CSV files is saved in the same location as the exported file.

> **TIP** The column structure metadata file can be used to load the column structure in the Import step. For more information, see "Importing Data from an External File" on page 29.

5 Click **Run**.

The following example shows the **`hat.sas`** SAS Program node that creates an output table in the **`hat_table`** Table node. The **`hat_table`** node is connected to the input port of the Export node and is exported as a text file.

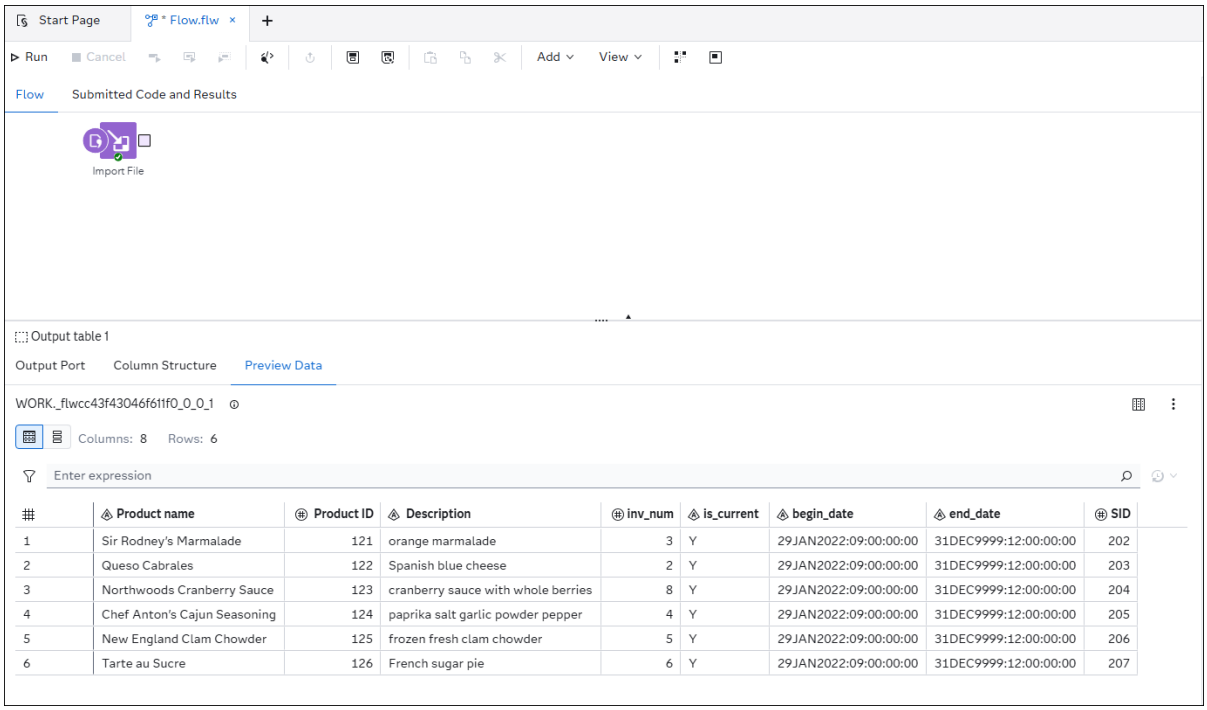


Importing Data from an External File

About the Import Step

The information in external files, such as delimited files and Microsoft Excel spreadsheets, must be converted to a SAS table in order to be queried, filtered, or analyzed by SAS. The Import node enables you to convert the data in external delimited, text, fixed width, and Microsoft Excel files to SAS tables.

The next figure shows a flow that converts the information in a delimited file (GourmetProducts) and writes the result to the output port of the Import node. By default, output for the Import node is written to a table in the Work library.



	Product name	Product ID	Description	inv_num	is_current	begin_date	end_date	SID
1	Sir Rodney's Marmalade	121	orange marmalade	3	Y	29JAN2022:09:00:00:00	31DEC9999:12:00:00:00	202
2	Queso Cabrales	122	Spanish blue cheese	2	Y	29JAN2022:09:00:00:00	31DEC9999:12:00:00:00	203
3	Northwoods Cranberry Sauce	123	cranberry sauce with whole berries	8	Y	29JAN2022:09:00:00:00	31DEC9999:12:00:00:00	204
4	Chef Anton's Cajun Seasoning	124	paprika salt garlic powder pepper	4	Y	29JAN2022:09:00:00:00	31DEC9999:12:00:00:00	205
5	New England Clam Chowder	125	frozen fresh clam chowder	5	Y	29JAN2022:09:00:00:00	31DEC9999:12:00:00:00	206
6	Tarte au Sucre	126	French sugar pie	6	Y	29JAN2022:09:00:00:00	31DEC9999:12:00:00:00	207

Node Connection Requirements

In order to run the Import step in a flow, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ File node	No connection is required. **Note:** Import node output can be connected to any flow node that accepts SAS data as an input, such as a Table node, a Query node, or a SAS Program node. By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Import an External File

1 Drag the file that you want to import on to the flow canvas. A Import File node is added to the flow.

2 Click the Import File node, and then click the **Options** tab. Click **Analyze** to identify the structure of the external file.

   - If you are importing a Microsoft Excel spreadsheet with multiple worksheets, select the worksheets that you want to import. By default, all of the worksheets are selected.
   - If you are importing a fixed-width file, the data is loaded into a single column. Use the Column Structure area to add the other columns to the output table and specify column properties. Use the Start Position and End Position columns to specify where in the data each column starts and ends.

3 Set the import options. These options depend on the type of file that you are trying to import.

   - "Options for Importing a Delimited File" on page 31
   - "Options for Importing an Excel File" on page 32
   - "Options for Importing a Fixed Width File" on page 33

Options for Importing a Delimited File

These options are available when you are importing a delimited file.

- **Delimiter** - specifies the delimiter to use when analyzing the input data.

  Note: The delimiter can be a single 7-bit character, Tab, '^[@A-Z]', or one of [file://, /0, /a, /b, /t, /v, /f]\\, \0, \a, \b, \t, \v, \f. Multi-byte UTF-8 characters are not valid.

- **Specify the row that contains column names** - specify the row that contains the column names.
- **Specify the range of rows** - specifies the rows of data to import
- **Scan rows for analysis** - specifies the number of rows to scan in order to determine column data types and lengths. A smaller value causes the import to complete quickly, but you increase the possibility of obtaining a value that is too small to accommodate character columns. Larger values reduce the possibility of truncating character columns, but they increase processing time.

Click **More import options** to set these options:

- **Line delimiter** - specifies the delimiter for the end of the line.
- **Treat two consecutive delimiters as a single delimiter** - specifies that two consecutive delimiters should be treated as a single delimiter. If you do not select this option, the consecutive delimiters are treated as a missing value.
- Select the option that you want to use for rows that have more columns than values:
  - **Set the remaining column values to missing (MISSOVER)** - specifies that columns without any values are treated as missing values.

- **Read the next file record to get the column values (FLOWOVER)** - reads the next row of data when there are columns in the previous row without values.
- **Rename column names to comply with the SAS V7 variable policy** - updates column names to comply with SAS variable name rules.
  - The name can begin with or contain any characters, including blanks, national characters, special characters, and multi-byte characters.
  - The name can be up to 32 bytes in length.
  - The name cannot contain any null bytes.
  - Leading blanks are preserved, but trailing blanks are ignored.
  - The name must contain at least one character. A name with all blanks is not permitted.
  - The name can contain mixed-case letters. SAS stores and writes the variable name in the same case that is used in the first reference to the variable. However, when SAS processes a variable name, SAS internally converts it to uppercase. Therefore, you cannot use the same variable name with a different combination of uppercase and lowercase letters to represent different variables. For example, cat, Cat, and CAT all represent the same variable.
- **Encoding** specifies the encoding to use when reading the file.

  Whether data from another locale imports correctly depends on whether the SAS server supports the locale of the data that is being imported. If you are importing data that contains characters that are different from the current locale, use a Unicode (UTF–8) server to import your data. If you do not use a UTF–8 server and the locale of the data is not supported, unsupported values might appear as questions marks (?) in your imported data. For more information about how to set the **Default text encoding** option, see "Specifying General Settings" in *SAS Data and AI Studio: User's Guide*.

Options for Importing an Excel File

- **First row contains column names** - specifies whether the first row in the worksheet contains column names.
- **Limit the range of columns and rows** - enables you to specify a range of cells to import from the Microsoft Excel file.

Click **More import options** to set these options:

- **Rename column names to comply with the SAS V7 variable policy** - updates column names to comply with SAS variable name rules.
  - The name can begin with or contain any characters, including blanks, national characters, special characters, and multi-byte characters.
  - The name can be up to 32 bytes in length.
  - The name cannot contain any null bytes.

- Leading blanks are preserved, but trailing blanks are ignored.
- The name must contain at least one character. A name with all blanks is not permitted.
- The name can contain mixed-case letters. SAS stores and writes the variable name in the same case that is used in the first reference to the variable. However, when SAS processes a variable name, SAS internally converts it to uppercase. Therefore, you cannot use the same variable name with a different combination of uppercase and lowercase letters to represent different variables. For example, cat, Cat, and CAT all represent the same variable.

- **Encoding** specifies the encoding to use when reading the file.

  Whether data from another locale imports correctly depends on whether the SAS server supports the locale of the data that is being imported. If you are importing data that contains characters that are different from the current locale, use a Unicode (UTF–8) server to import your data. If you do not use a UTF–8 server and the locale of the data is not supported, unsupported values might appear as questions marks (?) in your imported data. For more information about how to set the **Default text encoding** option, see "Specifying General Settings" in *SAS Data and AI Studio: User's Guide*.

Options for Importing a Fixed Width File

These options are available when you are importing a fixed width file.

- **Specify the row that contains column names** - specify the row that contains the column names.
- **Specify the range of rows** - specifies the rows of data to import
- **Scan rows for analysis** - specifies the number of rows to scan in order to determine column data types and lengths. A smaller value causes the import to complete quickly, but you increase the possibility of obtaining a value that is too small to accommodate character columns. Larger values reduce the possibility of truncating character columns, but they increase processing time.

Click **More import options** to set these options:

- **Add spaces to short lines to reach specified record length** - adds spaces to the ends of lines that are shorter than the specified record length.
- Select the option that you want to use for records that have more columns than values:
  - **Read the next file record to get the column values (FLOWOVER)** - reads the next row of data when there are columns in the previous row without values.
  - **Rename column names to comply with the SAS V7 variable policy** - updates column names to comply with SAS variable name rules.
    - The name can begin with or contain any characters, including blanks, national characters, special characters, and multi-byte characters.

- The name can be up to 32 bytes in length.
- The name cannot contain any null bytes.
- Leading blanks are preserved, but trailing blanks are ignored.
- The name must contain at least one character. A name with all blanks is not permitted.
- The name can contain mixed-case letters. SAS stores and writes the variable name in the same case that is used in the first reference to the variable. However, when SAS processes a variable name, SAS internally converts it to uppercase. Therefore, you cannot use the same variable name with a different combination of uppercase and lowercase letters to represent different variables. For example, cat, Cat, and CAT all represent the same variable.

□ **Encoding** specifies the encoding to use when reading the file.

Whether data from another locale imports correctly depends on whether the SAS server supports the locale of the data that is being imported. If you are importing data that contains characters that are different from the current locale, use a Unicode (UTF-8) server to import your data. If you do not use a UTF-8 server and the locale of the data is not supported, unsupported values might appear as questions marks (?) in your imported data. For more information about how to set the **Default text encoding** option, see "Specifying General Settings" in *SAS Data and AI Studio: User's Guide*.

Adding a Table from a SAS Library to a Flow

You can use Table nodes to add SAS tables to your flow. Table nodes enable you to specify the library and table name of a table in the flow and can be used to connect to the input and output ports of operational nodes.

If you have Read access to a table in a SAS library, you can specify the table in a Table node. You can use the Table node as the input for an operational node in the flow, such as a Query node or a SAS Program node.

If you have Write access to a SAS library, you can use a Table node to create or update a table in that library. The table can be an existing table or a table that is created when a flow runs. You can then use the Table node as the output for an operational node in the flow, such as an Import node, a Query node, or a SAS Program node. By default, output ports represent tables in the Work library. To specify a name and location for the data, add a Table node to the flow and connect the node to the output port.

To add a Table node to a flow:

1 Click the **Steps** section of the navigation pane.

2 Expand the **Data** folder and double-click the **Table** step.

> **TIP** You can quickly add a Table node to the flow and connect the node to the output data source of an operational node by right-clicking the output port of the operational node and selecting **Add a table**. The operational nodes include nodes such as Import, Query, and SAS Program. File nodes and Table nodes are not considered operational nodes.

3 In the flow, click the **Table** node and use the **Table Properties** tab to specify a library and table.

4 Use the **Published Columns** tab to edit and add columns. To edit and add columns to the table, click **Edit structure**. To copy the column definitions from an existing input table, click **Sync structure**.

Note: When you click **Sync structure**, you are prompted to replace your existing column structure with the column structure of the table that is specified on the Table Properties tab. Any changes you have made to the column structure are overwritten.

To add an existing table to a flow:

- From the **Libraries** section of the navigation pane, drag one or more tables to the flow canvas. A Table node is automatically created for each table.

3

Working with Parameters

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Why Use Parameters?

IMPORTANT You must license SAS Data and AI Studio Advanced to create or edit parameters. Parameters are processed when you run the flow.

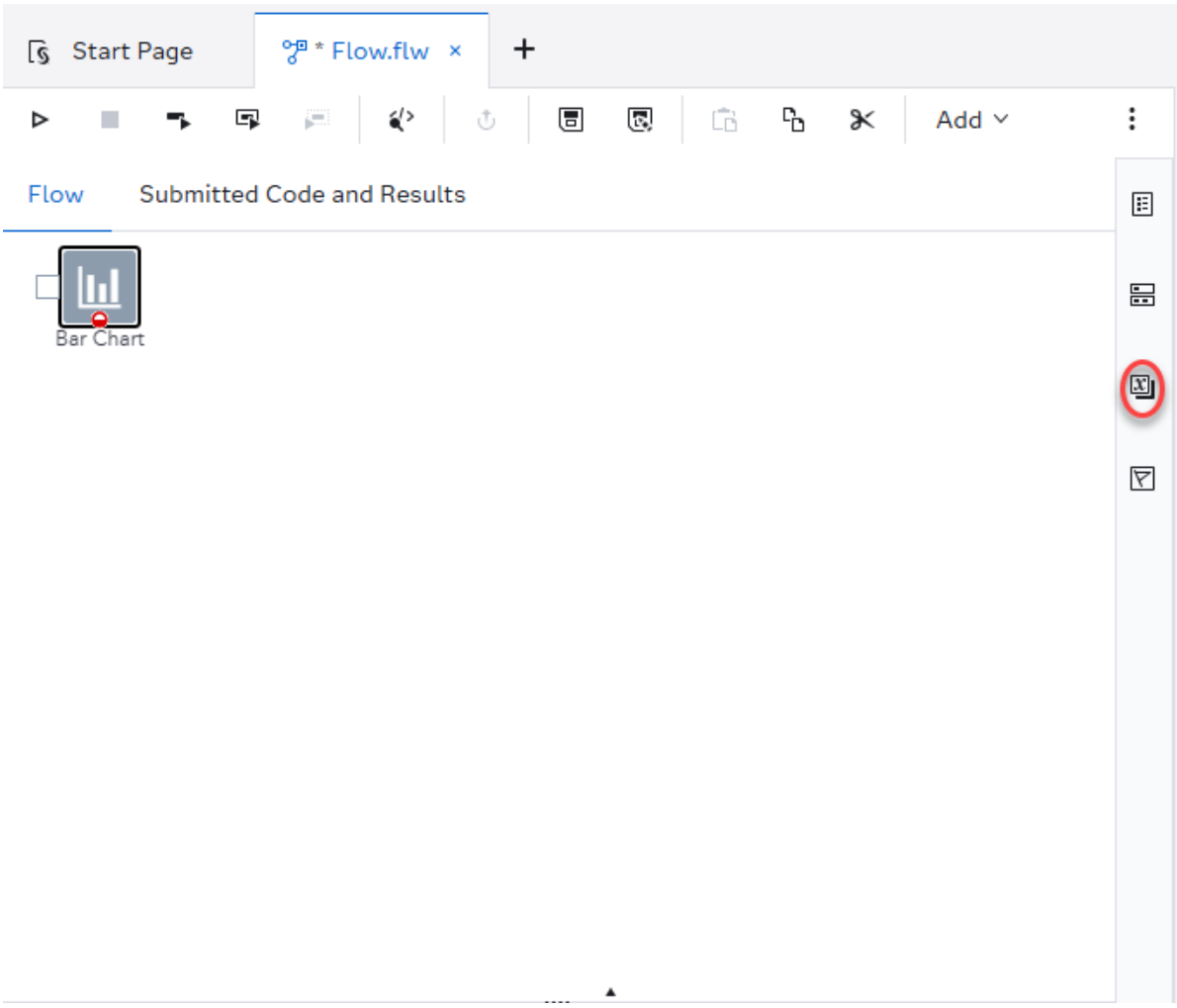
Parameters enable you to request input from the user when code is run. Including parameters in your code increases your ability to reuse code and also enables the code to be customized using the value that you enter for the prompt. You can define parameters that require the user to select or enter one or more values when a step, query, or program is run. Parameters can be used to provide the name of a variable in order to run a task or to provide a value for a filter expression in a query or program. When the parameter is run, one or more macro variables are automatically generated for each type of parameter.

Without parameters, the code that you run is static even though the data might change. For example, you could have a static query to determine which products had sales greater than USD 1500 in the 4th quarter of 2025. With parameters, both

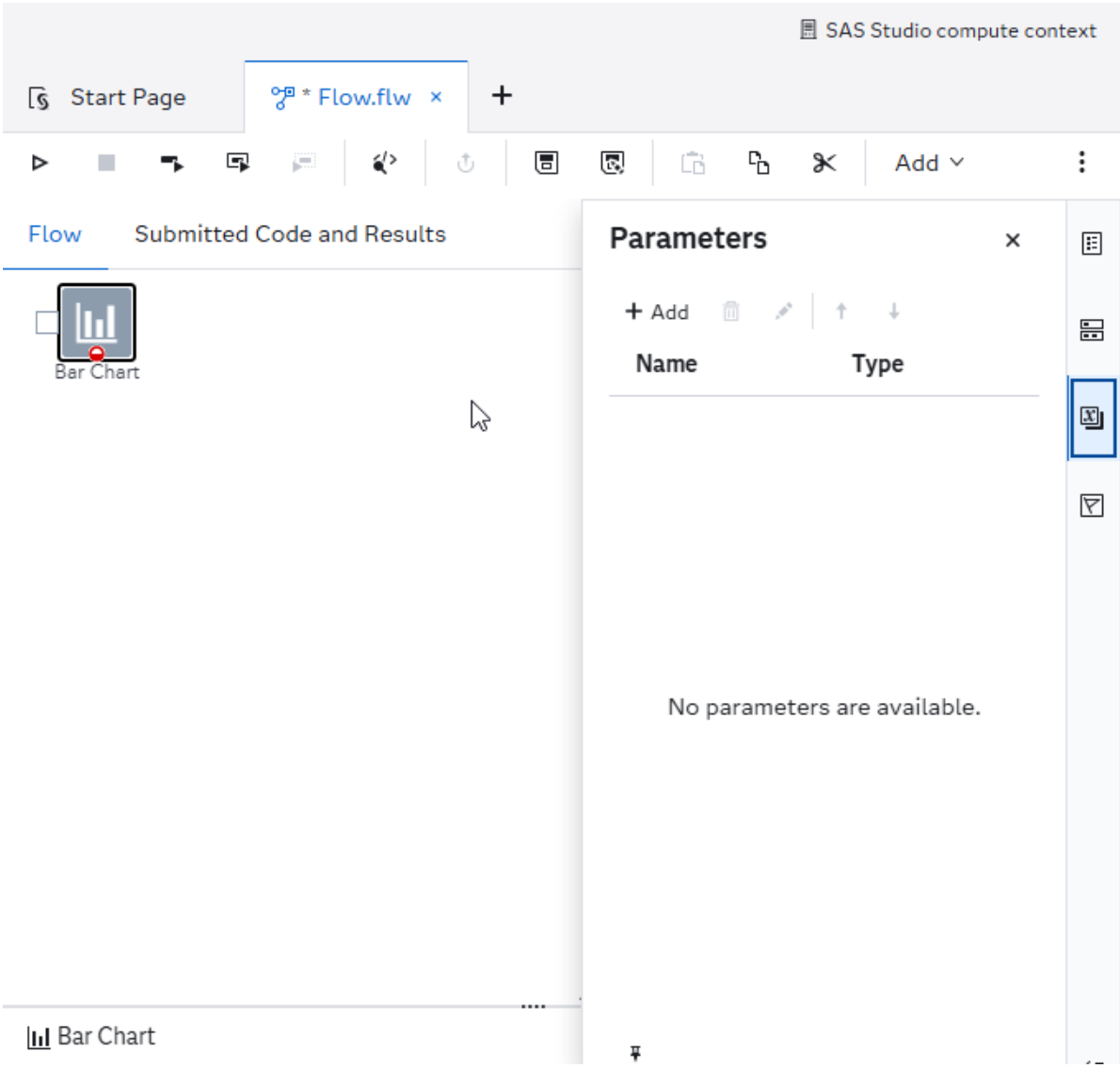
the data and the code can change. For example, you could create a query with parameters to determine which products had sales between *x* and *y* for the *n*th quarter of 2025. The values of *x*, *y*, and *n* are supplied by the user each time the query is run.

About the Parameters Pane

To create a parameter while working in a flow, click .



After you click the parameters icon, the Parameters pane opens.



Creating a Parameter

Specify the General Properties of a Parameter

1 In the **Parameters** pane, click **Add**. The Add Parameter window appears.

2 On the **Parameter** tab, enter a unique name for the parameter in the **Name** box. Names can contain only alphanumeric characters and underscores. Names cannot begin with a number and cannot exceed 32 characters.

3 In the **Description** box, enter the description to be displayed to the user when the parameter runs.

4 Select **Prompt at runtime** to specify that the user is prompted to enter a value for the parameter at run time. By default, the user is prompted at run time.

- (Optional) **Required** specifies whether a value is required for the parameter.
- (Optional) **Make prompt read-only** specifies whether the user can change the value of the prompt.

Creating a Text or Numeric Field

Create a Text Prompt

1 On the **Properties** tab, select **Text or numeric field** from the **Control type** drop-down list.

2 Enter a label for the prompt.

3 For the type of prompt, select **Text**.

4 (Optional) In the **Default value** box, specify the default value for the prompt. You can enter any character value. Blank spaces and nonprintable characters can be used, but the value cannot consist completely of these characters.

Note: If the **Prompt at runtime** option is deselected on the **Parameters** tab, the step uses the default value at run time.

5 To help users know what type of value to enter for the prompt, enter a hint in the **Placeholder text** field.

6 Click **OK**.

Create a Numeric Prompt

1 On the **Properties** tab, select **Text or numeric field** from the **Control type** drop-down list.

2 Enter a label for the prompt.

3 For the type of prompt, select **Numeric**.

4 (Optional) Select **Allow integer values only**.

5 (Optional) In the **Default value** box, specify the default value for the prompt.

Note: If the **Prompt at runtime** option is deselected on the **Parameters** tab, the step uses the default value at run time.

6 Specify the minimum and maximum values allowed for this prompt. By default, the minimum and maximum values are not included in the range of values that the user can specify for the prompt.

7 To help users know what type of value to enter for the prompt, enter a hint in the **Placeholder text** field.

8 Click **OK**.

Create a Validation Prompt

1 On the **Properties** tab, select **Text or numeric field** from the **Control type** drop-down list.

2 Enter a label for the prompt.

3 For the type of prompt, select **Validation**.

4 Enter the regular expression to use to determine whether the pattern of text is for a valid value.

5 Specify the default text that should be displayed when the control first appears.

6 To help users know what type of value to enter for the prompt, enter a hint in the **Placeholder text** field.

7 Click **OK**.

Create a Date and Time Prompt

1 On the **Properties** tab, select **Date and time picker** from the **Control type** drop-down list.

2 Enter a label for the prompt.

3 For the type of prompt, select one of these options:

- **Date**
- **Month**
- **Date and time**

- **Time**

4 (Optional) In the **Default value** box, specify the default value for the prompt.

Note: If the **Prompt at runtime** option is deselected on the **Parameters** tab, the step uses the default value at run time.

5 Specify the minimum and maximum values allowed for this prompt.

6 Click **OK**.

Creating a Drop-Down List

Create a Static Drop-Down List

1 On the **Properties** tab, select **Drop-down list** from the **Control type** drop-down list.

2 Enter a label for the prompt.

3 To create a list with predefined values, select **Static list**.

4 Enter the static values that appear in the drop-down list. You can add these values individually or click **Add Many** to add several values at the same time.

In some cases, you might want to map a value to a label. The value is returned as the value of the macro variable in the flow when the corresponding label is selected from the list control. To map values to the labels that appear in the list control, click . Now you can specify a label for each item in the list control.

5 (Optional) In the **Default item** box, specify the default value for the prompt.

Note: If the **Prompt at runtime** option is deselected on the **Parameters** tab, the step uses the default value at run time.

6 To help users know what type of value to enter for the prompt, enter a hint in the **Placeholder text** field.

7 Click **OK**.

Create a Dynamic Drop-Down List

1. On the **Properties** tab, select **Drop-down list** from the **Control type** drop-down list.
2. Enter a label for the prompt.
3. To create a list that displays the distinct values from a selected column, select **Dynamic list**.
4. Specify the library that contains the table that you want to use.
5. Specify the table name.
6. Specify the column name that contains the values for the list.
7. (Optional) In the **Default item** box, specify the default value for the prompt.

   Note: If the **Prompt at runtime** option is deselected on the **Parameters** tab, the step uses the default value at run time.

8. To help users know what type of value to enter for the prompt, enter a hint in the **Placeholder text** field.
9. Click **OK**.

4

Performing Impact Analysis

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- (Optional) Step 4: Analyze a Column in the Table . . . 55

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About Impact Analysis

Impact analysis helps you identify the potential consequences of making a change to a table or column. You can run an impact analysis on a table and then select columns from the table to analyze as well. You can run two types of impact analysis:

- Forward impact analysis enables you to identify any tables, columns, flows, or steps that are affected by a change to a selected table or column.
- Reverse impact analysis traces the sources that contribute to the content of a selected table or column.

When you run an impact analysis, the report opens in an Impact Analysis tab in the work area. The report includes a list of all saved flows that use or contribute to the selected table. You can expand each flow entry to view the swimlanes, steps, and tables in the flow.

Note: Flows must be saved in a SAS Content folder in order to be included in impact analysis reports.

Impact Analysis: Requirements

These are the requirements to run an impact analysis on a table:

- You can run an impact analysis only on a table in a flow that is saved in a SAS Content folder.
- You must run and save the flow at least once before you run the impact analysis.
- The table that you analyze must be stored in a permanent library; tables in the Work library cannot be used as the subject of an impact analysis.

Impact Analysis for both tables and columns is available for the following steps:

- Branch Rows
- Calculate Columns
- Execute Decisions
- Export
- Filter Rows
- Implement SCD
- Import File
- Insert Rows
- Load Table
- Lookup
- Manage Columns
- Merge Table
- Query
- Sort
- Summary Tables
- Table
- Union Rows

Impact Analysis for only tables, and not for columns, is available for the following steps:

- Clean Data
- Linear Regression
- Match Codes
- Parse Data
- Rank Data

- Split Columns
- Stack Columns
- Transpose Data

Example: Analyzing Tables and a Column in a Flow

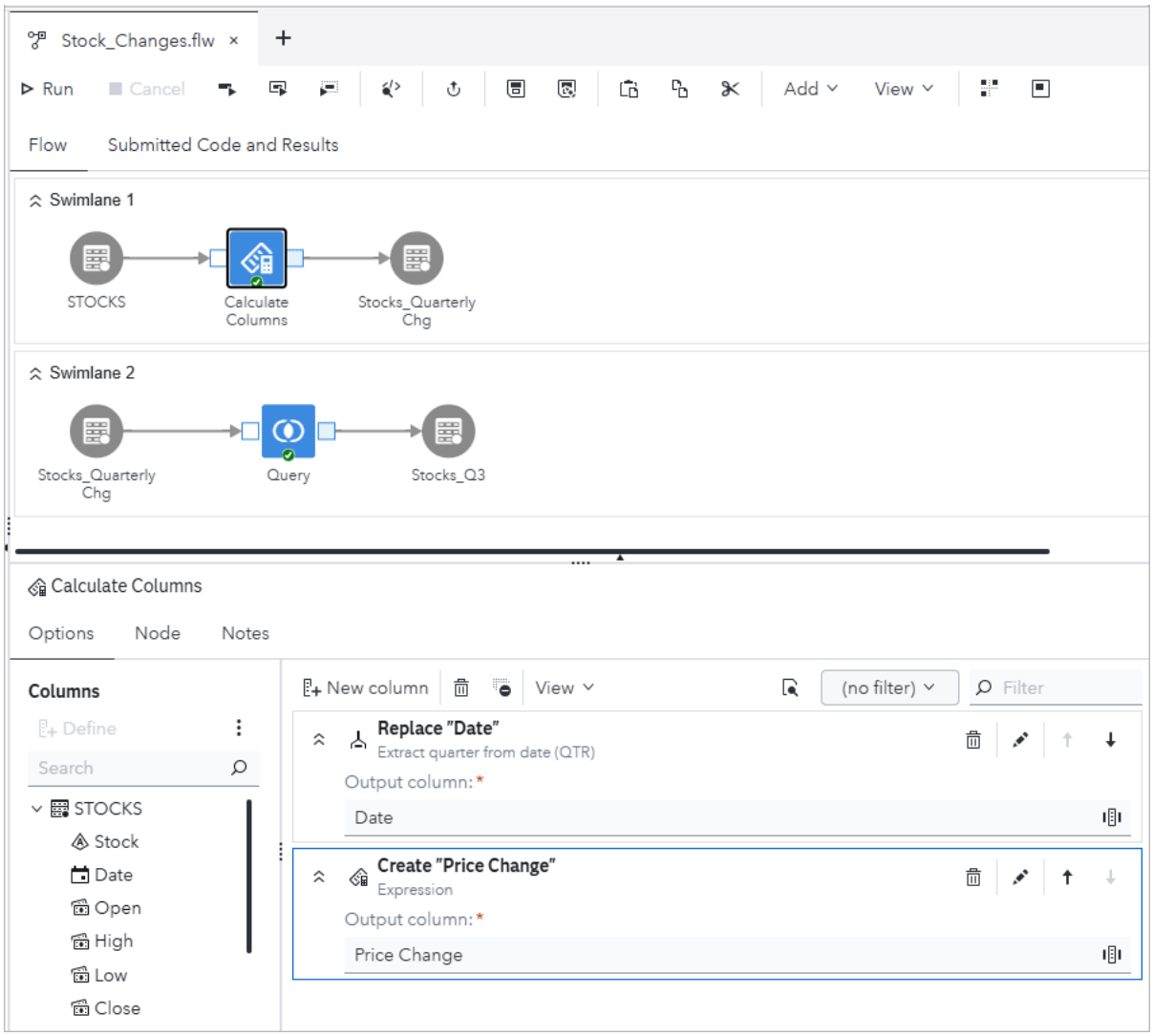
In this example, assume that you have a saved flow that uses the Sashelp.Stocks table to create a new table that includes quarterly stock price changes. The flow also includes a query to create a report of stock price changes in the third quarter. The new output tables are stored in a new library named Analysis. You run three impact analysis reports to analyze two of the tables and the Price Change column:

- Stocks table - the forward analysis displays how the Stocks table is used throughout the flow.
- Stocks_QuarterlyChg table - the forward analysis displays how the Stocks_QuarterlyChg table is used throughout the flow. The reverse analysis displays how the table was created.
- Price Change column - the reverse analysis displays the step and columns that were used to create the column.

Note: For information about the Calculate Columns step that is used in this example, see "Example: Creating a Table Based on the Sashelp.Stocks Data Set" on page 89.

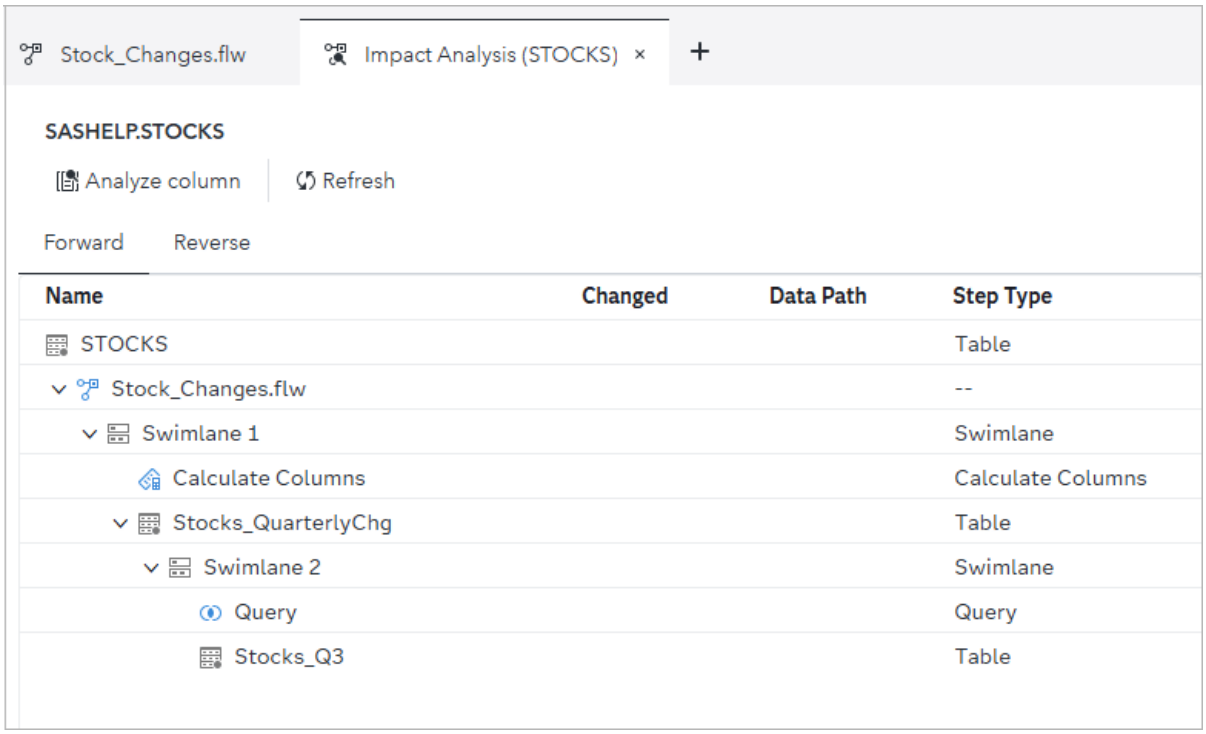
To create this example:

1 Open and run the saved flow.



2 In the **Library Connections** section of the navigation pane, right-click Sashelp.Stocks and select **View impact analysis**.

3 On the **Impact Analysis (STOCKS)** tab, expand all of the items in the report.

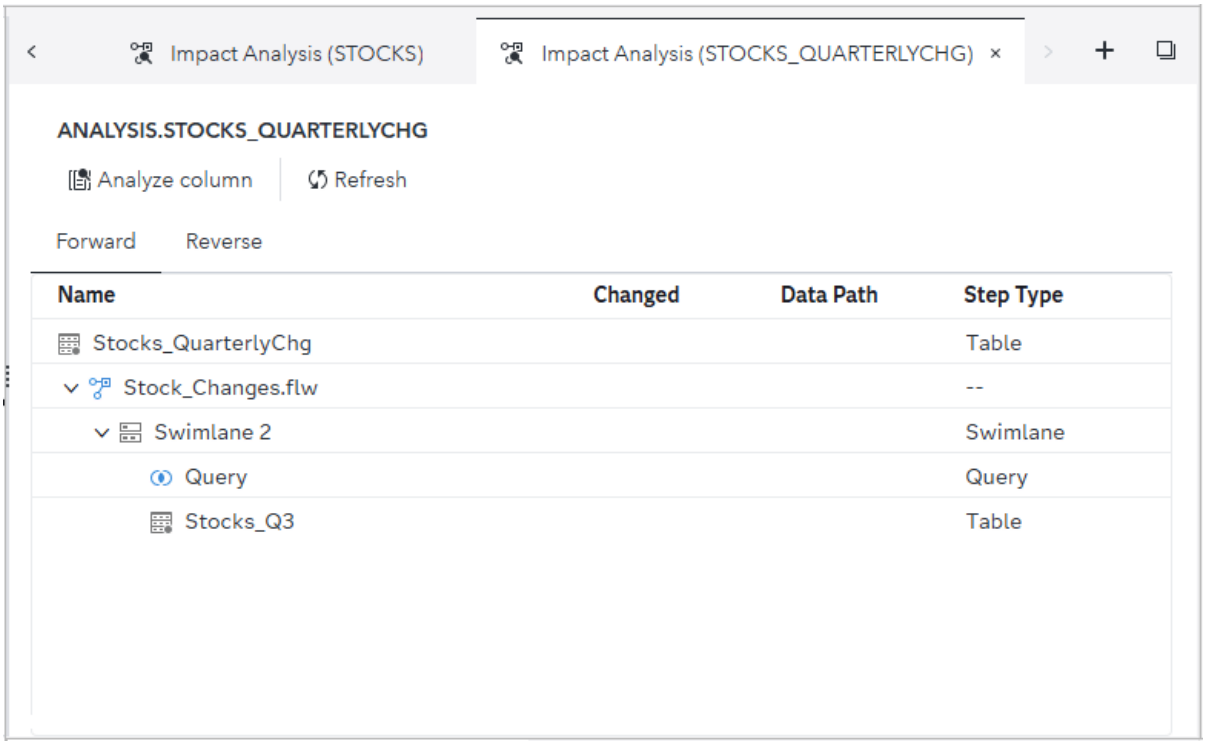


Notice that this report displays all of the downstream processes that are affected by the Stocks table, including the Stock_Changes flow, the two swimlanes in the flow, the Calculate Columns and Query steps, and the Stocks_Q3 table.

Note: If you click the **Reverse** subtab, no report is displayed because there are no flows that created this table.

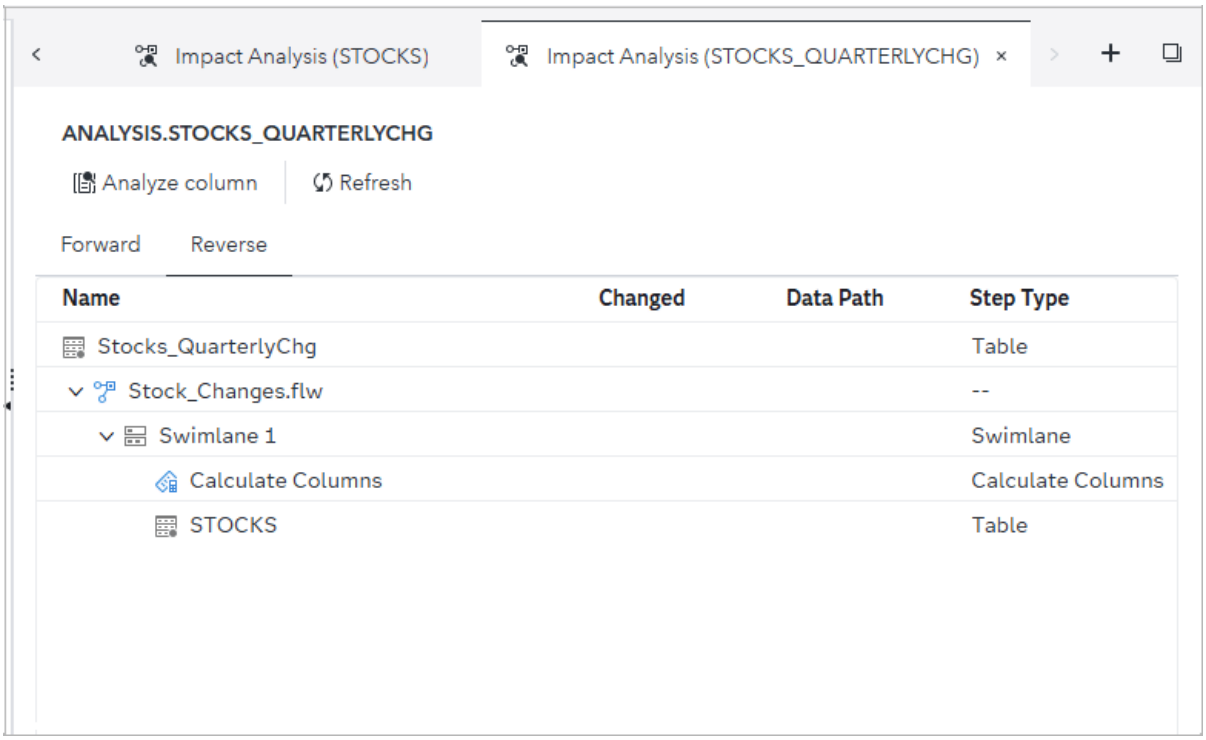
4 In the **Library Connections** section, right-click the Analysis.Stocks_QuarterlyChg table and select **View impact analysis**.

5 On the **Impact Analysis (STOCKS_QUARTERLYCHG)** tab, expand all of the items in the report.



Notice that this report displays all of the downstream processes that are affected by the Stocks_QuarterlyChg table, including the Stock_Changes flow, Swimlane 2, the Query step, and the Stocks_Q3 table.

6 Click the **Reverse** subtab to view the sources that created the Stocks_QuarterlyChg table. Expand all of the items in the report.

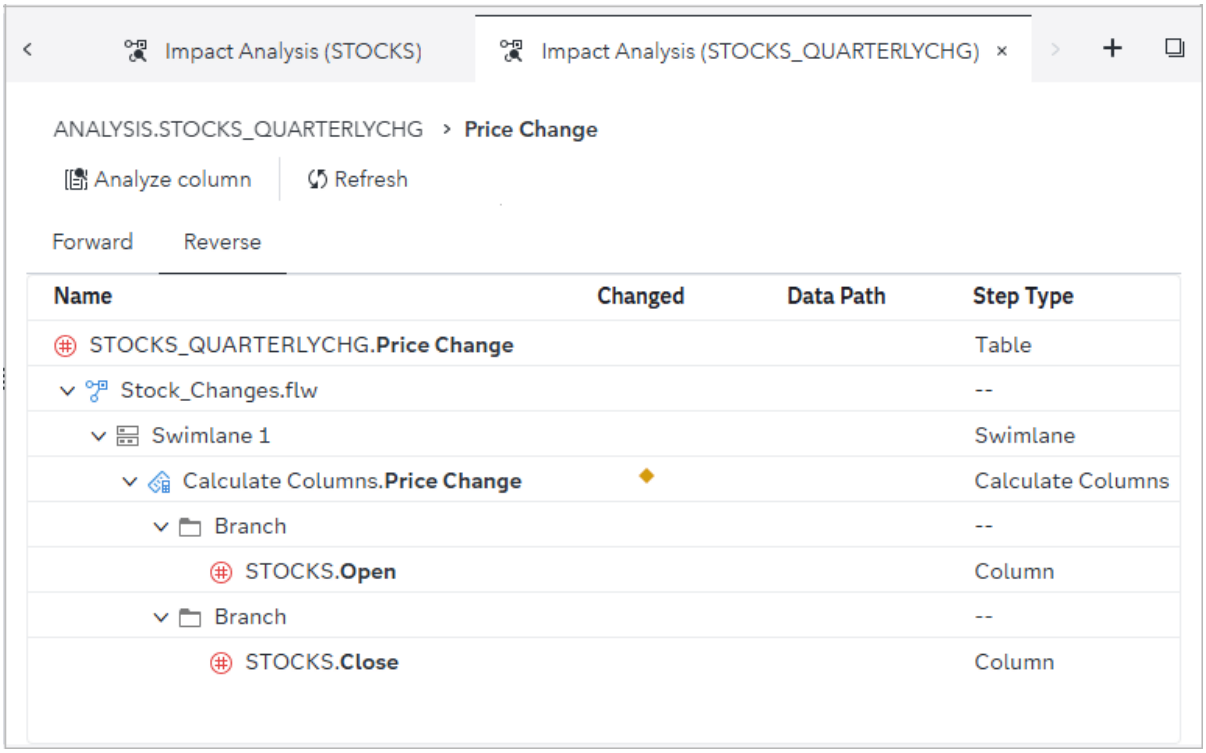


Notice that this report displays all of the upstream processes that created the Stocks_QuarterlyChg table, including the Stock_Changes flow, Swimlane 1, the Calculate Columns step, and the Stocks table.

7 On the **Impact Analysis (STOCKS_QUARTERLYCHG)** tab, click **Analyze column**.

8 Select **`Price Change`** and click **OK**. The column is not used in any downstream processes, so there is no forward impact report.

9 Click **Reverse** to view the upstream processes that created the column, and expand all of the items in the report.



Notice that this report displays all of the upstream processes and data sources that created the **`Price Change`** column, including the Stock_Changes flow, Swimlane 1, the Calculate Columns step, and the Stocks.Open and Stocks.Close columns. The Changed column of the report contains the ◆ icon for Price Change to indicate that Price Change is a new or calculated column.

Impact Analysis: Step-by-Step Instructions

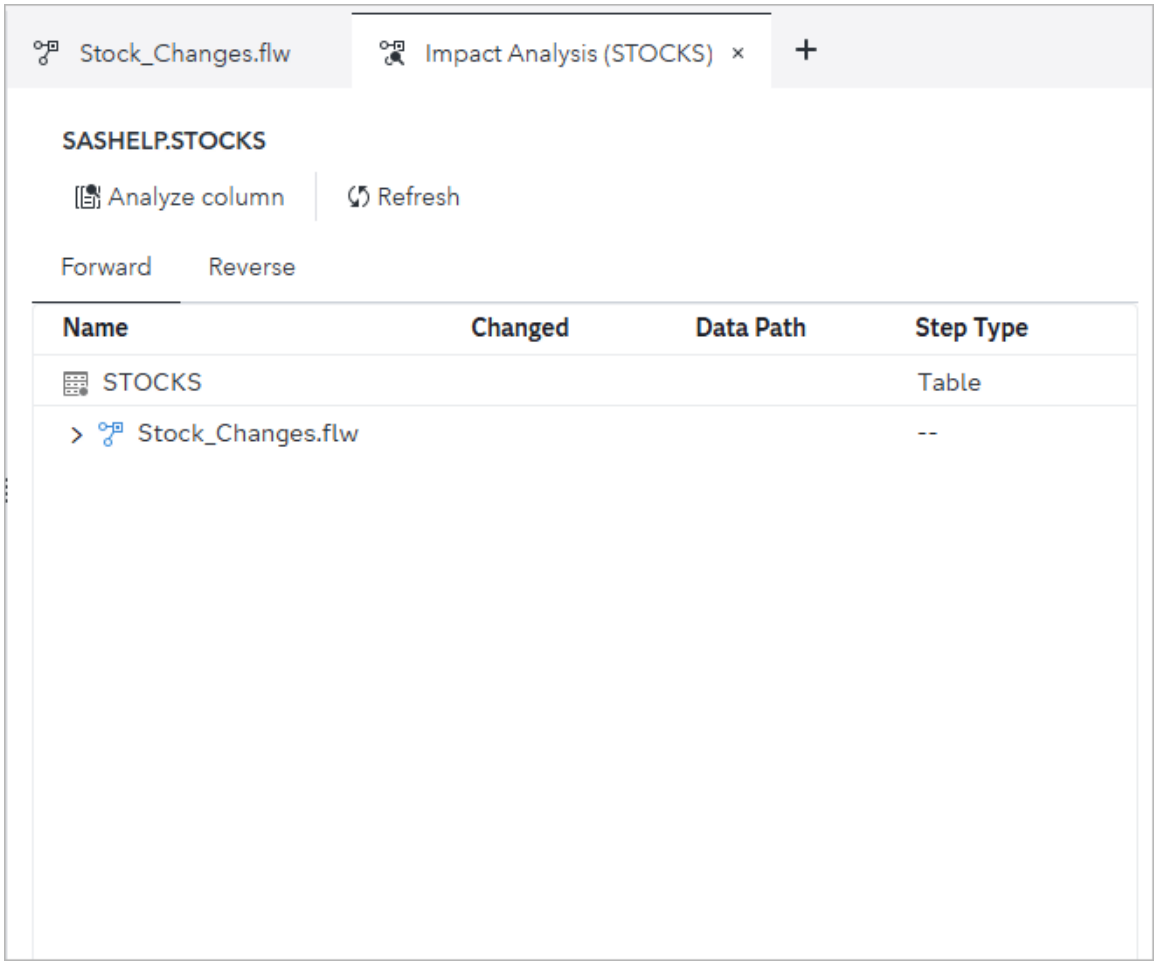
You can run an impact analysis on any table in a permanent library that is used in a flow. The flow must be saved in a SAS Content folder. You can use the impact analysis report for the table to analyze columns in the table.

Step 1: Run the Flow that Contains the Tables that You Want to Analyze

Open and run the flow that contains the tables and columns that you want to analyze. The flow must be saved in a SAS Content folder, and the table must be stored in a permanent library.

Step 2: View the Impact Analysis on a Table

In the **Library Connections** section of the navigation pane, right-click the table that you want to analyze and select **View impact analysis**. An Impact Analysis tab opens in the work area.



Note: You can open multiple Impact Analysis tabs at one time.

Step 3: View the Downstream and Upstream Processes and Tables that are Related to the Table

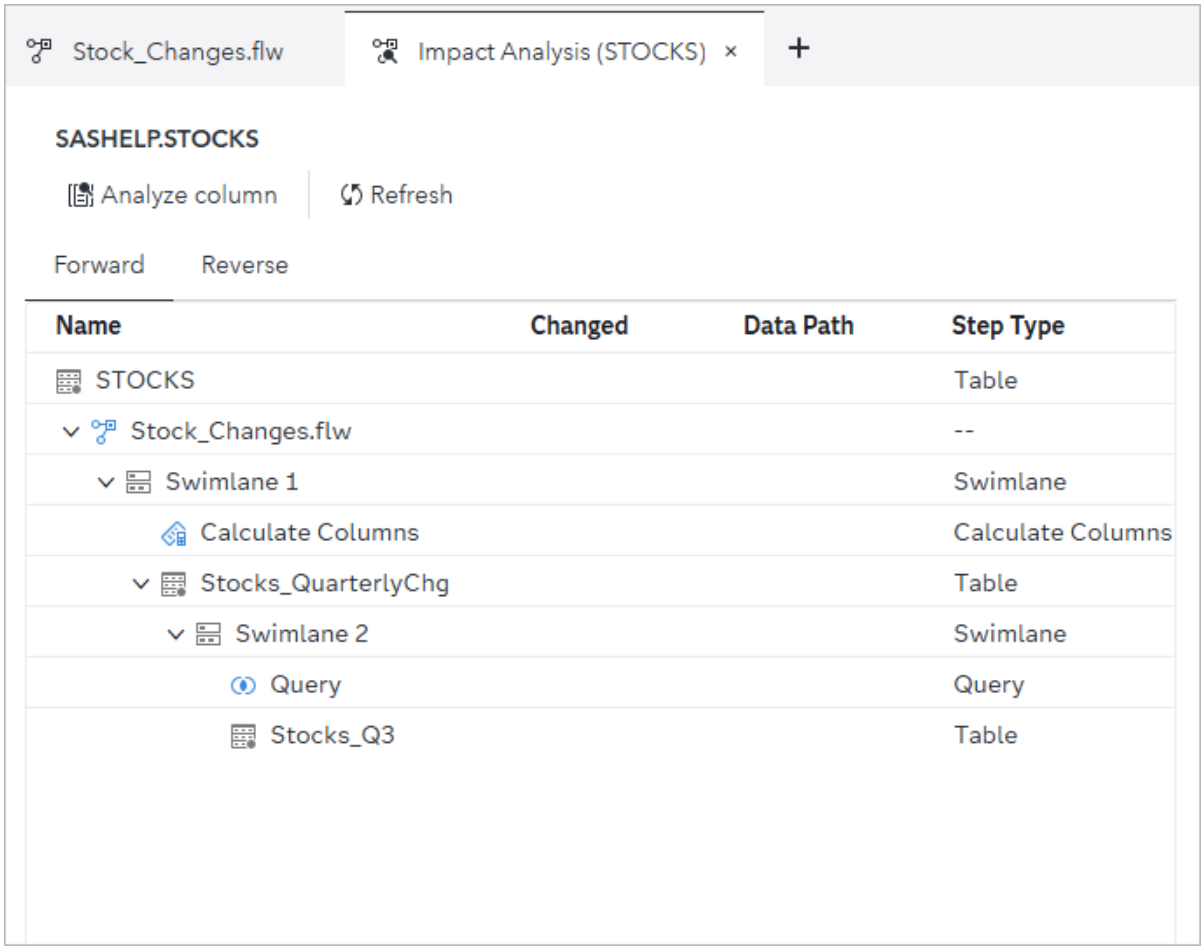
1 To view the downstream processes that are affected by the selected table, click **Forward**, if necessary. The Forward subtab is selected by default.

To view the upstream processes that contribute to the content of the selected table, click **Reverse**.

Any saved flows that include the selected table are listed in the impact analysis report.

2 To view all of the flows, steps, and tables in the report, right-click the flow and select **Expand all groups**.

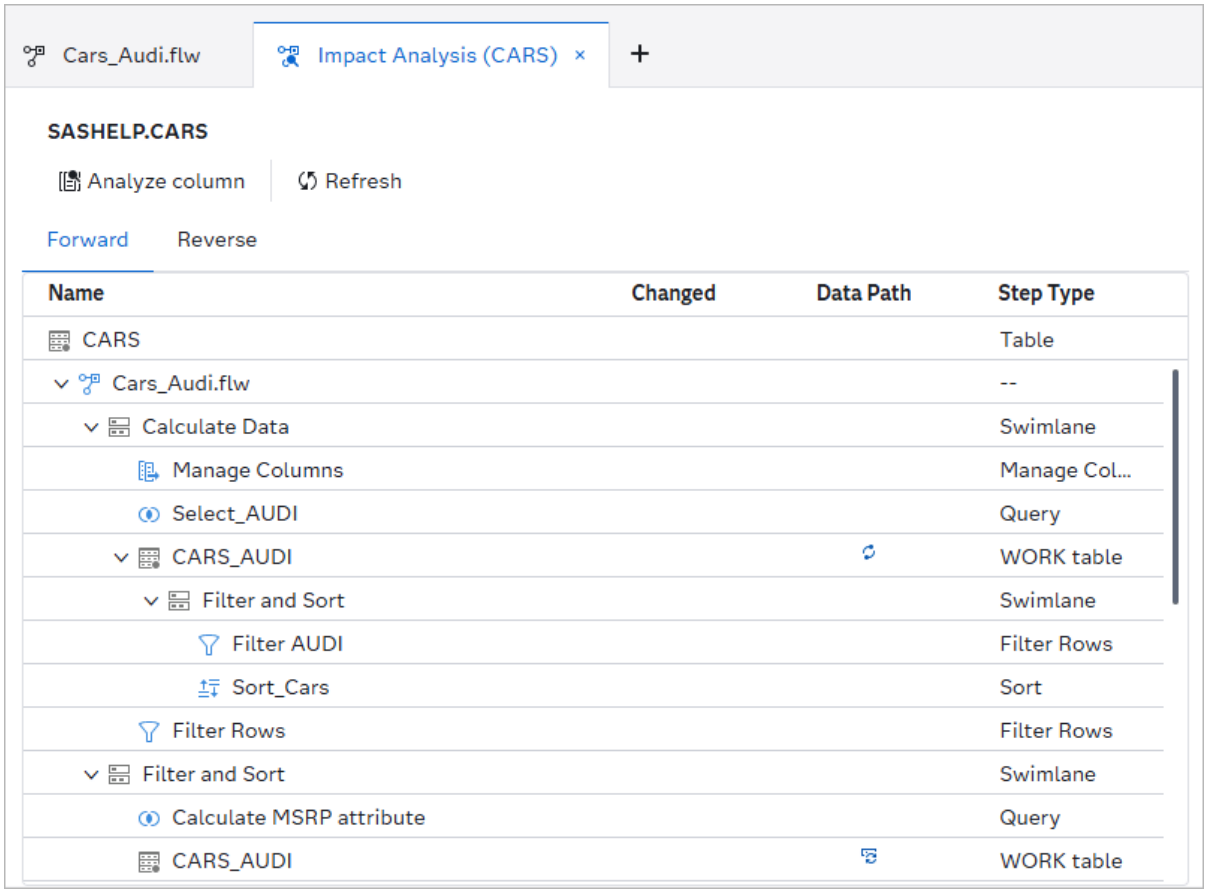
Note: You can double-click any flow or table in the report to open it in a new tab.



3 You can modify the impact analysis report in these ways:

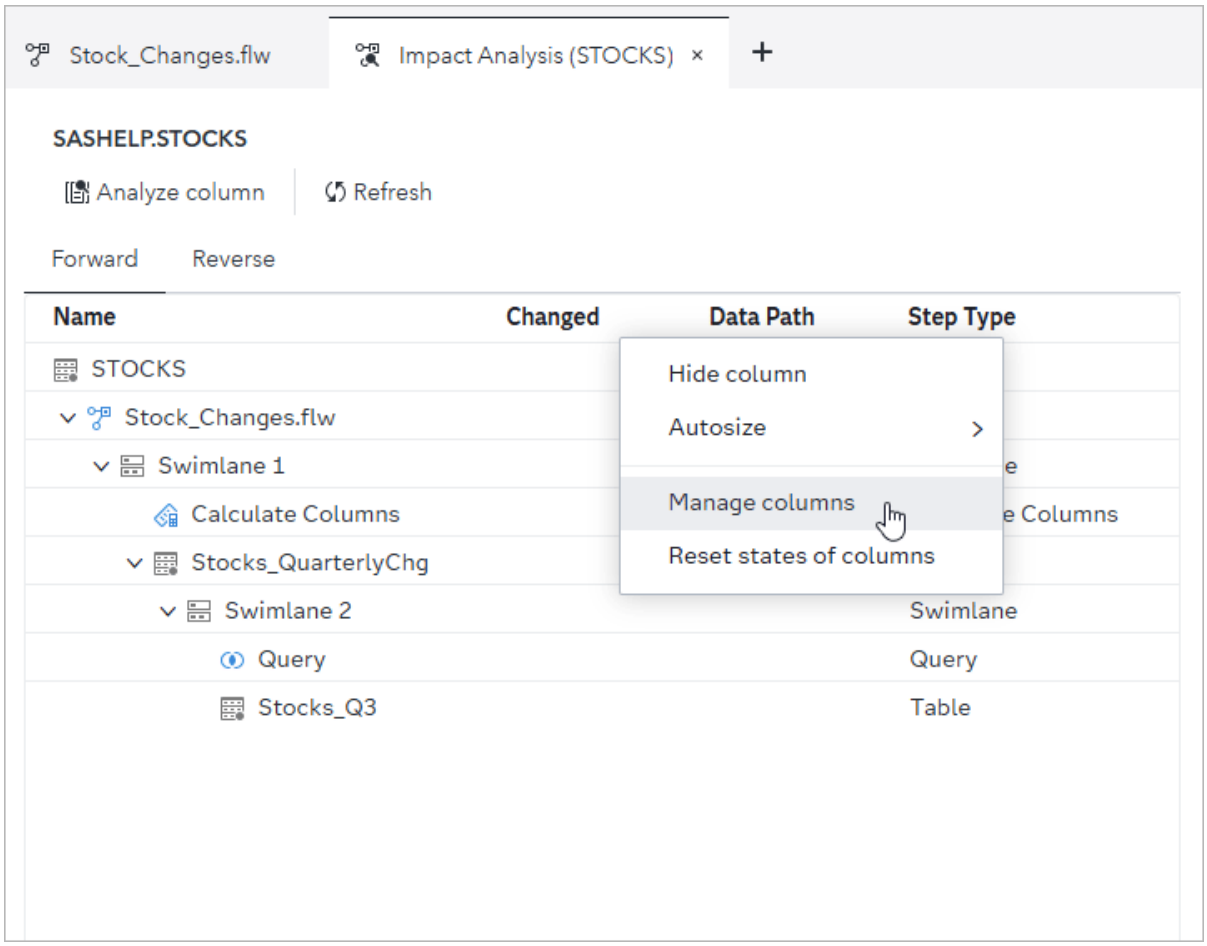
- To change or reorder the columns that are displayed, right-click the column header row of the report and select **Manage columns**. By default, these columns are displayed in the Impact Analysis tree:
  - **Changed** - indicates whether a column has been changed in the step. The Changed column does not apply to tables.
  - **Step Type** - identifies the type of step. All temporary tables that are generated when the flow runs are included in the report and labeled with a step type of `Table`. Temporary tables cannot be used as the subject of an impact analysis.
  - **Data Path** - indicates whether the table appears in the tree multiple times. If the table appears in the tree multiple times, the first occurrence of the table is represented by the icon. The tree displays the full data path of the table. Subsequent occurrences of the table are represented by the icon. The tree displays only the partial data path of the table. To see the full data path of the table, view the first occurrence of the table in the tree.

    In the example below, the first occurrence of the CARS_AUDI table is represented by the icon because the table occurs multiple times in the tree. The full path of the table, including both the Calculate Data and Filter and Sort swimlanes, is displayed in the tree. The second occurrence of CARS_AUDI is represented by the icon, and only the path for the Filter and Sort swimlane is displayed in the tree.



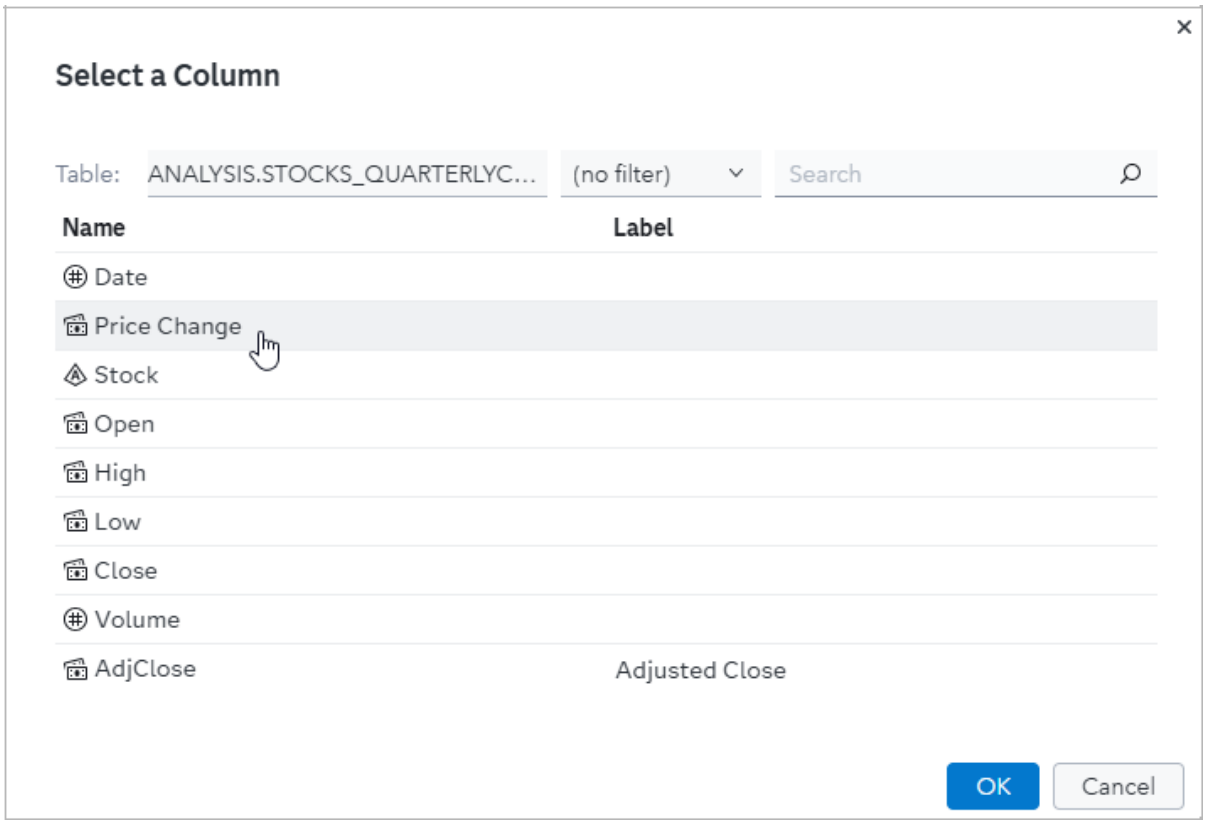
- To change the width of the columns, right-click the column header row of the report and select **Autosize**.

  Note: To reset the columns to their default widths, right-click the column header row of the report and select **Reset states of columns**.



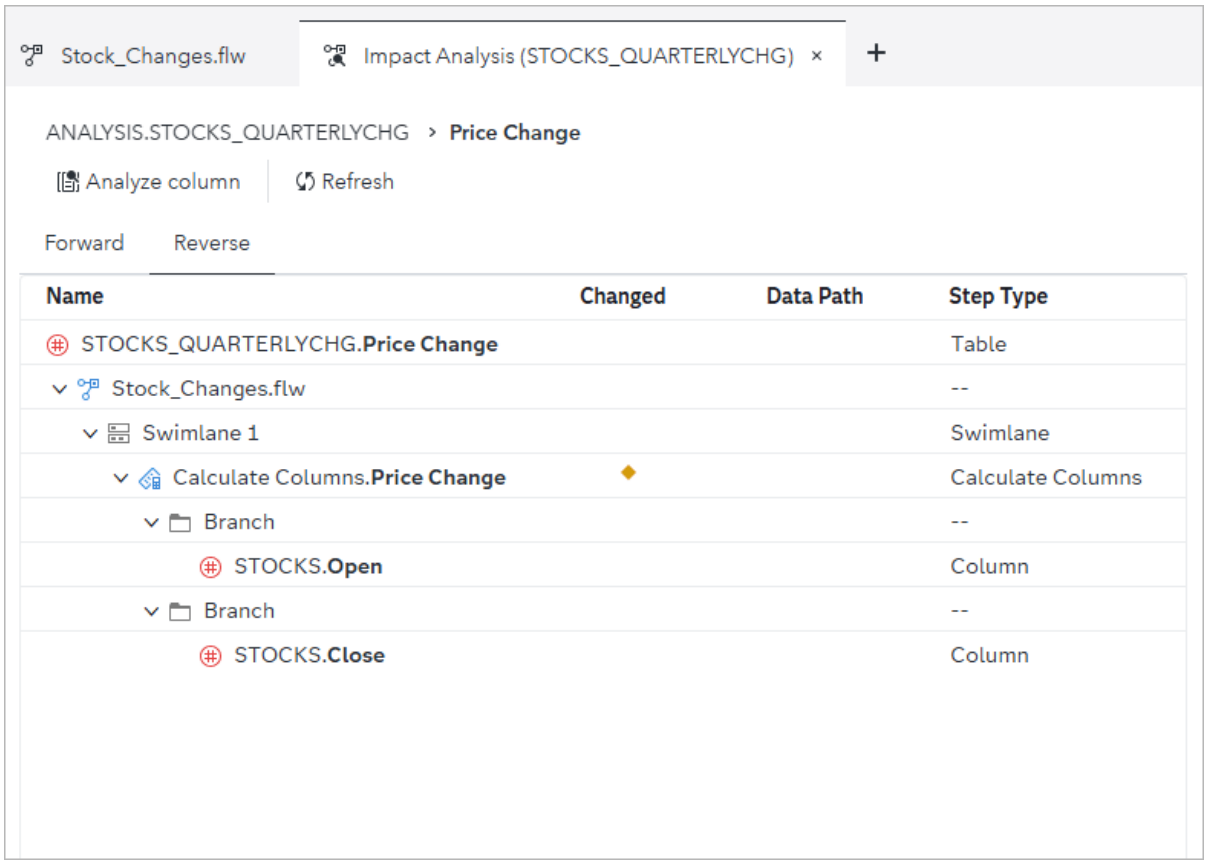
(Optional) Step 4: Analyze a Column in the Table

1 To analyze a column in the table, click **Analyze column** on the Impact Analysis tab.



2 In the Select a Column window, select the column that you want to analyze and click **OK**. The impact analysis report for the column opens in the same tab. For more information, see "Step 3: View the Downstream and Upstream Processes and Tables that are Related to the Table" on page 53.

Note: To return to the impact analysis report for the table, click the table name at the top of the report.



Impact Analysis: Troubleshooting Missing Metadata

If the impact analysis report is missing metadata, your SAS administrator can rerun the Load Metadata job in SAS Environment Manager. For more information, see "Load Metadata Job Times Out" in *SAS Viya Platform: Jobs and Flows*.

5

Creating a Subflow

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About Subflows

You can create a subflow by adding a saved flow to your flow. A subflow can be useful if you have a group of nodes that you want to use in multiple locations. You can also use a subflow to reduce the complexity of a flow.

Note: When you create a subflow, note these reminders:

- You cannot run a flow that contains itself as a subflow.
- Subflows cannot be connected to other nodes in the flow.
- The subflow feature is available only if your site licenses SAS Data and AI Studio Advanced.

Adding a Saved Flow to Another Flow

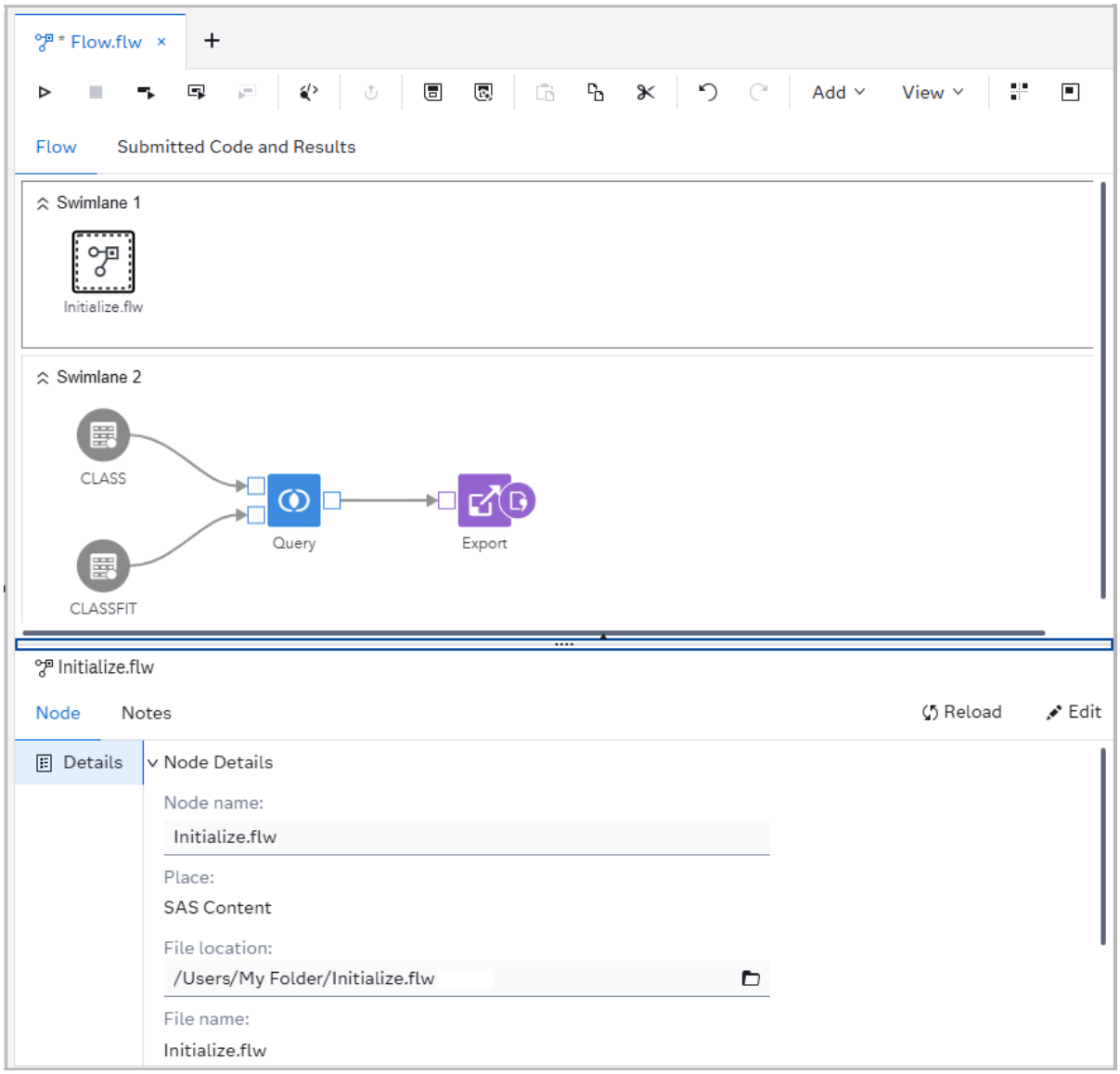
You can add saved flows from a SAS Content folder to another flow by using the **Explorer** section of the navigation pane.

To add a saved flow to another flow:

- From the **Explorer** section of the navigation pane, drag the flow file (*.flw) to the flow canvas. You can also right-click a flow file and select **Add to flow**.

Note: You must have a flow tab active in the work area in order to use the **Add to flow** option. If you do not have an open flow tab, you are prompted to create a flow.

TIP You can use swimlanes to control the order in which the subflow is run in your flow. For more information, see "Controlling the Submission Order of a Flow" on page 1355.



Editing a Subflow

You cannot make changes to a subflow from within another flow.

To edit a subflow:

1 You can open a subflow for editing in these ways:

- Click the subflow node on the flow canvas, and then click **Edit** in the node details.
- Double-click the subflow node on the flow canvas.
- Right-click the subflow node on the flow canvas and select **Open and edit**.

The subflow opens in a separate tab.

2 Edit the flow and save your changes.

Note: If you edit the subflow from within the same SAS Data and AI Studio session, SAS Data and AI Studio automatically refreshes the subflow content in your flow. If the subflow is edited in another SAS Data and AI Studio session, you must click **Refresh** in the node details to update the subflow content in your flow.

Note: You can also edit the subflow by opening it from the **Explorer** section of the navigation pane and saving your changes.

6

Developing Code in a Flow

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SAS Program Step: Writing SAS Code in a Flow

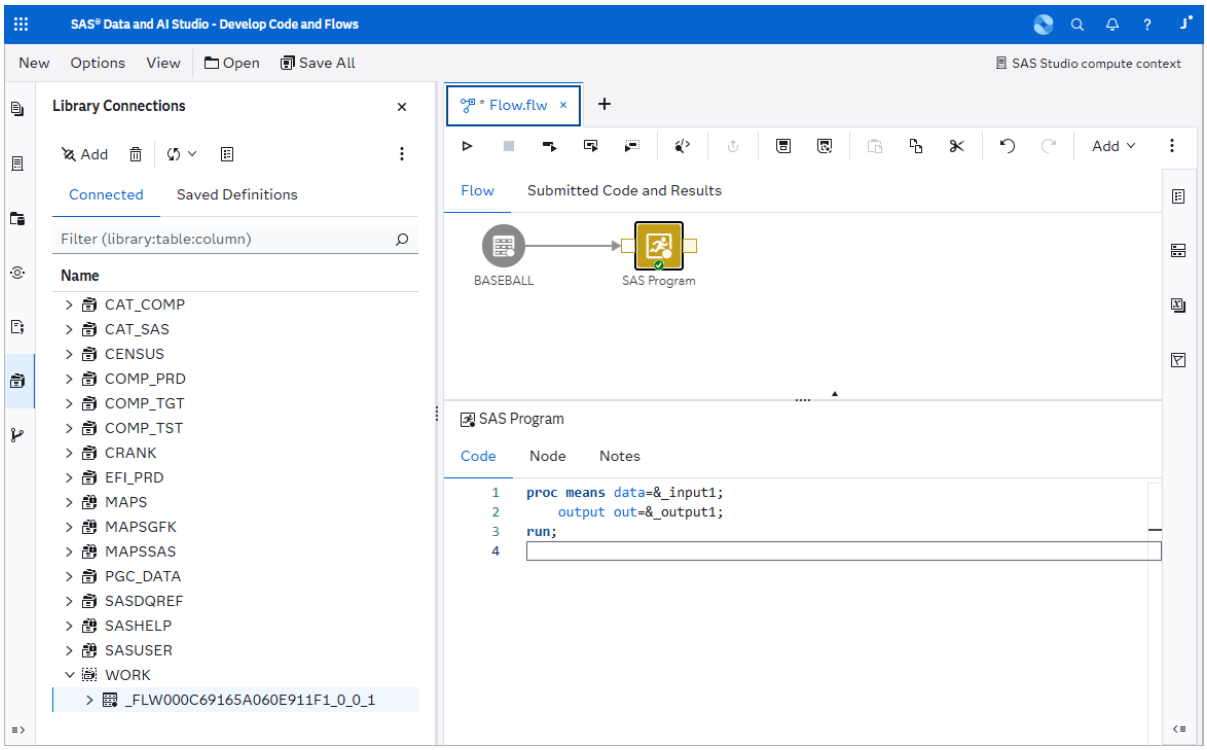
About the SAS Program Step

You can use the SAS Program step to include any type of SAS program that is required in a flow. The code that is associated with the SAS Program node is displayed in the node details on the Code tab. The Code tab includes the same color-coded, syntax-checking editor that you use to write stand-alone SAS

programs. For more information, see "About the SAS Code Editor" in *SAS Data and AI Studio: User's Guide*.

In a SAS Program node, your SAS program can either be embedded in the flow or reference an external program file. Embedded programs can be accessed only from within the flow; externally referenced programs are saved program files. For more information, see "Understanding Embedded and Externally Referenced Programs" on page 69.

By default, output data from a SAS Program node is written to a table in the Work library. The next example shows a flow in which a SAS Program node runs the MEANS procedure against the BASEBALL table. The results are written to a table in the Work library. The table name is automatically generated by SAS Data and AI Studio because the output port is not connected to a Table node. The example uses the **`&_input1`** and **`&_output1`** macro variables to reference the names of the tables that are associated with the input and output ports of the SAS Program node. For more information, see "Using Macro Variables to Reference Input and Output Ports" on page 73.



Node Connection Requirements

No node connections are required to run the SAS Program step. You can connect the SAS Program input and output ports to Table nodes or operational nodes that create an output table, such as a Query node or an Import node, and then use macro variables to reference the tables in your program. For more information, see "Using Macro Variables to Reference Input and Output Ports" on page 73.

Note: By default, any output data is written to temporary tables in the Work library. You can specify the library and name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

SAS Program: Step-by-Step Instructions

The SAS Program step requires no node connections.

1. In the **Steps** section of the navigation pane, expand the **Develop** folder and double-click **SAS Program**.
2. Click the **SAS Program** node, and then use the Code tab to enter your SAS code. The SAS Program node programming interface is the same as the interface for stand-alone SAS programs.
3. You can run the entire program, a region of code, or you can select specific lines of code to run:
   - To run the entire program, right-click the code editor, and select **Run**.
   - To run a region of code, right-click the region of code that you want to run, and select **Run region**. Regions of code are identified in the code editor as blocks of code that can be collapsed and expanded. The **Enable code folding** option must be selected in order to run a region of code. For more information, see "Specifying Code Editor Editing Settings" in *SAS Data and AI Studio: User's Guide*.
   - To run a portion of the program, select the lines of code that you want to run. Right-click the code editor, and select **Run**.

Creating a Flow from a SAS Program

You can convert a SAS program file to a flow. The input tables, procedures, and output tables in the program are used to create nodes in the flow.

Note: You might need to manually edit the flow that is created by the **Convert a Program to Flow** option in these cases:

- The **Convert a Program to Flow** option cannot parse all of the possible LIBNAME options for DBMS engines. If you are creating a flow from a program that contains LIBNAME options for DBMS engines, you need to verify that the LIBNAME statement in the SAS Program node in the flow is correct and that you can access the appropriate library. You might need to manually edit the SAS Program node to add any missing LIBNAME options.

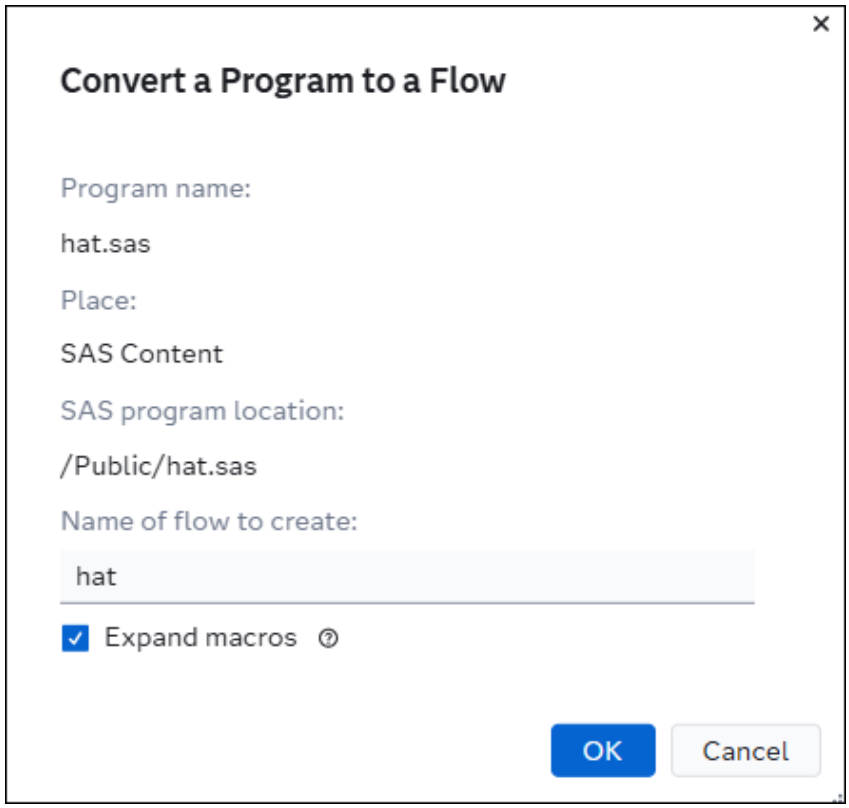
- If you are creating a flow from a program that uses CAS procedures, you might need to manually add input and output ports to the SAS Program nodes and create connections between nodes to ensure that the nodes are run in the correct order.

To create a flow from a SAS program:

1 Right-click the SAS program in the **SAS Server** or **SAS Content** section of the navigation pane and select **Convert program to flow**.

> **TIP** You can also create a flow from an open program by clicking ⋮ on the program toolbar and selecting **More options** ⇨ **Convert program to flow**.

Note: In order to create the flow, SAS Data and AI Studio runs the program.



By default, the new flow is created in the same location as the SAS program file. If a flow file with the same name already exists, the file is overwritten.

2 If your program includes macros and you want to create a separate SAS Program node for each macro, select **Expand macros**. This option is selected by default.

Note: Any programs that are created are embedded in the flow. For more information, see "Understanding Embedded and Externally Referenced Programs" on page 69.

3 Click **OK** to create the flow. The flow opens on a new tab in the work area.

Python Program Step: Writing Python Code in a Flow

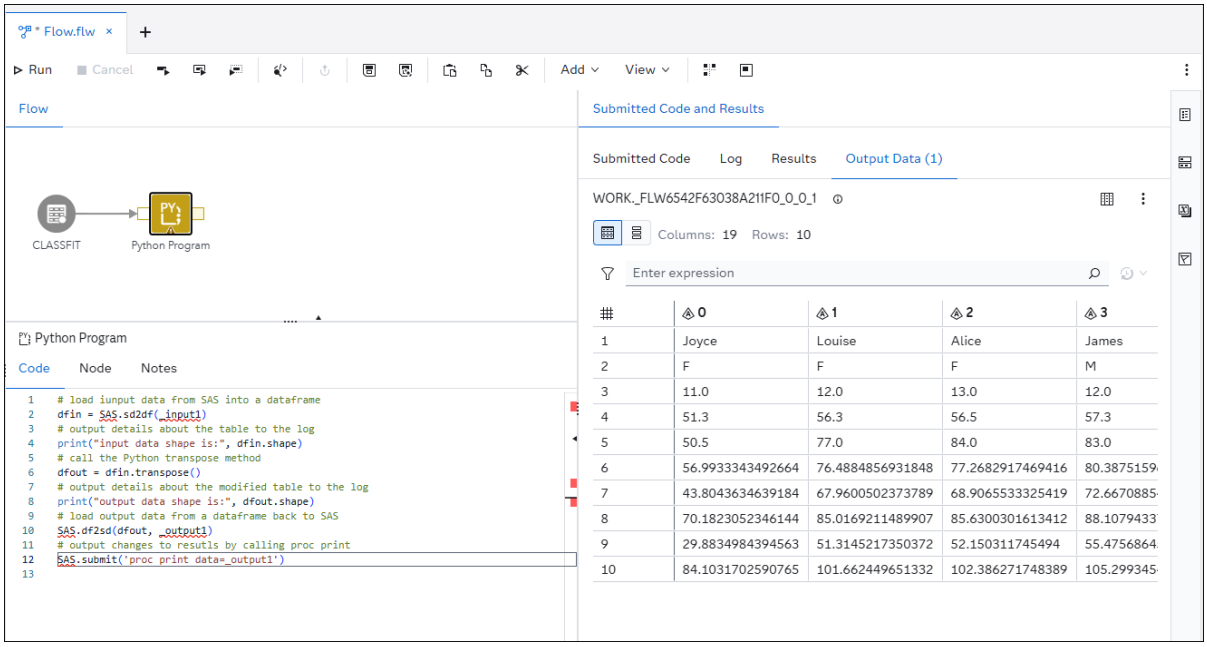
About the Python Program Step

You can use the Python Program step to run Python code in a flow without explicitly using PROC PYTHON. Your PROC PYTHON options are stored in SAS Environment Manager and do not need to be included in your Python program. SAS Data and AI Studio automatically uses your Python code to generate a SAS program by using PROC PYTHON. For more information, see "PYTHON Procedure" in *Base SAS Procedures Guide*.

The code that is associated with the Python Program node is displayed in the node details on the Code tab. The Code tab includes the same color-coded, syntax-checking editor that you use to write stand-alone Python programs. For more information, see "About the Python Code Editor" in *SAS Data and AI Studio: User's Guide*.

In a Python Program node, your Python program can either be embedded in the flow or reference an external program file. Embedded programs can be accessed only from within the flow; externally referenced programs are saved program files. For more information, see "Understanding Embedded and Externally Referenced Programs" on page 69.

The next example shows a flow in which a Python Program node transposes the rows and columns of the CLASSFIT table and writes the output data to the Work library. The table name is automatically generated by SAS Data and AI Studio because the output port is not connected to a Table node. The example uses the `_input1` and `_output1` Python variables to reference the names of the tables that are associated with the input and output ports of the Python Program node. For more information, see "Using Macro Variables to Reference Input and Output Ports" on page 73.



	0	1	2	3
1	Joyce	Louise	Alice	James
2	F	F	F	M
3	11.0	12.0	13.0	12.0
4	51.3	56.3	56.5	57.3
5	50.5	77.0	84.0	83.0
6	56.9933343492664	76.4884856931848	77.2682917469416	80.3875159
7	43.8043634639184	67.9600502373789	68.9065533325419	72.6670885
8	70.1823052346144	85.0169211489907	85.6300301613412	88.1079433
9	29.8834984394563	51.3145217350372	52.150311745494	55.4756864
10	84.1031702590765	101.662449651332	102.386271748389	105.299345

Node Connection Requirements

No node connections are required to run the Python Program step. You can connect the Python Program input and output ports to Table nodes or operational nodes that create output tables, such as a Query node or an Import node, and then use macro variables to reference the tables in your program. For more information, see “Using Macro Variables to Reference Input and Output Ports” on page 73.

Note: By default, any output data is written to temporary tables in the Work library. You can specify the library and name of the output table by connecting the output port to a Table node. For more information, see “Adding a Table from a SAS Library to a Flow” on page 34.

Python Program: Step-by-Step Instructions

The Python Program step requires no node connections.

1 In the **Steps** section of the navigation pane, expand the **Develop** folder and double-click **Python Program**.

2 Click the **Python Program** node, and then use the Code tab to enter your Python code. The Python Program node programming interface is the same as the interface for stand-alone Python programs.

3 You can run the entire program, or you can select specific lines of code to run:

- To run the entire program, right-click the code editor, and select **Run**.
- To run a portion of the program, select the lines of code that you want to run. Right-click the code editor, and select **Run**.

Understanding Embedded and Externally Referenced Programs

About Embedded and Externally Referenced Programs

The programs that are associated with SAS or Python Program nodes can either be embedded in the flow or externally referenced. Embedded programs are stored in the flow. You can access and edit an embedded program only from within the flow. When you create a program in your flow, the program is embedded until you save it as a file.

An externally referenced program is saved in an external location such as a SAS Content or SAS server folder. When you add an existing program to a flow, the path name of the program is stored in the program node. When you run an externally referenced program node, SAS Data and AI Studio runs the external program file. You cannot make changes to an externally referenced program from within a flow. You must edit the program outside of the flow. For more information, see "Editing an Externally Referenced Program" on page 71.

> **TIP** If you need to use a program in multiple flows, consider saving the program and adding it as an externally referenced program to each flow. If you need to make changes to the program later, you can edit the program in one place.

Changing How a Program Is Stored

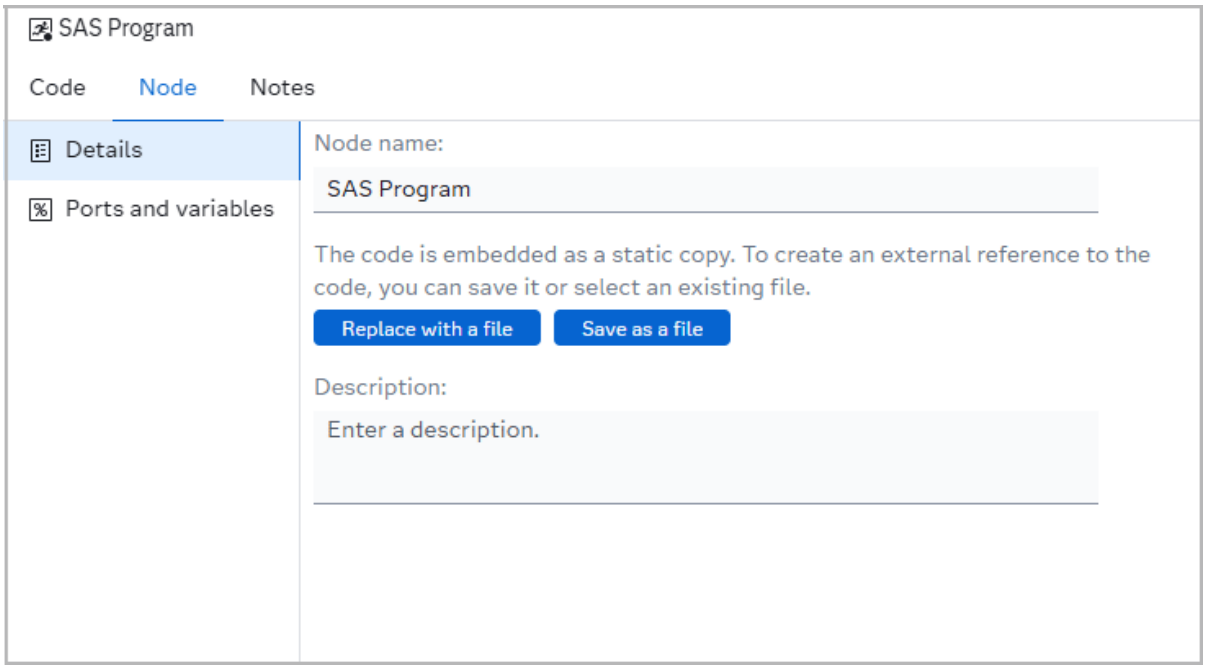
You can change whether a program is embedded in the flow or externally referenced.

To change how a program is stored:

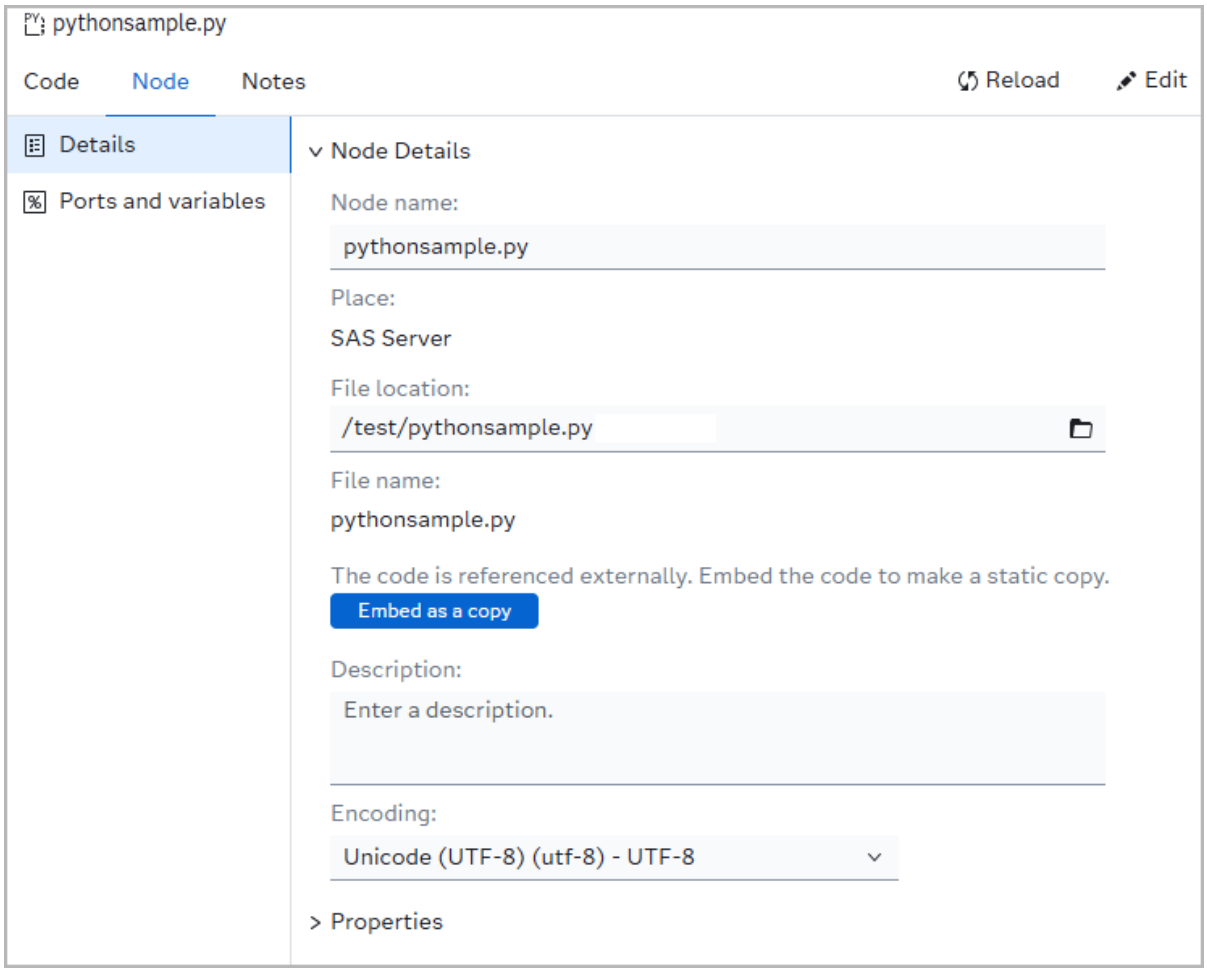
1 Click the SAS Program or Python Program node on the flow canvas, and then click the **Node** tab in the node details.

2 You can use these options on the Node tab of the node details to change how a program is stored:

- **Replace with a file** - replaces an embedded program with a saved program.
- **Save as a file** - saves an embedded program as an external program.



- **Embed as a copy** - saves a copy of an externally referenced program as an embedded program. The program no longer references the external file.



Editing an Externally Referenced Program

You cannot make changes to an externally referenced program from within a flow. To edit an externally referenced program, you must edit the program outside of the flow or embed the program in your flow.

To edit an externally referenced program:

1 Click the program node on the flow canvas, and then click the **Node** tab in the node details.

2 You can use these options to edit the program:

- Click **Edit** on the node details toolbar to open the external program in a new tab. Edit the program and save your changes. If necessary, click **Refresh** on the node details toolbar to update the program in your flow.

  Note: You can also double-click an external program on the flow canvas to open the program in a new tab for editing.

- Click **Embed as a copy** to embed the program in your flow. Edit the program on the Code tab of the node details. The program no longer references the external file.

Importing and Exporting Flows with Referenced Files

There are some important considerations to keep in mind when you import and export flows using SAS Environment Manager or the commmand-line interface (CLI) for the SAS Viya platform. Not all externally referenced files, including SAS programs, Python programs, and data files, are supported when you import and export a flow. For more information, see "SAS Data and AI Studio Flows" in *SAS Viya Platform: Content Migration from SAS Viya 4*.

Adding Existing Programs to a Flow

You can add an existing SAS or Python program to a flow by using the **SAS Server** or **SAS Content** section of the navigation pane.

Note: SAS and Python programs are added to the flow as externally referenced programs. For more information, see "Understanding Embedded and Externally Referenced Programs" on page 69.

To add an existing program to a flow:

- From the **SAS Server** or **SAS Content** section of the navigation pane, drag the SAS or Python program file to the flow canvas. You can also right-click a program and select **Add to flow**.

  Note: You must have a flow tab active in the work area in order to use the **Add to flow** option.

  TIP You can also add snippets to the flow from the **Snippets** section of the navigation pane. Snippets are added to the flow as embedded programs. For more information, see "Understanding Embedded and Externally Referenced Programs" on page 69.

Copying Code to a Flow

You can copy the SAS code that is automatically generated by a task, or you can copy the code from a SAS or Python program to a program node in a flow from which you can make and save changes.

Note: The code in the SAS Program or Python Program node is embedded in the flow and is no longer associated with the original program or step. Editing this code does not affect the original program or step. For more information, see "Understanding Embedded and Externally Referenced Programs" on page 69.

To copy code to a flow:

- Open the program or task from which you want to copy code. On the toolbar, click **Copy to flow** and select the flow to which you want to add a program node.

  Note: The **Copy to flow** option is available only if these conditions are met:

- A flow must be open in the work area.
- If you are copying code from a step, the input data source must be specified.

Using Macro Variables to Reference Input and Output Ports

SAS Data and AI Studio automatically generates SAS macro variables that represent the input and output ports of SAS Program nodes and Python variables for Python Program nodes. You can hard-code data references in your programs, or you can connect data sources to the input and output ports and use the macro variable names in your programs. By using the macro variables, you do not have to update your code if your data sources change. SAS Data and AI Studio also generates macro variables that represent the number of input and output ports on the node.

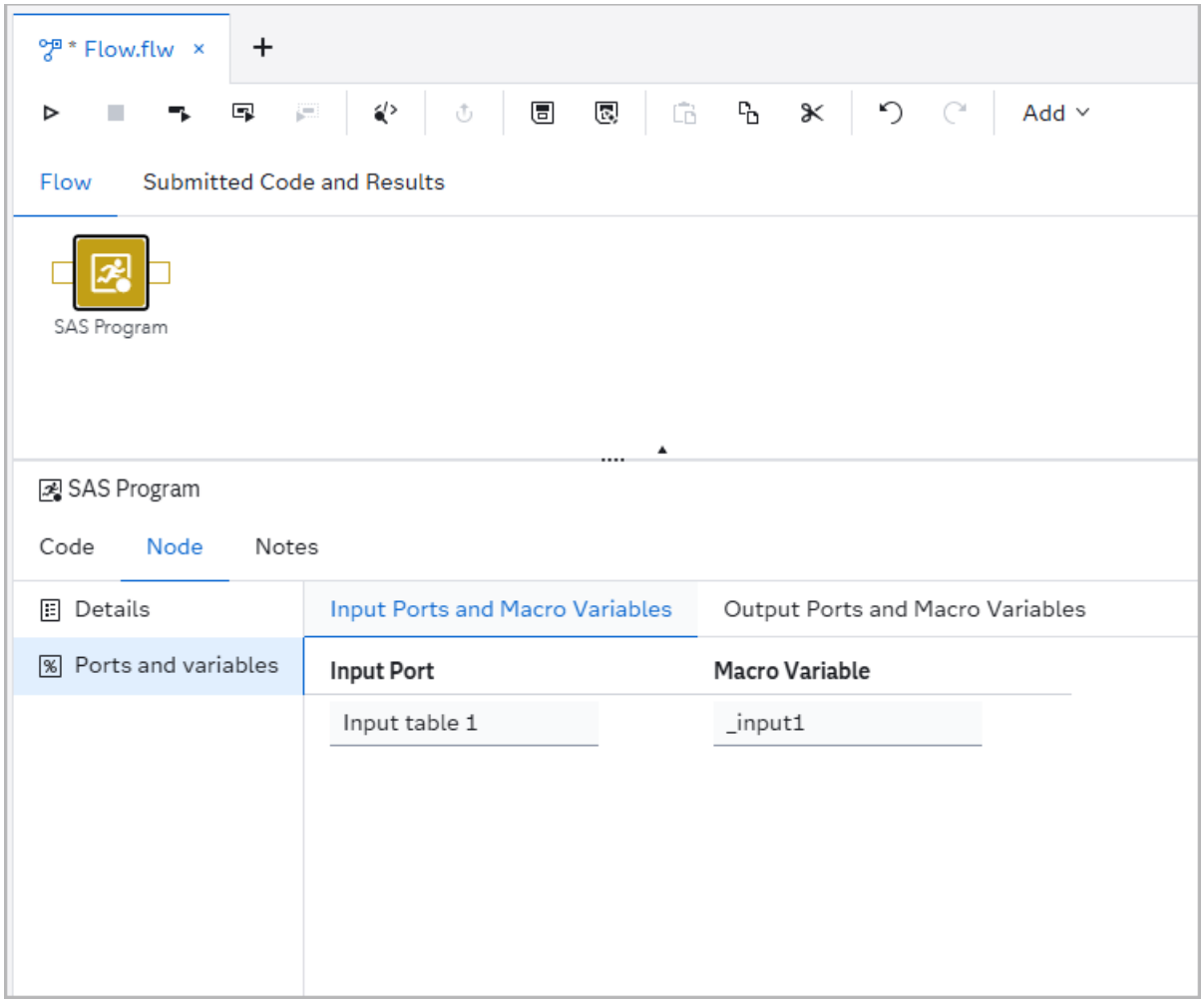
Here are the default variables that SAS Data and AI Studio automatically generates for both SAS Program nodes and Python Program nodes:

- `_input1`
- `_output1`

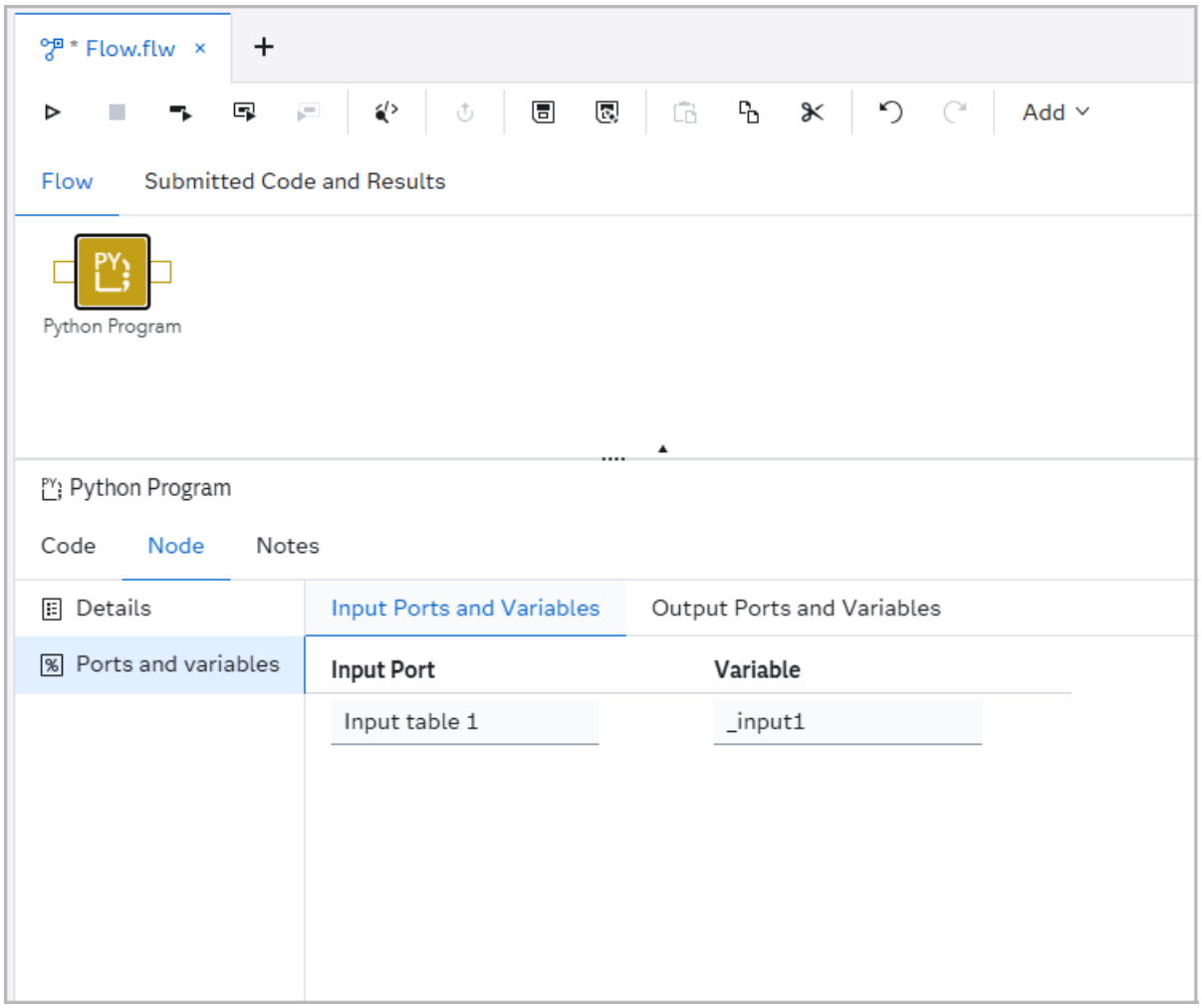
- `_inputCount`
- `_outputCount`

Note: If you add any input or output ports to the node, additional dedicated variables are generated for each new port.

You can view the default input and output ports and the associated macro variables of a program node by clicking the node in the flow, and then clicking the **Node** tab. The following example shows the macro variables that are generated for a SAS Program node with two input ports and one output port.

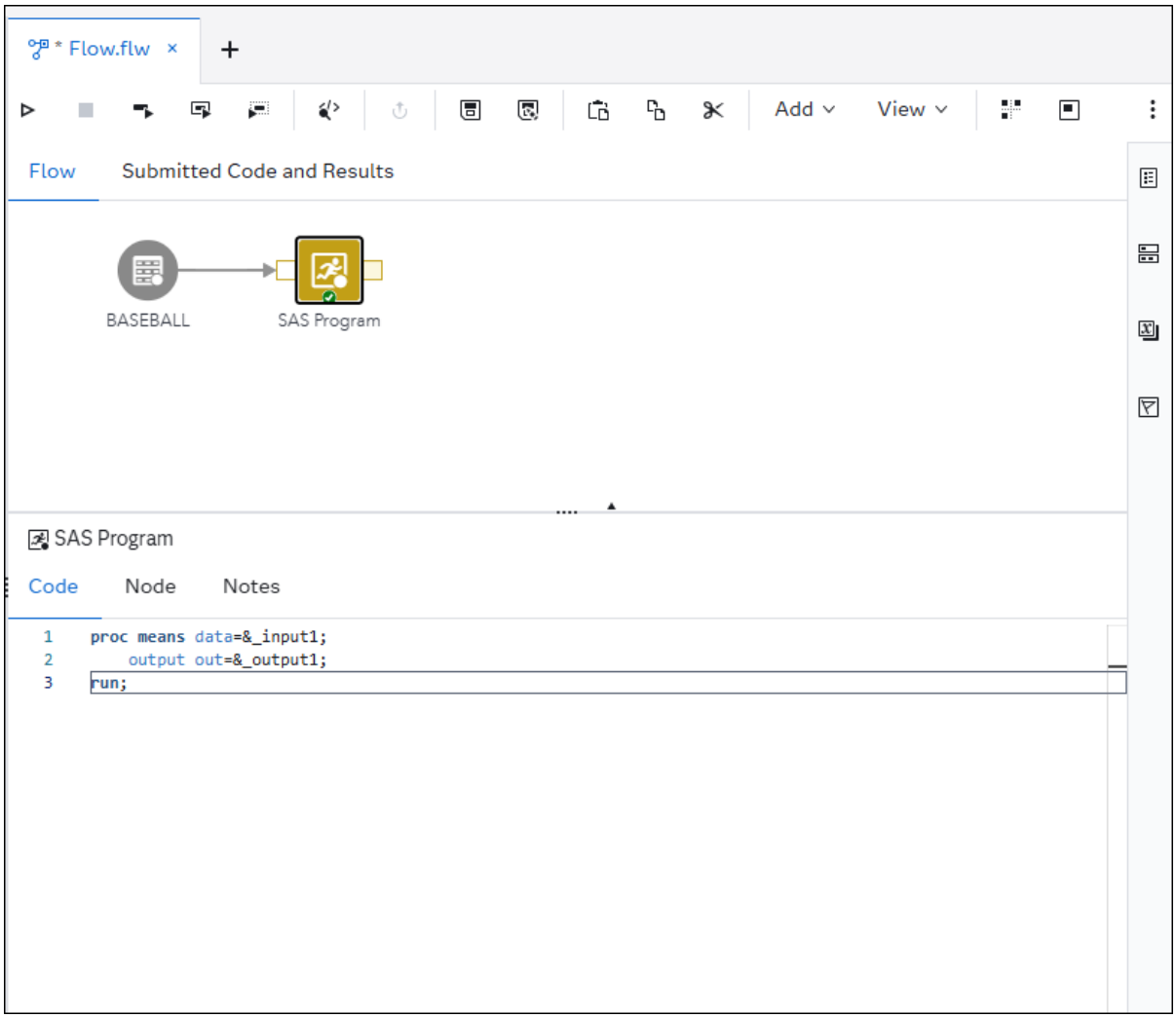


The next example shows the variables that are generated for a Python Program node with one input port and one output port.

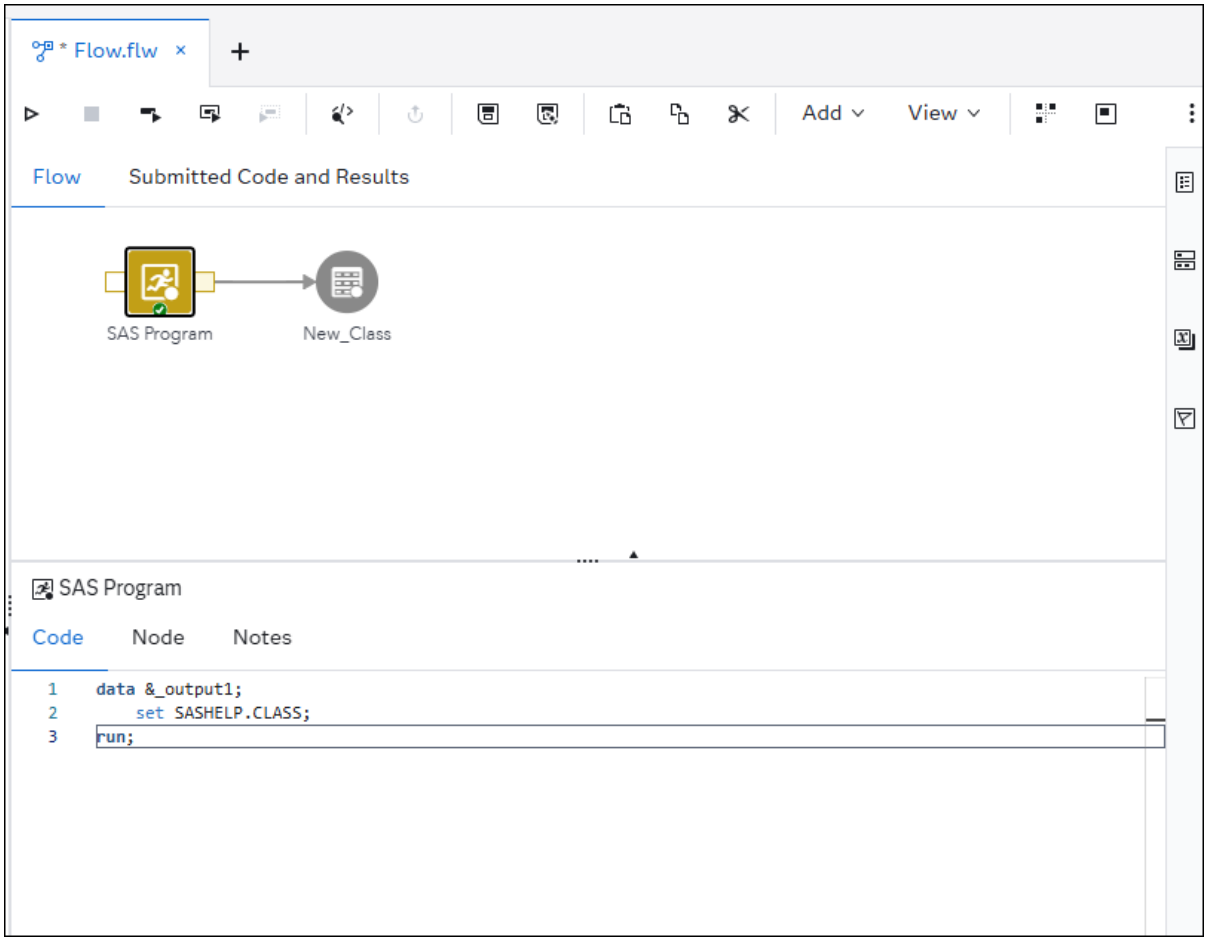


Note: You can change the default names of the macro variables. You can then reference the custom macro variable names in your code. For more information, see "Macro Variables Defined by Users" in *SAS Macro Language: Reference*.

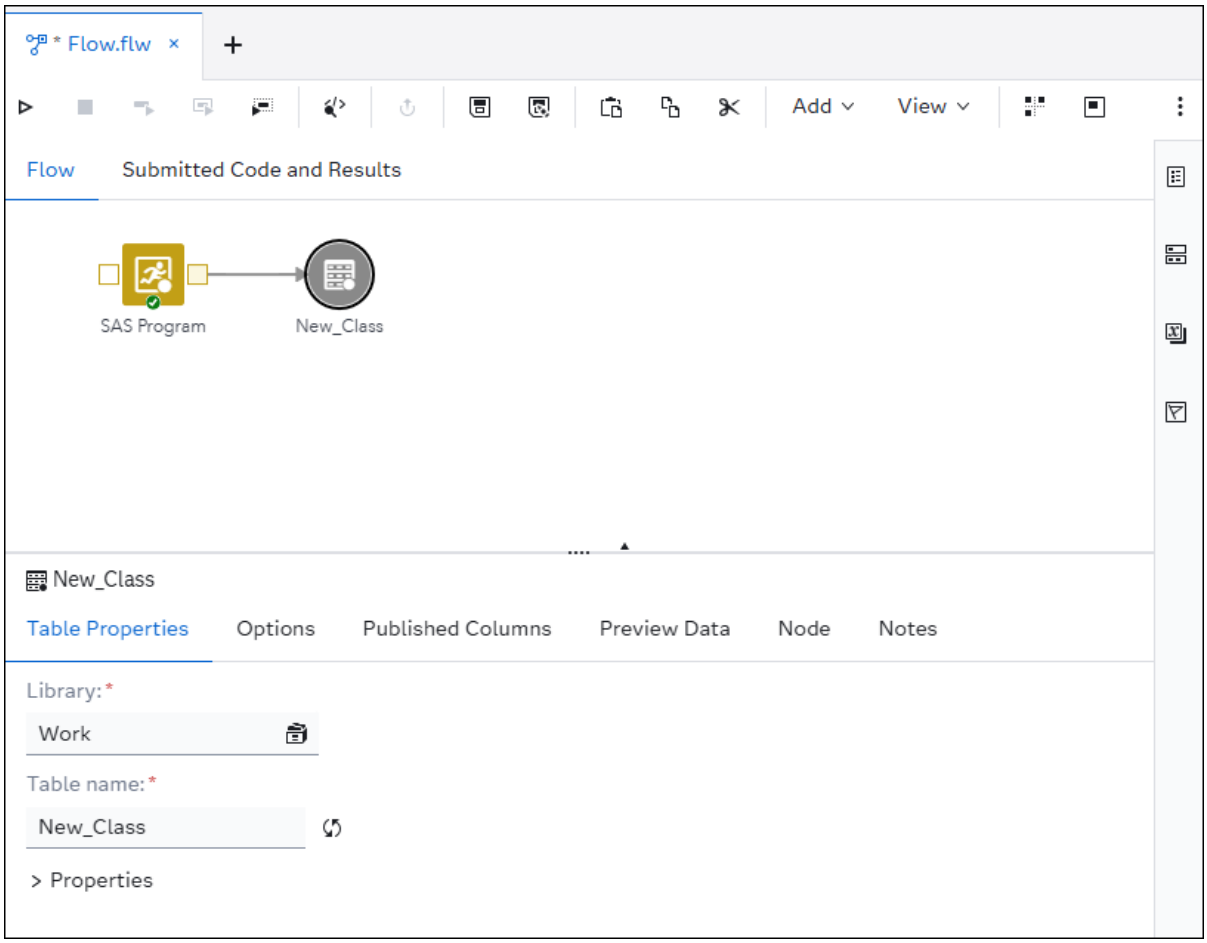
In the following example, the BASEBALL table is connected to a SAS Program node. The SAS Program node runs the MEANS procedure against the BASEBALL table. The code that is associated with the SAS Program node specifies the **`&_input1`** macro variable as the data source for the MEANS procedure and the **`&_output1`** macro variable as the destination for the output data. No output table is connected to the program node, so the results are written to a table in the Work library.



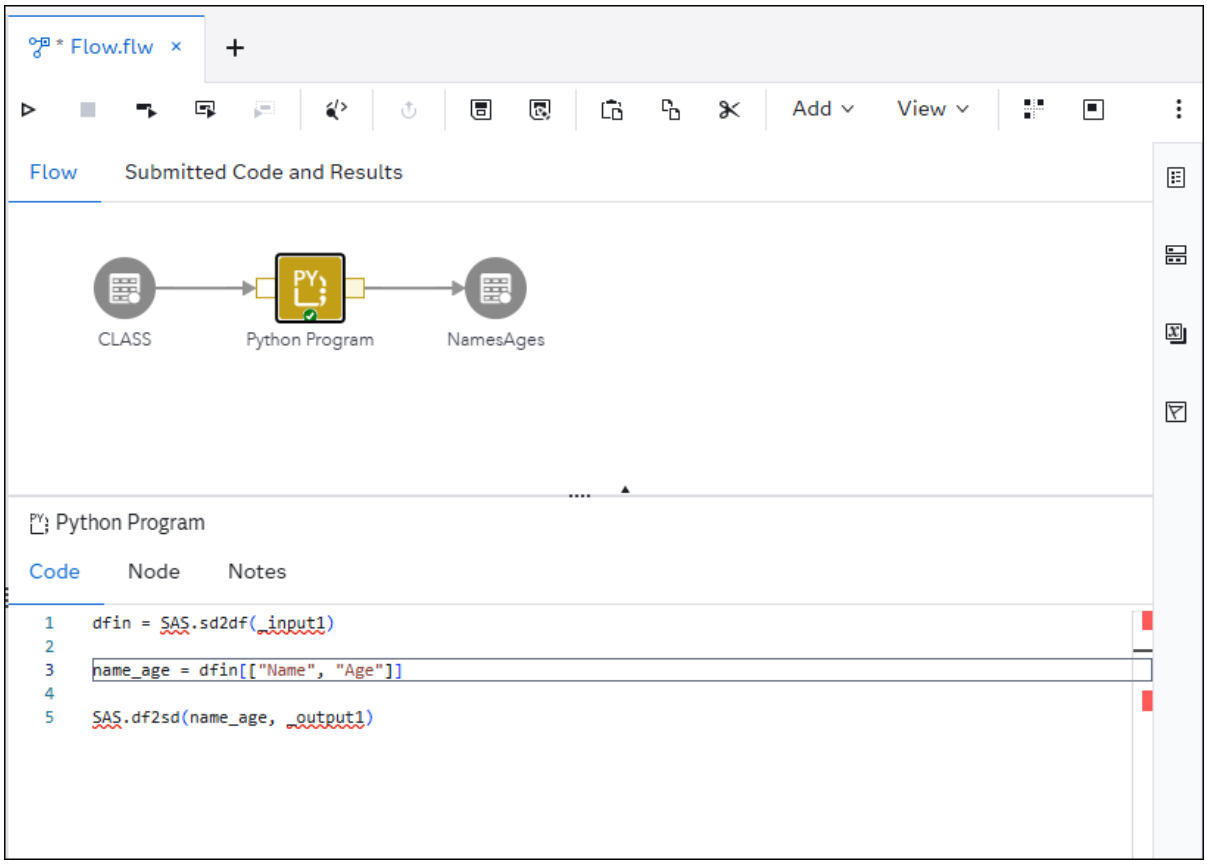
The following example shows a SAS Program node that writes output data to the NEW_CLASS table. The SAS Program node runs a DATA step to create a table that is based on the CLASS table. The code that is associated with the SAS Program node specifies the **`&_output1`** macro variable as the destination for the output data.



The table properties for the Table node specify the Work library and NEW_CLASS table name.



The next example shows a Python program that uses the CLASS table as input and writes two columns from the table to the NamesAges table in the Work library. The code that is associated with the Python Program node specifies the **`_input1`** variable as the data source and the **`_output1`** variable as the destination for the output data.


* Flow.flw
Add
View
Flow
Submitted Code and Results
CLASS
Python Program
NamesAges
Python Program
Code
Node
Notes
1 dfin = SAS.sd2df(_input1)
2
3 name_age = dfin[["Name", "Age"]]
4
5 SAS.df2sd(name_age, _output1)

7

Transforming Data

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Understanding the Steps That Subset Data

You can choose from among three different steps to select a subset of data from an input table. Each step can be useful in different situations, depending on your needs:

- **Branch Rows** - splits a table into multiple output tables based on conditions that you specify by using column values. The Branch Rows step performs only a single function in a flow, which makes it easy to understand the function of a Branch Rows node in a flow that is complicated and includes many nodes. For more information, see "Branch Rows" on page 84.
- **Filter Rows** - selects a subset of rows from an input table and writes the rows to a single output table. The Filter Rows step performs only a single function in a flow, which makes it easy to understand the function of a Filter Rows node in a flow that is complicated and includes many nodes. For more information, see "Filter Rows" on page 96.
- **Query** - selects, filters, and sorts columns from one or more input tables that can be joined together and writes the rows to a single output table. The Query step can perform multiple functions, which can make understanding a flow more complicated. To understand the functions that a Query node performs in a flow, you must examine the options that are specified for the node. For more information, see "Query" on page 123.

Note: The Branch Rows and Filter Rows steps are available only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.

Table 7.1 *Comparison of Steps That Subset Data*

	Branch Rows	Filter Rows	Query
Selects a subset of rows based on one or more filter conditions	x	x	x
Includes option to use the Expression Builder for creating expressions	x	x	x
Includes a condition for rows that do not match any other condition	x		
Writes rows to multiple output tables	x		

	Branch Rows	Filter Rows	Query
Selects rows from multiple input tables			x
Filters, sorts, and groups columns			x
Creates calculated columns			x

Branch Rows

About the Branch Rows Step

By default, the Branch Rows step splits a table into two output tables based on conditions that you specify by using column values. The conditions that you create do not need to be mutually exclusive: a row can be written to more than one output table.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.This step is not available in SAS Data and AI Studio. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

TIP You can also use the Filter Rows step and the Query step to select a subset of rows from an input table. For more information, see "Understanding the Steps That Subset Data" on page 83.

Branch Rows: Connection Requirements for the Node

In order to run the Branch Rows step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No connection is required. **Note:** By default, the output data is written to temporary tables in the Work library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Splitting the Sashelp.Class Data Set

In this example, you split the Sashelp.Class data set into two tables: one for male students and another for female students.

To create this example:

1 From the main SAS Data and AI Studio menu, select **New** ⇨ **Flow**.

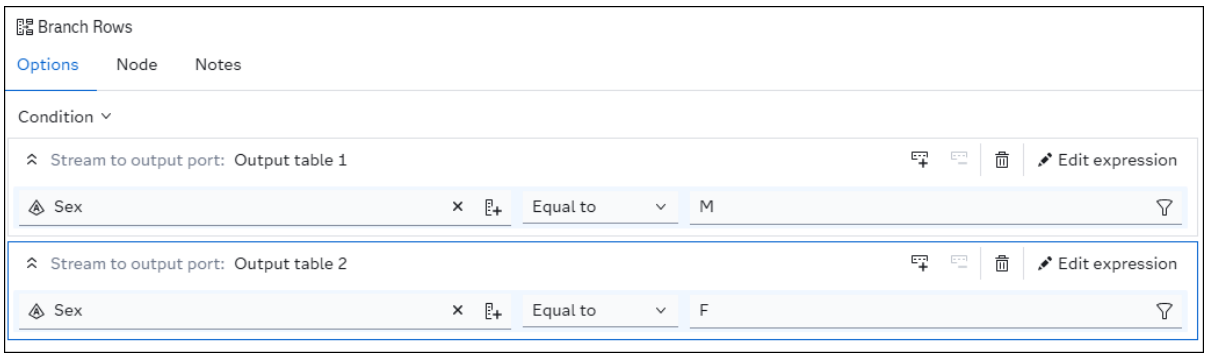
2 In the **Steps** section of the navigation pane, expand the **Transform Data** folder, and double-click **Branch Rows**.

3 Add the Sashelp.Class data set to your flow. Connect the input port of the Branch Rows node to the data source. For more information, see "Connecting Nodes" on page 13.

4 Click the Branch Rows node to specify the conditions for the output port. On the **Options** tab, click for Output table 1 and select the *Sex* column. Accept the default condition of **`Equal`**, and click .

5 In the Add Filter window, click . Select **`M`** and click **OK**. Click **Filter** to create the condition.

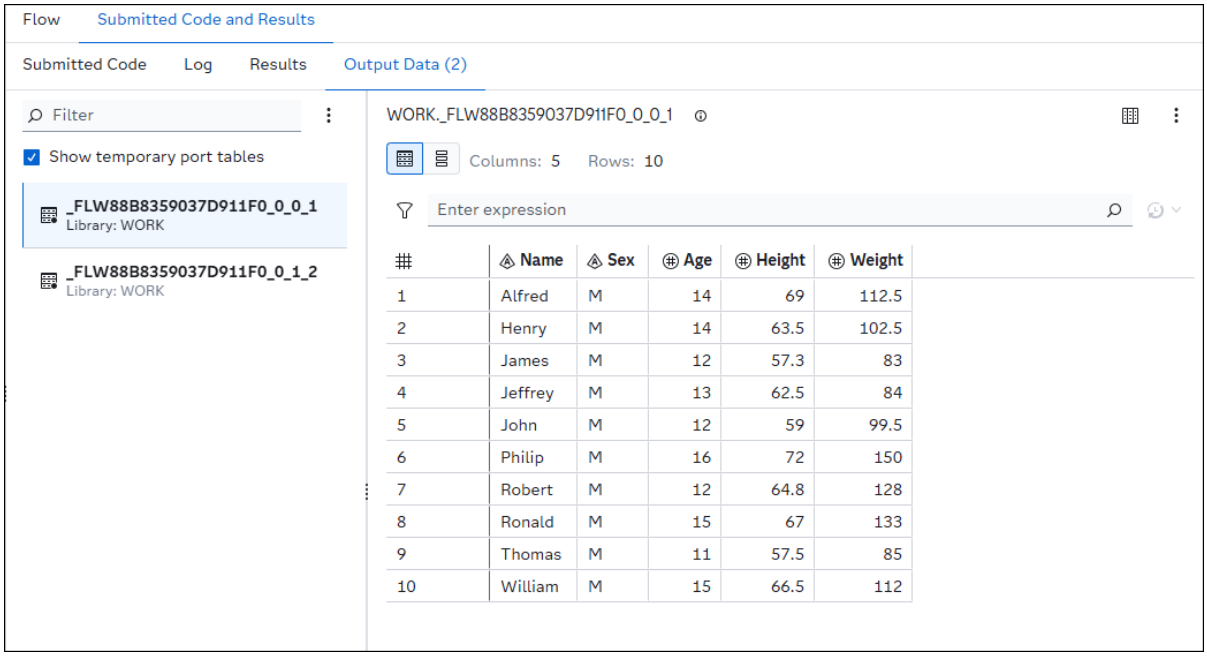
6 Repeat steps 4 and 5 to create a similar condition for Output table 2 for female students.



7 Run the flow.

Click **Submitted Code and Results** to view the output data. By default, the output data is saved in the Work library.

> **TIP** You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.



	Name	Sex	Age	Height	Weight
1	Alfred	M	14	69	112.5
2	Henry	M	14	63.5	102.5
3	James	M	12	57.3	83
4	Jeffrey	M	13	62.5	84
5	John	M	12	59	99.5
6	Philip	M	16	72	150
7	Robert	M	12	64.8	128
8	Ronald	M	15	67	133
9	Thomas	M	11	57.5	85
10	William	M	15	66.5	112

Branch Rows: Step-by-Step Instructions

By default, the Branch Rows step includes two output ports and the options for two conditions. You can choose to specify only one condition and output port, or you can add additional conditions and output ports. You can also add a nonmatching condition that writes the rows that do not meet any condition to a separate output port.

1. In the **Steps** section of the navigation pane, expand the **Transform Data** folder, and double-click **Branch Rows**.
2. Connect the input port of the Branch Rows node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.
3. Click the **Branch Rows** node, and then click the **Options** tab.
4. Click for Output table 1, and select the column that you want to use. Click **OK**.

> **TIP** To use the expression builder to create a condition, click **Expression Builder** on the toolbar for the condition. For more information, see "Building an Expression" in *SAS Data and AI Studio: User's Guide*.

5 Select a comparison operator from the operator drop-down list. The default value is **`Equal to`**.

6 If the operator that you have selected requires a value, click . In the Add Filter window, use the **Value** box to enter a value or select whether you want to look up a value or use a parameter:

- **Lookup value** - use the Select a Value window to specify a value.
- **Select a parameter** - use the Select a Parameter window to select a parameter. For more information, see "About the Parameters Pane" on page 38.

Click **OK**.

> **TIP** If you want to search for a value in the Select a Value window, use the unformatted value.

7 Depending on the data type of the column that you are using in the condition, you can choose from the following options:

- **Match case** – retrieves only rows that match the capitalization of the value that you specify. If this option is not selected, the UPPER function is applied to the expression. This option is not selected by default.
- **Quote string** – encloses values in single quotation marks. This option is selected by default. If you are using a macro variable or other value that is evaluated when the filter is run, you should clear this option.
- **Allow macros** – enables you to enter character values in a filter on a numeric column.

8 Click **Filter** to add values to the condition.

9 To add another row to the condition, click and repeat steps 4–8. If you create more than one comparison expression in your condition, the default relationship between these filter elements is AND. You can change the relationship between filter elements from AND to OR by clicking the relationship drop-down list.

Note: To delete a row from a condition, select the row and click

10 Repeat steps 4–9 to create a condition for Output table 2.

11 To create additional conditions, select **Condition** ⇨ **Add condition** and repeat steps 4–9.

To add a condition for the rows that do not match any other condition, select **Condition** ⇨ **Add nonmatching condition**.

12 To run the flow, click ▷ Run.

Calculate Columns

About the Calculate Columns Step

The Calculate Columns step enables you to create an output table that is based on the input table. The output table includes all of the columns from the input table. You can replace a column in the output table by applying a function to the corresponding column in the input table. You can also create additional columns that are based on columns from the input table.

When you replace or create a column for the output table, a calculation card is created for the column. You can use the card to edit the expression that is associated with the column and view the properties of the column. You can create multiple cards for the same column if you want to apply several functions to a column. The cards are processed in order from top to bottom. You can move columns up and down the list to change the processing order.

New columns are added to the beginning of the output table. Replaced columns are also added to the beginning of the output table, if you change any of the column attributes, including Label, Type, Length, Format, and Informat. The order in which new and replaced columns are added to the beginning of the table is based on the order of the cards.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. This step is not available in SAS Data and AI Studio. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Calculate Columns: Connection Requirements for the Node

In order to run the Calculate Columns step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node	No connection is required.

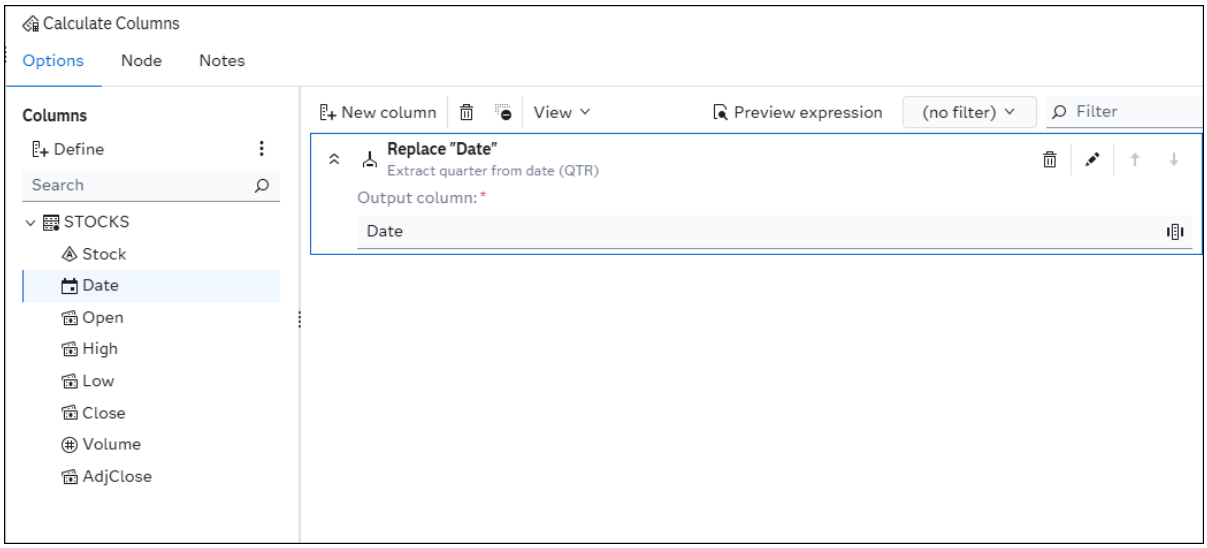
Input Port	Output Port
or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	**Note:** By default, the output data is written to temporary tables in the Work library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Creating a Table Based on the Sashelp.Stocks Data Set

In this example, you create a table from the Sashelp.Stocks data set. In the new table, the date column is replaced with a column of calendar quarter values. You also add a column to calculate the stock price change.

To create this example:

1. From the main SAS Data and AI Studio menu, select **New** ⇨ **Flow**.
2. In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Calculate Columns**.
3. Add the Sashelp.Stocks data set to your flow. Connect the input port of the Calculate Columns node to the data source. For more information, see "Connecting Nodes" on page 13.
4. Click the Calculate Columns node to define the columns for the output table. On the **Options** tab, select the **Date** column. Select **Define** ⇨ **Extract** ⇨ **Date** ⇨ **Quarter** to extract the quarter from the Date data. A `Replace "Date"` card is added to the node calculations. In the output table, the data in the Date column is replaced with the calendar quarter.

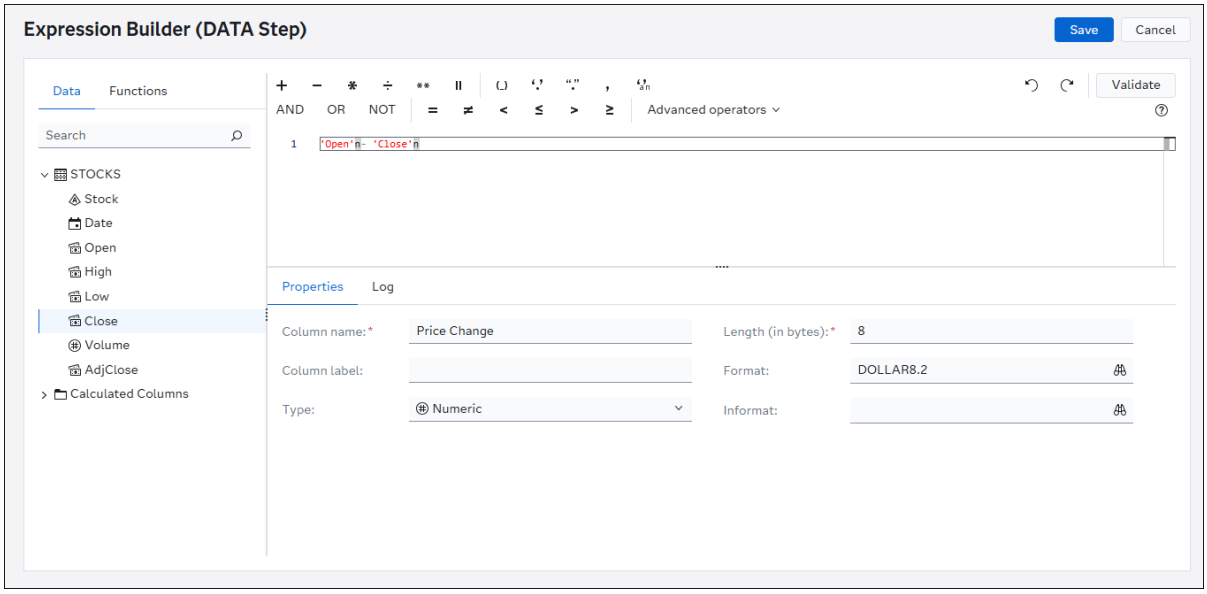


5 To add a column to the table, click **New column**. In the Expression Builder, drag the `Open` column to the expression box. Click the minus operator, and then drag the `Close` column to the expression box. The expression box should contain this expression:

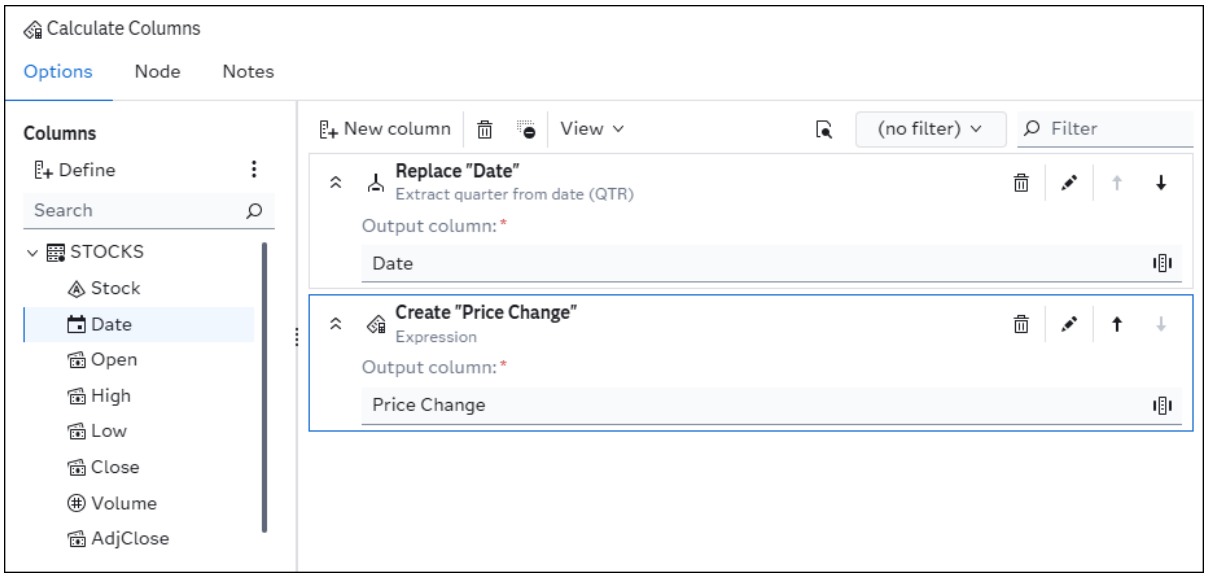
```
'Open'n -'Close'n
```

6 On the Properties tab, enter `Price Change` in the **Column name** box. Change **Type** to **Numeric**.

7 To specify a format of DOLLAR8.2, click . In the Change Format window, expand **Currency**, and select **DOLLAR**. In the **Overall width** field, enter `8`. In the **Decimal places** field, enter `2`. Click **OK**.



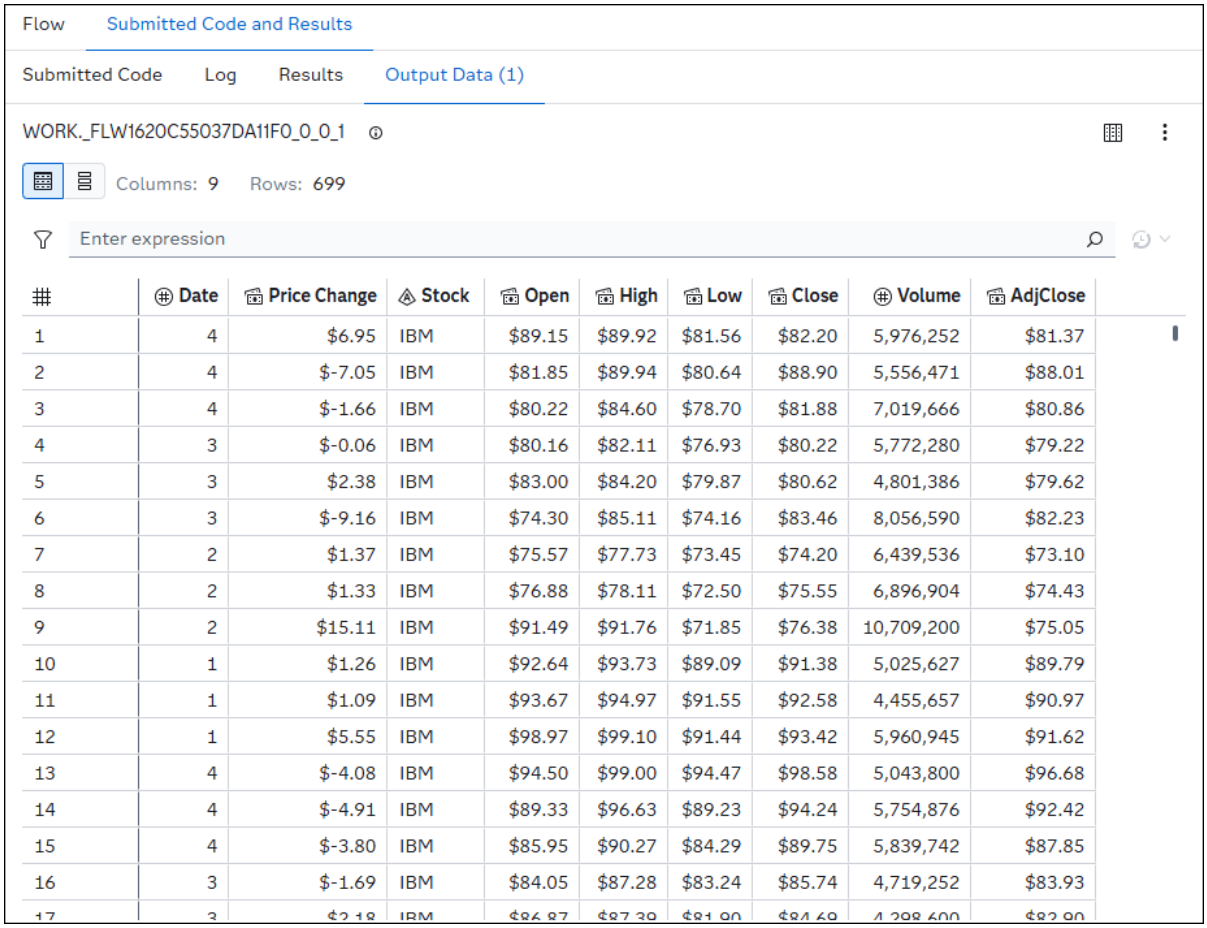
8 Click **Save** to add the new column to the table. A `Create "Price Change"` card is added to the node calculations.



9 Run the flow.

Click **Submitted Code and Results** to view the output data. Here is the output table with the replaced Date column and the new Price Change column.

> **TIP** By default, the output data is saved to the Work library. You can specify the library and name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.



	Date	Price Change	Stock	Open	High	Low	Close	Volume	AdjClose
1	4	$6.95	IBM	$89.15	$89.92	$81.56	$82.20	5,976,252	$81.37
2	4	$-7.05	IBM	$81.85	$89.94	$80.64	$88.90	5,556,471	$88.01
3	4	$-1.66	IBM	$80.22	$84.60	$78.70	$81.88	7,019,666	$80.86
4	3	$-0.06	IBM	$80.16	$82.11	$76.93	$80.22	5,772,280	$79.22
5	3	$2.38	IBM	$83.00	$84.20	$79.87	$80.62	4,801,386	$79.62
6	3	$-9.16	IBM	$74.30	$85.11	$74.16	$83.46	8,056,590	$82.23
7	2	$1.37	IBM	$75.57	$77.73	$73.45	$74.20	6,439,536	$73.10
8	2	$1.33	IBM	$76.88	$78.11	$72.50	$75.55	6,896,904	$74.43
9	2	$15.11	IBM	$91.49	$91.76	$71.85	$76.38	10,709,200	$75.05
10	1	$1.26	IBM	$92.64	$93.73	$89.09	$91.38	5,025,627	$89.79
11	1	$1.09	IBM	$93.67	$94.97	$91.55	$92.58	4,455,657	$90.97
12	1	$5.55	IBM	$98.97	$99.10	$91.44	$93.42	5,960,945	$91.62
13	4	$-4.08	IBM	$94.50	$99.00	$94.47	$98.58	5,043,800	$96.68
14	4	$-4.91	IBM	$89.33	$96.63	$89.23	$94.24	5,754,876	$92.42
15	4	$-3.80	IBM	$85.95	$90.27	$84.29	$89.75	5,839,742	$87.85
16	3	$-1.69	IBM	$84.05	$87.28	$83.24	$85.74	4,719,252	$83.93
17	3	$2.18	IBM	$86.87	$87.39	$81.90	$84.69	4,298,600	$82.90

Calculate Columns: Step-by-Step Instructions

The Calculate Columns step requires one input port and one output port. You must select at least one column from the input table to replace in the output table or to use as the basis for creating a column.

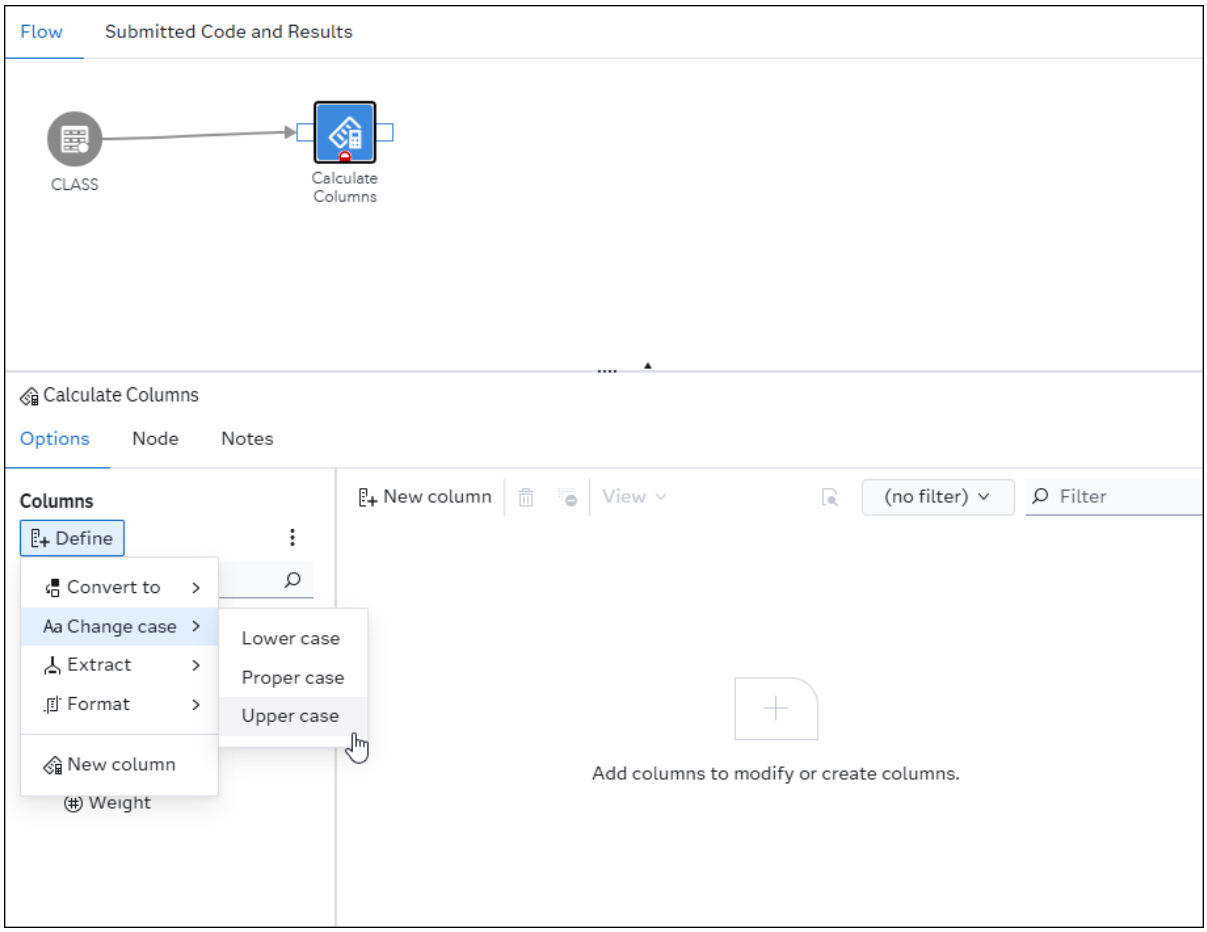
1 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Calculate Columns**.

2 Connect the input port of the Calculate Columns node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

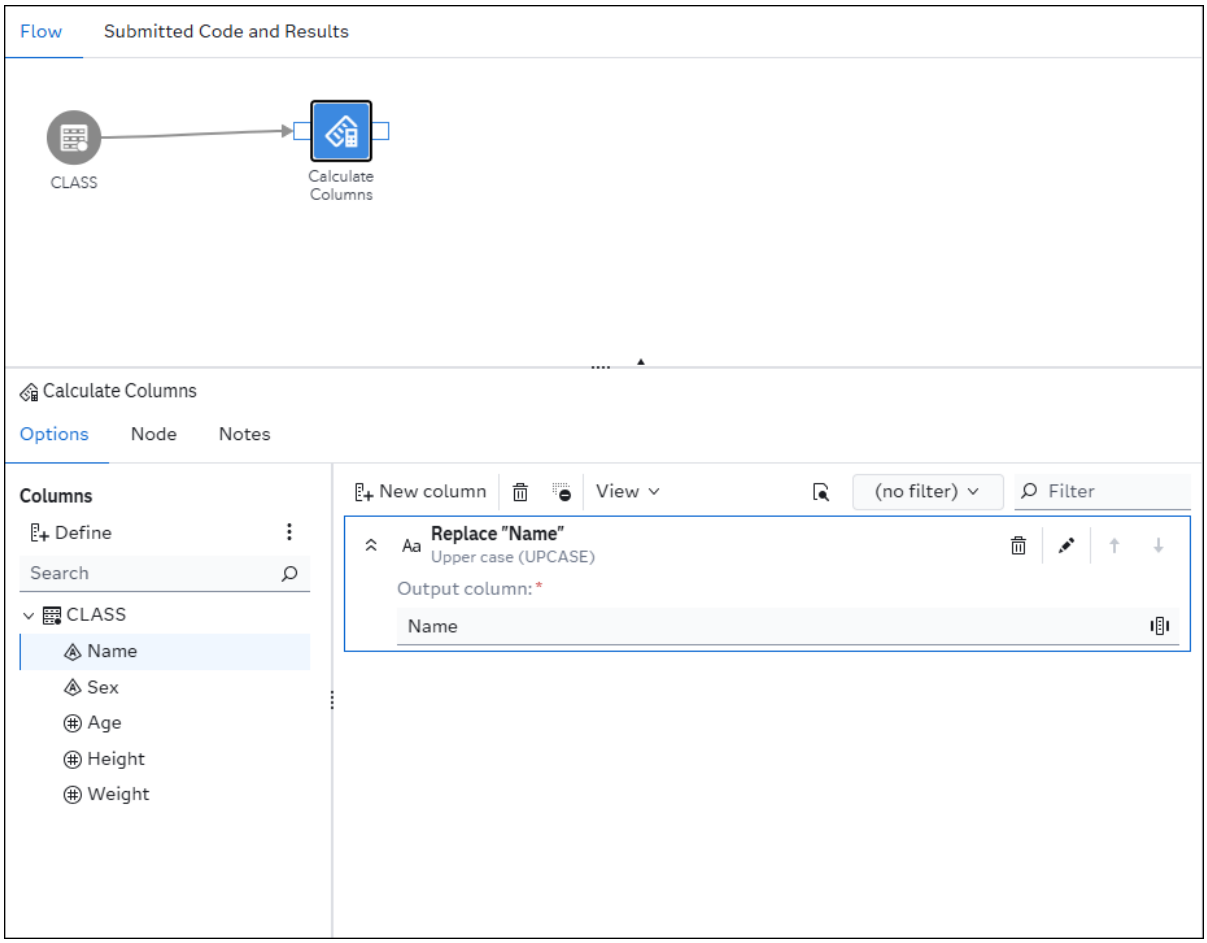
3 Click the **Calculate Columns** node, and then use the Options tab to select a column to replace or use as the basis for a new column.

4 To replace a column:

   a On the Options tab, select one or more columns that you want to replace. Click **Define** and select the function that you want to apply to the columns.



A card for each replaced column is added to the node calculations. The following figure shows a card that replaces the values in the Name column with uppercase values.



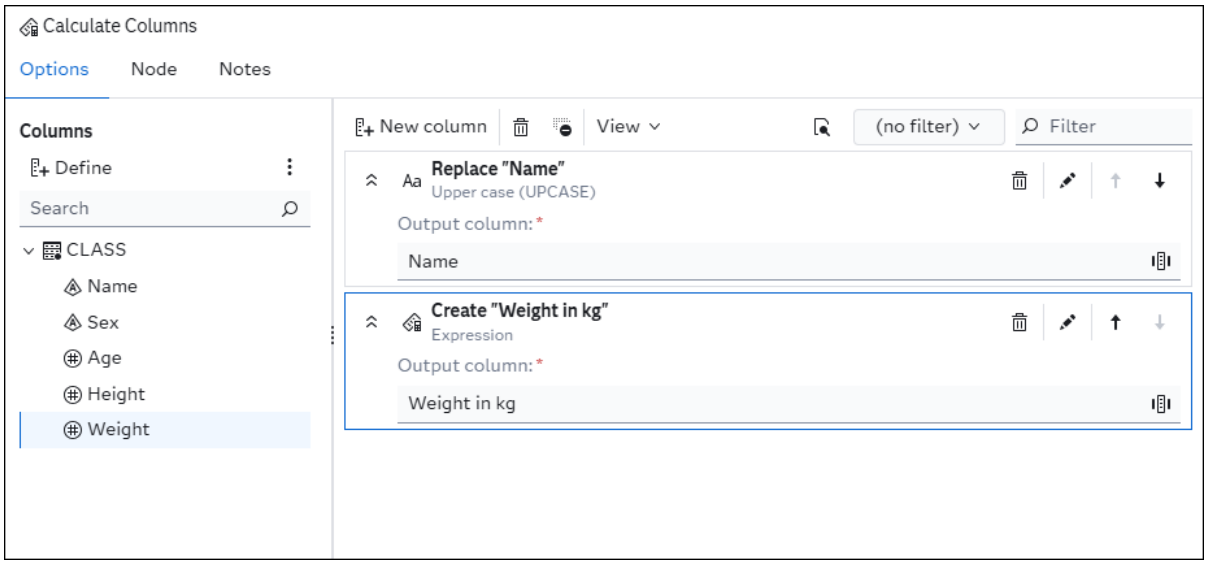
> **TIP** You can create a column in the output table by entering a new name for the output column in a Replace card. For example, if you create a card to replace the values in the Name column with uppercase values and rename the output column to `UpperName`, then the output table includes both the original Name column and the new UpperName column.

To create a column based on an existing column:

a On the Options tab, select the column that you want to use as the basis for the new column. Click **New column**.

b In the Expression Builder window, use the options to create the expression for the new column, or enter the expression in the expression box.

c Use the Properties tab to specify the column name, data type, and other properties. Click **Save**. A Create card is added to the node calculations. The following figure shows a new card that is based on the Weight column and creates a column for weight in kilograms.



5 You can use the calculation cards to perform these actions:

	View or edit the expression by using the Expression Builder.
	View the output column properties.
	Delete the column calculation.
,	Move the calculation card up or down the list.

Note: The calculation cards are processed by SAS Data and AI Studio in order from top to bottom. You can move cards up and down the list to change the processing order.

TIP You can use the Manage Columns step to change the order of the columns in the output table. For more information, see "Manage Columns" on page 105.

6 To preview all the calculations that have been generated for the node, click . To copy the calculations to the clipboard, click **Copy**.

7 Run the flow.

Filter Rows

About the Filter Rows Step

You can use the Filter Rows step to select a subset of rows from an input table and write the rows to an output table. The Filter Rows step can be combined with other steps in which you want to work with only a subset of the data in a table. For example, you can create a flow that uses the Filter Rows step to create a table that contains only baseball players who have had more than 10 home runs, and then use the Branch Rows step to split the filtered data into separate tables for each team.

> **TIP** You can also use the Branch Rows step and the Query step to select a subset of rows from an input table. For more information, see "Understanding the Steps That Subset Data" on page 83.

You can choose to create filter expressions by using the user interface in the step or you can create the filter by using the Expression Builder. For more information, see "Building an Expression" in *SAS Data and AI Studio: User's Guide*. SAS Data and AI Studio automatically generates the appropriate DATA step WHERE statement for the filter when the step is run.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. This step is not available in SAS Data and AI Studio. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Filter Rows: Connection Requirements for the Node

In order to run the Filter Rows step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or	■ Table node or

Input Port	Output Port
■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	■ Operational node that requires an input table, such as a Query node, a SAS Program node, or an Export node

Example: Subsetting Data from the Sashelp.Baseball Data Set

In this example, you select a subset of rows from the Sashelp.Baseball data set and write the rows to a new output table named BestHitters. The BestHitters table contains a subset of the rows and all of the columns that are in the Sashelp.Baseball data set.

To create this example:

1 From the main SAS Data and AI Studio menu, select **New** ⇨ **Flow**.

2 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Filter Rows**.

3 Add the Sashelp.Baseball data set to your flow. Connect the input port of the Filter Rows node to the data source. For more information, see "Connecting Nodes" on page 13.

4 On the flow toolbar, click **Add** ⇨ **Table**. Connect the Filter Rows node to the Table node by clicking the Filter Rows output port and dragging the mouse pointer to the Table node.

5 Click the Table node. In the table properties, enter **`Work`** as the library name and enter **`BestHitters`** as the table name.

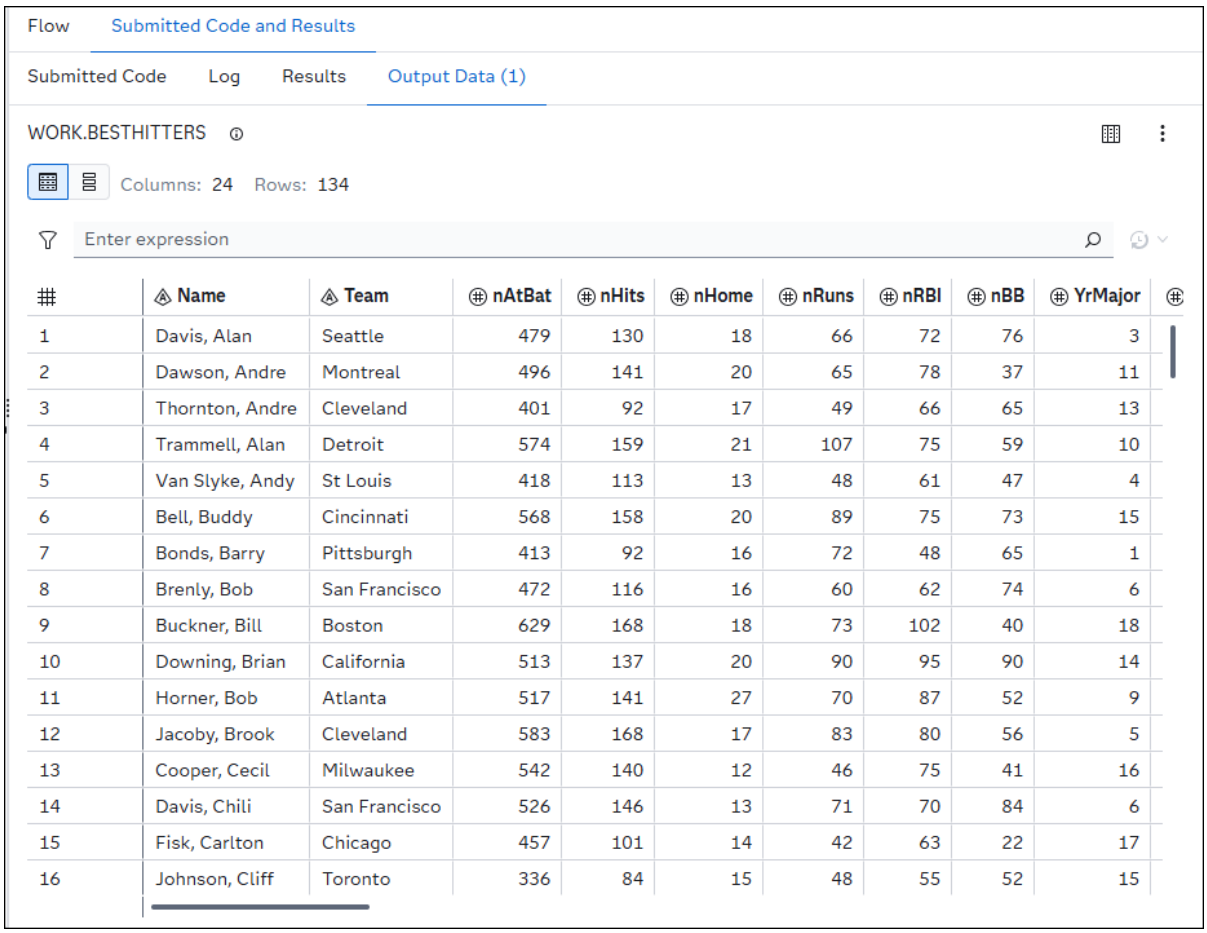
6 Click the **Filter Rows** node to specify the filter condition for the output table. On the **Options** tab, click and select the **nHome** column. Click **OK**.

7 From the **Condition** drop-down list, select **`Greater than`**, and then click .

8 In the Add Filter window, click . Select `10` and click **OK**. Click **Filter** to create the condition.

9 Run the flow.

Click **Submitted Code and Results** to view the output table. Here is the output table of players with more than 10 home runs.



	Name	Team	nAtBat	nHits	nHome	nRuns	nRBI	nBB	YrMajor
1	Davis, Alan	Seattle	479	130	18	66	72	76	3
2	Dawson, Andre	Montreal	496	141	20	65	78	37	11
3	Thornton, Andre	Cleveland	401	92	17	49	66	65	13
4	Trammell, Alan	Detroit	574	159	21	107	75	59	10
5	Van Slyke, Andy	St Louis	418	113	13	48	61	47	4
6	Bell, Buddy	Cincinnati	568	158	20	89	75	73	15
7	Bonds, Barry	Pittsburgh	413	92	16	72	48	65	1
8	Brenly, Bob	San Francisco	472	116	16	60	62	74	6
9	Buckner, Bill	Boston	629	168	18	73	102	40	18
10	Downing, Brian	California	513	137	20	90	95	90	14
11	Horner, Bob	Atlanta	517	141	27	70	87	52	9
12	Jacoby, Brook	Cleveland	583	168	17	83	80	56	5
13	Cooper, Cecil	Milwaukee	542	140	12	46	75	41	16
14	Davis, Chili	San Francisco	526	146	13	71	70	84	6
15	Fisk, Carlton	Chicago	457	101	14	42	63	22	17
16	Johnson, Cliff	Toronto	336	84	15	48	55	52	15

Filter Rows: Step-by-Step Instructions

The Filter Rows step requires one input port and one output port. You can create one or more filter conditions to select a subset of the data that is written to the output table.

1 In the **Steps** section of the navigation pane, expand the **Transform Data** folder, and double-click **Filter Rows**.

2 Connect the input port of the Filter Rows node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 Connect the output port of the Filter Rows node to a data source by using a Table node or another node that requires an input table, such as a Query Node, a SAS Program node, or an Export node.

Note: If you are using a Table node, click the node, and use the Table Properties tab to make sure that the node specifies a library and name for the table. Any existing data in the output table node is overwritten when you run the Filter Rows step.

4 Click the **Filter Rows** node, and then click the **Options** tab.

5 Click , and select the column that you want to use. Click **OK**.

> **TIP** To use the expression builder to create a condition, click **Expression Builder** on the toolbar for the condition. For more information, see "Building an Expression" in *SAS Data and AI Studio: User's Guide*.

6 Select a comparison operator from the **Condition** drop-down list. The default value is `Equal to`.

7 If the operator that you have selected requires a value, click . In the Add Filter window, use the **Value** box to enter a value or select whether you want to look up a value or use a parameter:

- **Lookup value** - use the Select a Value window to specify a value.
- **Select a parameter** - use the Select a Parameter window to select a parameter. For more information, see "About the Parameters Pane" on page 38.

Click **OK**.

> **TIP** If you want to search for a value in the Select a Value window, use the unformatted value.

8 Depending on the data type of the column that you are using in the condition, you can choose from the following options:

- **Match case** – retrieves only rows that match the capitalization of the value that you specify. If this option is not selected, the UPPER function is applied to the expression. This option is not selected by default.
- **Quote string** – encloses values in single quotation marks. This option is selected by default. If you are using a macro variable or other value that is evaluated when the filter is run, you should clear this option.
- **Allow macros** – enables you to enter character values in a filter on a numeric column.

9 Click **Filter** to add values to the condition.

10 To add another row to the condition, click and repeat steps 5–9. If you create more than one comparison expression in your condition, the default relationship between these filter elements is AND. You can change the relationship between filter elements from AND to OR by clicking the relationship drop-down list.

Note: To delete a row from a condition, select the row and click

11 Run the flow.

Insert Rows

About the Insert Rows Step

You can use the Insert Rows step to insert the rows from an input table into an output table. For example, you can create a flow that uses the Insert Rows step to create and add data to an output table. You can regularly update the data in the output table by scheduling the flow as a job.

The output table must contain one or more columns that have the same name and data type as columns in the input table. SAS Data and AI Studio automatically generates PROC SQL or PROC FEDSQL code when the step is run.

The Insert Rows step enables you to add rows to an output table in any of the following ways:

- append the rows in the input table to existing rows in the output table
- replace the existing rows in the output table with the rows from the input table
- add the rows from the input table to a new output table

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. This step is not available in SAS Data and AI Studio. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Insert Rows: Connection Requirements for the Node

In order to run the Insert Rows step, you must create connections to the input and output ports of the node as indicated here:

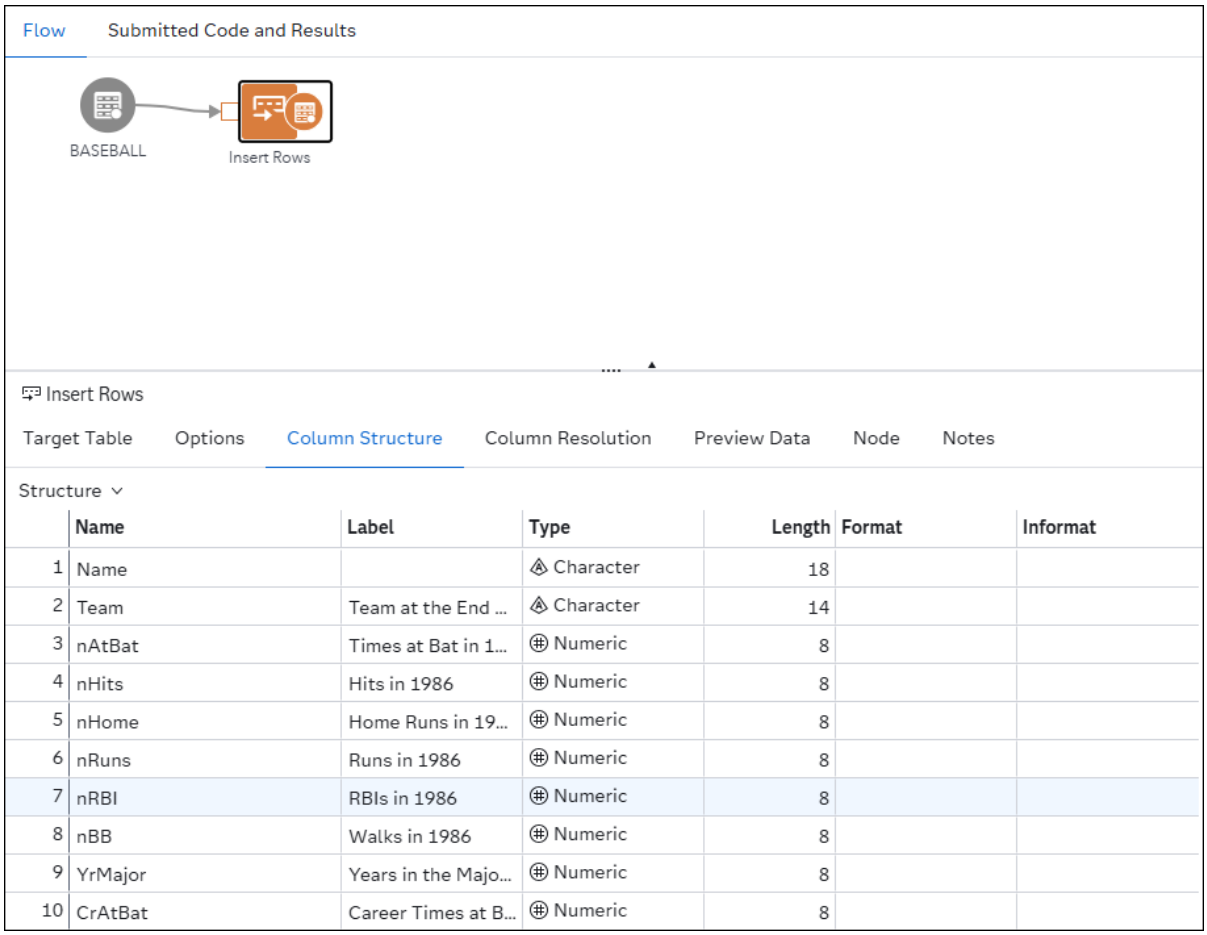
Input Port	Output Port
■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	Table node that contains one or more columns that have the same name and data type as columns in the input table

Example: Inserting Rows into a New Output Table from the Sashelp.Baseball Data Set

In this example, you insert rows from the Sashelp.Baseball data set into a new output table named KeyStats. The KeyStats table contains a subset of the columns that are in the Baseball data set.

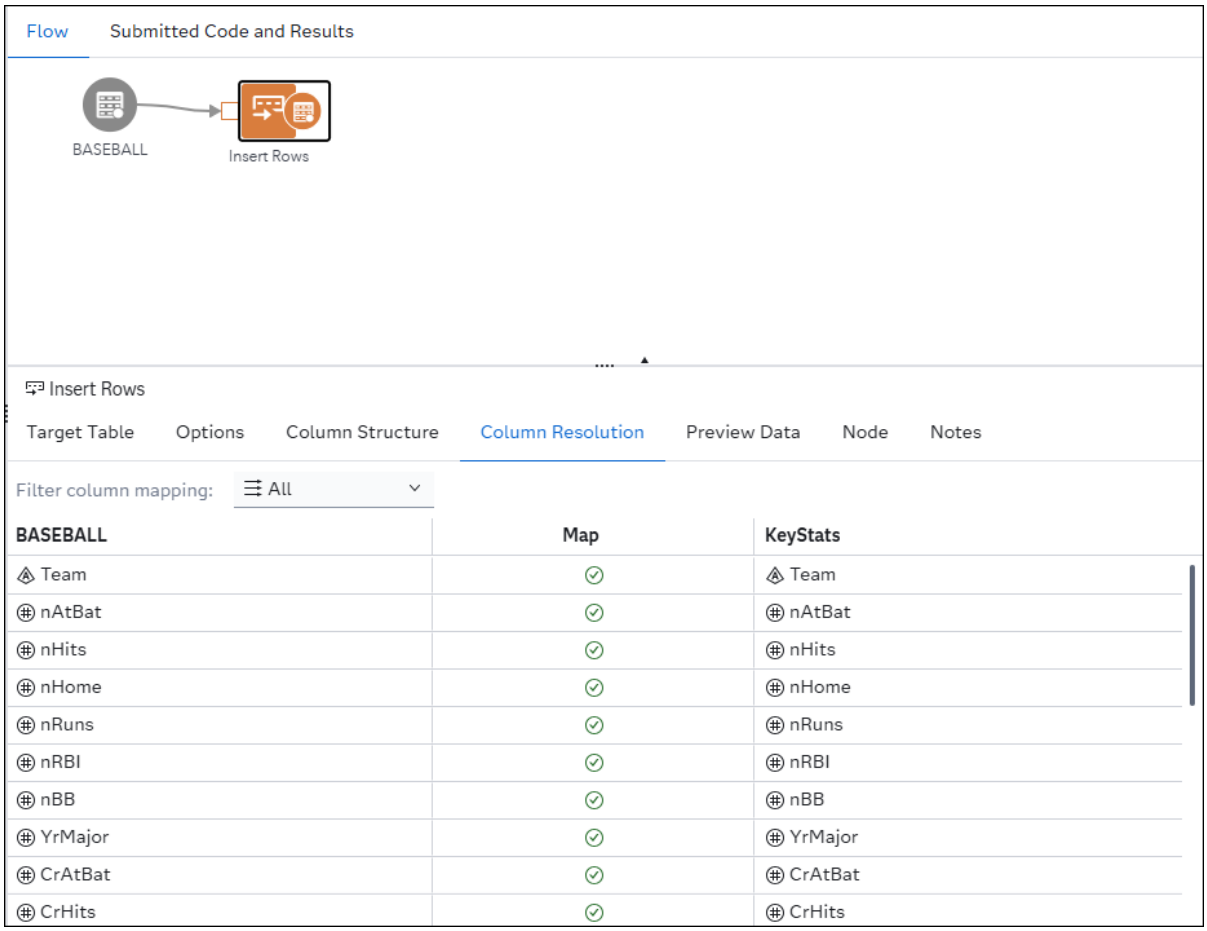
To create this example:

1. From the main SAS Data and AI Studio menu, select **New** ⇨ **Flow**.
2. In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Insert Rows**.
3. Add the Sashelp.Baseball data set to your flow. Connect the input port of the Insert Rows node to the data source. For more information, see "Connecting Nodes" on page 13.
4. To set the options for the Insert Rows step, select the Insert Rows node.
5. On the **Target Table** tab, enter `Work` as the library name and `KeyStats` as the name of the output table.
6. Click the **Column Structure** tab to generate the structure for the KeyStats table. Select **Structure** ⇨ **Copy structure from source**.



	Name	Label	Type	Length	Format	Informat
1	Name		Character	18		
2	Team	Team at the End ...	Character	14		
3	nAtBat	Times at Bat in 1...	Numeric	8		
4	nHits	Hits in 1986	Numeric	8		
5	nHome	Home Runs in 19...	Numeric	8		
6	nRuns	Runs in 1986	Numeric	8		
7	nRBI	RBIs in 1986	Numeric	8		
8	nBB	Walks in 1986	Numeric	8		
9	YrMajor	Years in the Majo...	Numeric	8		
10	CrAtBat	Career Times at B...	Numeric	8		

7 Click the **Column Resolution** tab. Notice that the columns in the KeyStats table are all mapped to columns in the Baseball data set.



8 Run the flow.

Click **Submitted Code and Results** to view the KeyStats output table.

Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK.KEYSTATS

Columns: 24 Rows: 322

Enter expression

	Name	Team	nAtBat	nHits	nHome	nRuns	nRBI	nBB	YrMajor
1	Allanson, Andy	Cleveland	293	66	1	30	29	14	1
2	Ashby, Alan	Houston	315	81	7	24	38	39	14
3	Davis, Alan	Seattle	479	130	18	66	72	76	3
4	Dawson, Andre	Montreal	496	141	20	65	78	37	11
5	Galarraga, Andres	Montreal	321	87	10	39	42	30	2
6	Griffin, Alfredo	Oakland	594	169	4	74	51	35	11
7	Newman, Al	Montreal	185	37	1	23	8	21	2
8	Salazar, Argenis	Kansas City	298	73	0	24	24	7	3
9	Thomas, Andres	Atlanta	323	81	6	26	32	8	2
10	Thornton, Andre	Cleveland	401	92	17	49	66	65	13
11	Trammell, Alan	Detroit	574	159	21	107	75	59	10
12	Trevino, Alex	Los Angeles	202	53	4	31	26	27	9
13	Van Slyke, Andy	St Louis	418	113	13	48	61	47	4
14	Wiggins, Alan	Baltimore	239	60	0	30	11	22	6
15	Almon, Bill	Pittsburgh	196	43	7	29	27	30	13
16	Beane, Billy	Minneapolis	183	39	3	20	15	11	3

Insert Rows: Step-by-Step Instructions

By default, the Insert Rows step appends rows from an input table to the end of the output table. You can also add rows to a new table or choose to delete any existing rows in the output table before you insert the new rows.

1 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Insert Rows**.

2 Connect the input port of the Insert Rows node to a data source by using a Table node or an operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see “Connecting Nodes” on page 13.

3 To set the options for the Insert Rows step, click the Insert Rows node.

4 On the **Target Table** tab, enter the library name and table name for the output table.

5 On the Options tab, use the **If physical table does not exist, create a table** option to create an output table if the table does not already exist. This option

is selected by default. If you clear this option, and the table does not already exist when you run the flow, the flow fails with an error.

To delete all of the existing rows in the output table before the rows from the input table are inserted, select **Delete all rows**. This option is not selected by default.

6 On the **Column Structure** tab, specify the column structure for the output table. You can choose from these options:

- **Copy the structure from source**
- **Load structure definition**
- **Generate structure definition**

7 On the **Column Resolution** tab, view the column mappings between the input and output tables. Use the **Filter column mapping** drop-down list to filter the mappings that are displayed. You can filter the mappings by the following categories:

- Successful (✓) - the input column is successfully mapped to a column in the output table. Data for this column is inserted in the corresponding column in the output table.
- Ignored (⊘) - the input column does not have a corresponding column in the output table. Data for this column is ignored in the output table.
- Informational (ⓘ) - the input column cannot be mapped to a column in the output table. For example, an unresolved column can occur when columns have the same name and different data types or when a column exists in the output table and not the input table.

8 Run the flow.

Manage Columns

About the Manage Columns Step

The Manage Columns step enables you to select a subset of columns from an input table and write the columns to an output table. You can use the Manage Columns step to change the names, labels, data types, lengths, formats, informats, and order of columns in the output table. You can also use the Expression Builder to create a new column in the output table. The Manage Columns step can be combined with other steps in which you want to work with only a subset of the columns in a table.

For example, you might want to analyze only the career statistics of players in the Baseball table. You can use the Manage Columns step to create an output table that is based on the Baseball table and includes only the player names, teams, and

the column names that begin with “Cr.” Reducing the number of columns in the data that you are analyzing can improve your performance.

You can choose to generate the output as a view instead of a physical table. A view is a stored query that generates a result set when you access the view. Views do not store data. A view is a virtual table and can be used like a table.

Manage Columns: Connection Requirements for the Node

In order to run the Manage Columns step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output tables by connecting the output port to a Table node. You can also choose to generate the output as a view instead of a physical table. ■ To create a view in the Work library using the output port, click the output port on the Manage Columns node. On the Output Port tab, select **Create a view**. ■ To create a view using a Table node, click the **Table Properties** tab, and select **Create a view**. For more information, see “Adding a Table from a SAS Library to a Flow” on page 34.

Example: Subsetting Columns from the Sashelp.Baseball Data Set

In this example, you select a subset of columns that contain the career statistics of players from the Sashelp.Baseball data set and create a new output table named CareerStats. The CareerStats table contains a subset of the columns and all of the rows that are in the Sashelp.Baseball data set.

To create this example:

1 From the main SAS Data and AI Studio menu, select **New** ⇨ **Flow**.

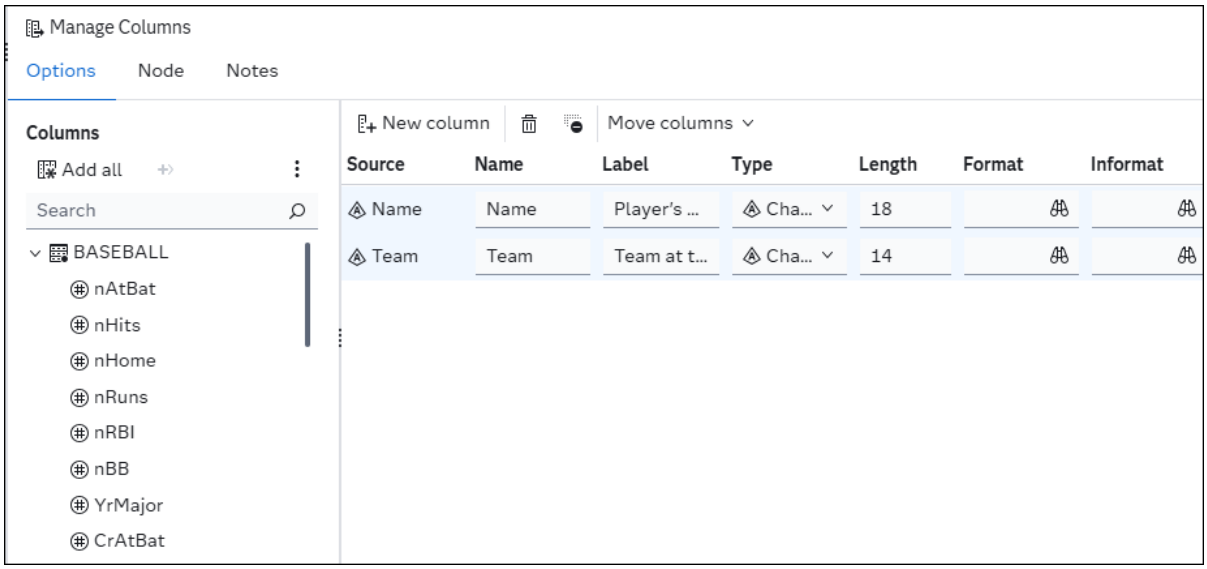
2 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Manage Columns**.

3 Add the Sashelp.Baseball data set to your flow. Connect the input port of the Manage Columns node to the data source. For more information, see "Connecting Nodes" on page 13.

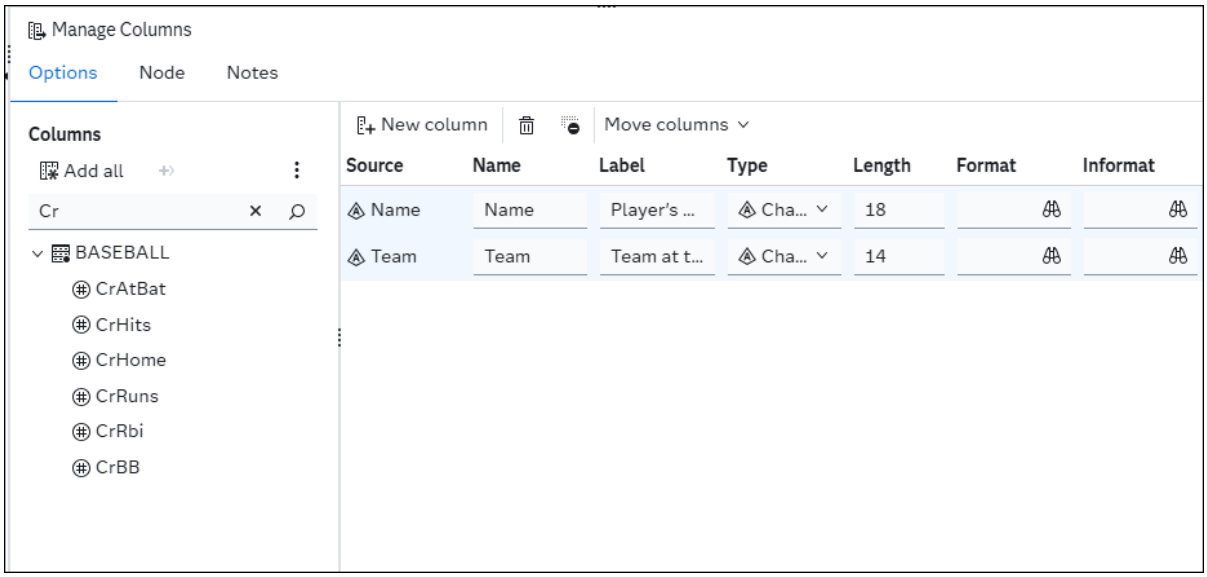
4 On the flow toolbar, click **Add** ⇨ **Table**. To connect the Manage Columns node to the Table node, click the Manage Columns output port and dragging the mouse pointer to the Table node.

5 Click the Table node. In the table properties, enter **`Work`** as the library name and enter **`CareerStats`** as the table name.

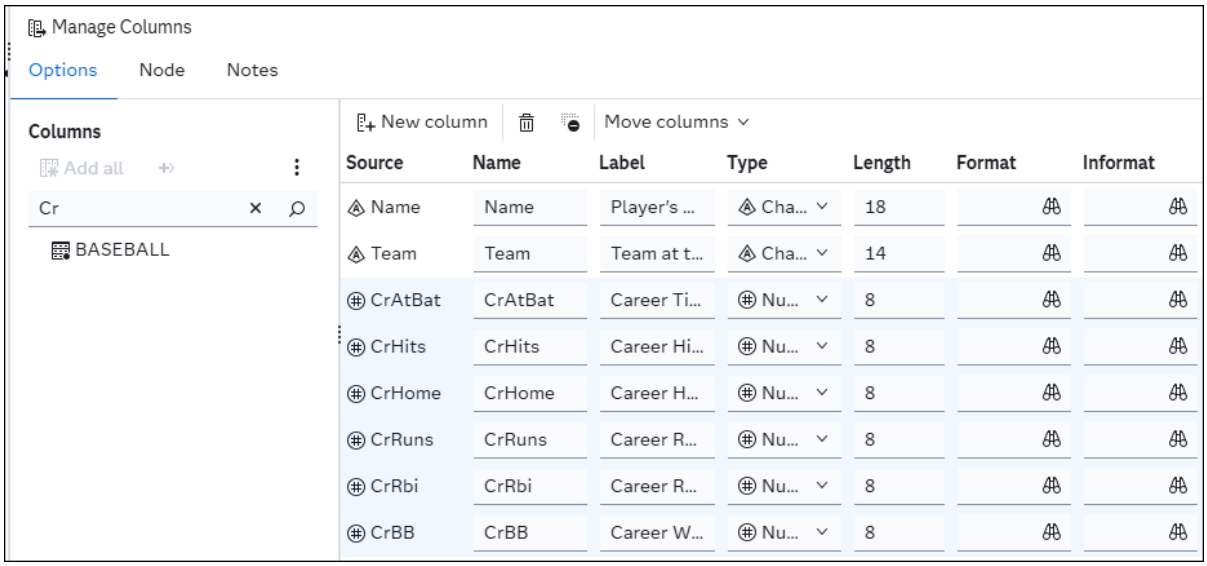
6 Click the Manage Columns node to specify columns for the output table. On the Options tab, right-click the **`Name`** and **`Team`** columns and select **Add columns**.



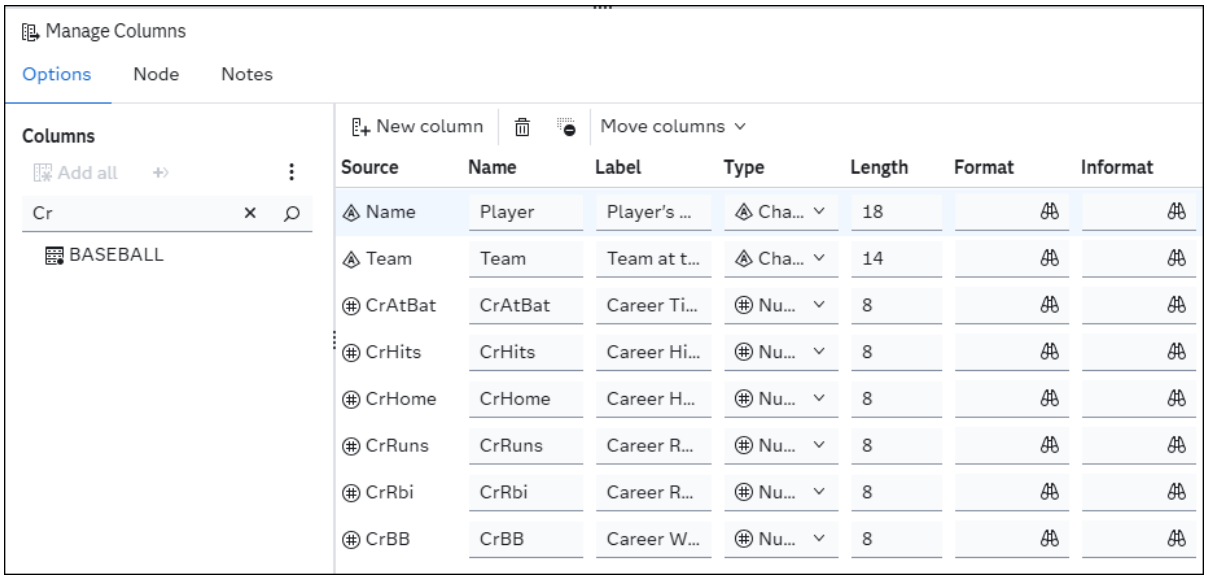
7 In the Columns area, enter **`Cr`** in the Search field and press Enter. The list of columns is filtered and displays only the career statistics columns that start with 'Cr'.



8 Click **Add all** to add all of the visible columns to the list of columns for the output table.

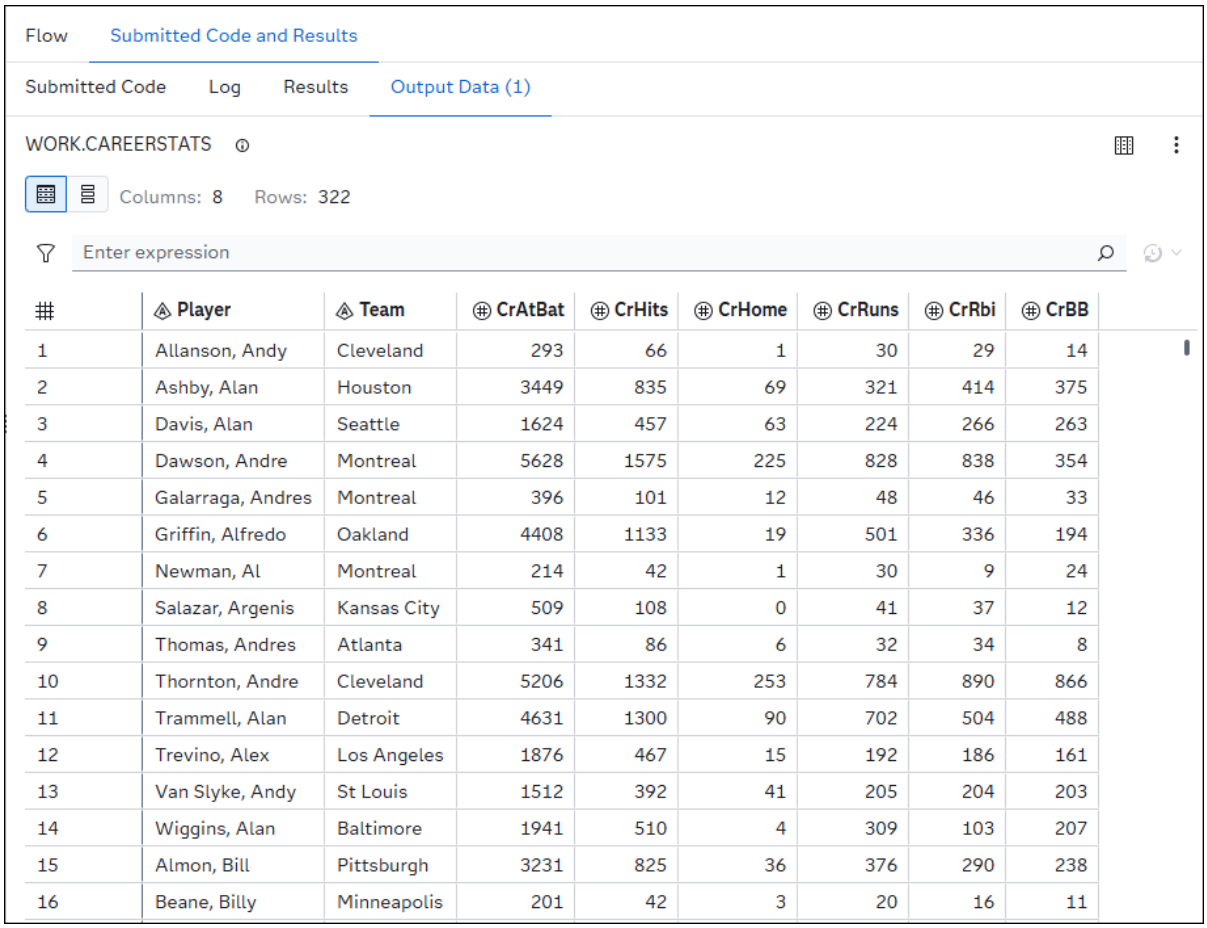


9 Change the Name column to Player by entering `Player` as the new name value.



10 Run the flow.

Click **Submitted Code and Results** to view the output table, which includes all of the rows from the Sashelp.Baseball data set and only the Player, Team, and career statistics columns.



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

WORK.CAREERSTATS

Columns: 8 Rows: 322

Enter expression

	Player	Team	CrAtBat	CrHits	CrHome	CrRuns	CrRbi	CrBB
1	Allanson, Andy	Cleveland	293	66	1	30	29	14
2	Ashby, Alan	Houston	3449	835	69	321	414	375
3	Davis, Alan	Seattle	1624	457	63	224	266	263
4	Dawson, Andre	Montreal	5628	1575	225	828	838	354
5	Galarraga, Andres	Montreal	396	101	12	48	46	33
6	Griffin, Alfredo	Oakland	4408	1133	19	501	336	194
7	Newman, Al	Montreal	214	42	1	30	9	24
8	Salazar, Argenis	Kansas City	509	108	0	41	37	12
9	Thomas, Andres	Atlanta	341	86	6	32	34	8
10	Thornton, Andre	Cleveland	5206	1332	253	784	890	866
11	Trammell, Alan	Detroit	4631	1300	90	702	504	488
12	Trevino, Alex	Los Angeles	1876	467	15	192	186	161
13	Van Slyke, Andy	St Louis	1512	392	41	205	204	203
14	Wiggins, Alan	Baltimore	1941	510	4	309	103	207
15	Almon, Bill	Pittsburgh	3231	825	36	376	290	238
16	Beane, Billy	Minneapolis	201	42	3	20	16	11

Manage Columns: Step-by-Step Instructions

The Manage Columns step requires one input port and one output port. You must select at least one column for the output table.

1. In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Manage Columns**.
2. Connect the input port of the Manage Columns node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.
3. Click the **Manage Columns** node, and then use the Options tab to specify one or more columns for the output table. To add one or more columns, right-click the columns that you want to add to the output table, and select **Add columns**. To add all of the columns that are currently displayed in the Columns area, click **Add all**.

> **TIP** You can specify filter criteria in the Searchh field, and then click **Add all** to add all of the columns that match your filter criteria.

4 In the right pane of the Options tab, you can modify the columns that are selected for the output table in the following ways:

- To add a new column to the output table, click **New column**. Use the Expression Builder to define the new column. For more information, see "Building an Expression" in *SAS Data and AI Studio: User's Guide*. The new column is added to the bottom of the list of columns.
- To remove columns from the right pane, select one or more columns and click . To remove all columns that are currently displayed in the right pane, click .
- To change the order in which the columns appear in the output table, select the column that you want to move. Click **Move columns** and select the appropriate option. The order in which the columns are listed in the right pane of the Options tab determines the order in which the columns appear in the output table.
- Use the appropriate boxes to change the name, label, data type, length, format, or informat.

5 Run the flow.

Note: You can choose to generate the output as a view instead of a physical table.

- To create a view in the Work library using the output port, click the output port on the Manage Columns node. On the Output Port tab, select **Create a view**.
- To create a view using a Table node, click the **Table Properties** tab, and select **Create a view**. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Mask Data

About the Mask Data Step

Use the Mask Data step to perform data masking by using three different obfuscation methods: masking, hashing, or substitution.

- Masking and hashing are one-way encryption methodologies and prevent you from analyzing the obfuscated data.

  Hashing is the transformation of data (known as a message) into a short fixed-length value (known as a digest) that represents the original string. Hashing is used to index and retrieve items in a database because it is faster to find the item using the hashed key than using the original value. Hashing functions are useful when you are developing shell scripts for software installation, file comparison, and detection of file corruption and tampering.

- Substitution enables you to analyze obfuscated data without compromising data integrity. The custom step enables you to implement substitution with a lookup table. You can specify a key column and a value column for each column that you want to substitute. As a result, the original data can be restored by referencing the lookup table.

Mask Data: Connection Requirements for the Node

In order to run the Mask Data step, you must create connections to the input and output ports of the node as indicated here:

Input Ports	Output Port
Two or more connections are required. You can connect either of the following types of nodes: ■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Mask Data: Step-by-Step Instructions for Masking Data

Step 1: Add the Mask Data Step and Connect a Source Table

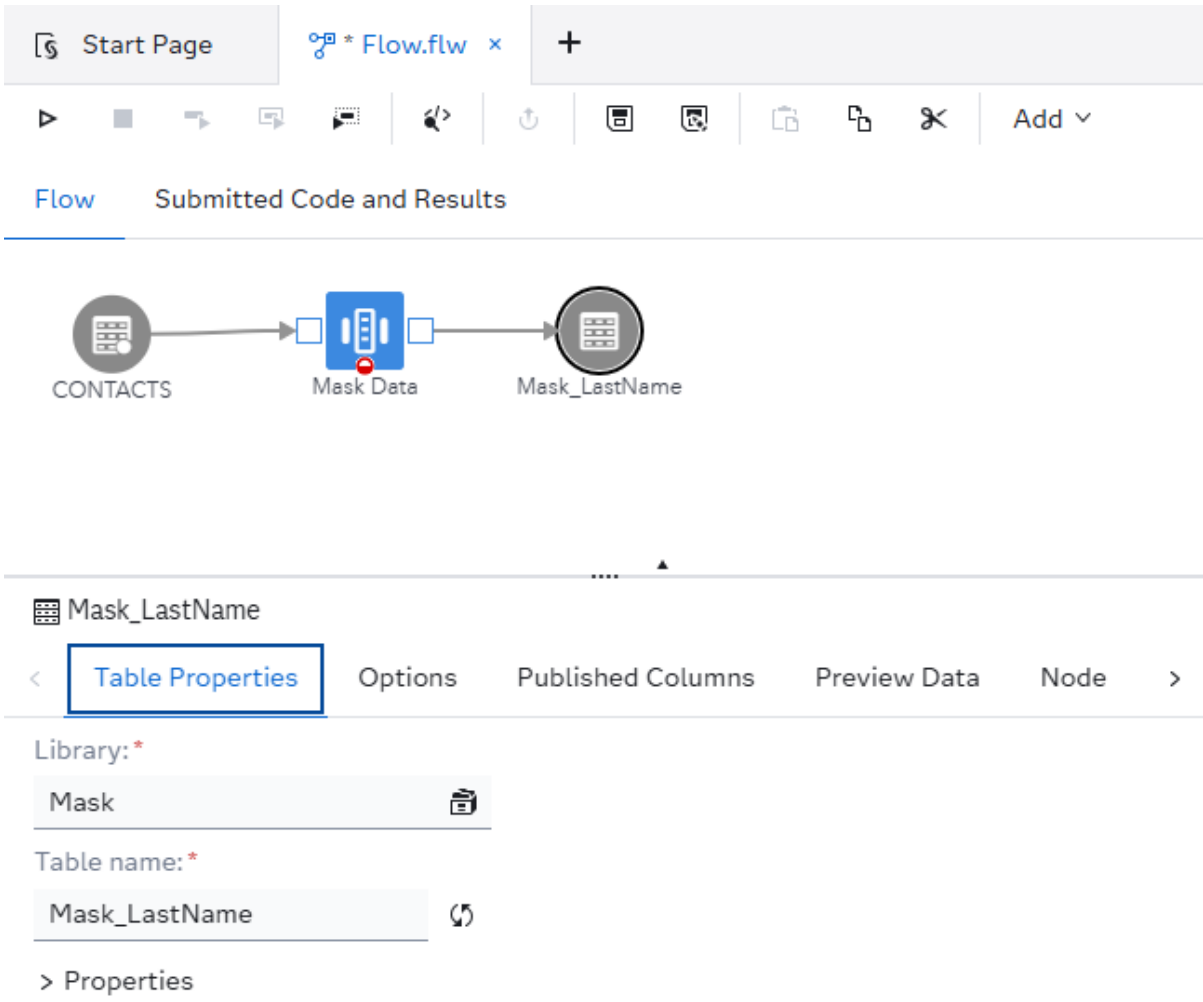
1 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Mask Data** to add the step to your flow.

2 Connect the input port of the Mask Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Mask Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table. (In this example, the output table is named Mask_LastName.)

Next, connect the output port of the Mask Data node to the table node.

Note: The output table does not have any columns until you run the flow.



Step 2: Select the Masking Method for Data Obfuscation

1 Select the QKB locale. You can use the global locale or select a locale.

2 Select **Masking** as the obfuscation method.

Here are the valid masking methods.

Note: All of these definitions are available if you select a QKB locale. If you select a custom locale, the available definitions depend on the selected locale.

- **Anonymize E-mail Domain** - This definition replaces the email domain with nodomain.com. For example, if the input is john.smith@xyz.com or john.smith@xyz.org, the output is john.smith@nodomain.com.

  Note: Any text that is not part of the email address is removed. For example, if the input is John Smith <john.smith@xyz.org>, the output is john.smith@nodomain.com.

- **Mask Address Except Street Type** - This definition replaces every digit with a zero and every alphanumeric character except those that refer to the street type with the * (asterisk) character. For example, if the input is `52 Commerce Street`, the output is `00 ******** Street`.

  Note: The address strings must be in a valid format for the country of the locale. Invalid input entries might not be masked.

- **Mask All Characters** - This definition replaces every alphanumeric, punctuation, and symbol character with the * (asterisk) character. For example, if the input is `John Smith 123`, the output is `**** ****** ***`.
- **Mask All Characters Except First and Last** - This definition replaces all of the characters between the first character and the last character with three * (asterisk) characters. For example, if the input is `John Smith 123`, the output is `J***3`.

  Note: If the input string has three or fewer characters, the entire string is replaced with three * characters. White space is considered a character.

- **Mask Digits** - This definition replaces every digit with the * (asterisk) character. For example, if the input is `John Smith 123`, the output is `John Smith ***`.
- **Mask E-mail Domain** - This definition replaces every non-space character in the complete email domain with the * character. For example, if the input is `john.smith@xyz.com` or `john.smith@xyz.org`, the output is `john.smith@*******`.

  Note: Any text that is not part of the email address is removed.

- **Mask E-mail Mailbox** - This definition replaces every non-space character in the mailbox portion of the email address with the * (asterisk) character. For example, if the input is `john.smith@xyz.com` or `John Smith <john.smith@xyz.com>`, the output is `**********@xyz.com`.

  Note: Any text that is not part of the email address is removed.

- **Mask E-mail Mailbox Except First and Last Characters** - This definition replaces all the characters between the first and last in the mailbox portion of the email address with three * (asterisk) characters. For example, if the input is `john.smith@xyz.com`, the output is `j***h@xyz.com`.

Note: If the mailbox portion of the email address has three or fewer characters, the entire mailbox is replaced with three * characters. For example, if the input is `a@xyz.com`, the output is `***@xyz.com`. White space is considered a character.

- **Mask E-mail Sub-Domain** - This definition replaces every non-space character in the email sub-domain with the * (asterisk) character. For example, if the input is `john.smith@xyz.com`, the output is `john.smith@***.com`.

  Note: Any text that is not part of the email address is removed. For example, if the input is `John Smith <john.smith@xyz.com>`, the output is `john.smith@***.com`.

- **Mask Letters** - This definition replaces every letter with the * (asterisk) character. For example, if the input is `John Smith 123`, the output is `**** ***** 123`.
- **Mask Partial String** - This definition replaces every alphanumeric character except the last four with the * (asterisk) character. For example, if the input is `IT8U676539TX99`, the output is `**********TX99`.

  Note: This string must be longer than four characters. Any strings that contain four or fewer characters are not masked.

- **Mask Phone Number** - This definition replaces every alphanumeric character except the last four alphanumeric characters of the base number with the * (asterisk) character. For example, if the input is `(507) 334-1871 ext151`, the output is `*** ***1871 ***`.

  Note: This definition is designed for single phone numbers in a valid format for the country of the locale. Invalid input might not be masked. There might be some format changes, such as parenthesis removal, that occurs prior to masking.

- **Truncate Word to Initial** - This definition removes all characters except the first letter or digit of each alphanumeric sub-string. For example, if the input is `John Smith 123`, the output is `J S 1`.

  Note: Sub-strings are delimited by punctuation, symbols, and white space with the exception of periods and commas in decimal numbers.

3 Select the column to mask.

4 Specify whether to replace an existing column or create a column for the masked data.

By default, the masked data replaces the input column, and the column name remains the same. If a column is created, the new column name is *InputColumnName*_Masked.

Step 3: Set the Options

On the **Options** tab, select **Show detailed log information** to include debugging information in the log.

Step 4: Specify the Output Data

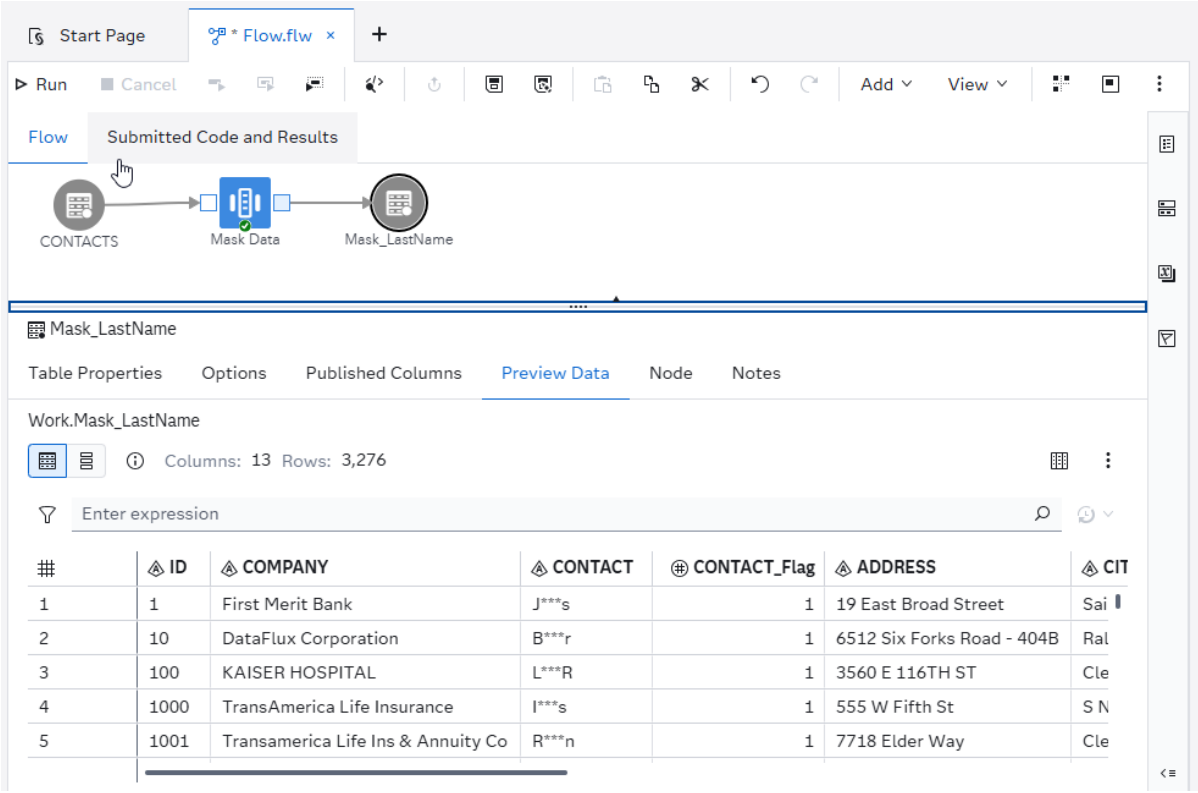
Select the **Output** tab to set these options:

1. (Optional) Select **Replace existing output table with the same name** to replace an existing table with the new table. Any output tables are replaced by default.
2. To create a CAS table from the output data, select these options:
   - **Promote to a global in-memory table**
   - **Save to persist the table on disk**
   - **File format**

Step 5: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node and click **Preview Data**.



Mask Data: Step-by-Step Instructions for Hashing Data

Step 1: Add the Mask Data Step and Connect a Source Table

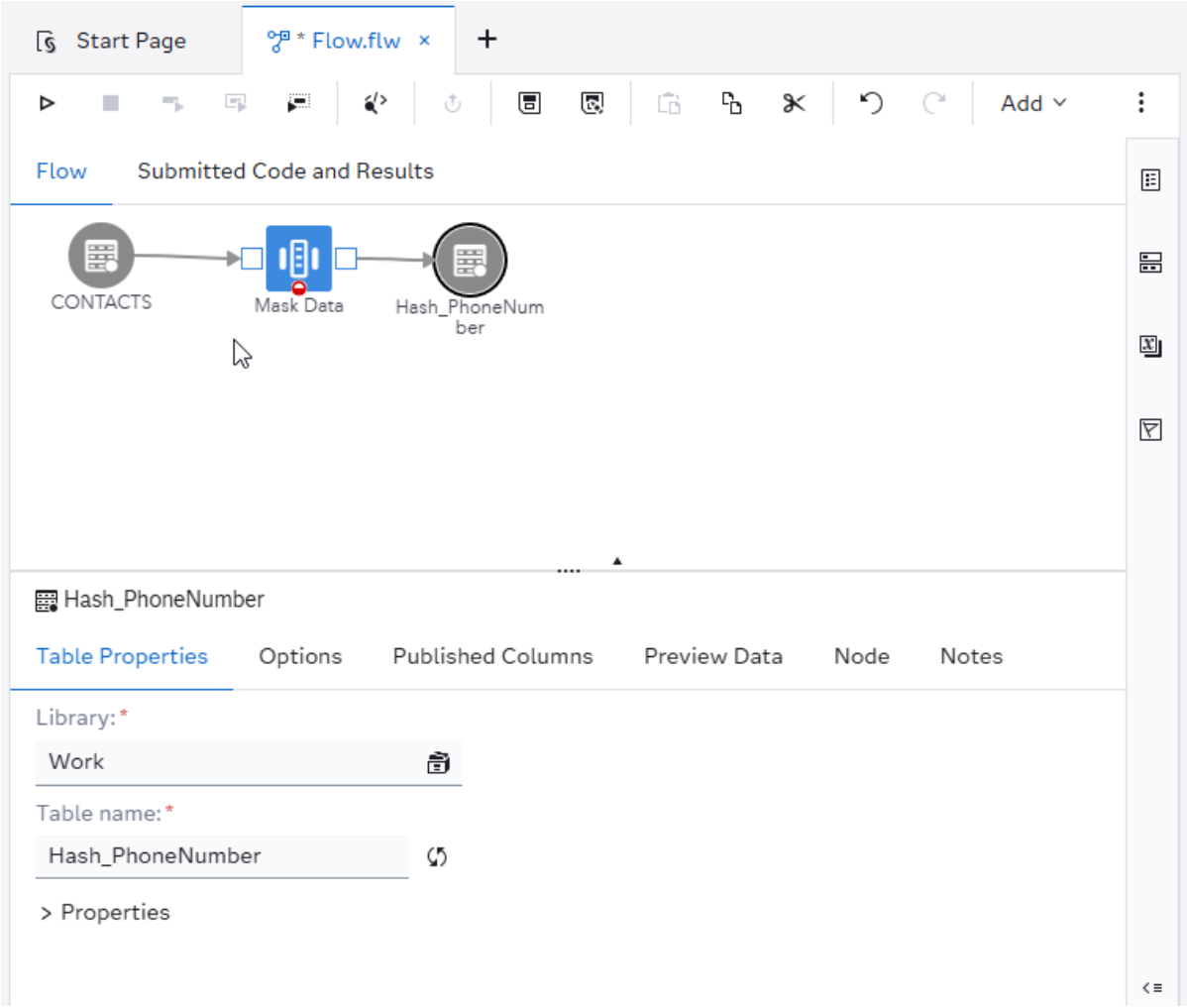
1 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Mask Data** to add the step to your flow.

2 Connect the input port of the Mask Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Mask Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table . (In this example, the output table is Hash_PhoneNumber.)

Next, connect the output port of the Mask Data node to the table node.

Note: The output table does not have any columns until you run the flow.



Step 2: Select the Hashing Method for Data Obfuscation

Note: The Hashing method ignores the QKB locale.

1 Select **Hashing** as the obfuscation method.

2 Select the hashing method.

3 Select the hash column.

4 Specify whether to replace an existing column or create a column for the hashed data.

By default, the hashed data replaces the input column, and the column name remains the same. If a column is created, the new column name is *InputColumnName*_Hashed.

5 (Optional) Select **Transcode data to UTF-8**.

6 If you want to authenticate your data by using a shared secret key, select **Use Hash-based Message Authentication Code (HMAC)**. Then specify the secret key. The strength of the HMAC depends on the size of the secret key.

7 (Optional) To mask additional columns, set the options under the Data Obfuscation heading.

Step 3: Set the Options

On the **Options** tab, select **Show detailed log information** to include debugging information in the log.

Step 4: Specify the Output Data

Select the **Output** tab to set these options:

1 (Optional) Select **Replace existing output table with the same name** to replace an existing table with the new table. Any output tables are replaced by default.

2 To create a CAS table from the output data, select these options:

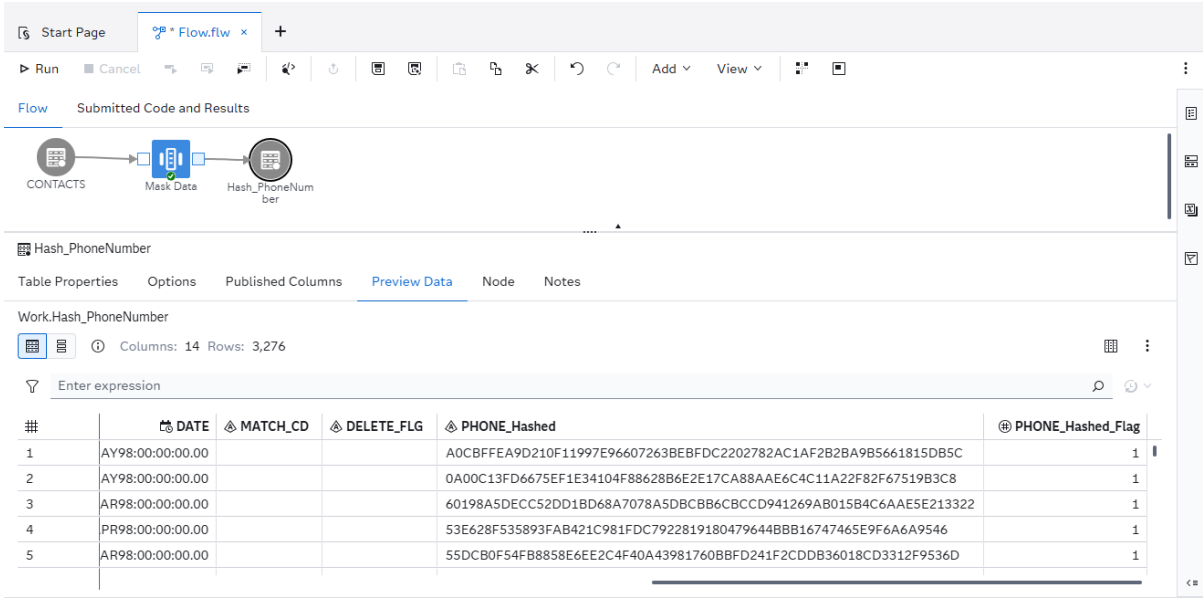
- **Promote to a global in-memory table**
- **Save to persist the table on disk**
- **File format**

Step 5: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

In this example, the new Phone_Hashed column contains the masked data. The Phone_Hashed_Flag column contains a value of `1` if the value from the Phone column was successfully hashed. The Phone_Hashed_Flag column contains a `0` if the value from the Phone column could not be hashed.



Mask Data: Step-by-Step Instructions for Substituting Data

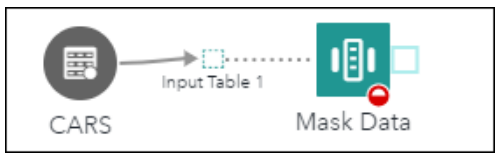
Step 1: Add the Mask Data Step and Connect a Source Table

To use the substitution method, you must have an input table and a lookup table.

1 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Mask Data** to add the step to your flow.

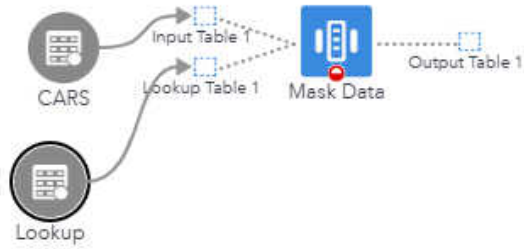
2 Connect the input port of the Mask Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. (In this example, the input table is Cars.) For more information, see “Connecting Nodes” on page 13.

3 Right-click the Mask Data node and select **Expand ports**.



4 Right-click the Mask Data node again and select **Add input port**. The flow now includes a port called Lookup Table 1.

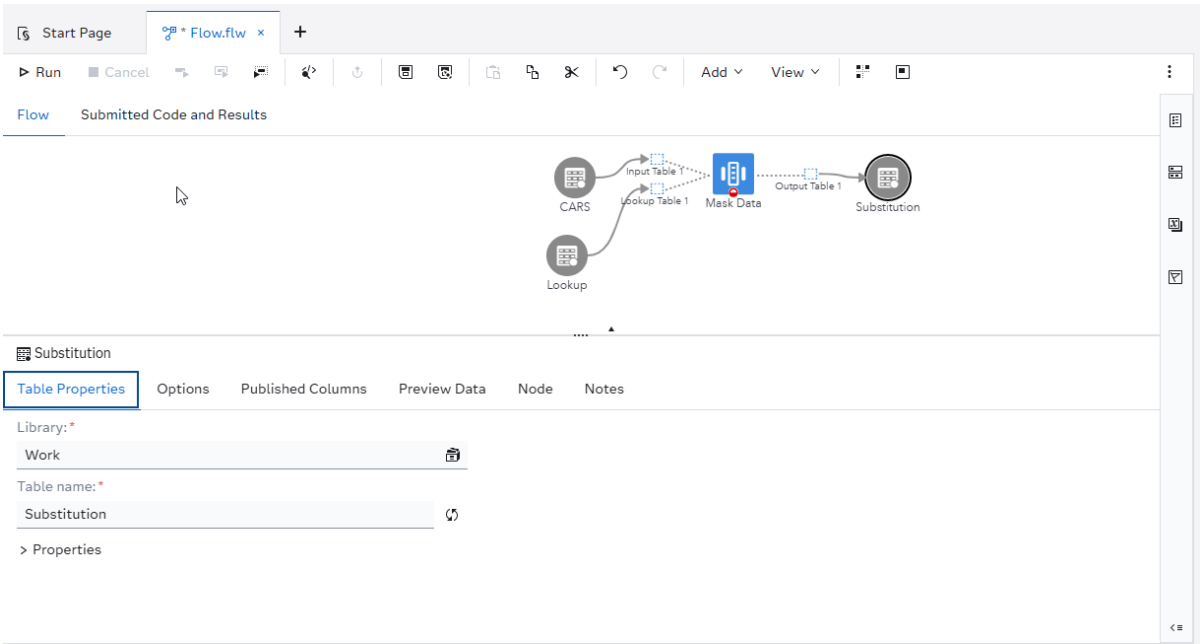
5 Add the lookup table to the flow and connect it to the Lookup Table 1 port. (In this example, the lookup table is Lookup.)



6 To save the results from the Mask Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table. (In this example, the output table is Substitution.)

Next, connect the output port of the Mask Data node to the table node.

Note: The output table does not have any columns until you run the flow.



Step 2: Select the Substitution Method for Data Obfuscation

Note: The Substitution method ignores the QKB locale.

1 Select **Substitution** as the obfuscation method.

2 Assign a column in the lookup table to the **Key column** role.

3 Assign a column in the lookup table to the **Value column** role.

4 Assign a column to the **Substitute column** role.

5 If the value in the input column does not match any value in the key column, specify whether to return the original value or a missing value. By default, the original value is returned.

6 Specify whether to replace the existing column or create a column.

By default, the substitute column replaces the input column and uses the same name. If a column is created, the name of the new column is *InputColumnName*_Sub.

7 (Optional) To mask additional columns, set the options under the Data Obfuscation heading.

Step 3: Set the Options

On the **Options** tab, select **Show detailed log information** to include debugging information in the log.

Step 4: Specify the Output Data

Select the **Output** tab to set these options:

1 (Optional) Select **Replace existing output table with the same name** to replace an existing table with the new table. Any output tables are replaced by default.

2 To create a CAS table from the output data, select these options:

- **Promote to a global in-memory table**
- **Save to persist the table on disk**
- **File format**

Step 5: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Suppose the values in the Cylinders column were replaced. The Cylinders_Flag column contains a `1` if the value in the Cylinders column was replaced. If the value was not replaced, the value in the Cylinders_Flag column is `0`.

Query

About the Query Step

Use the Query step to select, join, filter, and sort columns from a table in a flow. By default, output for the Query step is written to a table in the Work library. Query node output ports can be connected to a Table node, a Query node, or a SAS Program node.

Note: If the query results are generated using PROC SQL, you can choose to create a view instead of a physical table. A view is a stored query that generates a result set when you access the view. Views do not store data. A view is a virtual table and can be used like a table. For information about using PROC SQL and PROC FedSQL to generate queries, see "Generating a FedSQL Query" in *SAS Data and AI Studio: User's Guide*.

TIP You can also use the Branch Rows step and the Filter Rows step to select a subset of rows from an input table. For more information, see "Understanding the Steps That Subset Data" on page 83.

Query: Connection Requirements for the Node

In order to run the Query step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output data by connecting the output port to a Table node. If the query results are generated using PROC SQL, you can choose to create a view instead of a physical table. ■ To create a view in the Work library using the output port, click the output port on the Query node. On the Output Port tab, select **Create a view**.

Input Port	Output Port
	■ To create a view using a Table node, click the **Table Properties** tab, and select **Create a view**. For more information, see "About the Table Node" on page 21.

Query: Step-by-Step Instructions

The Query step requires one input port and one output port. You must select at least one column for the output. The Query node interface is mostly the same as the interface for standalone queries. For more information, see "Working with Queries" in *SAS Data and AI Studio: User's Guide*.

Note: If your query contains only Oracle, only SingleStore, or only Snowflake tables, you can use explicit pass-through processing.

1 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Query** to add the step to your flow.

2 Connect the Query node to a data source by using a Table node, an Import node, a Query node, or a SAS Program node.

Note:

- If you disconnect a data source from the Query node, any join conditions become unresolved until you connect a new data source.
- If you are joining tables and want to use the Expression Builder, enter the code for the FROM clause in the expression area. Enter only the code for the clause. Do not include the FROM keyword or the semicolon statement terminator in the code that you enter.

  For example, enter this expression to join the CLASS and CLASSFIT tables by using the Name column:

```
SASHELP.CLASS t1
   INNER JOIN SASHELP.CLASSFIT t2 ON (t1.'Name'n = t2.'Name'n)
```

TIP You can quickly add a Query node to the flow and connect the node to an input data source by right-clicking the input data source and selecting **Add a query**. Valid input data sources include a Table node or the output ports of the operational nodes, which include Import, SAS Program, and Query.

3 Click the **Query** node, click the **Options** tab, and then select output columns.

4 By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output data by connecting the output port to a Table node.

Note: If the query results are generated using PROC SQL, you can choose to create a view instead of a physical table.

- To create a view in the Work library using the output port, click the output port on the Query node. On the Output Port tab, select **Create a view**.
- To create a view using a Table node, click the **Table Properties** tab, and select **Create a view**. For more information, see "About the Table Node" on page 21.

Rank Data

About the Rank Data Step

The Rank Data step computes ranks for one or more numeric variables across the rows in a table and includes the ranks in an output table.

An example of when you might use the Rank Data step is to rank product sales. In this case, the ranking variable would show the order of product sales. The product with the highest number of sales would be ranked first.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Rank Data: Connection Requirements for the Node

In order to run the Rank Data step, you must create connections to the input and output ports of the node as indicated here:

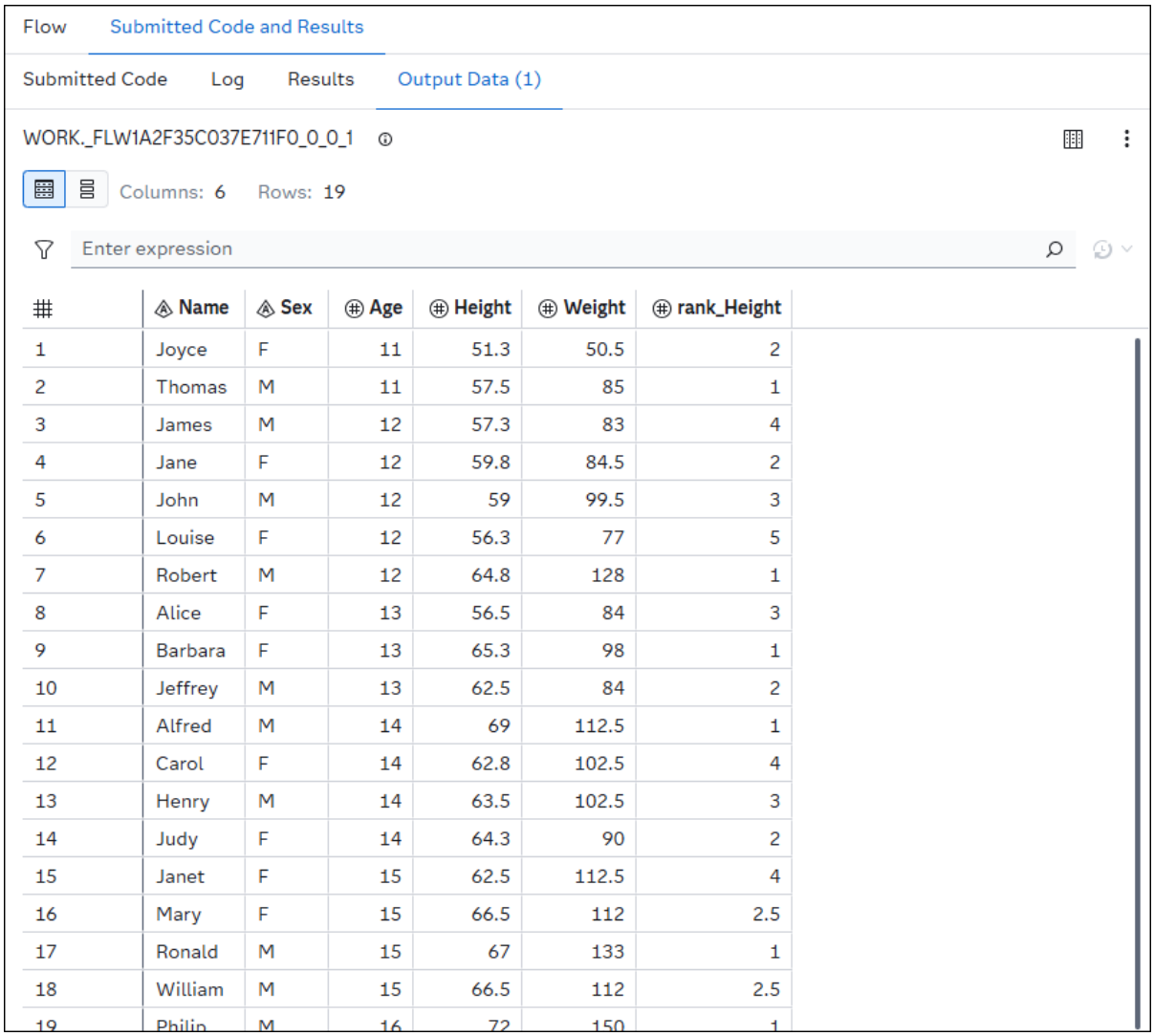
Input Port	Output Port
■ Table node	No connection is required.

Input Port	Output Port
or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	**Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Ranking Students by Height within Age

1. In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Rank Data** to add the step to your flow.
2. Add the Sashelp.Class table to your flow. Connect the input port of the Rank Data node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Rank Data step, click the Rank Data node.
4. On the **Data** tab, assign columns to these roles:
   - For the **Columns to rank** role, assign **Height**.
   - For the **Rank by** role, assign **Age**.
5. Open the **Options** tab. From the **Rank order** drop-down list, select **Largest to smallest**.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the output data. This table contains the additional rank_Height column, which shows where that student ranks within her age group. For example, in the 11-year-old age group, Joyce is ranked number 2. In the 12-year-old age group, Louise is ranked number 5.



	Name	Sex	Age	Height	Weight	rank_Height
1	Joyce	F	11	51.3	50.5	2
2	Thomas	M	11	57.5	85	1
3	James	M	12	57.3	83	4
4	Jane	F	12	59.8	84.5	2
5	John	M	12	59	99.5	3
6	Louise	F	12	56.3	77	5
7	Robert	M	12	64.8	128	1
8	Alice	F	13	56.5	84	3
9	Barbara	F	13	65.3	98	1
10	Jeffrey	M	13	62.5	84	2
11	Alfred	M	14	69	112.5	1
12	Carol	F	14	62.8	102.5	4
13	Henry	M	14	63.5	102.5	3
14	Judy	F	14	64.3	90	2
15	Janet	F	15	62.5	112.5	4
16	Mary	F	15	66.5	112	2.5
17	Ronald	M	15	67	133	1
18	William	M	15	66.5	112	2.5
19	Philip	M	16	72	150	1

Note: In this example, the output data is saved to the temporary Work library. To save this data to a permanent table, connect a table to the output port of the Rank Data node.

Rank Data: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Assign at least one variable to the **Columns to rank** role. The rankings column is given the name `rank_`*column-name*, where *column-name* is the name of the original column.

3 (Optional) Assign one or more variables to this role. The input table is sorted by the selected column or columns and rankings are calculated within each group.

Step 2: Set the Method Options

On the **Options** tab, you can set these options for the method.

1 Select the ranking method. Here are the valid values:

Ranks
partitions the original values into 100 groups, in which the smallest values receive a percentile value of 0 and the largest values receive a percentile value of 99.

Quantiles
partitions the original values into one of these quantiles.

- **Percentiles** partitions the data into 100 groups, in which the smallest values receive a percentage value of 0 and the largest values receive a percentage value of 99.
- **Deciles** partitions the original values into 10 groups, in which the smallest values receive a decile value of 0 and the largest values receive a decile value of 9.
- **Quartiles** partitions the original values into four groups, in which the smallest values receive a quartile value of 0 and the largest values receive a quartile value of 3.
- **N-tile groups** partitions the original values into *n* groups, in which the smallest values receive a value of 0 and the largest values receive a value of *n*–1. Specify the value of *n* in the **Number of groups** box.

Fractional ranks
computes the fractional ranks by using either a denominator of N or N+1. A denominator of N computes fractional ranks by dividing each rank by the number of observations that have nonmissing values of the ranking variable. A denominator of N+1 computes fractional ranks by dividing each rank by the denominator *n*+1, where *n* is the number of observations that have nonmissing values of the ranking variable.

Percentages
divides each rank by the number of observations that have nonmissing values of the variable and multiplies the result by 100 to get a percentage.

Normal scores of ranks
computes normal scores from the ranks. The resulting variables appear normally distributed.

Note: If you set the **If values are tied, use** option, the Rank Data step computes the normal score from the ranks based on non-tied values and applies the ties specification to the resulting score.

Savage scores of ranks
computes Savage (or exponential) scores from the ranks.

Note: If you set the **If values are tied, use** option, the Rank Data step computes the Savage score from the ranks based on non-tied values and applies the ties specification to the resulting score.

2 Specify how to compute normal scores or ranks for tied values.

Default method
assigns the default method for your ranking method. If you select **Percentages** or **Fractional** ranks as the ranking method, the high value is the default. For all other ranking methods, the mean is the default.

Mean of ranks
assigns the mean of the corresponding rank or normal scores.

High rank
assigns the largest of the corresponding ranks or normal scores.

Low rank
assigns the smallest of the corresponding ranks or normal scores.

Dense rank (ties are the same rank)
computes scores and ranks by treating tied values as a single-order statistic. For the default method, ranks are consecutive integers that begin with the number 1 and end with the number of unique, nonmissing values of the variable that is being ranked. Tied values are assigned the same rank.

3 Use the **Rank order** option to list the values from smallest to largest or from largest to smallest.

Step 3: Specify the Output Data

On the **Output** tab, you can set these options:

1 To replace an existing output table with the same name, select **Replace existing output table**.

2 To replace the original column with the ranked columns, clear the **Create new variables for the ranked variables** check box. If this option is selected, the output table contains the original columns as well as the ranked columns.

The ranked column is given the name `rank_`*column-name*, where *column-name* is the name of the original column.

3 Specify whether to show the output data in the Results tab.

Recode Ranges

About the Recode Ranges Step

The Recode Ranges step enables you to specify a range of numeric values and change all of the values in the range to another value. For example, you could replace test scores from 90 to 100 with a letter grade of "A," scores from 80 to 89 with a letter grade of "B," and so on.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Recode Ranges: Connection Requirements for the Node

In order to run the Recode Ranges step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. You can create an output table using the options on the **Output** tab. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Updating the Values for a Numeric Variable

1 Copy and paste this code on a **SAS program** tab.

```
data work.test;
    do num=1 to 9;
      output;
    end;
 run;
```

Click **Run** to create the Work.Test table.

2 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Recode Ranges** to add the step to your flow.

3 Add the Work.Test table to your flow. Connect the input port of the Recode Ranges node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Recode Ranges step, click the Recode Ranges node.

5 Assign **num** to the **Variables to recode** role.

6 Click the **Values** tab.

7 Select **Recode to numeric variable**.

8 For the lower bound, enter `1`. For the upper bound, enter `4`. For the new recoded value, enter `100`. Click +. A new row is added to the table.

9 In the lower bound, enter `4.1`. For the upper bound, enter `9`, For the new value, enter `200`.

10 Click the **Output** tab. Verify that you are writing the output table to another data set and not the input data set.

11 Add an output table to the flow.

   a Select **Add** ⇨ **Table**. A Table node is added to the flow.

   b Select the Table node. In the table properties, enter `Work` as the library and enter `Recoded_Ranges` as the table name.

   c Right-click the Recode Ranges node and select **Add output port**.

   d Connect the new output port to the Work.Recoded_Ranges table.

12 Run the flow.

Click the **Submitted Code and Results** tab to view the output data.

Any values in the input data set between 1 and 4 (inclusive) are recoded as 100. Values greater than 4.1 and less than or equal to 9 are recoded as 200.

Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK.RECODED_RANGES

Columns: 2 Rows: 9

Enter expression

	num	_recodeVar_
1	1	100
2	2	100
3	3	100
4	4	100
5	5	200
6	6	200
7	7	200
8	8	200
9	9	200

Recode Ranges in Your Data: Step-by-Step Instructions

1. On the **Data** tab, assign the variable whose values you want to change to the **Variable to recode** role.
2. On the **Values** tab, specify whether to recode the values to a character variable or a numeric variable. Specify the lower bound and upper bound for the range, and then enter the recoded value. To specify additional values, click +.
3. (Optional) Select the **Specify value for out of range data** check box if you might have data that is not specified in one of the ranges. Enter the value to use for this out-of-range data.
4. On the **Output** tab, specify a name for the variable that contains the recoded values. If you do not specify a recoded value for an observation, the same value is used for the observation in the recoded column. The default name is _recodeVar_.
5. Specify whether you want to add the recoded variable to the existing input data set or whether you want to create an output data set. You must specify a name for the output data set or use the default name. The resulting data sets contain the same information—all the variables from the input data set plus the new recoded variable.

   Note: If you are running this step in a flow, you must add an output table to the flow and connect any output tables to the Recode Ranges. For more information, see "Recode Ranges: Connection Requirements for the Node" on page 130.
6. Run the step.

Recode Values

About the Recode Values Step

The Recode Values step enables you to change the values of character and numeric variables. With this step, you can specify single values to be recoded as other values of the same type. For example, if your data contains a column named Gender

with possible values of "M" and "F," you can substitute "Male" for values of "M" and "Female" for values of "F" in your output data set.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Recode Values: Connection Requirements for the Node

In order to run the Recode Values step, you must create connections to the input port of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. You can create an output table using the options on the **Output** tab. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Examples: Recode Values Step

Example 1: Updating the Values for a Numeric Variable

1 Copy and paste this code on a **SAS program** tab:

```
data work.test;
    do num=1 to 5;
       if num <= 2 then char="abc";
       else if num = 3 then char="d";
       else char="ef";
```

```
      output;
   end;
run;
```

Click **Run** to create the Work.Test table.

2 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Recode Values** to add the step to your flow.

3 Add the Work.Test table to your flow. Connect the input port of the Recode Values node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Recode Values step, click the Recode Values node.

5 Select the **Numeric variable** option.

6 Assign **num** to the **Variables to recode** role.

7 Click the **Values** tab.

8 For the old value, enter `1`. For the new value, enter `1.1`. Click +. A new row is added to the table.

9 In the new row, enter `2` as the old value. For the new value, enter `2.2`.

10 Add an output table to the flow.

   a Select **Add** ⇨ **Table**. A Table node is added to the flow.

   b Select the Table node. In the table properties, enter `Work` as the library and enter `Recoded_Values` as the table name.

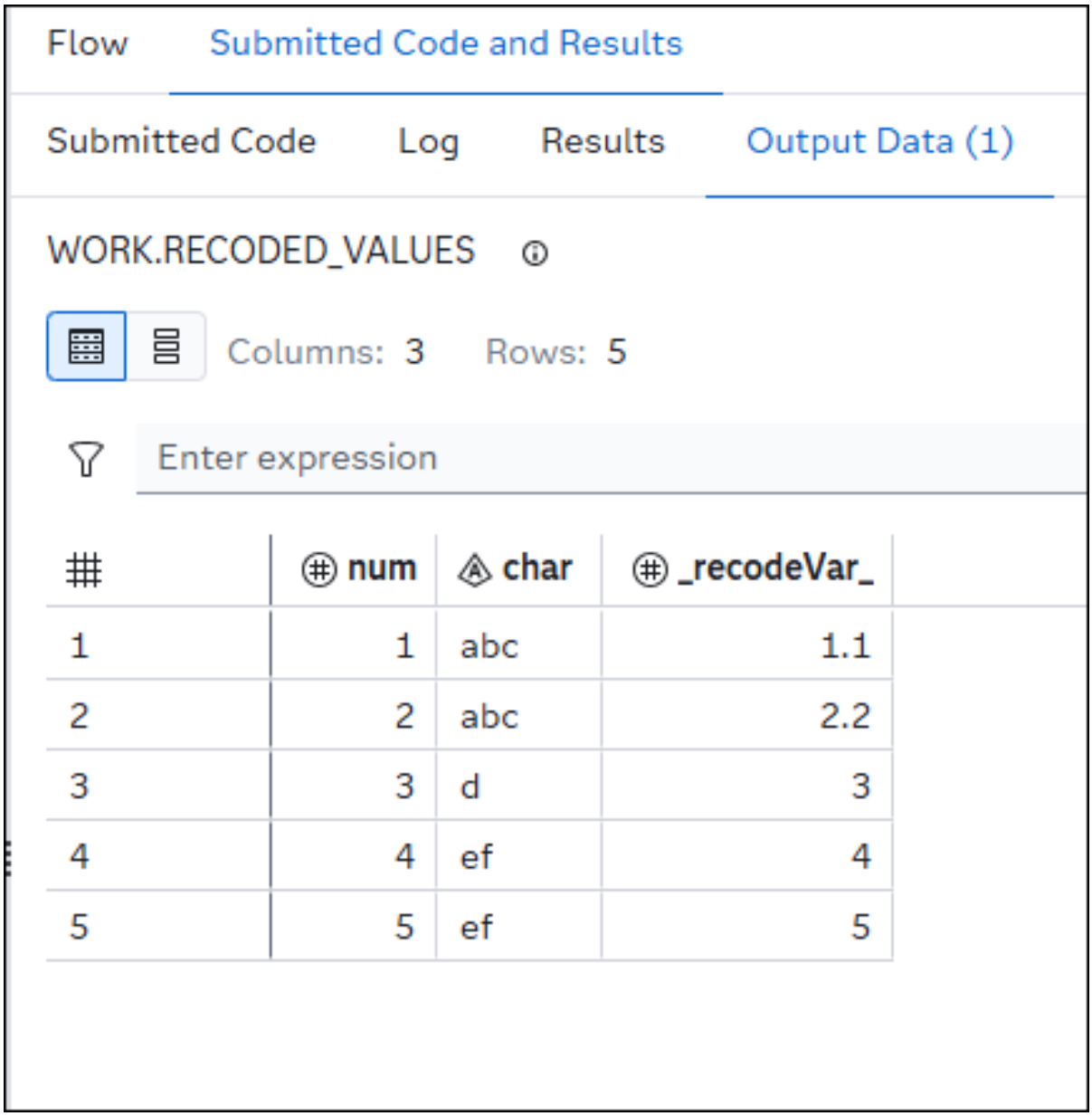
   c Right-click the Recode Values node and select **Add output port**.

   d Connect the new output port to the Work.Recoded_Values table.

11 Run the flow.

Click the **Submitted Code and Results** tab to view the output data.

Here is the output table. The coded values are in the _recodeVar_ column.



	num	char	_recodeVar_
1	1	abc	1.1
2	2	abc	2.2
3	3	d	3
4	4	ef	4
5	5	ef	5

Example 2: Updating the Values for a Character Variable

1 Copy and paste this code on a **SAS program** tab:

```
data work.test;
    do num=1 to 5;
       if num <= 2 then char="abc";
       else if num = 3 then char="d";
       else char="ef";
       output;
    end;
 run;
```

Click **Run** to create the Work.Test table.

2 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Recode Values** to add the step to your flow.

3 Add the Work.Test table to your flow. Connect the input port of the Recode Values node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Recode Values step, click the Recode Values node.

5 Select the **Character variable** option.

6 Assign **char** to the **Variables to recode** role.

7 Click the **Values** tab.

8 For the old value, enter **`abc`**. For the new value, enter **`ABC`**. Click +. A new row is added to the table.

9 In the new row, enter **`ef`** as the old value. For the new value, enter **`efgh`**.

10 Add an output table to the flow.

   a Select **Add** ⇨ **Table**. A Table node is added to the flow.

   b Select the Table node. In the table properties, enter **`Work`** as the library and enter **`Recoded_Values_Ex2`** as the table name.

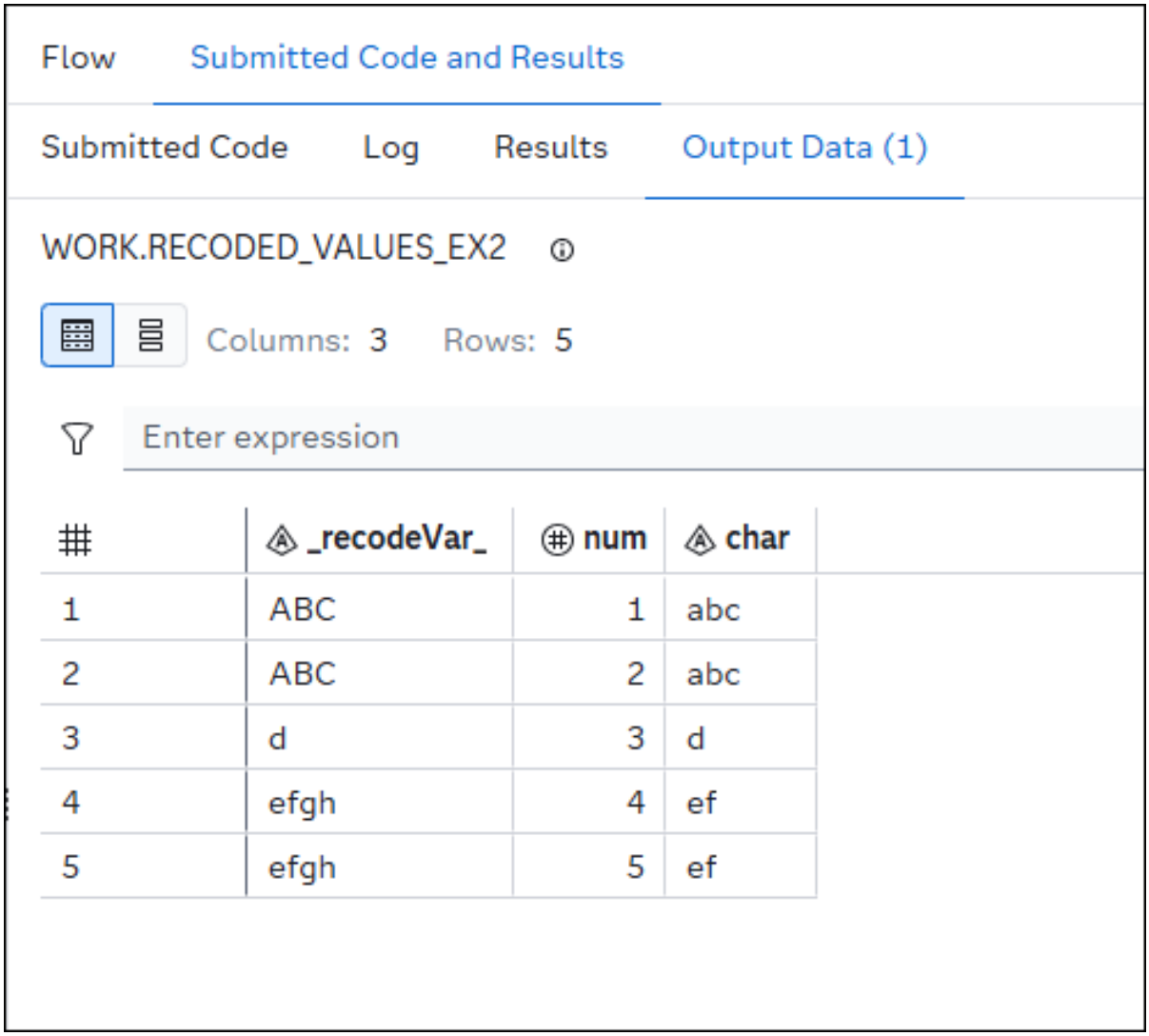
   c Right-click the Recode Values node and select **Add output port**.

   d Connect the new output port to the Work.Recoded_Values_Ex2 table.

11 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Here is the output table. The coded values are in the _recodeVar_ column.



	recodeVar	num	char
1	ABC	1	abc
2	ABC	2	abc
3	d	3	d
4	efgh	4	ef
5	efgh	5	ef

Recode Values in Your Data: Step-by-Step Instructions

1. On the **Data** tab, specify whether you are recoding values for a numeric or character variable.
2. Assign the variable whose values you want to change in the **Variable to recode** role.
3. On the **Values** tab, specify the old and new values.

   Note: If you are specifying date values, you must use the unformatted integer value for the date. You cannot use a formatted value or a literal value.

4 On the **Output** tab, specify a name for the variable that contains the recoded values. If you do not specify a recoded value for an observation, the same value is used for the observation in the recoded column. The default name is _recodeVar_.

5 Specify whether you want to add the recoded variable to the existing input data set or whether you want to create an output data set. You must specify a name for the output data set or use the default name. The resulting data sets contain the same information—all the variables from the input data set plus the new recoded variable.

6 Run the step.

Remove Duplicates

The Remove Duplicates node enables you to remove duplicate rows from an input data source.

- If your input data and output data are in a SAS library, the step runs the SORT procedure by using the NODUPKEY option to remove the duplicate data.
- If your input data and output data are in a CAS library, the step uses the simple.GroupByInfo action to remove the duplicate data.

To remove duplicates from a data source:

1 Click the **Steps** section of the navigation pane.

2 Expand the **Transform Data** folder and double-click the Remove Duplicates node.

3 Add the input data source to the flow. Connect the data source to the input port of the Remove Duplicates node.

4 Click the Remove Duplicates node. Select the **Remove duplicates across all columns** check box. If you clear this check box, select the columns to group by to determine whether there are duplicate rows in the data.

5 Specify these output options:

   - **Replace existing output table with the same name**
   - Specify whether to write the duplicate rows to the log or save the duplicate rows to a table.
   - For CAS output tables:
     - Specify whether to promote the table and save the table.
     - (Optional) Specify the file format (in lowercase) for the output table.

Sort

About the Sort Step

The Sort node enables you to order your data by the values of one or more columns. By default, output for the Sort node is written to a table in the Work library. Sort node output ports can be connected to Table, Query, and SAS Program nodes.

Sort: Connection Requirements for the Node

In order to run the Sort step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

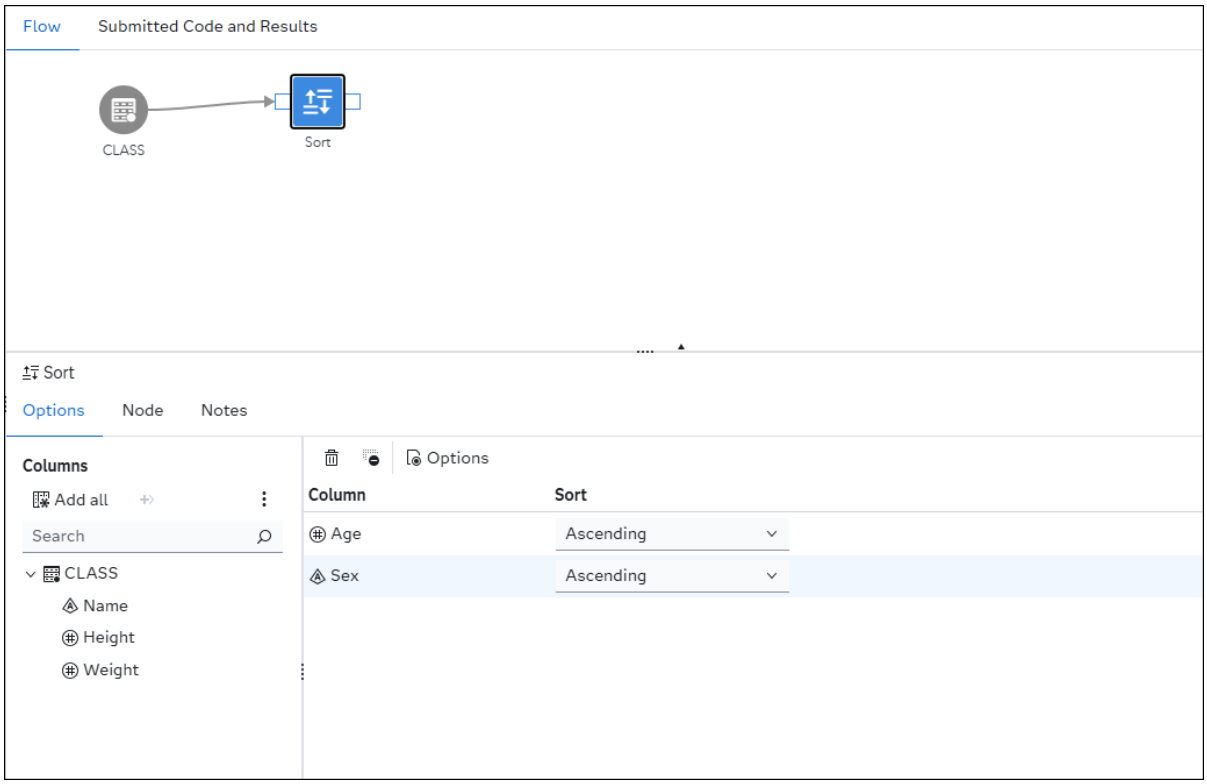
Sort: Step-by-Step Instructions

To sort a table:

1. Click the **Steps** section of the navigation pane.
2. Expand the **Transform Data** folder and double-click the **Sort** node.
3. Add the input data to your flow. Connect the input port of the Sort node to the data source. For more information, see "Connecting Nodes" on page 13.

4 Click the **Sort** node, and use the **Options** tab to add one or more columns. To add one or more columns, select the columns that you want to add to the sort, and then click **Add columns**. To add all of the columns, click **Add all**.

The order in which the columns are listed on the **Options** tab determines which variable is the primary sort key, which variable is the secondary sort key, and so on. The primary sort key is always the first variable in the list.



5 To specify the following optional arguments to the sort criteria, click **Options** on the toolbar.

- **Specify the output order** - specifies the order of the rows in the output data set.
- **Duplicate rows** - specifies whether to keep all rows that are in the output table, including duplicate rows.
- **Force redundant sorting** - sorts and replaces the data set and destroys all user-created indexes for the data set.
- **Use tags to sort large data** - reduces temporary disk usage by storing only the BY variables and observation numbers in temporary files.

Click **OK** to save your changes.

Split Columns

About the Split Columns Step

The Split Columns step creates an output table by splitting the unique combination of values of the selected columns in the input table into multiple columns. You can use the output table to individually analyze the columns that contain multiple rows of the input table.

This functionality is useful when you have a table in which one column contains multiple observations for different subgroups and you want to split the subgroup measures into separate columns. For example, you could transpose a column that contains the monthly temperature readings for various locations across a geographic region. The output table would contain the monthly temperature readings for each location in a column for each month.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Split Columns: Connection Requirements for the Node

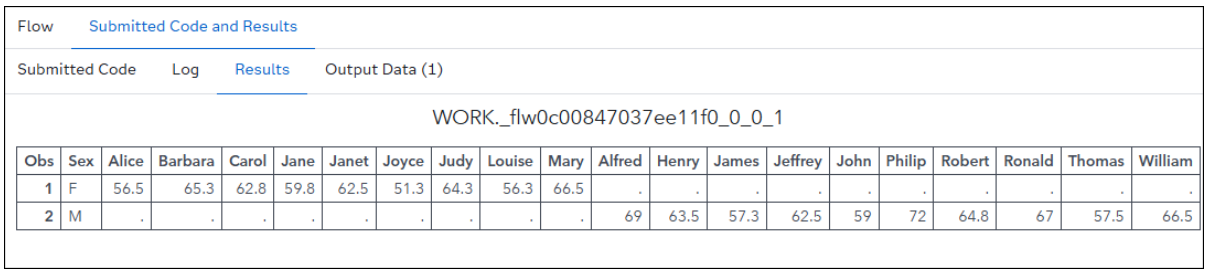
In order to run the Split Columns step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Splitting the Height Column in the Class Table

1. In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Split Columns** to add the step to your flow.
2. Add the Sashelp.Class table to your flow. Connect the input port of the Split Columns node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Split Columns step, click the Split Columns node.
4. On the **Data** tab, assign columns to these roles:
   - To the **Column to split** role, assign the **Height** variable.
   - To the **Formatted identifier values** role, assign the **Name** variable.
   - Expand the Additional Roles heading. To the **Group analysis by** role, assign the **Sex** variable.
5. On the **Output** tab, set these options:
   - Clear the **Use column name prefix** check box.
   - From the **Specify data to show in the Results tab** drop-down list, select **All data**.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK._flw0c00847037ee11f0_0_0_1

Obs	Sex	Alice	Barbara	Carol	Jane	Janet	Joyce	Judy	Louise	Mary	Alfred	Henry	James	Jeffrey	John	Philip	Robert	Ronald	Thomas	William
1	F	56.5	65.3	62.8	59.8	62.5	51.3	64.3	56.3	66.5	.	.	.	.	.	.	.	.	.	.
2	M	.	.	.	.	.	.	.	.	.	69	63.5	57.3	62.5	59	72	64.8	67	57.5	66.5

Split Columns: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Assign to the **Column to split** role the variable that contains the values that you want to split into multiple columns.

3 (Optional) Assign to the **Formatted identifier values** role the column that provides the name for the new columns that contain the transposed values of **Columns to split**.

4 (Optional) Assign to the **Labels for new columns** role the column that provides the labels for the new columns that contain the transposed values of **Columns to split**.

5 (Optional) To select a grouping variable, expand the **Additional Roles** heading and assign a column to the **Group analysis by** role.

Each variable that you assign to this role is used to segment the rows of **Column to split** into subgroups that are transposed into new columns. Each subgroup, which is defined using a unique combination of the values of the grouping variables, becomes a row in the output table. The number of rows that form a subgroup is determined by the number of unique values in the **Formatted identifier values** column.

Step 2: Specify the Output Data

On the **Output** tab, you can set these options:

1 (Optional) To replace an existing output table, select **Replace existing output table**. Any existing table is replaced by default.

2 (Optional) To use a prefix when constructing the names for the transposed variables in the output table, select **Use column name prefix**. When you use a prefix, the variable name begins with the prefix value and is followed by the number 1, 2, and so on.

By default, the new columns are prefixed with `Column`. You can customize this prefix.

3 Specify the data to show in the results. By default, no output table is displayed in the results.

Stack Columns

About the Stack Columns Step

The Stack Columns step creates an output table by restructuring the selected columns in the input table so that these columns are transposed into observations. You can use the output table to analyze values across multiple columns of the input table. If you group the observations, the selected columns are divided into subgroups that are based on the unique combinations of the grouping values. Each subgroup forms a row of the output table.

This functionality is useful when you have a table in which each observation contains the same type of data in multiple columns and you want to analyze the data across several columns. For example, you could transpose columns that contain monthly temperature readings for various locations across a geographic region. The output table would contain the monthly temperature readings by location in a single column.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Stack Columns: Connection Requirements for the Node

In order to run the Stack Columns step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output tables by connecting the output port to a Table node. For

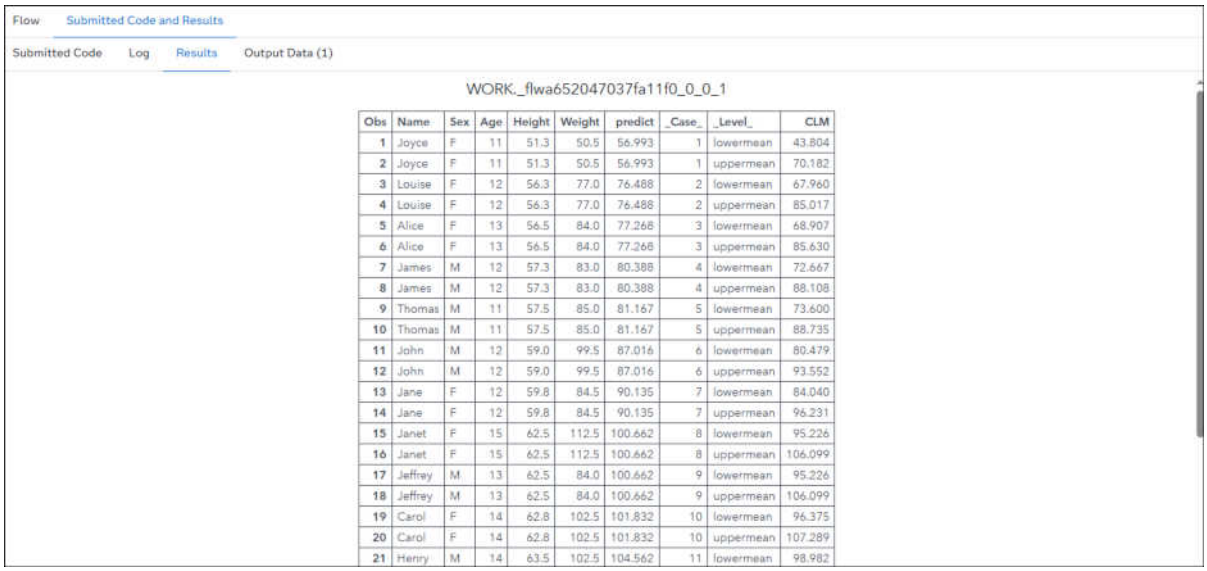
Input Port	Output Port
Program node, or an Import node	more information, see “Adding a Table from a SAS Library to a Flow” on page 34.

Example: Stacking Columns in the ClassFit Table

1. In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Split Columns** to add the step to your flow.
2. Add the Sashelp.ClassFit table to your flow. Connect the input port of the Stack Columns node to the data source. For more information, see “Connecting Nodes” on page 13.
3. To set the options for the Stack Columns step, click the Stack Columns node.
4. On the **Data** tab, assign the **lowermean** and **uppermean** columns to the **Columns to stack** role.
5. On the **Output** tab, complete these steps:
   - Enter `CLM` as the name of the new column.
   - From the **Case identifier** drop-down list, select **Add identifier variable**.
   - Include these variables in the output data table:
     - **Name**
     - **Sex**
     - **Age**
     - **Height**
     - **Weight**
     - **predict**
   - From the **Specify data to show in the Results tab** drop-down list, select **All data**.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results.

The results contain three new variables: _Case_, _Level_, and CLM. The _Case_ variable contains the case identifier. A case is the data for an individual student. The _Level_ variable contains the names of the stacked columns. The new CLM variable contains the value of the lower mean or upper mean.



Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK._flwa652047037fa11f0_0_0_1

Obs	Name	Sex	Age	Height	Weight	predict	_Case_	_Level_	CLM
1	Joyce	F	11	51.3	50.5	56.993	1	lowermean	43.804
2	Joyce	F	11	51.3	50.5	56.993	1	uppermean	70.182
3	Louise	F	12	56.3	77.0	76.488	2	lowermean	67.960
4	Louise	F	12	56.3	77.0	76.488	2	uppermean	85.017
5	Alice	F	13	56.5	84.0	77.268	3	lowermean	68.907
6	Alice	F	13	56.5	84.0	77.268	3	uppermean	85.630
7	James	M	12	57.3	83.0	80.388	4	lowermean	72.667
8	James	M	12	57.3	83.0	80.388	4	uppermean	88.108
9	Thomas	M	11	57.5	85.0	81.167	5	lowermean	73.600
10	Thomas	M	11	57.5	85.0	81.167	5	uppermean	88.735
11	John	M	12	59.0	99.5	87.016	6	lowermean	80.479
12	John	M	12	59.0	99.5	87.016	6	uppermean	93.552
13	Jane	F	12	59.8	84.5	90.135	7	lowermean	84.040
14	Jane	F	12	59.8	84.5	90.135	7	uppermean	96.231
15	Janet	F	15	62.5	112.5	100.662	8	lowermean	95.226
16	Janet	F	15	62.5	112.5	100.662	8	uppermean	106.099
17	Jeffrey	M	13	62.5	84.0	100.662	9	lowermean	95.226
18	Jeffrey	M	13	62.5	84.0	100.662	9	uppermean	106.099
19	Carol	F	14	62.8	102.5	101.832	10	lowermean	96.375
20	Carol	F	14	62.8	102.5	101.832	10	uppermean	107.289
21	Henry	M	14	63.5	102.5	104.562	11	lowermean	98.982

Stack Columns: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Assign to the **Columns to stack** role the variables that contain the values that you want to stack. Each column that you assign to this role becomes one or more rows of the output table. You must assign at least one column to this role.

3 Specify the number of stacked variables to create.

Note: The number of variables in the **Columns to stack** role must be a multiple of the number of stacked variables that you want to create.

4 (Optional) Assign to the **Group analysis by** role the variables to form BY groups.

Each variable that you assign to this role is used to segment the columns to stack into subgroups that are transposed separately. Each subgroup, which is defined by using a unique combination of the values of the grouping variables, becomes a row of the output data set. Each unique combination of the values of the grouping variable occurs only once.

Step 2: Specify the Output Data

On the **Output** tab, you can set these options:

1. (Optional) To replace an existing output table, select **Replace existing output table**. Any existing table is replaced by default.
2. Specify the name of the new column. The default name is **_NewColumn_**.

   You can also specify a label for the stacked variable columns. The default label is **The values of the column being stacked**.
3. (Optional) Specify whether to include a case identifier, which is the new column that contains the values that identify a particular case. You can select whether the step creates a case identifier variable, or you can select identifier variables from the input table. By default, there is no case identifier variable.
4. Specify the name of the new column that contains the values of the case identifier. The default name is **_Case_**.
5. Specify the name of the new column that contains the levels. The default name is **_Level_**.

   You can also specify a label for the levels of the stacked columns. The default label is **The name of the column from which the value came**. Specify whether to add a column to the output table that contains the level labels.
6. Select other variables from the input table that you want to include in the output table.
7. Specify the data to show in the results. By default, no output table is displayed in the results.

Transpose Data

About the Transpose Data Step

The Transpose Data step turns selected columns of an input table into the rows of an output table. If you do not use grouping variables, then each selected column is turned into a single row. If you use grouping variables, then the selected columns are divided into subcolumns based on the values of the grouping variables. Each subcolumn is turned into a row of the output table.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Transpose Data: Connection Requirements for the Node

In order to run the Transpose Data step, you must create connections to the input and output ports of the node as indicated here:

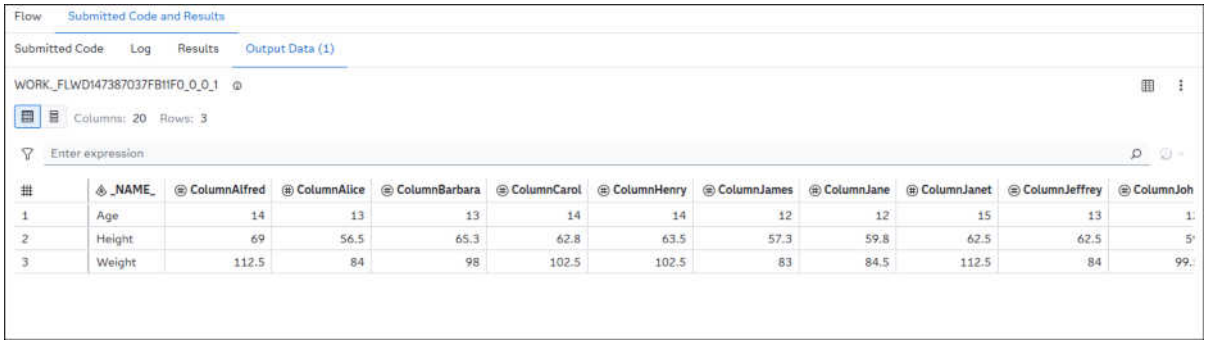
Input Port	Output Port
■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Transposing Data in the Class Data Set

1. In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Transpose Data** to add the step to your flow.
2. Add the Sashelp.Class table to your flow. Connect the input port of the Transpose Data node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Transpose Data step, click the Transpose Data node.
4. On the **Data** tab, assign the **Age**, **Height**, and **Weight** variables to the **Variables to transpose** role.
5. On the **Options** tab, complete these steps:
   - Clear the **Use prefix** check box.
   - Select the **Select a variable that contains the names of the new variables** check box.
   - To the **New column names** role, assign the **Name** variable.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



#	_NAME_	ColumnAlfred	ColumnAlice	ColumnBarbara	ColumnCarol	ColumnHenry	ColumnJames	ColumnJane	ColumnJanet	ColumnJeffrey	ColumnJoh
1	Age	14	13	13	14	14	12	12	15	13	1
2	Height	69	56.5	65.3	62.8	63.5	57.3	59.8	62.5	62.5	5
3	Weight	112.5	84	98	102.5	102.5	83	84.5	112.5	84	99.

To view the generated SAS code:

1 Open the **Log** tab.

2 Search for MPRINT(__CODE).

```
696  /* Main entry point: All the work is done in the macro. */
697  %let __locallyDefinedEntryPointMacro = 0;
698  %if %sysmacexist(__entryPoint) = 0 %then %do;
699      %let __locallyDefinedEntryPointMacro = 1;
700      %macro __entryPoint();
701          %runStep()
702      %mend __entryPoint;
703    %end;
704
705  options mprint;
706  %__entryPoint()
MPRINT(__CODE):   proc transpose data=SASHELP.CLASS out=WORK._flw001167544970699549800000;
MPRINT(__CODE):   var Age Height Weight;
MPRINT(__CODE):   id Name;
MPRINT(__CODE):   run;
NOTE: There were 19 observations read from the data set SASHELP.CLASS.
NOTE: The data set WORK._FLW001167544970699549800000 has 3 observations and 20 variables.
NOTE: PROCEDURE TRANSPOSE used (Total process time):
      real time           0.01 seconds
      cpu time            0.04 seconds
```

Transpose Data: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter** field.

2 Assign at least one variable to the **Variables to transpose** role.

Each variable that you assign to this role becomes one or more rows of the output table. If you do not select any grouping variables, then an entire column is turned into a single row. If you select one or more grouping variables, then the grouping variables are used to segment each column into subcolumns, each of which is turned into a row. In this case, a column is transposed to the number of rows that is equal to the number of groups that are defined by the grouping variables.

3 To select a grouping variable, assign a column to the **Group analysis by** role.

Each variable that you assign to this role is used to segment the about-to-be-transposed columns into subcolumns that are transposed separately. Each subcolumn, defined by a set of values of the grouping variables, becomes a row of the output table.

Step 2: Set Options for Transposed and Original Variables

On the **Options** tab, you can set these options for the transposed and original variables.

1 To construct new variable names, specify these options:

- Select the **Use prefix**option. You can specify a prefix to use in constructing the names for the transposed variables in the output data set. When you use a prefix, the variable name begins with the prefix value and is followed by the number 1, 2, and so on.
- Select **Select a variable that contains the names of the new variables**.

  The variable that you assign to the **New column names** role is used to name the transposed variables in the output data set. If you specified to use a prefix in the name, the name for the new variable begins with the prefix and is followed by the value of the **New column names** variable. If you select the **Allow duplicate of ID values** check box, the transposed output data set contains only the last observation for each BY group.

2 To construct new variable labels, select **Select a variable that contains the labels of the new variables**.

   The values of the variable that you assign to the **New column labels** role are used to label the variables in the output data set.

3 To put the original variable names and labels in a new variable, use these options:

   - **Put original variable names in a new variable** - Each row of the output table includes the name of the variable in the input table to which the values in that output row belong. To specify a heading for the output column that contains these variable names, enter the heading in the **Name** box. The name can include special characters, leading numbers, and white space, but it cannot exceed 32 characters. The default name is _Name_.
   - **Put original variables labels in a new variable** - Each row of the output table includes the label of the variable in the input table to which the values in that output row belong. To specify a heading for the output column that contains these variable labels, enter the heading in the **Label** box. The label can include special characters, leading numbers, and white space, but it cannot exceed 32 characters. The default label is _Label_.

Step 3: Specify the Output Data

On the **Output** tab, you can set these options:

1 To replace an existing output table with the same name, select **Replace existing output table**.

2 (Optional) Assign one or more variables to the **Copy to output data** role.

   Each variable that you assign to this role is copied directly from the input table to the output table without being transposed. Because these columns are copied directly to the output table, the number of rows in the output table equals the number of rows in the input table. The output table is padded with missing values if the number of rows in the input table does not equal the number of variables that it transposes.

3 (Optional) Specify whether to show the output data in the Results tab.

Union Rows

About the Union Rows Step

The Union Rows step enables you to combine data from multiple sources into a single target table. You can subset the source data and choose from multiple set operators to determine how to combine the data sources.

Note: The Union Rows step is available only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.

There are five main steps to use the Union Rows step:

1. Add the Union Rows step to your flow and connect source data to each input port.
2. Specify the set operators that you want to use to combine the data sources.
3. (Optional) Specify source data options.
4. (Optional) Specify set operator options.
5. Run the flow to combine the data.

Union Rows: Connection Requirements for the Node

In order to run the Union Rows step, you must create connections to the input and output ports of the node as indicated here:

Input Ports	Output Port
Two or more connections are required. You can connect either of the following types of nodes: ■ Table node or ■ Operational node that creates an output table, such as a Query	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output tables by connecting the output port to a Table node. For more information, see

Input Ports	Output Port
node, a SAS Program node, or an Import node	"Adding a Table from a SAS Library to a Flow" on page 34.

Example: Subsetting and Combining Data

In this example, you use the output data from the Branch Rows example as your source data. In the Branch Rows example, you split the Sashelp.Class data set into two separate tables: one with only male students and the other with only female students. You can use the Union Rows step to combine the two tables, but include only the male students under the age of 14 and the female students over the age of 12.

To replicate this example, start by following the steps in the Branch Rows example and specify two output tables: Work.Class_M and Work.Class_F. For more information, see "Example: Splitting the Sashelp.Class Data Set" on page 85.

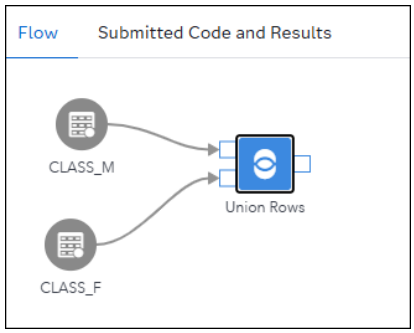
To create this example:

1 From the main SAS Data and AI Studio menu, select **New** ⇨ **Flow**.

2 In the **Steps** section of the navigation pane, expand the **Transform Data** folder and double-click **Union Rows**.

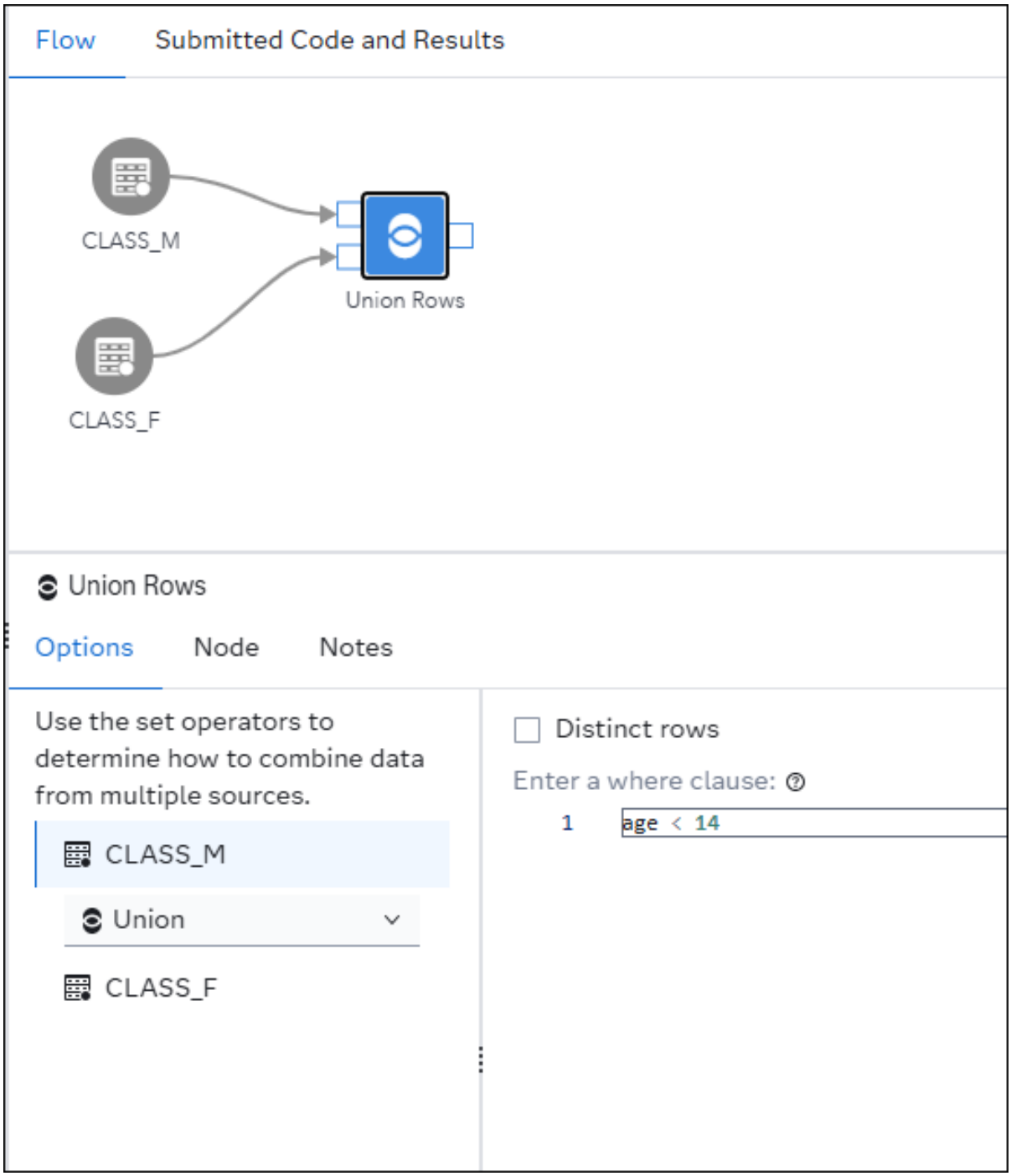
3 Add the Work.Class_M table to the flow. Connect the table to the first input port for the Union Rows step.

4 Repeat step 3 for the Class_F table and the second input port.



5 Click the Union Rows node. On the **Options** tab, accept `Union` as the default set operator.

6 On the **Options** tab, click CLASS_M. In the **Enter a where clause** box, enter `age < 14`.



7 Click CLASS_F, and in the **Enter a where clause** box, enter `age > 12`.

8 Run the flow.

> **TIP** You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Click **Submitted Code and Results** to view the output data. Here is the default output table of male students under age 14 and female students over age 12.

Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

WORK._FLW6D649FD037FD11F0_0_0_1

Columns: 5 Rows: 11

Enter expression

	Name	Sex	Age	Height	Weight
1	Alice	F	13	56.5	84
2	Barbara	F	13	65.3	98
3	Carol	F	14	62.8	102.5
4	James	M	12	57.3	83
5	Janet	F	15	62.5	112.5
6	Jeffrey	M	13	62.5	84
7	John	M	12	59	99.5
8	Judy	F	14	64.3	90
9	Mary	F	15	66.5	112
10	Robert	M	12	64.8	128
11	Thomas	M	11	57.5	85

Union Rows: Step-by-Step Instructions

Step 1: Add the Union Rows Step and Connect the Source Data

To add the Union Rows step to your flow:

1 In the **Steps** section of the navigation pane, expand the **Transform Data** folder, and double-click **Union Rows**.

2 Connect each input port of the Union Rows node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

Note: At least one source table or the target table must have a data type other than CAS.

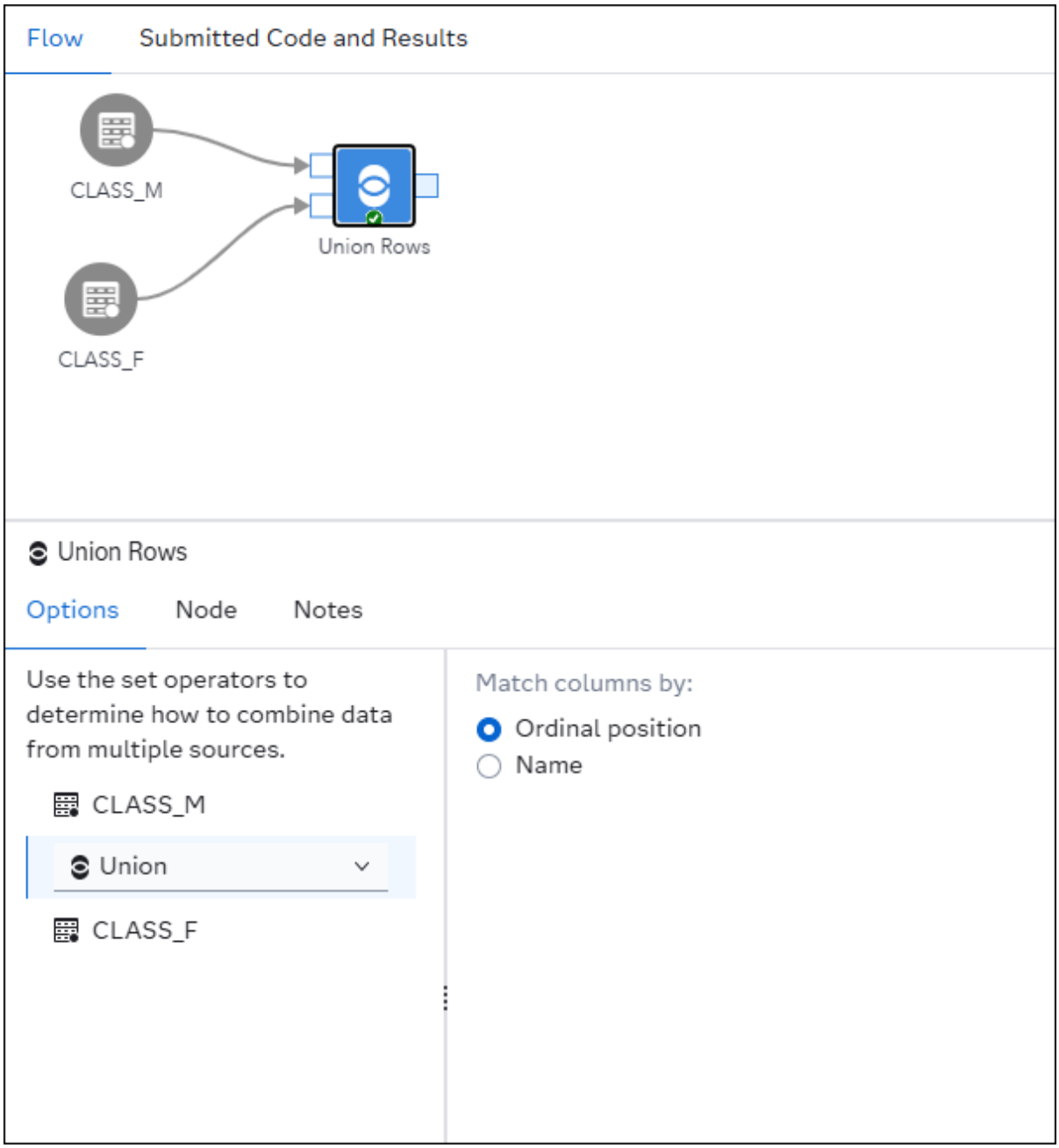
Step 2: Specify the Set Operators to Combine the Data Sources

Select a set operator for each pair of data sources that you are combining.

- Click the **Options** tab and select the set operator that you want to use to combine each pair of data sources.

  You can choose from among these set operators:

  - Union - returns all unique matching rows from both data sources. This is the default operator.
  - Union all - returns all matching rows from both data sources, including duplicate rows.
  - Outer Union - returns a concatenation of both data sources.
  - Except - returns the unique rows in the first data source that are not found in the second data source.
  - Except all - returns all unique and duplicate rows in the first data source that do not have a matching row in the second data source.
  - Intersect - returns the distinct rows that are common in both data sources.
  - Intersect all - returns the rows that are common in both data sources, including duplicates.



(Optional) Step 3: Specify Source Data Options

You can choose to include only the distinct rows and specify a WHERE clause for each input data source.

1 Click the **Options** tab and select the data source that you want to subset.

2 To include only the distinct rows from the selected data source, select **Distinct rows**. This option is not selected by default.

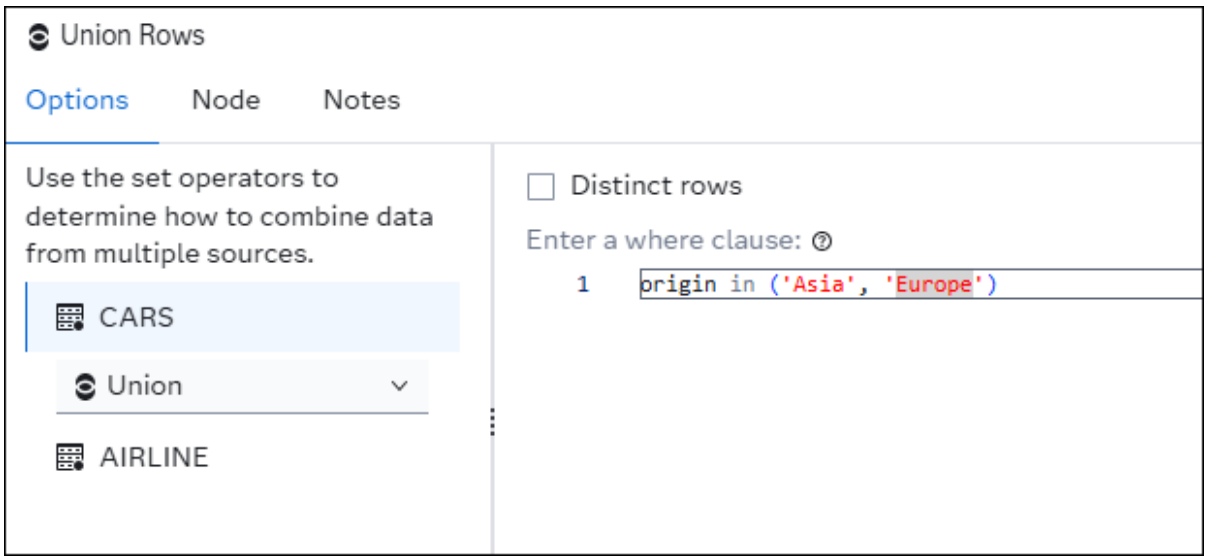
3 To specify a WHERE clause for the selected data source, enter the code for the WHERE clause conditions in the **Enter a where clause** box. Enter only the code for the condition. Do not include the WHERE keyword or the semicolon statement terminator in the text that you enter.

Note: The syntax for the WHERE clause conditions can vary depending on the code that is generated for the step and the data type of the source table. When PROC SQL code is generated, the WHERE clause code that you enter is used to generate a WHERE clause for the specific source table. When DATA step code is generated, the WHERE clause code that you enter is used to generate a WHERE= data set option for the specific source table.

For example, enter this condition to subset the Sashelp.Cars data by country of origin using PROC SQL syntax:

```
origin in ('Asia', 'Europe')
```

Note: The WHERE clause syntax is validated only when the step runs.



(Optional) Step 4: Specify Set Operator Options

You can specify whether to match columns by their ordinal position in the data or by name.

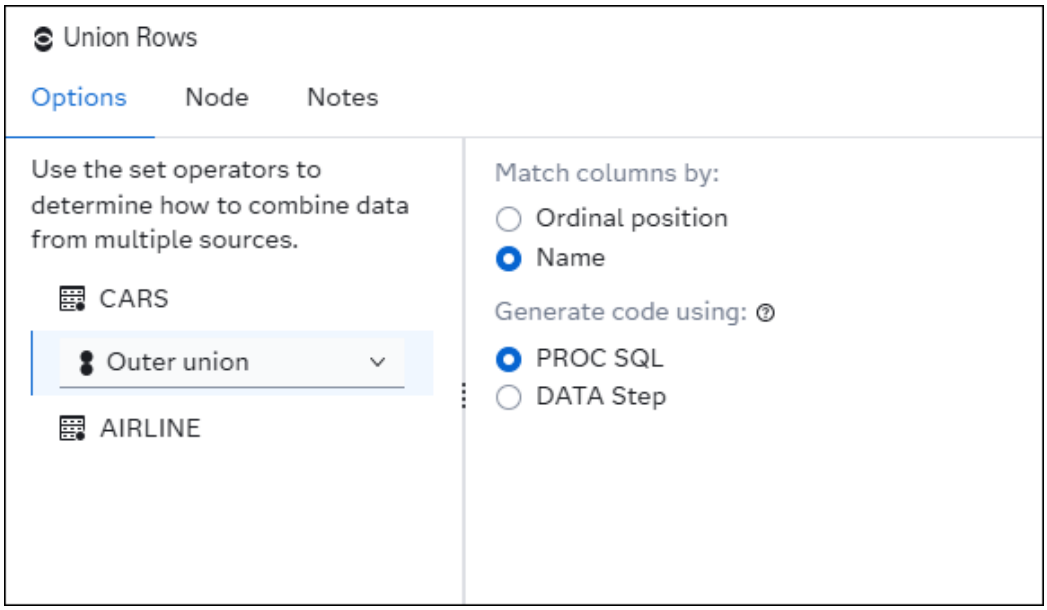
1 Click the **Options** tab and select the set operator for which you want to set options.

2 Use the **Match columns by** option to specify how to match columns.

- **Ordinal position** - matches columns by their position in the data source. This is the default value.

- **Name** - matches columns by name. Columns that do not match by name are excluded from the output data unless you are using the Outer Union set operator.

3 If you are using the Outer Union set operator and matching columns by name, you can use the **Generate code using** option to specify whether to generate code using PROC SQL or a DATA step. The default value is PROC SQL. If you are combining more than two tables, you can generate code using both PROC SQL and DATA steps in a single Union Rows node. In this case, SAS Data and AI Studio generates intermediary tables prior to creating the final target table.



Note: When you switch between generating code using PROC SQL and DATA Step, you might get errors if you have specified any conditions for a WHERE clause. You can edit the code that you entered to fix any errors.

Step 5: Run the Flow and Combine the Data

To combine the data sources into the target table, run the flow.

8

Enriching Your Data

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Geocode Data

About the Geocode Data Step

Geocoding is the process of adding geographic coordinates (latitude and longitude values) to an address. This process provides a way to convert address data into map locations. The geographic coordinates typically represent the center of a ZIP code, a city, an address, or any geographic region. After geocoding, the coordinates can be used to display a point on a map or to calculate distances. Geocoding also enables you to add attribute values such as census blocks to the geocoded address.

Note: This step is available to use in a flow or as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

The Geocode Data step uses the SAS GEOCODE procedure. The GEOCODE procedure uses two types of input data:

- an input table with columns that relate to specific geographic locations. For example, a table might contain mailing address variables such as ZIP codes and street addresses, or custom geographic variables such as sales regions.
- lookup tables that contain reference variables and geographic coordinates. For example, a lookup data table for the ZIP method contains ZIP codes and the geographic coordinates that are associated with the ZIP codes. Some geocoding methods require multiple lookup data tables. This data is essential to transform address data into location information that can be viewed on a map.

By default, the GEOCODE procedure produces an output data set that contains all of the variables from the input table. The data set also contains the X, Y or LONG, LAT, and _MATCHED_ variables. The X or LONG and Y or LAT coordinates must be in the same coordinate system as the lookup data set.

The Geocode step supports seven geocode methods:

- U.S. City
- World City
- Street
- Zip
- Plus4
- Custom
- Internet Protocol (IP) addresses or other ranges

> **Note:** The process of adding coordinates for IP addresses is usually called *geolocating*. IP data is a form of range data and was not designed to be geographic.

For more information, see "GEOCODE Procedure" in *SAS/GRAPH and Base SAS: Mapping Reference*.

Geocode Data: Connection Requirements for the Node

The Geocode Data step includes an input port and an output port. In order to run the Geocode Data step, you must create the input port of the node as indicated here:

Input Port	Output Port
■ Table node or	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can

Input Port	Output Port
■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	specify the library and name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

TIP Depending on the geocode method, you might need more than one input port on the Geocode Data node. To view the labels for the ports on the Geocode Data node, right-click the Geocode Data node and select **Expand ports**.

Using the U.S. City Geocode Method

About the U.S. City Geocode Method

For U.S. city geocoding, each observation in your input data must contain a city and a state. The recommended state value is the two-character state abbreviation, but the complete state name can also be used.

U.S. City Geocoding: Step-by-Step Instructions

Step 1: Add the Geocode Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Enrichment** folder and double-click **Geocode Data** to add the step to your flow.

2 Connect the input port of the Geocode Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

Note: The input data must contain columns for the city and state.

3 To save the results from the Geocode Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table.

Next, connect the output port of the Geocode Data node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Select U.S. City as the Geocoding Method

1 Select **World city** as the geocoding method.

2 Select the **U.S. city** check box.

3 Map these fields for geocoding:

- **City**
- **State/Province**
- **Postal code**

(Optional) Step 3: Set Additional Options

1 To convert the data to use standard two-letter abbreviation, select **Perform state two-letter abbreviation before processing**.

2 Specify any optional arguments from the GEOCODE procedure.

For example, add `LOOKUPCITY=SASHELP.ZIPCODE` to specify the lookup table for associating coordinates with addresses.

(Optional) Step 4: Set the Debugging Options

To add extra SAS debugging for macros, select **Debug SAS macros**.

Step 5: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Items to note in the output table:

- Columns from the SAS data source are prefixed with _dm.
- The GEOCODE procedure generates a _MATCHED_ column that indicates how the coordinates were found.

Using the World City Geocode Method

About the World City Geocode Method

For worldwide geocoding, each observation in your input address data must include the city name and the country. The country value can be the complete country name or its two- or three-character country abbreviation. An example is GB or GBR for the United Kingdom. An optional state, province, or region name can also be specified.

World City Geocoding: Step-by-Step Instructions

Step 1: Add the Geocode Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Enrichment** folder and double-click **Geocode Data** to add the step to your flow.

2 Connect the input port of the Geocode Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Geocode Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table.

Next, connect the output port of the Geocode Data node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Select World City as the Geocoding Method

1 In the Geocode Data step, select **World city** as the geocoding method.

2 Map these fields for geocoding:

- **City**
- **Country**

Step 3: Specify Lookup Table

1 To view the labels for the ports on the Geocode Data node, right-click the Geocode Data node in the flow and select **Expand ports**. In the flow, the input port for the input data source (in this example, GEO_WORLD_CITIES) is labeled Input Table 1.

2 Add the input port and data for the city lookup table.

   a Right-click the Geocode Data node and select **Add input port** ⇨ **Lookup City Table**.

   b Add the lookup table to the flow. Connect the lookup table node to the Lookup City Table port.

   c On the **Lookup** tab in the Geocode Data step, map these fields for the city lookup table:

   - **City**
   - **Country**

(Optional) Step 4: Set Additional Options

1 To convert the data to use the three-letter ISO standard for the country, select **Perform country three-letter ISO standardization before processing**.

2 Specify any optional arguments from the GEOCODE procedure.

   Here is an example: `attributevar=(isoname mapidname1) addressstatevar=province`

(Optional) Step 5: Set the Debugging Options

To add extra SAS debugging for macros, select **Debug SAS macros**.

Step 6: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Items to note in the output table:

- Columns from the original data source are prefixed with _dm.
- The GEOCODE procedure generates a _MATCHED_ column that indicates how the coordinates were found.

Using the Street Geocode Method

About the Street Geocode Method

The street geocode method computes geographical coordinates for specified U.S. or Canadian street addresses. This method converts a full street address that includes a house or building number, street name, city, state (or province), and ZIP (or postal) code to a map location.

Street Geocoding: Step-by-Step Instructions

Step 1: Add the Geocode Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Enrichment** folder and double-click **Geocode Data** to add the step to your flow.

2 Connect the input port of the Geocode Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Geocode Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table. (In this example, the output table is named Geo_Street_Out.)

Next, connect the output port of the Geocode Data node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Select Street as the Geocoding Method

1 In the Geocode Data step, select **Street** as the geocoding method.

2 Select the street method:

- **Default**
- **No city**
- **No zip**

3 Map these fields for geocoding:

- **Address**

- **City**

  Note: This field is not available when **No city** is selected as the street method.

- **State/Province**

  Note: This field is not available when **No city** is selected as the street method.

- **Postal code**

  Note: This field is not available when **No zip** is selected as the street method.

Step 3: Specify Lookup Table

By default, the Geocode Data step uses SasHelp.USM as the lookup table. You do not need to map any fields for the city lookup table or the lookup table. You must specify the Lookup library where all the lookup reference data is stored.

(Optional) Step 4: Set Additional Options

Specify any optional arguments from the GEOCODE procedure.

(Optional) Step 5: Set the Debugging Options

To add extra SAS debugging for macros, select **Debug SAS macros**.

Step 6: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Items to note in the output table:

- Columns from the original data source are prefixed with _dm.
- The GEOCODE procedure generates a _MATCHED_ column that indicates how the coordinates were found.

Using the Plus4 Geocode Method

About the Plus4 Geocode Method

With Plus4 geocoding, the GEOCODE procedure attempts to match the five-digit ZIP code and ZIP+4 extension from your address data set with the lookup data set.

Plus4 Geocoding: Step-by-Step Instructions

Step 1: Add the Geocode Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Enrichment** folder and double-click **Geocode Data** to add the step to your flow.

2 Connect the input port of the Geocode Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Geocode Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table.

Next, connect the output port of the Geocode Data node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Select Plus4 as the Geocoding Method

1 In the Geocode Data step, select **Plus4** as the geocoding method.

2 Map these fields for geocoding:

- **Postal code**
- **Zip+4**

Step 3: Specify Lookup Table

1 To view the labels for the ports on the Geocode Data node, right-click the Geocode Data node and select **Expand ports**. In the flow, the input port for the input data source is labeled Input Table 1.

2 To add the input port and data for the lookup table:

   a Right-click the Geocode Data node and select **Add input port** ⇨ **Lookup Table**.

   b Add the lookup table to the flow. Connect the lookup table node to the Lookup Table 1 port.

   c On the **Lookup** tab in the Geocode Data step, map these fields for the lookup table:

      - **Postal code**
      - **Zip+4**

(Optional) Step 4: Set Additional Options

Specify any optional arguments from the GEOCODE procedure.

(Optional) Step 5: Set the Debugging Options

To add extra SAS debugging for macros, select **Debug SAS macros**.

Step 6: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Items to note in the output table:

- Columns from the original data source are prefixed with _dm.
- The GEOCODE procedure generates a _MATCHED_ column that indicates how the coordinates were found.

Using the Zip Geocode Method

About the Zip Geocode Method

Your input data must contain a valid ZIP or postal code for each observation. If a ZIP code is not found, then the GEOCODE procedure attempts to find the city center location. If you are interested in the ZIP code location only, you can turn off this cascading behavior by selecting the **No city** option.

Zip Geocoding: Step-by-Step Instructions

Step 1: Add the Geocode Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Enrichment** folder and double-click **Geocode Data** to add the step to your flow.

2 Connect the input port of the Geocode Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Geocode Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table.

Next, connect the output port of the Geocode Data node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Select Zip as the Geocoding Method

1 In the **Geocode Data** step, select **Zip** as the geocoding method.

2 Select the **No city** check box if your input data does not include a column for city mappings.

3 Map these fields for geocoding:

- **City**

  Note: This field is not available if you select the **No city** check box.

- **State/Province**

  Note: This field is not available if you select the **No city** check box.

- **Postal code**

Step 3: Specify Lookup Table

For the Zip geocode method, you must specify a lookup table. If you did not select the **No city** check box on the **Geocode Data** tab, you also must add a city lookup table.

1 To view the labels for the ports on the Geocode Data node, right-click the Geocode Data node and select **Expand ports**. In the flow, the input port for the input data source (in this example, GEO_PLUS4) is labeled Input Table.

2 (Optional) Add the input port and data for the city lookup table.

   a Right-click the Geocode node and select **Add input port** ⇨ **Lookup City Table**.

   b Add the lookup table to the flow. Connect the lookup table node to the Lookup City Table port.

   c On the **Lookup** tab in the Geocode Data step, map these fields for the lookup table:

   - **City**
   - **State/Province**

   Note: This step is required only if you selected the **No city** check box on the Geocode Data tab.

3 To add the input port and data for the lookup table:

   a Right-click the Geocode Data node again and select **Add input port** ⇨ **Lookup Table**.

   b Add the lookup table to the flow. Connect the lookup table node to the Lookup Table port.

   c Map the **Postal code** field for the lookup table.

(Optional) Step 4: Set Additional Options

Specify any optional arguments from the GEOCODE procedure.

(Optional) Step 5: Set the Debugging Options

To add extra SAS debugging for macros, select **Debug SAS macros**.

Step 6: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Items to note in the output table:

- Columns from the original data source are prefixed with _dm.
- The GEOCODE procedure generates a _MATCHED_ column that indicates how the coordinates were found.

Using the Range of IP Addresses Geocode Method

About the Range of IP Addresses Geocode Method

Range geocoding matches individual address values to a lookup data set that contains a range of values. IP address data is a form of range data. IP data was not designed to be geographic like street addresses. For this reason, the process of adding coordinates to IP addresses is usually called geolocating rather than geocoding.

Generally, IP addresses are collected from visitors to websites and indicate the connection the visitor used. IP address lookup data contains information that matches ranges of IP addresses to particular geographic locations. A range of IP addresses usually belongs to a company or an internet provider. The location found is not at the street- or even ZIP-code level, but might indicate the city, state, or country where the IP address is registered.

Range geocoding with IPv4 addresses requires a lookup data set and an additional range data set. Two data sets are required because a range of addresses can map to more than one location. Range geocoding with IPv6 addresses is possible and requires a single lookup data set that contains all geographic coordinates and the ranges of IPv6 addresses.

- The lookup data set contains geographic coordinates (latitude and longitude).
- The range data set identifies the ranges (of IPv4 addresses or of other items).

A location ID key variable links the two data sets. Both data sets must contain this variable in order to identify locations for each IPv4 range. Internally, the proper range is found, and then the key value is used to access the lookup data set to find the latitude and longitude for that key. This key variable can map a range of addresses in the range data set to more than one location in the lookup data set.

Range of IP Addresses Geocoding: Step-by-Step Instructions

Step 1: Add the Geocode Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Enrichment** folder and double-click **Geocode Data** to add the step to your flow.

2 Connect the input port of the Geocode Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see “Connecting Nodes” on page 13.

3 To save the results from the Geocode Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table. (In this example, the output table is named Geo_Plus4_Out.)

   Next, connect the output port of the Geocode Data node to the table node.

   Note: The output table does not have any columns until you run the flow.

Step 2: Select Range of IP Addresses as the Geocoding Method

1 Select **Range of IP Address** as the geocoding method.

2 Map these fields for geocoding:

- **Address**
- **Begin range**
- **End range**

Step 3: Specify Lookup Table

For the Range of IP Addresses geocode method, you must specify a lookup table.

1 To view the labels for the ports on the Geocode Data node, right-click the Geocode node and select **Expand ports**. In the flow, the input port for the input data source is now labeled Input Table 1.

2 Right-click the Geocode Data node again and select **Add input port** ⇨ **Lookup Table**.

3 Add a table to the flow for the lookup table. Connect this table to the Lookup Table 1 port of the Geocode Data step.

4 On the **Lookup** tab in the Geocode Data step, map these fields for the lookup table:

- **Key**
- **Longitude**

5 Right-click the Geocode Data node again and select **Add input port** ⇨ **Range Table**.

6 Add a table to the flow for the range table. Connect this table to the Range Table 1 port of the Geocode Data step.

7 Map the key value.

(Optional) Step 4: Set Additional Options

Specify any optional arguments from the GEOCODE procedure.

(Optional) Step 5: Set the Debugging Options

To add extra SAS debugging for macros, select **Debug SAS macros**.

Step 6: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Items to note in the output table:

- Columns from the original data source are prefixed with _dm.
- The GEOCODE procedure generates a _MATCHED_ column that indicates how the coordinates were found.

Using the Custom Geocode Method

About the Custom Geocode Method

Any data can be used as lookup data with the Custom method of geocoding. The only requirement is that you have at least three variables. The variables must be the projected or unprojected coordinate values (X and Y or LAT and LONG) and include a key variable to look up.

Custom Geocoding: Step-by-Step Instructions

Step 1: Add the Geocode Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Enrichment** folder and double-click **Geocode Data** to add the step to your flow.

2 Connect the input port of the Geocode Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Geocode Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table.

Next, connect the output port of the Geocode Data node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Select Custom as the Geocoding Method

1 Select **Custom** as the geocoding method.

2 Map the **Address** field.

Step 3: Specify Lookup Table

For the Custom geocode method, you must specify a lookup table.

1 To view the labels for the ports on the Geocode Data node, right-click the Geocode node and select **Expand ports**. In the flow, the input port for the input data source is now labeled Input Table.

2 Right-click the Geocode node again and select **Add input port** ⇨ **Lookup Table**.

3 Add the lookup table to the flow. Connect the lookup table node to the Lookup Table port.

4 On the **Lookup** tab in the Geocode Data step, map these fields for the lookup table:

- **Address**
- **Longitude**
- **Latitude**

(Optional) Step 4: Set Additional Options

Specify any optional arguments from the GEOCODE procedure.

(Optional) Step 5: Set the Debugging Options

To add extra SAS debugging for macros, select **Debug SAS macros**.

Step 6: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Items to note in the output table:

- Columns from the original data source are prefixed with _dm.
- The GEOCODE procedure generates a _MATCHED_ column that indicates how the coordinates were found.

Verify with Loqate

About the Verify with Loqate Step

The Verify with Loqate step enables you to verify addresses, emails, and phone numbers that use the Loqate Verify API. Loqate also allows you to generate geocodes. Loqate is a third-party provider that specializes in address, email, and phone number verification.

Note: Loqate associates a cost for each verification. For more information, see the Loqate website.

Note: This step is available to use in a flow or as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Verify with Loqate: Connection Requirements for the Node

The Verify with Loqate step includes an input port and an output port. In order to run the Verify with Loqate step, you must create the input port of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Verify with Loqate: Step-by-Step Instructions

Step 1: Add the Verify with Loqate Step and Connect a Source Table

To add the Verify with Loqate step to your flow:

1 In the **Steps** section of the navigation pane, expand the **Enrichment** folder and double-click **Verify with Loqate**.

2 Connect the input port of the Verify with Loqate node to a data source by using a Table node or another node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Verify with Loqate step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table.

Next, connect the output port of the Verify with Loqate node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Verify Addresses

Use the options on the **Verify Address** tab to verify address information and obtain geocode coordinates from the Loqate Verify Address API. The step uses PROC HTTP to connect to the Loqate Verify Address API. The Loqate API returns JSON code to SAS with the enriched data.

1 Select the **Enable address verification** check box.

2 (Optional) To retrieve the latitude and longitude coordinates for the address from Loqate, select **Geocode the address**.

3 (Optional) To standardize the country code in your data source, select **Perform country ISO standardization before processing**.

Note: The Loqate Verify Address API requires that country name or code be in an ISO 3166 two-character country code or an ISO 3166 three-character country code. When you select the **Perform country ISO standardization before processing** option, SAS Data and AI Studio standardizes the country value to an ISO 3166 three-character country code. If this option is not selected, the Loqate Verify Address API processes country values only in the ISO two-character

code or the ISO three-character code format. In the sample_addresses data source, some countries are in an ISO format (for example, AUS, which is in the ISO 3166 three-character country code format), but other values (for example, United States of America) are not. In order for the Loqate Verify Address API to process all country values correctly, you need to select the **Perform country ISO standardization before processing** option.

4 (Optional) To show the request from SAS and the response from Loqate in the log, select **Show API input and output JSON in the log**.

5 Specify the number of records to send to Loqate at one time. The maximum value is `500`.

6 Use the address options to map the columns in your data source to the corresponding fields in the Loqate database. Depending on your data, you might not specify values for all of these fields. The **Country** and **Address 1** fields are required.

Step 3: Verify Email Addresses

Use the options on the **Verify Email** tab to verify email addresses that use the Loqate Verify Email Addresses API. The step uses PROC HTTP to connect to the Loqate Verify Email Addresses API. The Loqate API returns a CSV file to SAS with the enriched data.

1 Select the **Enable email verification** check box.

2 (Optional) To show the request from SAS and the response from Loqate in the log, select **Show API Input/Output CSV in the log** .

3 (Optional) In the **Batch size** field, specify the number of records to send to Loqate at one time. The maximum value is `100`.

4 Use the **Email address** field to map the columns in your data source to the corresponding fields in the Loqate database. Only English characters are supported.

Step 4: Verify Phone Numbers

Use the options on the **Verify Phone Numbers** tab to verify phone numbers that use the Loqate Verify Phone Numbers API. The step uses PROC HTTP to connect to the Loqate Verify Phone Numbers API. The Loqate API returns a CSV code to SAS with the enriched data.

1 Select the **Enable phone verification** check box.

2 (Optional) To standardize the country value to an ISO 3166 two-character country code, select the **Perform country ISO standardization before processing** option.

Note: The Loqate Verify Phone API requires that the country name be in an ISO 3166 two-character country code format. If this option is not selected, the Loqate Verify Phone Numbers API processes only country values in the ISO two-character code format.

3 (Optional) To show the request from SAS and the response from Loqate in the log, select **Show API input and output CSV in the log**.

4 Use the phone number options to map the columns in your data source to the corresponding fields in the Loqate database. The **Phone number** field is required.

Step 5: Specify the Loqate Key and Other Advanced Options

1 Enter your Loqate key. You can get this key from the Loqate website.

2 (Optional) To test your flow without making the call to Loqate, select **Test mode**.

Note: Because each call to the Loqate API incurs a cost, the **Test mode** option is selected by default. When you are ready to run your flow against the Loqate API, deselect this check box.

3 (Optional) Select **Do not use the Loqate external endpoint** if you want to point to a local container for verifying addresses instead of using the Loqate service.

Note: Loqate customers who have purchased address verification through a local container must select **Do not use the Loqate external endpoint** and must enter a valid URI for the container.

Step 6: Set the Options

On the **Options** tab, specify whether to show detailed debugging information in the SAS log.

Step 7: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Items to note in the output table:

- Columns from the SAS data source that were mapped to Loqate fields are prefixed with _dm.
- The remaining columns are from the Loqate Verify Address API. To understand the codes in your results, see the Loqate documentation.

9

Integrating Data

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Execute Decisions

About the Execute Decisions Step

You can use the Execute Decisions step to add a published decision from SAS Intelligent Decisioning to your flow. Decisions enable you to create a database of rules, combine those rules into decisions, and publish the decisions for use by other

applications such as SAS Data and AI Studio. For more information, see "Introduction to SAS Intelligent Decisioning" in *SAS Intelligent Decisioning: User's Guide*.

To use a decision in SAS Data and AI Studio, the decision must meet the following criteria:

- The decision must be published using SAS Intelligent Decisioning.
- The decision must be published to a CAS destination.
- The sas_model_table metadata table that is produced when you publish a decision must be loaded as an in-memory CAS table.

  Note: The Execute Decisions step attempts to load the persisted sas_model_table table when an in-memory version of the table is not found. If the sas_model_table table is persisted in a path-based caslib, the table name must include the .sashdat file extension.

- The input table must be a CAS table.

  Note: By default, the output data is written to the output port as a session-scoped CAS table in the same CAS library as the source table.

Note: This step is available in a flow and a standalone step in SAS Data and AI Studio Enterprise.

Execute Decisions: Connection Requirements for the Node

In order to run the Execute Decisions step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node	No connection is required.
Note: The input table for the Execute Decisions node must be a CAS table.	**Note:** Execute Decisions node output can be connected to any flow node that accepts a SAS or CAS table as an input, such as a Table node, a Query node, or a SAS Program node. By default, the output data is written to a session-scoped CAS table in the same CAS library as the source table. You can specify the library and name of the output tables by connecting the output port to a Table node. It is recommended that a CAS output table reside in the same CAS session as the input table.For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Execute Decisions: Step-by-Step Instructions

The Execute Decisions step requires one input port and one output port.

1 In the **Steps** section of the navigation pane, expand the **Integrate** folder and double-click **Execute Decisions**.

2 Click the **Execute Decisions** node, and then use the Options tab to select the decision that you want to use. To select a decision, click 🗀. In the **Select a Published Decision** box, specify the CAS destination and decision that you want to use.

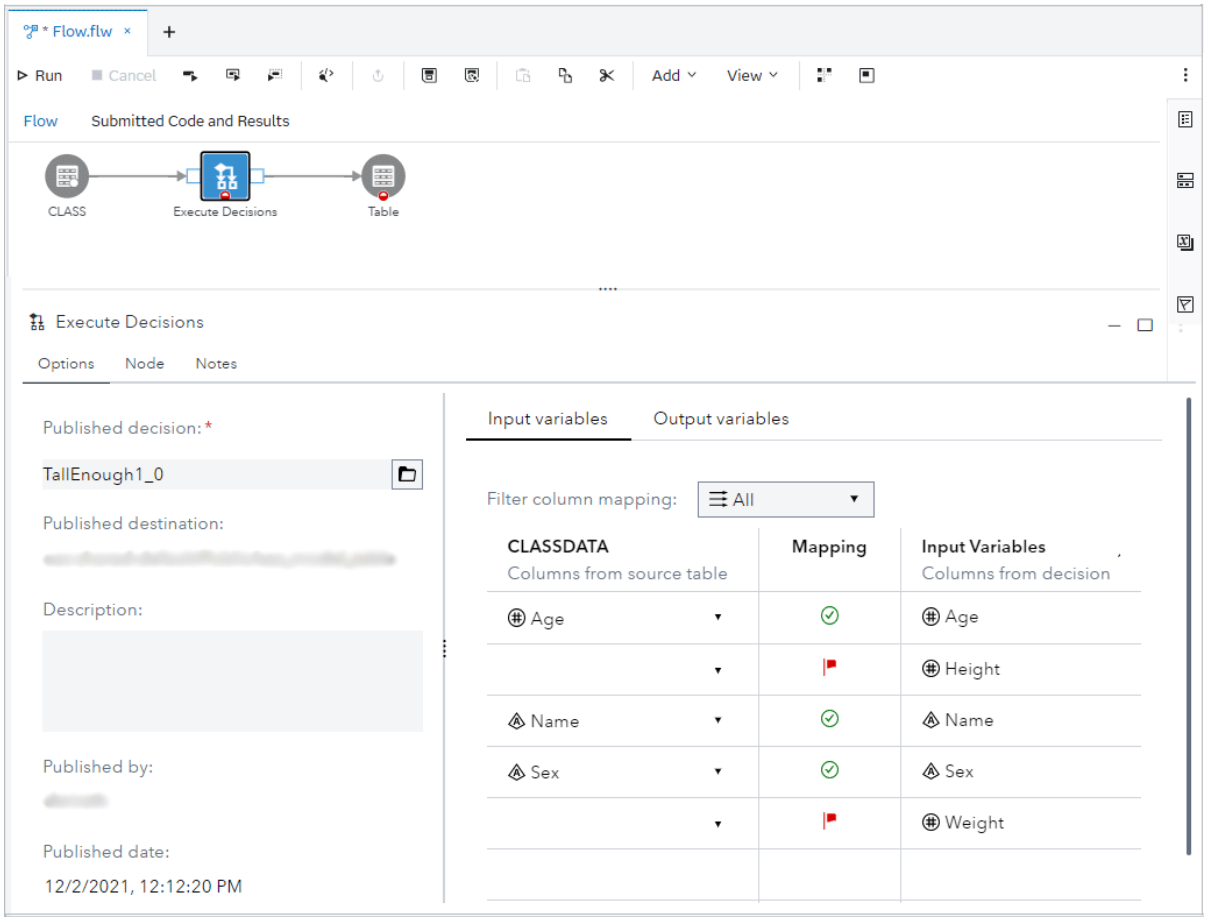
3 Connect the input port of the Execute Decisions node to the appropriate data source for the selected decision. The input data source must be a Table node that references a CAS table. For more information, see "Connecting Nodes" on page 13.

4 Click the **Execute Decisions** node to verify the column mapping for the decision. In the right pane of the Options tab, use the Input variables tab to view the mapping between the columns in the input table and the columns that are required by the decision. Columns are mapped automatically by name and data type.

Note: If the length of a column in the input table is different from the expected length of the corresponding column in the decision, the length of the column in the decision output table is overwritten, by default. If the length of an input column is shorter than the length of the output column, values in the output table can be truncated. You can use the `sas.decisions.variableLengthOverridden` property in SAS Environment Manager to keep the length of the output column. For more information, see "sas.decisions.variableLengthOverridden" in *SAS Intelligent Decisioning: Administrator's Guide*.

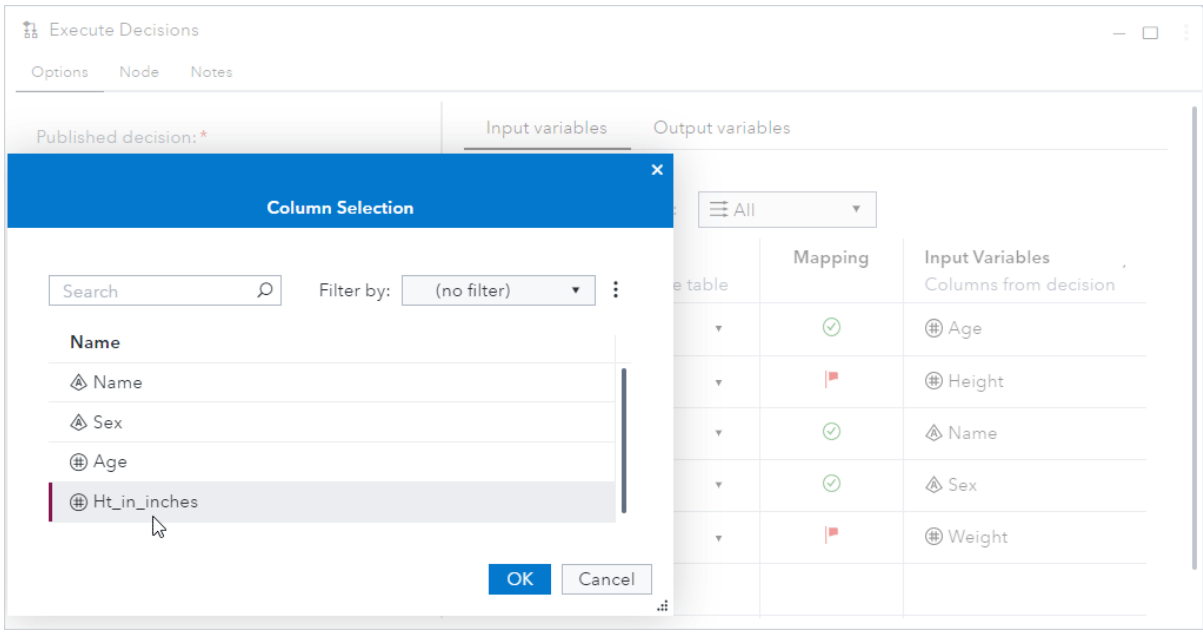
Use the **Filter column mapping** drop-down list to filter the mappings that are displayed. You can filter the mappings by the following categories:

- Successful (✓) - the input column is successfully mapped to a column that is used in the decision.
- Unresolved (⚑) - an input column is not yet mapped to the column in the decision. An unresolved column can occur when SAS Data and AI Studio cannot automatically map columns based on name and data type. You must manually map any unresolved column mappings.



5 If you have any unresolved column mappings, click ▾ beside the unmapped column and select the appropriate column to map to the column in the decision.

Note: The Execute Decisions node can run only when all columns are mapped successfully.



6 To view the output columns for the decision, click the **Output variables** tab.

7 To run the flow, click ▷ Run.

Implement SCD

About the Implement SCD Step

The Implement SCD step enables you to use the slowly changing dimensions (SCD) process to load data into target dimension tables. The data changes slowly, rather than changing on a time-based, regular schedule. The target tables are structured so that they can retain a history of changes to their data. This record of data changes can provide a basis for analysis. You can also choose to overwrite your data with new values and not preserve the historical data.

For example, a table named Customers might have columns for customer ID, home address, age, and income. Each time the address or income changes for a customer, a new row could be created for that customer, and the old row could be retained. This historical record of changes could be combined with purchasing information to forecast buying trends and to direct customer marketing campaigns.

SAS Data and AI Studio supports two types of slowly changing scenarios:

- Type 1 SCD - no history of data changes. Type 1 SCD overwrites the specified columns in the target table without retaining a history of changes. Type 1 SCD is useful for maintaining columns that are not used in historical analysis.
- Type 2 SCD - history of data changes is maintained. Type 2 SCD maintains multiple records for each business key in the target table. The latest entry is the current entry for that business key. Other rows comprise the historical record of data changes.

Note: This step is available in a flow in SAS Data and AI Studio Enterprise.

There are seven main steps to use the Implement SCD step:

1 Add the Implement SCD step to your flow and connect the source table.

2 Specify the library and name of the target table.

3 Specify one or more key columns that are used to match the rows between the source and target tables.

4 (Optional) Specify columns from the target table for SCD Type 1 changes. The selected columns are updated with values from the source table.

5 (Optional) Specify columns from the target table for SCD Type 2 changes. The selected columns are used in the new current row that is created. The columns are populated with data from the corresponding columns in the source table.

6 (Optional) Specify columns, which have not been selected for SCD Type 1 or Type 2 changes, to include when a new row is added to the target table.

7 Run the flow to update the target table.

Note:

- In order to run the Implement SCD step, you must specify either SCD Type 1 or SCD Type 2 changes or both.
- For all databases except SingleStore, the Implement SCD step does not support NULL values in SCD Type 1 or SCD Type 2 columns.

Implement SCD: Connection Requirements for the Node

The Implement SCD node includes only one input port. The target table is specified in the node details rather than with an output port. In order to run the Implement SCD step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
■ Table node. The source and target tables must reside on the same database server. The tables must reside in one of the following databases: □ Oracle □ SingleStore □ Snowflake □ SQL Server □ Teradata	Not applicable. The target table is specified in the node details.

Implement SCD: Step-by-Step Instructions

Step 1: Add the Implement SCD Step and Connect a Source Table

To add the Implement SCD step to your flow:

1 In the **Steps** section of the navigation pane, expand the **Integrate** folder and double-click **Implement SCD**.

2 Connect the input port of the Implement SCD node to a data source by using a Table node. The table must reside in one of the following databases: Oracle, SingleStore, Snowflake, SQL Server, or Teradata. For more information, see "Connecting Nodes" on page 13.

Note: If you are connecting to SingleStore data, you must specify `S2` as the SAS/ACCESS engine name and set DEFAULT_AUTH_PLUGIN=mysql_native_password in the LIBNAME statement. For more information, see "DEFAULT_AUTH_PLUGIN= LIBNAME Statement Option" in *SAS/ACCESS for Relational Databases: Reference*.

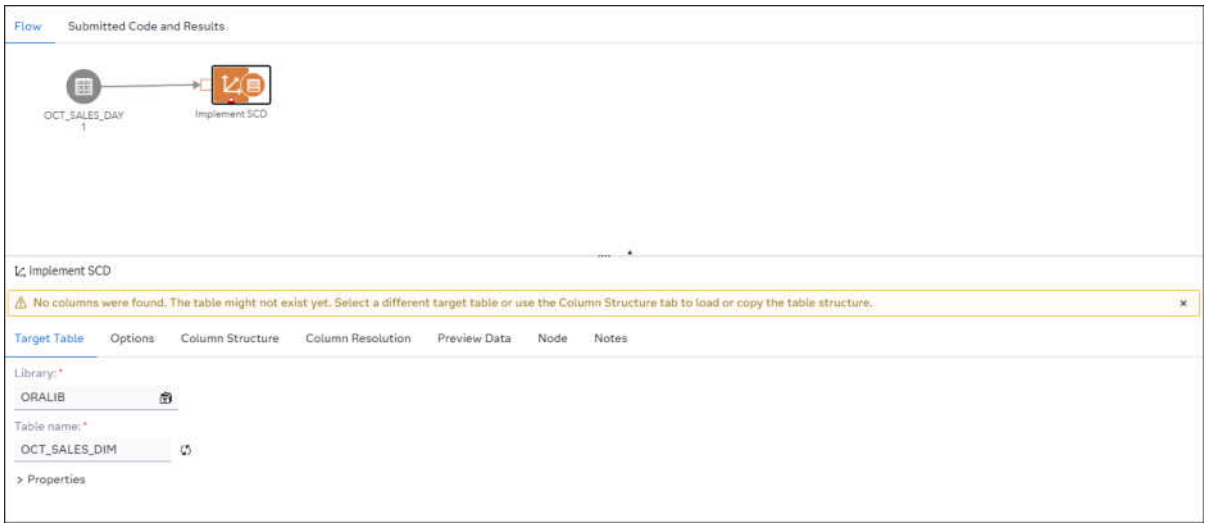
Step 2: Specify the Target Table

The source and target tables must reside on the same database server.

1 Click the **Implement SCD** node, and then click the **Target Table** tab.

2 Use the **Library** and **Table name** boxes to specify the target table.

Note: The Implement SCD node does not have an output port. You must specify the target table in the Implement SCD node details. However, you can connect the Implement SCD node to another operational node that requires a table as input.



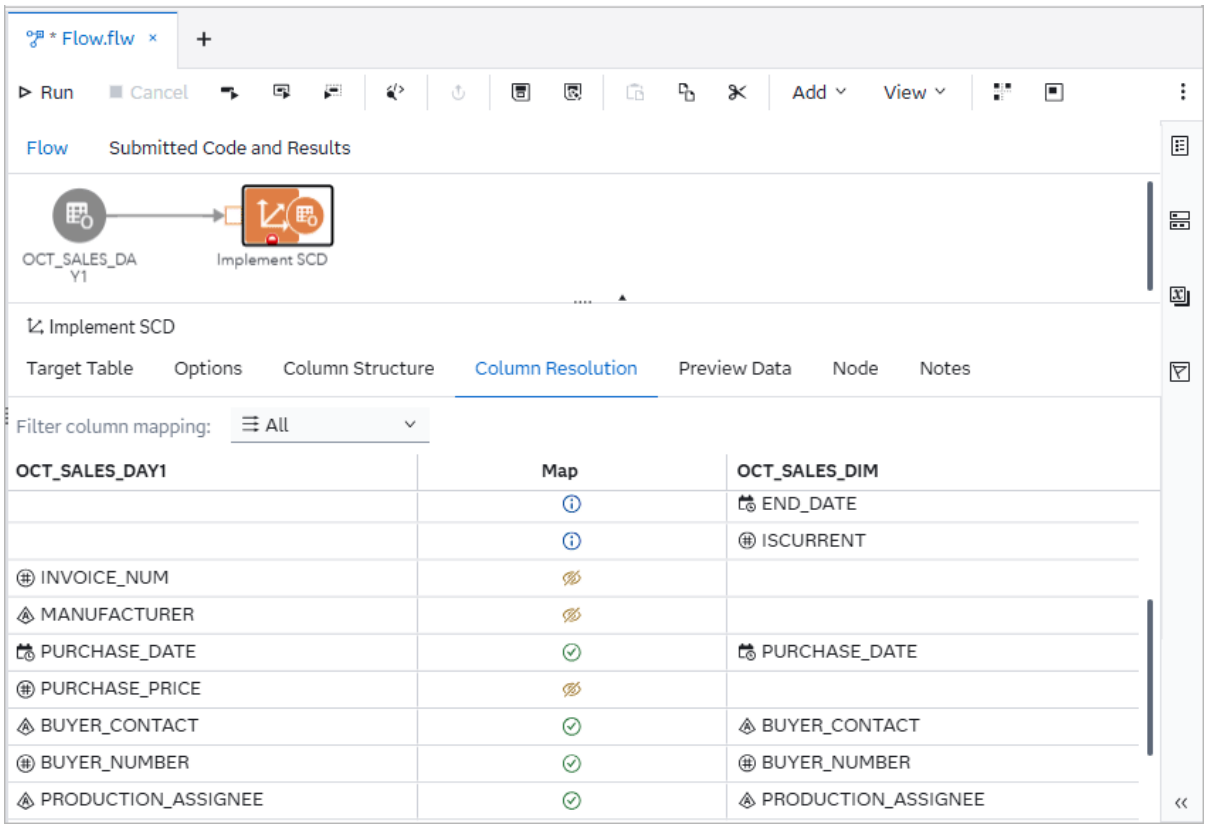
3 To view the structure of the target table, click the **Column Structure** tab.

To view the column mapping between the source and target tables, click the **Column Resolution** tab.

Note: On the Column Resolution tab, you can use the **Filter column mapping** drop-down list to filter the mappings that are displayed. You can filter the mappings by the following categories:

- Successful (✓) - the source column is successfully mapped to a column in the target table.
- Ignored (👁) - the source column does not have a corresponding column in the target table. Data for this column is ignored in the target table.
- Information (ⓘ) - a source column is not mapped to the column in the target table. An unresolved column can occur when SAS Data and AI Studio cannot automatically map columns based on name and data type.

In this example, there are two columns in the target table that do not have corresponding columns in the source table, and there are three columns in the source table that do not have corresponding columns in the target table.



Step 3: Specify One or More Key Columns

You must specify at least one business key column to run the Implement SCD step.

Note: To preview the expression that is generated by SAS Data and AI Studio, click **Preview expression**. You can also copy the code to use in a SAS program. This option is available only when you have specified one or more key columns and all of the options for at least one SCD Type 1 or Type 2 change.

1. Click the **Options** tab and select **Identify business keys**.
2. To add a key column, click **Select columns**.
3. In the Select Columns window, select one or more key columns. You must select at least one key column that uniquely identifies each row in the source table. Do not select all of the columns in the list. Click **OK**.
4. SAS Data and AI Studio attempts to match key columns in the source and target tables based on column name, regardless of case and data type. If a match is not found, click to select the source business key column. Click **OK**.

   Note: If you want SAS Data and AI Studio to treat NULL values as equal when key columns are matched, click the **Node** tab, and then click **Configuration**. Select **Treat NULLS as equal when comparing key columns**. If you do not select

this option, key columns with NULL values do not match any other column value. This option is not selected by default.

(Optional) Step 4: Specify the SCD Type 1 Changes

You can specify columns of data in the target table to overwrite with new data. SCD Type 1 changes do not preserve the historical data.

Note: You cannot update multiple Type 1 target columns with the same source column. Each source column can be used to update only one Type 1 target column.

1 Click the **Options** tab and select **Update records (SCD Type 1)**.

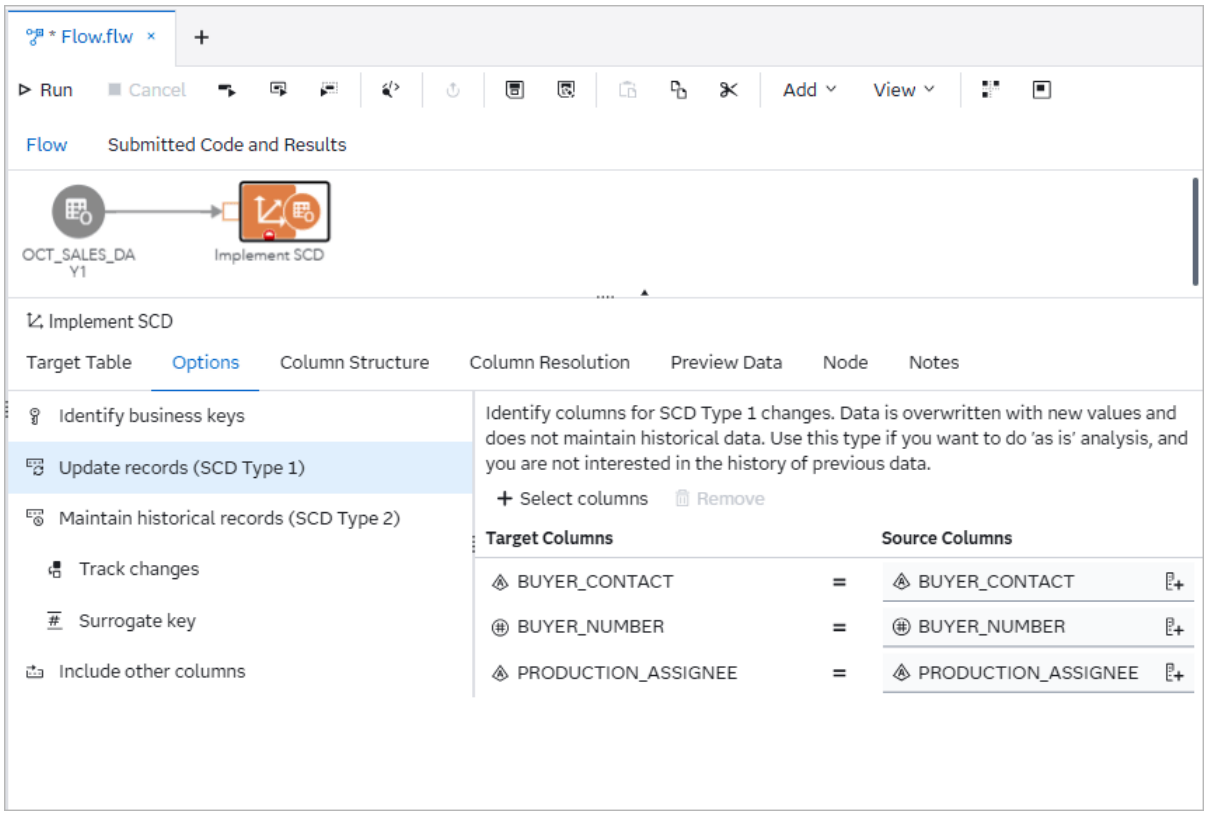
2 To select columns to update, click **Select columns**.

3 In the Select Columns window, select one or more target columns to update in the target table. Click **OK**.

Note: Any columns that you have selected for other options are not available.

4 SAS Data and AI Studio attempts to match columns in the source and target tables based on column name, regardless of case and data type. If a match is not found, click to select the column that you want to use from the source table. Click **OK**.

Note: If you want SAS Data and AI Studio to treat NULL values as equal when source and target columns are matched, click the **Node** tab, and then click **Configuration**. Select **Treat NULLS as equal when comparing values in columns**. If you do not select this option, columns with NULL values do not match any other column value. This option is not selected by default.



(Optional) Step 5: Specify the SCD Type 2 Changes

You can specify columns to insert in a new row in the target table for Type 2 changes. A new row is created in the target table and marked as the current row, and the old rows are preserved.

Note: You cannot match multiple Type 2 target columns to the same source column. Each source column can be matched with only one Type 2 target column.

1 Click the **Options** tab and select **Maintain historical data (SCD Type 2)**.

2 To select columns to add to the new row, click **Select columns**.

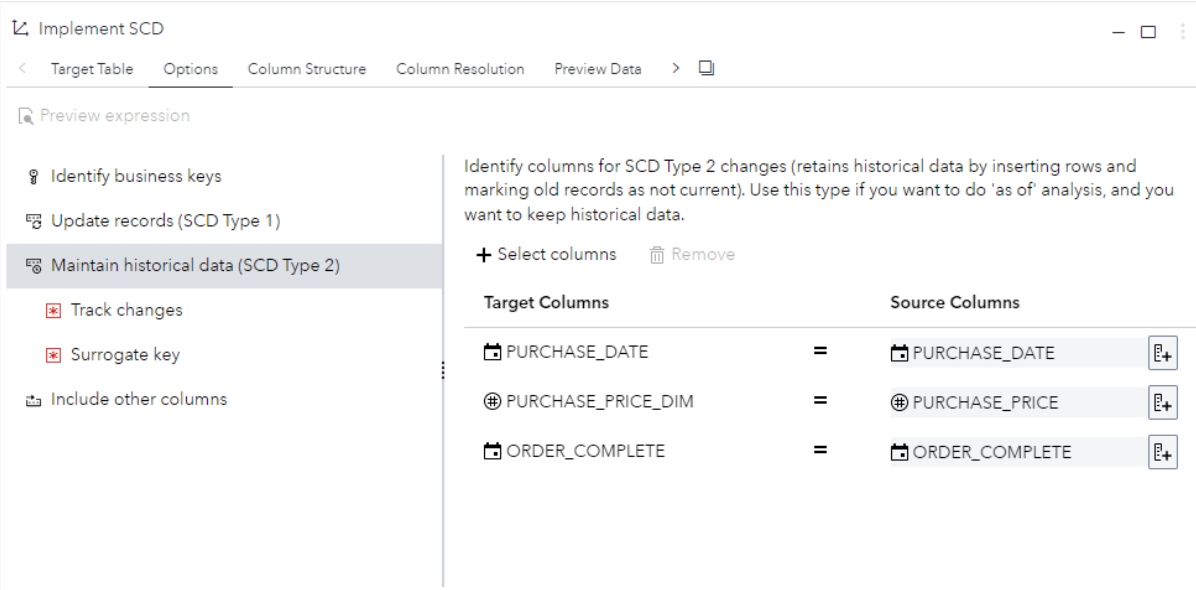
3 In the Select Columns window, select one or more target columns. Click **OK**.

Note: Any columns that you have selected for other options are not available.

4 SAS Data and AI Studio attempts to match columns in the source and target tables based on column name, regardless of case and data type. If a match is not found, click to select the column that you want to use from the target table. Click **OK**.

Note: If you want SAS Data and AI Studio to treat NULL values as equal when source and target columns are matched, click the **Node** tab, and then click

Configuration. Select **Treat NULLS as equal when comparing values in columns**. If you do not select this option, columns with NULL values do not match any other column value. This option is not selected by default.



5 To specify how the progression of changes is tracked, click **Track changes**. You must specify the effective date method. The flagging method is optional only if you are using SingleStore data.

a In the **Effective Date Method** area, specify the column that contains the start date timestamp that identifies the effective start date and time for the row.

Note:

- The column that you specify for the start date must be either a date column or a numeric column that contains date values. If the column does not contain date values, the flow cannot run.
- You must use database-specific syntax for the expressions that specify values for the **Start on**, **Expires on**, and **Future** options.

Use the **Start on** field to specify the timestamp when the row was created. The default value is the current date.

b Specify the column that contains the end date that identifies the current row.

Note: The column that you specify for the end date must be either a date column or a numeric column that contains date values. If the column does not contain date values, the flow cannot run.

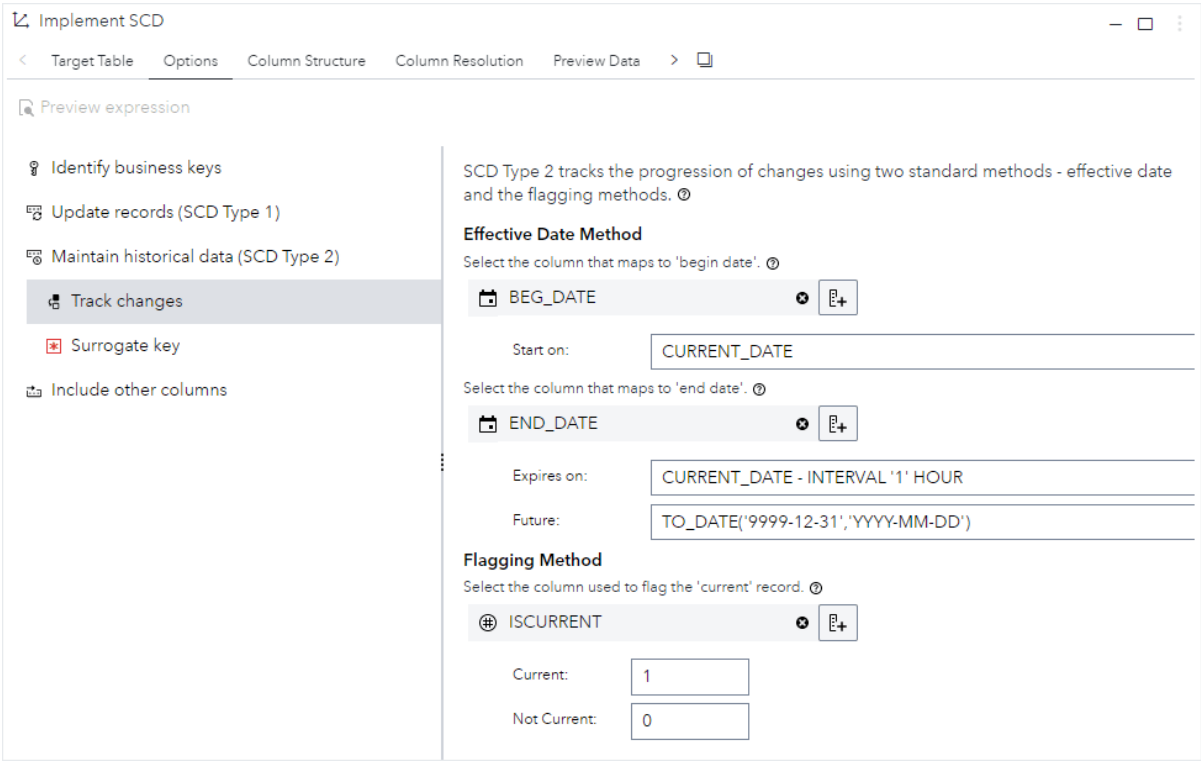
Use the **Expires on** field to specify an expression that defines the end date value when closing out a row that was previously current. The default

expression sets the effective end date timestamp to one hour earlier than the effective start date timestamp of the newly created current row.

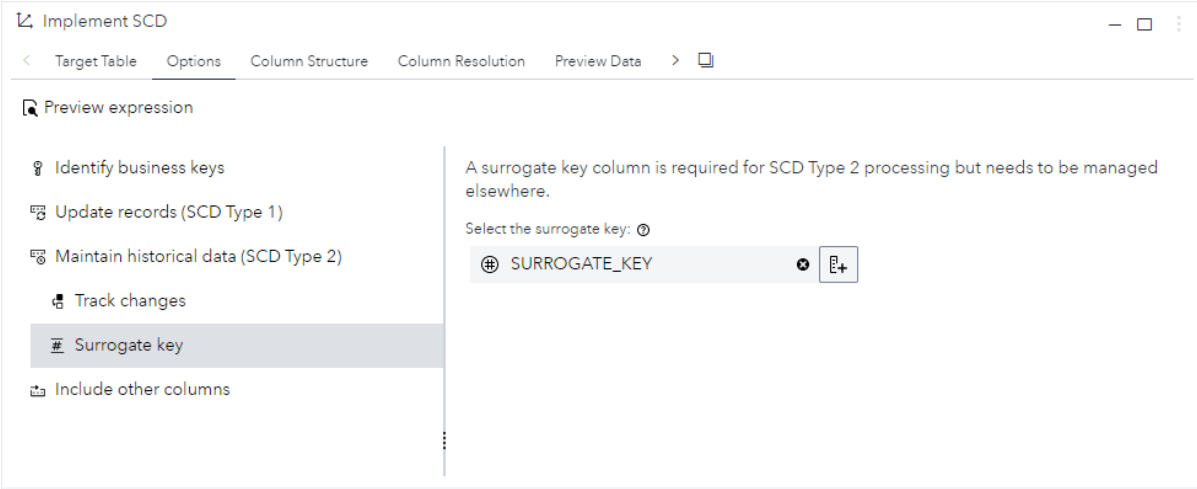
Use the **Future** field to specify the end date value for a row that is current. Typically, the future date value is set far into the future to ensure that the end date value does not expire while the row is still current. The default value is `9999-12-31`.

c In the **Flagging Method** area, specify the column that contains the Boolean-type value that identifies the current row. Use the **Current** and **Not Current** fields to specify the values that are used to label the rows. By default, for character columns, the values of `Y` and `N` are used to identify current and historical rows. For numeric columns, the default values are `1` and `0`.

Note: The flagging method is not required if you are using SingleStore data.



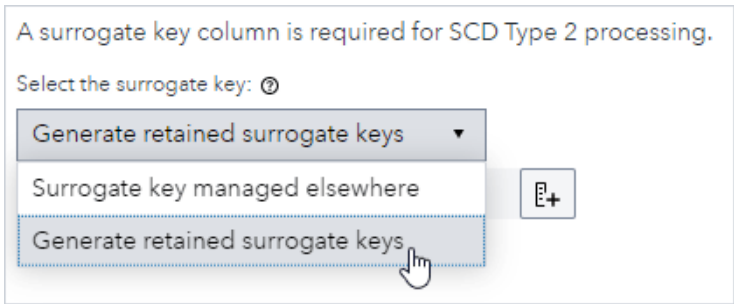
6 Click **Surrogate key** to specify the surrogate key in the target dimension table. To select the surrogate key column, click and select the target column. Click **OK**.



The surrogate key column values are system-generated values that are used to uniquely identify a row in the table. A surrogate key is required for Type 2 changes. The surrogate key and its values must be generated outside of SAS Data and AI Studio, unless you are using SingleStore data.

Note: If you are working with SingleStore data, you can use a surrogate key that is generated elsewhere, or you can generate the surrogate key in SAS Data and AI Studio:

- **Surrogate key managed elsewhere** - the surrogate key and its values are generated outside of SAS Data and AI Studio. Select the surrogate key that you want to use from the target dimension table. The surrogate key column values are system-generated values that are used to uniquely identify a row in the table.
- **Generate retained surrogate keys** - generates a surrogate key that uniquely identifies the selected business keys in the target table. SAS Data and AI Studio maintains the relationship between the surrogate and business keys when data is loaded into the target table.



(Optional) Step 6: Specify Other Columns to Include in the Target Table

When rows are created, you can include additional columns that have not already been identified as a surrogate key, business key, Type 1 column, Type 2 column, effective start and end date column, or current record indicator column. Columns that are not selected are added as missing values when rows are created in the target table.

1 Click the **Options** tab and select **Include other columns**.

2 To select columns to update, click **Select columns**.

3 In the Select Columns window, select one or more columns to update in the target table. Click **OK**.

Note: The columns that you have already selected for other options are not available.

Step 7: Run the Flow and Update the Target Table

To run the Implement SCD step and update the target table, click ▷ Run.

Load Table

About the Load Table Step

The Load Table step enables you to load a source table into a target table. When you use the Load Table step, you can control how data is loaded into the target table. You can choose to insert new source rows into the target table, update existing rows in the target table, or both. You can also control how existing rows in the target table are removed before new rows are inserted.

For example, you might have a sales table that you need to update periodically with new pricing data. You can use the Load Table step to update the price column of the sales table by using the product ID as the key column.

When you load a table, you can choose the load technique that you want to use:

- Insert rows – inserts all of the rows in the source table into the output table.

Note: If you are inserting rows from the source table into the target table, you can specify a preprocessing action that determines how existing rows in the target table are removed before rows are inserted.

- Update rows – updates existing rows in the target table by using matching rows from the source table based on one or more key columns.
- Upsert rows – inserts new rows into the target table and updates existing rows in the target table based on one or more key columns.

Note: This step is available in a flow in SAS Data and AI Studio Enterprise.

There are five main steps to use the Load Table step:

1. Add the Load Table step to your flow and connect the source table.

   Note: The Load Table node does not have an output port. You must specify the target table in the Load Table node details.

2. Specify the library and name of the target table.
3. Select the load technique that you want to use: Insert rows, Update rows, or Upsert rows. If you are using the Insert rows technique, you can also specify a preprocessing action. If you are using the Update rows or Upsert rows techniques, you must specify at least one key column.
4. (Optional) Specify output table options.
5. Run the flow to load the data.

Load Table: Connection Requirements for the Node

The Load Table step includes only one input port. The target table is specified in the node details rather than with an output port. In order to run the Load Table step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	Not applicable.

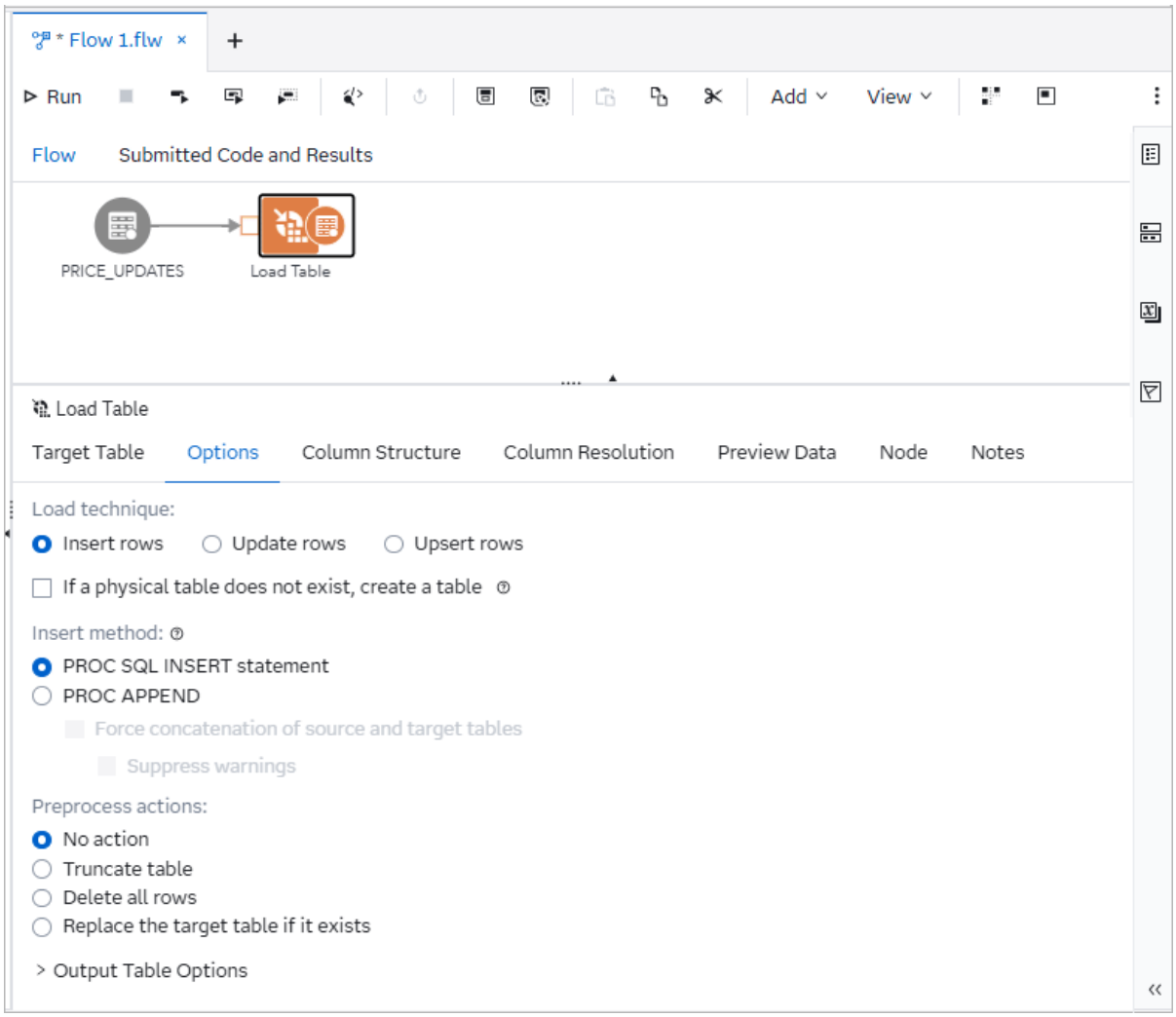
Load Table: Step-by-Step Instructions

Step 1: Add the Load Table Step and Connect a Source Table

To add the Load Table step to your flow:

1 In the **Steps** section of the navigation pane, expand the **Integrate** folder, and double-click **Load Table**.

2 Connect the input port of the Load Table node to a data source by using a Table node or another node that creates an output table, such a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.



Step 2: Specify the Target Table

The Load Table step can run only if the metadata that defines the column structure of the target table exists.

To specify the target table:

1 Click the **Load Table** node, and then click the **Target Table** tab.

2 Use the **Library** and **Table name** boxes to specify the target table.

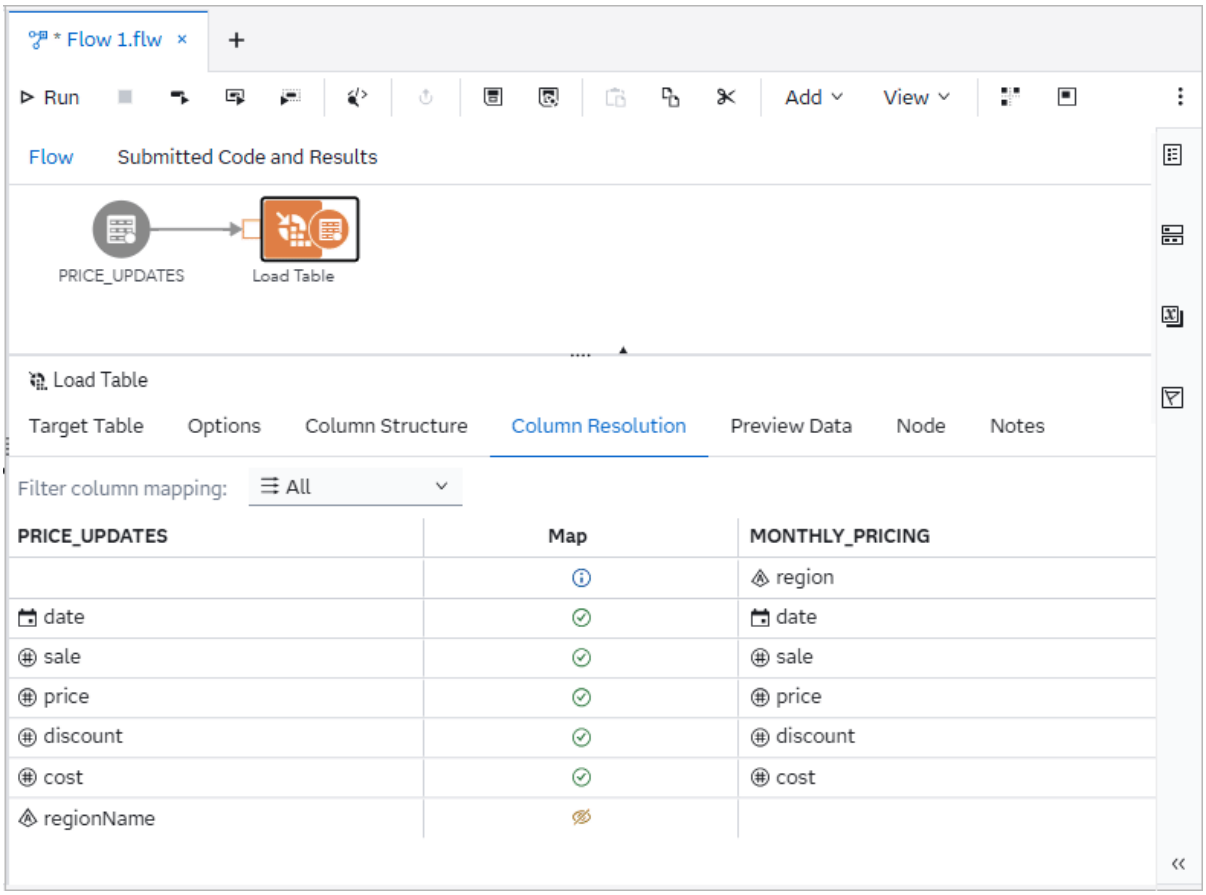
Note: If no metadata is found for the target table that you selected, you must either select a new target table or use the Column Structure tab to specify the column structure. You can copy the column structure from the source table or load the structure from a structure definition file. For more information, see "Specifying the Column Structure for the Target Table" on page 205.

3 To view the structure of the target table, click the **Column Structure** tab.

To view the column mapping between the source and target tables, click the **Column Resolution** tab.

Note: On the Column Resolution tab, you can use the **Filter column mapping** drop-down list to filter the mappings that are displayed. You can filter the mappings by the following categories:

- Successful ( ) - the source column is successfully mapped to a column in the target table.
- Ignored ( ) - the source column does not have a corresponding column in the target table. Data for this column is ignored in the target table.
- Information ( ) - a source column is not mapped to the column in the target table. An unresolved column can occur when SAS Data and AI Studio cannot automatically map columns based on name and data type.



Step 3: Select the Load Technique

- Load Data Using the Insert Rows Technique

  1 Click the **Options** tab and select **Insert rows**.

  2 If the physical target table does not exist, you can automatically create the table by selecting **If a physical table does not exist, create a table**. If no metadata is found for the target table that you specified, you must either select a new target table or use the Column Structure tab to specify the column structure. You can copy the column structure from the source table or load the structure from a structure definition file. For more information, see "Specifying the Column Structure for the Target Table" on page 205.

  If the physical target table does not exist and you do not select this option, the step cannot run successfully.

  3 Select an insert method. Both the **PROC SQL INSERT statement** and **PROC APPEND** options concatenate the source and target tables. If the target table is a SAS table type (for example, a Base SAS table or an SPD Server table), the **PROC APPEND** option can improve performance.

If you select the **PROC APPEND** option, you can use the **Force concatenation of source and target tables** option to force concatenation in these cases:

- Source table columns are not in the target table.
- Data types of source table columns do not match data types of target table columns.
- Column lengths are longer for source tables than for target tables.

If you do not want to write a warning to the log, select **Suppress warnings**.

4 Select the preprocess action that you want to use:

- **No action** - no preprocess action is applied. This option is selected by default.
- **Truncate table** - removes all rows from the table before the source data is loaded, but maintains the table structure, metadata, constraints, and indexes. Foreign key constraints are not maintained. This option uses the database TRUNCATE statement.

  Note: The **Truncate table** option is available only for SAS data sets and Oracle, SingleStore, Snowflake, and Microsoft SQL Server databases.

- **Delete all rows** - deletes all rows from the target table before the source data is loaded. If the target table is an Oracle, Teradata, Snowflake, SingleStore or Azure Synapse table, this option uses the DELETE statement that is associated with the data source. For all other data types, this option uses the PROC SQL DELETE statement.

  Note: When the **Delete all rows** action is used repeatedly to clear a SAS table, the size of that table should be monitored over time. **Delete all rows** performs only logical deletes for SAS tables. Therefore, the table's physical size continues to increase, which can negatively affect performance.

- **Replace the target table if it exists** - replaces the entire table with an empty table before the source data is loaded. This option does not preserve the existing table structure, metadata, constraints, and indexes.

- Load Data Using the Update Rows Technique

  You must specify at least one key column in order to use the Update rows technique.

  1 Click the **Options** tab and select **Update Rows**.

  2 Click + and select one or more key columns. You must select at least one key column that uniquely identifies each row in the source table. Do not select all of the columns in the list. Click **OK**.

  Note: For some databases, strict matching rules apply to key columns. Depending on the data type of the target table, you might not be able to select a column as a key column if the case of the source and target columns does not match. The Select Key Columns window indicates whether the case

of the source and target columns matches. Use the Column Resolution tab to view the source and target column names.

Note: If you are using the Update rows technique to load data into a SingleStore table, a primary or unique key must be defined for the target table.

- Load Data Using the Upsert Rows Technique

  You must specify at least one key column in order to use the Upsert rows technique. If you are working with SingleStore data and using native SQL code, a primary or unique key must be defined in the target table.

  1. Click the **Options** tab and select **Upsert Rows**.
  2. If the physical target table does not exist, you can automatically create the table by selecting **If a physical table does not exist, create a table**. If no metadata is found for the target table that you specified, you must either select a new target table or use the Column Structure tab to specify the column structure. You can copy the column structure from the source table or load the structure from a structure definition file. For more information, see "Specifying the Column Structure for the Target Table" on page 205.

     If the physical target table does not exist and you do not select this option, the step cannot run successfully.

     Note: This option is not available if you have selected **Use native database SQL code** because a primary or unique key must be defined in the target table.

  3. If both the source and target tables are located in a SingleStore database, you can use native SQL code by selecting **Use native database SQL code**. This option can improve performance. If you select this option, all other options on the **Options** tab are not available. In addition, some upsert features might not be available if they are not supported in the native SQL code.
  4. Click + and select one or more key columns. You must select at least one key column that uniquely identifies each row in the source table. Do not select all of the columns in the list. Click **OK**.

     For some databases, strict matching rules apply to key columns. Depending on the data type of the target table, you might not be able to select a column as a key column if the case of the source and target columns does not match. The Select Key Columns window indicates whether the case of the source and target columns matches. Use the Column Resolution tab to view the source and target column names.

     Note: If you have selected **Use native database SQL code**, the **Select key columns** option is not available. A primary or unique key must be defined in the target table.

5 Select an insert method. Both the **PROC SQL INSERT statement** and **PROC APPEND** options concatenate the source and target tables. If the target table is a SAS table type (for example, a Base SAS table or an SPD Server table), the **PROC APPEND** option can improve performance.

If you select the **PROC APPEND** option, you can use the **Force concatenation of source and target tables** option to force concatenation in these cases:

- Source table columns are not in the target table.
- Data types of source table columns do not match data types of target table columns.
- Column lengths are longer for source tables than for target tables.

If you do not want to write a warning to the log, select **Suppress warnings**.

Note: If you have selected **Use native database SQL code**, the insert method options are not available.

(Optional) Step 4: Specify Output Table Options

You can specify options to optimize how the data is loaded into the target table.

Note: If you are using the Upsert rows technique to load data into a SingleStore table, and you have selected **Use native database SQL code**, the output table options are not available.

1 Click the **Options** tab and expand **Output Table Options**.

2 If you are loading data into an Oracle, Snowflake, SingleStore, Azure Synapse, or Teradata target table, you can select one of the following options:

- **Use default table options** - uses the default SAS/ACCESS table options that are associated with the data type of the target table.
- **Bulk load** - loads the rows of data to the target table using the native bulk-load facility that is associated with the data type of the target table.

Note:

- If you are loading data into an Azure Synapse table, authentication to Azure Data Lake Storage is required. Single sign-on (SSO) is preferred. For more information, see "Authentication for Bulk Loading to Azure or to Microsoft Fabric Data Warehouse" in *SAS/ACCESS for Relational Databases: Reference*. If you need to specify any of the required authentication options as data set options instead of LIBNAME options, click **Advanced table options** and enter each option on a separate line.

- When you are loading data into a Snowflake target table and you have selected the **Bulk load** option, the BL_INTERNAL_STAGE= data set option is specified in the code that SAS Data and AI Studio generates as follows:

  ```
  BL_INTERNAL_STAGE="table/table-name"
  ```

  If you need to modify the bulk load data set options, you must select **Use default table options**, and then click **Advanced table options**. For more information, see "Bulk Loading and Unloading for Snowflake" in *SAS/ACCESS for Relational Databases: Reference*.

- **Commit all rows in a single transaction** - changes to the target table are committed after all the rows have been written. This option uses the DBCOMMIT = 0 data set option for Oracle, Teradata, Snowflake, SingleStore, and Azure Synapse target tables.
- **Commit every *n* rows** - changes to the target table are committed after the specified number of rows is written. The default value is 100,000 rows. This option uses the DBCOMMIT = n data set option for Oracle, Teradata, Snowflake, SingleStore, and Azure Synapse target tables.

3 If necessary, you can specify advanced output table options by clicking **Advanced table options**. Enter each option on a separate line. Advanced table options can include any DATA step options that are associated with inserting and updating data in a table, such as options to specify the number of rows to process prior to committing the data or to specify whether to use a DBMS-specific bulk-load facility. You must include any quotation marks that are required for string values.

Step 5: Run the Flow and Load the Data

To load the source data into the target table, click ▷ Run.

Specifying the Column Structure for the Target Table

If no metadata is found for the target table that you have specified, you can use the Column Structure tab in the node details to specify the column structure. You can copy the column structure from the source table or load the structure from a structure definition file. You can also use the Column Structure tab to create a structure definition file that you can use to define the metadata for other target tables.

To copy the structure from the source table:

- Click the **Column Structure** tab and select **Structure** ⇨ **Copy structure from source**.

To load the column structure from an external file:

1 Click the **Column Structure** tab.

2 Select **Structure** ⇨ **Load structure definition**, and then select the metadata definition file that you want to use.

To create a structure definition file that is based on the current structure of the target table:

1 Click the **Column Structure** tab and select **Structure** ⇨ **Generate structure definition**.

2 In the Generate a Column Structure File window, specify the location and name of the file. You can save the file as a comma-delimited (*.csv) or text (*.txt) file. The column structure metadata file is always saved with UTF-8 encoding.

Lookup

About the Lookup Step

The Lookup step enables you to add information to your data by looking up data values in reference, or lookup, tables. You can add the lookup data, along with data from a source table, to a target table. The Lookup step also provides a means of protecting your data quality by enabling you to define actions, such as writing data to an exception table, when there is no match in a lookup table for data in the source table.

For example, you might have a table named Movies that contains data about recent movies, including the name of the movie, the director, the actors, and the year in which the movie was made. Separate tables named Ratings and Streaming_Services include the name of the movie and additional data about ratings from different online sources and services that offer the movie for streaming. You can use the Lookup step to create a target table that includes data from all three tables. If the Movies table contains data for movies that do not have corresponding data in either of the lookup tables, you can decide what you want to happen, including writing those rows to an error or exception table, or both.

Note: The Lookup step is available only if your site licenses SAS Data and AI Studio Enterprise.

There are eight main steps to use the Lookup step:

1 Add the Lookup step to your flow and connect a source table and one or more lookup tables.

2 Specify one or more key columns that are used to match the rows between the source and lookup tables.

3 (Optional) Create filters on the lookup tables.

4 (Optional) Define exception conditions and associated actions. You can assign more than one action to a condition.

5 Specify columns to include in the target table.

6 (Optional) Create an error table.

7 (Optional) Create an exception table.

8 Run the flow to create the target table.

Lookup: Connection Requirements for the Node

By default, the Lookup step includes two input ports: one for a source table and one for a lookup table. You can add ports for additional lookup tables. For more information, see "Expanding and Collapsing Node Ports" on page 14.

In order to run the Lookup step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
Two or more connections are required for a source and at least one lookup table. You can connect either of the following types of nodes: ■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No connection is required. **Note:** By default, the output data is written to temporary tables in the Work library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

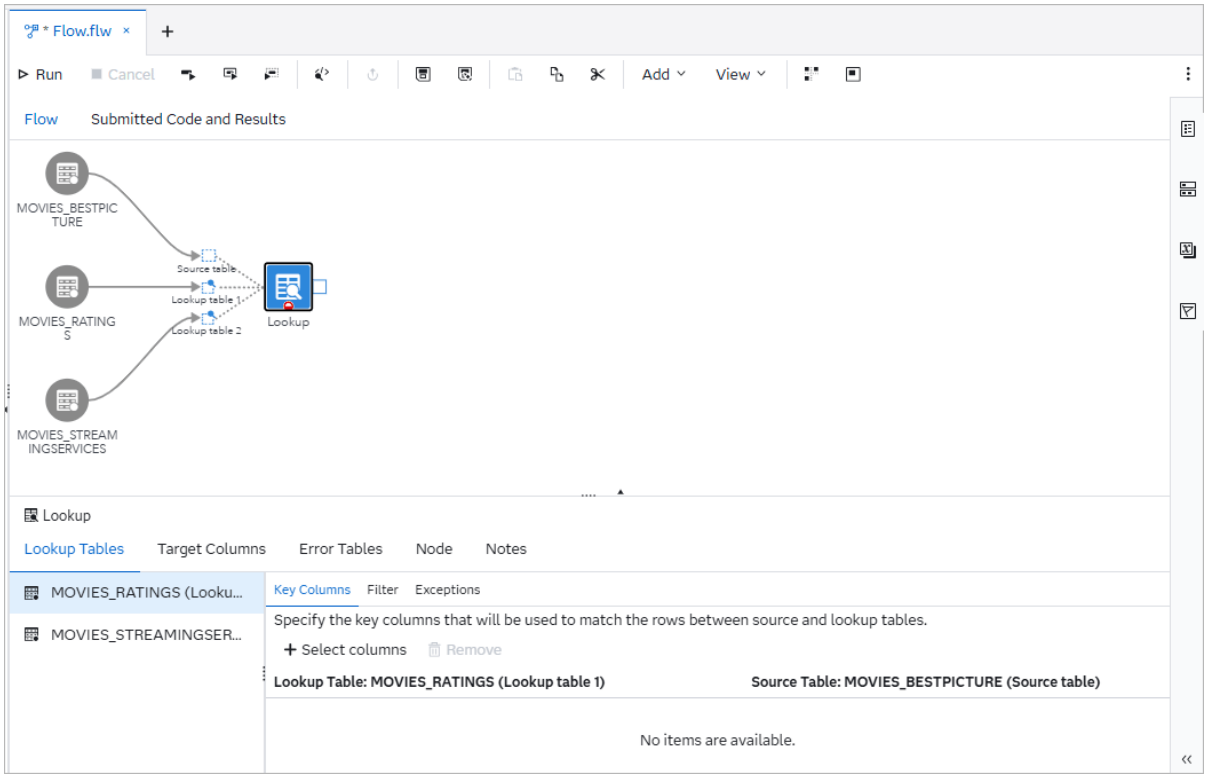
Lookup: Step-by-Step Instructions

Step 1: Add the Lookup Step and Connect Source and Lookup Tables

To add the Lookup step to your flow:

1 In the **Steps** section of the navigation pane, expand the **Integrate** folder, and double-click **Lookup**.

2 Connect all input ports of the Lookup node to data sources by using Table nodes or other nodes that create an output table, such a Query node, a SAS Program node, or an Import node. The upper port is for a source table, and the lower ports are for lookup tables. For more information, see "Connecting Nodes" on page 13.



Note: To view more details about the node ports, you can expand the ports by right-clicking the node and selecting **Expand ports**. For more information, see "Expanding and Collapsing Node Ports" on page 14.

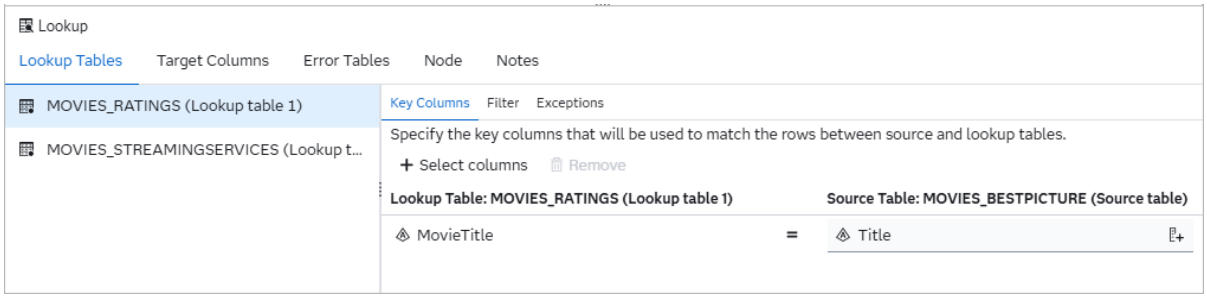
Step 2: Specify One or More Key Columns

The Lookup step can run only if you have specified one or more key columns that match rows from the source table with rows from each lookup table.

To specify the key columns:

1. Click the **Lookup Tables** tab, and select the lookup table for which you want to select key columns.
2. Click the **Key Columns** subtab, and click **Select columns**.
3. In the Select Columns window, select one or more columns.
4. SAS Data and AI Studio attempts to match a column in the source table to the column that you selected from the lookup table based on column name, regardless of case and data type. If a match is not found, click to select the column that you want to use from the source table. Click **OK**.

   Note: If you want SAS Data and AI Studio to treat NULL values as equal when key columns are matched, click the **Node** tab, and then click **Configuration**. Select **Treat NULLS as equal when comparing key columns**. If you do not select this option, key columns with NULL values do not match any other column value. This option is not selected by default.



(Optional) Step 3: Filter the Lookup Tables

To filter data from a lookup table:

1. On the Lookup Tables tab, select the lookup table on which you want to create a filter.
2. Click the **Filter** subtab.
3. Specify one or more conditions for a WHERE clause using PROC SQL syntax. The code that you enter is used to generate a WHERE clause for the selected lookup table. Enter only code for the conditions; do not include the WHERE

keyword in the code that you enter. The WHERE clause syntax is validated only when the step runs.

For example, enter this condition to subset the Sashelp.Cars data by country of origin:

```
origin in ('Asia', 'Europe')
```

To reference a column in a filter expression, you must use one of the following formats:

- *table-name.column-name*
- *column-name*

If the column name includes spaces or special characters or is case-sensitive, you must use a SAS name literal. For example, the column name `Lkup EMP ID` must be written as `'Lkup EMP ID'n`:

- `'Lkup EMP ID'n > 101`
- *table-name*`.'Lkup EMP ID'n > 101`

(Optional) Step 4: Define Exception Conditions and Actions

Exceptions include a condition that can occur, such as a missing value, and the action that you want to take, such as aborting the process. You can define exceptions for each lookup table. Each condition can have multiple actions. By default, SAS Data and AI Studio defines five exceptions for each lookup table. You can edit or delete the default exceptions, and you can add exceptions.

Note: If no exceptions are defined, the following default conditions and actions are applied:

- **Lookup table missing** - **Skip the record**
- **Lookup table contains no records** - **Skip the record**
- **Lookup value not found** - **Skip the record**.

You use the Error Tables tab to define the error and exception tables. By default, the error and exception tables are temporary and are deleted when you close SAS Data and AI Studio.

Note:

- Only the first error for a key column value in the source table is written to the error table. The error table can contain only one row for each key column value.
- Multiple exceptions for a key column value in the source table can be written to the exception table. The exception table can contain multiple rows for each key column value.

To add an exception:

1 On the Lookup Tables tab, select the lookup table for which you want to create an exception.

2 Click the **Exceptions** subtab.

3 Click **+ Exception** and select the condition and corresponding action. You can assign multiple actions to a condition. In some cases, an action can be ignored depending on the other actions that are assigned to the condition.

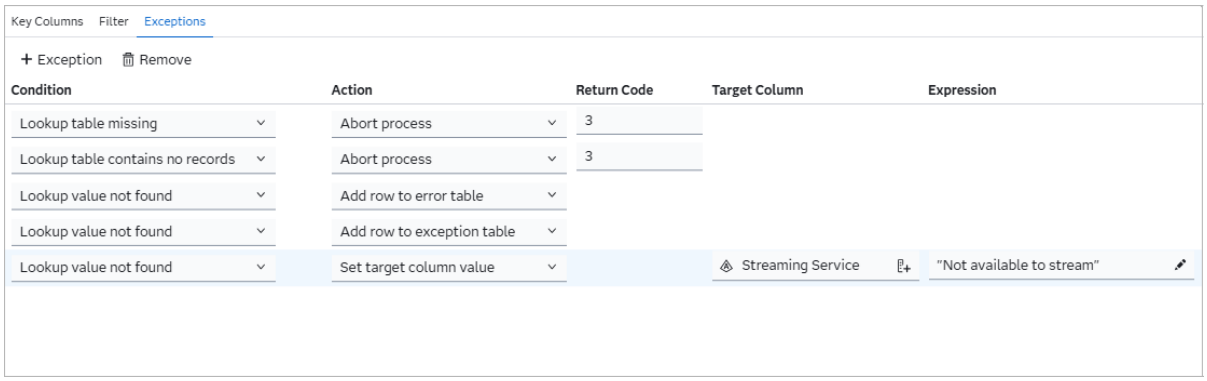
   You can choose from among these conditions:

   - **Lookup table missing**
   - **Lookup table contains no records**
   - **Lookup value not found**.

   You can assign these actions to any condition:

   - **Abort process** - requires a Return Code value. The default value is 3. If this action is assigned to a condition, any other actions that are assigned to the same condition are ignored.
   - **Add row to error table** - adds rows to the error table that you define on the Error Tables tab. If you do not define the error table on the Error Tables tab, you can still run the step, but the error data is not saved. This action is ignored if the **`Abort process`** action is assigned to the same condition.
   - **Add row to exception table** - adds rows to the exception table that you define on the Error Tables tab. If you do not define the exception table on the Error Tables tab, you can still run the step, but the exception data is not saved. This action is ignored if the **`Abort process`** action is assigned to the same condition.
   - **Set target column value** - sets the value of the selected target column to the value that is calculated by the expression in the Expression column. Use the **Target Column** box to select the target column to which you want to assign a new value. You can select any column that is selected for the target table. Enter an expression in the **Expression** box, or click to create an expression using the Expression Builder. The expression can use any column that is selected for the target table and must use PROC SQL syntax. For more information, see "Building an Expression" in *SAS Data and AI Studio: User's Guide*. This action is ignored if the **`Abort process`** action is assigned to the same condition.
   - **Set target column to missing** - sets the value of all target columns from the associated lookup table to a missing value. This action is ignored if the **`Abort process`** or the **`Set target column value`** actions are assigned to the same condition.
   - **Skip the record** - writes no data to the target table. This action is ignored if the **`Abort process`**, **`Set target column value`**, or **`Set target column to missing`** actions are assigned to the same condition.

In the following example, several exceptions are defined, including an exception that assigns the value of the Streaming_Service target column to "Not available to stream," if the lookup value is not found.



Note: To remove an exception from the Exceptions tab, select the exception and click **Remove**.

Step 5: Add Columns to the Target Table

You must add at least one column to the target table.

Note: Rows with duplicate key values in source and lookup tables are not excluded from the target table. If you do not want duplicate rows, you can use the Sort step to remove rows with duplicate key values from the source and lookup tables. For more information, see "Sort" on page 140.

To add columns to the target table:

1. Click the **Target Columns** tab.
2. From the table drop-down list, select the table whose columns you want to add. You can use the **Filter** box to filter the columns in the selected table.
3. Select one or more columns to add, and click **Add columns**. To add all columns from the selected table to the target table, click **Add all**.

   Note: Column names in the target table must be unique. You can edit any duplicate column names.
4. To rearrange columns in the target table, select one or more columns and use the options from the **Move columns** drop-down list.

(Optional) Step 6: Create Error Table

You can create exception conditions to write one or more columns of data from the source table to an error table. By default, the error table is temporary and is deleted when you close SAS Data and AI Studio.

To create an error table:

1 Click the **Error Tables** tab.

2 Click **Error Table**, and then click **Create error table**. An error table port is added to the step node.

3 Click + and use the Select Source Columns window to select the columns from the source table that you want to include in the error table. Click **OK**.

> **TIP** It is recommended that you include the source key columns in the error table so that you can locate the row in the source table that is associated with the error.

4 (Optional) To limit the number of rows that can be written to the error table, click **Limit number of errors**. Use the **Error limit** option to specify the maximum number of error rows. Use the **Error limit action** option to specify whether to abort the step or ignore any remaining errors when the limit is reached.

(Optional) Step 7: Create Exception Table

You can create exception conditions to write one or more columns of data to an exception table. By default, the exception table is temporary and is deleted when you close SAS Data and AI Studio.

1 Click the **Error Tables** tab.

2 Click **Exception Table**, and then click **Create exception table**. By default, the exception table includes columns that contain the lookup column name and the exception condition and action.

3 To add columns from the source table, click + and use the Select Source Columns window to select the columns that you want to include in the exception table. Click **OK**.

> **TIP** It is recommended that you include the source key columns in the exception table so that you can locate the row in the source table that is associated with the exception.

Step 8: Run the Flow and Load Data into the Target Table

To load the source and lookup data into the target table, click ▷ Run.

Lookup: Debugging Errors

SAS automatically includes several options that are useful for debugging at the top of the code that is generated by the step. By default, the debugging options are commented out. You can uncomment the region of code that includes the options and run the code to help analyze database processing or to diagnose warning and error messages in the SAS log. The debugging options include the following:

```
/* DEBUG SETTINGS: Uncomment options and filename statements below for
debugging */
/*
options
mlogic
mprint
mfile
symbolgen
sastrace=',,,d'
sastraceloc=saslog
nostsuffix
;

filename mprint 'TEMPOUT';
*/
```

Merge Table

About the Merge Table Step

You can use the Merge Table step to make changes to columns in a target table based on values from a source table. Rows in the source and target columns are matched using one or more key columns. The Merge Table step enables you to combine update and insert operations in one step.

The Merge Table step works with DBMS tables that support ANSI SQL standards, including Oracle, Teradata, Snowflake, and SQL Server. Both the source and target tables must reside on the same database server.

Note: This step is available in a flow in SAS Data and AI Studio Enterprise.

There are six main steps to use the Merge Table step:

1 Add the Merge Table step to your flow and connect the source table.

2 Specify the library and name of the target table.

3 Specify one or more key columns that are used to match the rows between the source and target tables.

4 (Optional) Specify the columns in the target table that should be updated with values from the source table.

5 (Optional) Specify the columns in the target table into which new values should be inserted when no matching row is found.

6 Run the flow to merge the tables.

Note: To run the flow, you must specify at least one column to update or insert new values.

Merge Table: Connection Requirements for the Node

The Merge Table step includes only one input port. The target table is specified in the node details rather than in an output port. In order to run the Merge Table step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
Table node. The table must reside in a database that supports ANSI SQL, including Oracle, Teradata, Snowflake, and SQL Server.	Not applicable.

Merge Table: Step-by-Step Instructions

Step 1: Add the Merge Table Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Integrate** folder, and double-click **Merge Table**.

2 Connect the input port of the Merge Table node to a data source by using a Table node. The table must reside in a database that supports ANSI SQL, such as Oracle, Teradata, Snowflake, and SQL Server. For more information, see "Connecting Nodes" on page 13.

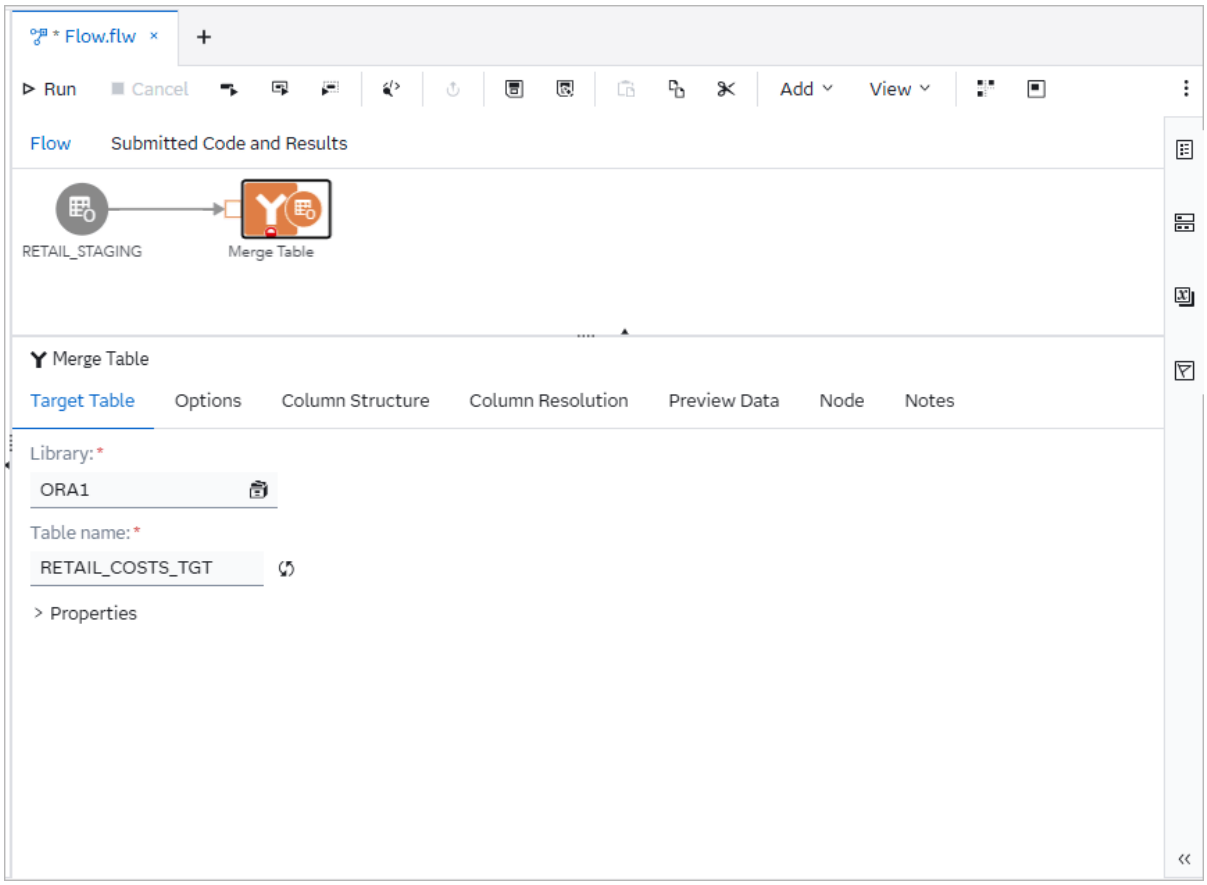
Step 2: Specify the Target Table

The source and target tables must reside on the same database server.

1 Click the **Merge Table** node, and then click the **Target Table** tab.

2 Use the **Library** and **Table name** boxes to specify the target table.

Note: The Merge Table node does not have an output port. You must specify the target table in the Merge Table node details. However, you can connect the Merge Table node to another operational node that requires a table as input.



3 To view the structure of the target table, click the **Column Structure** tab.

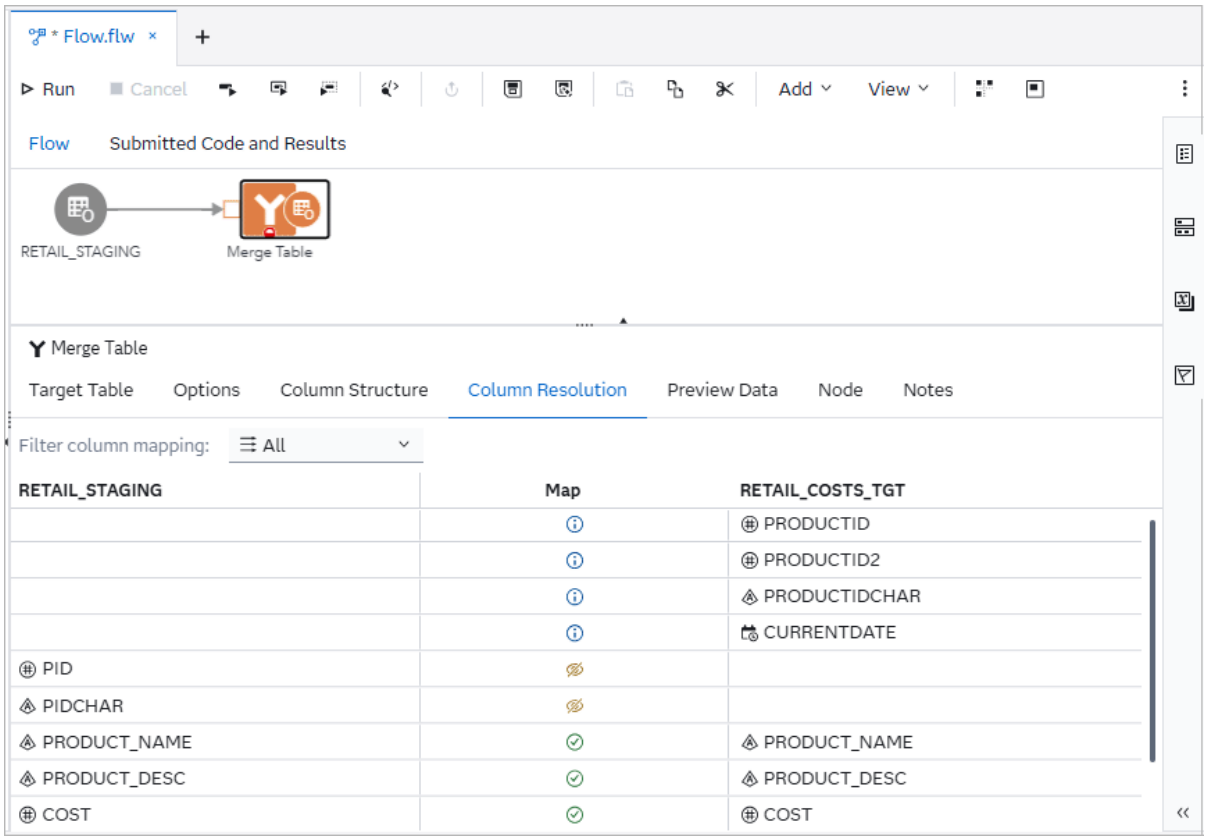
To view the column mapping between the source and target tables, click the **Column Resolution** tab.

Note: On the Column Resolution tab, you can use the **Filter column mapping** drop-down list to filter the mappings that are displayed. You can filter the mappings by the following categories:

- Successful (✓) - the source column is successfully mapped to a column in the target table.

- Ignored (👁) - the source column does not have a corresponding column in the target table. Data for this column is ignored in the target table.
- Information (ⓘ) - a source column is not mapped to the column in the target table. An unresolved column can occur when SAS Data and AI Studio cannot automatically map columns based on name and data type.

In this example, there are four columns in the target table that do not have corresponding columns in the source table, and two columns in the source table that do not have a corresponding column in the target table.



Step 3: Specify One or More Key Columns

You must specify at least one key column to run the Merge Table step.

Note: To use the SQL editor to create SQL code for the Merge Table expression, click **SQL editor**. If you have used the Options tab to specify one or more key columns and at least one other column to update or insert, SAS Data and AI Studio automatically generates the SQL code for those options. The SQL code is passed to the target database for processing by using explicit pass-through, so you should use the SQL syntax of your data source. The expression must include the code to specify the key columns, as well as any target columns to update and target column values to insert. When you select this option, you cannot revert to using the graphical expression builder.

To preview the merge expression that is generated by SAS Data and AI Studio, click **Preview expression**. You can also copy the code to use in a SAS program. This option is available only when you have specified one or more key columns and at least one column to update or insert.

1 Click the **Options** tab and select **Key columns**.

2 To add a key column, click **Select columns**.

3 In the Select a Column window, select one or more key columns. You must select at least one key column that uniquely identifies each row in the source table. Do not select all of the columns in the list. Click **OK**.

   Note: If you want SAS Data and AI Studio to treat NULL values as equal when key columns are matched, click the **Node** tab, and then click **Configuration**. Select **Treat NULLS as equal when comparing key columns**. If you do not select this option, key columns with NULL values do not match any other column value. This option is not selected by default.

4 SAS Data and AI Studio attempts to match key columns in the source and target tables based on column name, regardless of case and data type. If a match is not found, click to select the column that you want to use from the target table. Click **OK**.

(Optional) Step 4: Specify the Target Columns to Update

You can specify columns in the target table to update with values from the corresponding source columns for each row that is matched by a key column. This step is optional if you specify a column to insert values.

Note: Columns that are used as key columns cannot be updated.

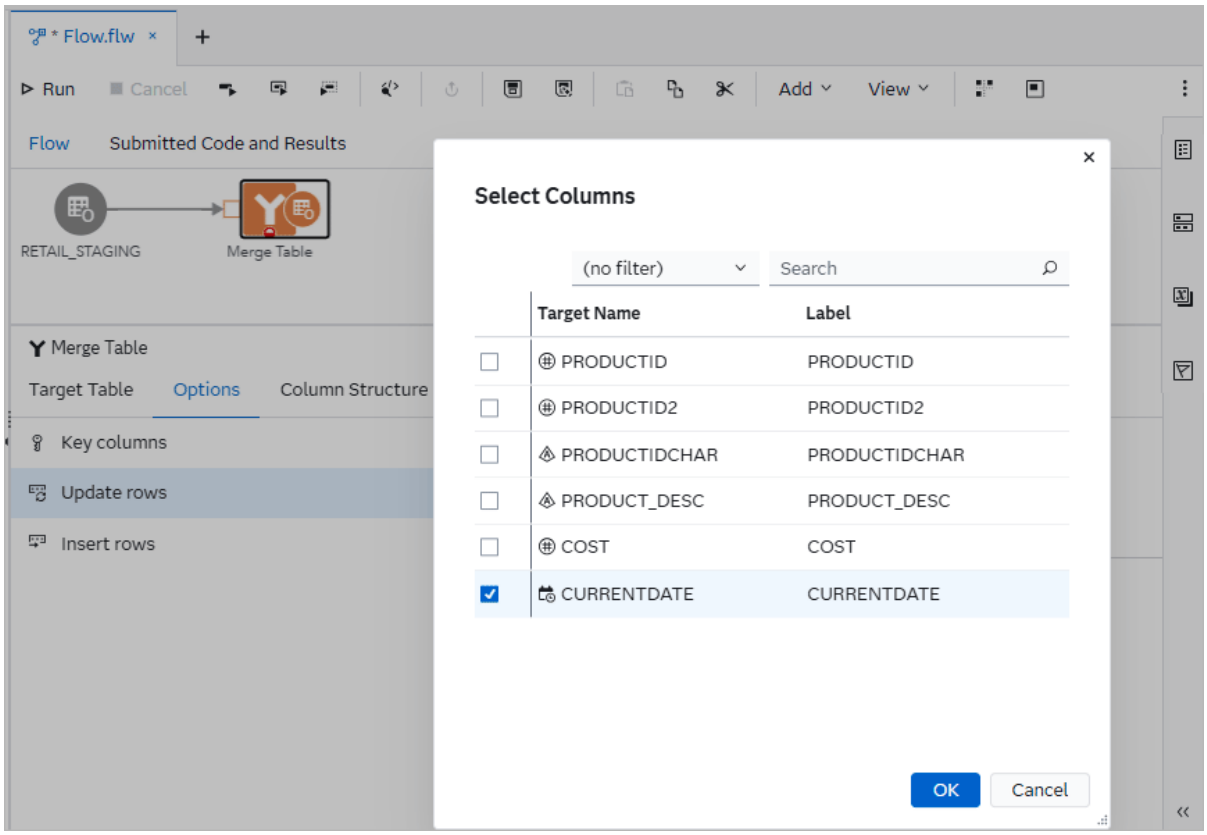
1 Click the **Options** tab and select **Update rows**.

2 To select a column to update, click **Add columns**.

   Note: You can add all of the columns in the target table by clicking **Add all columns**.

3 In the Select a Column window, select one or more columns.

4 SAS Data and AI Studio attempts to match a column in the source table to the column that you selected from the target table based on column name, regardless of case and data type. If a match is not found, click to select the column that you want to use from the source table. Click **OK**.



(Optional) Step 5: Specify Target Column Values to Insert

Specify the columns where new values should be inserted when no matching row is found. This step is optional if you specify a column to update.

1 Click the **Options** tab and select **Insert rows**.

2 To select a column to insert, click **Add columns**.

3 In the Select a Column window, select one or more columns.

4 SAS Data and AI Studio attempts to match a column in the source table to the column that you selected from the target table based on column name, regardless of case and data type. If a match is not found, click to select the column that you want to use from the source table. Click **OK**.

Step 6: Run the Flow and Merge the Tables

To merge the source and target tables, click ▷ Run.

10

Generating Statistics

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Analysis of Covariance

About the Analysis of Covariance Step

The Analysis of Covariance step fits a linear model that combines the continuous and categorical predictors of a continuous dependent variable. This step also produces graphical output to interpret the results.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or

SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Analysis of Covariance: Connection Requirements for the Node

In order to run the Analysis of Covariance step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Specify the Output Options" on page 229. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

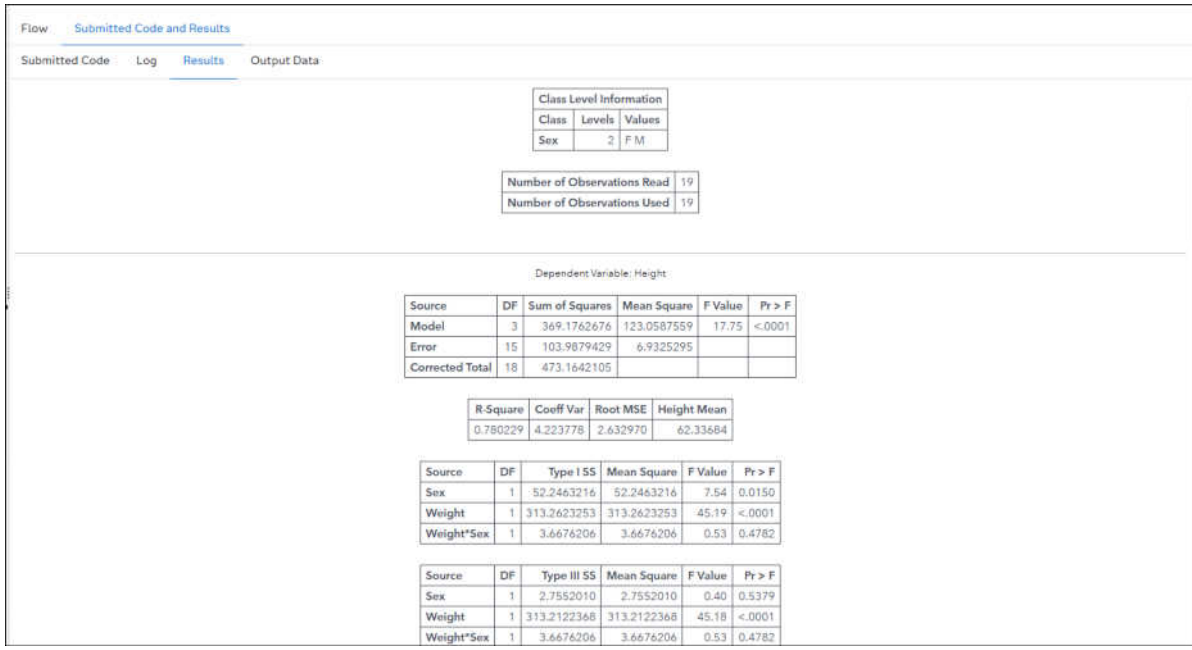
Example: Analyzing the Sashelp.Class Table

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Analysis of Covariance** to add the step to your flow.
2. Add the Sashelp.Class table to your flow. Connect the input port of the Analysis of Covariance node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Analysis of Covariance step, click the Analysis of Covariance node.
4. On the **Data** tab, set these options:
   - To the **Dependent variable** role, assign the **Height** column.
   - To the **Categorical variable** role, assign the **Sex** column.
   - To the **Continuous covariate** role, assign the **Weight** column.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Analysis of Covariance: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Dependent variable** role, assign a continuous numeric variable.

3 To the **Categorical variable** role, assign the variable that specifies the levels of the groups.

4 To the **Continuous covariate** role, assign a continuous numeric variable that is related to the dependent variable. You can specify whether to center the covariate variable.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Set the model options.

a Specify whether to use the equal or unequal intercepts for each level of the categorical variable.

b Specify whether to use the equal or unequal slopes for each level of the categorical variable.

c (Optional) Select **Show parameter estimates** to produce a solution to the normal equations (parameter estimates). By default, the step displays a solution if your model does not include any classification variables. Select this option only if you want to see the solution for models with classification effects.

2 Select **Perform multiple comparisons** to perform the least squares means for the categorical variable.

Then specify these options:

a Select the **Covariate value** to use in multiple comparisons. The covariate value can be either the mean value or a specified value.

b Select the method to request a multiple comparison adjustment for the *p*-values and confidence limits for the differences of LS-means.

Here are the available methods:

- Bonferroni
- Dunnett
- Nelson
- Scheffé
- Sidak
- Tukey

c Specify the significance level for the comparisons. The default is `0.05`.

3 Select the plots to include in the results. The list of available plots depends on the method that you selected for multiple comparisons. You can also specify the maximum number of plot points.

Step 3: Specify the Output Options

On the **Output** tab, you can specify whether to create an output data set. You can also specify the values to include in the output data set. You can include predicted values, residuals, standard errors, and influence statistics.

Note: If you are running the step in a flow, you must add output ports for the score data set and the statistics data set to the Analysis of Covariance node. For more information, see "Analysis of Covariance: Connection Requirements for the Node" on page 227.

ANOVA Statistical Power

About the ANOVA Statistical Power Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. The ANOVA Statistical Power step calculates power and sample size analyses for one degree of freedom contrasts and the overall *F* test.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

ANOVA Statistical Power: Connection Requirements for the Node

No input or output data is required to run the ANOVA Statistical Power step.

Example: One-Way ANOVA for Power and Sample Size Analysis

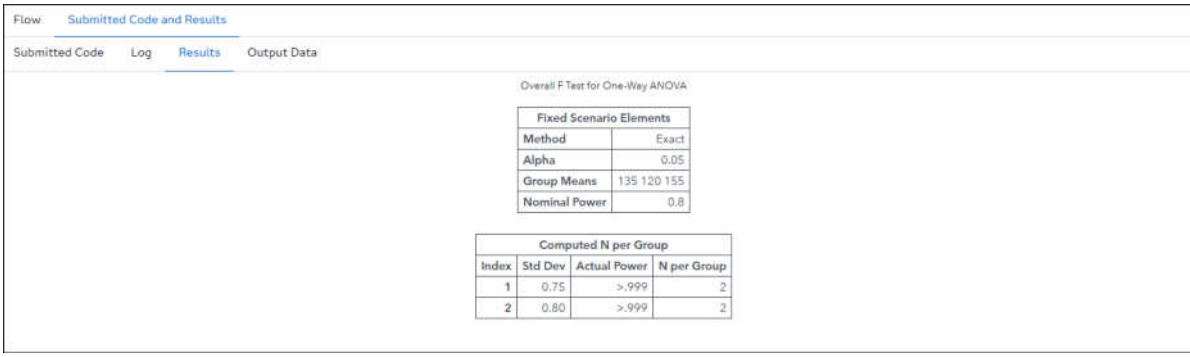
To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **ANOVA Statistical Power** to add the step to your flow.
2. To set the options for the ANOVA Statistical Power step, click the ANOVA Statistical Power node.
3. For the **Solve for** option, select **Sample size per group**.
4. In the **Number of groups** table, enter `3`.
5. In the **Means values** table, enter these values: `135`, `120`, and `155`

6 In the **Standard deviation values** table, click +. You should now have two rows. Enter `0.75` in the first row, and enter `0.8` in the second row.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



ANOVA Statistical Power: Step-by-Step Instructions

Step 1: Assign Properties

Set these properties on the **Options** tab. For many properties, you can specify more than one value. Click + to specify multiple rows of values.

1 For the **Solve for** option, specify the type of analysis.

2 Specify the number of groups. This value must be greater than or equal to 2 and less than or equal to 10.

3 Specify the significance level to use in the analysis. You can specify more than one value.

4 Specify the means for each group. You specified the number of groups in the **Number of groups** option, so you could have more than one row of means.

5 Specify the standard deviation values. You can specify more than one standard deviation.

6 Specify the power values for the analysis. These values must be greater than 0 and less than 1.

Note: This option is available only if you are solving for total sample size or sample size per group.

7 Specify whether fractions are allowed when you specify a sample size or when you are solving for sample size.

8 Specify the form to use to determine the sample size.

You can choose from these forms:

- **Sample size per group** specifies the values of N for each group. This value must be greater than or equal to 2.
- **Group sample sizes** specifies the values for the specified number of groups. (You set the number of groups by using the **Number of groups** option.) This value must be greater than or equal to 1.
- **Total N, Group weights** specifies the total sample size. The total sample size must be greater than the number of groups + 1.

  You can also specify equal or unequal group sizes. If the group sizes are unequal, you must specify allocation weights for the groups. Each allocation weight must be greater than or equal to 1.

Note: This option is available only if you are solving for power.

9 Specify whether to include contrasts in the analysis. Contrast coefficients can be zero, positive, or negative. Often these coefficients sum to zero, but that is not required.

If you selected **Sample size per group** for the form, you can choose to specify the contrast coefficients or select the orthogonal polynomial trend components.

Step 2: Create the Output Plots

On the **Plots** tab, specify whether to create these output plots:

- If you are solving for power, you can specify the minimum and maximum sample size.
- If you are solving for total sample size or sample size per group, you can specify the minimum and maximum power.

Canonical Correlation

About the Canonical Correlation Step

Canonical correlation is a generalization of multiple correlations for analyzing the relationship between two sets of variables. The Canonical Correlation step

performs canonical correlation, partial canonical correlation, and canonical redundancy analysis.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Canonical Correlation: Connection Requirements for the Node

In order to run the Canonical Correlation step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Specify the Output Options" on page 236. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Canonical Correlation Analysis

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

```
data jobs;
   input career supervisor finance variety feedback autonomy;
   datalines;
72 26 9 10 11 70
63 76 7 85 22 93
96 31 7 83 63 73
96 98 6 82 75 97
```

```
84 94 6 36 77 97
66 10 5 28 24 75
31 40 9 64 23 75
45 14 2 19 15 50
42 18 6 33 13 70
79 74 4 23 14 90
39 12 2 37 13 70
54 35 3 23 74 53
60 75 5 45 58 83
63 45 5 22 67 53
run;
```

Click **Run** to create the Work.Jobs table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Canonical Correlations** to add the step to your flow.

3 Add the Work.Jobs table to your flow. Connect the input port of the Canonical Correlations node to the data source. For more information, see "Connecting Nodes" on page 13.

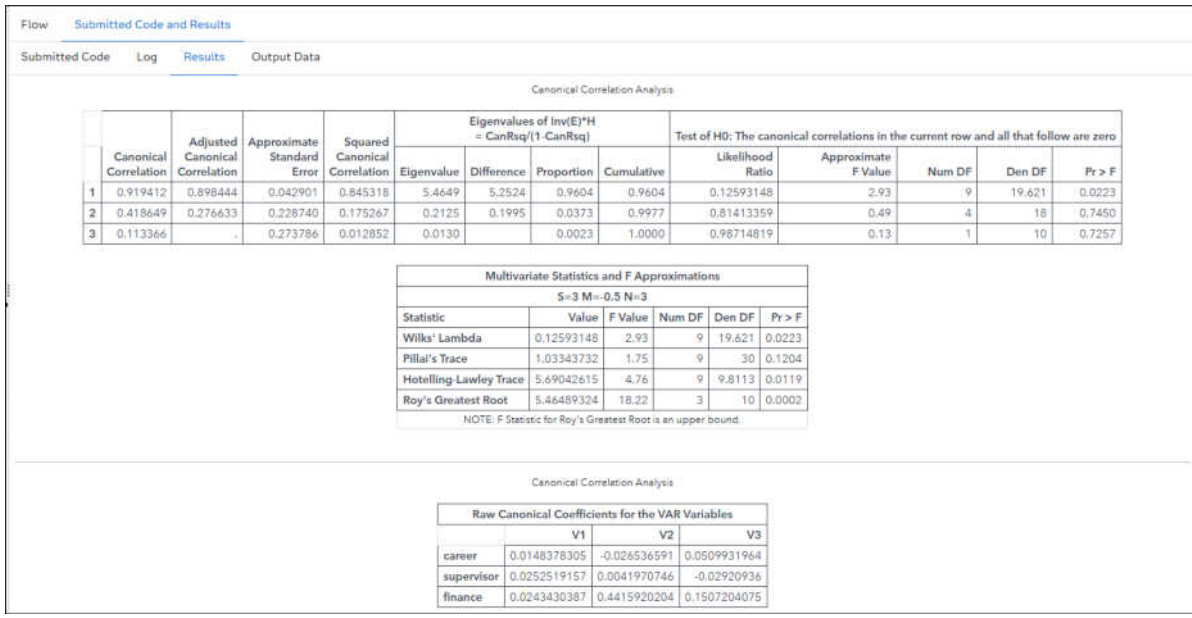
4 To set the options for the Canonical Correlation step, click the Canonical Correlations node.

5 On the **Data** tab, set these options:

- To the **Variable set 1** role, assign the **career**, **supervisor**, and **finance** columns.
- To the **Variable set 2** role, assign the **variety**, **feedback**, and **autonomy** columns.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



	Canonical Correlation	Adjusted Canonical Correlation	Approximate Standard Error	Squared Canonical Correlation	Eigenvalues of Inv(E)*H = CanRsq/(1-CanRsq)				Test of H0: The canonical correlations in the current row and all that follow are zero				
					Eigenvalue	Difference	Proportion	Cumulative	Likelihood Ratio	Approximate F Value	Num DF	Den DF	Pr > F
1	0.919412	0.898444	0.042901	0.845318	5.4649	5.2524	0.9604	0.9604	0.12593148	2.93	9	19.621	0.0223
2	0.418649	0.276633	0.228740	0.175267	0.2125	0.1995	0.0373	0.9977	0.81413359	0.49	4	18	0.7450
3	0.113366	.	0.273786	0.012852	0.0130		0.0023	1.0000	0.98714819	0.13	1	10	0.7257

Multivariate Statistics and F Approximations					
S=3 M=-0.5 N=3					
Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.12593148	2.93	9	19.621	0.0223
Pillai's Trace	1.03343732	1.75	9	30	0.1204
Hotelling-Lawley Trace	5.69042615	4.76	9	9.8113	0.0119
Roy's Greatest Root	5.46489324	18.22	3	10	0.0002

NOTE: F Statistic for Roy's Greatest Root is an upper bound.

Raw Canonical Coefficients for the VAR Variables			
	V1	V2	V3
career	0.0148378305	-0.026536591	0.0509931964
supervisor	0.0252519157	0.0041970746	-0.02920936
finance	0.0243430387	0.4415920204	0.1507204075

Canonical Correlation: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter** field.

2 To the **Variable set 1** role, assign the variables to include in the first set.

3 To the **Variable set 2** role, assign the variables to include in the second set.

4 (Optional) Specify the prefix and label for variable set 1. These canonical variables are given the names V1, V2, and so on. If you specify ABC as the prefix, the names are ABC1, ABC2, and so on. The label is a character constant to refer to variables in the output.

5 (Optional) Specify the prefix and label for variable set 2. These canonical variables are given the names W1, W2, and so on. If you specify ABC as the prefix, the names are ABC1, ABC2, and so on. The label is a character constant to refer to variables in the output.

6 (Optional) To the **Variables to partial out** role, assign the variable that is the base of the canonical analysis on partial correlations. The variables that you assign to this role are partialed out of Variable set 1 and Variable set 2.

7 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

8 (Optional) To the **Weight** role, specify the numeric variable to compute weighted product-moment correlation coefficients.

9 (Optional) To the **Group analysis by** role, assign the variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 (Optional) Specify whether to produce canonical redundancy statistics.

2 (Optional) Specify the number of canonical variables for which full output is desired. This number must be less than or equal to the number of canonical variables in the analysis.

3 (Optional) Specify whether to perform a regression analysis. You can select from these regression types:

- **Set 1 predicts Set 2** performs a multiple regression analysis with Variable set 1 as the regressors and variable set 2 as the dependent variables.
- **Set 2 predicts Set 1** performs a multiple regression analysis with Variable set 2 as the regressors and Variable set 1 as the dependent variables.

4 (Optional) Specify the regression statistics to include in the output:

- regression coefficients
- standardized regression coefficients
- standardized error of coefficients
- *t* statistics for coefficients
- squared multiple correlation

5 (Optional) Specify the correlation statistics to include in the output:

- correlations of regression coefficients
- partial correlations
- squared partial correlations
- semipartial correlations
- squared semipartial correlations

6 (Optional) Specify whether to create canonical variable plots.

Step 3: Specify the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Select **Create score data set** to create a score output table. By default, SAS Data and AI Studio overwrites any existing output tables.

2 (Optional) Select **Create statistics data set** to create a statistics output table. By default, SAS Data and AI Studio overwrites any existing output tables.

Note: If you are running the step in a flow, you must add output ports for the score data set and the statistics data set to the Canonical Correlation node. For more information, see "Canonical Correlation: Connection Requirements for the Node" on page 233.

Cluster Variables

About the Cluster Variables Step

The Cluster Variables step finds clusters of variables to use in additional clustering or to select non-redundant variables in further clustering.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Cluster Variables: Connection Requirements for the Node

In order to run the Cluster Variables step, you must create connections to the input and output ports of the node as indicated here:

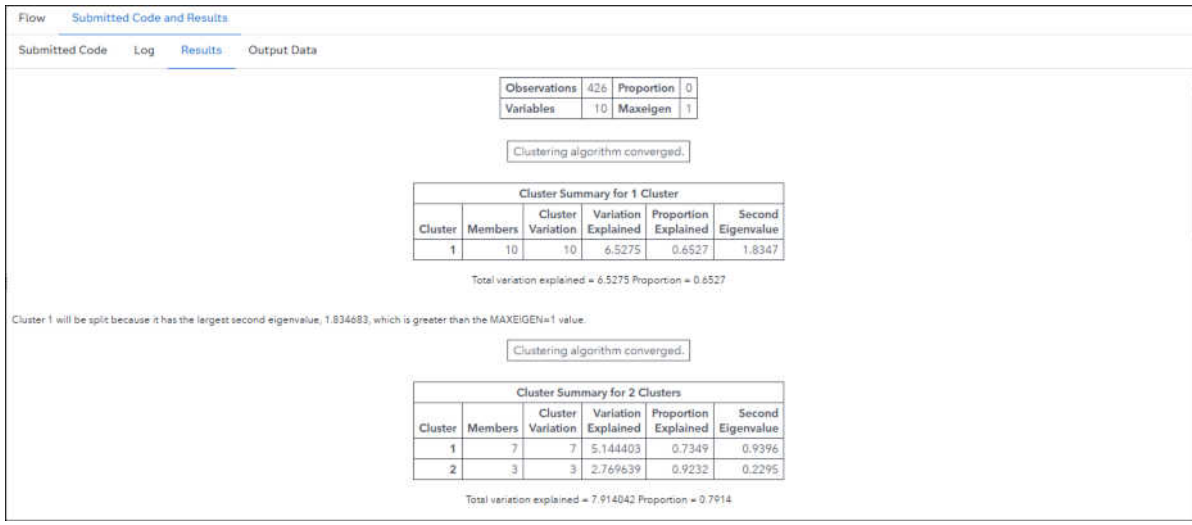
Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Cluster Variables: Connection Requirements for the Node" on page 237. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Cluster Variables

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Cluster Variables** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the Cluster Variables node to the data source. For more information, see "Connecting Nodes" on page 13.
3. On the **Data** tab, assign these variables to the **Variables to cluster** role:
   - **MSRP**
   - **Invoice**
   - **EngineSize**
   - **Cylinders**
   - **Horsepower**
   - **MPG_City**
   - **MPG_Highway**
   - **Weight**
   - **Wheelbase**
   - **Length**
4. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Cluster Variables: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Variables to cluster** role, assign the variables to be clustered.

3 To the **Variable set 2** role, assign the variables to be included in the second set.

4 (Optional) To the **Variables to partial out** role, assign the variables to be partialed out when you want to base the clustering on partial correlations.

5 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

6 (Optional) To the **Weight** role, specify the numeric variable to compute weighted product-moment correlation coefficients.

7 (Optional) To the **Group analysis by** role, assign the variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify whether to use the principal components method or the centroid components method.

2 Specify the maximum number of clusters.

3 (Optional) Specify the maximum second eigenvalue in a cluster. The default eigenvalue is `1`.

Note: This option is available only for the principal components method.

4 (Optional) Specify the minimum proportion of variation explained by a cluster component. The default proportion is `0.1`.

5 (Optional) Specify whether to require the clusters at different levels to maintain a hierarchical structure.

6 From the **Analyze** drop-down list, specify whether to analyze the correlation matrix or the covariance matrix.

7 (Optional) Specify whether to correct the covariances or correlations for the mean.

8 (Optional) Specify the maximum number of iterations during the alternating least squares phase.

9 Specify whether to display plots in the results.

Step 3: Specify the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Select **Create statistics data** to create a statistics output table. By default, SAS Data and AI Studio overwrites any existing output tables.

2 (Optional) Select **Create tree information data** to create an output table that contains the tree information. By default, SAS Data and AI Studio overwrites any existing output tables.

Note: If you are running the step in a flow, you must add output ports for the statistics data and the tree information data to the Cluster Variables node. For more information, see "Cluster Variables: Connection Requirements for the Node" on page 237.

Coin Toss Simulation

About the Coin Toss Simulation Step

The Coin Toss Simulation step simulates the tossing of a specified number of coins. The results show the frequency and percentage of occurrences that the coin displays heads given a specified number of tosses.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or

SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Coin Toss Simulation: Connection Requirements for the Node

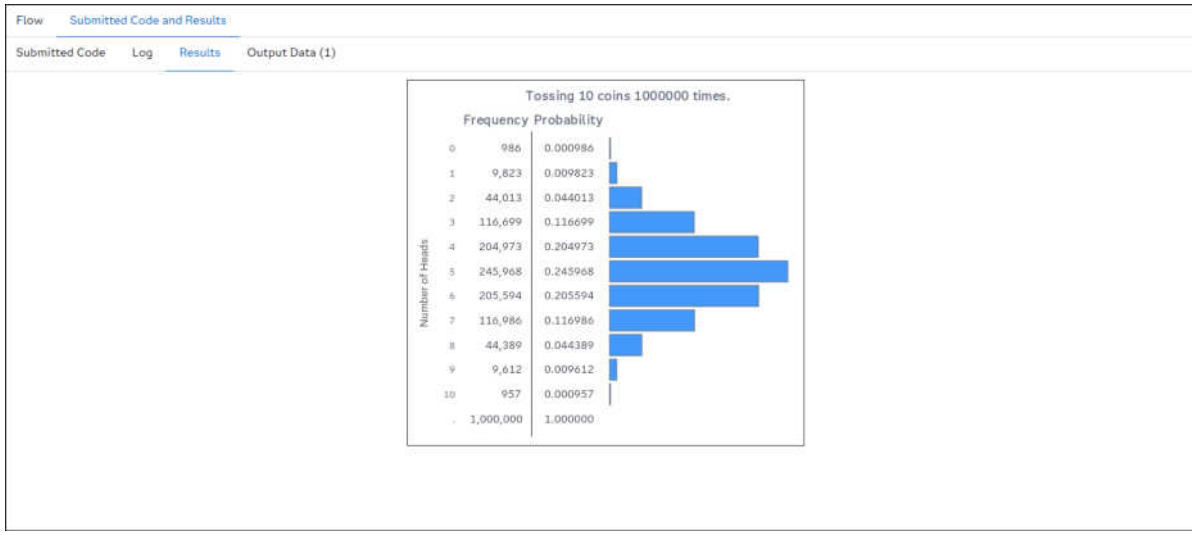
No input data is needed to run the Coin Toss Simulation step.

Input Port	Output Port
No input data is required.	By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Probability of Outcomes for 1,000,000 Coin Tosses

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Coin Toss Simulation** to add the step to your flow.
2. To set the options for the Coin Toss Simulation step, click the Coin Toss Simulation node.
3. In the **Number of coins** field, enter `10`.
4. In the **Number of tosses** field, enter `1,000,000`.
5. Select **Replace existing output table**.
6. Select **Show graph table**.
7. Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here are the results:



Coin Toss Simulation: Step-by-Step Instructions

1. Specify the number of coins to toss.
2. Specify the number of times to toss the coins.
3. Specify whether to replace the existing output table.
4. Specify whether to display the results in a graph format. You can specify whether to include grid lines, gradient fill, and data skin on the graph.

   Note: This option is available only if the number of coins is 30 or fewer.

Combinations

About the Combinations Step

The Combinations step computes the possible combinations of the total number of objects into sets with a specified number in each set.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or

SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Combinations: Connection Requirements for the Node

No input data is needed to run the Combinations step.

Input Port	Output Port
No input data is required.	By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Calculating the Combinations of 52 Objects in 5 Sets

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Combinations** to add the step to your flow.
2. To set the options for the Combinations step, click the Combinations node.
3. In the **Total number of objects** field, enter `52`.
4. In the **Number of objects in a set** field, enter `5`.
5. Run the flow.

Click **Submitted Code and Results** to view the output data.

Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK._FLW95F5CBB0387811F0_0_0_1

Columns: 5 Rows: 2,598,960

Enter expression

#	c1	c2	c3	c4	c5
1	1	2	3	4	5
2	1	2	3	4	6
3	1	2	3	4	7
4	1	2	3	4	8
5	1	2	3	4	9
6	1	2	3	4	10
7	1	2	3	4	11
8	1	2	3	4	12
9	1	2	3	4	13
10	1	2	3	4	14
11	1	2	3	4	15
12	1	2	3	4	16
13	1	2	3	4	17
14	1	2	3	4	18
15	1	2	3	4	19
16	1	2	3	4	20
17	1	2	3	4	21

Combinations: Step-by-Step Instructions

1 Specify the number of objects.

2 Specify the number of objects in a set.

3 Specify whether to replace an existing output table. By default, the table is saved in the Work library.

Compute Similarities and Distances

About the Compute Similarities and Distances Step

The Compute Similarities and Distances step computes various measures of distance, dissimilarity, or similarity between observations in an input table. This information can be used in hierarchical cluster analysis and multidimensional scaling.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Compute Similarities and Distances: Connection Requirements for the Node

In order to run the Compute Similarities and Distances step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Compute Similarities and Distances

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
data Protein;
   length Country $ 14;
   input RedMeat WhiteMeat Eggs Milk Fish Cereal Starch Nuts FruitVeg
Country &$;
datalines;
10.1 1.4 0.5 8.9 0.2 42.3 0.6 5.5 1.7 Albania
8.9 14.0 4.3 19.9 2.1 28.0 3.6 1.3 4.3 Austria
13.5 9.3 4.1 17.5 4.5 26.6 5.7 2.1 4.0 Belgium
7.8 6.0 1.6 8.3 1.2 56.7 1.1 3.7 4.2 Bulgaria
9.7 11.4 2.8 12.5 2.0 34.3 5.0 1.1 4.0 Czechoslovakia
10.6 10.8 3.7 25.0 9.9 21.9 4.8 0.7 2.4 Denmark
8.4 11.6 3.7 11.1 5.4 24.6 6.5 0.8 3.6 E Germany
9.5 4.9 2.7 33.7 5.8 26.3 5.1 1.0 1.4 Finland
18.0 9.9 3.3 19.5 5.7 28.1 4.8 2.4 6.5 France
10.2 3.0 2.8 17.6 5.9 41.7 2.2 7.8 6.5 Greece
5.3 12.4 2.9 9.7 0.3 40.1 4.0 5.4 4.2 Hungary
13.9 10.0 4.7 25.8 2.2 24.0 6.2 1.6 2.9 Ireland
9.0 5.1 2.9 13.7 3.4 36.8 2.1 4.3 6.7 Italy
9.5 13.6 3.6 23.4 2.5 22.4 4.2 1.8 3.7 Netherlands
9.4 4.7 2.7 23.3 9.7 23.0 4.6 1.6 2.7 Norway
6.9 10.2 2.7 19.3 3.0 36.1 5.9 2.0 6.6 Poland
6.2 3.7 1.1 4.9 14.2 27.0 5.9 4.7 7.9 Portugal
6.2 6.3 1.5 11.1 1.0 49.6 3.1 5.3 2.8 Romania
7.1 3.4 3.1 8.6 7.0 29.2 5.7 5.9 7.2 Spain
 9.9 7.8 3.5 4.7 7.5 19.5 3.7 1.4 2.0 Sweden
13.1 10.1 3.1 23.8 2.3 25.6 2.8 2.4 4.9 Switzerland
17.4 5.7 4.7 20.6 4.3 24.3 4.7 3.4 3.3 UK
9.3 4.6 2.1 16.6 3.0 43.6 6.4 3.4 2.9 USSR
11.4 12.5 4.1 18.8 3.4 18.6 5.2 1.5 3.8 W Germany
4.4 5.0 1.2 9.5 0.6 55.9 3.0 5.7 3.2 Yugoslavia
;
```

Run the flow to create the Work.Protein table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Compute Similarities and Distances** to add the step to your flow.

3 Add the Work.Protein table to your flow. Connect the input port of the Compute Similarities and Distances node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Compute Similarities and Distances step, click the Compute Similarities and Distances node.

5 On the **Data** tab, select the **Interval** check box.

6 To the **Interval variables** role, assign these variables:

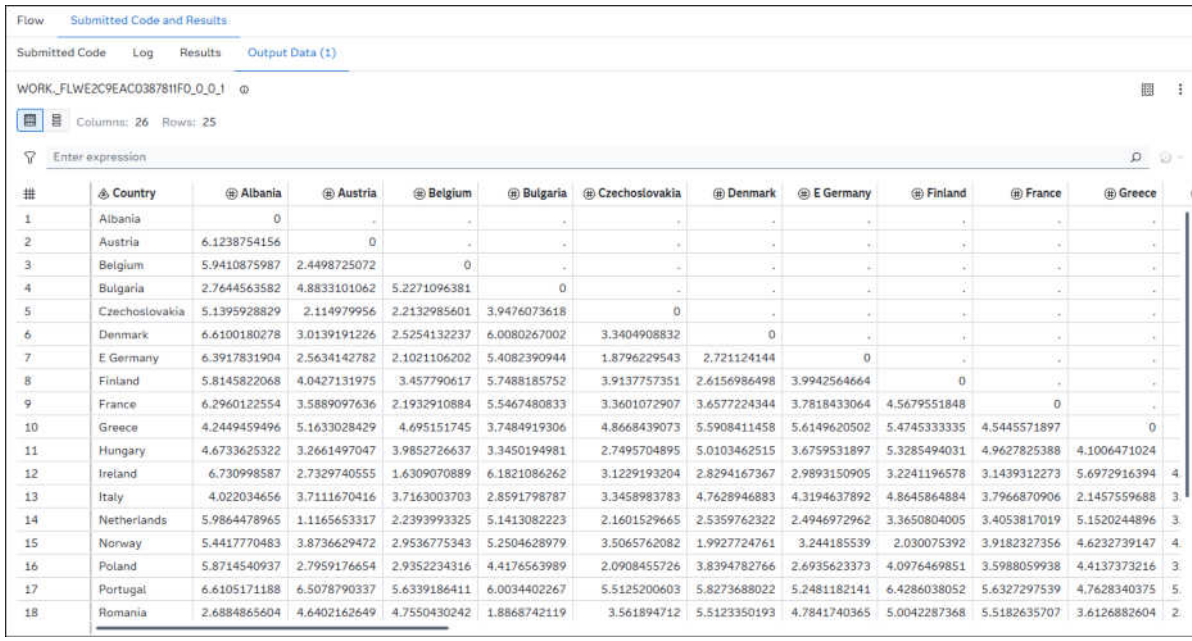
- **RedMeat**
- **WhiteMeat**
- **Eggs**
- **Milk**
- **Fish**
- **Cereal**
- **Starch**
- **Nuts**
- **FruitVeg**

7 On the **Options** tab, select **Standard deviation** as the standardization method.

8 On the **Output** tab, select the **Select a variable that contains the names for the new variables** check box. To the **New variable names** role, assign **Country**.

9 Run the flow.

This example generates an output table in the Work library. Here is a subset of the output data:



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

WORK._FLWE2C9EAC0387811F0_0_0_1

Columns: 26 Rows: 25

Enter expression

	Country	Albania	Austria	Belgium	Bulgaria	Czechoslovakia	Denmark	E Germany	Finland	France	Greece
1	Albania	0	.	.	.	.	.	.	.	.	.
2	Austria	6.1238754156	0	.	.	.	.	.	.	.	.
3	Belgium	5.9410875987	2.4498725072	0	.	.	.	.	.	.	.
4	Bulgaria	2.7644563582	4.8833101062	5.2271096381	0	.	.	.	.	.	.
5	Czechoslovakia	5.1395928829	2.114979956	2.2132985601	3.9476073618	0	.	.	.	.	.
6	Denmark	6.6100180278	3.0139191226	2.5254132237	6.0080267002	3.3404908832	0	.	.	.	.
7	E Germany	6.3917831904	2.5634142782	2.1021106202	5.4082390944	1.8796229543	2.721124144	0	.	.	.
8	Finland	5.8145822068	4.0427131975	3.457790617	5.7488185752	3.9137757351	2.6156986498	3.9942564664	0	.	.
9	France	6.2960122554	3.5889097636	2.1932910884	5.5467480833	3.3601072907	3.6577224344	3.7818433064	4.5679551848	0	.
10	Greece	4.2449459496	5.1633028429	4.695151745	3.7484919306	4.8668439073	5.5908411458	5.6149620502	5.4745333335	4.5445571897	0
11	Hungary	4.6733625322	3.2661497047	3.9852726637	3.3450194981	2.7495704895	5.0103462515	3.6759531897	5.3285494031	4.9627825388	4.1006471024
12	Ireland	6.730998587	2.7329740555	1.6309070889	6.1821086262	3.1229193204	2.8294167367	2.9893150905	3.2241196578	3.1439312273	5.6972916394
13	Italy	4.022034656	3.7111670416	3.7163003703	2.8591798787	3.3458983783	4.7628946883	4.3194637892	4.8645864884	3.7966870906	2.1457559688
14	Netherlands	5.9864478965	1.1165653317	2.2393993325	5.1413082223	2.1601529665	2.5359762322	2.4946972962	3.3650804005	3.4053817019	5.1520244896
15	Norway	5.4417770483	3.8736629472	2.9536775343	5.2504628979	3.5065762082	1.9927724761	3.244185539	2.030075392	3.9182327356	4.6232739147
16	Poland	5.8714540937	2.7959176654	2.9352234316	4.4176563989	2.0908455726	3.8394782766	2.6935623373	4.0976469851	3.5988059938	4.4137373216
17	Portugal	6.6105171188	6.5078790337	5.6339186411	6.0034402267	5.5125200603	5.8273688022	5.2481182141	6.4286038052	5.6327297539	4.7628340375
18	Romania	2.6884865604	4.6402162649	4.7550430242	1.8868742119	3.561894712	5.5123350193	4.7841740365	5.0042287368	5.5182635707	3.6126882604

Compute Similarities and Distances: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Select the measurement levels of the variables to create similarities or distances. Then select the variable for each level. These options are available:

- **Ratio** - To the **Ratio variables** role, assign one or more numeric variables to use as the ratio variables. Ratio variables should always contain positive measurements.
- **Interval** - To the **Interval variables** role, assign one or more numeric variables to use as the interval variables.
- **Ordinal** - To the **Ordinal variables** role, assign one or more numeric variables to use as the ordinal variables. Values of ordinal variables are replaced by their corresponding rank scores.
- **Nominal** - You can specify both symmetric nominal and asymmetric nominal variables. All asymmetric nominal variables must be of the same type. Specify the value for absent.

3 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

4 (Optional) To the **Group analysis by** role, assign the variables that specify how to group the analysis.

Step 2: Set the Options

Ratio Measurement Level

On the **Options** tab, you can set these options:

1 (Optional) Specify whether to suppress all standardization. Standardization is optional if a single measurement level is used. Standardization is required if

more than one measurement level is used unless only asymmetric nominal and nominal levels are specified or unless you select the **Suppress all standardization** check box.

2 For the ratio variables, specify the standardization method. The default method is maximum absolute value.

3 (Optional) Specify whether to compute a similarity or dissimilarity measure. The available measures depend on the selected levels of measurement on the **Data** tab.

Interval Measurement Level

On the **Options** tab, you can set these options:

1 (Optional) Specify whether to suppress all standardization. Standardization is optional if a single measurement level is used. Standardization is required if more than one measurement level is used unless only asymmetric nominal and nominal levels are specified or unless you select the **Suppress all standardization** check box.

2 For the interval variables, specify the standardization method. The default method is standard deviation for all measures except Gower and Legendre. If you select **Gower and Legendre** as the dissimilarity or similarity measure, the default method is range.

3 (Optional) Specify whether to compute a similarity or dissimilarity measure. The available measures depend on the selected levels of measurement on the **Data** tab.

Ordinal Measurement Level

On the **Options** tab, you can set these options:

1 (Optional) Specify whether to suppress all standardization. Standardization is optional if a single measurement level is used. Standardization is required if more than one measurement level is used unless only asymmetric nominal and nominal levels are specified or unless you select the **Suppress all standardization** check box.

2 For the ordinal variables, specify the standardization method. The default method is standard deviation for all measures except Gower and Legendre. If you select **Gower and Legendre** as the dissimilarity or similarity measure, the default method is range.

3 (Optional) Specify whether to compute a similarity or dissimilarity measure. The available measures depend on the selected levels of measurement on the **Data** tab.

Nominal Measurement Level

On the **Options** tab, you can set these options:

1 (Optional) Specify whether to suppress all standardization. Standardization is optional if a single measurement level is used. Standardization is required if more than one measurement level is used unless only asymmetric nominal and nominal levels are specified or unless you select the **Suppress all standardization** check box.

2 (Optional) Specify whether to compute a similarity or dissimilarity measure. The available measures depend on the selected levels of measurement on the **Data** tab.

Step 3: Set the Output Options

On the **Output** tab, you can set these options:

1 (Optional) Specify whether to replace the existing output table. This step automatically generates an output table that contains the computed distance variables.

Note: By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

2 (Optional) Specify how to construct the new variable names. You can use a prefix for these new variable names or select the variable in the input data that contains the names for the new variables.

3 (Optional) Specify whether to save the proximity measures in a lower triangular matrix or in a square matrix.

4 (Optional) Select the variables from the input data set to include in the output data.

Correlation Analysis

About the Correlation Analysis Step

Correlation is a statistical procedure for describing the relationship between numeric variables. The relationship is described by calculating correlation coefficients for the variables. The correlations range from –1 to 1. The Correlation Analysis step provides graphs and statistics for investigating associations among variables.

You might want to use the Correlations Analysis step to learn more about product sales. For example, you can use this step to determine whether there is a correlation between a customer's size (as measured by sales) and the amount of product that the customer purchases from your company.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Correlation Analysis: Connection Requirements for the Node

In order to run the Correlation Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Specify the Output Options" on page 255. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Correlations in Sashelp.Cars

1 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Correlation Analysis** to add the step to your flow.

2 Add the Sashelp.Cars table to your flow. Connect the input port of the Correlation Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

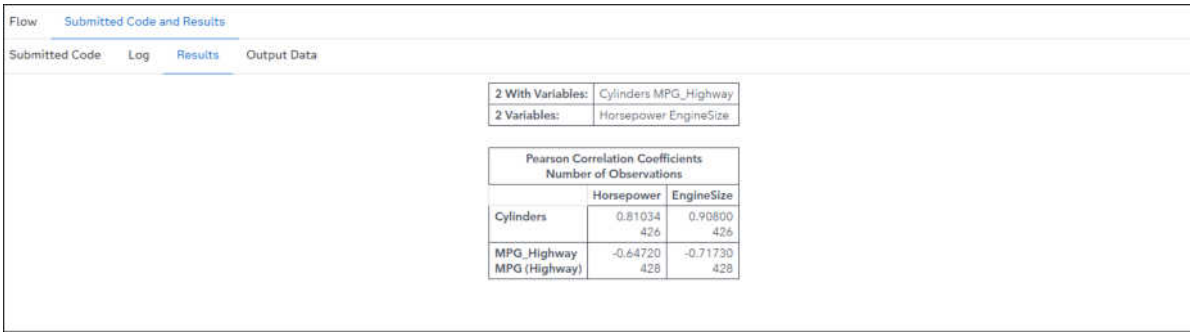
3 To set the options for the Correlation Analysis step, click the Correlation Analysis node.

4 On the **Data** tab, assign columns to these rows:

- To the **Analysis variables** role, assign **EngineSize** and **Horsepower**.
- To the **Correlate with** role, assign **Cylinders** and **MPG_Highway** roles.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here are the results:



Correlation Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run this step, you must perform one of these tasks:

- assign two or more Analysis variables
- assign at least one Analysis variable and one Correlate with variable

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Analysis variables** role, assign the variables for which to compute correlation coefficients.

3 To the **Correlate with** role, assign the variables with which the correlations of the analysis variables are to be computed.

4 (Optional) To remove the correlation of variables from the analysis, assign those variables to the **Partial variables** role.

5 (Optional) To specify the numeric variable whose value represents the frequency of the observation, assign a variable to the **Frequency count** role. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is

excluded from the analysis. The sum of the frequency variable represents the total number of observations.

6 To the **Weight** role, assign the variables that contain the weights to use in the calculation of the weighted product-moment correlation.

7 (Optional) To obtain separate analyses of observations for each unique group, assign a variable to the **Group analysis by** role.

Step 2: Select the Options

On the **Options** tab, you can set these options:

1 Select **Missing values** to specify how to treat observations with missing values.

- If you select **Use nonmissing values for all selected variables**, all observations with missing values are excluded from the analysis.
- If you select **Use nonmissing values for pairs of variables**, the correlation statistics are computed using the nonmissing pairs of variables. This is the default.

2 Select the divisor that is used in the calculation of variances, standard deviation, and covariances. By default, the divisor for variance is the degrees of freedom.

3 Select the statistics to display in the results. By default, only the correlations are displayed.

- **Correlations** includes the correlations in the results. You can also specify probabilities that are associated with each correlation coefficient and whether to order the correlations from highest to lowest in absolute value.
- **Display p-values** includes the *p*-values in the results.
- **Order correlations from highest to lowest (in absolute value)** ranks the correlation coefficients from highest to lowest. For each analysis variable, the **Correlate with** variables are listed in order of descending absolute value of correlation coefficient. By default, the correlation coefficients are not ranked.
- **Covariances** includes the variance and covariance matrix in the results. Also, the Pearson correlations are displayed. If you assign a column to the **Partial variables** role, the step computes a partial covariance matrix.
- **Sum of squares and cross-products** displays the sum of squares and cross-products in the results. If you assign a column to the **Partial variables** roles, then the unpartial sum of squares and cross-products matrix is computed.
- **Corrected sum of squares and cross-products** displays a table of the corrected sums of squares and cross-products. The Pearson correlations are also included in the results. If you assign a column to the **Partial variables** role, the step computes both an unpartial and a partial corrected sum of squares and cross-products matrix.

- **Descriptive statistics** displays the number of observations, mean, standard deviation, minimum value, maximum value, and label for each variable in the analysis.
- **Fisher's z transformation** works with a Pearson correlation. For a Pearson correlation, you can use the Fisher transformation options to request confidence limits and *p*-values under a specified alternative (null) hypothesis, $H_0: \rho = \rho_0$, for correlation coefficients that use Fisher's z transformation. If you select the **Fisher's z transformation** check box, you must specify a value in the **Null hypothesis** box.
  - **Two-sided confidence limits** requests two-sided confidence limits for the test of the null hypothesis, $H_0: \rho = \rho_0$. This is the default.
  - **Lower confidence limit** requests a lower confidence limit for the test of the one-sided null hypothesis, $H_0: \rho \leq \rho_0$.
  - **Upper confidence limit** requests an upper confidence limit for the test of the one-sided null hypothesis, $H_0: \rho \geq \rho_0$.
- You can also specify these nonparametric correlations:
  - **Spearman's rank-order correlation** calculates Spearman rank-order correlation. This is a nonparametric measure of association that is based on the rank of the data values. The correlations range from –1 to 1.
  - **Kendall's tau-b** calculates Kendall tau-b. This is a nonparametric measure of association that is based on the number of concordances and discordances in paired observations. Concordance occurs when paired observations vary together, and discordance occurs when paired observations vary differently. Kendall's tau-b ranges from –1 to 1.
  - **Hoeffding's measure of dependence** calculates Hoeffding's measure of dependence, D. This is a nonparametric measure of association that detects more general departures from independence. This D statistic is 30 times larger than the usual definition and scales the range between –0.5 and 1 so that only large positive values indicate dependence.

    Note: This option is not available if you assign a variable to the **Partial variables** role.

Note: The Nonparametric Correlations options are not available if you assign a variable to the **Weight variable** role.

4 Specify whether to include a plot in the results. By default, no plot is included.

- **Matrix of scatter plots** includes a matrix of scatter plots in the results. You can also choose to include a histogram of the analysis variables in the symmetric matrix plot.
- **Individual scatter plots** includes a scatter plot for each applicable pair of distinct variables from the analysis variables. You can specify whether to display the prediction ellipses for new observations or the confidence ellipses for the mean.

You can also specify the number of variables to plot and the maximum number of points to plot.

- **Create a scatter plot for each correlation pair** generates a scatter plot for each correlation pair.

Step 3: Specify the Output Options

On the **Output** tab, you can specify these options:

1 Select **Create output data** to save the results to an output table. By default, SAS Data and AI Studio overwrites any existing output tables.

Note: If you are running the step in a flow, you must add an output port for the output data to the Correlation node. For more information, see "Correlation Analysis: Connection Requirements for the Node" on page 251.

2 Select the statistics to show in the results:

- **Correlations** - By default, the output table contains the correlation coefficients with the corresponding _TYPE_ variable value of 'CORR'.
- **Covariances** - When you select this option, the output table contains the covariance matrix with the corresponding _TYPE_ variable value of 'COV'.
- **Sum of squares and cross-products** - If you assign a column to the **Partial variables** role, the output table does not contain a sum of squares and cross-products matrix.
- **Corrected sum of squares and cross-products** - If you assign a column to the **Partial variables** role, the output table contains a partial corrected sum of squares and cross-products matrix.

Confidence Intervals Statistical Power

About the Confidence Intervals Statistical Power Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. The Confidence Intervals step calculates the power or sample size for these confidence intervals:

- One-sample means is for confidence interval precision that involves one sample.
- Paired means is for confidence interval precision that involves paired samples.
- Two-sample means is for confidence interval precision that involves two independent samples.
- One proportion is for confidence interval precision for a single binomial proportion.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Confidence Intervals Statistical Power: Connection Requirements for the Node

No input or output data is required to run the Confidence Intervals Statistical Power step.

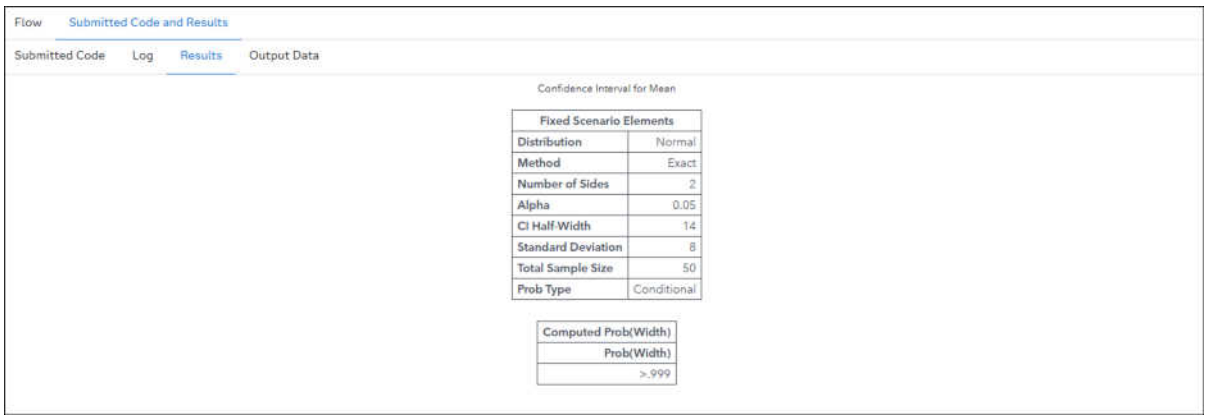
Example: Confidence Interval for One-Sample Means

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Confidence Intervals Statistical Power** to add the step to your flow.
2. To set the options for the Confidence Intervals Statistical Power step, click the Confidence Intervals Statistical Power node.
3. From the **Type of confidence interval** drop-down list, select **One-sample mean**.
4. For the **Solve for** option, select **Prob(Width)**.
5. For the half-width, enter `14`.
6. For the standard deviation, enter `8`.
7. For the sample size, enter `50`.
8. Run the flow.

Click the **Submitted Code and Results** tab to view the results.

In this case, the computed prob(width) is >.999.



Confidence Intervals Statistical Power: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Specify the confidence interval to use in the analysis. The options that are available in the step depend on the confidence interval that you choose. For more information about each confidence interval, see the descriptions in "About the Confidence Intervals Statistical Power Step" on page 255.

2 For the **Solve for** option, specify the type of analysis.

You can solve for these items:

- the probability of obtaining a confidence interval that is a half-width less than or equal to the value of the half-width
- total sample size

Note: If you select **One proportion** as the confidence interval, the **Total sample size** option is not available.

3 Specify whether to perform a one-sided or two-sided interval.

Note: If you select **One proportion** as the confidence interval, this option is not available.

4 Specify the interval to use if you selected **One proportion** from the **Type of confidence interval** drop-down list.

5 Specify the confidence level.

6 Specify the desired confidence interval half-width. The half-width is defined as the distance between the point estimate and a finite endpoint.

7 Specify the standard deviation.

8 Specify the proportion if you selected **One proportion** as the confidence interval.

9 Specify whether to allow fractional sample sizes.

10 Specify the sample size.

Step 2: Create the Output Plots

On the **Plots** tab, specify whether to create these output plots:

- a plot with sample size on the vertical axis and prob(width) on the horizontal axis. For this plot, you can specify the minimum and maximum values for power.
- a plot effect size on the horizontal axis. Power or sample size is on the vertical axis. For this plot, you can specify the minimum and maximum values for the effect size.

Correspondence Analysis

About the Correspondence Analysis Step

The Correspondence Analysis step performs simple or multiple correspondence analysis of qualitative data. You can specify either raw data or table data for the input data source.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Correspondence Analysis: Connection Requirements for the Node

In order to run the Correspondence Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 264. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Correspondence Analysis

To create this example:

1 On a **SAS Program** tab, copy and paste this code:

```
data PhD;
length Science $ 20;
input y1973-y1978 Science $&;
label y1973 = '1973' y1974 = '1974' y1975 = '1975' y1976 = '1976'
y1977 = '1977' y1978 = '1978';
datalines;
4489 4303 4402 4350 4266 4361 Life Sciences
4101 3800 3749 3572 3410 3234 Physical Sciences
3354 3286 3344 3278 3137 3008 Social Sciences
2444 2587 2749 2878 2960 3049 Behavioral Sciences
3338 3144 2959 2791 2641 2432 Engineering
1222 1196 1149 1003  959  959 Mathematics
;
```

Run the flow to create the Work.PhD table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Correspondence Analysis** to add the step to your flow.

3 Add the Work.PhD table to your flow. Connect the input port of the Corresponding Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

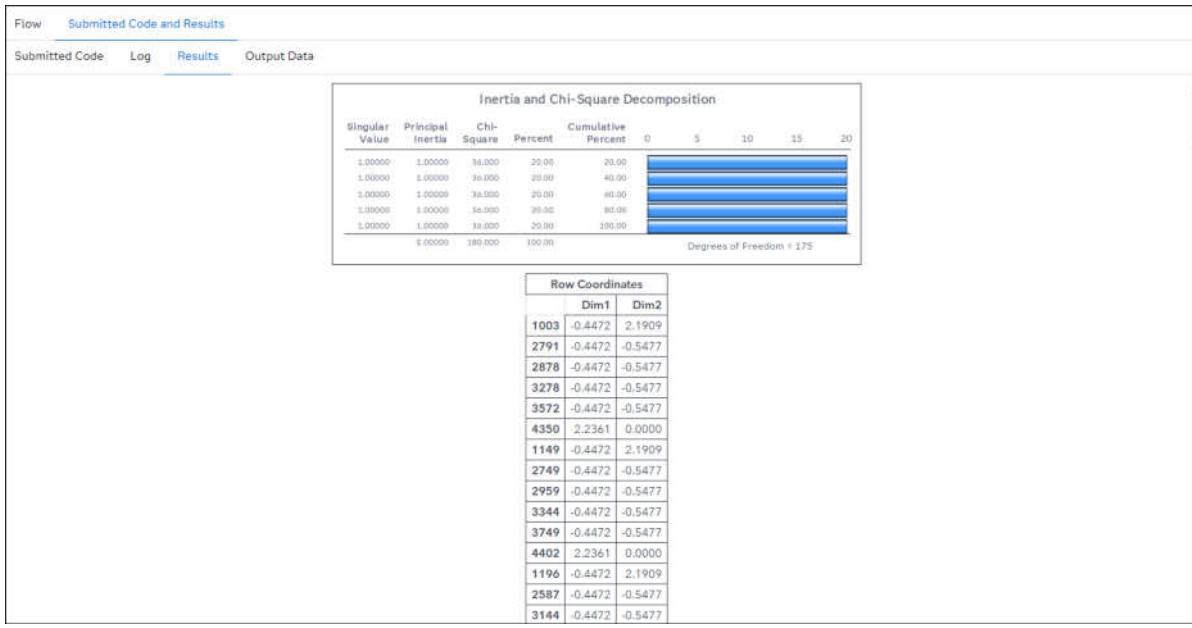
4 To set the options for the Corresponding Analysis step, click the Corresponding Analysis node.

5 On the **Data** tab, set these options:

- From the **Analysis** drop-down list, select **Simple correspondence analysis**.
- To the **Row variables** role, assign these columns:
  - **y1973**
  - **y1974**
  - **y1975**
  - **y1976**
  - **y1977**
  - **y1978**
- To the **Column variables** role, assign **Science**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Correspondence Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the step, you must choose the data layout. The **Roles** options differ depending on the data layout.

Simple Correspondence Analysis of Raw Data

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. For the data layout, select **Raw data**.
3. For the analysis, select **Simple correspondence analysis**.
4. To the **Row variables** role, specify the values to use to construct the rows of the contingency table.
5. Specify how to create the contingency table rows when you assign two or more row variables. You can choose from these options:
   - **Each level of each row variable appears as a table row**
   - **The factorial combinations of the levels of the row variables**
6. To the **Column variables** role, specify the values to use to construct the columns of the contingency table.
7. Specify how to create the contingency table columns when you assign two or more column variables. You can choose from these options:
   - **Each level of each column variable appears as a table column**
   - **The factorial combinations of the levels of the column variables**
8. (Optional) Specify whether to treat missing values as a distinct level.
9. (Optional) To the **Weight variable** role, specify the weights for each observation and indicate supplementary observations for simple correspondence analyses.
10. (Optional) To the **Group analysis by** role, assign variables to create separate analyses of observations in groups that are defined by the BY variables.

Multiple Correspondence Analysis of Raw Data

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 For the data layout, select **Raw Data**.

3 From the **Analysis** drop-down list, select **Multiple correspondence analysis**.

4 To the **Column variables** role, specify the values to use to construct the columns of the contingency table. You must assign at least two columns to this role.

5 (Optional) Specify whether to treat missing values as a distinct level.

6 (Optional) To the **Weight variable** role, specify the weights for each observation and indicate supplementary observations for simple correspondence analyses.

7 (Optional) To the **Group analysis by** role, assign variables to create separate analyses of observations in groups that are defined by the BY variables.

Simple Correspondence Analysis of Table Data

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 For the data layout, select **Table Data**.

3 From the **Analysis** drop-down list, select **Simple correspondence analysis**.

4 To the **Columns of the contingency table** role, specify the values to use to read an existing contingency table, binary indicator matrix, fuzzy-coded indicator matrix, or Burt table, rather than raw data.

5 (Optional) To the **Supplementary column of the contingency table** role, specify the variables to represent as points in the joint row and column space. These variables are not used in determining the locations of the other active row and column points of the contingency table. Supplementary observations on supplementary variables are ignored in simple correspondence analysis but are needed to compute the squared cosines for multiple correspondence analysis.

6 (Optional) To the **Label contingency table rows** role, assign the variable that contains the labels of the table rows with the values of this variable and includes this variable in the output table.

7 (Optional) To the **Weight variable** role, specify the weights for each observation and indicate supplementary observations for simple correspondence analyses for table data.

8 (Optional) To the **Group analysis by** role, assign variables to create separate analyses of observations in groups that are defined by the BY variables.

Multiple Correspondence Analysis of Table Data

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 For the data layout, select **Table Data**.

3 From the **Analysis** drop-down list, select **Multiple correspondence analysis**.

4 To the **Columns of the Burt table** role, specify the variables to use in the analysis.

5 Specify the number of classification variables to use to create the Burt table.

6 (Optional) To the **Supplementary columns of the Burt table** role, specify the variables to represent as points in the joint row and column space. These variables are not used in determining the locations of the other active row and column points of the contingency table. Supplementary observations on supplementary variables are ignored in simple correspondence analysis but are needed to compute the squared cosines for the multiple correspondence analysis.

7 (Optional) To the **Group analysis by** role, assign variables to create separate analyses of observations in groups that are defined by the BY variables.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the number of dimensions or axes to use.

2 Specify whether to include the frequencies, percents, or both in the output.

3 Specify whether to standardize the coordinates. A standard correspondence analysis jointly displays the principal row and column coordinates. Row coordinates are computed from the row profile matrix, and column coordinates are computed from the column profile matrix.

4 Select the statistics to be displayed.

For a simple correspondence analysis, these statistics are available:

- coordinates – row and column
- profiles – row and column
- inertia – P-value for chi-square
- frequencies – observed, expected, deviation, and cell contribution to chi-square

For multiple correspondence analysis, these statistics are available:

- column coordinates
- column profile
- inertia – P-value for chi-square, Benzécri adjusted inertia, Greenacre adjusted inertia, and Unadjusted inertia
- frequencies – observed, expected, deviation, and cell contribution to chi-square

5 Specify whether to include any plots in the output. By default, the inertia plot and configuration plot are included in the output.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create a coordinates data set.

Note: If you are running the step in a flow, you must add an output port for the output data to the Correspondence Analysis node. For more information, see "Correspondence Analysis: Connection Requirements for the Node" on page 259.

Cox Regression Statistical Power

About the Cox Regression Statistical Power Step

The Cox Regression Statistical Power step calculates the power or sample size for the score test. This test is for a single scalar predictor in Cox proportional hazards regression for survival data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Cox Regression Statistical Power: Connection Requirements for the Node

No input or output data is required to run the Cox Regression Statistical Power step.

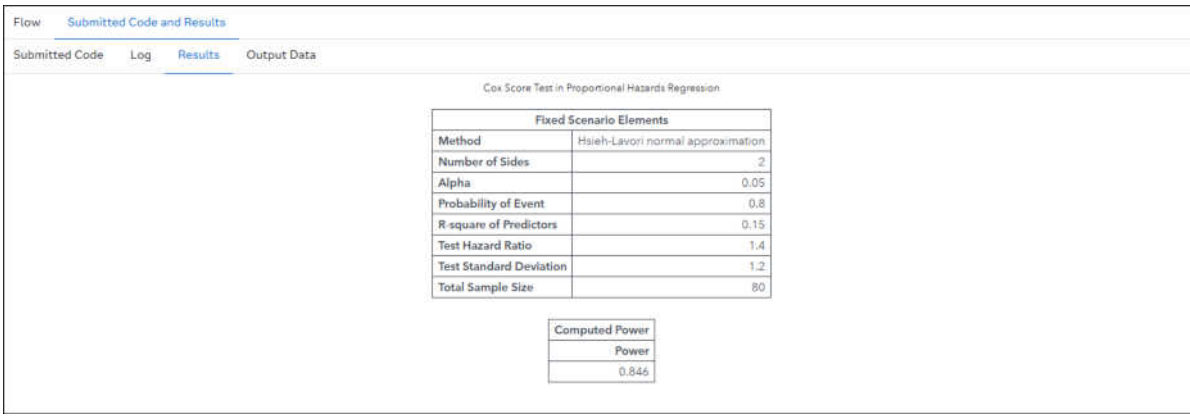
Example: Cox Regression for Power and Sample Size Analysis

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Cox Regression Statistical Power** to add the step to your flow.
2. To set the options for the Cox Regression Statistical Power step, click the Cox Regression Statistical Power node.
3. Under the **Solve for** heading, select **Power**.
4. For the hazard ratio, enter `1.4`.
5. For the R-square value, enter `.15`.
6. For the standard deviation, enter `1.2`.
7. For the probabilities of uncensored events, enter `0.8`.
8. For the sample size, enter `80`.
9. Run the flow.

Click the **Submitted Code and Results** tab to view the results.

In this case, the computed power is 0.846.



Cox Regression Statistical Power: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. Under the **Solve for** heading, request a solution for power, total sample size, or total number of uncensored events.
2. Specify whether to perform a one-sided test or two-sided test.
3. Specify the significance level for the analysis. You can specify more than one value.
4. Specify the hazard ratio for a one-unit increase in the predictor of x_1, holding any other predictors constant. The hazard ratio is equal to $\exp(\beta_1)$, where β_1 is the regression coefficient of x_1.
5. Specify the R^2 value from the regression of the predictor of interest on the remaining predictors. The sample size is either multiplied (if you are computing power) or divided (if you are computing sample size) by a factor of $\left(1 - R^2\right)$.
6. Specify the standard deviation for the predictor.
7. Specify the expected number of uncensored events.
8. Specify whether to allow fractional sample sizes.

Step 2: Create the Output Plots

On the **Plots** tab, specify whether to create these output plots.

- a plot with sample size on the vertical axis and power on the horizontal axis. For this plot, you can specify the minimum and maximum value for power.
- a plot effect size on the horizontal axis. Power or sample size is on the vertical axis. For this plot, you can specify the minimum and maximum value for the effect size.

Custom Tests Statistical Power

About the Custom Tests Statistical Power Step

The Custom Tests Statistical Power step calculates power or sample size for test statistics from the chi-square, Pearson correlation, normal, *F*, and *t* distributions.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Custom Tests Statistical Power: Connection Requirements for the Node

No input or output data is required to run the Custom Tests Statistical Power step.

Example: Custom Tests for Power and Sample Size Analysis

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Custom Tests Statistical Power** to add the step to your flow.
2. To set the options for the Custom Tests Statistical Power step, click the Custom Tests Statistical Power node.
3. Under the **Solve for** heading, select **Sample size**.
4. From the **Distribution of the test statistic** drop-down list, select **Chi-square**.
5. In the **Alpha values** box, enter `0.05`.
6. In the **Primary noncentrality values** box, enter `23`.

7 In the **Primary noncentrality multiplier values** box, enter `1`.

8 In the **Critical value multiplier values** box, enter `1`.

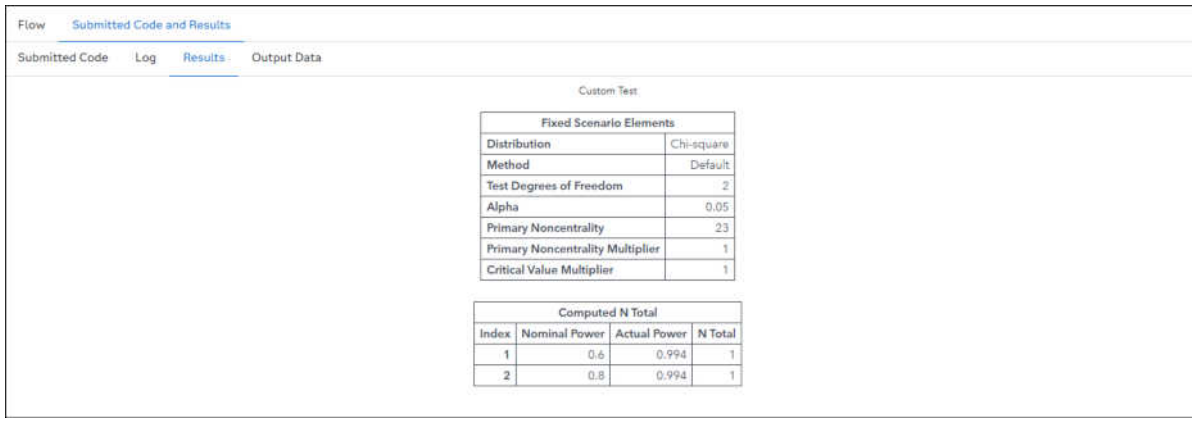
9 In the **Test degrees of freedom value** box, enter `2`.

10 Under the **Power** heading, click +. You should now have two rows in the table. Enter `0.6` in the first row and `0.8` in the second row.

11 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

In this case, the actual power is 0.994 for both nominal powers (0.6 and 0.8).


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Custom Test

Fixed Scenario Elements	
Distribution	Chi-square
Method	Default
Test Degrees of Freedom	2
Alpha	0.05
Primary Noncentrality	23
Primary Noncentrality Multiplier	1
Critical Value Multiplier	1

Computed N Total			
Index	Nominal Power	Actual Power	N Total
1	0.6	0.994	1
2	0.8	0.994	1

Custom Tests Statistical Power: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Under the **Solve for** heading, request a solution for power or sample size.

2 Specify the form of the distribution. If you select **Normal**, **Pearson correlation**, or **t** as the distribution, you must specify the number of sides for the test.

3 Specify the significance level for the analysis. You can specify more than one value.

4 Specify the primary noncentrality options.

- Use the **Primary noncentrality values** to specify a value of greater than or equal to 0 for chi-square or *F* distributions. This value can be any number for Normal and *t* distributions.
- Use the **Primary noncentrality multiplier values** to specify the multiplier for the primary noncentrality values.

Note: These options are available for the chi-square, *F*, Normal, and *t* distributions.

5 Use the **Partial correlation values** to specify a number less than 1 and greater than –1.

6 Specify the degrees of freedom.

- Use the **Model degrees of freedom values** option to specify a number greater than or equal to 0. At least one value must be equal to or greater than the largest value for the test degrees of freedom.
- Use the **Test degrees of freedom values** option to specify a number greater than or equal to 0. If the distribution is either Pearson correlation or *F*, the test degrees of freedom cannot be greater than the degrees of freedom for the model. The degrees of freedom value does not have to be an integer.
- **Note:** This option is not available for the *t* distributions.

Note: This group of options is available only for the Pearson correlation, *F*, or *t* distributions.

7 Use the **Critical value multiplier values** option , specify the scalar multiplier for the critical value.

Note: This option is available only for chi-square and normal distributions.

8 Specify the power values for the analysis. These values must be greater than 0 and less than 1.

Note: This option is available only if you are solving for sample size.

9 Specify whether fractions are allowed in the sample size. If you are solving for power, you can also specify values for the sample size.

Step 2: Create the Output Plots

On the **Plots** tab, specify whether to create these output plots:

- a plot with sample size on the vertical axis and power on the horizontal axis. For this plot, you can specify the minimum and maximum value for power.
- a plot effect size on the horizontal axis. Power or sample size is on the vertical axis. For this plot, you can specify the minimum and maximum value for the effect size.

Decision Tree

About the Decision Tree Step

The Decision Tree step produces tree-based statistical models called decision trees for nominal and interval targets.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Decision Tree: Connection Requirements for the Node

In order to run the Decision Tree step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Decision Tree for Interval Target

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.baseball;
   set sashelp.baseball;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Decision Tree** to add the step to your flow.

4 Add the MyCas.Baseball table to your flow. Connect the input port of the Decision Tree node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Decision Tree step, click the Decision Tree node.

6 Select **Use an interval target**.

7 Assign columns to these roles:

- To the **Interval target** role, assign **logSalary**.
- To the **Interval inputs** role, assign these columns:
  - **nAtBat**
  - **nHits**
  - **nHome**
  - **nRuns**
  - **nRBI**
  - **nBB**
  - **YrMajor**
  - **CrAtBat**
  - **CrHits**
  - **CrHome**
  - **CrRuns**
  - **CrRbi**
  - **CrBB**
  - **nOuts**
  - **nAssts**

- nError
- To the **Nominal inputs** role, assign **League** and **Division**.

8 On the **Options** tab, select **Selected plots** from the **Select plots to display** drop-down list. Select **Variable importance chart**.

9 On the **Output** tab, select **Save scored data**. For the **Include variables from the input CAS table** option, select **Variables used in the analysis**.

If you are running the step in a flow, you must create the output table.

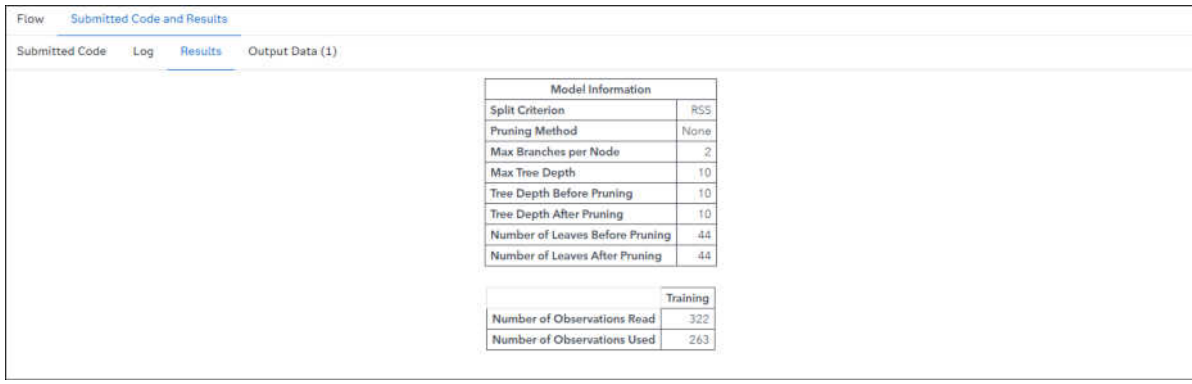
a Select **Add** ⇨ **Table**.

b In the table properties, enter `MyCas` as the library name and `Treesplit_scores` as the table name.

c Right-click the Decision Tree node and select **Add output port** ⇨ **Scored Data Table**.

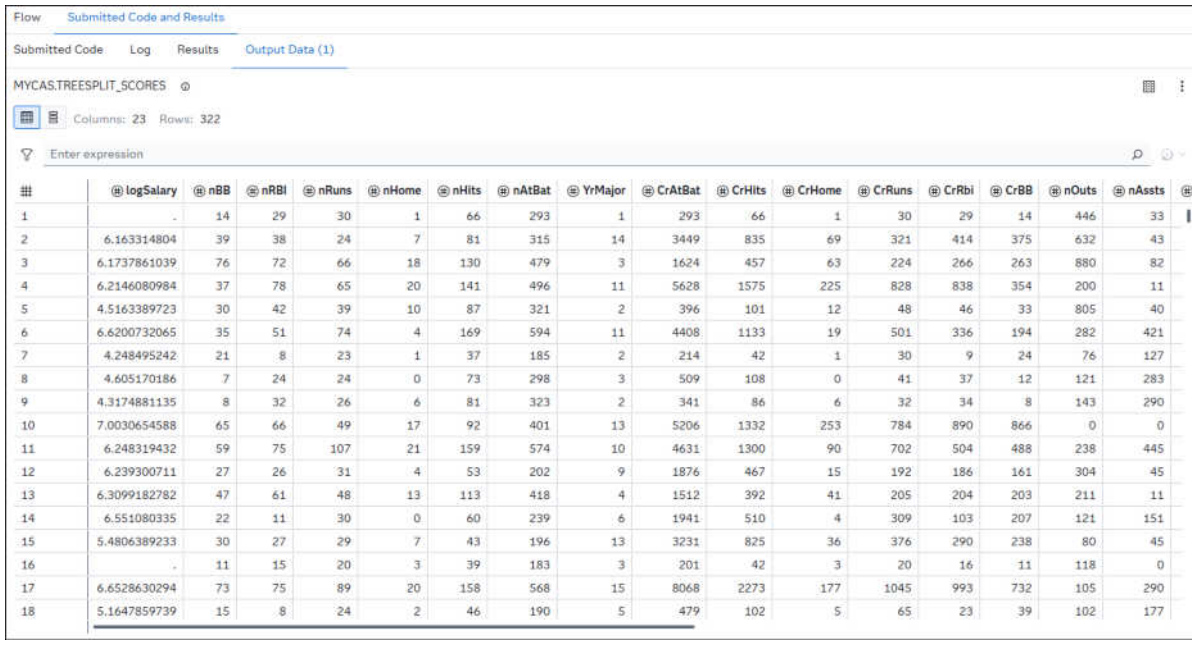
10 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Model Information	
Split Criterion	RSS
Pruning Method	None
Max Branches per Node	2
Max Tree Depth	10
Tree Depth Before Pruning	10
Tree Depth After Pruning	10
Number of Leaves Before Pruning	44
Number of Leaves After Pruning	44

	Training
Number of Observations Read	322
Number of Observations Used	263



#	logSalary	nBB	nRBI	nRuns	nHome	nHits	nAtBat	YrMajor	CrAtBat	CrHits	CrHome	CrRuns	CrRbi	CrBB	nOuts	nAssts
1	.	14	29	30	1	66	293	1	293	66	1	30	29	14	446	33
2	6.163314804	39	38	24	7	81	315	14	3449	835	69	321	414	375	632	43
3	6.1737861039	76	72	66	18	130	479	3	1624	457	63	224	266	263	880	82
4	6.2146080984	37	78	65	20	141	496	11	5628	1575	225	828	838	354	200	11
5	4.5163389723	30	42	39	10	87	321	2	396	101	12	48	46	33	805	40
6	6.6200732065	35	51	74	4	169	594	11	4408	1133	19	501	336	194	282	421
7	4.248495242	21	8	23	1	37	185	2	214	42	1	30	9	24	76	127
8	4.605170186	7	24	24	0	73	298	3	509	108	0	41	37	12	121	283
9	4.3174881135	8	32	26	6	81	323	2	341	86	6	32	34	8	143	290
10	7.0030654588	65	66	49	17	92	401	13	5206	1332	253	784	890	866	0	0
11	6.248319432	59	75	107	21	159	574	10	4631	1300	90	702	504	488	238	445
12	6.239300711	27	26	31	4	53	202	9	1876	467	15	192	186	161	304	45
13	6.3099182782	47	61	48	13	113	418	4	1512	392	41	205	204	203	211	11
14	6.551080335	22	11	30	0	60	239	6	1941	510	4	309	103	207	121	151
15	5.4806389233	30	27	29	7	43	196	13	3231	825	36	376	290	238	80	45
16	.	11	15	20	3	39	183	3	201	42	3	20	16	11	118	0
17	6.6528630294	73	75	89	20	158	568	15	8068	2273	177	1045	993	732	105	290
18	5.1647859739	15	8	24	2	46	190	5	479	102	5	65	23	39	102	177

Decision Tree: Partitioning Data

When you have sufficient data, you can partition your data into three parts: training data, validation data, and test data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds. Finally, after a model is selected, the test data can be used to assess how the selected model generalizes on data that played no role in selecting the model.

You can partition your data in either of these ways:

- You can specify a proportion of the validation or test data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is a validation case or a test case, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for the validation or test cases. The input data set is divided into partitions by using these values.

Decision Tree: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) Specify whether to partition the input data. For more information, see "Decision Tree: Partitioning Data" on page 273.
2. Select whether to use a nominal or interval target and assign a variable to the nominal or interval role.
3. Select one or more numeric variables to use as interval inputs.
4. Select one or more variables to use as nominal inputs.
5. (Optional) To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Set the Options

On the **Options** tab, you can set the options for the step. The options differ slightly if you decide to use the autotune process.

To use the autotune process:

1 Select **Automatically tune selected options**.

Note: The autotune process takes significantly longer than training a single model.

When you select this option, the step uses an optimization search process to select the best value for any specified autotune options. In the user interface, autotuning is identified by the **Autotune** `option-name` check box. For each autotune option, you can specify an initial value, a lower bound, or an upper bound for the search process.

If you are autotuning, here are the available options:

- **Autotune depth of tree** specifies the maximum depth of a tree. The default initial value is `10`.
- **Autotune number of bins** specifies the number of bins for the interval. The default initial value is `20`.

  Note: This option is available only if you assigned variables to the **Interval inputs** role.

- **Autotune splitting criteria** specifies the splitting criteria to use. The available choices depend on whether you have a nominal or interval target variable.

2 Specify the pruning method. The available choices depend on whether you use a nominal or interval target and whether you use validation data.

3 Specify the minimum observations for a leaf. The default value is `5`.

4 Specify the maximum branches of a node. The default value is `2`.

5 Specify the autotune settings:

- Specify the search method to use for tuning.
  - **Genetic algorithm** uses an initial Latin hypercube sample that seeds a genetic algorithm to generate a new population of alternative configurations at each iteration. You can also specify these settings: the maximum iterations, the maximum evaluations, and the evaluations per iteration.
  - **Latin hypercube sample** uses a Latin hypercube to generate a single sample of configurations that is uniform in each tuning parameter but random in combinations. You must specify the sample size.

- **Random sample** generates a single sample of purely random configurations. You must specify the sample size.
- **Bayesian sample** builds a kriging surrogate model to approximate the objective value and uses this surrogate model to generate new alternative configurations at each iteration. The kriging model is continuously updated during the search process.

- **Objective** specifies which measure of model performance the tuner users as the objective function.

  Note: The available options depend on whether you use a nominal or interval target.

- **Event of interest** specifies the target event to use for calculating the objective function.

  Note: This option is available only for nominal targets.

- **Maximum time (in minutes)** specifies the maximum time allowed for the tuner, where the number must be greater than or equal to 1. When this value is reached, the tuner terminates the search and returns results.
- **Validation method** specifies whether to use a partition or *k*-fold cross validation as the validation method.
  - **Partition** specifies the fraction of all data to be used for validation, where the fraction value must be between 0.01 and 0.99, inclusive. If you specify this option, the tuner uses a single partition validation for finding the objective value (validation error estimate). This option might not be advisable for small or unbalanced data tables where the random assignment of the validation subset might not provide a good estimate of error. For large, balanced data tables, a single validation partition is usually sufficient for estimating error; a single partition is more efficient than cross validation in terms of the total execution time.
  - **K-fold cross-validation** specifies the number of partition folds in the cross validation process, where the fraction value must be between 2 and 20, inclusive. If you specify this option, the tuner uses cross validation to find the objective value. In cross validation, each model evaluation requires a number of training executions (on number–1 data folds) and a number of scoring executions (on one holdout fold). Thus, the evaluation time is increased by approximately a factor of number. For small to medium data tables or for unbalanced data tables, cross validation provides on average a better representation of error (a better generalization error) across the entire data table.

  Note: This option is not available if you select the **Include validation data** check box on the **Data** tab.

- **Set number of parallel evaluations** specifies the number of evaluations to be performed in parallel, where the number must be greater than or equal to 0, and less than or equal to 32.

- **Evaluation history report** specifies whether to create and display the result table and log from the evaluation history report.

6 Specify whether to include these autotune plots in the results: objective history, best objective history, and option values versus objective.

7 Specify whether to include plots in the results. Available plots include a whole tree plot, a zoomed tree plot, and a variable importance chart.

8 Specify how the code is generated.

- **Use TREESPLIT procedure** uses the TREESPLIT procedure to run the step.
- **Use CAS procedure** uses the `decisionTree` action set to run the step.

If you do not want to use the autotune process, do not select **Automatically tune selected options**Instead, set these options.

1 Specify the maximum depth of a tree. The default value is `10`.

2 Specify the number of bins for the interval inputs. The default value is `20`.

Note: This option is available only if you assigned variables to the **Interval inputs** role.

3 Specify the splitting criterion. The choice depends on whether you have a nominal or interval target variable.

If you select **CHAID**, **F statistic**, or **Chi-square** as the splitting criterion, you must specify the *p*-value for the splitting variable. You can also use the Bonferroni adjustment to the *p*-value.

4 Specify the pruning method. The available choices depend on whether you use a nominal or interval target and whether you use validation data.

5 Specify the minimum observations for a leaf. The default value is `5`.

6 Specify the maximum branches of a node. The default value is `2`.

7 Specify whether to include plots in the results. Available plots include a whole tree plot, a zoomed tree plot, and a variable importance chart.

8 Specify how the code is generated.

- **Use TREESPLIT procedure** uses PROC TREESPLIT to run the step.
- **Use CAS procedure** uses the `decisionTree` action set to run the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains scored data. This table must use a CAS engine libref. You can also specify whether to include variables from the input data source.

2 (Optional) Specify whether to create an output table that contains the variable importance measures. You must specify a SAS libref.

3 (Optional) Specify whether to save the scoring code.

Note: If you are running the step in a flow, you must add an output table for the optional tables for scored data or variable importance measures. After you create these tables, you must add output ports to the Decision Tree node, and then connect the output table to the correct output port. For more information, see "Decision Tree: Connection Requirements for the Node" on page 270.

Dice Roll Simulation

About the Dice Roll Simulation Step

The Dice Roll Simulation step simulates rolling a specified number of dice. The results show the frequency and percentage of each possible roll given a specified number of throws.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Dice Roll Simulation: Connection Requirements for the Node

No input data is needed to run the Dice Roll Simulation step.

Input Port	Output Port
No input data is required.	By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Probability of Outcomes for 100,000,000 Dice Rolls

1 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Dice Roll Simulation** to add the step to your flow.

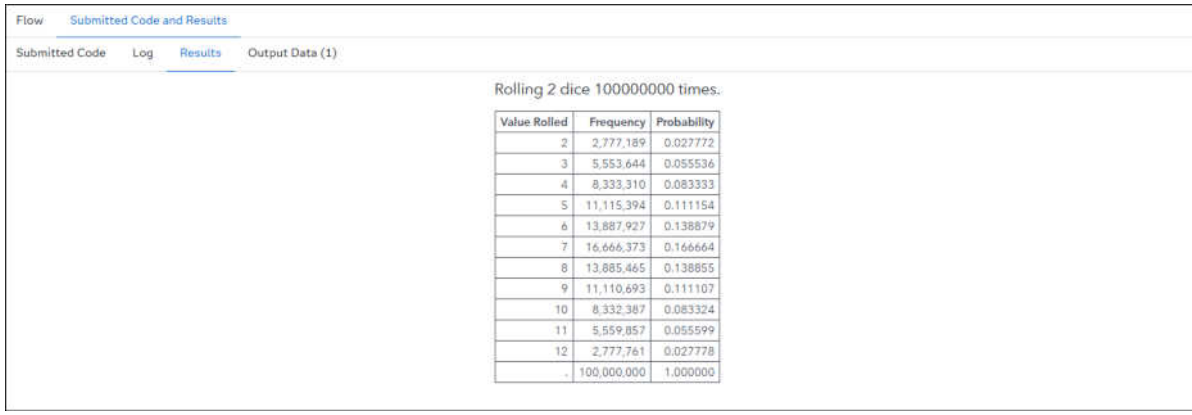
2 To set the options for the Dice Roll Simulation step, click the Dice Roll Simulation node.

3 In the **Number of dice** field, enter `2`.

4 In the **Number of rolls**, enter `100,000,000`.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here are the results:



Value Rolled	Frequency	Probability
2	2,777,189	0.027772
3	5,553,644	0.055536
4	8,333,310	0.083333
5	11,115,394	0.111154
6	13,887,927	0.138879
7	16,666,373	0.166664
8	13,885,465	0.138855
9	11,110,693	0.111107
10	8,332,387	0.083324
11	5,559,857	0.055599
12	2,777,761	0.027778
.	100,000,000	1.000000

Dice Roll Simulation: Step-by-Step Instructions

1 Specify the number of dice to roll.

2 Specify the number of times to roll the dice.

3 Specify whether to replace an existing output table. By default, the table is saved in the Work library.

Discriminant Analysis

About the Discriminant Analysis Step

For a set of observations with one or more quantitative variables and a classification variable, the Discriminant Analysis step develops a discriminant criterion to classify each observation into a group. The derived discriminant criterion from this data set can be applied to a second data set during the same run.

This step can also derive canonical variables. These variables are linear combinations of the quantitative variables that summarize between-class variance. This summarization is similar to how principal components summarize total variation.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Discriminant Analysis: Connection Requirements for the Node

In order to run the Discriminant Analysis step, you must create connections to the input port of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Discriminant Analysis on Crops Data

1 Copy and paste this code on a **SAS program** tab.

```
data crops;
   length crop $ 10;
   input Crop x1-x4 ;
   datalines;
Corn       16 27 31 33
Corn       15 23 30 30
Corn       16 27 27 26
Corn       18 20 25 23
Corn       15 15 31 32
Corn       15 32 32 15
Corn       12 15 16 73
Soybeans   20 23 23 25
Soybeans   24 24 25 32
Soybeans   21 25 23 24
Soybeans   27 45 24 12
Soybeans   12 13 15 42
Soybeans   22 32 31 43
Cotton     31 32 33 34
Cotton     29 24 26 28
Cotton     34 32 28 45
Cotton     26 25 23 24
Cotton     53 48 75 26
Cotton     34 35 25 78
Sugarbeets 22 23 25 42
Sugarbeets 25 25 24 26
Sugarbeets 34 25 16 52
Sugarbeets 54 23 21 54
Sugarbeets 25 43 32 15
Sugarbeets 26 54  2 54
Clover     12 45 32 54
Clover     24 58 25 34
Clover     87 54 61 21
Clover     51 31 31 16
Clover     96 48 54 62
Clover     31 31 11 11
Clover     56 13 13 71
Clover     32 13 27 32
Clover     36 26 54 32
Clover     53 08 06 54
Clover     32 32 62 16
run;
```

Click **Run** to create the Work.crops table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Discriminant Analysis** to add the step to your flow.

3 Add the Work.Crops table to your flow. Connect the input port of the Discriminant Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

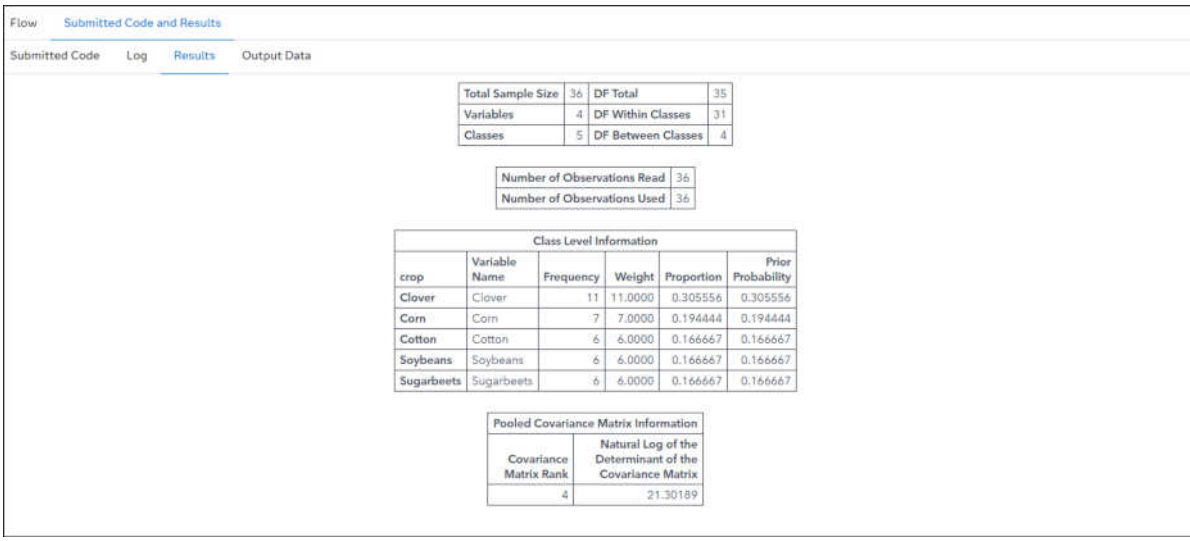
4 To set the options for the Discriminant Analysis step, click the Discriminant Analysis node.

5 On the **Data** tab, assign columns to these roles:

- To the **Group variable** role, assign **crop**.
- To the **Quantitative variables** role, assign **x1**, **x2**, **x3**, and **x4**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Total Sample Size	36	DF Total	35
Variables	4	DF Within Classes	31
Classes	5	DF Between Classes	4

Number of Observations Read	36
Number of Observations Used	36

Class Level Information

crop	Variable Name	Frequency	Weight	Proportion	Prior Probability
Clover	Clover	11	11.0000	0.305556	0.305556
Corn	Corn	7	7.0000	0.194444	0.194444
Cotton	Cotton	6	6.0000	0.166667	0.166667
Soybeans	Soybeans	6	6.0000	0.166667	0.166667
Sugarbeets	Sugarbeets	6	6.0000	0.166667	0.166667

Pooled Covariance Matrix Information

Covariance Matrix Rank	Natural Log of the Determinant of the Covariance Matrix
4	21.30189

Discriminant Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Group variable** role, assign the group variable for the discriminant analysis.

3 To the **Quantiative variables** role, assign the quantitative variables to use in the analysis.

4 (Optional) To specify the numeric variable whose value represents the frequency of the observation, assign a variable to the **Frequency count** role. If you assign a variable to this role, the step assumes that each observation

represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

5 (Optional) To the **Weight** role, assign the variable that lists the relative weight for each observation in the data source.

6 (Optional) To obtain separate analyses of observations for each unique group, assign a variable to the **Group analysis by** role.

Step 2: Select the Options

On the **Options** tab, you can set these options:

1 Specify the method to use in deriving the classification criterion. If you select **Parametric**, a parametric method based on the normal distribution within each class is used to derive a linear or quadratic discriminant function.

You can also choose from these nonparametric methods:

- **K nearest neighbors**. You must specify the value for K.
- **Kernel density estimation**. You must specify the value for the radius and the kernel density to estimate the group-specific densities.

2 Use the **Discriminant function** option to determine whether the pooled or within-group covariance matrix is the basis of the measure of the squared distance.

- If you select **Linear**, the step uses the pooled covariance matrix in calculating the (generalized) squared distances. Linear discriminant functions are computed.
- If you select **Quadratic**, the step uses the individual within-group covariance matrices in calculating the distances. Quadratic discriminant functions are computed.

3 Specify whether to perform a canonical discriminant analysis. You can also specify the number of canonical variables to compute. This number must be less than or equal to the number of variables.

4 Select the **Perform cross validation** check box to specify the cross validation classification of the input table.

When a parametric method is used, each observation in the input table is classified using a discriminant function. This function is computed from the other observations in the input data set, excluding the observation being classified. You can specify whether to display the cross validation classification results for misclassified observations.

When a nonparametric method is used, the covariance matrices that are used to compute the distances are based on all observations in the data set, excluding the observation that is being classified. However, the observation that is being

classified is excluded from the nonparametric density estimation or the *k* nearest neighbors of that observation.

5 Select the **Perform data set validation** option to specify the table that contains the observations to be classified. The names of the quantitative variables in this data set must match the names in the input table.

Note: If you are running this step in a flow, you must add the input table to the flow and connect it to an input port on the Discriminant Analysis node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

When performing data set validation, you can also select these options:

- **Classification results**
- **Misclassified observations**
- **Save classification data**

  Note: If you are running this step in a flow, you must add an output table to the flow and connect this table to the output port called Classification Table on the Discriminant Analysis node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

- **Save classification density data**

  Note: If you are running this step in a flow, you must add an output table to the flow and connect this table to the output port called Classification Density Table on the Discriminant Analysis node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

6 (Optional) Specify the statistics to include in the analysis. You can choose from these options:

- **Create classification data set** - creates an output SAS table that contains all the data from the **Data set to classify** table, plus the posterior probabilities and the class into which each observation is classified. If you select the **Canonical analysis** check box, the table also contains new variables with canonical variable scores.
- **Squared Mahalanobis distances** - calculates the squared Mahalanobis distances between the group means, *F* statistics, and the corresponding probabilities of greater Mahalanobis squared distances between the group means.
- **Posterior probability error-rate estimates** of the classification criterion based on the classification results.
- **Simple descriptive statistics** for the total sample and within each class.
- **Classification results** - the resubstitution classification results for each observation.
- **Misclassified observations** - the resubstitution classification results for misclassified observations only.

Step 3: Select the Selection Options

On the **Selection** tab, you can specify the selection method to use to select the variables to include in the model. The available options depend on the selection method.

- **None** - No selection method is used, and all variables are included in the model.
- **Stepwise selection** - Stepwise selection begins with no variables in the model. To add a variable to the model, the *F* statistic must be significant. The significance level is specified in the **Significance level for adding a variable** text box.

  At each step, all variables in the model are evaluated for retention. Any variable that does not have a significant F statistic is removed. The significance level is specified in the **Significance level for retaining a variable** text box.

  The stepwise process ends when either of these conditions is met:

  - no variable outside the model has an *F* statistic that is significant at the significance level for adding a variable, and every variable in the model is significant at the significance level to stay in the model
  - the variable that meets the criterion for addition to the model is the variable that was deleted from the model in the previous step
- **Forward selection** - The forward selection method begins with no variables in the model. For each of the explanatory variables, this method calculates *F* statistics that reflect the variable's contribution to the model. The *p*-values for these *F* statistics are compared to the significance level in the **Significance level for adding a variable** text box. By default, this value is `0.15`. If no *F* statistic has a significance level greater than this value, the forward selection stops.

  Otherwise, the forward selection method adds the variable with the largest *F* statistic to the model. The forward selection method then calculates *F* statistics again for the variables that remain outside the model, and the evaluation process is repeated. Thus, variables are added one by one to the model until no remaining variable produces a significant *F* statistic. After a variable is added to the model, it stays there.
- **Backward selection** - The backward selection method begins by calculating *F* statistics for all the explanatory variables. Then the variables are deleted from the model one by one until all the variables that remain in the model produce significant *F* statistics. The significance level is specified in the **Significance level for retaining a variable** text box. By default, this value is `0.15`. At each step, the variable that shows the smallest contribution to the model is deleted.

Step 4: Set the Output Options

On the **Output** tab, you can create these output tables:

- classification results

- statistics data
- cross validation data
- density data

Note: If you are running this step in a flow, you must add an output table to the flow and connect this table to the corresponding output port on the Discriminant Analysis node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Distribution Analysis

About the Distribution Analysis Step

Distribution analysis provides information about the distribution of numeric variables. A variety of plots such as histograms, probability plots, and quantile-quantile plots can be used in this analysis.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Distribution Analysis: Connection Requirements for the Node

In order to run the Distribution Analysis step, you must create connections to the input port of the node as indicated here:

Input Port	Output Port
■ Table node or	No output data is created.

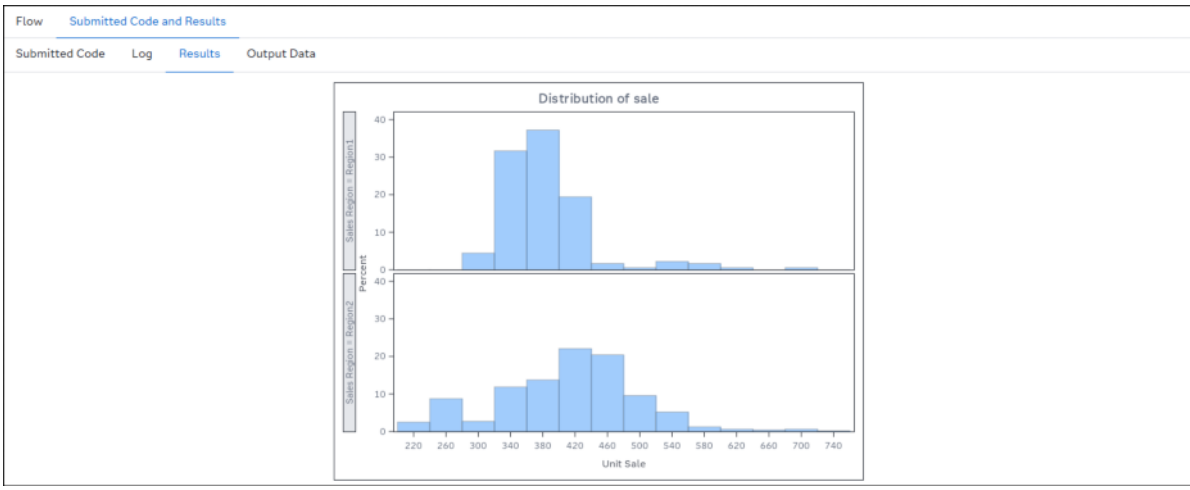
Input Port	Output Port
■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	

Example: Distribution Analysis of Sales for Each Region

In this example, you want to analyze the sales for each region. Because the data contains three regions, you get three sets of results.

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Distribution Analysis** to add the step to your flow.
2. Add the Sashelp.PriceData table to your flow. Connect the input port of the Distribution Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Distribution Analysis step, click the Distribution Analysis node.
4. On the **Data** tab, assign **sale** to the **Analysis variables** role.
5. On the **Options** tab, set these options:
   - In the Exploring Data group, assign the regionName variable to the **Classification variables** role.
   - In the Checking for Normality group, select the **Histogram and goodness-of-fit tests** and **Normal quantile-quantile plot** options.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a sample of the results:



Distribution Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Assign a numeric variable to the **Analysis variables** role. You can specify the order of the analysis variables in the results.

3 (Optional) To specify the numeric variable whose value represents the frequency of the observation, assign a variable to the **Frequency count** role. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

4 (Optional) To obtain separate analyses of observations for each unique group, assign a variable to the **Group analysis by** role.

Step 2: Select the Options

On the **Options** tab, you can set these options:

1 Select **Histogram** to create a graph that is used to determine the distribution of the data. A histogram is created by default.

You can also specify these options:

- In the **Classifications variables** role, specify the variables that are used to group the analysis variables into classification levels. You can assign a maximum of two columns to this role.
- If you select **Add normal curve**, the step uses the sample mean and sample standard deviation for μ and σ.
- If you select **Add kernel density estimate**, the step uses the AMISE method to compute the kernel density estimates.
- Select **Add inset statistics** to select where to display the statistics in relation to the histogram.

2 Under the Checking for Normality heading, select these options:

- **Histogram and goodness-of-fit tests** requests tests for normality that include a series of goodness-of-fit tests based on the empirical distribution function. The table provides test statistics and *p*-values for the Shapiro-Wilk test (provided the sample size is less than or equal to 2,000), the Kolmogorov-Smirnov test, the Anderson-Darling test, and the Cramér-von Mises test.

  You can also specify whether to include an inset box of selected statistics in the graph.
- **Normal probability plot** creates a probability plot that compares ordered variable values with the percentiles of the normal distribution. If the data distribution matches the normal distribution, the points on the plot form a linear pattern. Probability plots are preferable for graphical estimation of percentiles.

  The distribution reference line on the plot is created from the maximum likelihood estimate for the parameter.
- **Normal quantile-quantile plot** creates quantile-quantile plots (Q-Q plots) and compares ordered variable values with quantiles of the normal distribution. If the data distribution matches the normal distribution, the points on the plot form a linear pattern. Q-Q plots are preferable for graphical estimation of distribution parameters.

  The distribution reference line on the plot is created from the maximum likelihood estimate for the parameter.

  You can also specify whether to include an inset box of selected statistics in the graph.

3 Under the Fitting Distributions heading, select from these fitting distributions:

Beta

- **Histogram and goodness-of-fit tests** fits beta distribution with a threshold parameter, scale parameter, and shape parameter.
- **Probability Plot** specifies a beta probability plot for the shape parameters.
- **Quantile-quantile plot** specifies a beta Q-Q plot for the shape parameters.

Exponential

- **Histogram and goodness-of-fit tests** fits exponential distribution with a threshold parameter and scale parameter.
- **Probability Plot** specifies an exponential probability plot.
- **Quantile-quantile plot** specifies an exponential Q-Q plot.

Gamma

- **Histogram and goodness-of-fit tests** fits a gamma distribution with a threshold parameter, scale parameter, and shape parameter.
- **Probability Plot** specifies a gamma probability plot for the shape parameter.
- **Quantile-quantile plot** specifies a gamma Q-Q plot for the shape parameter.

Lognormal

- **Histogram and goodness-of-fit tests** fits lognormal distribution with a threshold parameter, scale parameter, and shape parameter.
- **Probability Plot** specifies a lognormal probability plot for the shape parameter.
- **Quantile-quantile plot** specifies a lognormal Q-Q plot for the shape parameter.

Weibull

- **Histogram and goodness-of-fit tests** fits Weibull distribution with a threshold parameter, scale parameter, and shape parameter.
- **Probability Plot** specifies a two-parameter Weibull probability plot.
- **Quantile-quantile plot** specifies a two-parameter Weibull Q-Q plot.

Equivalence Tests Statistical Power

About the Equivalence Tests Statistical Power Step

The Equivalence Tests Statistical Power step performs power analysis and sample size determination for equivalence tests of one-sample mean, paired means, two-sample means, and one proportion.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Equivalence Tests Statistical Power: Connection Requirements for the Node

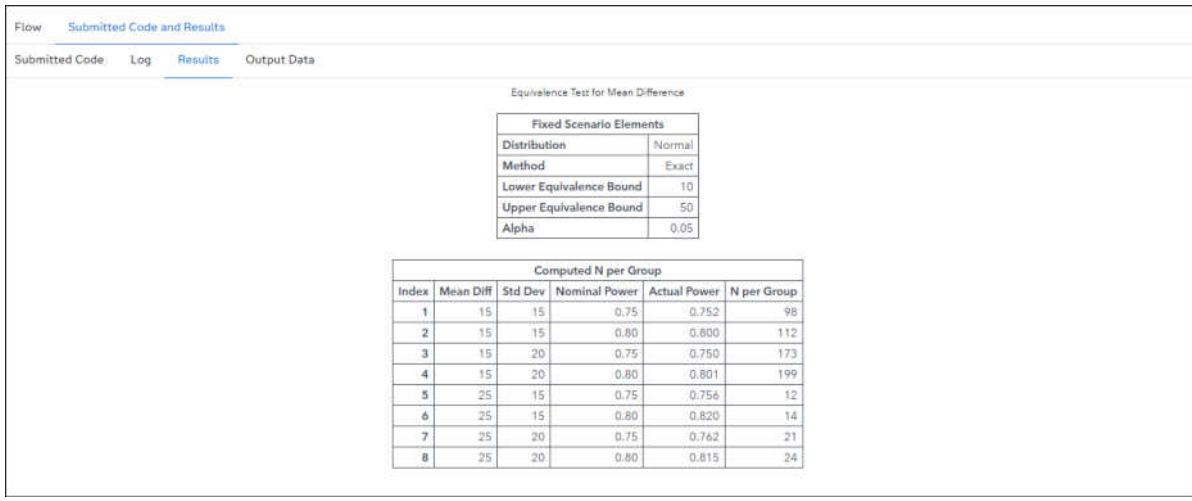
No input or output data is required to run the Equivalence Tests Statistical Power step.

Example: Equivalence Tests for Power and Sample Size Analysis

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Equivalence Tests Statistical Power** to add the step to your flow.
2. To set the options for the Equivalence Tests Statistical Power step, click the Equivalence Tests Statistical Power node.
3. From the **Type of test** drop-down list, select **Two-sample means**.
4. Under the **Solve for** heading, select **Sample size per group**.
5. Under the **Analysis Details** heading, select **Additive**.
6. In the **Alpha values** box, enter `0.05`.
7. Under the **Equivalence Bounds** heading, enter `10` as the lower bound and `50` as the upper bound.
8. Under the **Mean** heading, select **Difference between means**.
9. For the **Mean values** option, click +. You should now have two rows in the table. Enter `15` in the first row and `25` in the second row.
10. For the **Standard deviation values** option, click +.You should now have two rows in the table. Enter `15` in the first row and `20` in the second row.
11. For the **Power values** option, click +. You should now have two rows in the table. Enter `0.75` in the first row and `0.8` in the second row.
12. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Equivalence Tests Statistical Power Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Specify the type of test to perform in the analysis. Here are the valid tests:

- **One-sample mean**
- **Paired means**
- **Two-sample means**
- **One proportion**

2 For the **Solve for** option, request a solution for power or total sample size. For a two-sample means test, the **Sample size per group** option is also available.

Note: For a one proportion test, only the **Power** option is available if you select an exact test from the **Select a test** drop-down list under the **Analysis Details** heading.

3 Select an additive or multiplicative model.

Note: This option is available for one-sample mean, paired means, and two-sample means tests. This option is not available for one proportion tests.

4 For one proportion tests, specify the test to use in the analysis. You can choose from these options:

- **Exact binomial test**

- **Exact Z-test**
- **Exact continuity-adjusted Z-test**
- **Approximate Z-test**
- **Approximate continuity-adjusted Z-test**

For the Z tests, you must select the variance estimate for the test. This estimate can be based on the null proportion or the observed sample proportion.

5 In the **Alpha values** option, specify the significance level for the analysis. You can specify more than one value.

6 Specify the value of the lower bound and the upper bound for the equivalence test. You can specify more than one value.

7 For a one proportion test, specify the value for the proportion. You can specify more than one value.

8 Specify the options for the mean.

- Use the **Select a form** check box to specify whether to determine the difference between the means or the group means.

  Note: This option is available for a paired means test and a two-sample means test.

- Specify the value of the mean. You can specify more than one value.

9 Specify the options for the standard deviation.

- Use the **Select a form** check box to specify whether to use common or group standard deviations.

  Note: This option is available only for a paired means test.

- Specify the value of the standard deviation. You can specify more than one value.

10 For paired means tests, specify the correlation options.

- Specify the correlation. You can specify more than one value.
- Specify the power values for the analysis. These values must be greater than 0 and less than 1.

  Note: This option is available when you are solving for total sample size.

11 Specify whether fractions are allowed in the sample size.

If you are solving for power, you can also specify values for the sample size.

Step 2: Create the Output Plots

On the **Plots** tab, specify whether to create these output plots.

- a plot with sample size on the vertical axis and power on the horizontal axis. For this plot, you can specify the minimum and maximum value for power.
- a plot effect size on the horizontal axis. Power or sample size is on the vertical axis. For this plot, you can specify the minimum and maximum value for the effect size.

Estimate Within-Cluster Covariances

About the Estimate Within-Cluster Covariances Step

The Estimate Within-Cluster Covariances step uses the Art, Gnanadesikan, and Kettenring method to estimate within-cluster covariances. This approach might result in more spherical clusters when the resulting canonical variables are clustered.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Estimate Within-Cluster: Connection Requirements for the Node

In order to run the Estimate Within-Cluster Covariances step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Specify the Output Options" on page 297. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Estimate Within-Cluster Covariances

To create this example:

1 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Estimate Within-Cluster Covariances** to add the step to your flow.

2 Add the Sashelp.Iris table to your flow. Connect the input port of the Estimate Within-Cluster Covariances node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the Estimate Within-Cluster Covariances step, click the Estimate Within-Cluster Covariances node.

4 On the **Data** tab, assign these variables to the **Variables to use in clustering** role:

- **SepalLength**
- **SepalWidth**
- **PetalLength**
- **PetalWidth**

5 On the **Options** tab, select **Proportion of pairs** from the **Pairs of observations to include** drop-down list. In the **Proportion** field, enter `0.2`.

6 On the **Output** tab, select **Create canonical variables data**.

When running this step in a flow, you must add an output table and connect the table to an output port on the Estimate Within-Cluster Covariances node.

a To add an output table to the flow, click **Add** ⇨ **Table**.

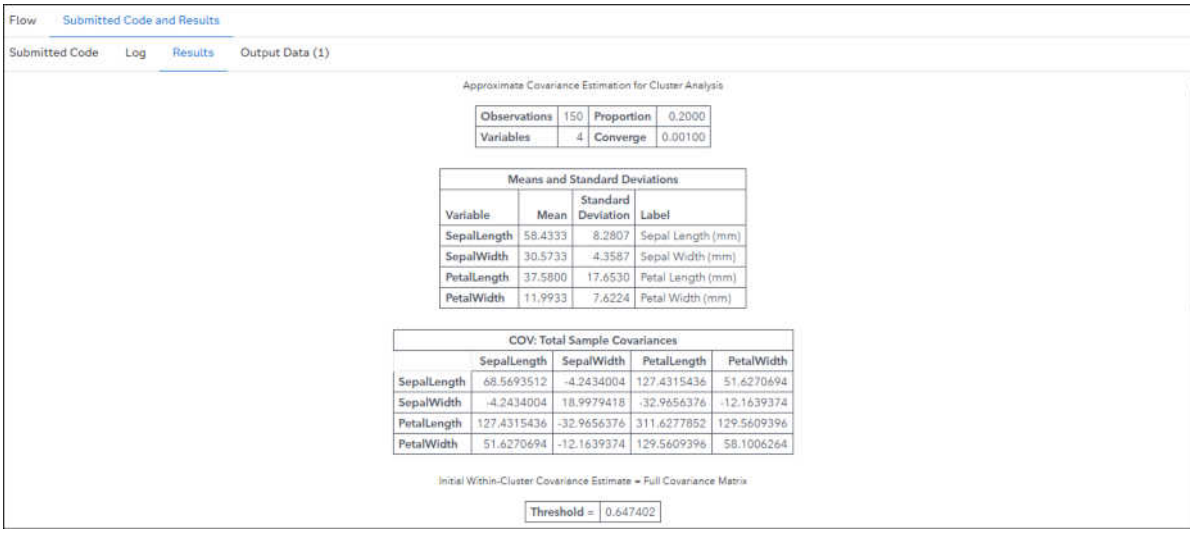
b Select the Table node. In the table properties, enter `Work` as the library and `Iris_output` as the table name.

c Right-click the Estimate Within-Cluster Covariances node and select **Add output port** ⇨ **Canonical Variables Table**.

d Connect the output port to the new table.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

Approximate Covariance Estimation for Cluster Analysis

Observations	150	Proportion	0.2000
Variables	4	Converge	0.00100

Means and Standard Deviations

Variable	Mean	Standard Deviation	Label
SepalLength	58.4333	8.2807	Sepal Length (mm)
SepalWidth	30.5733	4.3587	Sepal Width (mm)
PetalLength	37.5800	17.6530	Petal Length (mm)
PetalWidth	11.9933	7.6224	Petal Width (mm)

COV: Total Sample Covariances

	SepalLength	SepalWidth	PetalLength	PetalWidth
SepalLength	68.5693512	-4.2434004	127.4315436	51.6270694
SepalWidth	-4.2434004	18.9979418	-32.9656376	-12.1639374
PetalLength	127.4315436	-32.9656376	311.6277852	129.5609396
PetalWidth	51.6270694	-12.1639374	129.5609396	58.1006264

Initial Within-Cluster Covariance Estimate = Full Covariance Matrix

Threshold =	0.647402

Estimate Within-Cluster Covariances: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Variables to use in clustering** role, assign the variables to use in clustering.

3 (Optional) To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

4 (Optional) To the **Weight** role, assign the variable that specifies the relative weights for each observation in the input table.

5 (Optional) To the **Group analysis by** role, assign the variable to obtain separate analyses of observations in groups that are defined by the BY variables.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the pairs of observations to include in the analysis.

Here are the valid values:

- **Proportion of pairs** - Specifies the percentage of pairs to be included in the estimation of the within-cluster covariance matrix.
- **Cutoff value for distance between pairs** - Specifies the threshold for including pairs of observations in the estimation of the within-cluster covariance matrix. A pair of observations is included if the Euclidean distance between them is less than or equal to t times the root mean square distance computed over all pairs of observations.
- **Number of pairs** - Specifies the number of pairs to be included in the estimation of the within-cluster covariance matrix that is requested. The values must be greater than 0 but less than or equal to $(totfq * (totfq - 1))/2$, where *totfq* is the sum of nonmissing frequencies in the frequency variable. If you did not assign a frequency variable, *totfq* equals the number of total nonmissing observations.

2 Specify whether to use all the canonical variables in the analysis or only a specified number of variables.

3 Specify how to calculate the initial estimate for the covariance matrix.

Here are the valid values:

- **Diagonal matrix of variances**
- **Identity matrix**
- **Total sample covariance matrix (default)**

4 (Optional) Specify the maximum number of iterations to perform in the analysis.

Step 3: Specify the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains the canonical variables.

2 (Optional) Specify whether to create an output table that contains the statistics data.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Estimate Within-Cluster Covariances node. For more information, see "Estimate Within-Cluster: Connection Requirements for the Node" on page 293.

Factor Analysis

About the Factor Analysis Step

The Factor Analysis step performs a factor analysis with a variety of available methods and rotations.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Factor Analysis: Connection Requirements for the Node

In order to run the Factor Analysis step, you must create connections to the input port of the node as indicated here:

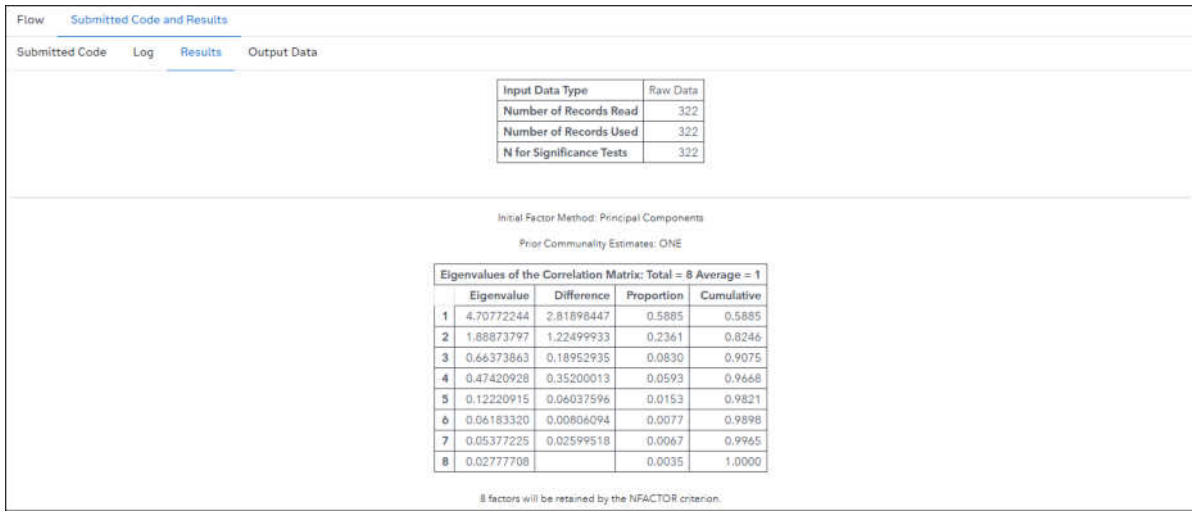
Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Specify the Output Options" on page 302. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Factor Analysis

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Factor Analysis** to add the step to your flow.
2. Add the Sashelp.Baseball table to your flow. Connect the input port of the Factor Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Factor Analysis step, click the Factor Analysis node.
4. On the **Data** tab, set these options:
   - To the **Analysis variables** role, assign these columns:
     - **nAtBat**
     - **nHits**
     - **nHome**
     - **nRuns**
     - **nRBI**
     - **nBB**
     - **YrMajor**
     - **CrAtBat**
5. On the **Options** tab, select these options:
   - From the **Rotation method** drop-down list, select **Varimax**.
   - For the type of rotation, select **Orthogonal rotation**.
6. Run the flow.

Open the **Submitted Code and Results** tab to view the results.



Factor Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) To filter the input data source, enter the filter expression in the **Filter** field.
2. To the **Analysis variables** role, assign the numeric variables to analyze.
3. (Optional) To the **Variables to partial out** role, assign the variables that are used to partial out the variables in the analysis. You specify a partial variable when you want the analysis to be based on a partial correlation or a covariance matrix.
4. (Optional) To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.
5. (Optional) To the **Weight** role, assign the variable that specifies the relative weights for each observation in the input table.
6. (Optional) To the **Group analysis by** role, assign the variable to obtain separate analyses of observations in groups that are defined by the BY variables.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1. (Optional) Select **Show only common extraction methods** to include only the common extraction methods (iterated principal factor analysis, maximum likelihood, and principal component analysis) in the **Factor extraction method** drop-down list.
2. (Optional) Use the **Factor extraction method** drop-down list to select the extraction method to use for extracting factors.

   If the **Show only common extraction methods** check box is not selected, the common extraction methods and these additional methods are available from the drop-down list:

   - **Alpha factor analysis**
   - **Harris component analysis**
   - **Image component analysis**
   - **Unweighted least squares factor analysis**
3. Specify the maximum number of factors to be extracted. By default, all analysis variables are included.

   From the **Estimation method for prior communalities** drop-down list, select a method for computing prior communality estimates.

   You can select from these options:

   - **Squared multiple correlation**
   - **Adjusted squared multiple correlation**
   - **Set to 1.0**
   - **Maximum absolute correlation**
   - **Set to a random number between 0 and 1**
4. From the **Analyze** drop-down list, specify whether to factor the correlation matrix or the covariance matrix.
5. (Optional) Specify whether to include the intercept in the analysis. Select **Correct the covariances or correlations for the means** check box to include the intercept in the analysis and to correct the covariances or correlations for the mean.
6. (Optional) Specify a prefix for naming the factors. By default, the names are Factor1, Factor2, ..., Factor*n*. If you specify ABC as the prefix, the factors are named ABC1, ABC2, ABC3, and so on.
7. (Optional) Set any communality that is greater than 1 to 1 for Heywood cases.

Note: This option is available if you select **Alpha factor analysis**, **Iterated principal factor analysis**, **Maximum likelihood**, or **Unweighted least squares factor analysis** as the factor extraction method.

8 (Optional) Specify the maximum number of iterations for factor extractions.

Note: This option is available if you select **Alpha factor analysis**, **Iterated principal factor analysis**, **Maximum likelihood**, or **Unweighted least squares factor analysis** as the factor extraction method.

9 (Optional) Specify the rotation method to use.

If you select any of these rotation methods, you can also specify an orthogonal or oblique rotation:

- **Biquartimax**
- **Equamax**
- **Factor parsimax**
- **Parsimax**
- **Promax**
- **Quartimax**
- **Varimax**

10 Select the statistics to be displayed in the results:

- descriptive statistics
- correlations
- residual correlations
- eigenvectors
- factor scoring coefficients
- Kaiser's measure of sampling adequacy

You can also specify whether to display factor loadings with the largest absolute loading first and whether to display small correlations and factor loadings.

11 Select the plots to be displayed in the results. By default, the eigenvalue by component (scree) plot and a plot of the variance explained are displayed.

You can also include these additional plots in the output:

- unrotated loadings plots.
- rotated loadings plots, which are available only if you select a rotation method.
- a path diagram. The path diagram is for the last factor model. The last factor model refers to the initial factor solution if you do not specify a rotation. The path diagram shows the links between factors and variables, the factor correlations, and the error variances in the model. The path diagram does not

display all nonzero directed links between factors and variables; it displays only those directed links that have factor loading estimates at 0.3 or larger in magnitude. To change this minimum value, select the **Specify the criterion to display paths** check box.

Step 3: Specify the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Select **Create factor score data set** to create an output table that contains the factor score data. By default, SAS Data and AI Studio overwrites any existing output tables.

2 (Optional) Select **Create statistics data set** to create an output table that contains the statistics. By default, SAS Data and AI Studio overwrites any existing output tables.

Note: If you are running the step in a flow, you must add output ports for the factor score data set and the statistics data set to the Factor Analysis node. For more information, see "Factor Analysis: Connection Requirements for the Node" on page 297.

Generalized Linear Models

About the Generalized Linear Models Step

Generalized linear models are an extension of traditional linear models. In a generalized linear model, the mean of a population depends on a linear predictor through a nonlinear link function. The response probability distribution can be any member of the exponential family of distributions. Examples of generalized linear models include classical linear models with normal errors, logistic and probit models for binary data, and log-linear models for multinomial data. Other statistical models can be formulated as generalized linear models by the selection of an appropriate link function and response probability distribution.

The Generalized Linear Models step provides model fitting and model building for generalized linear models. It fits models for standard distributions such as Normal, Poisson, and Tweedie in the exponential family. This task also fits multinomial models for ordinal and nominal responses. The task provides forward, backward, and stepwise selection methods.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Generalized Linear Models: Connection Requirements for the Node

In order to run the Generalized Linear Models step, you must create connections to the input port of the node as indicated here:

Input Port	Output Port
If you are running the step using SAS Compute Server, the table can be a SAS or CAS table. If you are running the step using SAS CAS Server, the table must use a CAS engine libref. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Specify the Output Options" on page 302. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Analyzing the Sashelp.Baseball Data Set

To create this example:

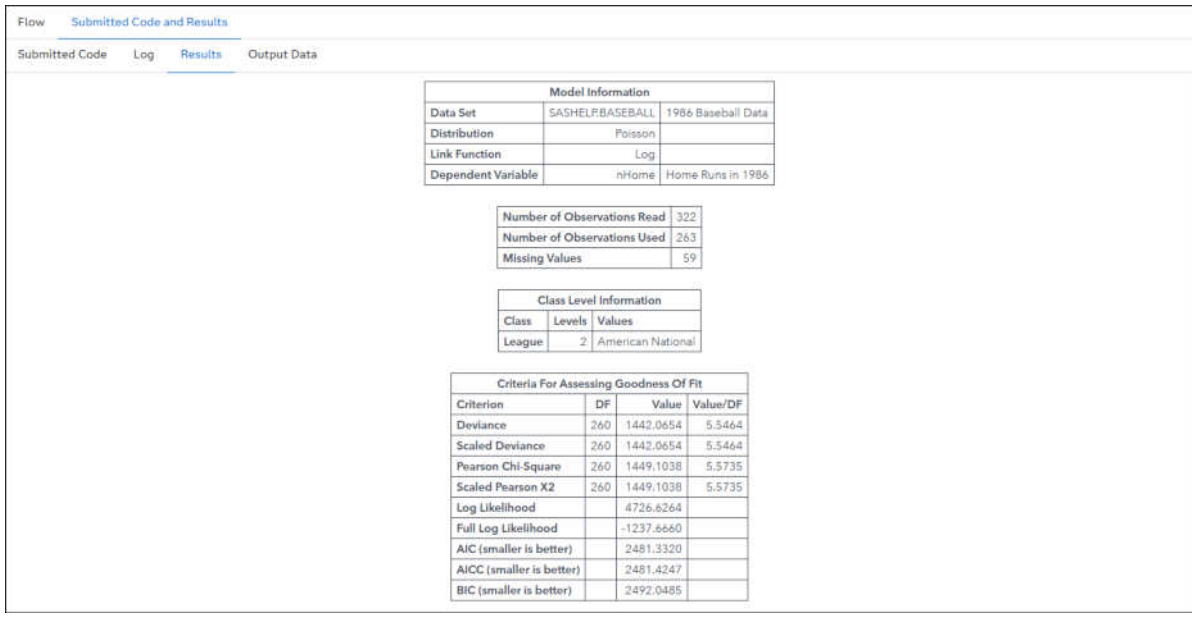
1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Generalized Linear Models** to add the step to your flow.
2. Add the Sashelp.Baseball table to your flow. Connect the input port of the Generalized Linear Models node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Generalized Linear Models step, click the Generalized Linear Models node.
4. On the **Data** tab, set these options:

- From the **Distribution** drop-down list, select **Poisson**.
- To the **Dependent variable** role, assign **nHome**. From the **Link function** drop-down list, select **Logarithm**.
- To the **Classification variables** role, assign **League**.
- To the **Continuous variables** role, assign **logSalary**.

5 On the **Model** tab, select **Custom model**. Specify **League** and **logSalary** as the model effects.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Model Information		
Data Set	SASHELP.BASEBALL	1986 Baseball Data
Distribution	Poisson	
Link Function	Log	
Dependent Variable	nHome	Home Runs in 1986

Number of Observations Read	322
Number of Observations Used	263
Missing Values	59

Class Level Information		
Class	Levels	Values
League	2	American National

Criteria For Assessing Goodness Of Fit			
Criterion	DF	Value	Value/DF
Deviance	260	1442.0654	5.5464
Scaled Deviance	260	1442.0654	5.5464
Pearson Chi-Square	260	1449.1038	5.5735
Scaled Pearson X2	260	1449.1038	5.5735
Log Likelihood		4726.6264	
Full Log Likelihood		-1237.6660	
AIC (smaller is better)		2481.3320	
AICC (smaller is better)		2481.4247	
BIC (smaller is better)		2492.0485	

Generalized Models: Partitioning Data

Note: You can partition data when you use a CAS server to run the step.

When you have sufficient data, you can partition your data into two parts: validation data and test data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds. Finally, after a model is selected, the test data can be used to assess how the selected model generalizes on data that played no role in selecting the model.

You can partition your data in either of these ways:

- You can specify a proportion of the validation or test data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is a validation or test case, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for validation or test cases. The input data set is divided into partitions by using these values.

Generalized Linear Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) Specify whether to partition the input data. For more information, see "Generalized Models: Partitioning Data" on page 304.

Note: This option is available only if you use SAS CAS Server to run the step.

3 (Optional) To filter the input data source, enter the filter expression in the **Filter** field.

4 From the **Distribution** drop-down list, select the distribution for your model. You can choose from these distributions.

- **Binomial**
- **Gamma**
- **Inverse Gaussian**
- **Multinomial**
- **Negative binomial**
- **Normal**

- **Poisson**
- **Tweedie**. If you select a Tweedie distribution, you can specify the Tweedie power parameter. This value must be greater than 1.1 and less than or equal to 3.0.
- **Zero-inflated negative binomial**
- **Zero-inflated Poisson**

5 (Optional) Set these options for binomial distributions.

- Select **Response data consists of numbers of events and trials** to specify that a pair of variables consists of response data for events and trials.
- Specify the column that contains the number of events.
- Specify the column that contains the number of trials.
- To the **Response** role, assign the variable that contains the response values. Use the **Event of interest** option to select a value of the response variables that represents the event that you want to model.

Note: The **Response** role and the **Event of interest** option are available only if you do not select the Response data consists of numbers of events and trials check box.

6 Specify these options for all distribution types.

- To the **Response** role, assign the variable that contains the response data. For most distribution types, you specify a single numeric variable.
- Specify the link function for your model. The functions that are available depend on the selected distribution.

7 (Optional) To the **Classification variables** role, assign the variables to use to group (classify) data in the analysis. Classification variables can be either character or numeric. A classification variable is a variable that enters the statistical analysis or model through its levels, not through its values. The process of associating values of a variable with levels is termed *levelization*.

8 (Optional) From the **Coding** drop-down list, specify the parameterization method for the classification variable. Design matrix columns are created from the classification variables according to the selected coding scheme.

You can select from these coding schemes:

- **Effect coding** specifies effect coding.
- **GLM coding** specifies less-than-full-rank, reference-cell coding. This coding scheme is the default.
- **Reference coding** specifies reference-cell coding.

9 (Optional) Review the information about missing values.

An observation is excluded from the analysis when either of these conditions is met:

- if any variable in the model contains a missing value

- if any classification variable contains a missing value (regardless of whether the classification variable is used in the model)

10 (Optional) To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

11 (Optional) To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

12 (Optional) To the **Weight** role, assign the numeric column to use as a weight to perform a weighted analysis of the data.

13 (Optional) To the **Group analysis by** role, assign a column to obtain separate analyses of observations for each unique group.

Step 2: Build the Model

On the **Options** tab, you can set these options:

1 Specify the effects for the model.

You can display the main effects model, display the main effects and all n-way interactions, or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the classification variables and continuous variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

2 (Optional) Specify whether to include the intercept in the model.

3 To the **Offset variable** role, assign a variable to be used as an offset to the linear predictor. An offset plays the role of an effect whose coefficient is known to be 1. Observations that have missing values for the offset variable are excluded from the analysis.

Step 3: Set the Model Selection

On the **Selection** tab, you can set these options.

Note: These options are available only if you are running the step on a CAS server. For more information, see "Step 1: Assign Data to Roles " on page 305.

1 Select the selection method to use for the model. The step performs model selection by examining whether effects should be added to or removed from the model according to the rules that are defined by the selection method.

   Here are the valid values for the selection methods:

   - **None** fits the full model.
   - **Forward selection** starts with no effects in the model and adds effects based on the value of the specified criterion.
   - **Backward elimination** starts with all the effects in the model and deletes effects based on the value of the specified criterion.
   - **Fast backward elimination** starts with all the effects in the model and deletes effects without refitting the model.

     Note: This selection method is available only if you selected a binary, exponential, Poisson, or binomial distribution.

   - **Stepwise selection** is similar to the forward selection model. However, effects that are already in the model do not necessarily stay there. Effects are added to the model based on the specified criterion and are removed from the model based on the specified criterion.
   - **LASSO** specifies the lasso method, which adds and deletes parameters based on a version of ordinary least squares in which the sum of the absolute regression coefficients is constrained. If the model contains classification variables, these variables are split.

2 Select which effects to include in all the models.

   Note: The availability of this option depends on the selection method.

3 Specify the criterion to use to add or remove effects from the model.

   Note: The availability of this option depends on the selection method.

4 Specify the criterion to use to identify the best fitting model.

5 Use the **Selection process details** option to specify how much information about the selection process to include in the results. You can display a summary, details for each step of the selection process, or all of the information about the selection process.

6 Specify whether a classification effect should be added or removed entirely or individually using a single degree of freedom.

   Note: This option is available only if you specified nominal inputs. This option is not available for the LASSO selection method.

7 Specify whether to retain the hierarchy of the effects. In order for a term to be included in the model, all model effects that are contained in the term must be present in the model.

Note: This option is not available for the LASSO selection method.

Step 4: Set the Options

On the **Options** tab, you can set these options.

These options are available if you are running the step using SAS Compute Server.

1 (Optional) Select **Adjust for overdispersion** to adjust the parameter covariance matrix and the likelihood function by a scale parameter. For the dispersion parameter, you can select a Pearson estimate or a deviance estimate. To define the subpopulations for calculating the Pearson and deviance chi-square goodness-of-fit tests, assign one or more variables to the role.

Note: This option is available only for binomial and multinomial distributions.

2 (Optional) Use the **Estimate dispersion parameter** to specify a fixed dispersion parameter for those distributions that have a dispersion parameter. By default, this parameter is estimated.

Note: This option is not available for binomial and multinomial distributions, but it is available for the other distribution types.

3 Specify the maximum number of iterations to perform for the selected optimization technique.

4 Select the statistics to include in the output. The list of statistics depends on the selected distribution.

Here are the additional statistics that you can include:

- type 1 (sequential) analysis
- type 3 analysis
- Wald statistics for Type 3 contrasts
- confidence intervals such as Profile likelihood confidence intervals and Wald confidence intervals
- correlations of parameter estimates
- covariances of parameter estimates
- observation statistics such as influence diagnostics, predicted values and confidence intervals, and residuals
- multiple comparisons for classification effects

- exact tests, which are available only for binomial distributions with a logit link function or a Poisson distribution with a log link function.

5 (Optional) Select the plots to be displayed in the output. If you choose to display multiple plots, you can display these plots individually or as a panel.

The list of available plots depends on the type of model. Here are some plots that you can include in your results:

- predicted plots
- influence plots such as Cook's D by observation number and DFBETA by observation number
- plots of residuals, deviance residuals, standardized deviance residuals, Pearson residuals, standardized Pearson residuals, standardized Pearson residuals, and likelihood residuals.

These options are available if you are running the step using SAS CAS Server.

1 Specify the confidence level to use for the construction of confidence intervals.

2 Specify the optimization method.

3 Specify the maximum number of iterations to perform for the selected optimization method.

4 Specify whether to include these statistics in the results:

- confidence intervals for parameter estimates
- correlations of parameter estimates
- covariances of parameter estimates

Step 5: Specify the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Select **Save observation statistics** to specify the values to include in an output table that contains the factor score data. You can include predicted values, residuals, influence statistics, and the standard error of the linear predictor in the output data set.

If you are running the step on a CAS server, you can include a partition identifier variable in the output if these conditions are met on the **Data** tab:

- The input data source is partitioned to use validation or test data.
- The partitions are generated by sampling. (In the **Identify partitions** drop-down list, you selected **Specify a sample proportion**.)

Note: If you are running the step on a CAS server, you must use a CAS engine libref.

2 (Optional) Select **Save scoring code** to save the scoring code to a separate file.

Note: If you are running the step in a flow, you must add output ports for the observation statistics table to the Generalized Linear Model node. For more information, see "Generalized Linear Models: Connection Requirements for the Node" on page 303.

Hierarchical Clustering

About the Hierarchical Clustering Step

The Hierarchical Clustering step enables you to perform hierarchical cluster analysis. The Hierarchical Clustering step can be used with either coordinate data or distance data. The distance data can be created using the Compute Similarities and Distances step.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Hierarchical Clustering: Connection Requirements for the Node

In order to run the Hierarchical Clustering step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Create the Output Data" on page 316. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information,

Input Port	Output Port
	see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Hierarchical Clustering

1 Copy and paste this code on a **SAS program** tab:

```
data Protein;
   length Country $ 14;
   input RedMeat WhiteMeat Eggs Milk Fish Cereal Starch Nuts FruitVeg
Country &$;
datalines;
10.1 1.4 0.5 8.9 0.2 42.3 0.6 5.5 1.7 Albania
8.9 14.0 4.3 19.9 2.1 28.0 3.6 1.3 4.3 Austria
13.5 9.3 4.1 17.5 4.5 26.6 5.7 2.1 4.0 Belgium
7.8 6.0 1.6 8.3 1.2 56.7 1.1 3.7 4.2 Bulgaria
9.7 11.4 2.8 12.5 2.0 34.3 5.0 1.1 4.0 Czechoslovakia
10.6 10.8 3.7 25.0 9.9 21.9 4.8 0.7 2.4 Denmark
8.4 11.6 3.7 11.1 5.4 24.6 6.5 0.8 3.6 E Germany
9.5 4.9 2.7 33.7 5.8 26.3 5.1 1.0 1.4 Finland
18.0 9.9 3.3 19.5 5.7 28.1 4.8 2.4 6.5 France
10.2 3.0 2.8 17.6 5.9 41.7 2.2 7.8 6.5 Greece
5.3 12.4 2.9 9.7 0.3 40.1 4.0 5.4 4.2 Hungary
13.9 10.0 4.7 25.8 2.2 24.0 6.2 1.6 2.9 Ireland
9.0 5.1 2.9 13.7 3.4 36.8 2.1 4.3 6.7 Italy
9.5 13.6 3.6 23.4 2.5 22.4 4.2 1.8 3.7 Netherlands
9.4 4.7 2.7 23.3 9.7 23.0 4.6 1.6 2.7 Norway
6.9 10.2 2.7 19.3 3.0 36.1 5.9 2.0 6.6 Poland
6.2 3.7 1.1 4.9 14.2 27.0 5.9 4.7 7.9 Portugal
6.2 6.3 1.5 11.1 1.0 49.6 3.1 5.3 2.8 Romania
7.1 3.4 3.1 8.6 7.0 29.2 5.7 5.9 7.2 Spain
 9.9 7.8 3.5 4.7 7.5 19.5 3.7 1.4 2.0 Sweden
13.1 10.1 3.1 23.8 2.3 25.6 2.8 2.4 4.9 Switzerland
17.4 5.7 4.7 20.6 4.3 24.3 4.7 3.4 3.3 UK
9.3 4.6 2.1 16.6 3.0 43.6 6.4 3.4 2.9 USSR
11.4 12.5 4.1 18.8 3.4 18.6 5.2 1.5 3.8 W Germany
4.4 5.0 1.2 9.5 0.6 55.9 3.0 5.7 3.2 Yugoslavia
;
```

Click **Run** to create the Work.Protein table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Hierarchical Clustering** to add the step to your flow.

3 Add the Work.Protein table to your flow. Connect the input port of the Hierarchical Clustering node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Hierarchical Clustering step, click the Hierarchical Clustering node.

5 On the **Data** tab, select the **Interval** option.

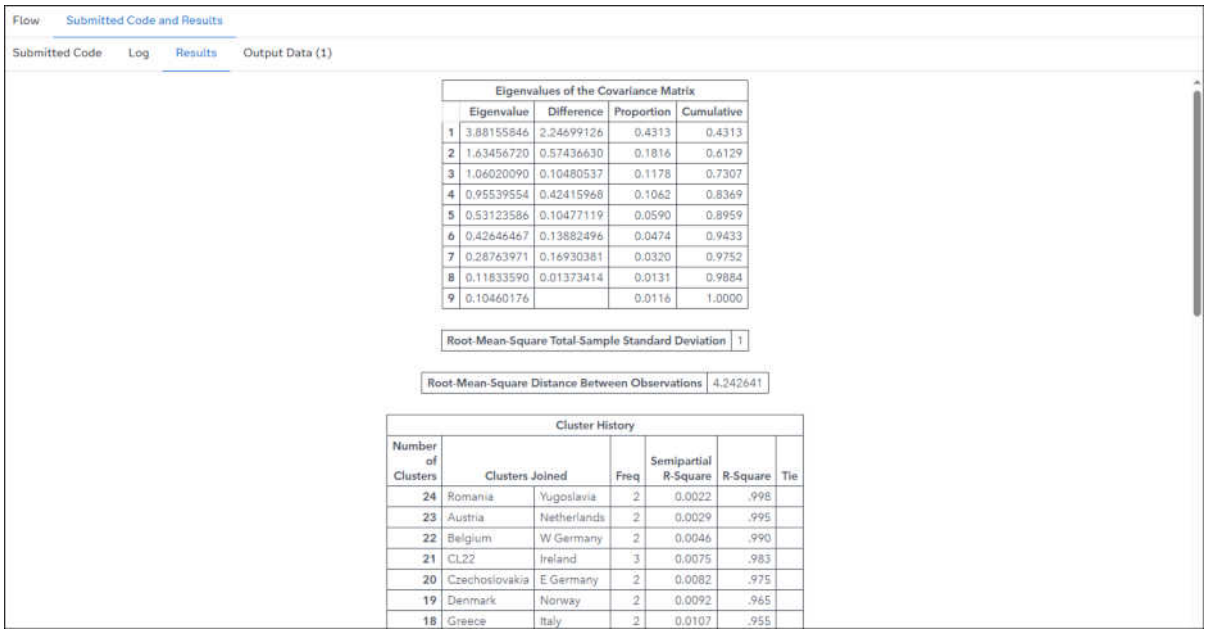
6 Assign variables to these roles:

- To the **Interval variables** role, assign these columns:
  - **RedMeat**
  - **WhiteMeat**
  - **Eggs**
  - **Milk**
  - **Fish**
  - **Cereal**
  - **Starch**
  - **Nuts**
  - **FruitVeg**
- To the **Identify observations in clusters** role, assign **Country**.

7 On the **Options** tab, select **Standard deviation** as the standardization method.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Eigenvalues of the Covariance Matrix

	Eigenvalue	Difference	Proportion	Cumulative
1	3.88155846	2.24699126	0.4313	0.4313
2	1.63456720	0.57436630	0.1816	0.6129
3	1.06020090	0.10480537	0.1178	0.7307
4	0.95539554	0.42415968	0.1062	0.8369
5	0.53123586	0.10477119	0.0590	0.8959
6	0.42646467	0.13882496	0.0474	0.9433
7	0.28763971	0.16930381	0.0320	0.9752
8	0.11833590	0.01373414	0.0131	0.9884
9	0.10460176		0.0116	1.0000

Root-Mean-Square Total-Sample Standard Deviation	1

Root-Mean-Square Distance Between Observations	4.242641

Cluster History

Number of Clusters	Clusters Joined		Freq	Semipartial R-Square	R-Square	Tie
24	Romania	Yugoslavia	2	0.0022	.998	
23	Austria	Netherlands	2	0.0029	.995	
22	Belgium	W Germany	2	0.0046	.990	
21	CL22	Ireland	3	0.0075	.983	
20	Czechoslovakia	E Germany	2	0.0082	.975	
19	Denmark	Norway	2	0.0092	.965	
18	Greece	Italy	2	0.0107	.955	

Hierarchical Clustering: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Select the measurement levels of the variables to use in clustering. Next, select the variables for each level.

- **Ratio**
- **Interval**
- **Ordinal**
- **Nominal**
  - **Symmetric nominal (more common)**
  - **Asymmetric nominal (uncommon)** —- All asymmetric nominal variables must be of the same type.

3 To the **Variables to use in clustering** role, assign the variables to use in the analysis.

Note: This option is available only if you are using distance data.

4 (Optional) To the **Identify observations in clusters** role, assign the variable that contains the values for identifying the clusters.

Note: This option is not available if you are using distance data.

5 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the task assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Note: This option is not available if you are using distance data.

6 (Optional) To the **Group analysis by** role, assign the variable that specifies how to group the analysis.

Step 2: Set the Options

On the **Options** tab, specify these options:

1 Select the method to use. The available methods depend on the measurement levels that you selected on the **Data** tab.

- Standardization
  - **Suppress all standardization** specifies whether to suppress all standardization. Standardization is optional if a single measurement level is used. Standardization is required if more than one measurement level is used unless you select the **Suppress all standardization** check box.
  - Specify the standardization method of each type of variable.
    - For the ratio variables, the default standardization method is maximum absolute value.
    - For interval variables, the default standardization method is standard deviation for all measures except Gower and Legende. If you select **Gower and Legende** as the dissimilarity or similarity measure, the default method is range.
    - For ordinal variables, the default standardization method is standard deviation for all measures except Gower and Legende. If you select **Gower and Legende** as the dissimilarity or similarity measure, the default method is range.
- **Dissimilarity measure** specifies the dissimilarity measure. The available measures depend on the types of measurement levels that you selected and on the different combinations of measurement levels.
- Clustering
  - **Clustering method** specifies the clustering method for the analysis.
  - **Omit outliers** omits points with low estimated probability densities from the analysis. By default, the minimum probability density is `0.1`.
  - **Kernel estimation method** specifies how to estimate the kernels.

    Here are the valid values:
    - **K-th nearest-neighbor-estimation** specifies the number of neighbors to use for kth-nearest-neighbor density estimation. The number of neighbors must be at least two but less than the number of observations.
    - **Uniform-kernel estimation** specifies the radius of the sphere of support for uniform-kernel density estimation.

    Note: This option is available only if you select the **Omit outliers** check box or if you select **Two-stage density linkage** as the clustering method.

2 Select the statistics that you want to be displayed in the results. The available statistics depend on the clustering method that you selected and the type of input table.

3 Select the plots that you want to be displayed in the results. The available plots depend on the clustering method that you selected and the type of input table.

Step 3: Create the Output Data

On the **Output** tab, you can create an output table that contains information about the tree structure. This information can be used to draw a tree diagram.

K-Means Clustering

About the K-Means Clustering Step

The K-Means Clustering step enables you to cluster interval or ratio data using the *k*-means algorithm. This step is a good starting point for cluster analysis.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

K-Means Clustering: Connection Requirements for the Node

In order to run the K-Means Clustering step, you must create connections to the input port of the node as indicated here:

Input Port	Output Port
If you are running the step using the SAS Compute Server, the input data source can be a SAS or CAS table. If you are running the step using the	By default, no output data is created. No connection is required.

Input Port	Output Port
SAS CAS Server, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 321. **Note:** If you are running the step using the SAS Compute Server, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: K-Means Clustering

To create this example:

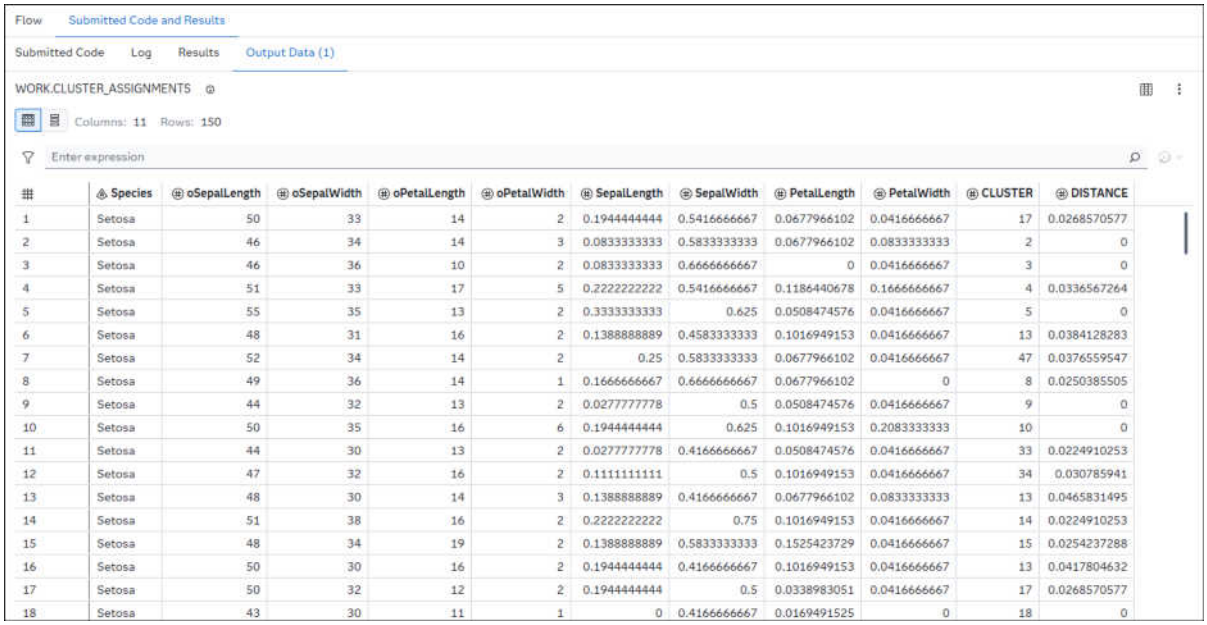
1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **K-Means Clustering** to add the step to your flow.
2. Add the Sashelp.Iris table to your flow. Connect the input port of the K-Means Clustering node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the K-Means Clustering step, click the K-Means Clustering node.
4. On the **Data** tab, assign these variables to the **Variables to use in clustering** role:
   - **SepalLength**
   - **SepalWidth**
   - **PetalLength**
   - **PetalWidth**
5. On the **Options** tab, select the **Maximum number of iterations** check box and enter `3` in the **Iterations** field.
6. On the **Output** tab, select **Create cluster assignment data**.
7. Add an output table for the cluster assignment data set to the flow.
   a. Select **Add** ⇨ **Table**.
   b. In the Table Properties, enter `Work` as the library name, and enter `Cluster_Assignments` as the table name.

c Right-click the K-Means Clustering node and select **Add output port** ⇨ **Cluster Assignment Table**.

d Connect the new output port to the Cluster_Assignments table.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results and the output data.



	Species	oSepalLength	oSepalWidth	oPetalLength	oPetalWidth	SepalLength	SepalWidth	PetalLength	PetalWidth	CLUSTER	DISTANCE
1	Setosa	50	33	14	2	0.1944444444	0.5416666667	0.0677966102	0.0416666667	17	0.0268570577
2	Setosa	46	34	14	3	0.0833333333	0.5833333333	0.0677966102	0.0833333333	2	0
3	Setosa	46	36	10	2	0.0833333333	0.6666666667	0	0.0416666667	3	0
4	Setosa	51	33	17	5	0.2222222222	0.5416666667	0.1186440678	0.1666666667	4	0.0336567264
5	Setosa	55	35	13	2	0.3333333333	0.625	0.0508474576	0.0416666667	5	0
6	Setosa	48	31	16	2	0.1388888889	0.4583333333	0.1016949153	0.0416666667	13	0.0384128283
7	Setosa	52	34	14	2	0.25	0.5833333333	0.0677966102	0.0416666667	47	0.0376559547
8	Setosa	49	36	14	1	0.1666666667	0.6666666667	0.0677966102	0	8	0.0250385505
9	Setosa	44	32	13	2	0.0277777778	0.5	0.0508474576	0.0416666667	9	0
10	Setosa	50	35	16	6	0.1944444444	0.625	0.1016949153	0.2083333333	10	0
11	Setosa	44	30	13	2	0.0277777778	0.4166666667	0.0508474576	0.0416666667	33	0.0224910253
12	Setosa	47	32	16	2	0.1111111111	0.5	0.1016949153	0.0416666667	34	0.030785941
13	Setosa	48	30	14	3	0.1388888889	0.4166666667	0.0677966102	0.0833333333	13	0.0465831495
14	Setosa	51	38	16	2	0.2222222222	0.75	0.1016949153	0.0416666667	14	0.0224910253
15	Setosa	48	34	19	2	0.1388888889	0.5833333333	0.1525423729	0.0416666667	15	0.0254237288
16	Setosa	50	30	16	2	0.1944444444	0.4166666667	0.1016949153	0.0416666667	13	0.0417804632
17	Setosa	50	32	12	2	0.1944444444	0.5	0.0338983051	0.0416666667	17	0.0268570577
18	Setosa	43	30	11	1	0	0.4166666667	0.0169491525	0	18	0

K-Means Clustering: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 Assign a variable to roles. The roles that are available depend on whether you are running the step using a SAS Compute Server or a SAS CAS Server.

   - If you are using a SAS Compute Server, use the **Variables to use in clustering** option to assign the numeric variable to use in clustering.
   - If you are using a SAS CAS Server, specify how to cluster the inputs. You can choose from these options:
     - **Interval inputs**. If you select this option, you must assign one or more numeric variables as an interval input.
     - **Nominal inputs**. If you select this option, you must assign one or more variables as a nominal input.
     - **Interval and nominal inputs**. If you select this option, you must assign at least one variable as an interval input and one variable as a nominal input.

4 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the task assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

5 (Optional) To the **Group analysis by** role, assign a variable to specify how to group the analysis.

Note: This role is available only if you are running the step using a SAS Compute Server.

Step 2: Set the Options

On the **Options** tab, you can set these options.

If you are running the step using a SAS Compute Server, these options are available.

1 From the **Standardization method** drop-down list, select the standardization method for the ratio and interval variables. The default method is **Range**, where the task subtracts the minimum and divides by the range.

2 (Optional) Specify the maximum number of clusters for the step to compute. The default value is `100`.

3 (Optional) Specify the minimum distance criterion for selecting new seeds. No observation is considered a new seed unless its minimum distance to previous seeds exceeds the specified value. The default value is `0`.

4 (Optional) Select **Update cluster centroid for each observation** to enable cluster seeds to drift during initialization. After initial seed selection, each observation is assigned to the cluster with the nearest seed. After an

observation is processed, the seed of the cluster to which it is assigned is recalculated as the mean of the observations currently assigned to the cluster. Therefore, the cluster seeds drift about rather than remaining fixed for the duration of the pass.

5 (Optional) Select **Read cluster centroid from a data set** to specify an input table from which initial cluster seeds are to be selected. This table must contain the same variables as the input table in the analysis. You might have created this output table by previously running the K-Means Clustering step and selecting the **Create cluster centroids data** check box on the **Output** tab.

If you are running the step in a flow, you must complete these steps:

a Add the cluster centroid data set to the flow.

b Right-click the K-Means Clustering node and select **Add input port**. An input port for the cluster centroid data is added to the K-Means Clustering node.

c Connect the node for the cluster centroid data to the Cluster Centroids input port in the K-Means Clustering step.

6 (Optional) Specify the maximum number of iterations for recomputing cluster seeds.

7 Specify whether to include any statistics in the results.

If you are running the step using a SAS CAS Server, these options are available.

1 Specify how to prepare the data.

- If you are clustering interval inputs, specify whether to replace interval missing values with the mean. Also, select the standardization method to use. You can choose from these options:
  - **No standardization**.
  - **Range** – subtracts the minimum value and divides by the range.
  - **Standard deviation** – subtracts the mean and divides by the standard deviation.
- If you are clustering nominal inputs, specify whether to replace missing values with the most frequent value.

2 Select the distance measure and number of clusters for the interval and nominal inputs.

- If you are using interval inputs:
  - Select the interval distance measure. Here are the valid values: **Euclidean distance** and **City block (Manhattan) distance**
  - Specify the number of clusters or have the step estimate the number of clusters. By default, the number of specified clusters is `6`. To estimate the number of clusters, specify the minimum and maximum values, and then select the relevant criterion.
- If you are using nominal inputs:

- Select the nominal distance measure. Here are the valid values: **Simple matching distance**, **Frequency-based dissimilarity**, and **Cluster frequency-based dissimilarity**.
- Specify the number of clusters. The default value is `6`.

3 (Optional) Specify the initial seed for the generation of random numbers. This value must be an integer that is greater than 0.

4 (Optional) Specify the maximum number of iterations to perform. By default, the maximum number of iterations is `10`.

5 (Optional) Create a plot of the gap statistic by number of clusters.

Note: This option is available only if you are using interval inputs.

Step 3: Set the Output Options

On the **Output** tab, specify the output data tables.

If you are running the step on SAS Compute Server, you can create these output tables. These tables must use a SAS libref.

- cluster assignment data
- cluster statistics
- cluster centroid data

By default, these tables are saved to the Work library. To save the output to a permanent table, you must add a table to the flow and connect it to an output port of the K-Means Clustering node.

If you are running the step using a SAS CAS Server, you can create these output tables. These tables must use a CAS engine libref.

- cluster scores
- cluster statistics

You can also choose to save the scoring code. The path must be in a URL format such as sascontent:/path/to/fileorfolder or sasserver:/path/to/fileorfolder.

Note: If you are running this step in a flow, you must add an output table to the flow and connect any output tables to the K-Means Clustering node. For more information, see "K-Means Clustering: Connection Requirements for the Node" on page 316.

Linear Regression

About the Linear Regression Step

You can use the Linear Regression step to perform linear regression analysis on multiple dependent and independent variables.

For example, you might use regression analysis to find out how well you can predict a child's weight if you know the child's height. Suppose that a SAS data set contains the height and weight measurements of 19 children. By using weight as the dependent variable and height as the independent variable, you can perform a linear regression analysis on this data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Linear Regression: Connection Requirements for the Node

In order to run the Linear Regression step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
An input data table is required to run this step. Additional input tables can be added using the options on the **Predictions** tab. For more information, see "Step 5: Set the Prediction Options" on page 329. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program	No output table is created by default, so no connection is required. To create an output data table for the predicted data and diagnostic statistics, use the options on the **Output** tab. For more information, see "Step 7: Set the Output Options" on page 330. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table

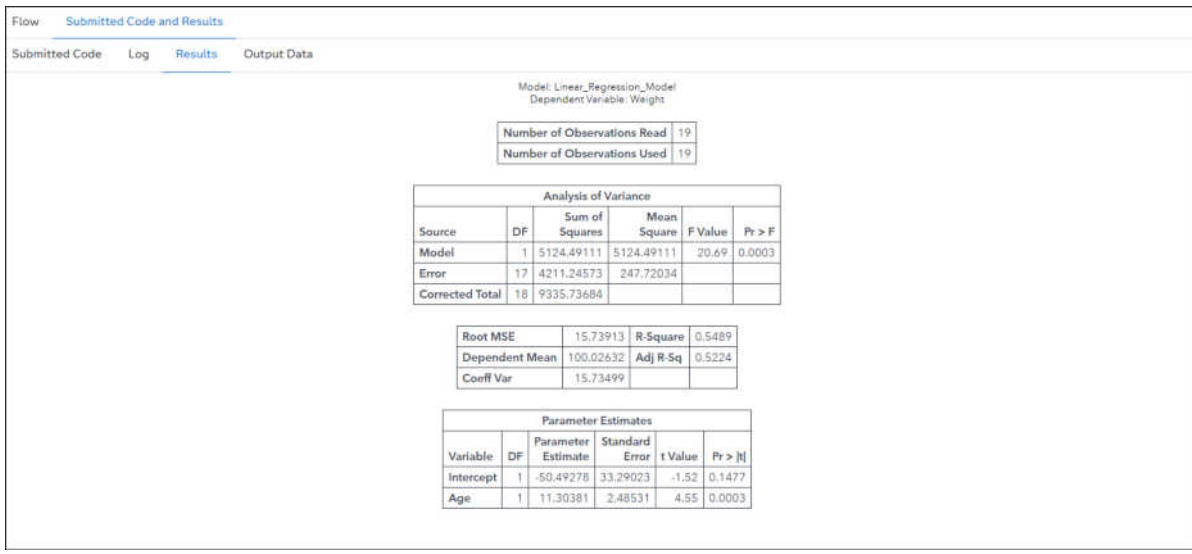
Input Port	Output Port
node, or an Import node) that creates an output table	node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Predicting Weight Based on a Student's Height

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Linear Regression** to add the step to your flow.
2. Add the Sashelp.Class table to your flow. Connect the input port of the Linear Regression node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Linear Regression step, click the Linear Regression node.
4. On the **Data** tab, assign variables to these roles:
   - To the **Dependent variable** role, assign the **Weight** column.
   - To the **Explanatory variables** role, assign the **Age** column.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Linear Regression: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Dependent variables** role, assign the variables to use as the dependent (response) variables. You must assign at least one variable to this role.

3 To the **Explanatory variables** role, assign the variables to use as the regressor (explanatory) variables. If you do not specify any regressor variables, each dependent variable is fit to a mean-only model. That is, each dependent variable is fit to a model with only a constant term.

4 (Optional) To the **Group analysis by** role, assign the variable to obtain separate analyses of observations in groups that are defined by the BY variables.

5 (Optional) To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

6 (Optional) To the **Relative weight** role, assign the variable that contains the values that are relative weights for a weighted least squares fit. The values of the relative weight variable must be nonnegative. You can assign a maximum of one variable to this role.

Step 2: Set the Model Options

On the **Model** tab, you can set these options:

1 Select a method from the drop-down list of model selection methods. If you do not select a method, the full model is used. Depending on the model selection method, additional options for that method become available.

Here are the valid values:

Full model fitted (no selection)
This method is the default and provides no model selection capability. This is the model that was created when you assigned the dependent variables and quantitative (explanatory) variables.

Forward selection

The forward selection method begins with no variables in the model. For each of the explanatory variables, this method calculates *F* statistics that reflect the variable's contribution to the model, if it is included. The *p*-values for these *F* statistics are compared to the significance level that is specified for including a variable in the model. By default, this value is `0.5`. To change this significance level, enter the value in the **To enter the model** text box.

If no *F* statistic has a significance level greater than this value, the forward selection stops. Otherwise, the forward selection method adds the variable with the largest *F* statistic to the model. The forward selection method then calculates *F* statistics again for the variables that remain outside the model, and the evaluation process is repeated. Thus, variables are added one by one to the model until no remaining variable produces a significant *F* statistic. After a variable is added to the model, it stays there.

Backward elimination

The backward elimination method begins by calculating *F* statistics for a model, including all of the explanatory variables. Then the variables are deleted from the model one by one until all the variables that remain in the model produce significant *F* statistics. The significance level is specified in the **To stay in the model** text box. By default, this value is `0.10`. At each step, the variable that shows the smallest contribution to the model is deleted.

Stepwise selection

The stepwise selection method is a modification of the forward selection method. In the stepwise method, variables that are already in the model do not necessarily stay there. As in the forward selection method, variables are added one by one to the model, and the *F* statistic for a variable must be significant to be added. The significance level is specified in the **To enter the model** text box.

However, after a variable is added, the stepwise method checks all the variables that are already included in the model and deletes any variable that does not produce a significant *F* statistic. The significance level is specified in the **To stay in the model** text box. Only after this check is made and the necessary deletions are accomplished can another variable be added to the model.

The stepwise process ends when either of these conditions is met:

- No variable outside the model has a significant *F* statistic, and every variable in the model is significant at the significance level that is specified to stay in the model.
- The variable to be added to the model is the variable that was just deleted from it.

Maximum R-squared improvement

The maximum R-squared improvement method does not settle on a single model. Instead, it tries to find the best one-variable model, the best two-variable model, and so on. It is not guaranteed to find the model with the largest R^2 for each size. This method begins by finding the one-variable model that produces the highest R^2. Then another variable, the one that yields the greatest increase in R^2, is added. After the two-variable model is

obtained, each variable in the model is compared to each variable not in the model. For each comparison, this method determines whether removing one variable and replacing it with the other variable increases R^2. After comparing all possible switches, this method makes the switch that produces the largest increase in R^2. Comparisons begin again, and the process continues until this method finds that no further switch could increase R^2. Thus, the resulting two-variable model is considered the best two-variable model that the method can find. Another variable is then added to the model, and the comparing-and-switching process is repeated to find the best three-variable model, and so on. The difference between the stepwise selection method and the maximum R^2 selection method is that in the maximum R^2 method, all switches are evaluated before any switch is made. In the stepwise selection method, the "worst" variable might be removed without considering what adding the "best" remaining variable might accomplish.

Minimum R-squared improvement

The minimum R-squared improvement method closely resembles the maximum R-squared improvement method, but the switch that is chosen is the one that produces the smallest increase in R^2. For a given number of variables in the model, the maximum R-squared and minimum R-squared methods usually produce the same best model, but the minimum R-squared method considers more models of each size. The R-squared selection method finds subsets of explanatory variables that best predict a dependent variable by linear regression in the given sample. You can specify the largest and smallest number of explanatory variables to appear in a subset and the number of subsets of each size to be selected. The R-squared method can efficiently perform all possible subset regressions and display the models in decreasing order of R^2 magnitude within each subset size. Other statistics are available for comparing subsets of different sizes. These statistics, as well as estimated regression coefficients, can be displayed or sent as output to a SAS data set. The R-squared selection method differs from the other selection methods in that the R-squared selection method always identifies the model with the largest R^2 for each number of variables that are considered.

Adjusted R-squared selection

The adjusted R-squared selection method is similar to the R-squared selection method, except that the adjusted R^2 statistic is used as the criterion for selecting models, and the method finds the models with the highest adjusted R^2 within the range of sizes.

Mallows' Cp selection

Mallows' Cp selection method is similar to the adjusted R-squared selection method, except that Mallows' Cp statistic is used as the criterion for model selection. Models are listed in ascending order of C_p.

2 Specify the significance level.

- For the forward selection method, specify a significance level to enter an explanatory variable in the model.
- For the backward elimination method, specify a significance level so that an explanatory variable stays in the model.

- For the stepwise selection method, specify both significance levels.

3 Specify the model fit statistics for the R-squared, adjusted R-squared selection, or Mallow's Cp selection.

4 Specify the effects to force into the model. Use the arrows to reorder the effects. To remove an effect, clear its check box.

Note: This option is not available for the full model fitted method.

5 (Optional) Specify whether to include the effects of the intercept in the analysis. The intercept is included by default.

Step 3: Select the Statistics to Include in the Analysis

On the **Statistics** tab, you can specify these options:

1 Set the estimate options. You can choose from these options:

- standardized regression coefficients. A standardized regression coefficient is computed by dividing a parameter estimate by the ratio of the sample standard deviation of the dependent variable to the sample standard deviation of the regressor.
- the sequential sum of squares (Type 1) and the partial sum of squares (Type 2) along with parameter estimates for each term in the model.
- the correlation matrix of the estimates.
- the covariance matrix of the estimates.
- the confidence level for parameter estimates. The default is a 95% confidence level.

2 (Optional) Specify whether to include squared partial and squared semi-partial correlation coefficients.

- The squared partial correlation coefficients are calculated as SS/(SS+SSE), where SSE is the error sum of squares.
- The squared semi-partial correlation coefficients are calculated as SS/SST, where SST is the corrected total sum of squares. If you choose not to include the intercept in the model, then the uncorrected total sum of squares is used in the denominator.

Each type of correlation uses both Type 1 and Type 2 sums of squares to calculate the correlation coefficients.

3 Specify the diagnostic analyses to perform.

- Collinearity analysis. This option requests a detailed analysis of collinearity among the regressors. This includes eigenvalues, condition indices, and

decomposition of the variances of the estimates with respect to each eigenvalue.

- Collinearity analysis without the intercept. This option requests the same analysis as the collinearity analysis option except that the intercept is not included in the analysis.
- Tolerance values for estimates. Tolerance for a variable is defined as 1-R2, where R2 is obtained from the regression of the variable on all other regressors in the model. Variance inflation is the reciprocal of tolerance.
- Heteroscedasticity test. This option tests that the first and second moments of the model are correctly specified.
- Asymptotic covariance matrix. This option displays the estimated asymptotic covariance matrix of the estimates under the hypothesis of heteroscedasticity.
- Durbin-Watson statistic. The Durbin-Watson statistic shows whether the errors have first-order autocorrelation. (This test is appropriate only for time series data.) The sample autocorrelation of the residuals is also produced.

Step 4: Include Plots in the Results

On the **Plots** tab, you select the plots that you want to include in the results.

By default, all appropriate plots for the current data selection are included in the output. However, you can choose which plots to include in the output by selecting the **Custom lists of plots** option. You can choose from these options:

- **Histogram plot of the residuals** creates a histogram of the fit residuals.
- **Residuals by predicted values plot** creates a plot of the residual versus predicted values. A residual is the difference between the observed value and the predicted value.
- **Studentized residuals by predicted values** creates a plot of the residual versus predicted values. A residual is the difference between the observed value and the predicted value.
- **Observed by Predicted values plot** creates a plot of the observed versus predicted values.
- **Plot Cook's D statistic** creates a plot of the Cook's *D* statistic versus the observation number.
- **Studentized residuals by leverage plot** creates a plot of the studentized residuals versus the leverage. A studentized residual is the value of the residual divided by the standard error with the current observation deleted. The leverage for an observation is the value of the corresponding diagonal element in the *H* matrix.
- **Normal quantile plot of the residuals** creates a Q-Q plot.
- **Residual-Fit plot** creates side-by-side plots of the quantiles of centered fit and the residuals.

- **Box plot of the residuals** creates a box plot of the residuals.
- **Diagnostic plots** creates plots of the fit diagnostics.
- **DFFITS plots** creates plots of DFFITS (Difference in Fit, Standardized). The DFFITS statistic is the standard influence of the observation on the predicted value. A large value indicates that the observation is very influential.
- **DFBETA plots** creates plots of the standardized difference in the parameter estimate due to deleting the observation. It is useful to assess the effect of an individual observation on each estimated parameter of the fitted model.
- **Residual plots** creates plots of the residuals versus the regressors.
- **Scatter plot with regression line** creates a plot of the regression line overlaid on a scatter plot of the data.

Step 5: Set the Prediction Options

On the **Predictions** tab, you can specify these options:

1. Select the data sources that you want to use to predict the output data.

   If you select **Additional data** and you are running this step in a flow, you must add an input port for this optional table to the Linear Regression node.

   a. Right-click the Linear Regression node and select **Add input port**.

   b. Add the additional data source to the flow and connect the table to the new input port.

2. Specify the additional statistics to include.

   - Select **Residuals** to include the ordinary residuals, standardized residuals, and studentized residuals in the output. An ordinary residual is the difference between the observed value and the predicted value. A standardized residual is the value of the residual divided by the standard error. A studentized residual is the value of the residual divided by the standard error with the current observation deleted.
   - Select **Prediction limits** to include the upper and lower limits of a 100*(1-alpha)% confidence interval for each prediction and the expected mean of the dependent variable in the output.

Step 6: Specifying Titles and Footnotes

On the **Titles** tab, you can decide whether to use the default text or custom text for the title and the footnote in the results.

- To use the default text that is generated by the step, select **Use default text**. When you select this option, the default text appears in the user interface of the step.

- To customize the text, enter your text in the text box. You can specify up to 10 lines of text.

Step 7: Set the Output Options

On the **Output** tab, you can specify these options:

1 Select **Save predictions** to save the predictions in an output table. To create this output table, you must set the options on the **Predictions** tab.

Note: If you are running the step in a flow, you must add an output port for the prediction data to the Linear Regression node. For more information, see "Linear Regression: Connection Requirements for the Node" on page 322.

2 (Optional) Specify whether to save the diagnostic statistics to an output table. Here are the diagnostic statistics:

- Cook's *D* influence statistic
- the standard influence of observation on predicted value (the DFFITS statistic)
- the leverage
- the standard error of the individual predicted value
- the standard error of the mean predicted value
- the standard error of the residual

Note: If you are running the step in a flow, you must add an output port for the diagnostics table to the Linear Regression node. For more information, see "Linear Regression: Connection Requirements for the Node" on page 322.

3 Specify whether to display the output and plots in the results. The results are displayed by default.

To suppress the results, clear the check box. If you clear this check box, the options on the **Plots** tab are not available.

To include the predictions in the results, select the **Show predictions** check box. This option is available only if the **Display output and plots** check box is selected.

Logistic Regression

About the Logistic Regression Step

The Logistic Regression step fits predictive models by using logistic regression of a binary response and automated model selection and validation.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Logistic Regression: Connection Requirements for the Node

In order to run the Logistic Regression step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running the step using SAS Compute Server, the input data source can be a SAS or CAS table. If you are running the step using SAS CAS Server, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, an output table is created. This table must use a CAS engine libref. For more information, see "Step 2: Create the Output Data" on page 1100. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Logistic Regression of Baseball Data

To create this example:

1 On a **SAS Program** tab, run this code to load the data into a CAS table.

```
libname mycas cas;
data mycas.class;
    set sashelp.class;
run;
```

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Logistic Regression** to add the step to your flow.

3 Add the MyCas.Class table to your flow. Connect the input port of the Logistic Regression node to the data source. For more information, see "Connecting Nodes" on page 13.

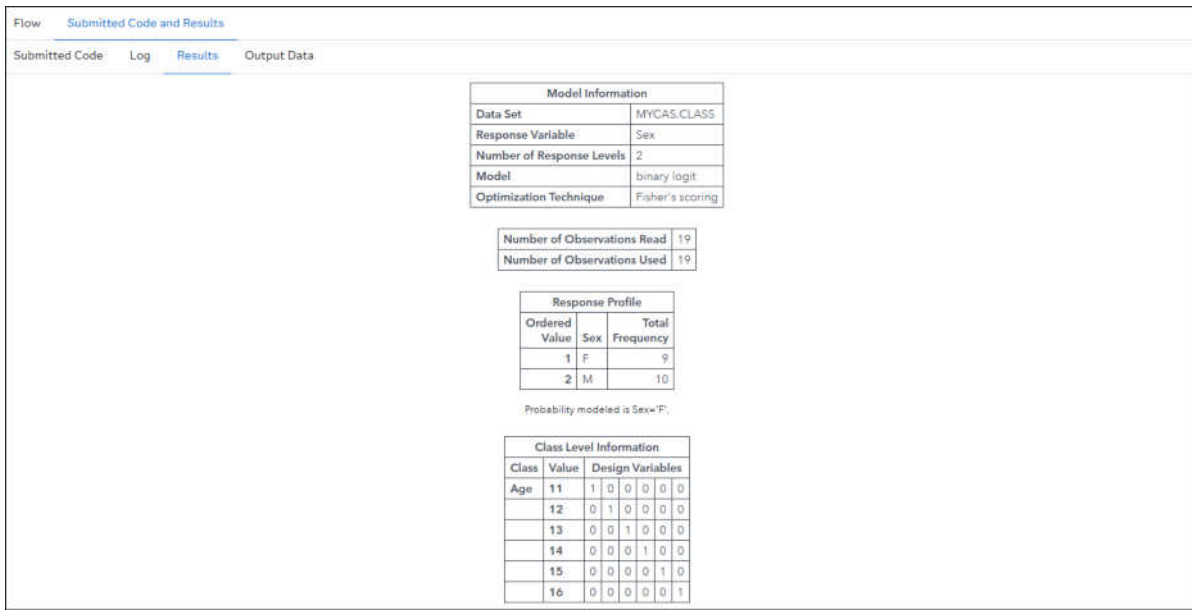
4 To set the options for the Logistic Regression step, click the Logistic Regression node.

5 On the **Data** tab, assign columns to these roles:

- To the **Binary dependent variable** role, assign **Sex**.
- For the **Event of interest** option, select **F**.
- To the **Classification variables** role, assign **Age**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Logistic Regression: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 Specify whether the binary dependent variable consists of numbers of events and trials.

4 To the **Binary dependent variable** role, assign the variable to use as the target variable for regression analysis. The selected variable must have two levels. Specify the event of interest.

Note: This option is available only if the **Binary dependent variable data consists of numbers of events and trials** check box is not selected.

5 Use the **Number of events** and **Number of trials** roles to specify these values.

Note: These options are available only if the **Binary dependent variable data consists of numbers of events and trials** check box is selected.

6 Specify the function that links the response probabilities to the linear predictors. Here are the valid values:

- **Complementary log-log**
- **Log-log**

  Note: This option is available only if you are running the step using the CAS server.

- **Probit**
- **Logit**

7 To the **Continuous variables** role, assign the numeric variables to use as the continuous variables.

8 To the **Classification variables** role, assign the variables to use to categorize the data.

9 To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the task assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

10 To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

11 To the **Group analysis by** role, assign the variable to obtain separate analyses of observations for each unique group.

Step 2: Build a Model

On the **Model** tab, you can specify how to create the model.

You can create these types of models:

- main effects model.
- main effects and all n-way interactions model.
- a custom model. Specify the effects using the continuous variables and categorical variables that you selected on the **Data** tab.

(Optional) Specify an offset variable.

Step 3: Set the Model Selection Options

On the **Selection** tab, you can set these options.

1 Specify the selection method for the model. The step performs model selection by examining whether effects should be added to or removed from the model according to the rules that are defined by the selection method. Here are the valid values for the selection methods:

   - **Forward selection** starts with no effects in the model and adds effects based on the value of the specified criterion.
   - **Backward elimination** starts with all the effects in the model and deletes effects based on the value of the specified criterion.
   - **Fast backward elimination** starts with all effects in the model and deletes effects without refitting the model.

- **Stepwise selection** is similar to the forward selection model. However, effects that are already in the model do not necessarily stay there. Effects are added to or removed from the model based on the specified criterion.
- **LASSO** specifies the lasso method, which adds and deletes parameters based on a version of ordinary least squares in which the sum of the absolute regression coefficients is constrained. If the model contains classification variables, these variables are split.
- **None** fits the full model.

2 Specify the criterion to use to add or remove effects from the model.

3 Specify the criterion to use to stop adding or removing effects from the model.

4 Specify the criterion to use to identify the best fitting model.

5 Specify how much information about the selection process to include in the results. You can display a summary, details for each step of the selection process, or all of the information about the selection process.

6 Specify whether a classification effect should be added or removed entirely or individually using a single degree of freedom.

Note: This option is available only if you specified classification variables.

7 Retain the hierarchy of the effects. In order for a term to be included in the model, all model effects that are contained in the term must be present in the model.

Step 4: Set the Options

On the **Options** tab, you can specify these options:

1 Specify the confidence level to use for the construction of confidence intervals.

2 Specify the optimization method.

3 Specify the maximum number of iterations. The default value is `50`.

4 Select whether to display these statistics:

- confidence intervals for parameter estimates
- correlations of parameter estimates
- covariances of parameter estimates

Step 5: Set the Output Options

On the **Output** tab, you can specify whether to create a table of the observation statistics. If your input data is a SAS table, you must specify a SAS libref for the output table. If your input data is a CAS table, you must specify a CAS libref for the output table.

You can choose to include these statistics in the output:

- predicted values
- residuals
- other statistics such as the leverage, the change in the chi-square goodness-of-fit from deleting the individual observation, and the standard error of the linear predictor

You can include a partition identifier variable in the output if these conditions are met on the **Data** tab:

- The input data source is partitioned to use validation or test data.
- The partitions are generated by sampling. (In the **Identify partitions** drop-down list, you selected **Specify a sample proportion**.)
- Other statistics, such as the leverage, the change in the chi-square goodness-of-fit from deleting the individual observation, and the standard error of the linear predictor, are calculated

You can also choose to include any variables from the input data source.

Finally, you can choose to save the scoring code.

To save this table permanently, add an output table to the flow.

1. Click **Add** and select **Table**.
2. Select the Table node. In the table properties, enter `Work` as the library name and `Example` as the table name.
3. Connect the output port to the Table node.

Logistic Regression Statistical Power

About the Logistic Regression Statistical Power Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. The Logistic Regression Statistical Power step calculates power and sample size analyses for the likelihood ratio chi-square test of a single predictor in binary logistic regression. This calculation possibly occurs in the presence of one or more covariates that might be correlated with the tested predictor.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Logistic Regression Statistical Power: Connection Requirements for the Node

No input or output data is required to run the Logistic Regression Statistical Power step.

Example: Logistic Regression for Power and Sample Size Analysis

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Logistic Regression Statistical Power** to add the step to your flow.
2. To set the options for the Logistic Regression Statistical Power step, click the Logistic Regression Statistical Power node.

3 Under the **Solve for** heading, select **Power**.

4 Specify an alpha value of `0.05`.

5 From the **Distribution of the predictor** drop-down list, select **Normal**.

6 Enter `0` as the mean, and enter `1` as the standard deviation.

7 From the **Select a form** drop-down list, select **Odds ratios**.

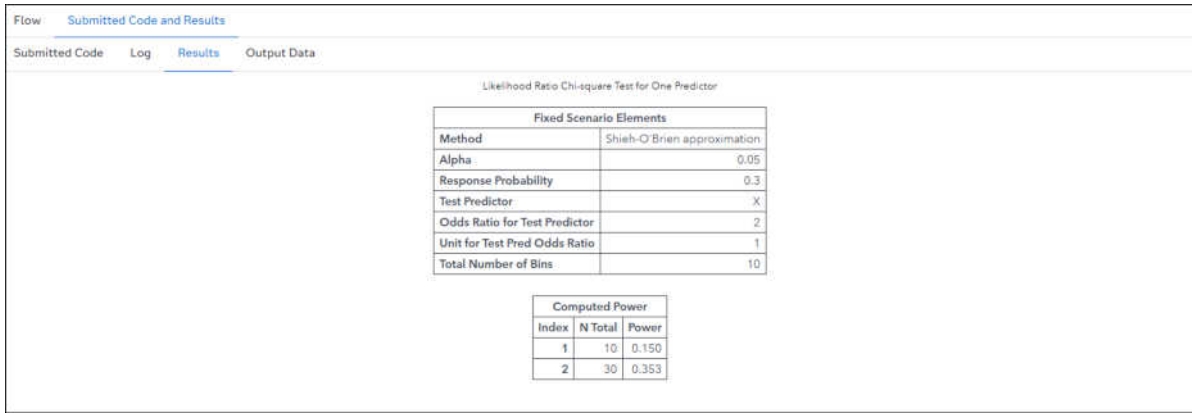
8 In the **Odds ratio value** box, enter `2`.

9 In the **Response probability value** box, enter `0.3`.

10 In the **Sample size value** box, enter `10`. Click + and enter `30`.

11 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Logistic Regression Statistical Power: Step-by-Step Instructions

Step 1: Assign the Properties

On the **Options** tab, assign these properties.

1 From the **Solve for** drop-down list, request a solution for power or sample size.

2 Specify the significance level for the analysis. You can specify more than one value.

3 Specify the distribution of the predictor. Each distribution has a different set of parameters. You can add multiple parameter values for each type of distribution.

Here are the available distributions and the parameters that you must provide:

- **Beta** — The beta parameter values are **Alpha** and **Beta**. Both of these parameters must be greater than 0.
- **Binomial** — The parameter values for the binomial distribution are **Probability of Success** (which must be greater than 0 but less than 1) and **Number of trials** (which must be greater than or equal to 1).
- **Lognormal** — The parameter values for a lognormal distribution are **Location** (which can be any number) and **Scale** (which must be greater than 0).
- **Normal** — The parameters for the normal distribution are **Mean** (which can be any number) and **Standard deviation** (which must be greater than 0).
- **Ordinal** — The parameter values for the ordinal distribution are **Ordered category** (which can be any number) and **Probability**. The probabilities must sum to 1 across all ordinal categories.
- **Poisson** — The parameter value for the Poisson distribution is **Mean** (which can be any number).

4 Specify whether to use the odds ratios form or the regression coefficients form.

- If you select **Odds ratio**, you must select the units of change and enter one or more odds ratios and response probabilities.
- If you select **Regression coefficients**, you must enter at least one regression coefficient and at least one intercept.

5 Specify the number of covariates. The minimum number of covariates is `0`, and the maximum number of covariates is `9`.

For each covariate, enter this information:

- the distribution for the covariate and any required parameter values for that distribution
- the odds ratios and response probabilities or the regression coefficients and the intercepts (depending on what you selected for the predictor from the **Select a form** drop-down list)

6 Specify the values for multiple correlations. These values must be greater than –1 and less than 1.

Note: This option is available only when a covariate is specified.

7 Specify the power values for the analysis. These values must be greater than 0 and less than 1.

Note: This option is available only when you are solving for sample size.

8 Specify whether to allow fractional sample sizes. If you selected the **Allow fractional sample sizes** check box, these values can contain a decimal component.

If you are solving for power, you can also enter one or more values for the sample size. If there are no covariates, enter an integer greater than or equal to

1. If you have covariates for the sample size, enter an integer greater than or equal to 2.

Step 2: Setting the Plot Options

In the results, you can include a power by sample size plot.

- If you are solving for power, you can specify the minimum and maximum sample sizes.
- If you are solving for sample size, you can specify the minimum and maximum power.

Mixed Models

About the Mixed Models Step

The Mixed Models step fits a variety of mixed linear models to data and enables you to use these fitted models to make inferences about the data. A mixed linear model is a generalization of the standard linear model. The generalization is that the data is permitted to exhibit correlation and nonconstant variability. Therefore, the mixed linear model provides the flexibility to model the means of your data (as in the standard linear model) but also the variances and covariances.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Mixed Models: Connection Requirements for the Node

In order to run the Mixed Models step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. For more information, see "Step 4: Set the Output Options" on page 345. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Analyzing Age and Gender

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
data pr;
input Person Gender $ y1 y2 y3 y4;
y=y1; Age=8; output;
y=y2; Age=10; output;
y=y3; Age=12; output;
y=y4; Age=14; output;
drop y1-y4;
datalines;
1 F 21.0 20.0 21.5 23.0
2 F 21.0 21.5 24.0 25.5
3 F 20.5 24.0 24.5 26.0
4 F 23.5 24.5 25.0 26.5
5 F 21.5 23.0 22.5 23.5
6 F 20.0 21.0 21.0 22.5
7 F 21.5 22.5 23.0 25.0
8 F 23.0 23.0 23.5 24.0
9 F 20.0 21.0 22.0 21.5
10 F 16.5 19.0 19.0 19.5
11 F 24.5 25.0 28.0 28.0
12 M 26.0 25.0 29.0 31.0
13 M 21.5 22.5 23.0 26.5
14 M 23.0 22.5 24.0 27.5
15 M 25.5 27.5 26.5 27.0
16 M 20.0 23.5 22.5 26.0
17 M 24.5 25.5 27.0 28.5
18 M 22.0 22.0 24.5 26.5
19 M 24.0 21.5 24.5 25.5
20 M 23.0 20.5 31.0 26.0
```

```
21 M 27.5 28.0 31.0 31.5
22 M 23.0 23.0 23.5 25.0
23 M 21.5 23.5 24.0 28.0
24 M 17.0 24.5 26.0 29.5
25 M 22.5 25.5 25.5 26.0
26 M 23.0 24.5 26.0 30.0
27 M 22.0 21.5 23.5 25.0
;
```

Click **Run** to create the Work.Pr table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Mixed Models** to add the step to your flow.

3 Add the Work.Pr table to your flow. Connect the input port of the Mixed Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Mixed Models step, click the Mixed Models node.

5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **y**.
- To the **Classification variables** role, assign **Person** and **Gender**.
- To the **Continuous variables** role, assign **Age**.

6 Click the **Model** tab.

- In the **Fixed effects** box, enter `Gender*Age`.
- Select the **Add repeated effects** check box. In the **Model effects** box, enter `Person`.

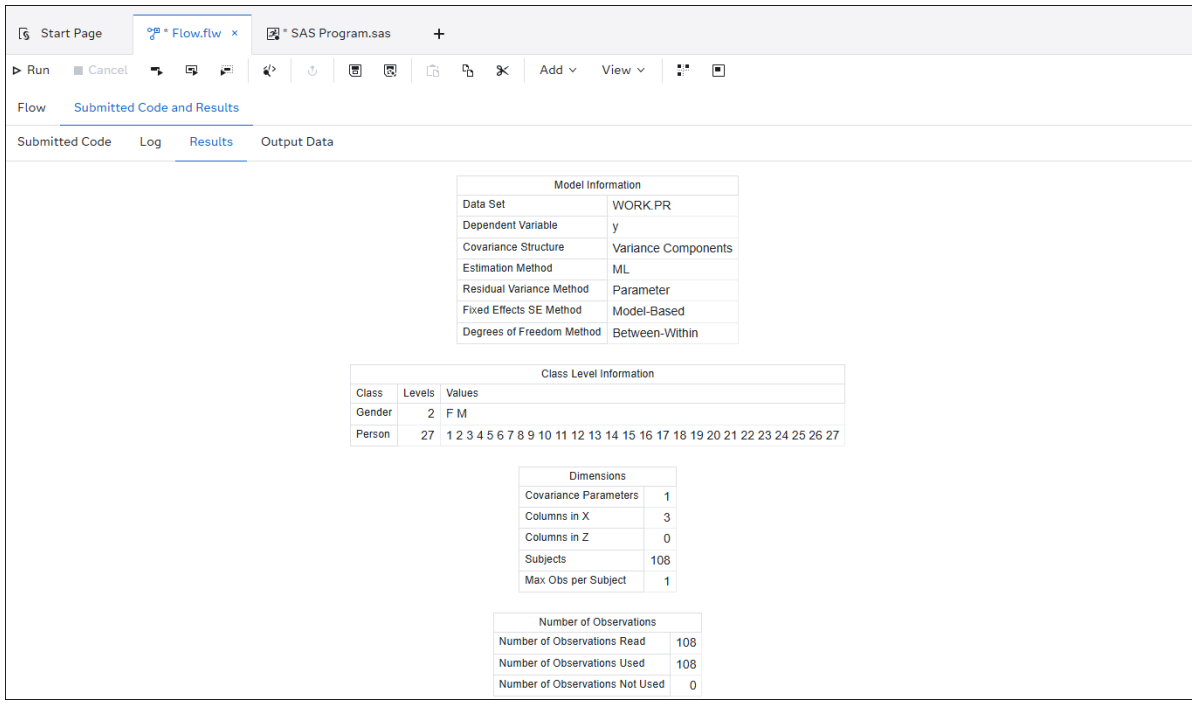
7 On the **Options** tab, select **Maximum likelihood** as the estimation method.

8 From the **Statistics to display** drop-down list, select **Default and additional statistics**.

- Expand the **Tests** heading and select **Standard errors and Wald Test of covariance parameters**.
- Expand the **Parameter Estimates** heading. Under the **Fixed Effects** heading, select **Show parameter estimates**. Under the **Repeated Effect** heading, select **Estimated R matrix**.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Mixed Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Dependent variable** role, assign the numeric variable to use as the dependent variable for the analysis. You must assign a numeric variable to this role.

3 (Optional) To the **Classification variables** role, assign classification variables to use in the model. Examples of classification variables are Treatment, Race, Group, Sex, and Replication.

4 Review the information about the treatment of missing values. An observation is excluded from the analysis when either of these conditions is met:

- if any variable in the model contains a missing value
- if any classification variable contains a missing value (regardless of whether the classification variable is used in the model)

5 (Optional) To the **Continuous variables** role, assign any continuous variables to include in the model.

6 (Optional) To the **Weight** role, assign the variable to perform a weighted analysis of data.

7 (Optional) To the **Group analysis by** role, assign the variable to create a separate analysis for each group of observations.

Step 2: Set the Model Options

On the **Model** tab, you can specify the model effects.

Note: Model settings are available when you assign a classification or continuous variable.

1 Specify the fixed effects. For fixed effects, the intercept is included by default.

2 (Optional) To create a random effect, select **Add random effects**. You can create these types of single effects: a main effect, a crossed effect, an effect with a polynomial degree of *n*, and a nested effect.

   You can also create a subject effect or a group effect. Specifying a subject effect is equivalent to nesting all other random effects in the subject effect. The group effect is an effect that specifies heterogeneity in the covariance structure of the *R* matrix. All observations that have the same level of the group effect have the same covariance parameters.

3 (Optional) To create a repeated effect, select **Add repeated effects**. You can have only one repeated effect in the model. Only classification variables can be used to create a repeated effect.

   You can create these types of single effects: a main effect, a crossed effect, an effect with a polynomial degree of *n*, and a nested effect.

   You can also create a subject effect or a group effect. Specifying a subject effect is equivalent to nesting all other random effects in the subject effect. The group effect is an effect that specifies heterogeneity in the covariance structure of the *R* matrix. All observations that have the same level of the group effect have the same covariance parameters.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Select the estimation method for the covariance parameters. You can choose from these methods:

- **Restricted maximum likelihood**, which is the default
- **Maximum likelihood**
- **Minimum variance quadratic unbiased estimation**

- **Type 1**
- **Type 2**
- **Type 3**

2 Specify the level to use for the confidence intervals.

3 Specify the maximum number of iterations. The default is `50`.

4 Specify the method for computing the denominator degrees of freedom for the tests of fixed effects.

5 Select the statistics to include in the results. The options that are available depend on the effects that you added to the **Model** tab.

6 Select the plots to include in the output. You can choose from these types of plots:

- residuals
- studentized residuals
- Pearson residuals
- Press residuals
- influence statistics

Specify the maximum number of points to include in the plot. The default value is `5,000`.

Step 4: Set the Output Options

On the **Output** tab, you can specify whether to create these output tables:

- predicted values data set, which contains the random effects as part of the prediction
- predicted means data set, which does not contain the random effects as part of the prediction

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Mixed Models node. For more information, see "Mixed Models: Connection Requirements for the Node" on page 340.

Multidimensional Preference Analysis

About the Multidimensional Preference Analysis Step

The Multidimensional Preference Analysis step performs a principal components analysis of rank-ordered data. The principal result is a plot of the scores. These scores are the objects that are being rated. In the plot, the scores are represented as points, and the structure (raters) are represented as vectors.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Multidimensional Preference Analysis: Connection Requirements for the Node

In order to run the Multidimensional Preference Analysis step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 350. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Multidimensional Preference Analysis

To create this example:

1 On a **SAS Program** tab, copy and paste this code:

```
data icecream;
input brand $ 'consumer 1'n 'consumer 2'n 'consumer 3'n;
cards;
A 9 10 5
B 4 8 7
C 8 6 7
D 2 4 9
run;
```

Click **Run**. The Work.IceCream table is created.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Multidimensional Preference Analysis** to add the step to your flow.

3 Add the Work.IceCream table to your flow. Connect the input port of the Multidimensional Preference Analysis node to the data source. For more information, see “Connecting Nodes” on page 13.

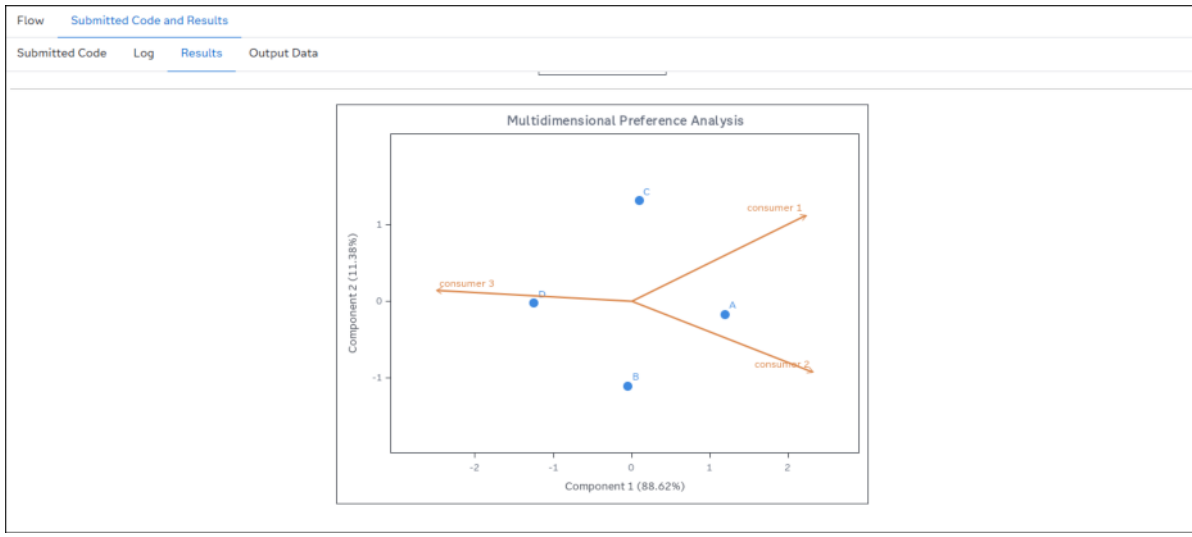
4 To set the options for the Multidimensional Preference Analysis step, click the Multidimensional Preference Analysis node.

5 On the **Data** tab, assign **consumer 1**, **consumer 2**, and **consumer 3** to the **Raters** role.

6 On the **Options** tab, assign **brand** to the **Label MDPREF plot points** role.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Multidimensional Preferences Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

In the input data source, each subject (also referred to as a rater) must be a separate column, and each object that is being rated must be a separate row. Therefore, the data is a transposed version of the usual multivariate data matrix. In other words, the columns are the people. In a more typical matrix, the rows represent people.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Raters** role, assign at least two variables to analyze.

3 To the **Level of measurement** role, specify the level of measurement for the analysis variables.

4 Specify the transformation to use in the analysis. The transformation options depend on the value that is selected from the **Level of measurement** drop-down list.

If you select **Interval** from the **Level of measurement** drop-down list, these options are available:

- **Linear** specifies the optimal linear transformation of each variable. For variables with no missing values, the transformed variable is the same as the original variable. For variables with missing values, the transformed nonmissing values have a different scale and origin than the original values.
- **B-spline** finds a B-spline transformation (De Boor 1978) of each variable.

- **Monotonic B-spline** (mspline).
- **No transformation** (identity).

If you select **Ordinal** from the **Level of measurement** drop-down list, these options are available:

- **Monotonic** finds a monotonic transformation of each variable, with the restriction that ties are preserved. The Kruskal (1964) secondary least squares monotonic transformation is used. This transformation weakly preserves order and category membership (ties).
- **Rank** transforms variables to ranks. Ranks are averaged within ties. The smallest input value is assigned the smallest rank.

If you select **Nominal** from the **Level of measurement** drop-down list, the optimal scoring transformation is used. No transformation options are available.

5 (Optional) Specify the degree of the B-spline transformation. The degree must be a nonnegative integer. The defaults are 3 degrees for B-spline variables and 2 degrees for monotonic B-spline variables.

Note: This option is available only for **B-spline** and **Monotonic B-spline** transformations.

6 (Optional) Specify the number of knots. This option creates *n* knots—the first at the $100/(n+1)th$ percentile, the second at the $200/(n+1)th$ percentile, and so on. Knots are always placed at data values; there is no interpolation. For example, if the number of knots is 3, knots are placed at the 25th percentile, the median, and the 75th percentile.

Note: This option is available only for **B-spline** and **Monotonic B-spline** transformations.

7 (Optional) Specify whether to reflect the transformation $y = -(y-\overline{y}) + \overline{y}$ after the iterations are completed and before the final standardization and results calculations. By default, the **Higher preferences** option is not selected and the transformation is not reflected.

8 (Optional) To the **Frequency count** role, assign a numeric value whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

9 (Optional) To the **Group analysis by** role, assign the variable to obtain separate analyses of observations in each unique group.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1. Specify the number of principal components to compute.
2. Specify whether to compute the principal components from the correlation matrix or the covariance matrix.
3. (Optional) Specify whether to exclude all observations with missing values from the analysis. However, these observations are not excluded from the output data set. If you do not select this option, the step computes the optimal transformations of the nonmissing values and estimates the missing values that minimize the squared error.
4. Specify whether to standardize the variance scores. You can standardize the values to equal the eigenvalue or equal to 1.
5. (Optional) Specify the maximum number of iterations.
6. Specify the plots to include in the results:
   - a scree plot (eigenvalue by component).
   - an MDPREF plot. This plot is produced with points for each row and vectors for each column. Often, the vectors are short, and a better graphical display is produced when the vectors are stretched. By default, the length of the vectors is 1, so you see the vectors without any stretching. Select the **Change length of the MDPREF plot vectors** check box to specify the absolute lengths of each vector. Specify the scaling factor in the **Vector scaling factor** text box. Now, the vector coordinates are all multiplied by *n*. The relative lengths of the different vectors are important and interpretable, and these lengths are preserved by the stretching.

     To label the plot points in the graph and to include tooltips, assign variables to the **Label MDPREF plot points** role.

     You can also include a variable transformations plot in the results.

Step 3: Set the Output Options

On the **Output** tab, specify whether to create a component scores output table.

Note: If you are running the step in a flow, you must add an output port to the Multidimensional Preference Analysis node. For more information, see "Multidimensional Preference Analysis: Connection Requirements for the Node" on page 346.

Multiple Regression Statistical Power

About the Multiple Regression Statistical Power Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. The Multiple Regression Statistical Power step calculates the power or sample size for multiple regression.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Multiple Regression Statistical Power: Connection Requirements for the Node

No input data or output data is required to run the Multiple Regression Statistical Power step.

Example: Multiple Regression Statistical Power

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Multiple Regression Statistical Power** to add the step to your flow.
2. To set the options for the Multiple Regression Statistical Power step, click the Multiple Regression Statistical Power node.
3. For the **Solve for** option, select **Power**.
4. Under the **Analysis Details** heading, select **Random predictors**.

5 Under the **Number of Predictors** heading in the **Number of full model predictors** box, enter `7`.

6 In the **Number of reduced model predictors** box, enter `3`.

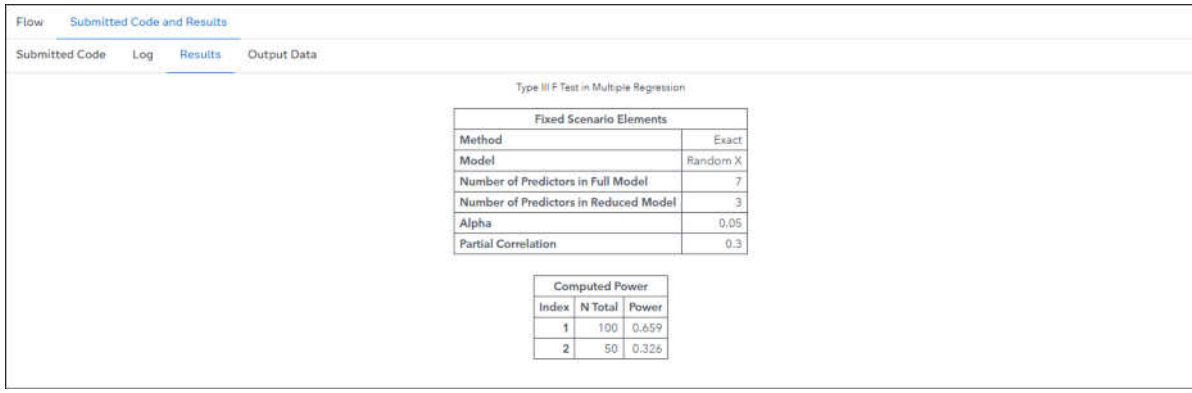
7 Under the **Variance Accounted For** heading, select **Partial correlation** from the **Select a form** drop-down list.

8 In the **Partial correlation value** box, enter `.3` as the partial correlation.

9 For the sample size, enter `100`. To add a second sample size, click +. In the second row, enter `50`.

10 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Type III F Test in Multiple Regression

Fixed Scenario Elements	
Method	Exact
Model	Random X
Number of Predictors in Full Model	7
Number of Predictors in Reduced Model	3
Alpha	0.05
Partial Correlation	0.3

Computed Power		
Index	N Total	Power
1	100	0.659
2	50	0.326

The computed power for the sample with 100 values is 0.659. The computed power for the sample with 50 values is 0.326.

Multiple Regression Statistical Power Step-by-Step Instructions

Step 1: Assign Data to Roles

1 For the **Solve for** option, request a solution for power or sample size.

2 Specify whether to use fixed or random predictors in the model. You can also specify whether to include the intercept in the model.

3 Specify the significance level.

4 Specify the number of full model and reduced model predictors.

5 Under the **Variance Accounted For** heading, use the **Select a form** drop-down list to specify whether to calculate *R*-square for the full model or the reduced

model. You can also choose to calculate the partial correlation. In these calculations, *R*-square is the proportion of variation explained by the model.

6 Select the **Allow fractional sample sizes** check box to enable fractional input and output for sample sizes.

7 Specify the value for the sample size. You can specify more than one sample size.

Step 2: Create the Output Plots

On the **Plots** tab, specify whether to create these plots.

- a plot with sample size on the vertical axis and power on the horizontal axis. For this plot, you can specify the minimum and maximum value for power.
- a plot effect size on the horizontal axis. Power or sample size is on the vertical axis. For this plot, you can specify the minimum and maximum value for the effect size.

N-Way ANOVA

About the N-Way ANOVA Step

The N-way ANOVA step tests and provides graphs for effects of one or more factors on the means of a single, continuous dependent variable.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

N-Way ANOVA: Connection Requirements for the Node

In order to run the N-way ANOVA step, you must create connections to the input and output ports of the node as indicated here:

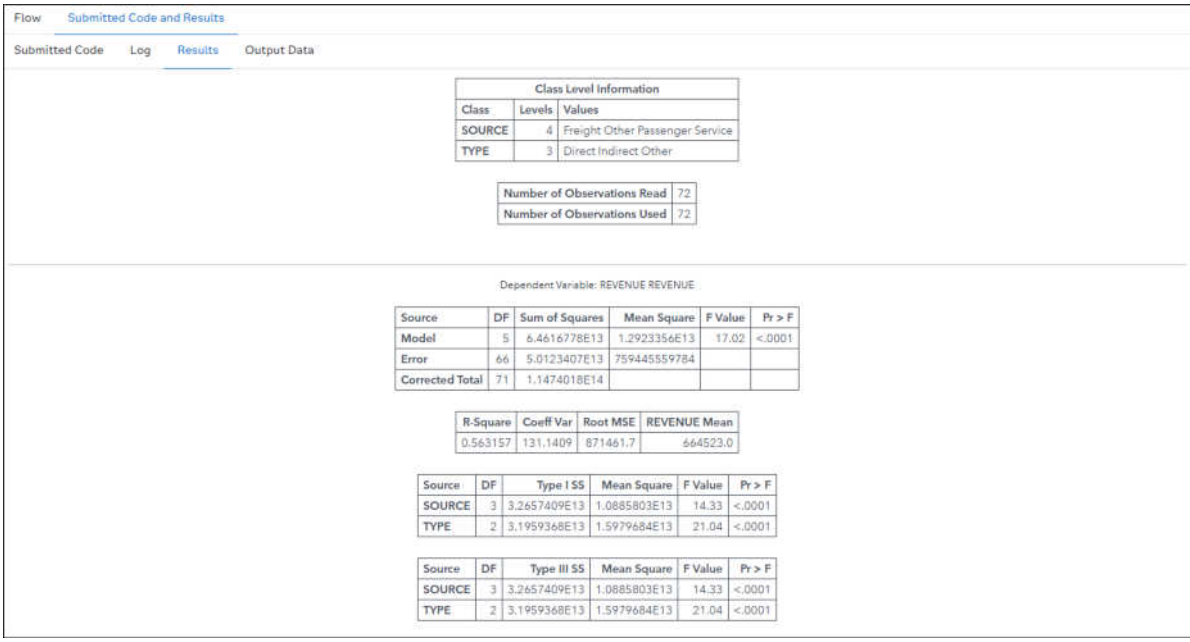
Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output table. For more information, see "Step 4: Set the Output Options" on page 356. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Analyzing the Sashelp.RevHub2 Data Set

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **N-Way ANOVA** to add the step to your flow.
2. Add the Sashelp.RevHub2 table to your flow. Connect the input port of the N-way ANOVA node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the N-way ANOVA step, click the N-way ANOVA node.
4. On the **Data** tab, assign columns to these roles:
   - To the **Dependent variable** role, assign **REVENUE**.
   - To the **Factors** role, assign **SOURCE** and **TYPE**.
5. On the **Model** tab, enter `SOURCE` and `TYPE` as the model effects.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



N-way ANOVA: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Dependent variable** role, assign the dependent variable.

3 To the **Factors** role, assign the classification variable.

Step 2: Create the Model

On the **Model** tab, you can set these options:

1 Specify the model effects.

2 (Optional) Specify whether to include the intercept in the model.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Select the statistics to display in the results.

   - **Perform multiple comparisons** computes the least squares means for the specified effects. You can specify the method for adjustments for the p-values and confidence limits for the differences of the least squares means.
   - The **Sum of Squares** options enable you to display the sum of squares associated with Type I estimable functions for each effect and the sum of squares associated with Type III estimable functions for each effect.

2 Select the plots to display in the results.

   Here are some plots that you can include in the results:

   - least squares means plot
   - mean difference plot
   - interaction plot (available only if there are two variables assigned to the **Factors** role)
   - analysis of means plot (available only if you select the **Nelson** method for adjustment)
   - diagnostic plots, which can be displayed individually or in a panel

3 Specify the maximum number of plot points. The default value is `5,000`.

Step 4: Set the Output Options

On the **Output** tab, you can specify whether to create an output data set. You can also specify the values to include in the output data set. You can include predicted values, residuals, standard errors, and influence statistics.

If you are running this step in a flow, add an output table to the flow.

1 Select **Add** ⇨ **Table**.

2 Select the Table node. In the Table Properties, enter the library name and the table name.

3 Right-click the N-way ANOVA node and select **Add output port**.

4 Connect the new output port to the Table node.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the N-way ANOVA node. For more information, see "Step 4: Set the Output Options" on page 356.

Nonparametric One-Way ANOVA

About the Nonparametric One-Way ANOVA Step

The Nonparametric One-Way ANOVA step consists of nonparametric tests for location and scale differences across a one-way classification. The step also provides a standard analysis of variance on the raw data and statistics based on the empirical distribution function.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Nonparametric One-Way ANOVA: Connection Requirements for the Node

In order to run the Nonparametric One-Way ANOVA step, you must create a connection to the input port of the node as indicated here:

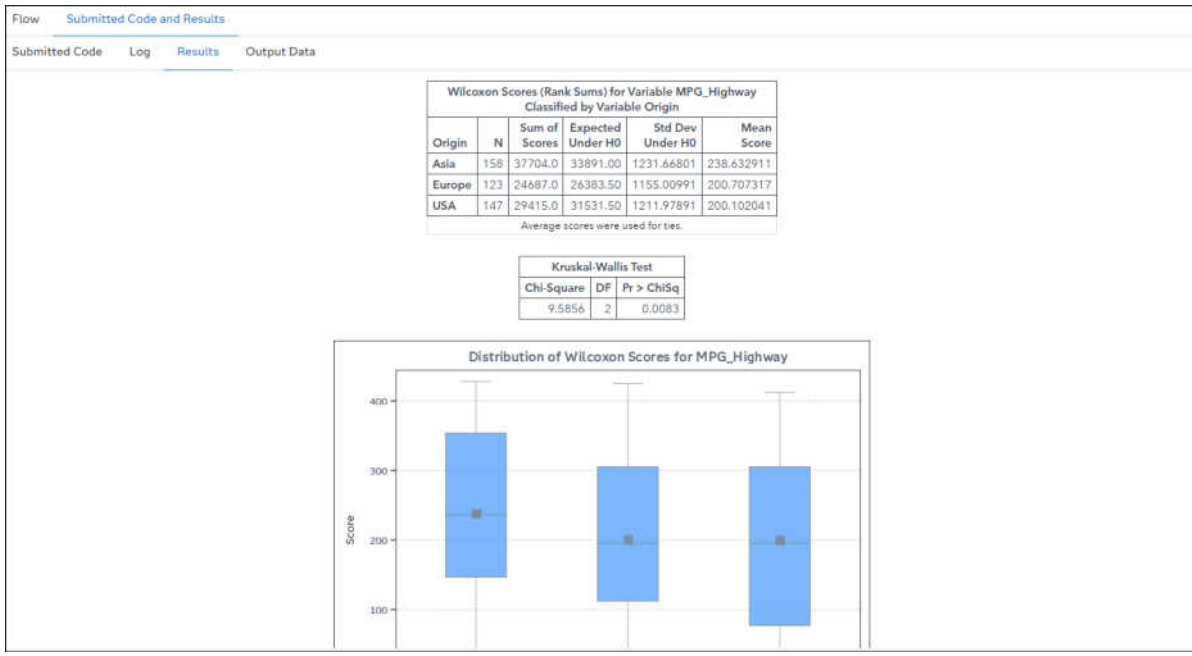
Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 361. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Nonparametric One-Way ANOVA

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Nonparametric One-Way ANOVA** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the Nonparametric One-Way ANOVA node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Nonparametric One-Way ANOVA step, click the Nonparametric One-Way ANOVA node.
4. On the **Data** tab, assign columns to these roles:
   - To the **Dependent variable** role, assign **MPG_Highway**.
   - To the **Classification variable** role, assign **Origin**.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Nonparametric One-Way ANOVA: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Dependent variable** role, assign the column to use as the dependent variable.

3 To the **Classification variable** role, assign the variable that defines the subgroups. Separate analyses are performed for each subgroup. You can specify whether to treat missing values as a valid level.

4 (Optional) To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

5 (Optional) To the **Group analysis by** role, assign the variable to obtain separate analyses of observations in each unique group.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the plots to include in the results. These plots are determined by the options that you select. Here are some of the plots that you can create:

- By selecting the options in the **Location Differences** section, you can create a box plot of Wilcoxon scores, a stacked bar chart showing frequencies above or below the overall median, a box plot of Van der Waerden scores, and a box plot of Savage scores.
- By selecting the options in the **Scale Differences** section, you can create a box plot of Ansari-Bradley scores, a box plot of Klotz scores, a box plot of Mood scores, and a box plot of Siegel-Tukey scores.
- By selecting the options in the **Location and Scale Differences** section, you can create a box plot of Conover scores.

- By selecting the **Empirical distribution function tests**, including the **Kolmogorov-Smirnov and Cramer-von Mises tests** option, you can create a plot of the empirical distribution test.

To suppress the plots from the results, select the **Suppress plots** check box.

You can specify whether to display the *p*-values in the plot.

2 Specify whether to calculate only the asymptotic tests or both the asymptotic tests and exact tests for the various analyses.

3 Select the location differences tests.

- **Wilcoxon scores** computes the ranks of the observations. The Wilcoxon scores are calculated by default.
- **Median scores** equals 1 for observations greater than the median and 0 otherwise.
- **Van der Waerden scores** computes the quantiles of a standard normal distribution. These scores are also known as quantile normal scores.
- **Savage scores** computes the expected values of order statistics from the exponential distribution with 1 subtracted to center the scores around 0.

4 (Optional) Select the tests for scale differences.

- **Ansari-Bradley scores** computes scores similar to the Siegel-Tukey scores but assigns the same scores to corresponding extreme ranks.
- **Klotz scores** computes the squares of the Van der Waerden (or quantile normal) scores.
- **Mood scores** computes the square of the difference between each rank and the average rank.
- **Siegel-Tukey scores** computes scores as $a(1) = 1, a(n) = 2, a(n-1) = 3, a(2) = 4, a(3) = 5, a(n-2) = 6, \ldots$.

  The score values continue to increase in this pattern toward the middle ranks until all observations are assigned a score.

5 (Optional) Specify the tests for location and scale differences.

Select **Conover scores** to compute the Conover scores, which are based on the squared ranks of the absolution deviations from the sample means.

6 Specify any additional tests.

- **Empirical distribution function tests, including Kolmogorov-Smirnov and Cramer-von Mises tests** computes the empirical distribution function (EDF) statistics.
- **Pairwise multiple comparison analysis (asymptotic only)** computes the Dwass, Steel, Critchlow-Fligner (DSCF) multiple comparison analyses.

7 (Optional) Select **Continuity correction for two sample Wilcoxon and Siegel-Tukey tests** to use a continuity correction for the asymptotic two-sample Wilcoxon and Siegel-Tukey tests by default. The step incorporates this correction when computing the standardized test statistic *z* by subtracting 0.5

from the numerator $(S - E_0(S))$ if it is greater than zero. If the numerator is less than zero, the step adds 0.5.

8 Specify whether to use the exact statistics for your computation.

- Select **Use Monte Carlo estimation** to request the Monte Carlo estimation of the exact *p*-values instead of using the direct exact *p*-value computation. You can also specify the level of the confidence limits for the Monte Carlo *p*-value estimates.
- Select **Limit computation time** to specify the time limit for calculating each exact *p*-value. Calculating exact *p*-values can consume a large amount of time and memory.

Step 3: Set the Output Options

On the **Output** tab, specify whether to create a statistics output table.

Note: If you are running the step in a flow, you must add an output port to the Nonparametric One-Way ANOVA node. For more information, see "Nonparametric One-Way ANOVA: Connection Requirements for the Node" on page 357.

Nonparametric Survival Analysis

About the Nonparametric Survival Analysis Step

The Nonparametric Survival Analysis step computes nonparametric estimates of the survival distribution function and compares survival functions of two or more groups.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Nonparametric Survival Analysis: Connection Requirements for the Node

In order to run the Nonparametric Survival Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output table is created by default. For more information, see "Step 3: Set the Output Options" on page 372. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Nonparametric Survival Analysis: Examples

Example 1: Right Censoring

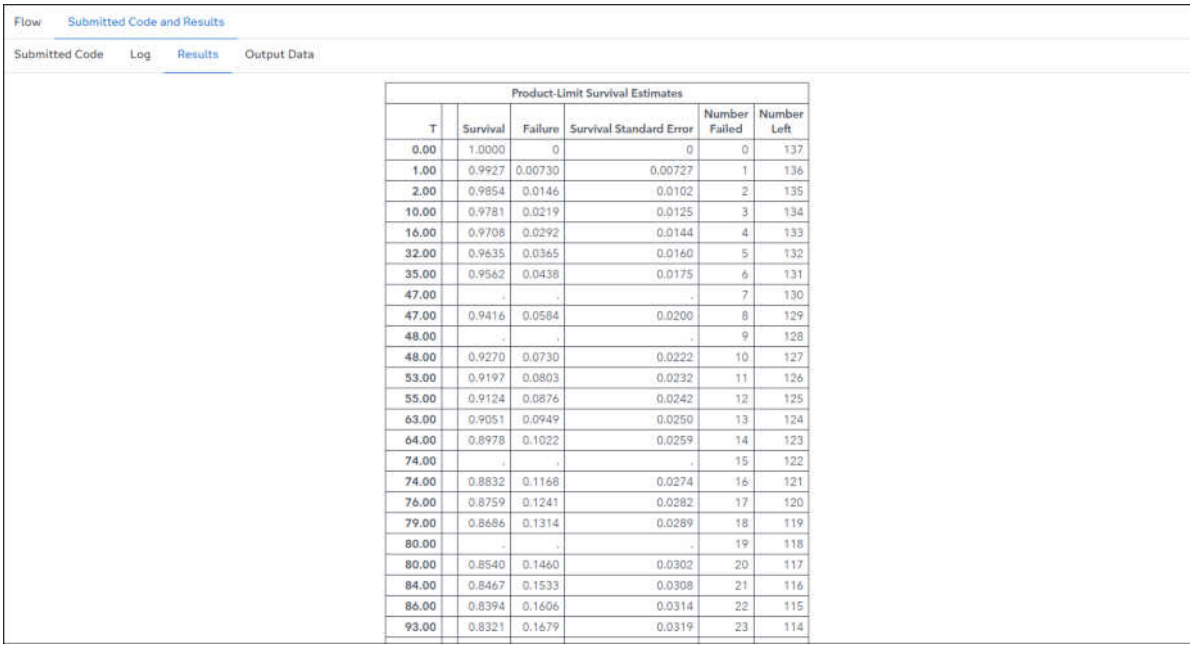
To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Nonparametric Survival Analysis** to add the step to your flow.
2. Add the Sashelp.Bmt table to your flow. Connect the input port of the Nonparametric Survival Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Nonparametric Survival Analysis step, click the Nonparametric Survival Analysis node.
4. On the **Data** tab, select **Right censoring** from the **Censoring type** drop-down list.
5. Assign columns to these roles:
   - To the **Survival time** role, assign **T**.

- To the **Status variable** role, assign **Status**. In the **Censoring value** box, enter **0**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Product-Limit Survival Estimates

T	Survival	Failure	Survival Standard Error	Number Failed	Number Left
0.00	1.0000	0	0	0	137
1.00	0.9927	0.00730	0.00727	1	136
2.00	0.9854	0.0146	0.0102	2	135
10.00	0.9781	0.0219	0.0125	3	134
16.00	0.9708	0.0292	0.0144	4	133
32.00	0.9635	0.0365	0.0160	5	132
35.00	0.9562	0.0438	0.0175	6	131
47.00	.	.	.	7	130
47.00	0.9416	0.0584	0.0200	8	129
48.00	.	.	.	9	128
48.00	0.9270	0.0730	0.0222	10	127
53.00	0.9197	0.0803	0.0232	11	126
55.00	0.9124	0.0876	0.0242	12	125
63.00	0.9051	0.0949	0.0250	13	124
64.00	0.8978	0.1022	0.0259	14	123
74.00	.	.	.	15	122
74.00	0.8832	0.1168	0.0274	16	121
76.00	0.8759	0.1241	0.0282	17	120
79.00	0.8686	0.1314	0.0289	18	119
80.00	.	.	.	19	118
80.00	0.8540	0.1460	0.0302	20	117
84.00	0.8467	0.1533	0.0308	21	116
86.00	0.8394	0.1606	0.0314	22	115
93.00	0.8321	0.1679	0.0319	23	114

Example 2: Competing Risks

To create this example:

1 On a **SAS Program** tab, copy and paste this code:

```
data Bmt_cr;
   input Disease Dftime Status Gender@@;
   Dftime= Dftime / 365.25;
   label Dftime='Disease-Free Survival Time (Years)'
         Disease='Disease Group';
   datalines;
1       2081       0       1       1       1602     0       1
1       1496       0       1       1       1462     0       0
1       1433       0       1       1       1377     0       1
1       1330       0       1       1       996      0       1
1       226        0       0       1       1199     0       1
1       1111       0       1       1       530      0       1
1       1182       0       0       1       1167     0       0
1       418        2       1       1       383      1       1
1       276        2       0       1       104      1       1
1       609        1       1       1       172      2       0
1       487        2       1       1       662      1       1
1       194        2       0       1       230      1       0
1       526        2       1       1       122      2       1
1       129        1       0       1       74       1       1
```

```
1       122     1       0       1       86      2       1
1       466     2       1       1       192     1       1
1       109     1       1       1       55      1       0
1       1       2       1       1       107     2       1
1       110     1       0       1       332     2       1
2       2569    0       1       2       2506    0       1
2       2409    0       1       2       2218    0       1
2       1857    0       0       2       1829    0       1
2       1562    0       1       2       1470    0       1
2       1363    0       1       2       1030    0       0
2       860     0       0       2       1258    0       0
2       2246    0       0       2       1870    0       0
2       1799    0       1       2       1709    0       0
2       1674    0       1       2       1568    0       1
2       1527    0       0       2       1324    0       1
2       957     0       1       2       932     0       0
2       847     0       1       2       848     0       1
2       1850    0       0       2       1843    0       0
2       1535    0       0       2       1447    0       0
2       1384    0       0       2       414     2       1
2       2204    2       0       2       1063    2       1
2       481     2       1       2       105     2       1
2       641     2       1       2       390     2       1
2       288     2       1       2       421     1       1
2       79      2       0       2       748     1       1
2       486     1       0       2       48      2       0
2       272     1       0       2       1074    2       1
2       381     1       0       2       10      2       1
2       53      2       0       2       80      2       0
2       35      2       0       2       248     1       1
2       704     2       0       2       211     1       1
2       219     1       1       2       606     1       1
3       2640    0       1       3       2430    0       1
3       2252    0       1       3       2140    0       1
3       2133    0       0       3       1238    0       1
3       1631    0       1       3       2024    0       0
3       1345    0       1       3       1136    0       1
3       845     0       0       3       422     1       0
3       162     2       1       3       84      1       0
3       100     1       1       3       2       2       1
3       47      1       1       3       242     1       1
3       456     1       1       3       268     1       0
3       318     2       0       3       32      1       1
3       467     1       0       3       47      1       1
3       390     1       1       3       183     2       0
3       105     2       1       3       115     1       0
3       164     2       0       3       93      1       0
3       120     1       0       3       80      2       1
3       677     2       1       3       64      1       0
3       168     2       0       3       74      2       0
3       16      2       0       3       157     1       0
3       625     1       0       3       48      1       0
3       273     1       1       3       63      2       1
3       76      1       1       3       113     1       0
3       363     2       1
;
```

Click **Run** to create the Work.BMT_CR table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Nonparametric Surival Analysis** to add the step to your flow.

3 Add the Work.BMT_CR table to your flow. Connect the input port of the Nonparametric Survival Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

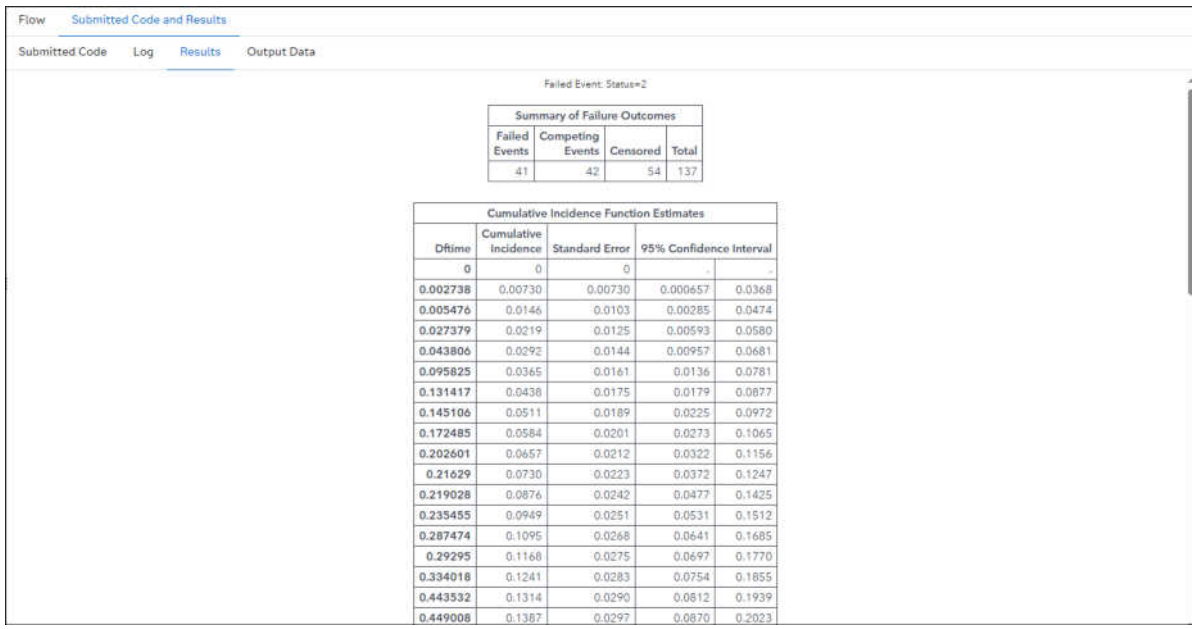
4 To set the options for the Nonparametric Survival Analysis step, click the Nonparametric Survival Analysis node.

5 On the **Data** tab, assign columns to these roles:

- To the **Survival time** role, assign **Dftime**.
- To the **Status variable** role, assign **Status**.
  - In the **Censoring value** box, enter `0`.
  - Select **Competing risks analysis** and select **2** from the **Event of interest** drop-down list.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Failed Event: Status=2

Summary of Failure Outcomes

Failed Events	Competing Events	Censored	Total
41	42	54	137

Cumulative Incidence Function Estimates

Dftime	Cumulative Incidence	Standard Error	95% Confidence Interval	
0	0	0	.	.
0.002738	0.00730	0.00730	0.000657	0.0368
0.005476	0.0146	0.0103	0.00285	0.0474
0.027379	0.0219	0.0125	0.00593	0.0580
0.043806	0.0292	0.0144	0.00957	0.0681
0.095825	0.0365	0.0161	0.0136	0.0781
0.131417	0.0438	0.0175	0.0179	0.0877
0.145106	0.0511	0.0189	0.0225	0.0972
0.172485	0.0584	0.0201	0.0273	0.1065
0.202601	0.0657	0.0212	0.0322	0.1156
0.21629	0.0730	0.0223	0.0372	0.1247
0.219028	0.0876	0.0242	0.0477	0.1425
0.235455	0.0949	0.0251	0.0531	0.1512
0.287474	0.1095	0.0268	0.0641	0.1685
0.29295	0.1168	0.0275	0.0697	0.1770
0.334018	0.1241	0.0283	0.0754	0.1855
0.443532	0.1314	0.0290	0.0812	0.1939
0.449008	0.1387	0.0297	0.0870	0.2023

Example 3: Interval Censoring

To create this example:

1 On a **SAS program** tab, copy and paste this code:

```
data hiv;
   input Left Right Stage Dose CdLow CdHigh;
```

```
   if (Left=0) then Left=.;
   if (Right>=26) then Right=.;
   datalines;
0 16 0 0 0 1
15 26 0 0 0 1
12 26 0 0 0 1
17 26 0 0 0 1
13 26 0 0 0 1
0 24 0 0 1 0
6 26 0 1 1 0
0 15 0 1 1 0
14 26 0 1 1 0
12 26 0 1 1 0
13 26 0 1 0 1
12 26 0 1 1 0
12 26 0 1 1 0
0 18 0 1 0 1
0 14 0 1 0 1
0 17 0 1 1 0
0 15 0 1 1 0
3 26 1 0 0 1
4 26 1 0 0 1
1 11 1 0 0 1
13 19 1 0 0 1
0 6 1 0 0 1
0 11 1 1 0 0
6 26 1 1 0 0
0 6 1 1 0 0
2 12 1 1 0 0
1 17 1 1 1 0
0 14 1 1 0 0
0 25 1 1 0 1
2 11 1 1 0 0
0 14 1 1 0 0
;
```

Click **Run** to create the Work.HIV table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Nonparametric Surival Analysis** to add the step to your flow.

3 Add the Work.HIV table to your flow. Connect the input port of the Nonparametric Survival Analysis node to the data source. For more information, see “Connecting Nodes” on page 13.

4 To set the options for the Nonparametric Survival Analysis step, click the Nonparametric Survival Analysis node.

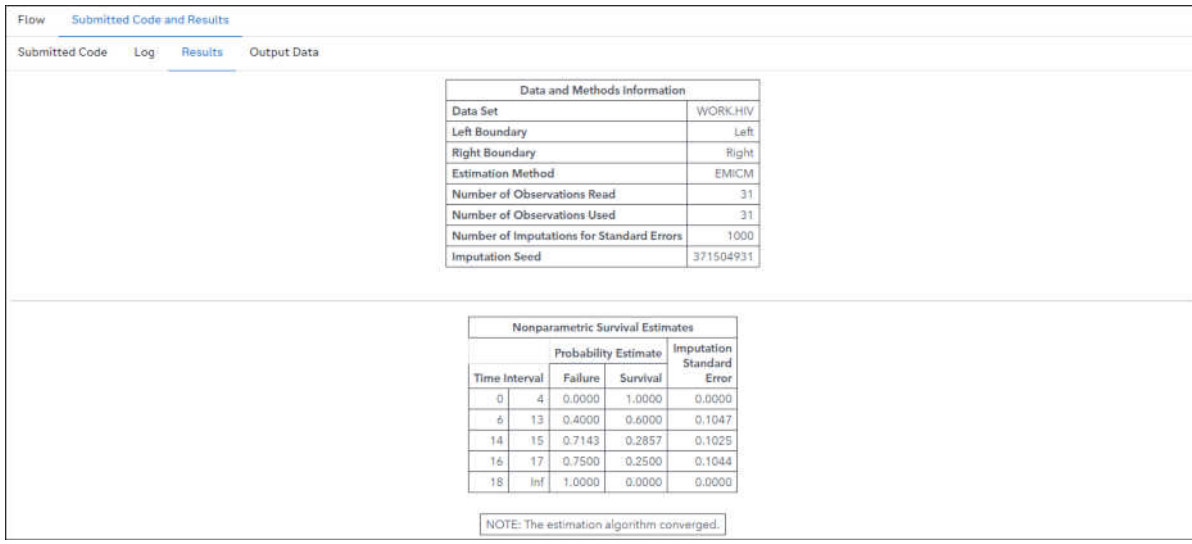
5 On the **Data** tab, select **Interval censoring** from the **Censoring type** drop-down list.

6 Assign columns to these roles:

- To the **Lower interval bound** role, assign **Left**.
- To the **Upper interval bound** role, assign **Right**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Nonparametric Survival Analysis: Step-by-Step Instructions

Step 1: Specify the Censoring Type

The options on the **Data** tab depend on what you select as the censoring type.

Right Censoring

These options are available under the **Survival Time** heading when you select **Right censoring** as the **Censoring type**.

1 To the **Survival time** role, assign the column that contains the survival or failure time to analyze. Negative values are ignored.

2 To the **Status variable** role, assign the numeric variable that indicates the various types of events that are associated with the observed failure times.

Censoring values indicate that the observed failure time is right-censored. You can specify a maximum of five different censoring values.

Select **Competing risks analysis** if the event of interest can be impeded by a prior event of a different type. For example, a patient's relapse might be the event of interest, but it is not observable if the patient dies before relapse occurs.

- If you select **Specify an event of interest**, select the distinct value that corresponds to the event of interest. Any event that is not selected as a censoring value or event of interest is considered a competing risk.

- If you select **Analyze each event separately**, the step performs a separate analysis for each distinct event value of the status variable that is not chosen as a censoring value.

Interval Censoring

These options are available under the **Survival Time** heading when you select **Interval censoring** as the **Censoring type**.

1. To the **Lower interval bound** role, assign the column that specifies the lower bounds of the censoring intervals.
2. To the **Upper interval bound** role, assign the column that specifies the upper bound of the censoring intervals.

Note: If the value for the lower bound is missing or 0 and the value for the upper bound is not missing, the observation is treated as left-censored. If the value for the upper bound is missing and the value for the lower bound is not missing, the observation is treated as right-censored. Observations for which both values are missing are not analyzed.

No Censoring

If you select **No censoring** as the **Censoring type**, assign the column that contains the survival or failure time to analyze to the **Survival time** role. Negative values are ignored.

Explanatory Variables and Additional Roles for All Censoring Types

These options are available for all censoring types.

1. (Optional) To the **Group variable** role, assign the column that contains the different groups for which survival functions are estimated and compared. These survival functions are also referred to as *k*-sample tests.
2. (Optional) To the **Stratify by** role, assign the column that specifies the strata levels for a stratified test. A stratified test compares the survival functions of the groups that are determined by the group variable, while adjusting for the **Stratify by** variable. For example, you could compare the survival functions of two treatment groups while controlling for gender. In this case, Treatment is the **Group variable** and Gender is the **Stratify by** variable.

   Note: This role is available only when you assign a group variable.

3. (Optional) To the **Frequency count** role, assign the column that contains the frequency for each observation.

4 (Optional) To the **Weight variable** role, assign the column that contains the values to use to weigh the observations by using an inverse probability weighting scheme.

Note: This option is not available if **Interval censoring** is selected as the censoring type or if you are performing a competing risks analysis.

5 (Optional) To the **Group analysis by** role, assign the column that determines the groups of observations for which separate analyses are performed. When you assign one or more variables to this role, the table is sorted by the selected variable or variables, and analyses are performed on each group separately.

Step 2: Set the Options for the Censoring Type

Right Censoring or No Censoring

On the **Options** tab, set these options for right censoring or no censoring.

1 From the **Survival function estimation method** drop-down list, specify how to compute the survival function estimates.

- **Breslow** uses the Breslow estimator, which is the exponentiation of the negative Nelson-Aalen estimator of the cumulative hazard function.
- **Fleming-Harrington** is a tie-breaking modification of the Breslow estimator. If there are no tied event times, this estimator is the same as the Breslow estimator.
- **Kaplan-Meier (product-limit) (default)** computes the Kaplan-Meier estimates (also known as product-limit estimates).
- **Life table (actuarial)** computes the life-table estimates (also known as actuarial estimates).

Note: This option is not available for competing risks analysis or if you have a **Weight variable**.

2 Specify whether to compute restricted means analysis, which is an alternative to summarizing the survival time by using the survival rate at a particular time or the mean or median survival rate.

You can specify the Restricted Mean Survival Time (RMST) and the restricted mean time lost. RMST is the mean survival time up to a specified point in time (tau). The restricted mean time lost is tau – RMST.

Note: This option is not available if you have a **Weight variable**.

3 For the **Confidence interval transformation** option, specify the transformation that is used to obtain the pointwise confidence intervals of the survival function.

4 Specify the confidence level for the confidence intervals.

5 (Optional) Specify these tests.

Note: These options are available only when you assign a **Group variable** on the **Data** tab.

- **Gray's test**.

  Note: This is the only option available for a competing risks analysis.

- **Trend test (one-sided test)** computes the trend test for testing the null hypothesis that the k population hazards rates are the same versus an ordered alternative.
- **Survival function tests** specifies the tests to produce. Each test corresponds to a different weight function.

  When selecting a test, remember these items:

  - The Fleming-Harrington test has two parameters, *p1* and *p2*, which must be nonnegative numbers. The default for *p1* is `1`. The default for *p2* is `0`.
  - *k*-sample tests are performed when there is no **Stratify by** variable. **Log-rank**, **Likelihood ratio**, and **Wilcoxon** are selected by default.
  - Stratified tests are performed when there is a **Stratify by** variable. For both stratified tests and trend tests, **Likelihood ratio** is not available. **Log-rank** and **Wilcoxon** are selected by default.

- **Perform multiple comparisons** specifies whether to perform multiple comparisons.

  You can specify where to perform all pairwise comparisons or compare all curves with a control curve. You must also specify the comparison method.

6 (Optional) Specify these statistics.

- **Survival function estimates** specifies to display a table with the survival function estimates.

  If you are not performing a competing risks analysis, these options are available:

  - **Include number of units at risk** adds the number of subjects at risk to the survival estimate table.
  - **Include Nelson-Aalen estimates** produces the Nelson-Aalen estimates of the cumulative hazards and the corresponding standard errors.

- **Restricted mean survival time** computes the statistics for the restricted mean survival time.

Note: This option is available if you select **Restricted mean survival time** under the **Methods** heading.

- **Restricted mean time lost** computes the statistics for the restricted mean time lost.

  Note: This option is available if you select **Restricted mean time lost** under the **Methods** heading.

- **Cumulative incidence function estimates** displays a table with the cumulative incidence function estimates.

  Note: This is the only option available for a competing risks analysis.

7 (Optional) Select the plots to include in the results. The available plots depend on your selections on the **Data** tab.

Here are examples of the plots that are available:

- **Survival function**
- **Negative log of survival function**
- **Log of negative log of survival function**
- **Hazard function**
- **Probability density function**

  Note: This option is available only if the life-table estimation method was selected.

- **Restricted mean survival time**

  Note: This option is available only if restricted mean survival time was selected as a method.

- **Restricted mean time lost**

  Note: This option is available only if **Restricted mean time lost** was selected as a method.

- If you are performing a competing risks analysis, only the **Cumulative incidence function** is available.

Interval Censoring

On the **Options** tab, set these options for interval censoring:

1 From the **Survival function estimation method** drop-down list, specify how to compute the survival function estimates.

- **EMICM** specifies the expectation maximization iterative convex minorant algorithm.
- **ICM** specifies the Turnbull EM algorithm.
- **Turnbull (EM)** computes the Kaplan-Meier estimates (also known as product-limit estimates).
- **Life table (actuarial)** computes the life-table estimates (also known as actuarial estimates).

2 For the **Confidence interval transformation** option, specify the transformation that is used to obtain the pointwise confidence intervals of the survival function.

3 Specify the confidence level for the confidence intervals.

4 (Optional) Specify these tests.

Note: These options are available only when you assign a **Group variable** on the **Data** tab.

- **Trend test (one-sided test)** computes the trend test for testing the null hypothesis that the k population hazards rates are the same versus an ordered alternative.
- **Weight function** specifies the weights to be applied to the generalized log-rank statistics to perform various tests.
- **Perform multiple comparisons** specifies whether to perform multiple comparisons.

  You can specify where to perform all pairwise comparisons or compare all curves with a control curve. You must also specify the comparison method.

5 (Optional) Specify whether to present the survival estimates in terms of Turnbull intervals. Turnbull intervals are a set of nonoverlapping intervals for which the survival estimates cannot be uniquely determined.

6 (Optional) Select the plots to include in the results. The available plots depend on your selections on the **Data** tab.

Here are examples of the plots that are available:

- **Survival function**
- **Negative log of survival function**
- **Log of negative log of survival function**
- **Hazard function**

Step 3: Set the Output Options

On the **Output** tab, you can specify the output tables for the step.

If a competing risks analysis is not performed, you can specify whether to save the survival function estimates to an output table. You can choose to include the standard errors and the confidence bands for the survival function.

If a competing risks analysis is performed, you can specify whether to save the estimates of the cumulative incidence function.

Note: If you are running the step in a flow, you must add an output port for the output table to the Nonparametric Survival Analysis node. For more information, see "Bubble Map: Connection Requirement for the Node" on page 939.

One-Way ANOVA

About the One-Way ANOVA Step

The one-way analysis of variance (ANOVA) step tests and provides graphs for differences among the means of a single categorical variable on a single continuous dependent variable.

You might use the One-Way ANOVA step to complete these tasks:

- study the effect of bacteria on the nitrogen content of red clover plants. The factor is the bacteria strain, and it has six levels.
- compare the life spans of three different brands of batteries. The factor is the brand, and it has three levels.

One-Way ANOVA: Connection Requirements for the Node

In order to run the One-Way ANOVA step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 377.

Input Port	Output Port
an Import node) that creates an output table	**Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

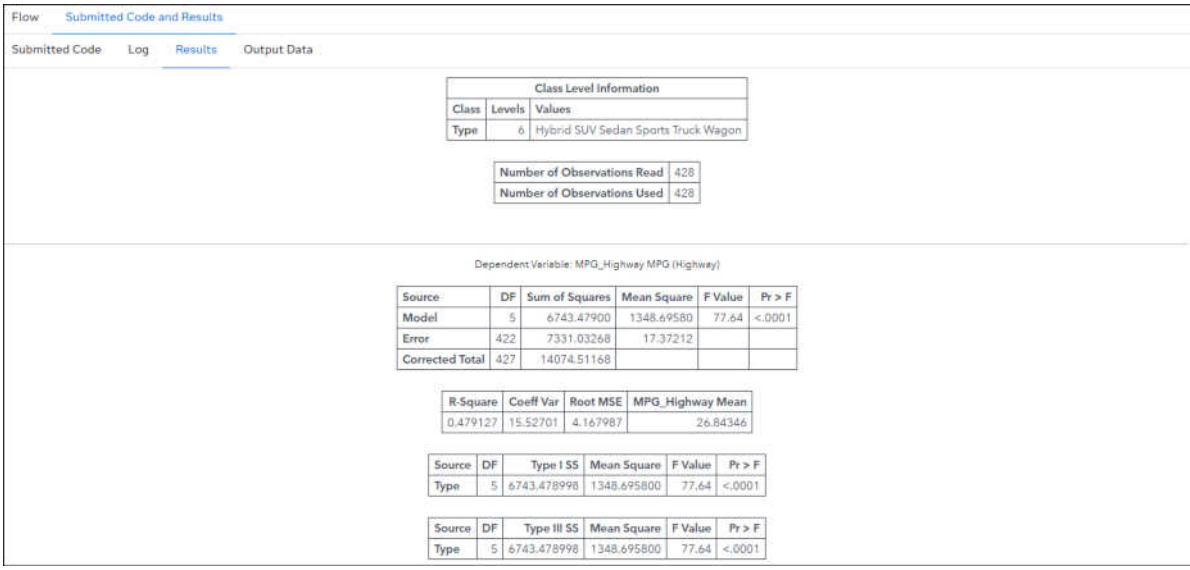
Example: Testing for Differences in the Means for MPG_Highway by Car Type

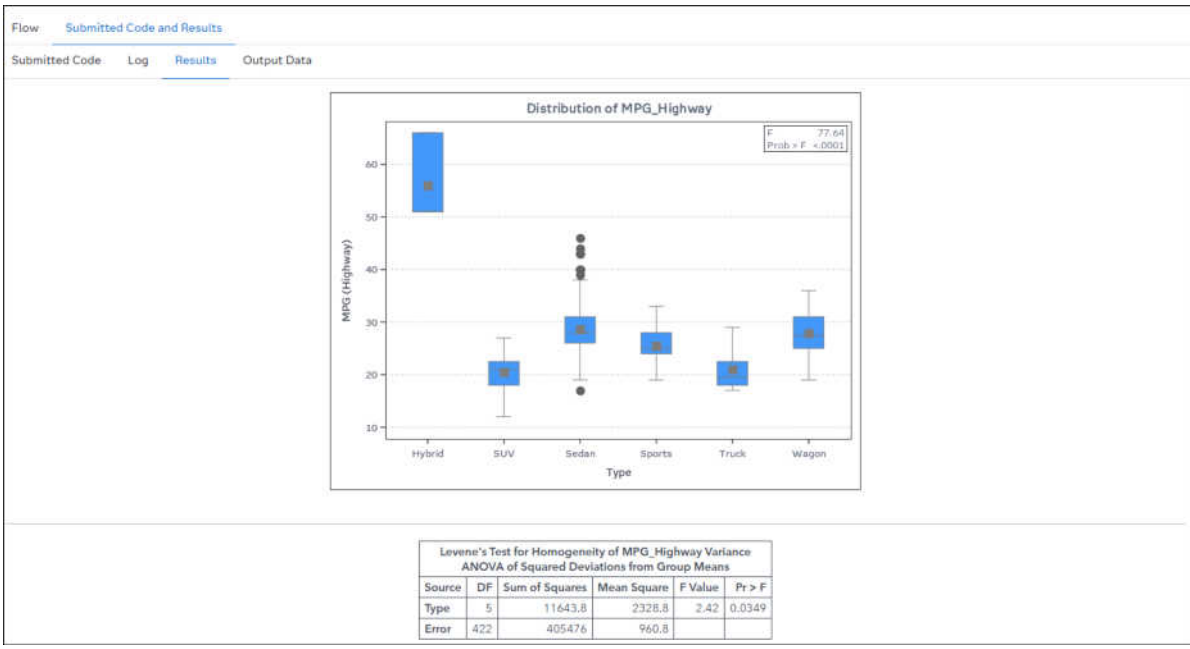
In this example, you want to study the differences in the means for the number of highway miles per gallon for six car types.

To create this example:

1. In the **Steps** section, expand the **Statistics** folder, and then double-click **One-Way ANOVA** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the One-Way ANOVA node to the data source. For more information, see "Connecting Nodes" on page 13.
3. On the **Data** tab, assign columns to these roles:
   - To the **Dependent variable** role, assign **MPG_Highway**.
   - To the **Categorical variable** role, assign **Type**.
4. Run the flow.

Click the **Submitted Code and Results** tab to view the results.





One-Way ANOVA: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the One-Way ANOVA step, you must assign columns to the **Dependent variable** and **Categorical variable** roles.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Dependent variable** role, assign a continuous numeric column.

3 To the **Categorical variable** role, assign a character or numeric column with values that specify the levels of the groups. The column that you assign to this role must have two or more distinct values.

Step 2: Set the Options

1 Specify the type of test to perform. Here are the valid values:

None
specifies that no test is performed.

Bartlett
computes accurate Type I error rates when the distribution of the data is normal.

Brown & Forsythe
is a variation of Levene's test. Equal variances are determined using the absolute deviations from the group medians. Although this is a good test for determining variance differences, it can be resource intensive if your data contains several large groups.

Levene
computes the squared residuals to determine equal variance. Levene's test is considered to be the standard homogeneity of variance tests. This is the default.

O'Brien
specifies O'Brien's test, which is a modification of Levene's test that uses squared residuals.

2 (Optional) Select **Welch's variance-weighted ANOVA** to test the group means by using a weighted variance. You can use this test if the assumption of equal variances is rejected.

3 Select the comparison method. You can select from these comparison methods:

Bonferroni
performs Bonferroni *t* tests of differences between means for all means of the main effect.

Duncan multiple range
performs Duncan's multiple range test on all means of the main effect.

Dunnett two-tail
performs Dunnett's two-tailed *t* test, testing whether any treatments are significantly different from a single control for all main-effect means.

Dunnett lower one-tail
performs Dunnett's one-tailed *t* test, testing whether any treatment is significantly less than the control.

Dunnett upper one-tail
performs Dunnett's one-tailed *t* test, testing whether any treatment is significantly greater than the control.

Gabriel
performs Gabriel's multiple-comparison procedure on all means of the main effect.

Nelson
analyzes all the differences with the least squares means.

Ryan-Einot-Gabriel-Welch
performs the Ryan-Einot-Gabriel-Welsch multiple range test on all means of the main effect.

Scheffé
performs Scheffé's multiple-comparison procedure on all means of the main effect.

Sidak
performs pairwise *t* tests on differences between means with levels adjusted according to Sidak's inequality for all means of the main effect.

Student-Newman-Keuls
performs the Student-Newman-Keuls multiple range test on all main effect means.

Least significant difference (LSD)
performs pairwise *t* tests for all means of the main effect. In the case of equal cell sizes, this test is equivalent to Fisher's least significant difference test.

Tukey
performs Tukey's studentized range test (HSD) on all means of the main effect. When the group sizes are different, this is the Tukey-Kramer test.

4 Select the significance level for the selected test.

5 Select the plots to include in the results. By default, the results include a box plot, a means plot, and a least squares mean difference plot. You can also specify to include any diagnostic plots, which can be displayed in a panel or as individual plots.

You can also specify the maximum number of points to include in these plots.

Step 3: Set the Output Options

On the **Output** tab, specify whether to create an observation statistics data set. By default, the output table is saved in the Work library.

One-Way Frequencies

About the One-Way Frequencies Step

The One-Way Frequencies step generates frequency tables from your data. You can also use this step to perform binomial and chi-square tests.

You might want to use this step to analyze the efficiency of a new drug. For example, suppose a group of medical researchers are interested in evaluating the efficacy of a new treatment for a skin condition. Dermatologists from participating clinics are trained to conduct the study and to evaluate the condition. After the training, two dermatologists examine patients with the skin condition from a pilot study and rate the same patients. The One-Way Frequencies step can be used to evaluate the agreement of the diagnoses.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

One-Way Frequencies: Connection Requirements for the Node

In order to run the One-Way Frequencies step, you must create the input port of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: One-Way Frequencies of Unit Sales

In this example, you want to analyze unit sales for each sales region.

To create this example:

1 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **One-Way Frequencies** to add the step to your flow.

2 Add the Sashelp.PriceData table to your flow. Connect the input port of the One-Way Frequencies node to the data source. For more information, see "Connecting Nodes" on page 13.

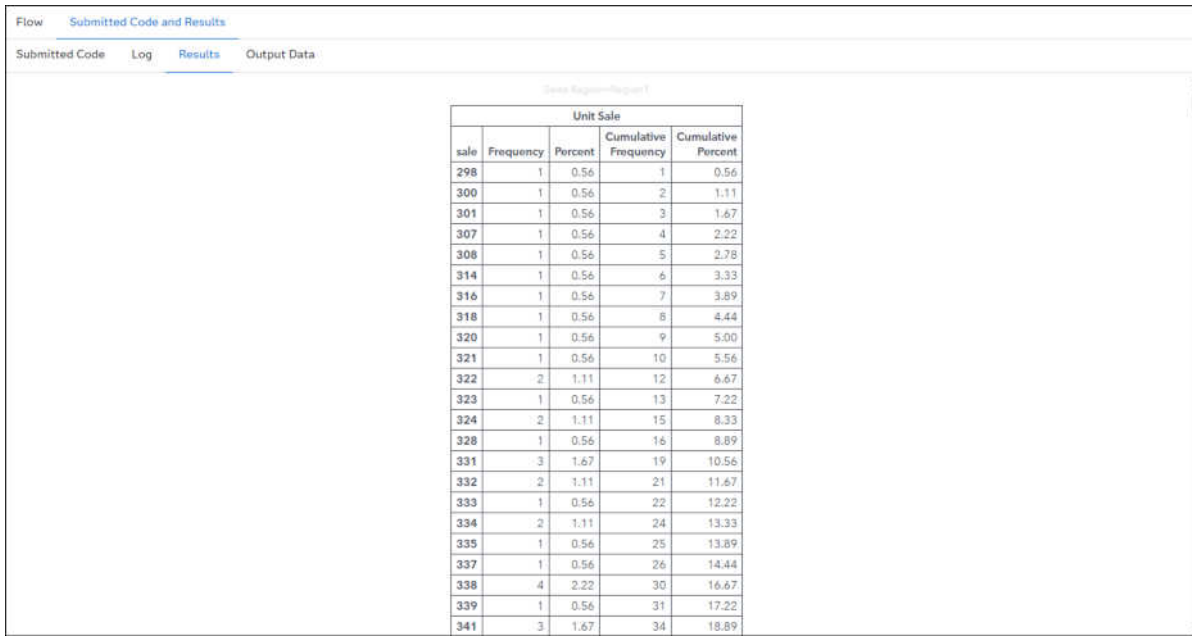
3 To set the options for the One-Way Frequencies step, click the One-Way Frequencies node.

4 On the **Data** tab, assign columns to these roles:

- Assign the **sale** column to the **Analysis variables** role.
- Expand the **Additional Roles** heading. Assign the **regionName** column to the **Group analysis by** role.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Unit Sale

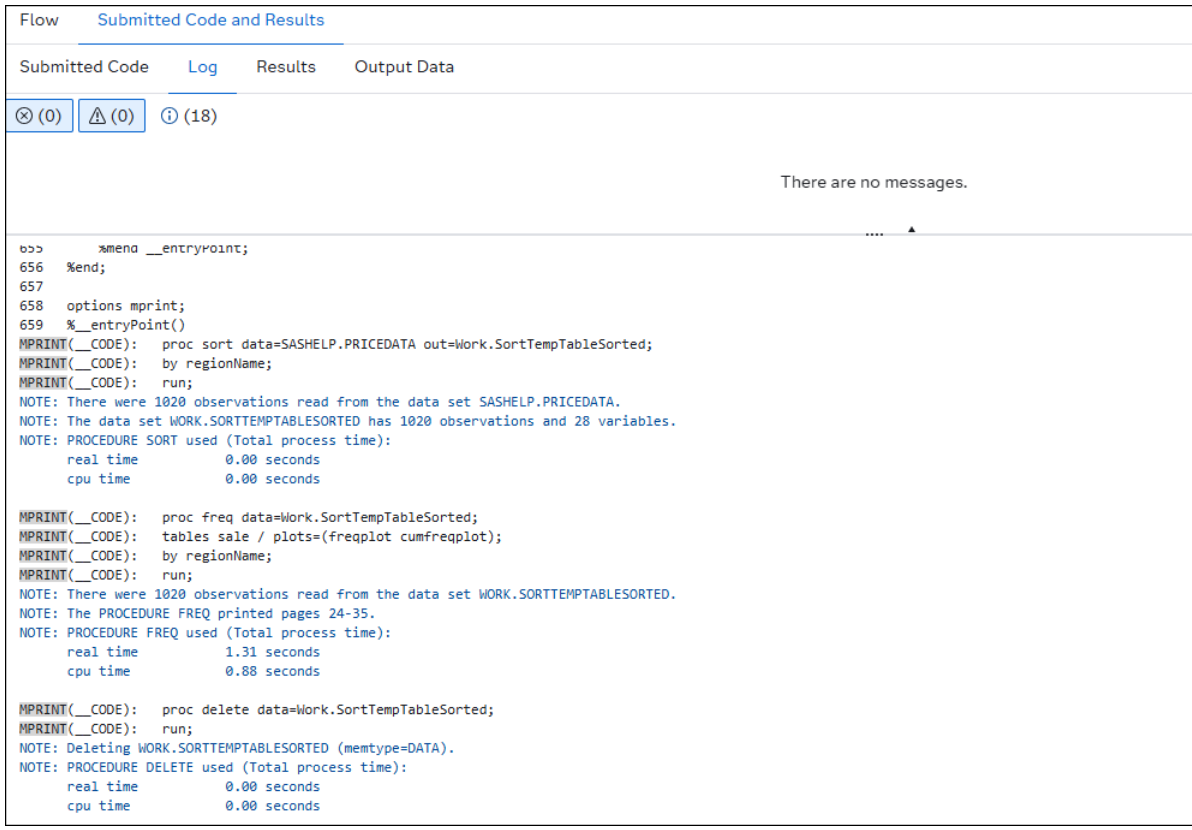
sale	Frequency	Percent	Cumulative Frequency	Cumulative Percent
298	1	0.56	1	0.56
300	1	0.56	2	1.11
301	1	0.56	3	1.67
307	1	0.56	4	2.22
308	1	0.56	5	2.78
314	1	0.56	6	3.33
316	1	0.56	7	3.89
318	1	0.56	8	4.44
320	1	0.56	9	5.00
321	1	0.56	10	5.56
322	2	1.11	12	6.67
323	1	0.56	13	7.22
324	2	1.11	15	8.33
328	1	0.56	16	8.89
331	3	1.67	19	10.56
332	2	1.11	21	11.67
333	1	0.56	22	12.22
334	2	1.11	24	13.33
335	1	0.56	25	13.89
337	1	0.56	26	14.44
338	4	2.22	30	16.67
339	1	0.56	31	17.22
341	3	1.67	34	18.89

To view the generated SAS code:

1 Open the **Log** tab.

2 Search for MPRINT(_CODE).

In this example, here is the generated SAS code.



One-Way Frequencies: Step-By-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Assign the variables to be analyzed to the **Analysis variables** role. For each variable that you assign to this role, the step creates a one-way frequency table. You must assign at least one variable to this role.

3 (Optional) Assign a variable to the **Frequency count** role.

If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n*is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

4 (Optional) To obtain separate analyses of observations for each unique group, assign a variable to the **Group analysis by** role.

Step 2: Setting Options

On the **Options** tab, you can set these options:

1 Select the frequencies and percentages to calculate. By default, all of these options are selected.

- **Frequency table** specifies whether to create the frequencies table.
- **Include percentages** creates a table that contains the cumulative frequencies and percentages and the percentages of total frequencies for each value of the analysis variable.
- **Include cumulative frequencies and percentages** creates a table that contains the frequencies and cumulative frequencies for each value of the analysis variable.

2 Specify the order of the rows.

- **Unformatted values** to order the values by their unformatted values. This is the default.
- **Data set order** to order the values by their appearance in the data set.
- **Formatted values** to order the values by their ascending formatted values.
- **Descending frequency** to order the values so that the levels with the highest frequency counts come first.

3 (Optional) Specify whether to calculate asymptotic tests for binomial proportion and chi-square goodness-of-fit tests.

- For binomial proportions, specify a null hypothesis proportion and a confidence level. To compute the exact *p*-values, select **Exact test**.
- For chi-square goodness-of-fit, specify whether to compute exact tests.

  Select **Limit computation time** to specify the time limit (in seconds) for the computation of each *p*-value for each crosstabulation table. The default is 300 seconds (or 5 minutes).

  To compute the Monte Carlo estimates of the exact *p*-values instead of directly computing the exact *p*-values, select **Use Monte Carlo estimation**. Monte Carlo estimation can be useful for large problems that require a great amount of time and memory for exact computations but for which asymptotic approximations might be insufficient.

4 (Optional) Select the options for plots and missing values.

- **Suppress plots** suppresses the plots from the results.
- **Include in frequency table** includes missing values in the frequency tables.
- **Include in percentages and statistics** includes the frequencies of missing values in binomial or chi-square tests and in the calculations of percentages.

Partial Least Squares Regression

About the Partial Least Squares Regression Step

The Partial Least Squares Regression step performs partial least squares analysis. It also performs principal components regression and reduced rank regression. These techniques combine dimension reduction of the predictors and dependent variables with predictive modeling.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Partial Least Squares Regression: Connection Requirements for the Node

In order to run the Partial Least Squares Regression step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running the step using the SAS Compute Server, the input data source can be a SAS or CAS table. If you are running the step using the SAS CAS Server, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output table is created by default, so no connection is required. To create an output data table that contains the observation statistics, use the option on the **Output** tab. For more information, see "Step 4: Set the Output Options" on page 388. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Partial Least Squares Regression Analysis

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data pentaTrain;
input obsnam $ S1 L1 P1 S2 L2 P2
S3 L3 P3 S4 L4 P4
S5 L5 P5 log_RAI @@;
n = _n_;
datalines;
VESSK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
1.9607 -1.6324 0.5746 1.9607 -1.6324 0.5746
2.8369 1.4092 -3.1398 0.00
VESAK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
1.9607 -1.6324 0.5746 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 0.28
VEASK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
0.0744 -1.7333 0.0902 1.9607 -1.6324 0.5746
2.8369 1.4092 -3.1398 0.20
VEAAK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
0.0744 -1.7333 0.0902 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 0.51
VKAAK -2.6931 -2.5271 -1.2871 2.8369 1.4092 -3.1398
0.0744 -1.7333 0.0902 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 0.11
VEWAK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
-4.7548 3.6521 0.8524 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 2.73
VEAAP -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
0.0744 -1.7333 0.0902 0.0744 -1.7333 0.0902
-1.2201 0.8829 2.2253 0.18
VEHAK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
2.4064 1.7438 1.1057 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 1.53
VAAAK -2.6931 -2.5271 -1.2871 0.0744 -1.7333 0.0902
0.0744 -1.7333 0.0902 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 -0.10
GEAAK 2.2261 -5.3648 0.3049 3.0777 0.3891 -0.0701
0.0744 -1.7333 0.0902 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 -0.52
LEAAK -4.1921 -1.0285 -0.9801 3.0777 0.3891 -0.0701
0.0744 -1.7333 0.0902 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 0.40
FEAAK -4.9217 1.2977 0.4473 3.0777 0.3891 -0.0701
0.0744 -1.7333 0.0902 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 0.30
VEGGK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
2.2261 -5.3648 0.3049 2.2261 -5.3648 0.3049
2.8369 1.4092 -3.1398 -1.00
VEFAK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
-4.9217 1.2977 0.4473 0.0744 -1.7333 0.0902
```

```
2.8369 1.4092 -3.1398 1.57
VELAK -2.6931 -2.5271 -1.2871 3.0777 0.3891 -0.0701
-4.1921 -1.0285 -0.9801 0.0744 -1.7333 0.0902
2.8369 1.4092 -3.1398 0.59
;
```

Click **Run** to create the Work.pentraTrain table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Partial Least Squares Regression** to add the step to your flow.

3 Add the Work.pentraTrain table to your flow. Connect the input port of the Linear Regression node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Partial Least Squares Regression step, click the Partial Least Squares Regression node.

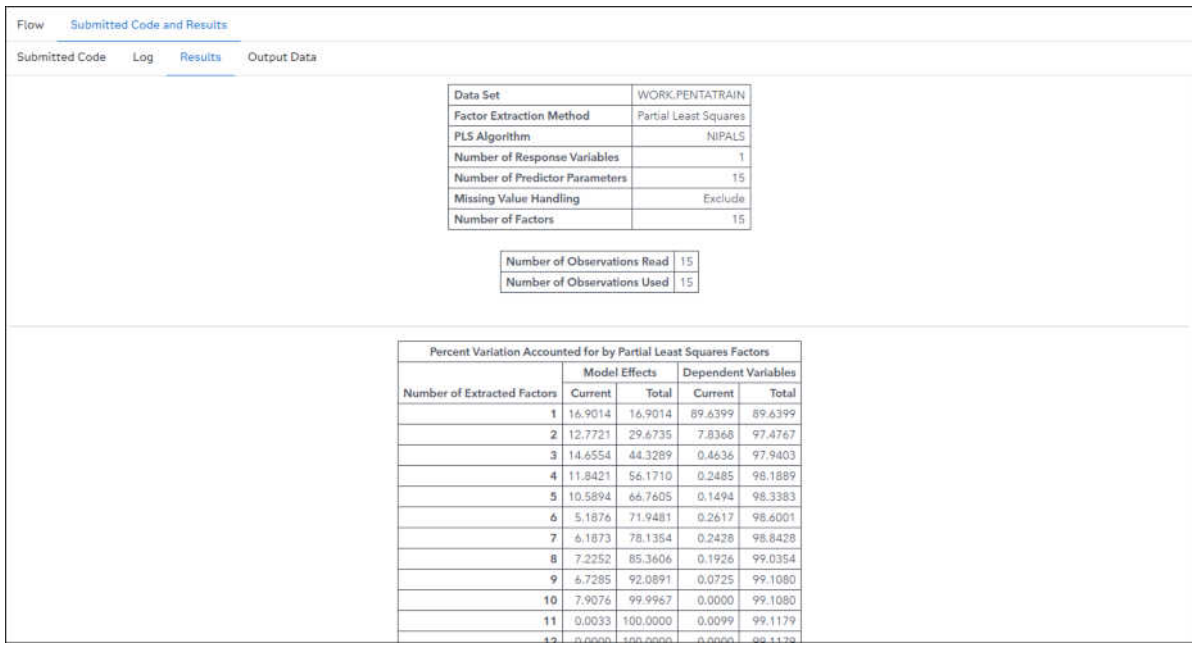
5 On the **Data** tab, assign variables to these roles:

- To the **Dependent variable** role, assign the **log_RAI** column.
- To the **Continuous variables** role, assign these columns:
  - **S1-S5**
  - **L1-L5**
  - **P1-P5**

6 On the **Model** tab, select **Main effects model**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Partial Least Square Regression: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on the SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use the SAS Compute Server. Using the SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 (SAS CAS Server only) Specify whether the input data includes test data.

4 To the **Dependent variables** role, assign the numeric variables to use as the dependent variables for the analysis.

5 To the **Continuous variables** role, assign any continuous variables to include in the model.

6 To the **Classification variables** role, assign the classification variables to use in the model. Examples of classification variables are Treatment, Race, Group, Sex, and Replication.

7 (SAS Compute Server only) Expand the **Treatment of Missing Values** heading to learn how the step treats missing values.

An observation is excluded from the analysis when either of these conditions is met:

- if any variable in the model contains a missing value
- if any classification variable contains a missing value (regardless of whether the classification variable is used in the model)

8 (Optional) To the **Group analysis by** role, assign the column to obtain separate analyses of observations in groups that are defined by the BY variables.

Step 2: Set the Model Options

On the **Models** tab, select the model type. You can choose from these options:

- **Main effects model**.
- **Main effects and all n-way interactions**. To create this model, you must assign at least two variables to the **Explanatory variables** role on the **Data** tab. Specify the value of *N* for the *n*-way interactions.
- **Custom model**. Specify the model effects to use in the custom model. You can also choose whether to include the intercept in the model.

Step 3: Set the Options

On the **Options** tab, you can specify these options:

1. Select the general factor extraction method to use. You can choose from these options:
   - **Partial least squares regression**
   - **De Jong's SIMPLS**
   - **Principal components regression**
   - **Reduced rank regression**
2. Select the **Center the responses and predictors** check box to include the intercept in the model. By default, the responses and predictors are centered and the intercept is not included in the model.
3. Select the **Scale the responses and predictors** check box to scale the responses and predictors.
4. Select the **Specify the number of factors** check box to specify the number of factors to extract. The default is $\min\{15, p, N\}$. *p* is the number of predictors (or the number of dependent variables when you select **Reduced rank regression** as the method). *N* is the number of runs (observations).
5. (SAS Compute Server only) Select the cross validation method. By default, no cross validation method is selected.

   Here are the available methods:
   - **Exclude one observation at a time**
   - **Exclude every nth observation**
   - **Exclude blocks of consecutive observations**
   - **Exclude observations at random**
6. Select the algorithm to use to compute the extracted factors. You can choose from these algorithms:

- **Iterative NIPALS** requests the usual iterative NIPALS algorithm.
- **Singular value decomposition** bases the extraction on singular value decomposition of X'Y.
- **Eigenvalue decomposition** bases the extraction on the eigenvalue decomposition of Y'XX'Y.
- **Iterative RLGW** is an iterative approach that is efficient when there are many predictors.

7 Specify the maximum number of iterations if you selected **Iterative NIPALS** or **Iterative RLGW**.

8 Select the statistics to include in the results. You can choose the default statistics or from these options:

- **Coefficients of final predictive model**, which lists the coefficients of the final predictive model for the responses. The coefficients for predicting the centered and scaled responses based on the centered and scaled predictors are displayed. The coefficients for predicting the raw responses based on the raw predictors are also displayed.
- **Van der Voet's model comparison test** specifies that van der Voet's randomization-based model comparison test be performed to test models with different numbers of extracted factors against the model that minimizes the predicted residual sum of squares.

  Note: This option is available only if you are running the step on SAS CAS Server and you selected **Include test data** on the **Data** tab.

- **Variation accounted for in responses and predictors**, which lists the amount of variance that is accounted for in each response and predictor. The option also includes the average response and predictor sum of squares that is accounted for by each successive factor.
- **Details of the fitted model**, which is the details of the fitted model for each successive factor. The details that are listed are different for different extraction methods.

9 Select the plots to include in the results. By default, only the correlation plot is included in the results.

If you are running on the SAS Compute Server, you can choose to include these additional plots:

- correlation loading plot
- diagnostics plots
- residuals of dependent by independent variables
- profiles of regression coefficients

  Note: This plot is available only when you specify two or more effects on the **Models** tab.

- variable importance factors

- distance plots for X and Y models
- matrix of X-scores against Y-scores

Step 4: Set the Output Options

On the **Output** tab, you can specify whether to save the observation statistics in an output table. You can choose the statistics to include in the output table and whether to include any variables from the input table.

Note: If you are running the step in a flow, you must add an output port for the scored data to the Partial Least Squares Regression node. For more information, see "Partial Least Squares Regression: Connection Requirements for the Node" on page 382.

Pearson Correlation Statistical Power

About the Pearson Correlation Statistical Power Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. This step performs power and sample size analyses for tests of simple and partial Pearson correlation between two variables. Both Fisher's *z* transformation and the *t* transformation are supported.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

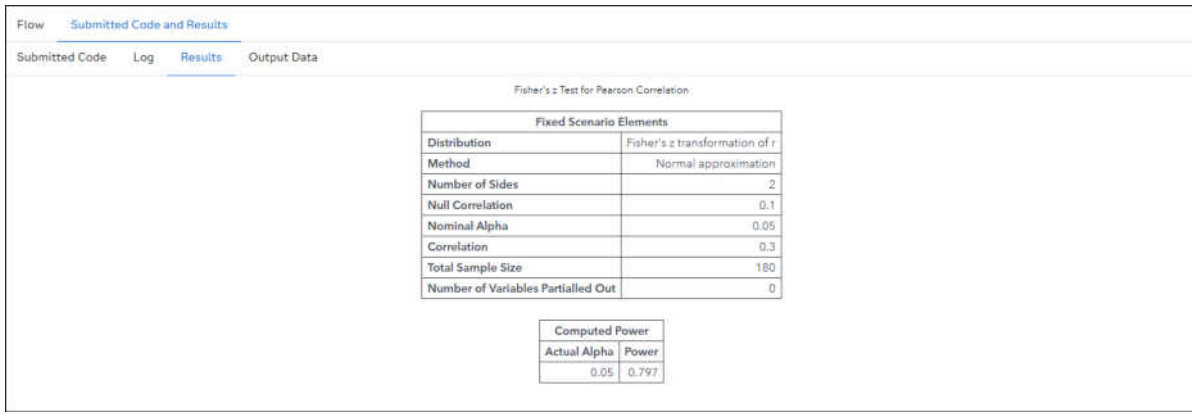
Pearson Correlation Statistical Power: Connection Requirements for the Node

No input data or output data is required for the Pearson Correlation Statistical Power step.

Example: Pearson Correlation for Power and Sample Size Analysis

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Pearson Correlation Statistical Power** to add the step to your flow.
2. To set the options for the Pearson Correlation Statistical Power step, click the Pearson Correlation Statistical Power node.
3. For the **Solve for** option, select **Power**.
4. For the transformation of the correlations coefficient, select **Fisher's z transformation**.
5. For the number of sides, select **Two-sided test**.
6. Specify a significance level of `0.05`.
7. Under the **Correlation** heading, select **Correlation and null correlation** from the **Select a form** drop-down list.
8. Enter `.3` as the correlation, and enter `.1` as the null correlation.
9. For the sample size value, enter `180`.
10. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



The computed power is 0.797.

Pearson Correlation Statistical Power: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 For the **Solve for** option, request a solution for power or total sample size.

2 Select a transformation of the correlation coefficient. This option specifies the underlying distribution assumed for the test statistic. You can choose from a Fisher's *z* transformation or a *t* transformation. If you select a *t* transformation, you must specify whether to use fixed variables or random (bivariate normal) variables.

3 Specify the number of sides (or tails) and the direction of the statistical test. Here are the valid tests:

- a one-sided test, with the alternative hypothesis in the same direction as the effect.
- an upper one-sided test. The alternative hypothesis indicates a correlation greater than the null value.
- a lower one-sided test. The alternative hypothesis indicates a correlation less than the null value.
- a two-sided test

4 Specify the alpha value of the statistical test. The default is `0.05`.

5 Specify the correlation options.

- Use the **Select a form** option to specify whether to calculate the correlation or the correlation and the null correlation. Correlation specifies the correlation between two variables, possibly adjusting for any partial

variables. Null correlation specifies the null value of the correlation. The default value is 0.

Note: This option is available only if you select a Fisher's *z* transformation.

- Specify the correlation values.
- Specify the value of the null correlation.

Note: This option is available only if you select a Fisher's *z* transformation and the **Correlation and null correlation** option from the **Select a form** drop-down list.

6 Specify the options for the sample size.
   - Specify whether to allow fractional input and output for sample sizes.
   - Specify the sample size to use in the analysis.

7 Specify the number of variables to partial out. These variables are adjusted for the correlation between the two primary variables. The default value is `0`, which corresponds to a simple correlation.

Step 2: Create the Output Plots

On the **Output** tab, specify whether to create these output plots.

- a plot with sample size on the vertical axis and power on the horizontal axis. For this plot, you can specify the minimum and maximum value for sample size.
- a plot effect size on the horizontal axis. Power or sample size is on the vertical axis. For this plot, you can specify the minimum and maximum value for the effect size.

Permutations

About the Permutations Step

The Permutations step computes the possible permutations of a given number of objects.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as

a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Permutations: Connection Requirements for the Node

No input data is needed to run the Permutations step.

Input Port	Output Port
No input data is required.	By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Calculating the Permutations of Six Objects

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Permutations** to add the step to your flow.
2. To set the options for the Permutations step, click the Permutations node.
3. In the **Number of objects** field, enter `6`.
4. Run the flow.

Click the **Submitted Code and Results** tab to view the output data.

Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK._FLW1A380F20388611F0_0_0_1

Columns: 6 Rows: 720

Enter expression

#	p1	p2	p3	p4	p5	p6
1	1	2	3	4	5	6
2	1	2	3	4	6	5
3	1	2	3	5	4	6
4	1	2	3	5	6	4
5	1	2	3	6	4	5
6	1	2	3	6	5	4
7	1	2	4	3	5	6
8	1	2	4	3	6	5
9	1	2	4	5	3	6
10	1	2	4	5	6	3
11	1	2	4	6	3	5
12	1	2	4	6	5	3
13	1	2	5	3	4	6
14	1	2	5	3	6	4
15	1	2	5	4	3	6
16	1	2	5	4	6	3
17	1	2	5	6	3	4
18	1	2	5	6	4	3

Permutations: Step-by-Step Instructions

1 Specify the number of objects.

2 Specify whether to replace an existing output table. By default, the table is saved in the Work library.

Poker Hand Probability

About the Poker Hand Probability Step

The Poker Hand Probability step calculates the frequency and probability of poker hands.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Poker Hand Probability: Connection Requirements for the Node

The input table for the Poker Hand Probability step must be the output table that is generated by the Computations step.

Input Port	Output Port
Table node from the Computations step	No output data is created.

Example: Results from the Poker Hand Probability Step

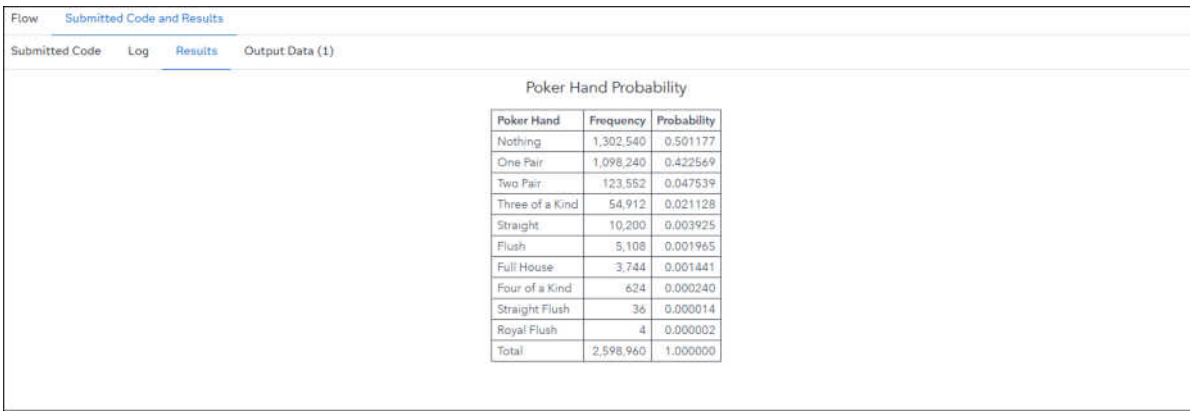
To create this example:

1. Create the Work.Combo table. For more information, see "Example: Calculating the Combinations of 52 Objects in 5 Sets" on page 243.
2. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Poker Hand Probability** to add the step to your flow.

3 Connect the output port of the Combinations node (which represents the Work.Combo table) to the input port of the Poker Hand Probability node. For more information, see "Connecting Nodes" on page 13.

4 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Poker Hand	Frequency	Probability
Nothing	1,302,540	0.501177
One Pair	1,098,240	0.422569
Two Pair	123,552	0.047539
Three of a Kind	54,912	0.021128
Straight	10,200	0.003925
Flush	5,108	0.001965
Full House	3,744	0.001441
Four of a Kind	624	0.000240
Straight Flush	36	0.000014
Royal Flush	4	0.000002
Total	2,598,960	1.000000

Predictive Regression Models

About the Predictive Regression Models Step

The step is predictive in that it selects the most influential effects based on observed data. This step enables you to logically partition your data into disjoint subsets for model training, validation, and testing. The Predictive Regression Models step focuses on the standard independently and identically distributed general linear model for univariate responses and offers great flexibility and insight into the model selection algorithm. This step can also create a scored data set. The results for this step make it easy to explore the selected model in more detail with other steps such as the Linear Regression step.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Predictive Regression Models: Connection Requirements for the Node

In order to run the Predictive Regression Models step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output table is created by default, so no connection is required. To create an output data table for the scored data, use the option on the **Output** tab. For more information, see "Step 5: Set the Output Options" on page 403. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Predicting a Baseball Player's Salary

To create this example:

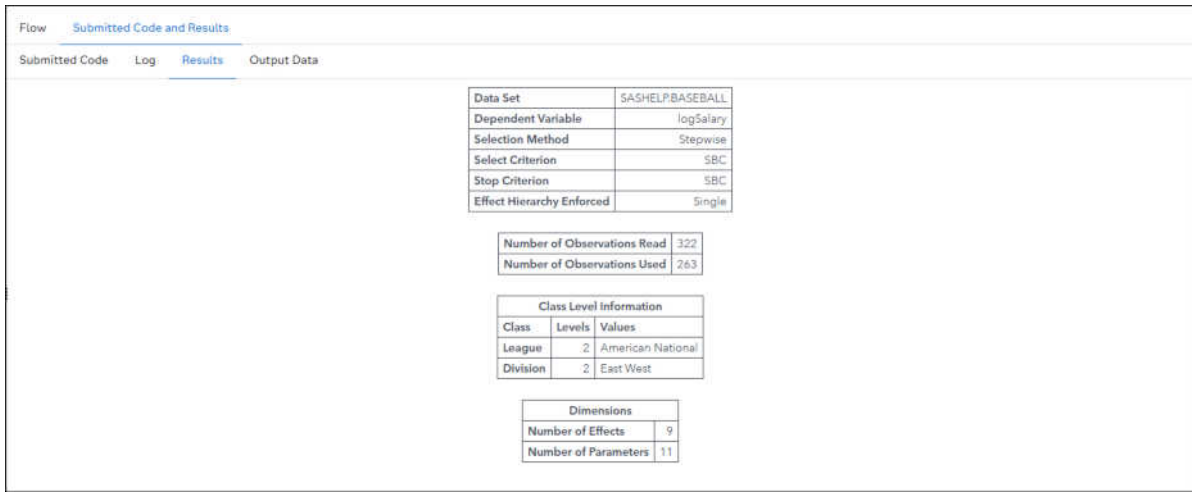
1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Predictive Regression Models** to add the step to your flow.
2. Add the Sashelp.Baseball table to your flow. Connect the input port of the Linear Regression node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Predictive Regression Models step, click the Predictive Regression Models node.
4. On the **Data** tab, assign variables to these roles:
   - To the **Dependent variable** role, assign the **logSalary** column.
   - To the **Classification variables** role, assign the **League** and **Division** columns.
   - To the **Continuous variables** role, assign these columns:
     - **nAtBat**

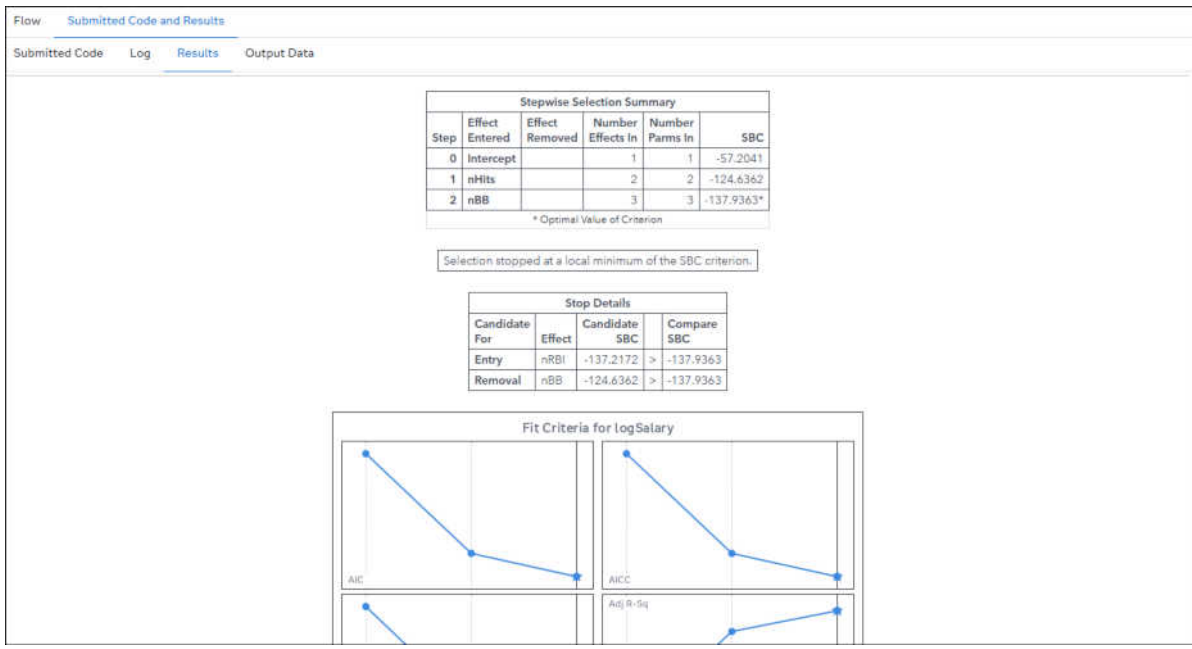
- **nHits**
- **nHome**
- **nRuns**
- **nRBI**
- **nBB**

5 On the **Model** tab, select **Custom model** and enter these model effects: `nAtBat nHits nHome nRuns nRBI nBB League Division`.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.





Partitioning Data

When you have sufficient data, you can partition your data into two parts: validation data and test data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds. Finally, after a model is selected, the test data can be used to assess how the selected model generalizes on data that played no role in selecting the model.

You can partition your data in either of these ways:

- You can specify a proportion of the validation or test data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is a validation or test case, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for validation or test cases. The input data set is divided into partitions by using these values.

Predictive Regression Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. Specify whether the input data contains any training data. For more information, see "Partitioning Data" on page 398.
3. To the **Dependent variable** role, assign the numeric variable to use as the dependent variable for the regression analysis.
4. To the **Explanatory variables** role, assign the variables to use to group (classify) data in the analysis. A classification variable is a variable that enters the statistical analysis or model through its levels, not through its values. The process of associating values of a variable with levels is called *levelization*.
5. Expand the **Parameterization of Effects** heading. From the **Coding** drop-down list, select the parameterization method for the classification variable. Design matrix columns are created from the classification variables according to the selected coding scheme.

You can select from these coding schemes:

- **Effects coding** specifies effect coding.
- **GLM coding** specifies less-than-full-rank, reference-cell coding. This coding scheme is the default.
- **Reference coding** specifies reference-cell coding.

6 Expand the **Treatment of Missing Values** heading to learn how the step treats missing values.

An observation is excluded from the analysis if any variable in the model contains a missing value. In addition, an observation is excluded if any classification variable that is specified earlier in this table contains a missing value, regardless if the variable is used in the model.

7 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

8 (Optional) To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

9 (Optional) To the **Weight** role, assign the numeric column to use as a weight to perform a weighted analysis of the data.

10 (Optional) To the **Group analysis by** role, assign the column to obtain separate analyses of observations in groups that are defined by the BY variables.

Step 2: Set the Model Options

On the **Models** tab, you can select the model type. You can choose from these options:

- **Main effects model**.
- **Main effects and all n-way interactions**. To create this model, you must assign at least two variables to the **Explanatory variables** role on the **Data** tab. Specify the value of *N* for the *n*-way interactions.
- **Custom model**. Specify the model effects to use in the custom model.
- You can also choose whether to include the intercept in the model.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

Step 3: Select the Selection Method and Statistics

On the **Selection** tab, you can specify these options:

1 Select the selection method. You can choose from these options:

- **Forward selection** specifies forward selection. This method starts with no effects in the model and adds effects.
- **Backward elimination** specifies backward elimination. This method starts with all effects in the model and deletes effects.
- **Stepwise regression** specifies stepwise regression, which is similar to the forward selection method except that effects already in the model do not necessarily stay there.
- **LASSO** specifies the LASSO method, which adds and deletes parameters based on a version of ordinary least squares where the sum of the absolute regression coefficients is constrained. If the model contains classification variables, these classification variables are split.
- **Adaptive LASSO** requests that adaptive weights be applied to each of the coefficients in the LASSO method. The ordinary least squares estimates of the parameters in the model are used in forming the adaptive weights.
- **Elastic net** specifies the elastic net method, which is an extension of LASSO. The elastic net method estimates parameters based on a version of ordinary least squares in which both the sum of the absolute regression coefficients and the sum of the squared regression coefficients are constrained. If the model contains classification variables, these classification variables are split.
- **Least angle regression** specifies least angle regression. This method starts with no effects in the model and adds effects. The parameter estimates at any step are “shrunk” when compared to the corresponding least squares estimates. If the model contains classification variables, these classification variables are split.

2 From the **Add/remove effects with** drop-down list, select the criterion to use to determine whether an effect should be added or removed from the model.

3 From the **Stop adding/removing effects with** drop-down list, select the criterion to use to determine whether effects should stop being added or removed from the model.

4 From the **Select best model by** drop-down list, select the criterion to use to determine the best fitting model.

5 From the **Model fit statistics** drop-down list, select which model fit statistics are displayed in the fit summary table and the fit statistics tables. If you select **Default fit statistics**, the default set of statistics that are displayed in these tables includes all the criteria that are used in model selection.

Here are the additional fit statistics that you can include in the results:

- Adjusted R-square
- Akaike's information criterion
- Akaike's information criterion corrected for small-sample bias
- Average square error
- Bayesian information criterion
- Mallows' *Cp*
- Press statistic, which specifies the predicted residual sum of squares statistic
- R-square
- Schwarz's Bayesian information criterion

6 Select the plots to include in the results. You can choose from these options:

- **Criteria plot** displays plots for these criteria: adjusted R-square, Akaike's information criterion, Akaike's information criterion corrected for small-sample bias, and the criterion that is used to select the best fitting model. You can choose to display these plots in a panel or individually.
- **Coefficient plots** displays these plots:
  - a plot that shows the progression of the parameter values as the selection process proceeds
  - a plot that shows the progression of the criterion that is used to select the best fitting model

7 From the **Selection process details** drop-down list, specify how much information about the selection process to include in the results. You can display a summary, details for each step of the selection process, or all of the information about the selection process.

8 From the **Add/remove classification effects** drop-down list, specify which classification variables are included in the model as one or more actual variables. The number of variables is related to the number of levels of the classification variable. For example, if a classification variable has three levels (young, middle-aged, old), it might be represented by three variables. Each variable is a single degree of freedom effect.

You can choose from these options:

- **Add/remove as entire effect**, which specifies that all or none of the variables for a classification effect are included in the model.
- **Add/remove as individual single degree of freedom effects**, which specifies that one or more of the individual variables are included in the model. Some individual variables might not be included in the model.

9 From the **Model effects hierarchy** drop-down list, specify how the model hierarchy requirement is applied and that only a single effect or multiple effects can enter or leave the model at one time. For example, suppose you specify the main effects A and B and the interaction A*B in the model. In the first step of the selection process, either A or B can enter the model. In the second step, the other main effect can enter the model. The interaction effect can enter the

model only when both main effects have already been entered. Also, before A or B can be removed from the model, the A*B interaction must be removed.

Model hierarchy refers to the requirement that, for any term to be in the model, all effects that are contained in the term must be present in the model. For example, in order for the interaction A*B to enter the model, the main effects A and B must be in the model. Likewise, neither effect A nor B can leave the model while the interaction A*B is in the model.

10 From the **Model effects subject to the hierarchy requirement** drop-down list, specify whether to apply the model hierarchy requirement to the classification and continuous effects in the model or to only the classification effects.

Step 4: Set the Options for the Final Model

On the **Options** tab, you select the options for the selected model.

1 Select the statistics to include for the selected model.

You can choose to include the default statistics in the results or choose to include additional statistics such as the standardized regression coefficients. A standardized regression coefficient is computed by dividing a parameter estimate by the ratio of the sample standard deviation of the dependent variable to the sample standard deviation of the regressor.

If you include additional statistics in the model, you can also set the options for collinearity.

- **Collinearity analysis** requests a detailed analysis of collinearity among the regressors. This includes eigenvalues, condition indices, and decomposition of the variances of the estimates with respect to each eigenvalue.
- **Tolerance values for estimates** produces tolerance values for the estimates. Tolerance for a variable is defined as $1 - R^2$, where R-square is obtained from the regression of the variable on all other regressors in the model.
- **Variance inflation factors** produces variance inflation factors with the parameter estimates. Variance inflation is the reciprocal of tolerance.

2 Select the plots to include in the results.

You must specify whether to include the default diagnostic plots in the results. You can also specify whether to include plots of the residuals for each explanatory variable.

You can choose to include these additional diagnostic plots.

- **Rstudent statistic by predicted values** plots studentized residuals by predicted values. If you select the **Label extreme points** option, observations with studentized residuals that lie outside the band between the reference lines $RSTUDENT = \pm 2$ are deemed outliers.
- **DFFITS statistic by observation number** plots the DFFITS statistic by observation number. If you select the **Label extreme points** option, observations with a DFFITS statistic greater in magnitude than $2\sqrt{\frac{p}{n}}$ are

deemed influential. The number of observations used is *n*, and the number of regressors is *p*.

- **DFBETAS statistic by observation number for each explanatory variable** produces panels of DFBETAS by observation number for the regressors in the model. You can view these plots as a panel or as individual plots. If you select the **Label extreme points** option, observations with a DFBETAS statistic greater in magnitude than $\frac{2}{\sqrt{n}}$ are deemed influential for that regressor. The number of observations used is *n*.
- Select the **Label extreme plots** to identify the extreme values on each different type of plot.

You can also include these scatter plots.

- **Observed values by predicted values** produces a scatter plot of the observed values versus the predicted values.
- **Partial regression plots for each explanatory variable** produces partial regression plots for each regressor. If you display these plots in a panel, there is a maximum of six regressors per panel.

Specify the maximum number of points to include in each plot.

Step 5: Set the Output Options

On the **Output** tab, you can specify these options:

1 Select **Save scored data** to create an output table that contains the scored data.

Note: If you are running the step in a flow, you must add an output port for the scored data to the Predictive Regression Model node. For more information, see "Predictive Regression Models: Connection Requirements for the Node" on page 396.

2 Specify whether to save the scoring code.

Principal Component Analysis

About the Principal Component Analysis Step

Principal component analysis is a multivariate technique for examining relationships among several quantitative variables. Use the principal component

analysis step if you are interested in summarizing data and detecting linear relationships.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Principal Component Analysis: Connection Requirements for the Node

In order to run the Principal Component Analysis step, you must create connections to the input port of the node as indicated here:

Input Port	Output Port
If you are running the step on a SAS Compute Server, the input data can be a SAS or CAS table. If you are running this step on a SAS CAS Server, the input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. You can create output tables using the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 407. **Note:** By default, the output data is saved to the temporary Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

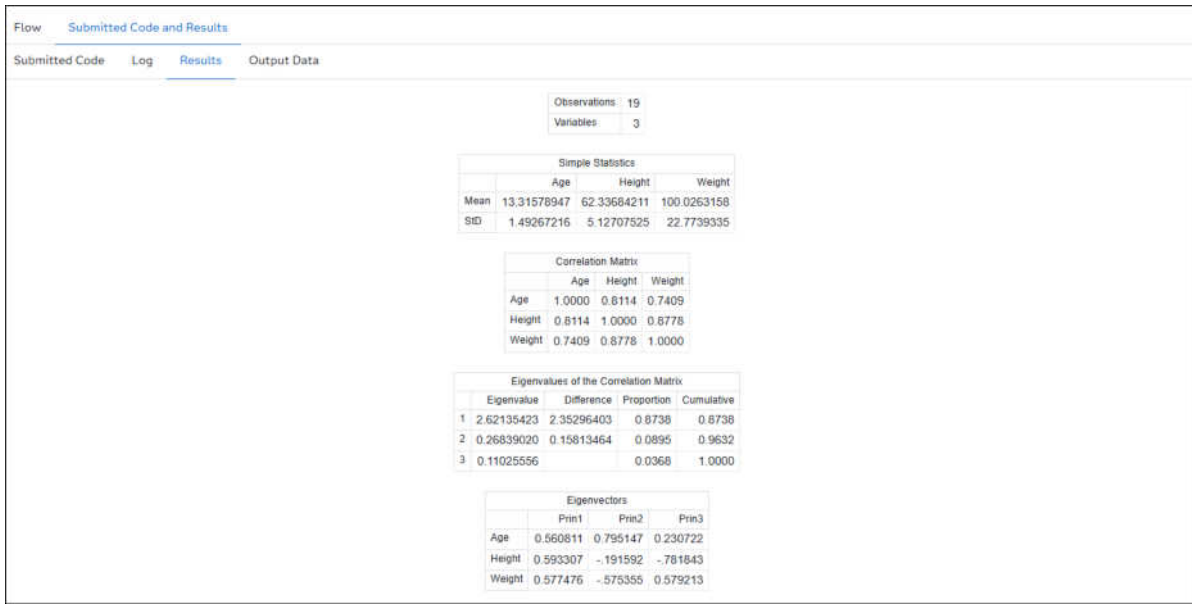
Example: Principal Component Analysis

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Principal Component Analysis** to add the step to your flow.
2. Add the Sashelp.Class table to your flow. Connect the input port of the Principal Component Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Principal Component Analysis step, click the Principal Component Analysis node.

4 On the **Data** tab, assign columns to the **Interval variables** role:
   - **Age**
   - **Height**
   - **Weight**

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Principal Component Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Interval inputs** role, assign the variables for the principal component analysis.

4 (Optional) To the **Inputs to partial out** role, assign the variables to analyze in a partial correlation or covariance matrix.

5 (Optional) To the **Frequency count** role, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

6 To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

7 To the **Group analysis by** role, assign a variable to obtain separate analyses of observations for each unique group.

Step 2: Set the Options

On the **Options** tab, set these options:

1 Specify the number of principal components to compute.

2 For the **Method** option, select the method to use in the principal component analysis.

Note: This option is available only if you are running the step on a SAS CAS Server. You can select the server on the **Data** tab.

3 Use the **Analyze** option to specify whether to compute the principal components from a correlation or covariance matrix.

4 Use the **Correct the covariances or correlations for the means** option to specify whether to include the intercept in the model.

5 Specify how to standardize the principal component scores. The variance of the scores can be equal to 1 or equal to the corresponding eigenvalue.

6 (Optional) Specify a prefix for naming the principal components. By default, the names are Prin1, Prin2, ..., Prin*n*. If you specify Abc as the prefix, the components are named Abc1, Abc2, Abc3, and so on.

7 Select the plots to include in the results. By default, an eigenvalue by component plot (scree plot) is displayed in the results. You can also include any of these plots:

- component pattern profiles.
- scores for pairs of components. You can specify whether to include a prediction ellipse.
- component scores matrix.
- patterns for pairs of components.

Note: The plots that are available depend on whether you are running the step in a SAS Data and AI Studio compute context or on a SAS CAS Server.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create an output table that contains the component scores and a statistics table. If you are running the step on a SAS CAS server, these tables must use a CAS engine libref.

- The component scores table contains the original variables from the input table and the principal component scores.
- The statistics table contains summary statistics, which include correlations or covariances, eigenvalues, eigenvectors, and so on.

Note: If you are running the step in a flow, you must add an output port for each output table to the Principal Component Analysis node. For more information, see "Robust Principal Component Analysis: Connection Requirements for the Node" on page 1184.

Proportional Hazards Regression

About the Proportional Hazards Regression Step

The Proportional Hazards Regression step fits proportional hazards regression models to survival data. These models include the widely used semi-parametric Cox regression model and its extensions, such as the shared frailty model and the Fine-Gray model. The step supports the analysis of data that might be left-censored, right-censored, or interval-censored.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or

SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Proportional Hazards Regression: Connection Requirements for the Node

In order to run the Proportional Hazards Regression step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, an output table is created. This table must use a CAS engine libref. For more information, see "Quantile Regression" on page 425. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Examples

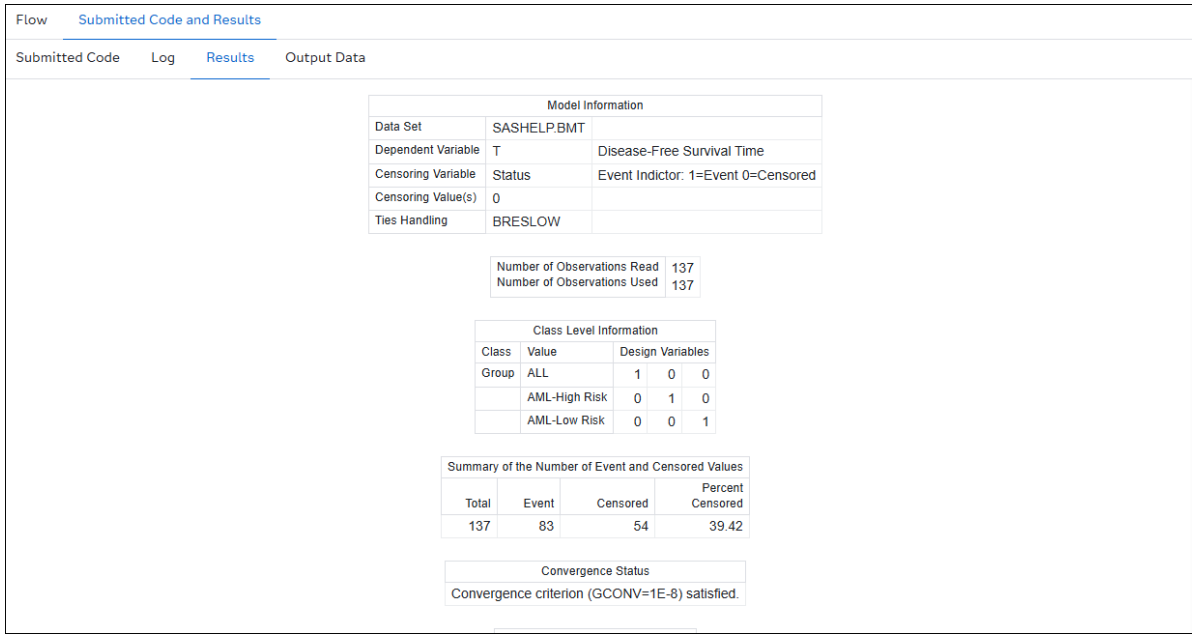
Example 1: Right Censoring

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Proportional Hazards Regression** to add the step to your flow.
2. Add the Sashelp.Bmt table to your flow. Connect the input port of the Proportional Hazards Regression node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Proportional Hazards Regression step, click the Proportional Hazards Regression node.
4. On the **Data** tab, assign columns to these roles:
   - To the **Survival time** role, assign **T**.
   - To the **Status variable** role, assign **Status**. In the **Censoring values** box, enter `0`.

- To the **Classification variables** role, assign **Group**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Example 2: Counting Process Style of Input

1 On a **SAS program** tab, copy and paste this code:

```
data Tumor1;
   input ID Dose T1 T2 Status NPap;
   datalines;
1   1   0   27  0   0
1   1   27  34  0   5
1   1   34  37  0   6
1   1   37  41  0   8
1   1   41  47  1   10
2   1   0   47  0   0
2   1   47  71  1   1
3   1   0   27  0   0
3   1   27  81  0   1
4   1   0   81  0   0
5   1   0   81  0   0
6   1   0   37  0   0
6   1   37  65  1   1
7   1   0   71  0   0
8   1   0   69  0   0
9   1   0   34  0   0
9   1   34  41  0   1
9   1   41  47  0   2
9   1   47  67  1   3
10  1   0   81  0   0
```

```
11  1    0   37  1   9
12  1    0   81  0   0
13  1    0   41  0   0
13  1   41   77  0   1
14  1    0   81  0   0
15  1    0   81  0   0
16  2.5  0   27  0   0
16  2.5 27   41  0   1
16  2.5 41   54  0   2
17  2.5  0   53  0   0
18  2.5  0   27  0   5
18  2.5 27   34  0   13
18  2.5 34   38  0   14
19  2.5  0   27  0   2
19  2.5 27   54  0   6
20  2.5  0   37  0   15
20  2.5 37   43  0   16
20  2.5 43   51  1   17
21  2.5  0   27  0   13
21  2.5 27   47  1   20
22  2.5  0   27  1   22
23  2.5  0   27  0   6
23  2.5 27   41  1   13
24  2.5  0   27  0   0
24  2.5 27   49  1   3
25  2.5  0   34  0   0
25  2.5 34   53  0   1
26  2.5  0   34  0   0
26  2.5 34   37  0   2
26  2.5 37   41  0   3
26  2.5 41   43  0   4
26  2.5 43   50  1   6
27  2.5  0   27  0   3
27  2.5 27   37  1   15
28  2.5  0   27  0   2
28  2.5 27   43  0   3
28  2.5 43   49  1   4
29  2.5  0   27  0   4
29  2.5 27   34  0   6
29  2.5 34   37  0   7
29  2.5 37   46  1   9
30  2.5  0   27  0   15
30  2.5 27   48  0   26
31  10   0   27  0   12
31  10  27   34  0   14
31  10  34   54  0   15
32  10   0   27  0   12
32  10  27   34  0   16
32  10  34   37  1   17
33  10   0   27  0   3
33  10  27   53  1   6
34  10   0   27  0   4
34  10  27   34  0   12
34  10  34   37  0   15
34  10  37   45  1   20
35  10   0   27  0   6
```

```
35  10  27  34  0   10
35  10  34  43  0   13
35  10  43  51  0   15
35  10  51  53  0   20
36  10  0   27  0   0
36  10  27  49  1   2
37  10  0   27  0   7
37  10  27  39  0   8
38  10  0   27  1   17
39  10  0   27  0   0
39  10  27  34  0   6
39  10  34  37  0   9
39  10  37  49  1   14
40  10  0   27  0   14
40  10  27  34  0   18
40  10  34  43  1   20
41  10  0   28  0   8
42  10  0   27  0   11
42  10  27  34  1   18
43  10  0   27  0   10
43  10  27  34  0   12
43  10  34  45  1   16
44  10  0   27  0   0
44  10  27  37  1   1
45  10  0   27  0   9
45  10  27  43  1   19
;
```

Run the flow to create the Work.Tumor1 table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Proportional Hazards Regression** to add the step to your flow.

3 Add the Work.Tumor1 table to your flow. Connect the input port of the Proportional Hazards Regression node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Proportional Hazards Regression step, click the Proportional Hazards Regression node.

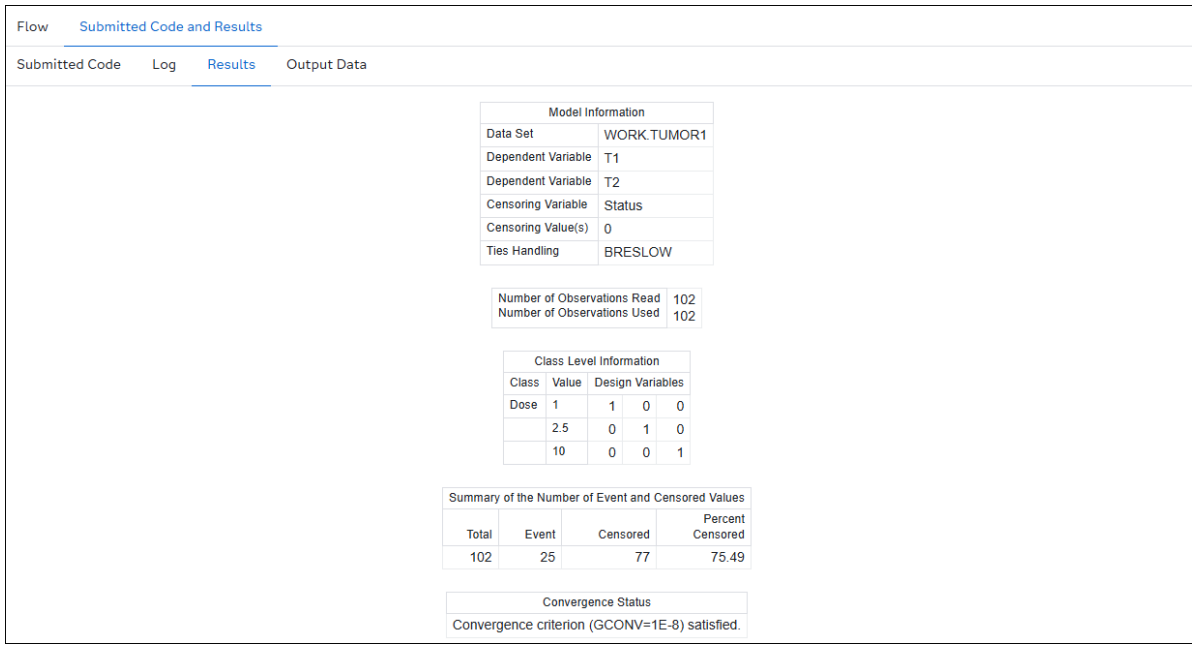
5 On the **Data** tab, select the **Counting process style of input** check box.

6 Assign columns to these roles:

- To the **Lower interval bound** role, assign **T1**.
- To the **Upper interval bound** role, assign **T2**.
- To the **Status variable** role, assign **Status**. In the **Censoring values** box, enter `0`.
- To the **Classification variables** role, assign **Dose**.
- To the **Continuous variables** role, assign **NPap**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Example 3: Stratified Cox Proportional Hazards Model

1 On a **SAS program** tab, copy and paste this code:

```
data Bmt_cr;
   input Disease Dftime Status Gender@@;
   Dftime= Dftime / 365.25;
   label Dftime='Disease-Free Survival Time (Years)'
         Disease='Disease Group';
   datalines;
1       2081       0       1       1       1602     0       1
1       1496       0       1       1       1462     0       0
1       1433       0       1       1       1377     0       1
1       1330       0       1       1       996      0       1
1       226        0       0       1       1199     0       1
1       1111       0       1       1       530      0       1
1       1182       0       0       1       1167     0       0
1       418        2       1       1       383      1       1
1       276        2       0       1       104      1       1
1       609        1       1       1       172      2       0
1       487        2       1       1       662      1       1
1       194        2       0       1       230      1       0
1       526        2       1       1       122      2       1
1       129        1       0       1       74       1       1
1       122        1       0       1       86       2       1
1       466        2       1       1       192      1       1
1       109        1       1       1       55       1       0
1       1          2       1       1       107      2       1
1       110        1       0       1       332      2       1
2       2569       0       1       2       2506     0       1
```

```
2       2409    0       1       2       2218    0       1
2       1857    0       0       2       1829    0       1
2       1562    0       1       2       1470    0       1
2       1363    0       1       2       1030    0       0
2       860     0       0       2       1258    0       0
2       2246    0       0       2       1870    0       0
2       1799    0       1       2       1709    0       0
2       1674    0       1       2       1568    0       1
2       1527    0       0       2       1324    0       1
2       957     0       1       2       932     0       0
2       847     0       1       2       848     0       1
2       1850    0       0       2       1843    0       0
2       1535    0       0       2       1447    0       0
2       1384    0       0       2       414     2       1
2       2204    2       0       2       1063    2       1
2       481     2       1       2       105     2       1
2       641     2       1       2       390     2       1
2       288     2       1       2       421     1       1
2       79      2       0       2       748     1       1
2       486     1       0       2       48      2       0
2       272     1       0       2       1074    2       1
2       381     1       0       2       10      2       1
2       53      2       0       2       80      2       0
2       35      2       0       2       248     1       1
2       704     2       0       2       211     1       1
2       219     1       1       2       606     1       1
3       2640    0       1       3       2430    0       1
3       2252    0       1       3       2140    0       1
3       2133    0       0       3       1238    0       1
3       1631    0       1       3       2024    0       0
3       1345    0       1       3       1136    0       1
3       845     0       0       3       422     1       0
3       162     2       1       3       84      1       0
3       100     1       1       3       2       2       1
3       47      1       1       3       242     1       1
3       456     1       1       3       268     1       0
3       318     2       0       3       32      1       1
3       467     1       0       3       47      1       1
3       390     1       1       3       183     2       0
3       105     2       1       3       115     1       0
3       164     2       0       3       93      1       0
3       120     1       0       3       80      2       1
3       677     2       1       3       64      1       0
3       168     2       0       3       74      2       0
3       16      2       0       3       157     1       0
3       625     1       0       3       48      1       0
3       273     1       1       3       63      2       1
3       76      1       1       3       113     1       0
3       363     2       1
;
```

Run the flow to create the Work.BMT_CR table.

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Proportional Hazards Regression** to add the step to your flow.

3 Add the Work.BMT_CR table to your flow. Connect the input port of the Proportional Hazards Regression node to the data source. For more information, see “Connecting Nodes” on page 13.

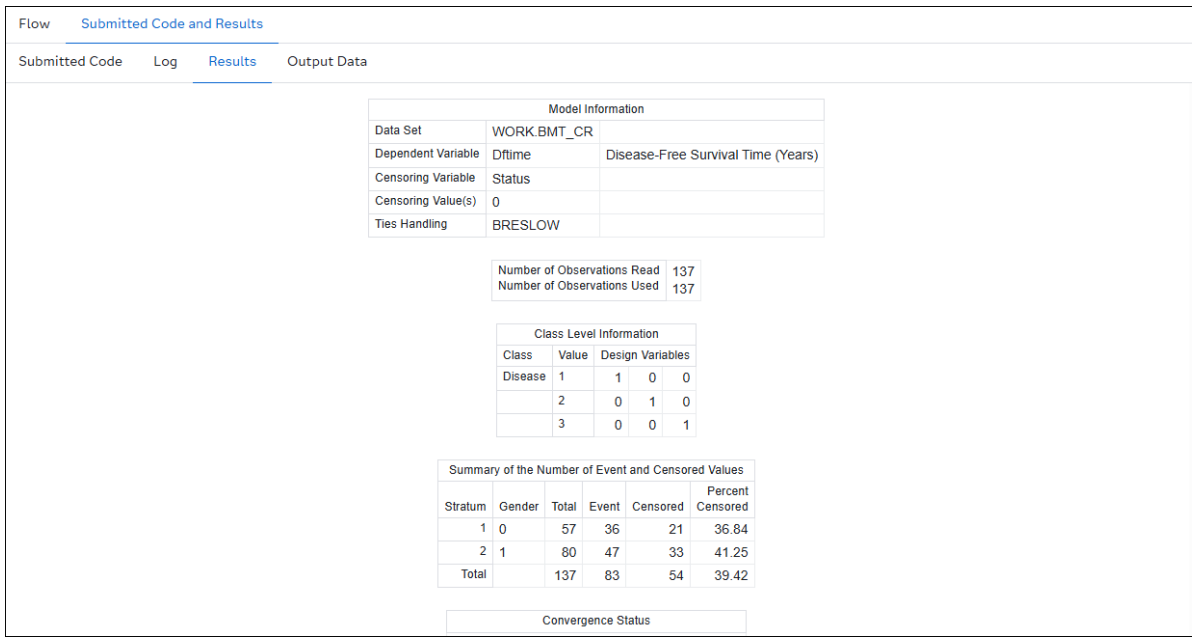
4 To set the options for the Proportional Hazards Regression step, click the Proportional Hazards Regression node.

5 On the **Data** tab, assign columns to these roles:

- To the **Survival time** role, assign **Dftime**.
- To the **Status variable** role, assign **Status**. In the **Censoring values** box, enter `0`.
- To the **Classification variables** role, assign **Disease**.
- To the **Stratify by** role, assign **Gender**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Model Information

Data Set	WORK.BMT_CR	
Dependent Variable	Dftime	Disease-Free Survival Time (Years)
Censoring Variable	Status	
Censoring Value(s)	0	
Ties Handling	BRESLOW	

Number of Observations Read	137
Number of Observations Used	137

Class Level Information

Class	Value	Design Variables		
Disease	1	1	0	0
	2	0	1	0
	3	0	0	1

Summary of the Number of Event and Censored Values

Stratum	Gender	Total	Event	Censored	Percent Censored
1	0	57	36	21	36.84
2	1	80	47	33	41.25
Total		137	83	54	39.42

Convergence Status

Proportional Hazards Regression: Right Censoring or No Censoring

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 (Optional) Select **Counting process style of input** to use data in the counting process formulation. The data for each unit or subject can span more than one row in the data set. This format can be used to handle time-dependent covariates as well as multiple events.

- If **Counting process style of input** is not selected and the censoring type is either **Right censoring** or **No censoring**, you must specify the **Survival time**.

  These options are available under the **Survival Time** heading when you select **Right censoring** as the **Censoring type**.

  - The **Status variable** role specifies the numeric variable that indicates various types of events that are associated with the observed failure times.
  - Censoring values indicate that the observed failure time is right-censored. You can specify a maximum of five different censoring values.
  - Select **Competing risks analysis** if the event of interest can be impeded by a prior event of a different type. For example, a patient's relapse might be the event of interest, but it is not observable if the patient dies before the relapse occurs.
    - From the **Event of interest** drop-down list, select the distinct value that corresponds to the event of interest. Any event that is not selected as a censoring value or event of interest is considered a competing risk.
    - Select a modeling approach. Here are the valid values: **Fine and Gray (subdistribution hazards)** and **Cause-specific hazard function**.
- If **Counting process style of input** is selected, you must specify the lower and upper bounds for the censoring intervals.

  Note: If the value for the lower bound is missing or 0 and the value for the upper bound is not missing, the observation is treated as left-censored. If the upper bound is missing and the value for the lower bound is not missing, the observation is treated as right-censored. Observations for which both variables are missing are not analyzed.

3 To the **Classification variables** role, assign one or more variables to use as the classification variables. You can also specify the parameterization of effects. The default is GLM coding.

An observation is excluded from the analysis if any variable in the model contains a missing value. Also, an observation is excluded if any classification variable contains a missing value (regardless of whether the classification variable is used in the model).

4 To the **Continuous variables** role, assign one or more numeric variables to use in the model.

5 To the **Stratify by** role, assign the variable whose values indicate the strata levels for a stratified analysis, such as a stratified Cox regression model.

6 (Optional) To the **Correlated data ID variable** role, assign the variable that identifies the correlated observations in multivariate failure time data.

This data occurs when each study subject can potentially experience several events (for example, multiple infections after surgery) or when there exists some natural or artificial clustering of subjects (for example, a litter of mice) that induces correlation among the failure times of the same cluster or unit. Data in the former situation is referred to as multiple events data, of which recurrent events data is a special case, and data in the latter situation is referred to as clustered data.

You can also specify the within-unit correlation adjustment. By default, no adjustment is performed. Here are the valid values:

- **Robust sandwich covariance matrix estimate** requests the robust sandwich estimate of Lin and Wei (1989) for the covariance matrix. The score residuals that are used in computing the middle part of the sandwich estimate are aggregated over identical ID values.
- **Random effect (frailty model)** uses the shared frailty model in which cluster effects are incorporated into the model as independent and identically distributed random effects.

Note: The **Correlated data ID variable** option is not available if you are performing a competing risks analysis or if the censoring type is **Interval censoring**.

7 (Optional) To the **Offset variable** role, assign the explanatory variable with a regression coefficient fixed as one.

8 (Optional) To the **Frequency count** role, assign the variable that specifies the frequency of each observation.

9 (Optional) To the **Weight variable** role, assign the variable that specifies the numeric variable whose case weights are used to weight each observation. Only positive, nonmissing values are used in the computation.

Note: This option is not available if **Interval censoring** is selected as the censoring type.

10 (Optional) To the **Group analysis by** role, assign the variables that determine the groups of observations for which separate analyses are performed. When you assign one or more variables to this role, the table is sorted by the selected variables, and analyses are performed on each group separately.

Step 2: Build a Model

On the **Model** tab, specify the model type.

You can choose from these options:

- **Main effects model**.
- **Main effects and all n-way interactions** - You must specify the value of N.

- **Custom model** - Specify the effects by using the continuous variables and classification variables that you selected on the **Data** tab.

  For more information, see Specification of Effects in *SAS/STAT User's Guide*.

Specify whether to include any time*variable interactions. These interactions are available only for continuous explanatory variables.

Step 3: Set the Options

Right Censoring or No Censoring

On the **Options** tab, you can set these options.

1 Specify a confidence level for the confidence intervals.

2 Specify how to handle ties in the survival time.

  Here are the valid values:

  - **Breslow (default)** uses the approximate likelihood of Breslow (1974).
  - **Discrete** replaces the proportional hazards model by a discrete logistic model.
  - **Efron** uses the approximate likelihood of Efron (1977).
  - **Exact** computes the exact conditional probability under the proportional hazards assumption that all tied event times occur before censored times of the same value or before larger values.

    Note: This computation can take a considerable amount of computer resources.

3 Specifies whether to set a maximum number of iterations. The default value depends on the selected optimization method. The default value is `25`.

4 (Optional) Specify these statistics.

  - Select **Number of units at risk** to display a table that contains the number of units at risk at each event time and the corresponding number of events in the risk sets.
  - Select **Event and censored observation frequencies** to display a table of the event and censored observation frequencies. This is the default.
  - Select **Schemper-Henderson measure of explained variance** to request the Schemper-Henderson measure (Schemper and Henderson 2000) of the proportion of variation that is explained by a Cox regression. This measure of explained variation is the ratio of distance measures between the observed survival processes and the fitted survival curves with and without covariates (explanatory variables) information. The distance measure is referred to as the predictive inaccuracy, because the smaller the predictive inaccuracy, the better the prediction.

Note: This option is not available with a counting process style of input, a frailty model, or time*variable interactions.

- Select **Concordance statistics** to display Harrell's concordance statistic. The concordance statistic, also known as the C-statistic, measures the agreement between observed and predicted outcomes to gauge the predictive accuracy of the model. The higher the C-statistic, the better the model can discriminate between subjects who do experience the outcome of interest and subjects who do not.

  Note: This option is available with a regular Cox regression model. It is not available with a counting process style of input, a frailty model, the robust sandwich covariance matrix estimate, a stratified analysis, or time*variable interactions.

- Specify these statistics for parameter estimates.
  - Produce the confidence intervals for hazard ratios of main effects that are not involved in interactions or nestings.

    You can also request the confidence limits based on the profile likelihood or based on the Wald tests.
  - Display the estimated correlation matrix of the parameter estimates.
  - Display the estimated covariance matrix of the parameter estimates.

5 Specify whether to perform these tests.

- Select **Include tests using model-based covariance matrix** to request that tests using the model-based covariance matrix (which is the inverse of the observed information matrix) are calculated in addition to tests that use the robust sandwich covariance matrix.

  Note: This option is available only if you select the robust sandwich covariance matrix estimate when you specify a correlated data ID variable on the **Data** tab.

- Select **Type 1 (sequential analysis)** to request that a Type 1 (sequential) analysis of likelihood ratio test be performed. This test consists of sequentially fitting models, beginning with the null model and continuing up to the model that is specified in the MODEL statement. The likelihood ratio statistic for each successive pair of models is computed and displayed in a table.

  Note: This option is not available with a frailty model or if a model selection method is requested on the **Selection** tab.

- Select **Type 3 analysis** to request the likelihood ratio tests, the score tests, or the Wald tests.

Note: Likelihood ratio tests and score tests are not available with a frailty model or the use of the robust sandwich covariance matrix estimate.

- Select **Correlation tests between weighted Schoenfeld residuals and survival time** to request a correlation test between the weighted Schoenfeld residuals and survival time as a way to check the proportional hazards assumption. This test is performed for each explanatory variable. You can also request the global correlation test.

  Note: This option is not available for a frailty model or time*variable interactions.

6 Select the plots to include in the results.

Note: No plots are available with a frailty model or time*variable interactions.

Specify the baseline functions.

- **Survival function**
- **Cumulative hazard function**

Set these options:

- Specify whether to include the pointwise confidence limits.

  Note: This option is not available for the hazard function plot.

- Specify whether to plot baseline functions at specified values of the explanatory variable.

  If you specify a data set for the explanatory variables in the **Save baseline function estimates and statistics** option on the **Output** tab, the same data set is used for calculating the estimates for these plots.

7 Specify these options for diagnostic and residual plots:

- Select **Cumulative martingale residuals** to create plots that can be used to assess the functional form of a continuous explanatory variable in the model. Each observed residual pattern can be compared graphically with a number of simulated realizations from the null distribution that assumes the model holds. Such comparisons enable you to objectively assess whether the observed residual pattern reflects anything beyond random fluctuation.

  For each variable selected, the observed cumulative martingale residuals are plotted against the values of the (continuous) explanatory variable along with simulated residual patterns. The number of simulated residual patterns is determined by the **Number of simulated patterns to display** option.

  Note: This option is available only for continuous explanatory variables. It is not available with the counting process style of input.

- Select the **Standardized score process** option to request plots for checking the proportional hazards assumption based on the score process. For each explanatory variable in the model, the observed score process component is plotted against the follow-up time along with simulated realizations from the null distribution that assumes the model holds. Such comparisons enable you to objectively assess whether the observed pattern reflects anything beyond random fluctuation.
  - Specify the number of simulated patterns to display in the cumulative martingale residual plots and the standardized score process plots.
  - Perform a Kolmogorov-type supremum test to supplement the graphical inspection in determining appropriate functional forms of continuous explanatory variables and assessing the proportional hazards assumption.
  - Specify a random seed for the random number generator that is used in creating simulated realizations for plots and for the Kolmogorov-type supremum tests. Specifying a seed enables you to reproduce identical graphs and p-values for the model assessments from the same PHREG specification.

  Note: This option is not available with the counting process style of input.

- Select **Weighted Schoenfeld residuals** to display the time-varying coefficient versus time, as well as a smoothed curve, as a means of assessing the proportional hazards assumption.

Competing Risks Analysis with Right Censoring or No Censoring

On the **Options** tab, you can set these options. These options are available if you selected **Competing risks analysis** on the **Data** tab.

1. Specify a confidence level for the confidence intervals.
2. Specify whether to set a maximum number of iterations. The default value depends on the selected optimization method. The default value is `25`.
3. Specify whether to display the default statistics. You can include these additional statistics. Select **Event and censored observation frequencies** to display a table of the event and censored observation frequencies. This is the default.
4. Specify whether to display the estimated correlation matrix and the estimated covariance matrix of the parameter estimates.
5. Select **Wald** to request Wald tests.
6. Select **Cumulative hazard function** to display a plot of the estimated cumulative hazard function.

   If you are running this step in a flow, you must add the input data for the analysis.

   a. Add your input table to the flow.

b Right-click the Proportional Hazards node and select **Add input port** ⇨ ***type-of-input-table***.

c Connect the input data to the new input port.

Note: If you specify a data set for the explanatory variables in the **Save baseline function estimates and statistics** option on the **Output** tab, the same data set is used for calculating the estimates for these plots.

Select the curve ID variable and how to display the curves on the plot.

Step 4: Set the Model Selection Options

On the **Selection** tab, you can specify these options.

Note: These options are not available if you are performing a competing risks analysis.

1 Specify the model selection method for the model. The step performs model selection by examining whether effects should be added to or removed from the model according to the rules that are defined by the selection method.

   Here are the valid values for the selection methods:

   - **None** fits the full model.
   - **Forward selection** starts with no effects in the model and adds effects based on the **Significance level to add an effect to the model** option.
   - **Backward elimination** starts with all the effects in the model and deletes effects based on the value in the **Significance level to remove an effect from the model** option.
   - **Stepwise selection** is similar to the forward selection model. However, effects that are already in the model do not necessarily stay there. Effects are added to the model based on the **Significance level to add an effect to the model** option and are removed from the model based on the **Significance level to remove an effect from the model** option.

2 Select whether to include the selection process details in the results.

3 Specify whether to maintain the hierarchy of effects. This option is selected by default.

Step 5: Set the Output Options

On the **Output** tab, you can specify the output tables for the step.

1 Specify whether to create a table that contains the survival function estimates and statistics.

Note: This option is not available for a frailty model, a cause-specific competing risks analysis, or time*variable interactions.

2 Specify whether to create a table that contains the regression coefficient estimates.

Note: This option is not available for a cause-specific competing risks analysis or interval censoring.

3 Specify whether to create a table that contains the baseline function estimates and statistics.

4 For each output table that you create, add an output table to the flow.

a Click **Add** and select **Table**.

b Select the Table node. In the table properties, enter the library name and the table name.

c Connect the output port to the Table node.

Proportional Hazards Regression: Interval Censoring

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 (Optional) Select **Counting process style of input** to use data in the counting process formulation. The data for each unit or subject can span more than one row in the data set. This format can be used to handle time-dependent covariates as well as multiple events.

3 For the censoring type, select **Interval censoring**.

4 Specify the lower interval bound and upper interval bound.

5 To the **Classification variables** role, assign one or more variables to use as the classification variables. You can also specify the parameterization of effects. The default is GLM coding.

An observation is excluded from the analysis if any variable in the model contains a missing value. Also, an observation is excluded if any classification

variable contains a missing value (regardless of whether the classification variable is used in the model).

6 To the **Continuous variables** role, assign one or more numeric variables to use in the model.

7 To the **Stratify by** role, assign the variable whose values indicate the strata levels for a stratified analysis, such as a stratified Cox regression model.

8 (Optional) To the **Offset variable** role, assign the explanatory variable with a regression coefficient fixed as 1 one.

9 (Optional) To the **Frequency count** role, assign the variable that specifies the frequency of each observation.

10 (Optional) To the **Group analysis by** role, assign the variables that determine the groups of observations for which separate analyses are performed. When you assign one or more variables to this role, the table is sorted by the selected variables, and analyses are performed on each group separately.

Step 2: Build a Model

On the **Model** tab, specify the model type.

You can choose from these options:

- **Main effects model**.
- **Main effects and all n-way interactions** – You must specify the value of N.
- **Custom model** – Specify the effects by using the continuous variables and classification variables that you selected on the **Data** tab.

  For more information, see Specification of Effects in *SAS/STAT User's Guide*.

Specify whether to include any time*variable interactions. These interactions are available only for continuous explanatory variables.

Step 3: Set the Options

On the **Options** tab, you can set these options.

1 Specify the functional form for the baseline function. Here are the valid values:

   - **Number of piecewise constant intervals** – Specify an integer between 0 and 100 (inclusive). The default value is 5.
   - **Cubic splines** – Specify degrees of freedom between 0 and 50 (inclusive). The default value is 2.

2 Specify a confidence level for the confidence intervals.

3 Specify the optimization method.

4 Specify whether to set a maximum number of iterations. The default value depends on the selected optimization method.

- If the optimization method is **Newton-Raphson with line search and ridging**, **Trust region**, or **Newton-Raphson with ridging**, the default value is `50`.
- If the optimization method is **Double-dogleg** or **Quasi-Newton**, the default value is `200`.
- If the optimization method is **Conjugate-gradient**, the default value is `400400`.
- If the optimization method is **Neider-Mead simplex**, the default value is `400`.

5 (Optional) Specify these statistics for parameter estimates.

- ☐ Display the estimated correlation matrix of the parameter estimates.
- ☐ Display the estimated covariance matrix of the parameter estimates.

6 Select the plots to include in the results.

Note: No plots are available with a frailty model or time*variable interactions.

Specify the baseline functions.

- **Survival function**
- **Cumulative hazard function**
- **Hazard function**

Set these options:

- Specify whether to include the pointwise confidence limits.

  Note: This option is not available for the hazard function plot.

- Specify whether to plot baseline functions at specified values of the explanatory variable.

  If you specify a data set for the explanatory variables in the **Save baseline function estimates and statistics** option on the **Output** tab, the same data set is used for calculating the estimates for these plots.

7 Specify these options for diagnostic and residual plots:

- **Deviance residuals**
- **Lagakos residuals**

Step 4: Set the Output Options

On the **Output** tab, you can specify the output tables for the step.

1 Specify whether to create a table that contains the survival function estimates and statistics.

Note: This option is not available for a frailty model, a cause-specific competing risks analysis, or time*variable interactions.

2 Specify whether to create a table that contains the baseline function estimates and statistics.

3 For each output table that you create, add an output table to the flow.

   a Click **Add** and select **Table**.

   b Select the Table node. In the table properties, enter the library name and the table name.

   c Connect the output port to the Table node.

Quantile Regression

About the Quantile Regression Step

The Quantile Regression step fits predictive models by using quantile regression with automated model selection.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Quantile Regression: Connection Requirements for the Node

In order to run the Quantile Regression step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data source must be a CAS table. ■ Table node	By default, an output table is created. This table must use a CAS engine libref. For more

Input Port	Output Port
or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	information, see "Quantile Regression" on page 425. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Quantile Regression of Baseball Data

To create this example:

1 On a **SAS program** tab, run this code to load the data into a CAS table.

```
libname mycas cas;

data mycas.baseball;
   set sashelp.baseball;
run;
```

2 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Quantile Regression** to add the step to your flow.

3 Add the MyCas.Baseball table to your flow. Connect the input port of the Quantile Regression node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Quantile Regression step, click the Quantile Regression node.

5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **Salary**.
- To the **Continuous variables** role, assign these variables:
  - **nAtBat**
  - **nHits**
  - **nHome**
  - **nRuns**
  - **nRBI**
  - **nBB**
  - **YrMajor**
  - **CrAtBat**
  - **CrHits**

- **CrHome**
- **CrRuns**
- **CrRbi**
- **CrBB**
- **nOuts**
- **nAssts**
- **nError**

- To the **Classification variables** role, assign **League** and **Division**.

6 Click the **Selection** tab. From the **Selection method** drop-down list, select **Forward selection**. From the **Add/remove effects with** drop-down list, select **Significance level** and enter `0.1` to add an effect to the model.

7 Click the **Options** tab. From the **Statistics to display** drop-down list, select **Default and selected statistics**. Next, select **Confidence limits for parameter estimates**.

8 Click the **Output** tab and select **Save observation statistics**. Select the **Predicted values** and **Residuals** check boxes.

9 Add an output table to the flow.

a Click **Add** and select **Table**.

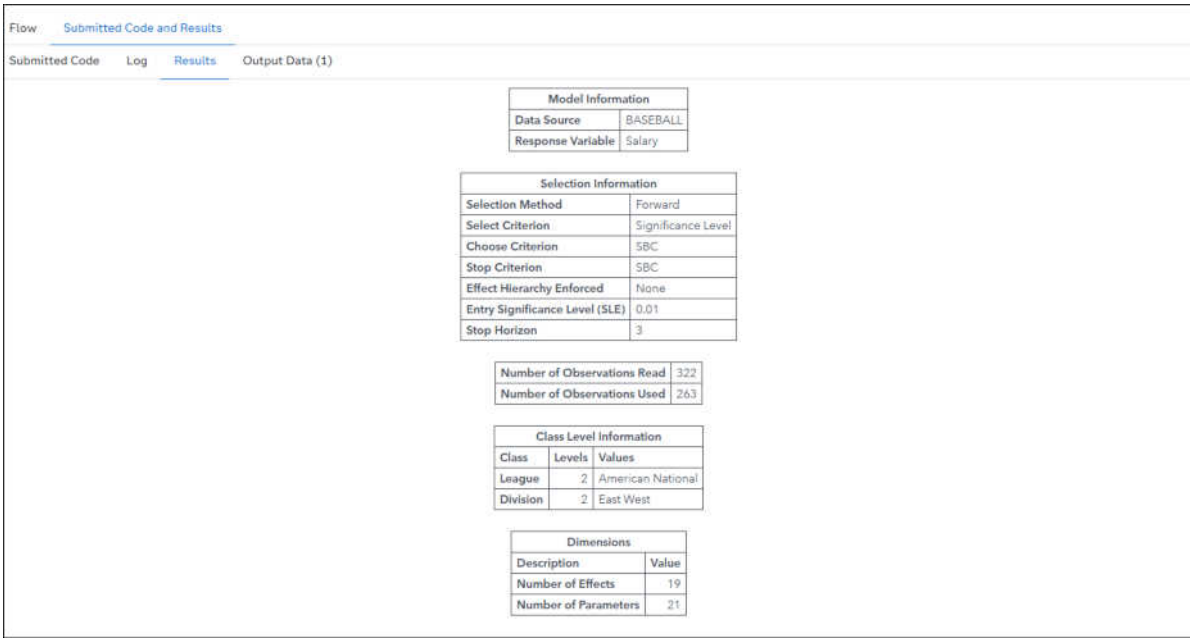
b Select the Table node. In the table properties, enter `MyCas` as the library name and `Example` as the table name.

c Right-click the Quantile Regression node and select **Add output port**.

d Connect the output port to the Table node.

10 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow
Submitted Code and Results
Submitted Code
Log
Results
Output Data (1)
Model Information
Data Source BASEBALL
Response Variable Salary
Selection Information
Selection Method Forward
Select Criterion Significance Level
Choose Criterion SBC
Stop Criterion SBC
Effect Hierarchy Enforced None
Entry Significance Level (SLE) 0.01
Stop Horizon 3
Number of Observations Read 322
Number of Observations Used 263
Class Level Information
Class Levels Values
League 2 American National
Division 2 East West
Dimensions
Description Value
Number of Effects 19
Number of Parameters 21

Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

MYCAS.EXAMPLE

Columns: 2 Rows: 322

Enter expression

	predicted	residual
1	178.11553035	.
2	529.25005163	-54.25005163
3	628.93486477	-148.9348648
4	1013.79379	-513.79379
5	335.62693769	-244.1269377
6	693.59561125	56.404388748
7	15.169309382	54.830690618
8	139.2121197	-39.2121197
9	171.11696757	-96.11696757
10	825.6180357	274.3819643
11	802.88725291	-285.7442529
12	219.78595935	292.71404065
13	396.03145539	153.96854461
14	194.39091629	505.60908371
15	255.03694494	-15.03694494
16	32.5383257	.
17	1116.8356519	-341.8356519
18	65.122798611	109.87720139

Quantile Regression: Partitioning Data

When you have sufficient data, you can partition your data into three parts: training data, validation data, and test data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds. Finally, after a model is selected, the test data can be used to assess how the

selected model generalizes on data that played no role in selecting the model. You can partition your data in either of these ways:

- You can specify a proportion of the validation or test data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is a validation or test case, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for validation or test cases. The input data set is divided into partitions by using these values.

Quantile Regression: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. (Optional) Specify whether you want to partition the data.
3. To the **Dependent variable** role, assign the numeric variable to use as the interval target.
4. Select the quantiles to calculate.
5. To the **Continuous variables** role, assign one or more numeric variables to use as the interval inputs.
6. To the **Classification variables** role, assign one or more variables to use as the classification variables.
7. To the **Weight** role, assign the variable for the weight.
8. To the **Group analysis by** role, assign the variable to obtain separate analyses of observations for each unique group.

Step 2: Build a Model

On the **Model** tab, specify the model type.

You can choose from these options:

- **Main effects model**.
- **Custom model** - You must specify the model effects.
- **Main effects and all n-way interactions** - You must specify the value of N.

Step 3: Set the Model Selection Options

On the **Selection** tab, you can set these options.

1 Specify the selection method for the model. The step performs model selection by examining whether effects should be added to or removed from the model according to the rules that are defined by the selection method. Here are the valid values for the selection methods:

- **None** fits the full model.
- **Forward selection** starts with no effects in the model and adds effects based on the value of the specified criterion.
- **Backward elimination** starts with all the effects in the model and deletes effects based on the value of the specified criterion.
- **Stepwise selection** is similar to the forward selection model. However, effects that are already in the model do not necessarily stay there. Effects are added to the model based on the specified criterion and are removed from the model based on the specified criterion.

2 Specify the criterion to use to add or remove effects from the model. The Schwarz Bayesian information criterion is used by default.

You can choose from these options:

- **Adjusted R1 statistic**.
- **Akaike's information criterion**.
- **Akaike's information criterion corrected for small-sample bias**.
- **R1 statistic**.
- **Schwarz Bayesian information criterion (Default)**.
- **Significance level** - You must enter the significance level in the **Significance level to add an effect to the model** option. The default value is `0.1`.

3 Specify the criterion to use to stop adding or removing effects from the model.

- **Adjusted R1 statistic**.
- **Akaike's information criterion**.
- **Akaike's information criterion corrected for small sample**.
- **Schwarz Bayesian information criterion (Default)**.
- **Significance level** - You must enter the significance level in the **Significance level to add an effect to the model** option. The default value is `0.1`.
- **None**.

4 Specify the criterion to use to identify the best fitting model.

- **Adjusted R1 statistic**
- **Akaike's information criterion**

- **Akaike's information criterion corrected for small sample**
- **Schwarz Bayesian information criterion (Default)**

5 Specify how much information about the selection process to include in the results. You can display a summary, details for each step of the selection process, or all of the information about the selection process.

6 Specify whether a nominal effect should be added or removed entirely or individually using a single degree of freedom.

Note: This option is available only if you specified classification variables.

7 (Optional) Specify whether to maintain the hierarchy of the effects. In order for a term to be included in the model, all model effects that are contained in the term must be present in the model.

Step 4: Set the Options

On the **Options** tab, you can specify these options:

1 Specify the confidence level to use for the construction of confidence intervals.

2 Select whether to display only the default statistics or the default statistics and the confidence limits for parameter estimates.

Step 5: Set the Output Options

On the **Output** tab, you can specify the output tables for the step.

1 Specify whether to create a table that contains the observation statistics. You can include the predicted values, confidence intervals for quantile prediction, residuals, and the standard errors of quantile prediction in the table.

Add an output table to the flow.

a Click **Add** and select **Table**.

b Select the Table node. In the table properties, enter the library name and the table name. When naming this table, you must specify a CAS engine libref.

c Connect the output port to the Table node.

2 (Optional) Include a partition identifier variable in the table if these conditions are met on the **Data** tab:

- The input data source is partitioned to use validation or test data.
- The partitions are generated by sampling. (In the **Identify partitions** drop-down list, you selected **Specify a sample proportion**.)

- (Optional) Specify what variables to include from the input data source.

3 (Optional) Save the scoring code. Specify the output folder for this code.

Same Birthday Probability

About the Same Birthday Probability Step

The Same Birthday Probability step computes the probability that two or more people in a room have the same birthday.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Same Birthday Probability: Connection Requirements for the Node

No input data is needed to run the Same Birthday Probability step.

Input Port	Output Port
No input data is required.	By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Probability of Two or More People Sharing a Birthday in a Room of 145 People

To create this example:

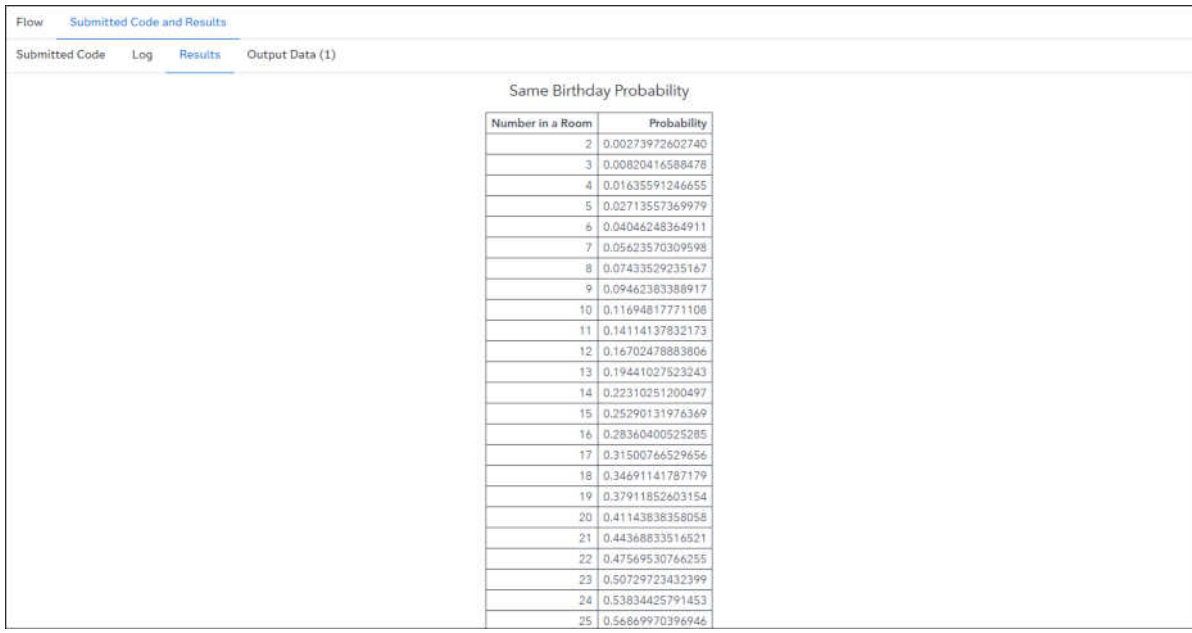
1 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Same Birthday Probability** to add the step to your flow.

2 In the **Number in a room** field, enter `145`.

3 Select **Replace existing output table**.

4 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

Same Birthday Probability

Number in a Room	Probability
2	0.00273972602740
3	0.00820416588478
4	0.01635591246655
5	0.02713557369979
6	0.04046248364911
7	0.05623570309598
8	0.07433529235167
9	0.09462383388917
10	0.11694817771108
11	0.14114137832173
12	0.16702478883806
13	0.19441027523243
14	0.22310251200497
15	0.25290131976369
16	0.28360400525285
17	0.31500766529656
18	0.34691141787179
19	0.37911852603154
20	0.41143838358058
21	0.44368833516521
22	0.47569530766255
23	0.50729723432399
24	0.53834425791453
25	0.56869970396946

Same Birthday Probability: Step-by-Step Instructions

1 Specify the number of people in the room.

2 (Optional) Specify whether to replace an existing output table with the same name.

Summary and Level Statistics

About the Summary and Level Statistics Step

The Summary and Level Statistics step computes level and descriptive statistics for variables in a data source.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Summary and Level Statistics: Connection Requirements for the Node

In order to run the Summary and Level Statistics step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input table must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output table, select the options on the **Output** tab. If you are running this step on a CAS server, you must use a CAS libref. For more information, see "Step 3: Set the Output Options" on page 438. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Summary and Level Statistics for Cars Data

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Run this code to load the data into a CAS table:

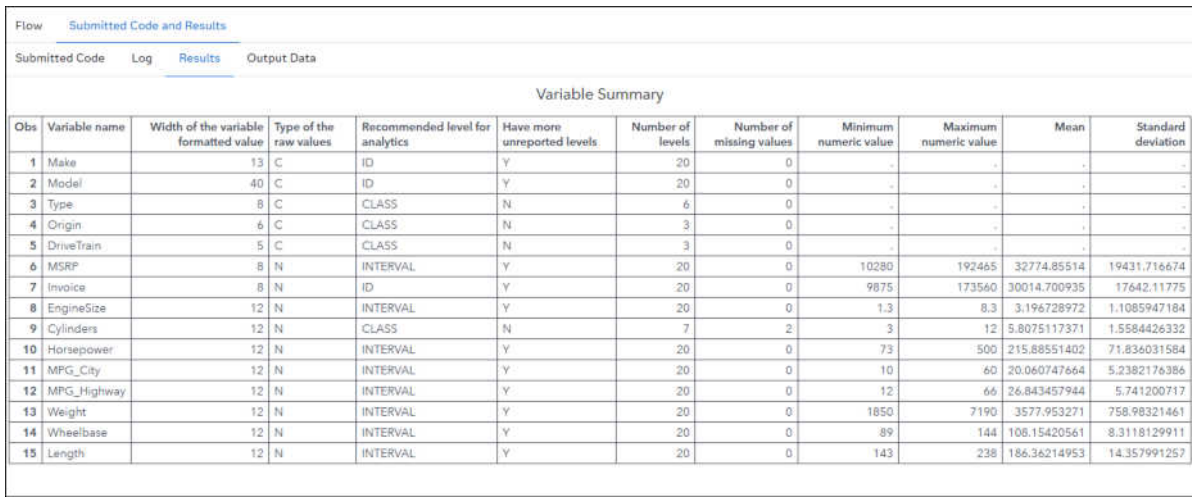
```
libname mycas cas;

data mycas.cars;
   set sashelp.cars;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Summary and Level Statistics** to add the step to your flow.

4 Add the MyCas.Cars table to your flow. On the Summary and Level Statistics node, connect the input port for the Links data to the data source. For more information, see "Connecting Nodes" on page 13.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

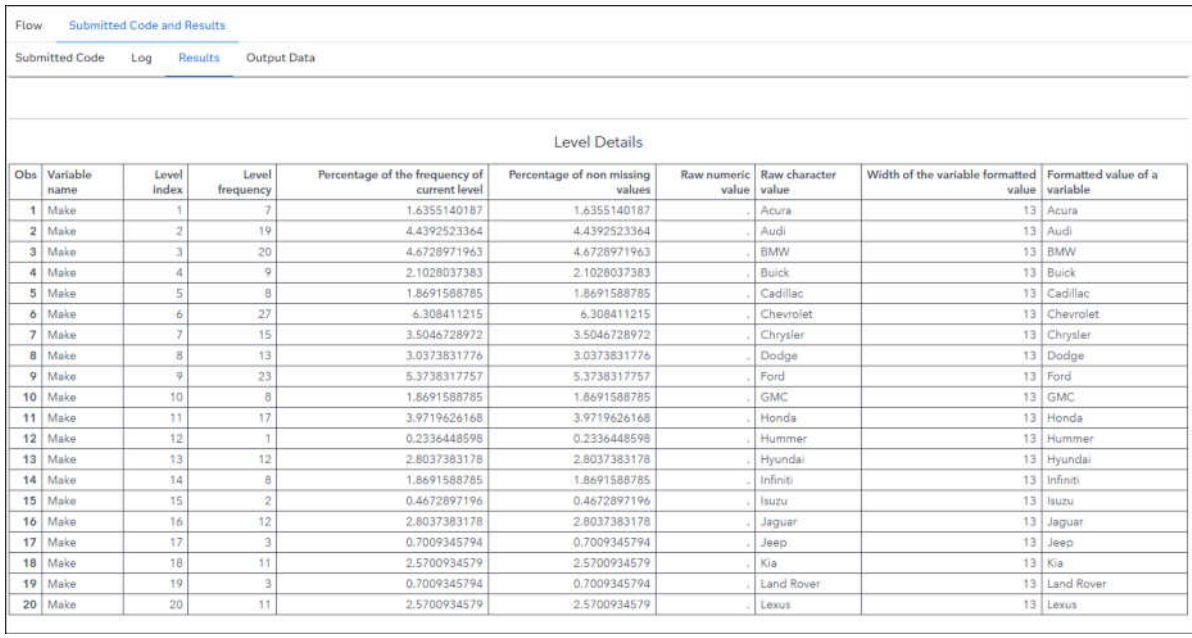


Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data

Variable Summary

Obs	Variable name	Width of the variable formatted value	Type of the raw values	Recommended level for analytics	Have more unreported levels	Number of levels	Number of missing values	Minimum numeric value	Maximum numeric value	Mean	Standard deviation
1	Make	13	C	ID	Y	20	0	.	.	.	.
2	Model	40	C	ID	Y	20	0	.	.	.	.
3	Type	8	C	CLASS	N	6	0	.	.	.	.
4	Origin	6	C	CLASS	N	3	0	.	.	.	.
5	DriveTrain	5	C	CLASS	N	3	0	.	.	.	.
6	MSRP	8	N	INTERVAL	Y	20	0	10280	192465	32774.85514	19431.716674
7	Invoice	8	N	ID	Y	20	0	9875	173560	30014.700935	17642.11775
8	EngineSize	12	N	INTERVAL	Y	20	0	1.3	8.3	3.196728972	1.1085947184
9	Cylinders	12	N	CLASS	N	7	2	3	12	5.8075117371	1.5584426332
10	Horsepower	12	N	INTERVAL	Y	20	0	73	500	215.88551402	71.836031584
11	MPG_City	12	N	INTERVAL	Y	20	0	10	60	20.060747664	5.2382176386
12	MPG_Highway	12	N	INTERVAL	Y	20	0	12	66	26.843457944	5.741200717
13	Weight	12	N	INTERVAL	Y	20	0	1850	7190	3577.953271	758.98321461
14	Wheelbase	12	N	INTERVAL	Y	20	0	89	144	108.15420561	8.3118129911
15	Length	12	N	INTERVAL	Y	20	0	143	238	186.36214953	14.357991257



Flow Submitted Code and Results

Submitted Code Log Results Output Data

Level Details

Obs	Variable name	Level index	Level frequency	Percentage of the frequency of current level	Percentage of non missing values	Raw numeric value	Raw character value	Width of the variable formatted value	Formatted value of a variable
1	Make	1	7	1.6355140187	1.6355140187	.	Acura	13	Acura
2	Make	2	19	4.4392523364	4.4392523364	.	Audi	13	Audi
3	Make	3	20	4.6728971963	4.6728971963	.	BMW	13	BMW
4	Make	4	9	2.1028037383	2.1028037383	.	Buick	13	Buick
5	Make	5	8	1.8691588785	1.8691588785	.	Cadillac	13	Cadillac
6	Make	6	27	6.308411215	6.308411215	.	Chevrolet	13	Chevrolet
7	Make	7	15	3.5046728972	3.5046728972	.	Chrysler	13	Chrysler
8	Make	8	13	3.0373831776	3.0373831776	.	Dodge	13	Dodge
9	Make	9	23	5.3738317757	5.3738317757	.	Ford	13	Ford
10	Make	10	8	1.8691588785	1.8691588785	.	GMC	13	GMC
11	Make	11	17	3.9719626168	3.9719626168	.	Honda	13	Honda
12	Make	12	1	0.2336448598	0.2336448598	.	Hummer	13	Hummer
13	Make	13	12	2.8037383178	2.8037383178	.	Hyundai	13	Hyundai
14	Make	14	8	1.8691588785	1.8691588785	.	Infiniti	13	Infiniti
15	Make	15	2	0.4672897196	0.4672897196	.	Isuzu	13	Isuzu
16	Make	16	12	2.8037383178	2.8037383178	.	Jaguar	13	Jaguar
17	Make	17	3	0.7009345794	0.7009345794	.	Jeep	13	Jeep
18	Make	18	11	2.5700934579	2.5700934579	.	Kia	13	Kia
19	Make	19	3	0.7009345794	0.7009345794	.	Land Rover	13	Land Rover
20	Make	20	11	2.5700934579	2.5700934579	.	Lexus	13	Lexus

Summary and Level Statistics: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Specify whether to include all the variables in the input table in the summary or to select the variables to include in the summary.

3 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the default order for determining the levels to maintain for the classification variable.

2 Specify the maximum number of levels to define from the values for any given classification variable. The levels are in the order that is specified in the **Order of levels** option. All other values for the classification variable are grouped into a single category. Missing values are not included as levels. The valid range for this option is from 1 to 254 (inclusive).

3 Specify the statistics to display in the results. The available statistics are listed by category:

- variable attributes
- cardinality
- descriptive statistics
- most frequent level
- last seen level

4 Specify whether to include all the variables in the variable summary or only a subset of the variable summary.

5 Specify whether to show levels for all the variables, the selected variables, or a subset of levels.

- If you select the **Show all levels of specified variables** option and you also select the **Select variables to summarize** option on the **Data** tab, only the variables that you assigned to the **Variables** role are available.
- If you select the **Show all levels of specified variables** option and you also select the **Summarize all variables** option on the **Data** tab, all variables in the data source are available for selection.

Step 3: Set the Output Options

On the **Output** tab, you can create these output tables. When naming these tables, you must specify a CAS engine libref.

1 (Optional) Specify whether to create a variable summary table that contains various statistics for the selected variables.

2 (Optional) Specify whether to create a level details table that contains the list of level (distinct values) for selected variables.

Note: If you are running the step in a flow, you must add an output port for each output table to the Summary and Level Statistics node. For more information, see "Summary and Level Statistics: Connection Requirements for the Node" on page 435.

Summary Statistics

About the Summary Statistics Step

The Summary Statistics step provides descriptive statistics for variables across all observations and within groups of observations. You can also summarize your data in a graphical display such as histograms and box plots.

For example, you could use this step to create a report on the number of new sales, arranged by product type and country.

Note: The Summary Statistics step is available only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.

Summary Statistics: Connection Requirements for the Node

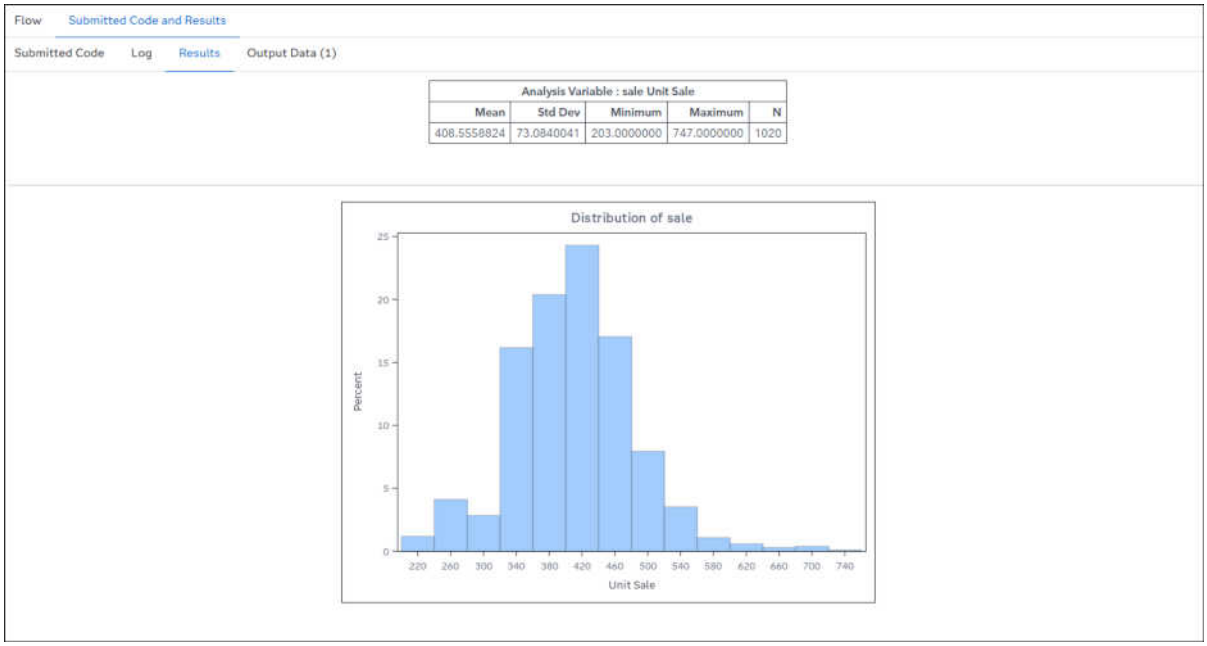
In order to run the Summary Statistics step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, an output data table is created. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Summary Statistics of Unit Sales

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Summary Statistics** to add the step to your flow.
2. Add the Sashelp.PriceData table to your flow. Connect the input port of the Summary Statistics node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Summary Statistics step, click the Summary Statistics node.
4. On the **Data** tab, assign**sale** to the **Analysis variables** role.
5. On the **Options** tab, expand the Plots heading. Select the **Histrogram** check box.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a sample of the results:



Summary Statistics: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Assign a numeric variable to the **Analysis variables** role.

3 Assign a character or discrete numeric variable to the **Classification variables** role. The statistics are calculated on all selected analysis variables for each unique combination of classification variables.

Specify the combinations of classification variables.

- **N-way only** creates a single table that shows the summary statistics for the n-way combination of the classification variables. For example, suppose that you want to compare the sales that result from two different marketing campaigns. You assign the variable Profit to the **Analysis variables** role and the variables Month, Marketing Campaign, and Region to the **Classification variables** role. Then selecting the **N-way only** option results in a table of Month*Marketing Campaign*Region.
- **All ways** creates a separate table of summary statistics for each unique combination of the classification variables. For example, using the variables Month, Campaign, and Region, and then selecting the **All ways** option results in the following tables:
  - a table of overall sales. This is called a zero-way table, and the classification variables are not included.
  - a one-way table that displays the summary statistics for each month (for example, May, June, and July).
  - a one-way table that displays the summary statistics for each region (for example, north, south, east, and west).
  - a one-way table that displays the summary statistics for each type of marketing campaign (for example, TV commercial, magazine ad).
  - a two-way table that displays the summary statistics for Month*Region.
  - a two-way table that displays the summary statistics for Month*Campaign.
  - a two-way table that displays the summary statistics for Region*Campaign.
  - a three-way table that displays the summary statistics for Month*Campaign*Region.
- **Specify ways** creates a separate table of summary statistics for each unique combination of the classification variables that you specify. For example, if

you enter `1`, `2`, or `3` in the **Specify ways** box, the results contain all the possible one-way, two-way, or three-way tables. If you specify `0` in this box, then the results contain a zero-way table, which does not include the classification variables.

4 (Optional) To obtain separate analyses of observations for each unique group, assign a variable to the **Group analysis by** role.

5 (Optional) To specify the numeric variable whose value represents the frequency of the observation, assign a variable to the **Frequency count** role. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

6 (Optional) Assign a variable to the **Weight variable** role. If you assign a variable to this role, the value of the variable for each observation is used to calculate weighted means, variances, and sums. You can assign a maximum of one variable to this role.

Step 2: Select the Statistics

On the **Options** tab, you can set these options:

1 Select the basic statistics to include in the analysis.

- **Mean** is the arithmetic average, calculated by adding the values of an analysis variable and dividing this sum by the number of nonmissing observations.
- **Standard deviation** is a statistical measure of the variability of a group of data values. This measure, which is the most widely used measure of the dispersion of a frequency distribution, is equal to the positive square root of the variance.
- **Minimum value** is the smallest value for an analysis variable.
- **Maximum value** is the largest value for an analysis variable.
- **Number of observations** is the total number of observations with nonmissing values.
- **Number of missing values** is the total number of observations with missing values.

2 Specify the maximum number of decimal places for the calculated statistics. By default, a statistic is displayed by using the best fit, which is usually seven decimal places.

3 Specify the divisor to use in the calculation of the variance and standard deviation. By default, the divisor is the degrees of freedom.

4 Select any additional statistics:

- **Standard error** is the standard deviation of the sample mean. The standard error is defined as the ratio of the sample standard deviation to the square root of the sample size.
- **Variance** is a statistical measure of dispersion of data values. This measure is an average of the total squared dispersion between each observation and the sample mean.
- **Mode** is the most frequent value for the analysis variable.

  Note: This option is not available if you assigned a weight variable.

- **Range** is the difference between the largest and smallest values in the data.
- **Sum** is the sum of all values in the analysis variable.
- **Sum of weights** is the sum of the numeric variable that is used to weight each observation.
- **Confidence limits for the mean** is the two-sided confidence limits for the mean.
- **t statistic and Prob > |t|** produces *t* statistics for the regression coefficients and probability levels for the *t* statistics.
- **Coefficient of variation** is a unitless measure of relative variability. This measure is defined as the ratio of the standard deviation to the mean expressed as a percentage. The coefficient of variation is meaningful only if the variable is measured on a ratio scale.
- **Uncorrected sum of squares** displays the uncorrected sum of squares.
- **Skewness** measures the tendency of the deviations to be larger in one direction than in the other.

  Note: This option is not available if you assign a weight variable.

- **Kurtosis** measures the heaviness of tails.

  Note: This option is not available if you assign a weight variable.

5 Select the percentiles to compute.

6 Select whether to include a histogram or box plot in the results.

Note: Weight variables are ignored when calculating plots.

- **Histogram** creates a graph that is used to determine the distribution of the data. You can also specify these options:
  - If you select **Add normal density curve**, the step uses the sample mean and sample standard deviation for μ and σ.
  - If you select **Add kernel density estimate**, the step uses the AMISE method to compute the kernel density estimates.

- Select **Add inset statistics** to select where to display the statistics in relation to the histogram.
- If you assigned only one analysis variable, select **Use midpoints** to specify the starting and ending midpoints. You can also specify the step interval to use to calculate the other midpoints. The midpoint is the middle value of the range of values represented by each bar.

- **Box plot** creates a box plot that shows a measure of central location (the median), two measures of dispersion (the range and interquartile range), the skewness (from the orientation of the median relative to the quartiles), and potential outliers. Box plots are especially useful in comparing two or more sets of data.

Step 3: Specify the Titles and Footnotes for the Results

On the **Titles** tab, you specify whether to use the default text for the title and the footnote. Alternatively, you can customize this text. You can use macro variables in titles and footnotes.

Step 4: Specify the Output Options

On the **Output** tab, you can specify these options:

1. Select **Create output data** to save the results to an output table. By default, SAS Data and AI Studio overwrites any existing output tables.

   Note: If you are running the step in a flow, you must add an output port for the output data to the Summary Statistics node. For more information, see "Bubble Map: Connection Requirement for the Node" on page 939.

2. Select **Show statistics** to show the statistics for the combinations of the classification variables in the results.
3. Select **Show Analysis labels** to display the labels for the analysis variables.

Summary Tables

About the Summary Tables Step

The Summary Tables step displays descriptive statistics in tabular format, using some or all of the variables in a data set. You can create a variety of tables, ranging from simple to highly customized.

For example, suppose that you have a SAS data set that contains data on sales of a product by two types of customers, residential and business, in individual states in the northeast and west regions of the United States. You can use the Summary Tables step to sum the sales for each customer type in each state in a geographic region.

Note: The Summary Tables step is available only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.

Summary Tables: Connection Requirements for the Node

In order to run the Summary Statistics step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Creating a Summary Table

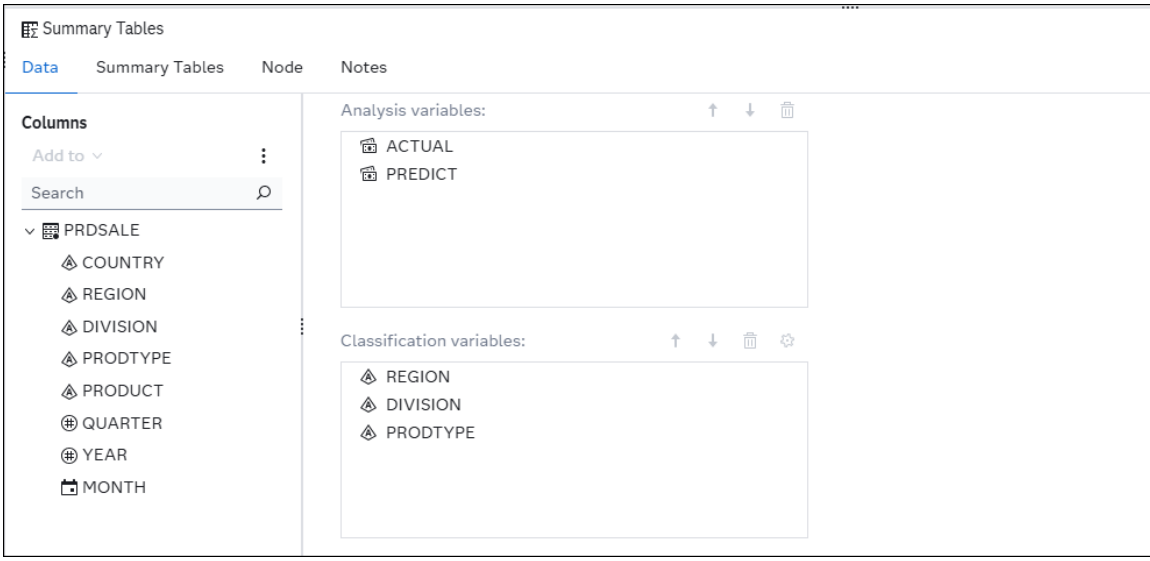
1 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Summary Tables** to add the step to your flow.

2 Add the Sashelp.PrdSale table to your flow. Connect the input port of the Summary Tables node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the step, click the Summary Tables node.

4 On the **Data** tab, assign variables to these roles:

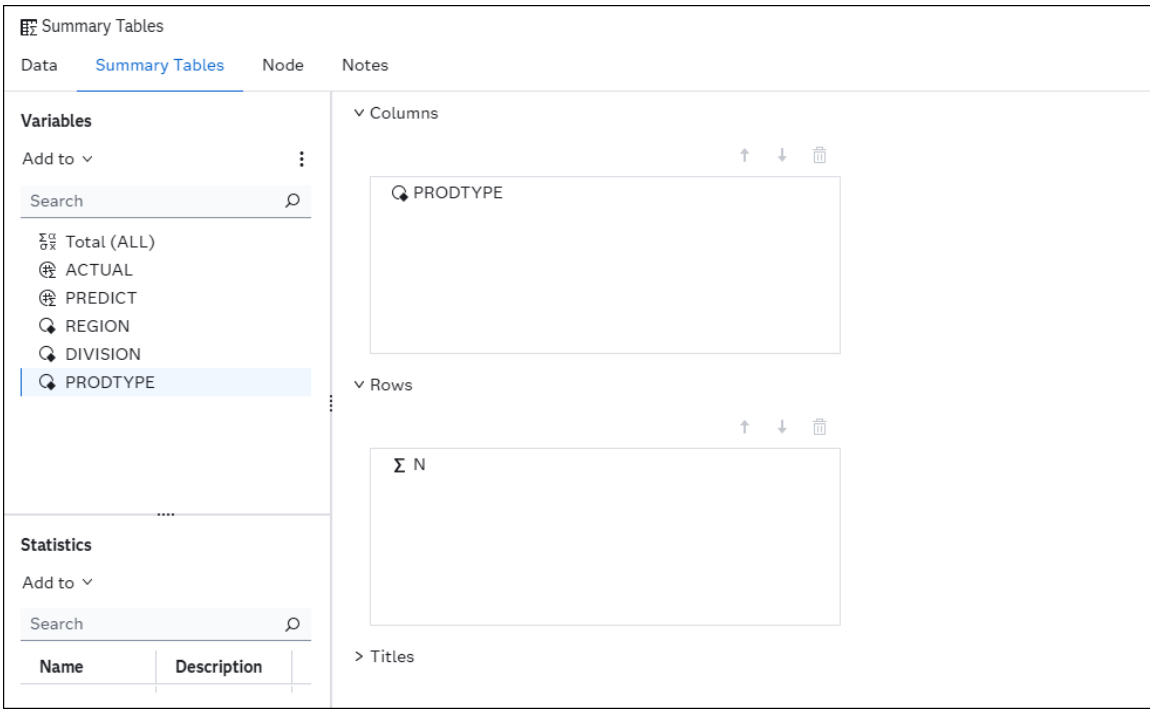
- In the Columns pane, select **ACTUAL** and **PREDICT**. Select **Add to** ⇨ **Analysis variables**.
- In the Columns pane, select **REGION**, **DIVISION**, and **PRODTYPE**. Select **Add to** ⇨ **Classification variables**.



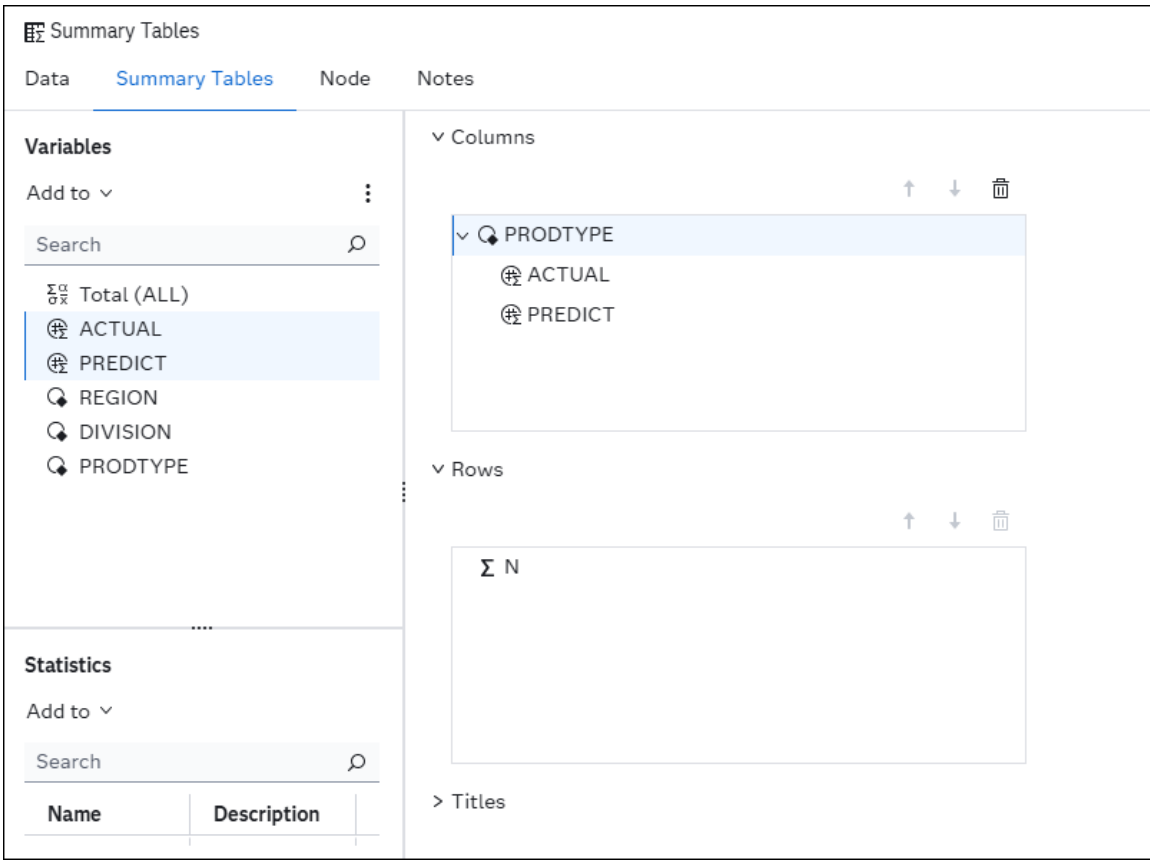
5 Click the **Summary Tables** tab.

In the Variables pane, select **PRODTYPE**. Select **Add to** ⇨ **Columns**.

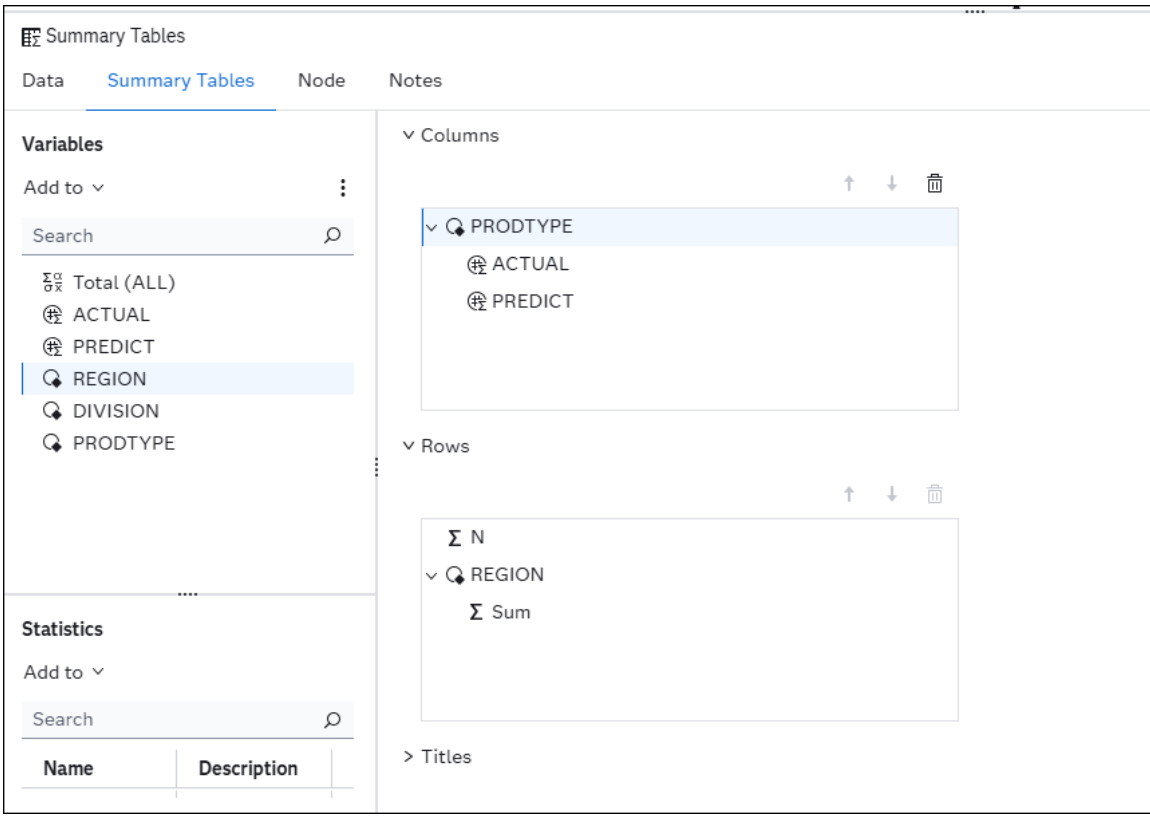
The ProdType variable is added to the root level. The number of observations (N) statistic is added to the **Rows** box by default.



6 In the Columns pane, select **PRODTYPE**. In the Variables pane, select **ACTUAL** and **PREDICT**. Select **Add to** ⇨ **Columns**.



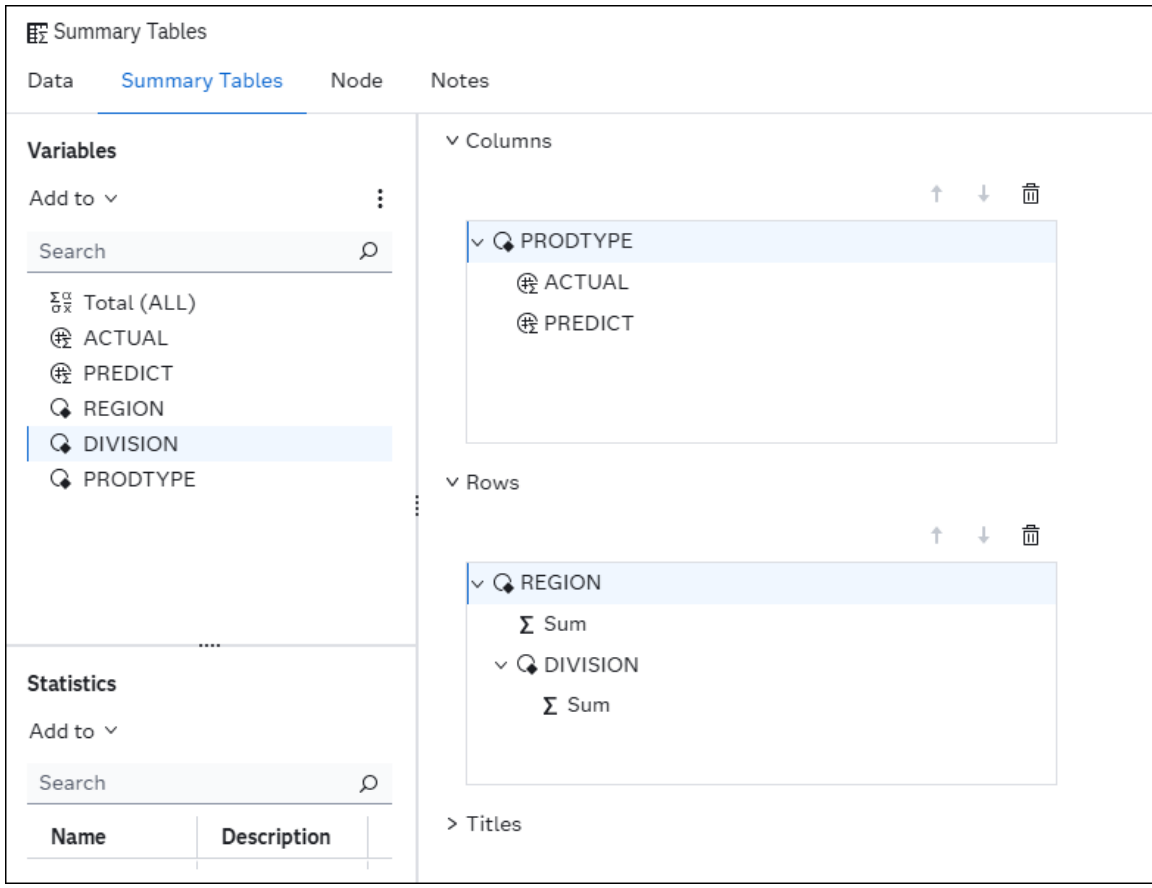
7 In the Variables pane, select **REGION**. Select **Add to** ⇨ **Rows**.



Note: The Region variable is added to the root level in the **Rows** box. If the N statistic had been selected, Region would have been added as a child of N. To add a variable or statistic to the root level of the **Columns** or **Rows** box, make sure no columns or rows are selected.

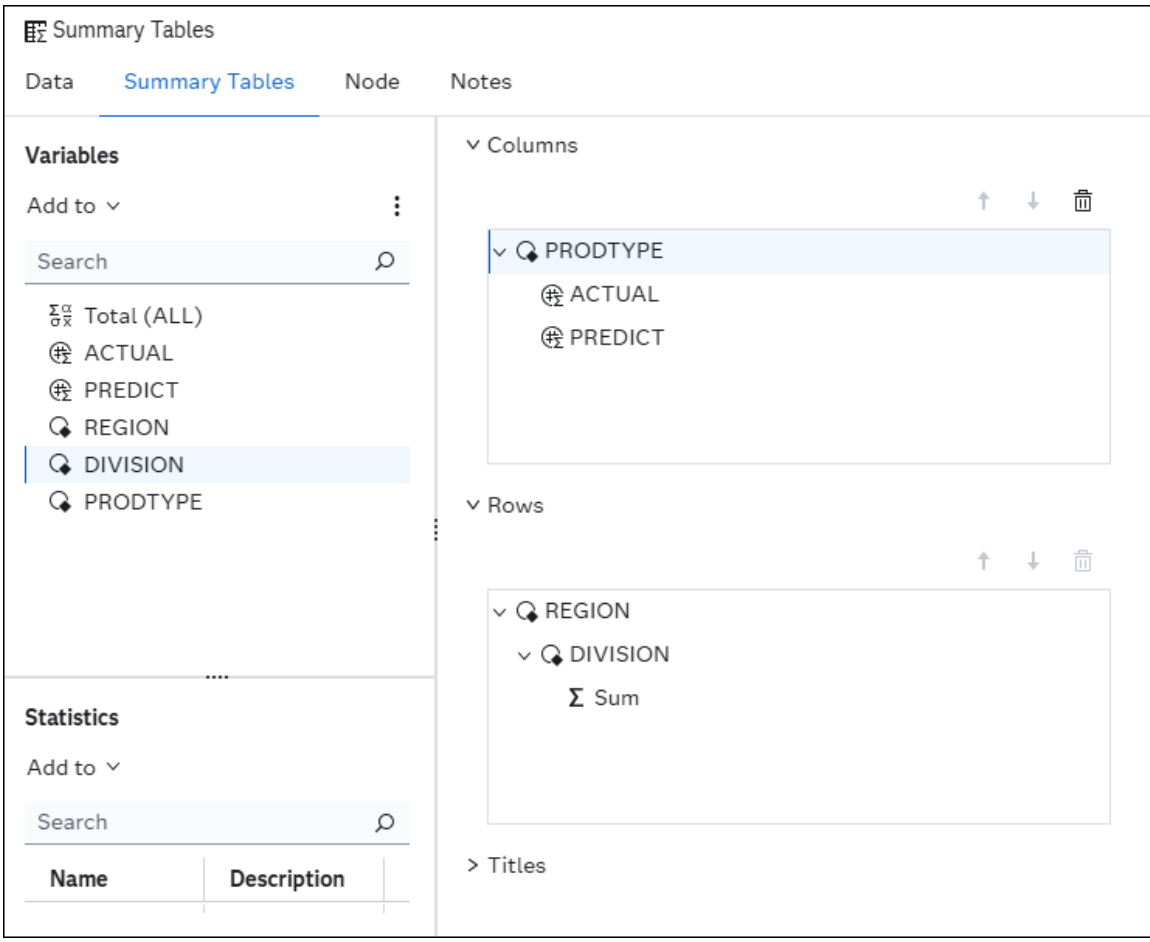
8 In the **Rows** box, select **N** and click .

9 In the **Rows** box, select **REGION**. In the Variables pane, select **DIVISION**. Select **Add to** ⇨ **Rows**.



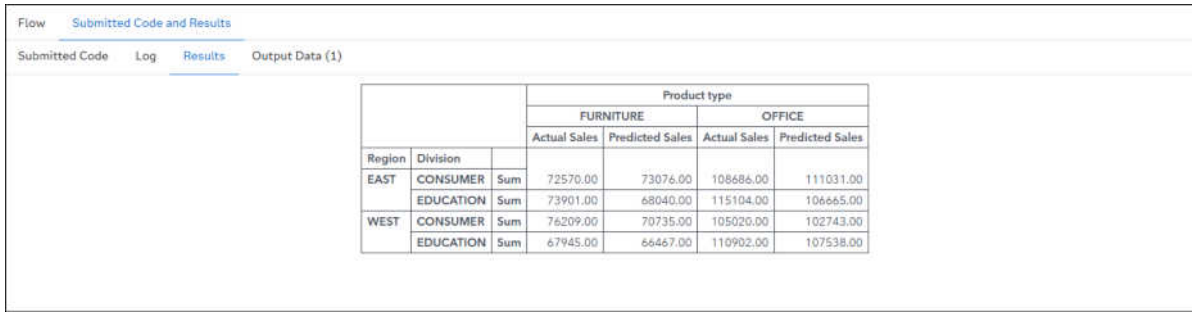
10 In the **Rows** box, select **Sum** under REGION and click .

Now, the settings on the **Summary Tables** tab should look like this screenshot.



11 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



			Product type			
			FURNITURE		OFFICE	
			Actual Sales	Predicted Sales	Actual Sales	Predicted Sales
Region	Division					
EAST	CONSUMER	Sum	72570.00	73076.00	108686.00	111031.00
	EDUCATION	Sum	73901.00	68040.00	115104.00	106665.00
WEST	CONSUMER	Sum	76209.00	70735.00	105020.00	102743.00
	EDUCATION	Sum	67945.00	66467.00	110902.00	107538.00

Summary Tables: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 To assign a numeric variable to the **Analysis variables** role, select the column name and select **Add to** ⇨ **Analysis variables**.

2 To assign a character or discrete numeric value to the **Classification variables** role, select the column name and select **Add to** ⇨ **Classification variables**. The classification variables are used to divide the input data into categories or subgroups. The statistics are calculated on all selected analysis variables for each unique combination of classification variables.

To change the settings for a selected classification variable, click . You can set these options:

- **Sort by** - You can sort the values of the classification variable by data set order, formatted values, descending frequencies, or unformatted values (default).
- **Order** - You have the values in ascending or descending order.
- **Missing values** - You can specify whether to include or exclude missing values.
- **Restrict levels to format variables** - You can specify whether to restrict levels to format variables or to use levels for all variables.
- **Pre-load levels from format** - You can specify whether to preload the values.
- **Multilabel formats** - You can set this option so that the primary and secondary format labels for a given range or overlapping ranges are used to create subgroup combinations when a multilabel format is assigned to this variable.
- **Heading format** - You can specify the format for the heading.

3 (Optional) To assign a variable to the **Pages** role, select the column name and select **Add to** ⇨ **Pages**. This variable generates a separate summary table for each distinct value.

4 (Optional) To assign a variable to the **Relative weight** role, select the column name and select **Add to** ⇨ **Relative weight**. This variable is used to calculate the weighted means, variances, and sums.

5 (Optional) To assign a variable to the **Frequency count** role, select the numeric variable whose value represents the frequency of the observation, and then select **Add to** ⇨ **Frequency count**. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than

1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Create the Summary Table

On the **Summary Tables** tab, you can create the summary table.

To set up a summary table, you must decide what information you want and how you want it to appear. The Summary Tables step is very flexible; you can arrange classification and analysis variables in any way you want.

1 To assign a variable or statistic to a column, select the variable or statistic in the pane, and then select **Add to** ⇨ **Columns**.

2 To assign a variable or statistic to a row, select the variable or statistic in the pane, and select **Add to** ⇨ **Rows**.

Note: By default, the number of observations (N) statistic is applied to the analysis variables.

3 Specify whether to use the default text for the title and the footnote. Alternatively, you can customize this text. You can use macro variables in titles and footnotes.

Survival Rank Tests

About the Survival Rank Tests Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. The Survival Rank Tests step calculates power, sample size, or number of events for two-sample survival rank tests.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see “Summary of Flow Functionality” in *SAS Data and AI Studio: User’s Guide*.

Survival Rank Tests: Connection Requirements for the Node

No input or output data is required to run the Survival Rank Tests step.

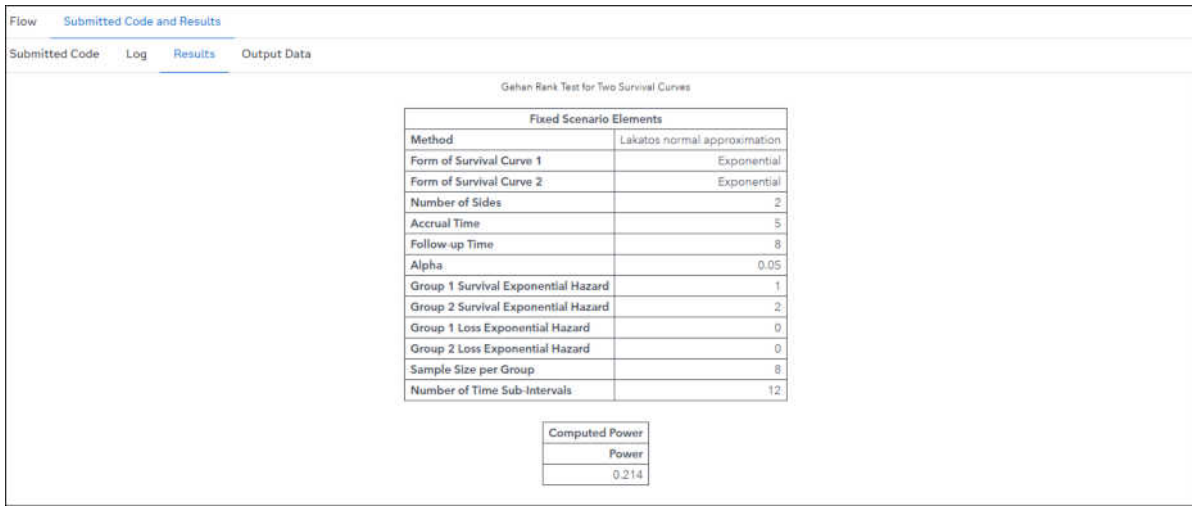
Example: Survival Rank Tests

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Survival Rank Tests** to add the step to your flow.
2. For the **Solve for** option, select **Power**.
3. For the **Select a test** option, select **Gehan rank**.
4. From the **Select the number of sides of the test** drop-down list, select **Two-sided test**.
5. In the **Alpha values** box, enter `0.05`.
6. Under the **Survival Distribution** heading, select these options:
   - From the **Select a form** drop-down list, select **Group survival hazards**.
   - For the values of the group survival hazard, enter `1` and `2`.
7. Expand the **Loss (Censoring) Distribution** heading and select the **Specify the loss distribution** check box.
   - From the **Select a form** drop-down list, select **Group loss hazards**.
   - For the values of the group loss hazard, enter `0` and `0`.
8. Under the **Accrual Time** heading, select **Accural and follow-up times** from the **Select a form** drop-down list. Enter an accrual time of `5` and a follow-up time of `8`.
9. Under the **Sample Size** heading, select **Sample size per group** from the **Select a form** drop-down list. Enter `8` as the value of the sample size per group.
10. Run the flow.

Click the **Submitted Code and Results** tab to view the results.

The computed power is 0.214.



Survival Rank Tests: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 For the **Solve for** option, select whether to solve for power, total sample size, sample size per group, or number of events.

2 Select the test to use in the analysis:

- Gehan rank
- Log rank
- Tarone-Ware rank

3 Select the number of sides (or tails) of the test. You can perform a one-sided test, a lower one-sided test, an upper one-sided test, or a two-sided test.

4 Specify the significance level to use in the analysis. You can specify more than one value.

5 Select the form of the distribution:

- **Survival hazard ratios and hazards** - Enter one or more values for the hazard ratio (which must be greater than 0) and the hazard (which must be greater than 0).
- **Group survival harzards** - Enter a hazard value for each group. These values must be greater than 0. You can enter more than one row of hazard values.
- **Group median survival times** - Enter a median survival time for each group. These times must be greater than 0. You can enter more than one row of median survival times.

6 Specify the options for the loss distribution.

- Specify whether to include the loss distribution in the analysis.
- From the **Select a form** option, specify whether to use group loss hazards or group median loss times for the loss distribution. You must specify one or more values for the hazards or times.

7 Specify whether to use accrual and follow-up times; accrual and total times; or follow-up and total times.

8 Specify the power values for the analysis. These values must be greater than 0 and less than 1.

Note: This option is not available if you are solving for power.

9 From the **Allow fractional sample sizes** option, specify whether decimal components are allowed when you specify a sample size.

Note: This option is available only if you are solving for power.

10 Specify the form to use to determine the sample size.

- **Sample size per group** specifies the values of N for each group. This value must be greater than or equal to 1.
- **Group sample sizes** specifies the values for the specified number of groups. If you select the **Allow fractional sample sizes** check box, these values must be greater than 0. If you do not select the **Allow fractional sample sizes** check box, these values must be greater than 1.
- **Total N, Group weights** specifies the total sample size. These values must be greater than or equal to 2.

  You can also specify equal or unequal group sizes. If the group sizes are unequal, you must specify allocation weights for the groups. The weights must be greater than or equal to 1.
- **Total events, Group weights** specifies the values for the total events. These values must be greater than or equal to 2 and can contain a decimal.

  You can also specify equal or unequal group sizes. If the group sizes are unequal, you must specify allocation weights for the groups. The group allocation weights must be greater than 0.
- **Accrual rate per group** specifies the values for the accrual rates per group. A rate must be greater than or equal to 1 and can contain a decimal.
- **Group accrual rates** specifies the values for the group accrual rates. A rate must be greater than or equal to 1 and can contain a decimal.

Note: This option is available only if you are solving for power.

11 From the **Select the relative group size** option, specify whether the groups should be equal in size.

Note: This option is available only if you are solving for total sample size.

Step 2: Create the Output Plots

On the **Output** tab, specify whether to create these output plots.

In the results, you can include a power by sample size plot. If you are solving for power, you can specify the minimum and maximum sample size. If you are solving for sample size, you can specify the minimum and maximum power.

If you selected **Survival hazards and hazard ratios** for the survival distribution, the power by effect size plot is also available.

Note: No plots are available if you selected **Group sample size** or **Group accrual rates** as the form of the sample size on the **Properties** tab.

t Tests

About the t Tests Step

Using the t Tests step, you can perform a one-sample test, a paired test, or a two-sample test.

Note: The t Tests step is available only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.

t Tests: Connection Requirements for the Node

In order to run the t Tests step, you must create connections to the input port of the node as indicated here:

Input Port	Output Port
■ Table node or	No output data is created.

Input Port	Output Port
■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	

One-Sample T Test

About the One-Sample T Test

A one-sample *t* test compares the mean of the sample to the null hypothesis mean.

To compare an individual mean with a sample size of *n* to a value *m*, use $t = \frac{\overline{x} - m}{\frac{s}{\sqrt{n}}}$.

In this example, $\overline{x}$ is the sample mean of the observations and s^2 is the sample variance of the observations.

For example, you want to perform a one-sample *t* test on the horsepower values in the Sashelp.Cars data set. The null hypothesis is 300.

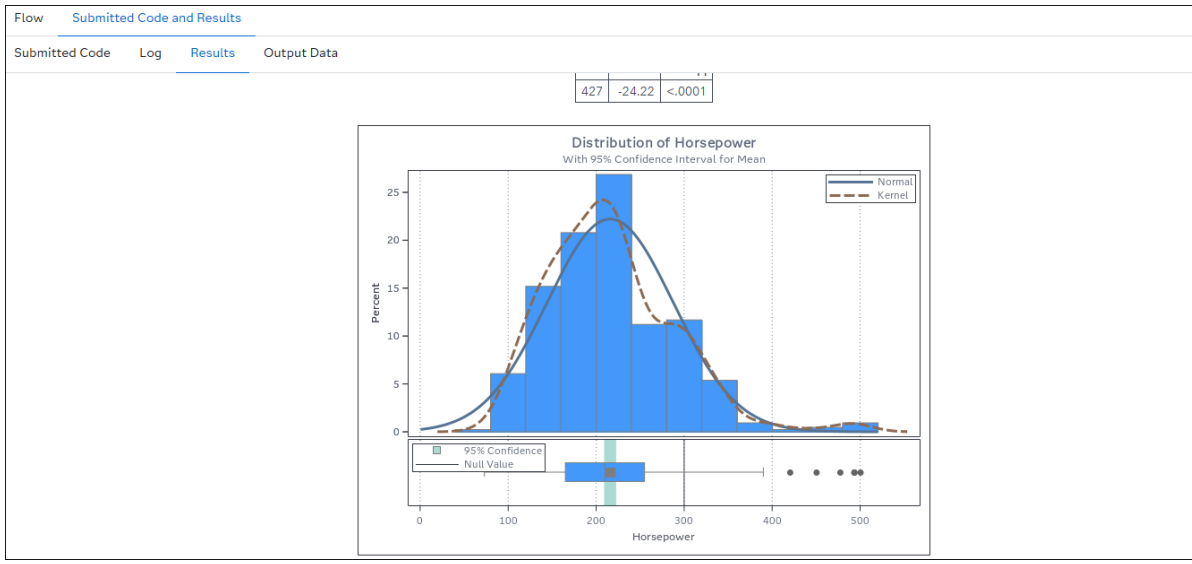
To run a one-sample *t* test, open the *t* Tests step. From the **t test** drop-down list, select **One-sample test**.

Example: One-Sample T Test for Horsepower

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **t Tests** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the t Test node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the t Tests step, click the t Tests node.

   From the **t test** drop-down list, select **One-sample test**.
4. To the **Analysis variable** role, assign **Horsepower**.
5. On the **Options** tab, enter `300` in the **Alternative hypothesis** field.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here are the results:



One-Sample T Test: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run a one-sample *t* test, you must complete these steps.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 From the **t test** drop-down list, select **One-sample test**.

3 To the **Analysis variable** role, assign a numeric column.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the number of sides (or tails) and direction of the statistical tests and test-based confidence intervals. You can choose from these options:

- **Two-tailed tests** specifies two-sided tests and confidence intervals for means.
- **Upper one-tailed test** specifies upper one-sided tests in which the alternative hypothesis indicates a mean greater than the null value, and upper one-sided confidence intervals between the lower confidence limit and infinity.
- **Lower one-tailed test** specifies lower one-sided tests in which the alternative hypothesis indicates a mean less than the null value, and lower one-sided confidence intervals between minus infinity and the upper confidence limit.

2 (Optional) Specify the value of the alternative hypothesis. By default, the alternative hypothesis has a value of `0`.

3 (Optional) Run tests for normality that include a series of goodness-of-fit tests based on the empirical distribution function. The table provides test statistics and *p*-values for the Shapiro-Wilk test (provided the sample size is less than or equal to 2000), the Kolmogorov-Smirnov test, the Anderson-Darling test, and the Cramér-von Mises test.

4 (Optional) Specify whether to include the sign test and Wilcoxon signed rank test.

- The sign test statistic is $M = (n^+ - n^-)/2$. In this example, n^+ is the number of values that are greater than μ_0, and n^- is the number of values that are less than μ_0. Values equal to μ_0 are discarded.

  The Wilcoxon signed rank statistic S is calculated as $S = \sum_{i:\,|x_i - \mu_0| > 0} r_i^+ - \frac{n_t(n_t+1)}{4}$. In this example, r^+_i is the rank of $x_i - \mu_0$ after discarding values of $x_i - \mu_0$, and n_t is the number of x_i values not equal to μ_0. Average ranks are used for tied values.

5 (Optional) Specify whether to include these plots in the results.

- a histogram and box plot together in a single panel, sharing common X axes
- a normal quantile-quantile (Q-Q) plot
- a plot of the confidence interval for the means

Paired Test

About the Paired Test

A paired *t* compares the mean of the differences in the observations to a given number, the null hypothesis difference. The paired *t* test is used when the two samples are correlated, such as two measures of blood pressure from the same person.

To compare *n* paired differences to a value *m*, use $t = \frac{\bar{d} - m}{\frac{s_d}{\sqrt{n}}}$. In this example, $\bar{d}$ is the sample mean of the paired differences, and s^2_d is the sample variance of the paired differences.

To run a paired *t* test, open the *t* Tests step. From the **t test** drop-down list, select **Paired test**.

Example: Determining the Distribution of Price - Cost

In this example, you want to compare the means of differences in price and cost in the Sashelp.Pricedata data set. The null hypothesis for this test is 30.

1 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **t Tests** to add the step to your flow.

2 Add the Sashelp.PriceData table to your flow. Connect the input port of the t Test node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the t Tests step, click the t Tests node.

   From the **t test** drop-down list, select **Paired test**.

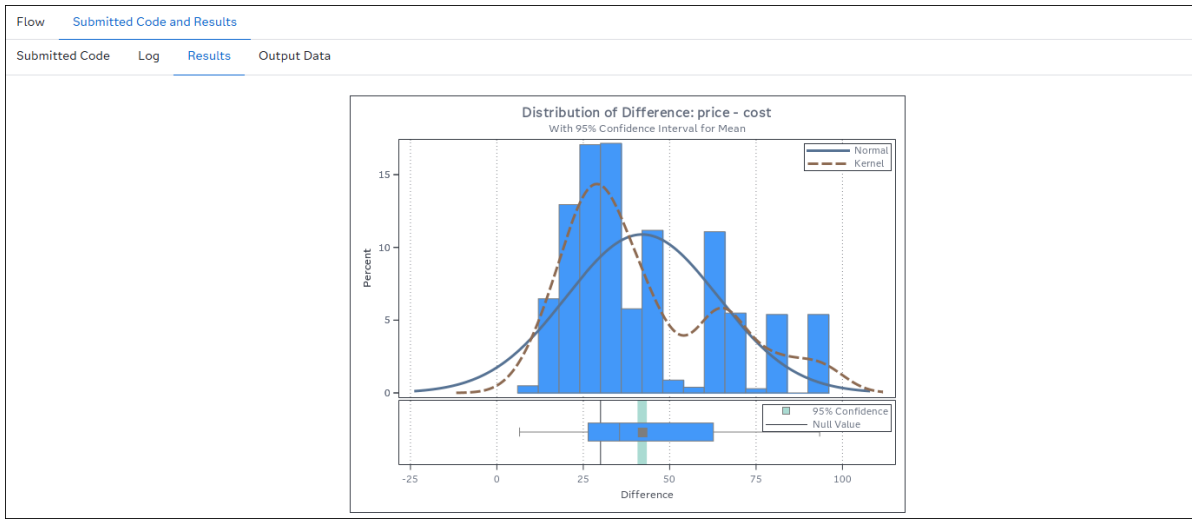
4 To the **Group 1 variable** role, assign **price**.

5 To the **Group 2 variable** role, assign **cost**.

6 On the **Options** tab, enter `30` in the **Alternative hypothesis** field.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here are the results:



Paired T Test: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run a paired *t* test, you must complete these steps.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 From the **t test** drop-down list, select **Paired test**.

3 To the **Group 1 variable** and **Group 2 variable** roles, assign a numeric column.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the number of sides (or tails) and direction of the statistical tests and test-based confidence intervals. You can choose from these options:

- **Two-tailed tests** specifies two-sided tests and confidence intervals for means.
- **Upper one-tailed test** specifies upper one-sided tests in which the alternative hypothesis indicates a mean greater than the null value, and upper one-sided confidence intervals between the lower confidence limit and infinity.
- **Lower one-tailed test** specifies lower one-sided tests in which the alternative hypothesis indicates a mean less than the null value, and lower one-sided confidence intervals between minus infinity and the upper confidence limit.

2 (Optional) Specify the value of the alternative hypothesis. By default, the alternative hypothesis has a value of `0`.

3 (Optional) Runs tests for normality that include a series of goodness-of-fit tests based on the empirical distribution function. The table provides test statistics and *p*-values for the Shapiro-Wilk test (provided the sample size is less than or equal to 2000), the Kolmogorov-Smirnov test, the Anderson-Darling test, and the Cramér-von Mises test.

4 (Optional) Specify whether to include the sign test and Wilcoxon signed rank test.

- The sign test statistic is $M = (n^+ - n^-)/2$. In this example, n^+ is the number of values that are greater than μ_0, and n^- is the number of values that are less than μ_0. Values equal to μ_0 are discarded.

The Wilcoxon signed rank statistic S is calculated as $S = \sum_{i:\,|x_i - \mu_0| > 0} r_i^+ - \frac{n_t(n_t+1)}{4}$. In this example, r^+_i is the rank of $x_i - \mu_0$ after discarding values of $x_i - \mu_0$, and n_t is the number of x_i values not equal to μ_0. Average ranks are used for tied values.

5 (Optional) Specify whether to include these plots in the results.

- a histogram and box plot together in a single panel, sharing common X axes.
- a normal quantile-quantile (Q-Q) plot.
- an agreement plot, which plots the second response in each pair against the first response. The mean is shown as a large bold symbol. A diagonal line with slope=0 and y-intercept=1 is overlaid. The location of the points with respect to the diagonal line reveals the strength and direction of the difference or ratio. The tighter the clustering along the same direction as the line, the stronger the positive correlation of the two measurements for each subject. Clustering along a direction perpendicular to the line indicates negative correlation.
- a response profile plot, which is a plot where a line is drawn for each observation from left to right that connects the first response to the second response. The mean first response and mean second response are connected with a bold line. The more extreme the slope, the stronger the effect. A wide spread of profiles indicates high between-subject variability. Consistent positive slopes indicate strong positive correlation. Widely varying slopes indicate lack of correlation. Consistent negative slopes indicate strong negative correlation.
- a plot of the confidence interval for the means.

Two-Sample T Test

About the Two-Sample T Test

A two-sample t test compares the mean of the first sample minus the mean of the second sample to a given number, the null hypothesis difference.

To compare means from two independent samples with n_1 and n_2 observations to a value m, use $t = \frac{(\overline{x_1} - \overline{x}_2) - m}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$. In this example, s^2 is the pooled variance $s^2 = \frac{\left(n_1 - 1\right)s_1^2 + \left(n_1 - 1\right)s_2^2}{n_1 + n_2 - 2}$, and s^2_1 and s^2_2 are the sample variances of the two groups. The use of this t statistic depends on the assumption that $\sigma_1^2 = \sigma_2^2$, where σ_1^2 and σ_2^2 are the population variances of the two groups.

To run a two-sample *t* test, open the *t* Tests step. From the **t test** drop-down list, select **Two-sample test**.

Example: Two-Sample T Test

1 In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **t Tests** to add the step to your flow.

2 Add the Sashelp.Class table to your flow. Connect the input port of the t Test node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the t Tests step, click the t Tests node.

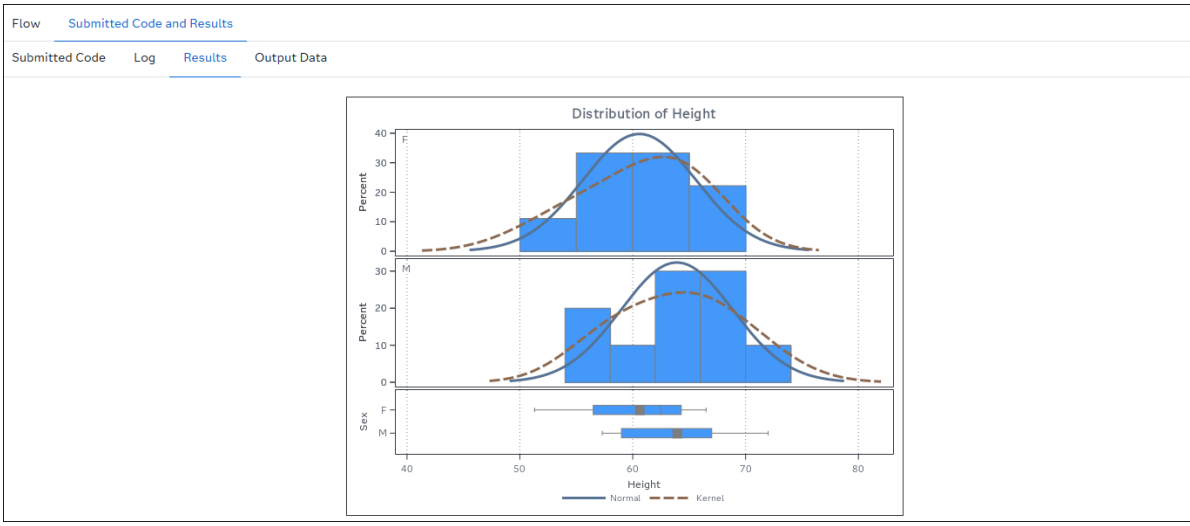
From the **t test** drop-down list, select **Two-sample test**.

4 To the **Analysis variable** role, assign **Height**.

5 To the **Class variable** role, assign **Sex**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a subset of the results:



Two-Sample T Test: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run a two-sample *t* test, you must complete these steps.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 From the **t test** drop-down list, select **Two-sample test**.

3 To the **Analysis variable** and **Class variable** roles, assign a column.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the number of sides (or tails) and direction of the statistical tests and test-based confidence intervals. You can choose from these options:

- **Two-tailed tests** specifies two-sided tests and confidence intervals for means.
- **Upper one-tailed test** specifies upper one-sided tests in which the alternative hypothesis indicates a mean greater than the null value, and upper one-sided confidence intervals between the lower confidence limit and infinity.
- **Lower one-tailed test** specifies lower one-sided tests in which the alternative hypothesis indicates a mean less than the null value, and lower one-sided confidence intervals between minus infinity and the upper confidence limit.

2 (Optional) Specify the value of the alternative hypothesis. By default, the alternative hypothesis has a value of `0`.

3 (Optional) Calculate the Cochran and Cox approximation for unequal variances.

4 (Optional) Run tests for normality that include a series of goodness-of-fit tests based on the empirical distribution function. The table provides test statistics and *p*-values for the Shapiro-Wilk test (provided the sample size is less than or equal to 2000), the Kolmogorov-Smirnov test, the Anderson-Darling test, and the Cramér-von Mises test.

5 (Optional) Specify whether to generate an analysis of Wilcoxon scores. When there are two classification levels (samples), this option produces the Wilcoxon rank-sum test.

Note: This option is available only for a two-tailed test when the alternative hypothesis equals 0.

6 (Optional) Specify whether to include these plots in the results.

- a histogram and box plot together in a single panel, sharing common X axes.
- a normal quantile-quantile (Q-Q) plot.
- a plot of the confidence interval for the means.
- a box plot of Wilcoxon scores. This box plot is associated with the Wilcoxon analysis.

Note: This plot is available only for a two-tailed test when the alternative hypothesis equals 0.

t Tests Statistical Power

About the *t* Tests Statistical Power Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. The *t* Tests Statistical Power step calculates the power or sample size for *t* tests of means and mean ratios.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

t Tests Statistical Power: Connection Requirements for the Node

No input data is required to run the *t* Tests Statistical Power step.

Example: One-Sample t Test for Mean

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **t Tests Statistical Power** to add the step to your flow.
2. To set the options for the *t* Tests Statistical Power step, click the t Tests Statistical Power node.
3. From the **Type of t test** drop-down list, select **One-sample test**.

4 From the **Select the number of sides of the test** drop-down list, select **Two-sided test**.

5 For the mean, enter `8`.

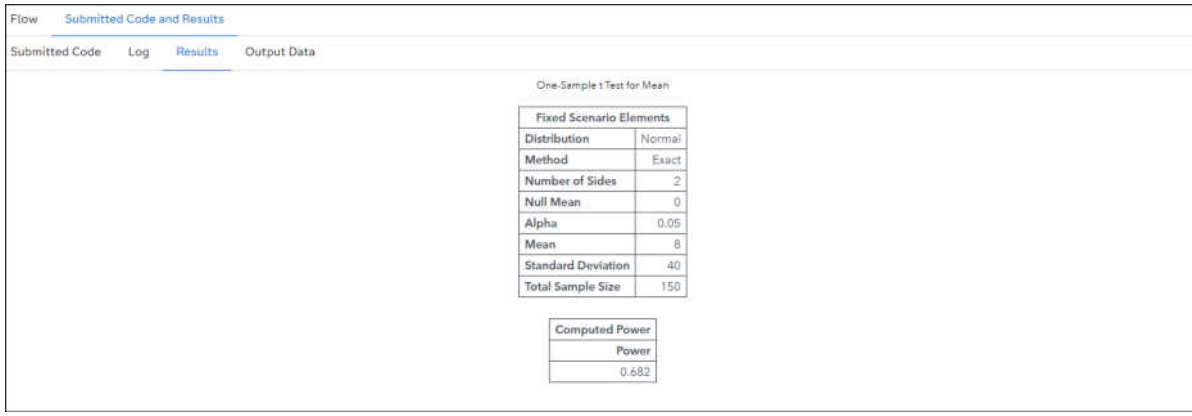
6 For the standard deviation, enter `40`.

7 For the sample size, enter `150`.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

The computed power is 0.682.



t Tests Statistical Power: Step-by-Step Instructions

Step 1: Set the Options

1 From the **Type of t test** drop-down list, select a one sample, paired sample, or two independent sample *t* test.

2 For the **Solve for** option, select whether to solve for power or total sample size.

3 Specify the underlying distribution assumed for the test statistics. By default, the step assumes a normal distribution.

4 Select the number of sides (or tails) and the direction of the statistical test or confidence interval.

5 Specify whether to perform the Pooled *t* test or the Satterthwaite *t* test.

Note: This option is available only for a two-sample test.

6 Specify the alpha value (significance level) for the test.

7 Specify the mean values. The available options depend on the type of *t* test:

- For a one-sample *t* test, specify the values of the mean and the null mean.
- For a paired test or a two-sample *t* test, the available options depend on the distribution type.
  - For a lognormal distribution, you can calculate the mean ratio, the group means, and the null mean ratio.
  - For a normal distribution, you can calculate the difference between the means, the group means, and the difference for the null mean.

8 Specify the standard deviation values. The available options depend on the type of *t* test.

- For a paired test, you can specify a standard deviation for both groups, or you can specify a standard deviation for each group.
- For a two-sample *t* test, the standard deviation is assumed to be the same for both groups.

Note: This option is available only if you specify a normal distribution.

9 Specify the coefficient of variation. The coefficient of variation is defined as the ratio of the standard deviation to the mean on the original data scale.

- For a paired test, you can specify a coefficient of variation for both groups, or you can specify individual coefficients of variation for each group.
- For a two-sample *t* test, the coefficient of variation is assumed to be the same for both groups.

Note: This option is available only if you specify a lognormal distribution.

10 Specify the correlation between members of a pair.

Note: This option is available only if you select a paired test.

11 Specify the sample size and specify whether to allow fractional sample sizes.

Step 2: Create the Output Plots

On the **Plots** tab, specify whether to create these output plots:

- a plot with sample size on the vertical axis and power on the horizontal axis. For this plot, you can specify the minimum and maximum value for power.
- a plot effect size on the horizontal axis. Power or sample size is on the vertical axis. For this plot, you can specify the minimum and maximum value for the effect size.

Table Analysis

About the Table Analysis Step

The Table Analysis step provides one-way to n-way frequency and contingency (crosstabulation) tables. This step also generates statistics about the association between rows and columns.

Note: The Table Analysis step is available only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.

Table Analysis: Connection Requirements for the Node

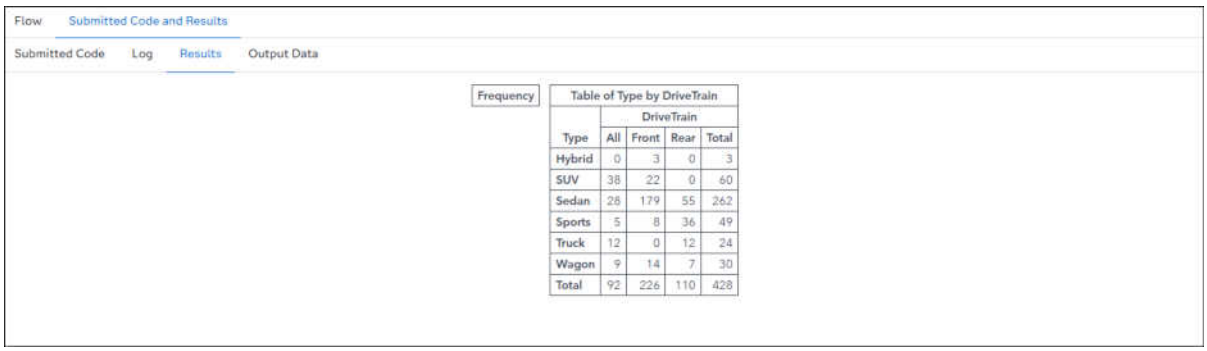
In order to run the Table Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 7: Create Output Data for the Cell Statistics" on page 474. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Distribution of Type by DriveTrain

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Table Analysis** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the Table Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Table Analysis step, click the Table Analysis node.
4. On the **Data** tab, assign columns to these roles:
   - For the **Row variables** role, assign **Type**.
   - For the **Column variables** role, assign **DriveTrain**.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a sample of the results:



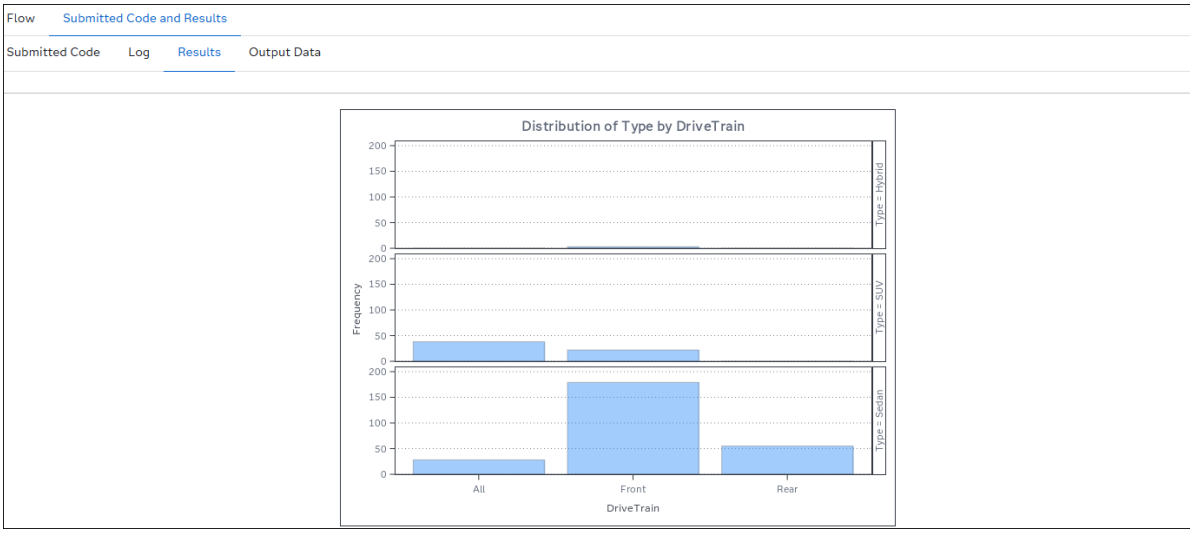


Table Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Assign the row for one-way table analysis to the **Row variables** role. If multiple variables are assigned to this role, the step performs multiple one-way table analyses.

3 Assign a column to the **Column variables** role. This role creates the columns for one-way table analysis. If only column variables are assigned, the step performs multiple one-way table analyses.

4 In the **Strata variables** role, assign a variable to create separate tables for n-way frequency and n-way frequency and crosstabulation tables.

Note: You must assign columns to both the **Row variables** and **Column variables** roles to use a strata variable.

5 (Optional) Assign a variable to the **Frequency count** role.

If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Select the Cell Statistics

On the **Cell Statistics** tab, you can set these options:

1 Select the frequency statistics.

Observed
displays the frequency count for each cell.

Expected
displays the expected cell frequency for each cell.

Deviation
displays the deviation of the cell frequency from the expected value for each cell.

Missing values
specifies whether to display the frequencies for the missing values.

2 Select the percentages.

Cell
displays overall percentages in crosstabulation tables.

Row
displays row percentages in crosstabulation table cells.

Column
displays column percentages in crosstabulation table cells.

You can also choose from these options:

- **Include percentages in the data set** displays the percentages for the columns and rows in the output data set.
- **Percentages of total frequency** displays the percentage of total frequency on *n*-way tables when *n*>2.

3 Select the cumulative statistics.

Column percentages
displays the cumulative column percentages in each cell.

Frequencies and percentages
displays the cumulative frequencies and percentages in one-way frequency tables.

4 Select the chi-square statistics.

Cell contributions to the chi-square statistics
displays each table cell's contribution to the Pearson chi-square statistic in the crosstabulation table.

Step 3: Select the Table Statistics

On the **Table Statistics** tab, you can set these options:

1 To compute tests and measures of classification agreement for square tables, select **Measures**.

This option provides McNemar's test for 2×2 tables and Bowker's test of symmetry for tables with more than two response categories. It also produces the simple kappa coefficient, the weighted kappa coefficient, the asymptotic standard errors for the simple and weighted kappas, and the corresponding confidence limits. When there are multiple strata and two response categories, this option also computes Cochran's Q test.

2 To calculate the ordered differences, select **Jonckheere-Terpstra test**.

This option computes the Jonckheere-Terpstra test, which is a nonparametric test for ordered differences among classes. It tests the null hypothesis that the distribution of the response variable does not differ among classes.

3 To calculate a trend test, select **Cochran-Armitage test (for 2 x c and r x 2 tables)**.

This option computes the Cochran-Armitage test for trend, which tests for trend in binomial proportions across levels of a single factor or covariate. This test is appropriate for a contingency table where one variable has two levels and the other variable is ordinal. The two-level variable represents the response, and the other variable represents an explanatory variable with ordered levels.

Step 4: Select the Association Statistics

On the **Association Statistics** tab, you can set these options:

1 Select the tests of association.

Chi-square statistics
This test requests chi-square tests of homogeneity or independence and measures of association that are based on the chi-square statistic. The tests include the Pearson chi-square, likelihood-ratio chi-square, and Mantel-Haenszel chi-square. For 2×2 tables, this test includes Fisher's exact test and the continuity-adjusted chi-square.

You can also select these options:

- **Exact p-values** computes the exact *p*-values for the following statistics: chi-square goodness-of-fit test for one-way tables; Pearson chi-square, likelihood-ratio chi-square, and Mantel-Haenszel chi-square tests for two-way tables.
- **Fisher's exact test (for r x c tables)** computes Fisher's exact test for tables that are larger than 2×2. This test is also known as the Freeman-Halton test.

Note: For some large problems, computation of exact tests might require a considerable amount of time and memory.

2 Select the measures of association.

Measures of association
This test computes several measures of association and their asymptotic standard errors (ASE). The measures include gamma, Kendall's tau-b, Stuart's tau-c, Somers' D (C|R), Somers' D (R|C), the Pearson and Spearman correlation coefficients, lambda (symmetric and asymmetric), and uncertainty coefficients (symmetric and asymmetric).

Binomial proportions and risk difference (for 2x2 tables)
This test requests risks (binomial proportions) and risk differences for 2x2 tables.

Odds ratio and relative risk (for 2x2 tables)
This test requests relative risk measures and their asymptotic Walk confidence limits for 2x2 tables.

3 To calculate the Cochran-Mantel-Haenszel statistics, select **CMH statistics**.

This test requests Cochran-Mantel-Haenszel statistics, which test for association between the row and column variables after adjusting for the remaining variables in a multiway table. These statistics include the CMH correlation statistic, the row mean scores (ANOVA), and the adjusted relative risks and odds ratios.

Step 5: Select the Computation Options

On the **Computation Options** tab, you can set these options:

1 Select the score type for any association, agreement, or trend tests.

The score type specifies the type of row and column scores to use with the Mantel-Haenszel chi-square statistic, Cochran-Mantel-Haenszel statistics, Pearson correlation, Cochran-Armitage test for trend, and weighted kappa coefficient. You can choose from these options:

- **Table** - For numeric variables, table scores are the values of the row and column levels. If the row or column variables are formatted, then the table score is the internal numeric value corresponding to that level. If two or more numeric values are classified into the same formatted level, then the internal numeric value for that level is the smallest of these values.

  For character variables, table scores are defined as the row numbers and column numbers—that is, 1 for the first row, 2 for the second row, and so on.
- **Rank** - Rank scores are defined by row scores and column scores.
- **RIDIT** - Ridit scores are derived from rank scores.
- **Modified RIDIT** - Modified ridit (MODRIDIT) scores represent the expected values of the order statistics for the uniform distribution on (0,1). Modified ridit scores are derived from rank scores.

2 Specify how to treat missing values.

Exclude missing values
specifies that an observation is excluded from a table if the observation has a missing value for any of the variables.

Display missing value frequencies
displays the frequencies of the missing values in the frequency and crosstabulation tables. These frequencies are not included in any computations of percentages, tests, or measures.

Include missing values in calculations
includes missing values in the calculations of percentages and other statistics.

3 Select the confidence level for the calculations. The default value is `95%`.

4 Specify the order in which the values of the variables in the crosstabulation tables are reported. Here are the valid values:

- **Unformatted values** orders the values by their unformatted values. This is the default.
- **Data set order** orders the values by their appearance in the data set.
- **Formatted values** orders the values by their ascending formatted values.
- **Descending frequency** orders the values so that the levels with the highest frequency counts come first.

5 If you are computing exact tests, select the maximum computation time for these calculations.

To compute the Monte Carlo estimates of the exact *p*-values instead of directly computing the exact **p**-values, select the **Use Monte Carlo estimation** check box. Monte Carlo estimation can be useful for large problems that require a great amount of time and memory for exact computations but for which asymptotic approximations might not be sufficient.

6 To display the entire multiway table in one table instead of displaying a separate two-way table for each stratum, select **Display tables in a list format**.

Note: This option is ignored if all output is suppressed.

7 To suppress the plots from the output, select **Suppress plots**. By default, plots are included in the results.

Step 6: Specify the Title and Footnote in the Output

On the **Titles** tab, you specify whether to use the default text for the title and the footnote. Alternatively, you can customize this text. You can use macro variables in titles and footnotes.

Step 7: Create Output Data for the Cell Statistics

On the **Output** tab, you specify whether to create an output data table for the cell statistics. By default, this output data table is saved in the Work library.

Note: If you are running the step in a flow, you must add an output port for the output table to the Table Analysis node. For more information, see "Bubble Map: Connection Requirement for the Node" on page 939.

Tests of Proportions Statistical Power

About the Tests of Proportions Statistical Power Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. The Tests of Proportions Statistical Power step calculates the power or sample size for tests of one proportion, two correlated proportions, and two independent proportions.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Tests of Proportions Statistical Power: Connection Requirements for the Node

No input or output data is required to run the Tests of Proportions Statistical Power step.

Example: Power Analysis for One Proportion

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Tests of Proportion Statistical Power** to add the step to your flow.
2. To set the options for the Tests of Proportion Statistical Power step, click the Tests of Proportion Statistical Power node.
3. From the **Type of test** drop-down list, select **One proportion**.
4. Under the **Solve for** heading, select **Power**.

Note: Only the **Power** option is available for a one-proportion test.

5 From the **Select the number of sides of the test** drop-down list, select **One-sided test**.

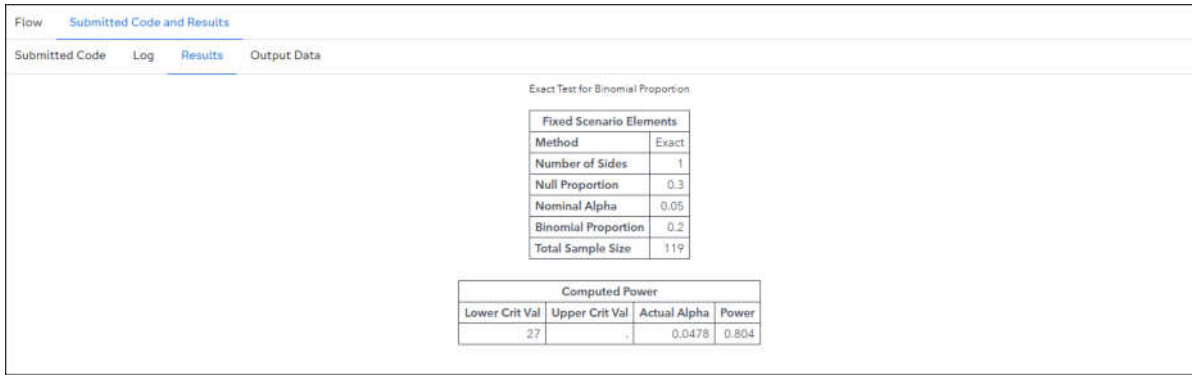
6 For the proportion, enter `0.2`.

7 For the null proportion, enter `0.3`.

8 For the total sample size, enter `119`.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Tests of Proportions Statistical Power: Create a One-Proportion Test

To create a one-proportion test:

1 From the **Type of test** drop-down list, select **One proportion**.

2 Select the binomial proportion test.

Here are the valid values:

- **Equality**.
- **Noninferiority**. You must specify a margin value less than or equal to 0 and greater than or equal to –1.
- **Superiority**. You must specify a margin value greater than or equal to 0 and less than or equal to 1.

3 Under the **Solve for** heading, select **Power** or **Total sample size**.

4 Select the test to perform. You can choose from these options:

- **Exact binomial test**
- **Exact Z-test**

- **Exact continuity-adjusted Z-test**
- **Approximate Z-test**
- **Approximate continuity-adjusted Z-test**

5 Select the variance estimate for the test. The variance can be based on either the null proportion or the observed sample proportion.

Note: This option is not available if you are performing an exact binomial test.

6 Select whether to perform a one-sided test or two-sided test.

7 Specify the significance level.

8 Specify the proportion and the null proportion.

9 Specify the sample size and whether to allow for fractional sample sizes.

Tests of Proportions Statistical Power: Create a Two Correlated Proportions Test

1 From the **Type of test** drop-down list, select **Two correlated proportions**.

2 Under the **Solve for** heading, select **Power** or **Total sample size**.

Note: To solve for a total sample size, you must select **Connor approximation** or **Miettinen approximation** for the **Select a method** option.

3 Select the method to use:

- **Exact**
- **Connor approximation**
- **Miettinen approximation**

4 Select the distribution for the test statistic:

- **Exact conditional**
- **Normal approximation to the binomial**

5 Select whether to perform a one-sided test or two-sided test.

6 Specify the significance level.

7 Specify the values for proportions, odds ratios, or relative risk.

8 Specify whether to allow for fractional sample sizes and the number of pairs.

Tests of Proportions Statistical Power: Create a Two Independent Proportions Test

1. From the **Type of test** drop-down list, select **Two independent proportions**.
2. For the quantity to solve for, select **Power** or **Sample size per group**.
3. Select the test to use:
   - **Fisher's exact test**
   - **Farrington-Manning score test**
   - **Likelihood ratio chi-square test**
   - **Pearson chi-square test**
4. Select whether to perform a one-sided test or two-sided test.
5. Specify the significance level.
6. Select the form for the proportions and any related values.
7. Specify whether to allow for fractional sample sizes and the form of sample size.

Tests of Proportions Statistical Power: Set the Plot Options

You can create these plots:

- a plot with sample size on the vertical axis and power on the horizontal axis. For this plot, you can specify the minimum and maximum value for power.
- a plot effect size on the horizontal axis. Power or sample size is on the vertical axis. For this plot, you can specify the minimum and maximum value for the effect size.

Wilcoxon Test Statistical Power

About the Wilcoxon Test Statistical Power Step

Power and sample size analysis optimizes the resource usage and design of a study, which improves the chances of conclusive results with maximum efficiency. The Wilcoxon Test Statistical Power step calculates power and sample size analyses for the Wilcoxon-Mann-Whitney test for two independent groups. This test is also called the Wilcoxon rank-sum test, Mann-Whitney-Wilcoxon test, and Mann-Whitney U test.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Wilcoxon Test Statistical Power: Connection Requirements for the Node

No input or output data is required to run the Wilcoxon Test Statistical Power step.

Example: Wilcoxon Test for Power and Sample Size Analysis

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Statistics** folder and double-click **Wilcoxon Test** to add the step to your flow.
2. To set the options for the Wilcoxon Test Statistical Power step, click the Wilcoxon Test Statistical Power node.
3. Under the **Solve for** heading, select **Power**.

4 From the **Select the number of sides of the test** drop-down list, select **Two-sided test**.

5 Under the **Distributions** heading, select these options:

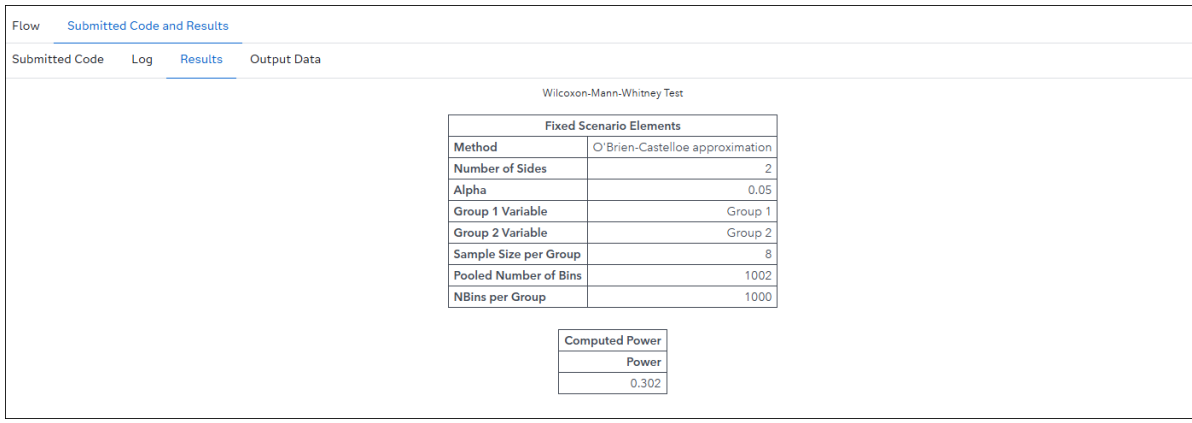
- From the **Distribution for Group 1** drop-down list, select **Binomial**. For the **Probability of success**, enter `0.3`. For the **Number of trials**, enter `2`.
- From the **Distribution for Group 2** drop-down list, select **Normal**. For the **Mean**, enter `0`. For the **Standard deviation**, enter `1`.

6 In the **Alpha values** box, enter `0.05`.

7 Under the **Sample Size** heading, select **Sample size per group** from the **Select a form** drop-down list. Enter `8` as the value of the sample size per group.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Wilcoxon Test Statistical Power: Step-by-Step Instructions

Step 1: Assign the Properties

On the Options tab, assign these properties.

1 From the **Solve for** drop-down list, request a solution for power, total sample size, or sample size per group.

2 Specify whether to perform a one-sided test, a lower one-sided test, an upper one-sided test, or a two-sided test.

3 Specify the form of distribution. The parameter values that are available depend on the distribution type.

4 Specify the significance level for the analysis. You can specify more than one value.

5 Specify the power values for the analysis. These values must be greater than 0 and less than 1.

6 Specify the sample size.

The **Allow fractional sample sizes** check box is always available. If you select this check box, fractions are allowed in the sample size.

- If you are solving for **Power**, you can choose from these forms:
  - **Sample size per group** specifies the values of *N* for each group. This value must be greater than or equal to 1.
  - **Group sample sizes** specifies the values for the specified number of groups. This value must be greater than or equal to 1.
  - **Total sample size, Group weights** specifies the total sample size. These values must be greater than or equal to 2. You can also specify equal or unequal group sizes. If the group sizes are unequal, you must specify allocation weights for the groups. The weights must be greater than or equal to 1.
- If you are solving for **Total sample size**, you can specify equal or unequal group sizes. If the group sizes are unequal, you must specify allocation weights for the groups. The weights must be greater than or equal to 1.
- If you are solving for **Sample group per size**, the only option available is the **Allow fractional sample sizes** check box.

Step 2: Setting the Plot Options

In the results, you can include a power by sample size plot.

- If you are solving for power, you can specify the minimum and maximum sample sizes.
- If you are solving for sample size, you can specify the minimum and maximum power.

11

Working with Econometrics

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Aggregate Loss Models

About the Aggregate Loss Models Step

The Aggregate Loss Models step computes an estimate of the probability distribution model of the aggregate loss. This estimate is based on the knowledge of the distribution of loss severity and loss count.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Aggregate Loss Models: Connection Requirements for the Node

In order to run the Aggregate Loss Models step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
If you are running the step using the SAS Compute Server, the table can be either a SAS or CAS table. If you are running the step using the SAS CAS Server, the table must use a CAS engine libref. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output table. For more information, see "Step 5: Create the Output Data" on page 494. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Construct a Severity Model and a Count Model

To create this example:

1 Enter this code on a **SAS Program** tab:

```
/* Simulate data for losses that several policyholders incur in a year
*/
data losses(keep=policyholderId age gender carType annualMiles
education
   carSafety income noloss lossamount);
   call streaminit(12345);
   array cx{5} age gender carType annualMiles education;
   array cbeta{6} _TEMPORARY_ (1 -0.75 1 0.6 -1 -0.25);

   array sx{3} carType carSafety income;
   array sbeta{4} _TEMPORARY_ (3.5 1.5 -0.8 0.6);

   alpha = 1/3; theta = 1/alpha;
   Sigma = 1;
```

```
   do policyholderId=1 to 5000;
      /* simulate policyholder and vehicle attributes */
      age = MAX(int(rand('NORMAL', 35, 15)),16)/50;

      if (rand('UNIFORM') < 0.5) then gender = 1; * female;
      else gender = 2; * male;

      if (rand('UNIFORM') < 0.7) then carType = 1; * sedan;
      else carType = 2; * SUV;

      annualMiles = MAX(1000, int(rand('NORMAL', 12000, 5000)))/5000;

      educationLevel = rand('UNIFORM');
      if (educationLevel < 0.5) then education = 1; *high school
graduate;
      else if (educationLevel < 0.85) then education = 2; *college
graduate;
      else education = 3; *advanced degree;

      carSafety = rand('UNIFORM'); /* scaled to be between 0 & 1 */

      income = MAX(15000,int(rand('NORMAL', education*30000, 50000)))/
100000;

      /* simulate number of losses incurred by this policyholder */
      cxbeta = cbeta(1);
      do i=1 to dim(cx);
         cxbeta = cxbeta + cx(i) * cbeta(i+1);
      end;
      Mu = exp(cxbeta);
      p = theta/(Mu+theta);
      numloss = rand('NEGB',p,theta);

      /* simulate severity of each loss */
      if (numloss > 0) then do;
         noloss = 0;
         do iloss=1 to numloss;
            Mu = sbeta(1);
            do i=1 to dim(sx);
               Mu = Mu + sx(i) * sbeta(i+1);
            end;
            lossamount = exp(Mu) * rand('LOGNORMAL')**Sigma;
            output;
         end;
      end;
      else do;
         noloss = 1;
         lossamount = .;
         output;
      end;
   end;
run;

/* Aggregate number of annual loss events for each policyholder */
data losscounts(keep=age gender carType annualMiles education numloss);
   set losses;
```

```
   by policyholderId;
   retain numloss 0;
   if (noloss ne 1) then
      numloss = numloss + 1;
   if (last.policyholderId) then do;
      output;
      numloss = 0;
   end;
run;

/* Generate the scenario data table for single policyholder */
data singlePolicy(keep=age gender carType annualMiles education
carSafety income);
   call streaminit(67897);

   age = MAX(int(rand('NORMAL', 35, 15)),16)/50;

   if (rand('UNIFORM') < 0.5) then gender = 1; * female;
   else gender = 2; * male;

   if (rand('UNIFORM') < 0.7) then carType = 1; * sedan;
   else carType = 2; * SUV;

   annualMiles = MAX(1000, int(rand('NORMAL', 12000, 5000)))/5000;

   educationLevel = rand('UNIFORM');
   if (educationLevel < 0.5) then education = 1; *high school graduate;
   else if (educationLevel < 0.85) then education = 2; *college
graduate;
   else education = 3; *advanced degree;

   carSafety = rand('UNIFORM'); /* scaled to be between 0 & 1 */

   income = MAX(15000,int(rand('NORMAL', education*30000, 50000)))/
100000;

   output;
run;
```

Click **Run** to create the Work.Losses, Work.LossCounts, and Work.SinglePolicy tables.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Aggregate Loss Models** to add the step to your flow.

3 To set the options for the Aggregate Loss Models step, click the Aggregate Loss Models node.

4 To construct a severity model:

   a Add the Work.Losses table to your flow. Connect the input port of the Aggregate Loss Models node to the data source. For more information, see "Connecting Nodes" on page 13.

   b On the **Data** tab, select **Construct a new severity model**.

   c On the **Severity** tab, assign these columns to roles:

- To the **Loss variable** role, assign **lossamount**.
- To the **Continous variables** role, assign **carSafety** and **income**.
- To the **Categorical variable** role, assign **carType**.

5 To construct a count model:

a Add the Work.LossCount table to your flow.

b Right-click the Aggregate Loss Models node and select **Add input port** ⇨ **Count Data**.

c Connect the Work.LossCount table to the Count Data input port. For more information, see "Connecting Nodes" on page 13.

d To set the options for the Aggregate Loss Models step, click the Aggregate Loss Models node.

e On the **Data** tab, select **Construct a new count model**.

f On the **Count** tab, assign these columns to roles:

- To the **Dependent count variable** role, assign **numloss**.
- To the **Continuous variables** role, assign **age** and **annualMiles**.
- To the **Categorical variable** role, assign **gender**, **carType**, and **education**.

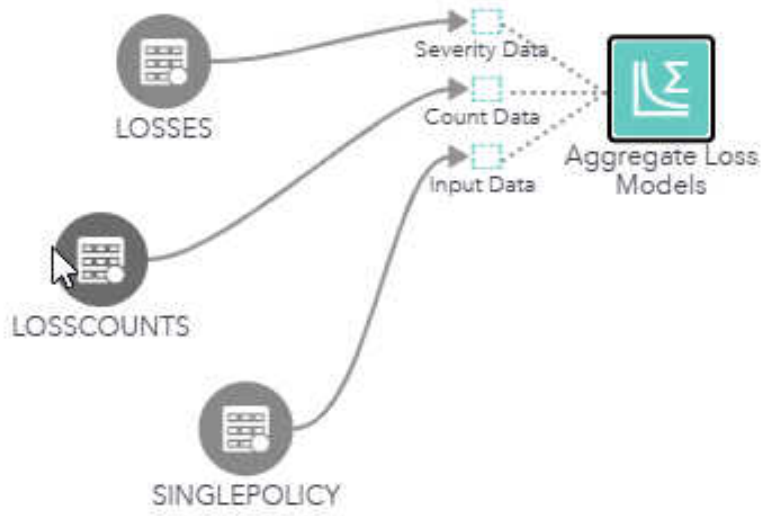
6 Add input data to the step.

a Add Work.SinglePolicy to the flow.

b Right-click the Aggregate Loss Models node and select **Add input port** ⇨ **Input Data**. A new Input Data port is added to the Aggregate Loss Models node.

c Connect the Work.SinglePolicy table to the Input Data port. For more information, see "Connecting Nodes" on page 13.

Note: By default, multiple input ports are collapsed on the Aggregate Loss Models node. To view all the input ports, right-click the collapsed node and select **Expand ports**.



7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data

Performance Information	
Execution Mode	Single-Machine
Number of Threads	4

Data Access Information			
Data	Engine	Role	Path
WORK.SINGLEPOLICY	V9	Input	On Client

Input Data Summary	
Name	WORK.SINGLEPOLICY
Observations	1
Valid Observations	1

Severity Model: Logn
Count Model: Poisson

Compound Distribution Information	
Severity Model	Lognormal Distribution
Scale Model Regressors	carSafety income carType
Count Model	Poisson Model in Item Store WORK.__COUNTSTORE

Sample Summary Statistics			
Mean	217.86670	Median	42.57908
Standard Deviation	415.23334	Interquartile Range	276.23381
Variance	172418.7	Minimum	0
Skewness	4.83564	Maximum	10525.4
Kurtosis	45.82417	Sample Size	100000

Aggregate Loss Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 Specify the loss severity model. You can choose from these options:

- **Construct a new severity model** - Use the options on the **Severity** tab. For more information, see "Step 2: Creating a Severity Model" on page 491.
- **Use an existing severity model** - If the severity model contains scale regressors, select **Model includes scale regressors**.

3 Specify the loss count model. You can choose from these options:

- **Use externally simulated counts** – If you select this option, you must specify a data table that contains the externally simulated counts under the Input Data heading. You must specify the loss count variable and the replicate identifier.
- **Simulate counts internally** – To simulate the counts, you can either construct a new model or use an existing count model. You can construct this count model by using the COUNTREG procedure or by using the options on the **Count** tab. If the existing count model contains regressors, select **Model includes regressors**.

4 Add an input data table to the step in these cases:

- you use externally simulated counts
- the severity model includes any scale regressors
- the count model includes any regressors

a Add the input data to the flow.

b Right-click the Aggregate Loss Models node and select **Add input port** ⇨ **Input Data**. A new Input Data port is added to the Aggregate Loss Models node.

c Connect the input data table to the Input Data port. For more information, see "Connecting Nodes" on page 13.

Note: By default, multiple input ports are collapsed on the Aggregate Loss Models node. To view all the input ports, right-click the collapsed node and select **Expand**.

5 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

6 For the input data, assign numeric columns to these roles:

- **Count**
- **Replicate identifier**

Step 2: Creating a Severity Model

On the **Severity** tab, you can use these options to create a Severity model. These options are available only if you select **Construct a new severity model** on the **Data** tab.

If you are running the step using the SAS Compute Server, an output ITEMSTORE model is created when you run the step. The location of this model is listed in the SAS log.

1 If you are running this step in a flow, you must add the severity data for the model to the flow.

a Add the severity data to the flow.

b Right-click the Aggregate Loss Models node and select **Add input port** ⇨ **Severity Data**. A new Severity Data port is added to the Aggregate Loss Models node.

c Connect the input data table to the Severity Data port. For more information, see "Connecting Nodes" on page 13.

2 On the **Severity** tab, assign to the **Loss variable** role the column whose distribution needs to be modeled.

3 (Optional) Specify the variable or value to use for setting the left-censoring limit. If the variable value is missing, the step assumes that the observation is not left-censored.

By the definition of left-censoring, an exact value of the response is not known when it is less than or equal to the left-censoring limit.

4 (Optional) Specify the variable or value to use for setting the right-censoring limit. If the variable value is missing, the step assumes that the observation is not right-censored.

By the definition of right-censoring, an exact value of the response is not known when it is less than or equal to the right-censoring limit.

5 (Optional) Specify the variable or value to use for the left-truncation threshold. If the variable value is missing or 0, the observation is not left-truncated.

   By the definition of left-truncation, you can observe only a value that is greater than the left-truncation threshold. If a response variable value is less than or equal to the left-truncation threshold, a warning is printed to the SAS log and the observation is ignored.

6 (Optional) Specify the variable or value to use for the right-truncation threshold. If the variable value is missing, the observation is not right-truncated.

   By the definition of right-truncation, you can observe only a value that is less than or equal to the right-truncation threshold. If a response variable value is greater than the right-truncation threshold, a warning is printed to the SAS log and the observation is ignored.

7 Assign the continuous variables to specify the regression effects. A regression effect is formed from one or more regressor variables according to effect construction rules.

8 Specify the categorical variables to use in the analysis.

9 Specify the candidate distribution. You can specify one or more of these predefined distributions: Burr, exponential, gamma, generalized Pareto, inverse Gaussian or Wald, lognormal, Pareto, Weibull, Tweedie, and Scaled Tweedie.

   Note: If the model contains a regression effect or an offset variable is selected, the Tweedie distribution is not available. Use the scaled Tweedie distribution instead.

10 Build your model. You can choose between a main effects model or a custom model.

   Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

11 (Optional) Set the offset variable to use as the offset to the linear predictor. An offset plays the role of an effect whose coefficient is known to be 1. Observations that have missing values for the offset variable are excluded from the analysis.

Step 3: Creating a Count Model

On the **Count** tab, you can set these options to create a Count model. These options are available only if you select **Construct a new count model** on the **Data** tab.

If you are running the step using the SAS Compute Server, an output ITEMSTORE model is created when you run the step. The location of this model is listed in the SAS log.

1 If you are running this step in a flow, you must add the count data for the model to the flow.

   a Add the count data to the flow.

   b Right-click the Aggregate Loss Models node and select **Add input port** ⇨ **Count Data**. A new Count Data port is added to the Aggregate Loss Models node.

   c Connect the input data table to the Count Data port. For more information, see "Connecting Nodes" on page 13.

2 On the **Count** tab, assign columns to these roles:

   - To the **Dependent count variable** role, assign a single numeric variable.
   - To the **Continuous variable** role, assign a continuous variable to use in the analysis.
   - To the **Categorical variables** role, assign a continuous variable to use in the analysis.

3 Specify the distribution. You can select one of these predefined distributions: Poisson, Negative binomial with linear variance, Negative binomial with quadratic variance, zero-inflated Poisson, and zero-inflated negative binomial.

4 Build your model. You can choose between a main effects model or a custom model.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

Step 4: Set the Options

On the **Output** tab, set these options.

1 Specify the sample size, which specifies a number that controls the size of the compound distribution sample that the procedure simulates. The number is different if the counts are externally or internally simulated.

   - If you select **Use externally simulated counts** on the **Data** tab, this option is called *Sample size multiplier*. The total size of the compound distribution sample equals the number of replicates that are specified in the Input Data table multiplied by the value of the **Sample size multiplier**.
   - If you select **Simulate counts internally** on the **Data** tab, this option is called *Sample size*. The total size of the compound distribution sample is equal to the value of the **Sample size**.

2 Specify the maximum number of the loss count for simulating one aggregate loss sample point. The default value is `1000`.

3 Specify whether to perform a perturbation analysis. The default number of perturbed samples is `30`.

4 Specify the statistics to include in the output. You can also include these additional statistics:

   - summary statistics of the aggregate loss sample
   - percentiles of the aggregate loss sample

   For a perturbation analysis, you can also include the summary statistics and percentiles of the samples from that analysis.

5 Specify whether to include the probability density function and empirical distribution function in the results.

6 If you are running the step using the SAS CAS Server, specify how to generate the code for the step.

   - **Use Econometrics procedures** - The step uses the econometrics procedures for the SAS CAS Server.
   - **Use CAS procedure** - The step uses the CAS procedure.

Step 5: Create the Output Data

On the **Output** tab, specify whether to create any output tables.

If you are running the step using the SAS Compute Server, you can create these output tables:

- a table that contains the summary statistics of the aggregate loss samples data
- a table that contains the aggregate loss samples data

When naming these tables, you must use a SAS libref. By default, these tables are saved to the Work library.

If you are running the step using the SAS CAS Server, you can create these output tables:

- a table that contains the summary statistics of the aggregate loss samples data
- a table that contains the aggregate loss samples data
- a table that contains the individual severity random draws data

When naming these tables, you must use a SAS CAS engine libref. If you are running the step in a flow, you must add an output port to the Aggregate Loss Models node. For more information, see "Aggregate Loss Models: Connection Requirements for the Node" on page 485.

Causal Models

About the Causal Models Step

Causal models deal with a special type of cross-sectional data that has endogenous variables. An endogenous variable is a factor in a causal model or causal system whose value is determined by the states of other variables in the system. (The value of an exogenous variable is independent from the states of other variables in the system.)

With the Causal Models step, you can use these two techniques:

- two-stage least squares
- Heckman's two-step selection method

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Causal Models: Connection Requirements for the Node

In order to run the Causal Models step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output table. This table must use a CAS engine libref. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Causal Models node and select **Output Table**.

Input Port	Output Port
	Note: By default, the output data is written to a temporary table in the Work library. For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Two-Stage Least Squares Analysis

Example: Two-Stage Least Squares

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Causal Models** to add the step to your flow.
2. Add the Sashelp.PriceData table to your flow. Connect the input port of the Causal Models node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Causal Models step, click the Causal Models node.
4. On the **Data** tab, set these options:
   - Select **Two-stage least squares**.
   - To the **Dependent variable** role, assign the **sale** column.
   - To the **Exogenous explanatory variables** role, assign the **price** column.
   - To the **Endogenous explanatory variables** role, assign the **cost** column.
   - To the **Excluded instrumental variables** role, assign the **price1** and **price2** columns.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Two-Stage Least Squares: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Select **Two-stage least squares**.

3 For the **Dependent variable** role, specify the dependent variable for this equation:

$$y_1 = c_0 + c_1 * y_2 + c_2 * y_3 + c_3 * x_1 + c_4 * x_2$$

Here is an explanation of each variable:

- y_1 is the dependent variable.
- y_2 and y_3 are endogenous explanatory variables.
- x_1 and x_2 are exogenous explanatory variables.

4 For the **Exogenous explanatory variables** role, specify a factor in the model whose values are not determined by the states of other variables in the system.

5 For the **Endogenous explanatory variables** role, specify a factor in the model whose values are determined by the states of other variables in the system.

6 To the **Excluded instrumental variables** role, assign the variables not to include in the equation.

7 (Optional) To the **Group analysis by** role, assign the variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Options

On the **Options** tab, you can set these options.

1 Specify the optimization method to use.

You can use the default method, or you can choose from these methods:

- **Gauss-Newton**
- **Levenberg-Marquardt**

2 Specify the maximum number of iterations for the selected method. You can use the default value or specify a custom value.

3 Specify whether the results include the statistics that the step creates by default, the default statistics and any selected statistics, or no statistics.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of parameter estimates
- iteration history of the objective function and parameter estimates

4 Specify the plots to include in the results. By default, a plot of the predicted and actual values is included in the results. You can choose to display all of the plots, selected additional plots, or no plots.

You can include these additional plots in the results:

- autocorrelation plot
- inverse autocorrelation of residuals
- partial autocorrelation of residuals
- QQ plot of residuals
- residuals
- studentized residuals
- histogram of residuals

Step 3: Set the Output Options

On the **Output** tab, specify whether to create a table that contains the parameter estimates from the analysis.

Note: If you are running the step in a flow, you must add an output port to the Causal Models node. For more information, see "Causal Models: Connection Requirements for the Node" on page 495.

Heckman's Two-Step Selection Method

About Heckman's Two-Step Selection Method

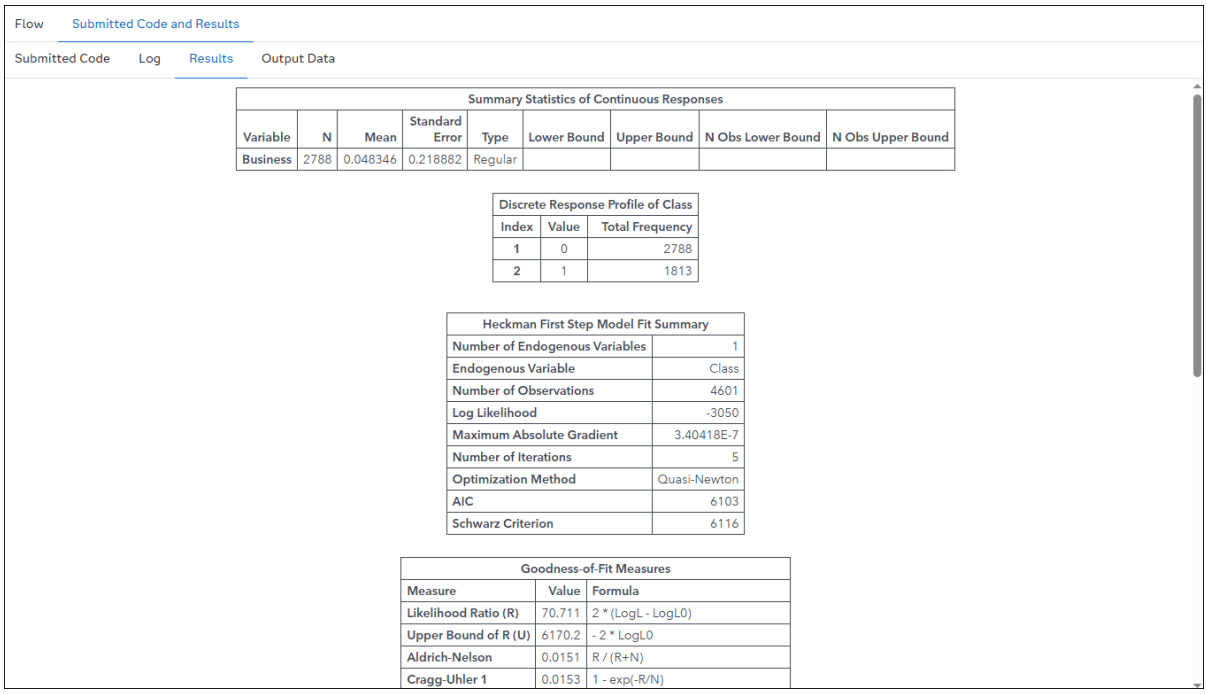
The Heckman's two-step selection method provides a means of correcting for non-randomly selected samples. It is a two-stage estimation method. The first stage performs a probit analysis on a selection equation. The second stage analyzes an outcome equation based on the first-stage binary probit model.

Example: Heckman's Two-Step Selection Method

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Causal Models** to add the step to your flow.
2. Add the Sashelp.JunkMail table to your flow. Connect the input port of the Causal Models node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Causal Models step, click the Causal Models node.
4. On the **Data** tab, select **Heckman's two-step selection method**.
5. For the outcome equation, set these options:
   - To the **Dependent variable** role for the outcome equation, assign the **Business** column.
   - To the **Continuous variables** role for the outcome equation, assign the **CapAvg** and **CapTotal** columns.
6. For the selection equation, set these options:
   - To the **Dependent variable** role for the selection equation, assign the **Class** column.
   - From the **Select the distinct value of the dependent variable** drop-down list, select **0**.
   - To the **Categorical variables** role for the selection equation, assign the **Make** column.
7. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Summary Statistics of Continuous Responses

Variable	N	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
Business	2788	0.048346	0.218882	Regular				

Discrete Response Profile of Class

Index	Value	Total Frequency
1	0	2788
2	1	1813

Heckman First Step Model Fit Summary

Number of Endogenous Variables	1
Endogenous Variable	Class
Number of Observations	4601
Log Likelihood	-3050
Maximum Absolute Gradient	3.40418E-7
Number of Iterations	5
Optimization Method	Quasi-Newton
AIC	6103
Schwarz Criterion	6116

Goodness-of-Fit Measures

Measure	Value	Formula
Likelihood Ratio (R)	70.711	2 * (LogL - LogL0)
Upper Bound of R (U)	6170.2	- 2 * LogL0
Aldrich-Nelson	0.0151	R / (R+N)
Cragg-Uhler 1	0.0153	1 - exp(-R/N)

Heckman's Two-Step Selection Method: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Assign these options for the outcome equation:

- To the **Dependent variable** role, assign the single numeric column to use.
- To the **Continuous variables** role, assign the independent variables (or regressors) to use in the model for the outcome equation dependent variable.
- To the **Categorical variables** role, assign the independent variables to use to group the values into levels.
- Specify whether to include the intercept in the outcome equation.

3 Assign these options for the selection equation:

- To the **Dependent variable** role, assign the single numeric column that takes binary values. Select the value to use for the dependent variable from the **Select the distinct value of the dependent variable** drop-down list.

- To the **Continuous variables** role, assign the independent variables (or regressors) to use in the model for the selection equation dependent variable.
- To the **Categorical variables** role, assign the independent variables to use to group the values into levels.
- Specify whether to include the intercept in the selection equation.

4 (Optional) To the **Group analysis by** role, assign the variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Options

On the **Options** tab, you can set these options.

1 Specify the optimization method to use.

2 Specify the maximum number of iterations for the selected method. You can use the default value or specify a custom value.

3 Specify whether to calculate the standard errors by using the corrected standard errors or the OLS standard errors.

4 Specify the method to calculate the covariance matrix of parameter estimates. You can use the default value, or you can select the covariance from the inverse Hessian matrix, from the outer product matrix, or from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

5 Specify whether the results include the statistics that the step creates by default, the default statistics and any selected statistics, or no statistics.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of the parameter estimates
- iteration history of the objective function and parameter estimates

Step 3: Set the Output Options

On the **Output** tab, specify whether to create a table that contains the parameter estimates from the analysis.

Note: If you are running the step in a flow, you must add an output port to the Causal Models node. For more information, see "Causal Models: Connection Requirements for the Node" on page 495.

Cross-sectional Data Models

About the Cross-Sectional Data Models Step

The Cross-Sectional Data Models step applies econometric techniques to analyze cross-sectional data. In the Cross-Sectional Data Models step, no panel structure (which consists of the cross-sectional ID and the time ID variables) is required.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Cross-Sectional Data Models: Connection Requirements for the Node

In order to run the Cross-Sectional Data Models step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table **Note:** The spatial weight table must be in a specified format.	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Cross-Sectional Data Models node and select ***name-of-output-table***. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Linear Models

Example: Linear Regression with Fixed Effects

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data cigar;
   input state year price pop pop_16 cpi ndi sales pimin;
   label
   state  = 'State abbreviation'
   year   = 'YEAR'
   price  = 'Price per pack of cigarettes'
   pop    = 'Population'
   pop_16 = 'Population above the age of 16'
   cpi    = 'Consumer price index with (1983=100)'
   ndi    = 'Per capita disposable income'
   sales  = 'Cigarette sales in packs per capita'
   pimin  = 'Minimum price in adjoining states per pack of cigarettes';
datalines;
1 63 28.6 3383 2236.5 30.6 1558.3045298 93.9 26.1
1 64 29.8 3431 2276.7 31.0 1684.0732025 95.4 27.5
1 65 29.8 3486 2327.5 31.5 1809.8418752 98.5 28.9
1 66 31.5 3524 2369.7 32.4 1915.1603572 96.4 29.5
1 67 31.6 3533 2393.7 33.4 2023.5463678 95.5 29.6
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47 85 83.6 5701 4453.6 107.6 12246.923612 134.6 79.3
47 86 91.3 5795 4540.3 109.6 13127.223459 135.8 85.4
47 87 94.6 5904 4627 113.6 13942.780019 133 90.5
47 88 102.1 6015 4725 118.3 15010 129.5 94.4
47 89 109.4 6098 4782 124 15936 122.5 103.8
47 90 128.6 6164.8 4834.4 130.7 16698 118.9 115.6
47 91 136.5 6263.4 4898.2 136.2 17038 109.1 120.5
47 92 157.9 6354.1 4965.1 140.3 18010 108.2 135.8
48 63 30.1 2961 2030.7 30.6 2409.3326822 99.1 28
```

```
48 64 29.9 2971 2045.2 31 2569.1936184 95.4 29.4
48 65 30 2973 2057.8 31.5 2764.3485276 98.3 29.1
48 66 34.7 3074 2140 32.4 3003.101874 86.9 29.8
48 67 35 3208 2250.3 33.4 3143.2397077 99.7 30.1
48 68 37.1 3296 2333.5 34.8 3363.3080096 101.5 32
48 69 37.6 3402 2421.5 36.7 3529.397294 100.2 31.9
48 70 38.7 3409 2438 38.8 3664.3448376 96.7 33.8
48 71 40.3 3433 2477.6 40.5 3829.396064 97 33.6
48 72 46.1 3423 2489.2 41.8 4072.3016424 88.5 33.7
48 73 45.9 3443 2528.9 44.4 4593.4067723 91 36.3
48 74 46.9 3503 2597.6 49.3 5079.2179292 98.6 38
48 75 49 3563 2667.3 53.8 5631.4647999 99.5 40.3
48 76 53 3623 2735 56.9 6166.0646842 100.3 42.5
48 77 53.7 3693 2806.6 60.6 6674.7131177 99.3 45.6
48 78 58.6 3793 2899.4 65.2 7521.7684683 101.3 51.5
48 79 61.6 3926 3014.6 72.6 8311.7306273 101.4 55.4
48 80 63.8 4132 3165.5 82.4 9105.8450185 101.4 56.4
48 81 66.6 4217 3233.2 90.9 9940.4436727 112.7 59.2
48 82 80.3 4245 3252.6 96.5 10492.690543 106.6 67.6
48 83 93.1 4300 3299 99.6 11018.985963 102.4 76.5
48 84 105.9 4349 3345.4 103.9 11805.833948 96.2 88.5
48 85 114.4 4406 3394.8 107.6 12336.2816 96.5 97.6
48 86 125.7 4463 3450.9 109.6 12946.659721 94.2 99.9
48 87 134.2 4538 3507 113.6 13522.781926 91.3 107.1
48 88 141.4 4648 3591 118.3 14347 88.2 121.9
48 89 150.6 4761 3669 124 15438 86.1 133.6
48 90 167.5 4882.4 3762.5 130.7 16252 83.4 141.3
48 91 177.4 5033.9 3866.5 136.2 16967 78.7 144.4
48 92 199.2 5152.2 3950.2 140.3 18038 81.1 167.2
49 63 27.7 1815 1247 30.6 1598.0632813 111.8 24.1
49 64 28 1823 1260.4 31 1721.5317383 109 25
49 65 28.2 1815 1264.3 31.5 1855.0382813 110.5 24.5
49 66 28.4 1815 1275.8 32.4 1962.4458008 111.2 24.7
49 67 29.5 1807 1280.6 33.4 2097.9599609 113.6 25
49 68 31.3 1819 1301.8 34.8 2202.3560547 119.8 26.3
49 69 32.1 1819 1310.4 36.7 2358.9501953 112.1 27
49 70 33.7 1744 1255.6 38.8 2659.0889648 114.5 28.3
49 71 41.6 1761 1277.7 40.5 2868.8849609 111.5 30.1
49 72 41.3 1781 1300.8 41.8 3118.8333008 117.5 29.9
49 73 39.9 1782 1310.4 44.4 3424.9949219 116.6 30.1
49 74 42 1784 1320 49.3 3815.4764648 119.9 31.3
49 75 45.2 1803 1340.2 53.8 4251.1293945 123.2 33.3
49 76 48.4 1833 1369.1 56.9 4646.6299805 129.7 36
49 77 48.9 1853 1389.2 60.6 5074.2524414 133.9 36.9
49 78 53.9 1861 1399.8 65.2 5525.9663086 131.6 41.4
49 79 62.4 1878 1416.2 72.6 6080.0686523 122.1 43.4
49 80 64.3 1950 1467.1 82.4 6593.0148437 122.3 46.3
49 81 66.2 1952 1471.9 90.9 7108.9724609 120.5 49.4
49 82 75.1 1948 1473.8 96.5 7632.9605469 119.8 56.3
49 83 88.2 1965 1490.2 99.6 7830.7108398 115.7 66.4
49 84 97.2 1952 1487.3 103.9 8338.6379883 111.9 75.4
49 85 103.2 1936 1484.4 107.6 8780.3137695 109.1 79.3
49 86 104.1 1917 1477.7 109.6 9173.8067383 112.1 85.4
49 87 112.8 1897 1470 113.6 9599.421582 107.5 90.5
49 88 122.2 1876 1460 118.3 10279 109.1 94.4
49 89 131.2 1857 1452 124 10901 104 103.8
```

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49 90 142.9 1842.6 1440.8 130.7 11946 104.1 115.6
49 91 144.1 1850.8 1454.1 136.2 12381 100.1 120.5
49 92 158.2 1862.1 1465.4 140.3 13526 98 135.8
50 63 27.6 4059 2702.5 30.6 2146.2878788 110.4 25.4
50 64 29.5 4100 2735.1 31 2307.5212121 106.2 25.6
50 65 29.8 4140 2773.5 31.5 2456.1909091 109.4 26.2
50 66 32.1 4178 2812.8 32.4 2633.1287879 106.3 30
50 67 32.8 4194 2841.6 33.4 2726.3090909 108.3 30.1
50 68 33.6 4211 2878 34.8 2939.8909091 111.4 32.7
50 69 33.6 4233 2898.1 36.7 3109.5 111.5 32.8
50 70 38.5 4417 3059.2 38.8 3339.8333333 106.4 37.7
50 71 40.2 4466 3129.2 40.5 3582.730303 105.4 38.5
50 72 40.3 4510 3197.2 41.8 3814.1106061 108.8 41.9
50 73 42.6 4537 3253.8 44.4 4269.5424242 109.5 41
50 74 43.9 4563 3310.4 49.3 4634.9348485 111.8 41.9
50 75 46.6 4601 3377.5 53.8 5039.0651515 113.5 45.2
50 76 51.3 4623 3430.2 56.9 5487.1681818 115.4 47.8
50 77 52.1 4658 3489.6 60.6 6063.0015152 117.2 49.4
50 78 57.1 4683 3537.6 65.2 6728.8742424 116.7 54.6
50 79 58.7 4720 3590.3 72.6 7622.9863636 117.1 56.4
50 80 61.2 4705 3551 82.4 8173.6924242 117.6 58.8
50 81 64.9 4742 3592.2 90.9 8663.6742424 119.9 61.4
50 82 75 4765 3617.1 96.5 9196.5818182 115.6 69.6
50 83 92 4751 3616.2 99.6 9815.3409091 106.3 80.8
50 84 100.8 4766 3639.2 103.9 10641.4 105.6 89.6
50 85 106.8 4775 3657.4 107.6 11228.75 107 96.7
50 86 110.8 4783 3670.8 109.6 11763.751515 105.4 104.8
50 87 116.3 4807 3690 113.6 12336.443939 106 116.2
50 88 128.6 4855 3728 118.3 13129 102.6 124.1
50 89 138.3 4867 3745 124 13933 100.3 132.7
50 90 151.1 4902.1 3772 130.7 14958 94.1 147.3
50 91 158.6 4965.2 3817.4 136.2 15438 95.5 154.4
50 92 176.5 5017.3 3853.8 140.3 16351 96.2 178.5
51 63 26.2 335 221.9 30.6 2212.8687965 125.6 24.9
51 64 26.2 338 224.8 31 2323.4089278 134 27.5
51 65 26.1 330 220 31.5 2468.0408753 137.6 27.6
51 66 26.5 320 215.2 32.4 2593.0442013 133.3 29.6
51 67 27.4 319 216.1 33.4 2775.9003063 137.4 30.1
51 68 32.5 322 221.9 34.8 2921.5653392 136.5 32
51 69 32.6 320 228.7 36.7 3066.1972867 135.7 31.9
51 70 34.1 332 231.6 38.8 3269.7150985 132.2 33.8
51 71 34.4 339 240.3 40.5 3514.5563239 131.7 33.6
51 72 34.4 345 247 41.8 3975.3123851 140 33.7
51 73 34.4 351 253.8 44.4 4505.2851641 141.2 36.3
51 74 35.8 362 263.4 49.3 4980.5044201 145.8 37.8
51 75 38.6 377 276 53.8 5455.7236761 160.7 40.3
51 76 42.6 392 288.5 56.9 5985.6964551 161.5 42.5
51 77 43.4 407 300.1 60.6 6640.6725602 160.4 44.7
51 78 49.8 425 314.5 65.2 7609.7066083 160.3 49.5
51 79 51.7 450 332.9 72.6 8482.6637199 168.6 53.7
51 80 55.3 470 343.5 82.4 9402.1096718 158.1 56.4
51 81 55.9 492 358 90.9 10046.754923 163.1 59.2
51 82 64.3 502 364.7 96.5 10180.022932 157.7 65.7
51 83 71 514 371.5 99.6 9855.6341357 141.2 76.5
51 84 81.7 511 370.5 103.9 10382.507659 128.9 88.5
51 85 87.4 510 369.5 107.6 10839.131379 125.7 92.3
```

```
51 86 97.8 507 368.6 109.6 11089.138031 124.8 99.9
51 87 102.7 490 357 113.6 11113.932079 110.4 106.2
51 88 112.9 479 353 118.3 11803 114.3 115.3
51 89 118.6 475 352 124 12399 111.4 123
51 90 129.5 470.9 348.9 130.7 13871 96.9 138.9
51 91 127 477.1 355.2 136.2 14675 109.1 143.6
51 92 155.1 483.3 360.5 140.3 15607 110.8 160
;
```

Click **Run** to create the Work.Cigar table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-sectional Data Models** to add the step to your flow.

3 Add the Work.Cigar table to your flow and connect it to the Cross-Sectional Data Models node. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

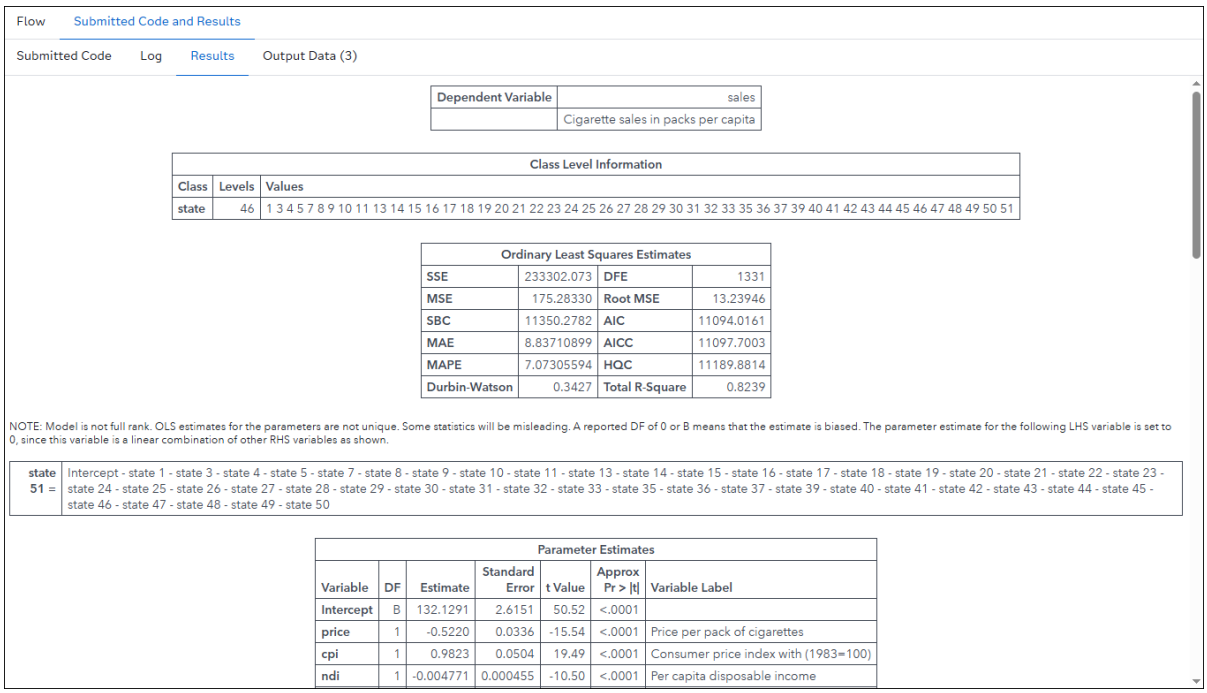
5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **sales**.
- To the **Continuous variables** role, assign **price**, **cpi**, and **ndi**.
- To the **Categorical variables** role, assign **state**.

6 On the **Model** tab, select **Linear** as the model type.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Linear Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric variable for the analysis.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the linear model.

1 From the **Model type** drop-down list, select **Linear**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Specify whether to analyze the heteroscedasticity. You can specify the variables on the variance function and the form of the variance function.

Note: This option is available only if you are running the step on SAS Compute Server.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available if you are running the step using SAS Compute Server.

- **Newey and West**
- **HCCME*n*** specifies a heteroscedasticity-corrected covariance matrix; *n* is a value from 0–4.

If the **Analyze heteroscedasticity** option is selected on the **Models** tab, these methods are available:

- **Outer product matrix (default)**.
- **Newey and West**.
- **Inverse Hessian matrix**.
- **HCCMEn** specifies a heteroscedasticity-corrected covariance matrix; *n* is a value from 0–4.

These options are available if you are running the step using CAS Server.

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 (CAS Server only) Specifies the variables that are related to the heteroscedasticity of the residuals and how these variables are used to model the error variance.

3 (CAS Server only) Specify the optimization method to use.

4 (CAS Server only) Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

5 Select the statistics to be displayed in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of the parameter estimates
- iteration history of the objective function and parameter estimates

Note: This option is available only if the **Analyze heteroscedasticity** option is selected on the **Models** tab.

6 Select the plots to include in the results.

7 (CAS Server only) Specify the code generation method to use. You can choose from these options:

- **Use Econometrics procedures**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- If you are running the step using SAS Compute Server, you can create an output table and a parameter estimates table.
- If you are running the step using CAS Server, you can create a CAS table that contains the default statistics from the analysis and any selected statistics such as the error standard deviation and the linear predictor. You can also include variables from the input data source in this table. When naming this table, you must specify a CAS engine libref.

  You can also create a table of the parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Logit Models

Example: Logit Model

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data mroz;
   input inlf nwifeinc educ exper expersq age kidslt6 kidsge6 lwage;
datalines;
1 10.91006    12 14  196   32  1   0   1.210154
1 19.49998    12 5   25    30  0   2   0.3285121
1 12.03991    12 15  225   35  1   3   1.514138
1 6.799996    12 6   36    34  0   3   0.0921233
```

```
1 20.10006    14 7   49    31  1   2   1.524272
1 9.859054    12 33  1089  54  0   0   1.55648
1 9.152048    16 11  121   37  0   2   2.12026
1 10.90004    12 35  1225  54  0   0   2.059634
1 17.305      12 24  576   48  0   2   0.7543364
1 12.925      12 21  441   39  0   2   1.544899
1 24.29995    12 15  225   33  0   1   1.401922
1 19.70007    11 14  196   42  0   1   1.524272
1 15.00001    12 0   0     30  1   2   0.7339532
1 14.6        12 14  196   43  0   2   0.8183691
1 24.63091    10 6   36    43  0   1   1.302831
1 17.53103    11 9   81    35  0   3   0.2980284
1 14.09998    12 20  400   43  0   2   1.16761
1 15.839      12 6   36    39  0   5   1.643839
1 14.1        12 23  529   45  0   0   0.6931472
1 10.29996    12 9   81    35  0   4   2.021932
1 22.65498    16 5   25    42  0   2   1.254248
1 8.090048    12 11  121   30  0   0   1.272958
1 17.479      13 18  324   48  0   0   1.178655
1 9.56        12 15  225   45  0   0   1.178655
1 8.274953    12 4   16    31  1   1   0.7675587
1 27.34999    17 21  441   43  0   2   1.331812
1 16          12 31  961   59  0   0   1.386294
1 16.99998    12 9   81    32  0   3   1.55327
1 15.10006    17 7   49    31  1   0   1.981815
1 15.69998    12 7   49    42  0   0   1.76936
1 5.11896     11 32  1024  50  0   0   0.4308079
1 16.75001    16 11  121   59  0   0   0.8997548
1 13.59993    13 16  256   36  0   2   1.76663
1 17.10005    12 14  196   51  0   1   1.272958
1 16.73405    16 27  729   45  0   3   1.336789
1 14.19698    11 0   0     42  0   1   0.9017048
1 10.31999    12 17  289   46  0   0   0.8651237
1 11.3841     10 28  784   46  0   1   1.511847
1 14.59408    14 24  576   51  0   0   1.726029
1 17.50044    17 11  121   30  0   0   2.683142
1 15.51       12 1   1     30  1   2   0.9852943
1 21.99998    12 14  196   57  0   0   1.365939
1 22.5        16 6   36    31  1   2   0.9450337
1 19.994      12 10  100   48  0   2   1.512376
1 14.13       12 6   36    30  0   3   0.6931472
1 5.000013    12 4   16    34  0   2   1.244788
1 21.1549     16 10  100   48  0   2   0.7011649
1 7.141946    12 22  484   45  0   0   1.519863
1 16.65007    12 16  256   51  0   0   0.8209686
1 6.352       12 6   36    30  0   2   0.9698315
1 27.31395    12 12  144   46  0   1   0.8285082
1 14.5        12 32  1024  58  0   0   0.0943096
1 16.25799    12 15  225   37  0   8   0.1625439
1 9.5         8  17  289   52  0   0   0.4700036
1 7.999956    10 34  1156  52  0   0   0.6292484
1 12.50003    16 9   81    31  0   0   1.39716
1 14.00003    14 37  1369  55  0   0   2.265444
1 20.80007    17 10  100   34  0   0   2.084541
1 19.38511    14 35  1225  55  0   0   1.525839
1 12.38699    12 6   36    39  0   2   0.7621601
```

```
1 28.5        14 19  361   40  0   3   1.481605
1 15.04991    12 10  100   43  0   4   1.262826
1 10.49998    8  11  121   48  0   0   0.9996756
1 11.81       12 15  225   47  0   0   1.832582
1 6.950073    12 12  144   41  0   4   2.479308
1 12.41997    8  12  144   36  0   0   1.279015
1 17.4        17 14  196   46  0   2   1.937936
1 15.5        12 11  121   34  0   0   1.070453
1 21.21704    12 9   81    41  0   3   1.123923
1 18          12 24  576   51  0   1   1.321756
1 11.89992    12 12  144   33  0   0   1.745
1 26.75196    12 13  169   52  0   0   1.301744
1 12.14996    9  29  841   58  0   0   1.641866
1 10.19999    10 11  121   34  2   4   2.10702
1 8.120015    12 13  169   31  0   1   1.467068
1 10.65996    12 19  361   48  0   1   1.605811
1 18.10001    12 2   4     32  0   2   -1.029739
1 8.599986    17 24  576   49  0   0   1.087686
1 13.665      15 9   81    32  2   2   0
1 32.34996    12 6   36    58  0   0   0.9382087
1 12.08501    6  22  484   50  0   0   -0.1505904
1 12.15       14 30  900   60  0   0   0
1 17.69502    12 10  100   50  0   1   1.073671
1 24.7        14 6   36    56  0   0   1.265848
1 2.133992    9  29  841   51  0   0   0.486369
1 20.95005    17 29  841   54  0   1   2.12026
1 10.50008    13 36  1296  59  0   0   1.129853
1 10.55       9  19  361   46  0   2   0.9932518
1 45.75       15 8   64    46  0   1   1.658628
1 13.63204    12 13  169   39  1   3   0.3474122
1 18.23894    12 16  256   44  0   2   1.568324
1 17.09       12 11  121   33  2   0   0.5108456
1 30.2349     12 15  225   33  1   2   0.1148454
1 28.7        12 6   36    48  0   2   -0.6931472
1 19.63       12 13  169   31  0   4   -0.3364523
1 12.82494    12 22  484   45  0   1   1.028226
1 23.8        12 24  576   45  0   1   1.580689
1 26.30003    13 2   4     32  0   2   0.5558946
1 20.69991    12 6   36    47  0   0   0.9014207
1 26          13 2   4     34  0   2   0.8843046
1 10.87702    12 2   4     37  0   1   0.4282046
1 25.61206    12 14  196   36  0   1   1.058415
1 20.98899    12 9   81    47  1   2   0.8783396
1 70.74993    16 11  121   48  0   1   1.654908
1 17.05       12 9   81    42  0   2   1.321756
1 21          13 6   36    33  0   3   0.3285121
1 8.12        11 19  361   46  0   0   1.386294
1 20.88599    12 26  676   47  0   3   1.172885
1 17.66892    12 19  361   44  0   1   1.224187
1 25.20003    12 3   9     36  0   4   0.2876571
1 14.24501    17 7   49    31  2   0   2.230262
1 14.3        14 28  784   55  0   0   1.504077
1 23.70001    16 13  169   45  0   1   1.531152
1 46          17 9   81    47  0   0   1.375158
1 42.9999     12 15  225   46  0   3   1.760269
1 14.749      11 20  400   49  0   0   -0.6931472
```

```
1 16.15005    12 29  841   49  0   0   1.406489
1 17.774      12 9   81    45  0   2   1.791759
1 91          17 1   1     38  1   3   1.299292
1 22.29993    10 8   64    47  0   0   1.351004
1 34.60001    13 19  361   54  0   3   1.016281
1 9.620002    11 23  529   41  0   0   1.075344
1 10.89995    12 3   9     43  0   2   1.478965
1 14.49994    16 13  169   31  1   1   1.689487
1 22.00002    17 8   64    47  0   0   2.288598
1 17.90008    12 17  289   35  0   2   -1.822631
1 23.67506    16 4   16    45  0   3   -0.9607652
1 11.79996    12 15  225   33  1   0   1.290994
1 16.14195    16 11  121   54  0   1   0.8648711
1 18.39997    8  7   49    35  0   4   1.540452
1 15.49995    12 0   0     31  1   2   0.6162121
1 17.324      12 0   0     55  0   0   1.648659
1 19.205      12 10  100   34  0   2   1.193498
1 21.30006    13 8   64    38  0   1   2.143976
1 23.56       11 2   4     45  0   1   0.7244036
1 20.85       12 4   16    47  0   1   0.9416075
1 26.15       12 6   36    39  0   2   0.7827594
1 17          14 18  324   36  1   0   1.832582
1 20.72       12 3   9     33  1   2   1.203963
1 17.00009    12 22  484   50  0   0   1.491645
1 16          12 33  1089  58  0   0   1.892133
1 19.50005    17 28  784   49  0   0   2.130895
1 12          14 23  529   41  0   2   1.480604
1 13.73191    12 27  729   51  0   1   0.8943313
1 27.19999    9  11  121   53  0   0   0.2025325
1 5.315       12 6   36    36  1   2   0.4855078
1 16          12 11  121   46  0   2   1.098612
1 27.87198    12 14  196   36  0   2   1.55327
1 40.00001    14 17  289   53  0   1   0.121598
1 15.90003    16 17  289   40  0   3   2.001804
1 27.49997    17 14  196   42  0   2   1.495037
1 17.02005    15 11  121   33  1   1   0.9052298
1 22.39494    12 7   49    43  0   3   0.6325476
1 11.1        16 8   64    31  1   0   1.386294
1 32.70001    17 6   36    47  0   0   2.102914
1 27.79996    17 8   64    54  0   0   1.959644
1 2.199994    12 4   16    33  1   3   0.5108456
1 19.72095    16 25  625   43  0   0   1.236924
1 9.999988    13 24  576   46  0   1   1.443313
1 13.19997    12 11  121   35  0   3   1.021659
1 12.70897    11 19  361   37  0   3   0.6361535
1 27.30005    16 9   81    37  0   2   1.616453
1 21.2        14 19  361   34  0   3   0.2231435
1 14.4        16 14  196   43  1   0   1.049807
1 20.57596    12 22  484   46  0   0   1.415052
1 12.49999    9  6   36    35  0   3   0.5753766
1 17.50022    17 23  529   46  0   0   2.606682
1 44.00004    14 15  225   46  0   0   1.517915
1 13.11895    12 6   36    43  0   2   0.7550416
1 14.00006    12 11  121   30  0   0   1.094972
1 9.645086    11 2   4     41  0   2   0.9421144
1 17.39705    12 22  484   54  0   1   1.724943
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1 7.799889    12 10  100   31  0   1   1.031546
1 13.13398    10 14  196   44  0   0   0.4743691
1 25.6        12 12  144   32  0   1   0.8109302
1 13.90003    5  9   81    47  0   0   0.7092666
1 19.29794    17 13  169   46  0   1   1.710549
1 9.200016    11 18  324   37  0   0   0.4602689
1 37.99999    12 8   64    51  0   2   1.331812
1 44          12 11  121   49  0   1   1.098612
1 21.37202    14 9   81    36  0   4   2.157999
1 23.66802    11 9   81    39  0   1   1.437581
1 9           12 14  196   48  0   2   1.544899
1 25.19995    14 9   81    38  0   2   1.410597
1 21.22       12 2   4     40  0   2   3.218876
1 33.96991    10 12  144   39  1   5   0.9681619
1 17.07       16 15  225   37  0   0   1.791759
1 6.016024    13 11  121   49  0   1   1.68873
1 17.10001    12 7   49    33  0   3   -0.409172
1 8.237       12 9   81    30  0   0   0.2231435
1 13.30008    12 19  361   54  0   0   0.8221558
1 16.00002    11 11  121   39  0   4   1.241702
1 12.53999    12 8   64    43  0   3   1.427124
1 18.00004    9  13  169   31  0   3   1.497097
1 31.2        13 4   16    33  0   3   0.5596158
1 20.74991    12 7   49    40  0   3   1.300028
1 11.09992    12 19  361   36  0   1   1.88443
1 20.68       12 14  196   51  0   0   0.9555114
1 18.00001    13 14  196   44  0   1   1.582087
1 32.43007    16 3   9     42  0   3   1.755614
1 32.90003    12 9   81    40  0   1   1.513103
1 24.10001    16 7   49    34  1   1   2.251892
1 17.80039    17 7   49    30  0   0   2.364432
1 20.50002    12 14  196   54  0   0   0.1053505
1 10.4999     12 29  841   51  0   0   1.399729
1 10.43703    9  19  361   44  0   2   0.9884625
1 18.19499    12 14  196   43  0   1   1.090647
1 12.84508    12 16  256   34  0   1   1.154614
1 13.8        13 10  100   45  0   0   1.266948
1 22.2        12 12  144   39  0   0   2.885192
1 6.699941    12 24  576   50  0   0   1.22888
1 6.250016    12 6   36    52  0   0   1.203963
1 15.60001    12 9   81    41  0   2   1.35738
1 3.30001     10 14  196   59  0   0   0.8377236
1 3.670978    12 26  676   52  0   0   0.5369611
1 7.789997    16 7   49    46  0   0   0.7487238
1 18.27199    12 4   16    41  1   5   2.295873
1 10.95398    11 15  225   33  0   2   1.107803
1 13.49999    12 23  529   45  0   0   0.6208453
1 11.20001    10 1   1     36  1   2   -2.054164
1 20.99991    12 29  841   48  0   1   1.892012
1 25.7        12 9   81    47  0   1   1.729725
1 8.932994    12 6   36    45  0   0   0.4693784
1 19.15998    12 11  121   37  0   2   0.9808417
1 26.58999    16 17  289   46  0   4   2.069492
1 22.40001    17 6   36    43  0   3   1.675188
1 20.633      12 7   49    42  0   2   1.386294
1 28.20001    17 2   4     34  1   2   1.799215
```

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1 28.8         12 24  576   52  0   0   1.832582
1 8.999997     12 4   16    37  0   3   1.090647
1 11.39994     12 11  121   37  0   1   1.443124
1 10.40001     8  25  625   52  0   0   1.25036
1 19.08006     12 11  121   30  1   0   1.602313
1 9.46604      13 2   4     31  0   1   1.018559
1 6.50006      12 19  361   38  0   1   1.297053
1 29.11701     12 7   49    43  0   3   1.685194
1 19.10302     8  2   4     49  0   1   -0.4209849
1 16.34997     12 20  400   55  0   0   1.562095
1 32.02502     17 10  100   38  0   2   2.146528
1 16.70006     17 19  361   52  0   0   2.347463
1 4.811038     12 17  289   48  0   0   0.9698315
1 24.62601     13 12  144   32  0   2   1.924146
1 17.40001     12 11  121   32  0   1   1.626728
1 13.02504     12 6   36    38  0   2   -0.0392607
1 19.00698     12 10  100   46  0   3   1.460149
1 14.03        12 4   16    40  0   3   1.955394
1 14.89991     9  2   4     31  0   4   0.9263599
1 25.00006     10 13  169   43  0   1   2.066192
1 10.70007     12 21  441   51  0   0   1.422843
1 24.25        16 9   81    30  1   0   2.101032
1 39.13997     13 4   16    52  0   0   2.261461
1 7.199973     8  2   4     30  1   5   0.7013138
1 31.811       16 19  361   51  0   0   2.031013
1 10.00005     13 4   16    31  0   2   1.162369
1 20.66        12 9   81    34  0   4   0.4700036
1 13.49998     11 14  196   49  0   0   1.410597
1 25.38        13 6   36    35  1   3   0.3930551
1 18.27498     12 24  576   53  1   0   1.290994
1 39.213       12 1   1     32  0   3   0
1 10.49994     10 13  169   38  0   3   0.9571255
1 34.857       12 3   9     54  0   0   0.5596158
1 28.502       17 10  100   47  0   1   1.568616
1 12.99996     15 16  256   45  0   1   1.710188
1 41.39991     16 9   81    47  0   1   1.410597
1 14.78        10 19  361   59  0   0   0.2231435
1 15.05        11 4   16    32  0   1   0.5108456
1 29.69998     12 10  100   45  0   1   1.332392
1 16.16502     12 5   25    40  0   4   0.8601859
1 25.20516     14 7   49    47  0   2   2.32278
1 14.2         16 3   9     36  1   2   1.919595
1 18.15897     14 38  1444  56  0   0   1.976107
1 28.98106     8  16  256   41  0   1   0.8954347
1 13.392       7  13  169   48  0   3   0.1812376
1 9.17502      12 1   1     36  1   2   0.4953058
1 27.03985     12 7   49    41  0   0   0.5777924
1 13.14995     14 15  225   41  0   0   1.078818
1 16.40007     12 10  100   36  0   3   1.603199
1 21.29999     12 2   4     37  0   3   0.6208453
1 17.20102     12 19  361   38  0   0   2.083894
1 8.560026     14 25  625   43  0   2   1.379169
1 6.49084      16 25  625   54  0   0   1.112384
1 12.49997     12 7   49    38  0   1   1.067122
1 27.00002     12 15  225   30  1   0   1.118807
1 53.50005     12 11  121   49  0   0   1.588541
```

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1 52.49995    13 25  625   45  0   1   1.390311
1 38.39998    13 19  361   51  0   0   1.714806
1 13.89194    10 4   16    34  0   0   0.2010615
1 3.899993    12 14  196   34  0   2   0.987271
1 34.2        12 19  361   41  0   1   0.9835007
1 19.70008    12 18  324   49  0   1   2.233171
1 18.49995    12 14  196   32  0   0   1.143618
1 10.99998    14 11  121   32  0   0   -0.6113829
1 43.30001    17 4   16    32  0   2   2.153052
1 18.76001    10 29  841   47  0   0   1.299837
1 4.800096    9  21  441   39  0   1   0.8409204
1 21.5        12 24  576   49  0   0   1.058484
1 28.03994    12 19  361   37  0   3   1.152658
1 26          16 31  961   59  0   0   1.293576
1 27          12 28  784   50  0   0   1.832582
1 17.79969    17 15  225   32  0   1   2.32718
1 17.40195    12 27  729   46  0   0   1.166146
1 19.30999    17 13  169   43  0   2   2.034993
1 9.99998     11 4   16    37  0   3   0.6792511
1 11.17998    16 10  100   32  0   2   1.547137
1 18.85696    11 8   64    39  0   1   0.7530186
1 12.30002    13 4   16    34  0   2   0.8472836
1 13.67712    11 18  324   39  0   1   0.871126
1 9.559997    8  3   9     45  0   3   0.2282505
1 24.49998    11 11  121   50  0   0   0.0896578
1 23.15       12 8   64    40  0   1   1.321756
1 15.59088    10 10  100   30  0   1   1.196102
1 14.42092    17 33  1089  57  0   0   1.636119
1 17.45491    12 19  361   39  0   1   1.892012
1 9.800019    12 35  1225  53  0   0   1.518309
1 17.57446    17 21  441   48  0   1   2.472159
1 16.555      14 7   49    46  0   1   1.321756
1 13.29497    12 18  324   47  0   0   1.473641
1 11.844      12 4   16    43  0   1   1.369479
1 46.64506    12 12  144   47  0   0   1.203963
1 14.69999    12 16  256   47  0   1   1.198729
1 26.09008    12 14  196   47  0   0   1.27021
1 9.9         12 3   9     46  0   0   0.4700036
1 9.048026    9  1   1     34  0   4   0.7999817
1 30.75006    10 27  729   48  0   0   1.565946
1 8.49994     12 12  144   30  0   1   1.758978
1 22.24999    12 6   36    51  0   1   0.8580258
1 42.91       12 9   81    52  0   5   0.6931472
1 33.3        12 2   4     37  0   2   0.6418539
1 13.8199     12 6   36    32  0   2   1.63374
1 23.60001    17 9   81    36  0   2   1.703748
1 13.00007    12 16  256   35  0   2   1.844004
1 20.74994    17 22  484   45  0   0   1.966119
1 6.3         12 26  676   56  0   0   0.8649974
1 7.788925    10 11  121   40  0   2   0.9333052
1 10.47004    12 11  121   45  1   2   0.7792332
1 12          12 15  225   32  0   2   0.9555114
1 16.97992    12 13  169   45  0   0   1.316247
1 17.9        12 6   36    40  0   2   1.475906
1 15.53994    12 20  400   38  0   1   1.491397
1 9.883986    12 17  289   49  0   4   1.45575
```

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1 28.59995    16 8   64    47  0   1   0.5108456
1 17.66001    13 13  169   52  0   0   1.180438
1 25.99992    13 15  225   34  0   1   1.688489
1 13.60201    12 14  196   44  0   2   0.7907275
1 15.8        16 14  196   36  0   3   1.401799
1 41.09999    17 6   36    50  0   0   -0.433556
1 10.77504    12 24  576   45  0   0   1.683172
1 9.000047    14 10  100   44  0   2   -1.766677
1 24.39899    12 2   4     57  0   2   3.155595
1 37.30009    17 9   81    35  0   0   2.259521
1 27.99995    12 23  529   46  0   0   1.306926
1 13.7        14 12  144   30  2   1   0.7984977
1 17.20994    12 8   64    42  0   3   0.5590442
1 14.00001    12 16  256   34  0   1   0.1479026
1 35.75502    17 10  100   45  0   2   1.944495
1 23.5        16 7   49    35  1   2   1.378338
1 31.99993    16 19  361   40  0   0   3.064745
1 17.15       12 2   4     32  0   1   -0.7419173
1 20.25002    9  9   81    54  0   0   0.7657004
1 5.485985    12 14  196   38  0   3   0.619393
1 25.07504    12 9   81    43  0   3   1.465452
1 18.21995    16 16  256   54  0   0   2.18926
1 26          14 7   49    39  0   3   1.021659
1 34.50007    12 6   36    37  0   1   0.9770095
1 12.4        12 22  484   46  0   2   0.9162908
1 10.78685    11 9   81    56  0   0   2.905096
1 16.32301    12 9   81    41  0   3   -0.1996712
1 30.5        16 14  196   45  0   1   0.6931472
1 51.29963    17 17  289   44  0   1   2.733393
1 33.04997    17 12  144   50  0   1   1.868335
1 34.75001    14 13  169   37  0   5   2.12026
1 16.40004    12 8   64    44  0   1   1.515193
1 19.70007    14 10  100   32  0   2   0.9146093
1 6.600003    12 16  256   34  1   1   1.499556
1 9.020008    10 1   1     32  0   2   0.8030772
1 10.40001    12 6   36    37  0   3   0.7280316
1 14.51999    13 4   16    44  0   1   0.51641
1 17.2        16 8   64    34  0   2   1.226448
1 43          12 4   16    33  1   3   0.9162908
1 13.87196    7  15  225   43  0   3   1.376471
1 -0.0290575  16 7   49    35  0   2   1.828975
1 16.76994    14 14  196   43  0   1   1.368283
1 7.8         12 16  256   34  0   0   1.064711
1 14.50006    10 15  225   36  0   3   1.406489
1 7.9         12 23  529   41  0   2   1.047319
1 79.80001    16 19  361   41  0   0   1.948093
1 7.17597     10 4   16    35  0   3   1.078001
1 17.50698    12 12  144   32  1   3   0.6539385
1 20.6        14 12  144   30  0   0   1.927892
1 18.55992    12 25  625   43  0   0   1.361028
1 9.3         6  14  196   54  0   0   0.6931472
1 5.120008    15 14  196   35  0   2   1.604687
1 14.50004    12 11  121   50  0   0   0.1839036
1 19.8        17 7   49    34  1   1   3.113515
1 18.29995    14 18  324   52  0   0   1.926829
1 33.99994    13 4   16    35  0   3   1.270126
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1 11.62794    6  37  1369  55  0   0   0.6826927
1 11.80005    16 13  169   35  0   0   1.68107
1 39.09998    14 14  196   49  0   1   0.556296
1 18.43007    15 17  289   38  2   2   1.62822
1 21          14 5   25    42  0   2   0.9162908
1 59          8  2   4     48  0   1   1.341558
1 25.3        14 0   0     51  0   0   0
1 23.24899    12 3   9     43  0   2   1.122231
1 24.92809    12 21  441   43  0   1   0.5401708
1 14.78199    12 20  400   38  0   1   1.391506
1 18.90003    12 19  361   44  0   1   1.697174
1 21          12 4   16    36  1   3   3.218876
1 10.00001    12 19  361   38  0   0   0.8711678
1 29.30997    8  11  121   47  0   0   1.16733
1 13.14003    12 14  196   34  0   2   1.216988
1 25.08999    17 8   64    40  1   2   0.5753766
1 14.59993    12 13  169   31  0   1   1.151616
1 1.200001    12 24  576   46  0   0   0.9942513
1 32          14 1   1     36  0   3   0.5263249
1 16.11997    13 1   1     39  1   2   -1.543182
1 26.50002    17 3   9     36  0   2   1.912043
1 12.75006    8  4   16    37  0   4   0.5542873
1 12.9        12 21  441   39  0   4   0.9162908
1 10.69998    11 10  100   36  1   3   1.500939
1 14.43403    12 13  169   49  0   2   0.9446838
1 23.709      12 9   81    45  1   1   1.241269
1 15.1        17 14  196   32  2   0   1.564984
1 18.19998    10 2   4     36  0   5   0.8380265
1 22.64106    12 21  441   40  0   1   1.668857
1 21.64008    13 22  484   43  0   2   1.769429
1 23.99998    12 14  196   33  0   1   1.226448
1 16.00002    12 7   49    30  0   1   1.406489
0 21.025      12 2   4     49  0   1   .
0 23.6        16 5   25    30  2   0   .
0 22.8        12 12  144   30  1   0   .
0 35.91       12 1   1     41  0   4   .
0 21.7        12 12  144   45  0   1   .
0 21.823      12 4   16    43  0   5   .
0 31          13 9   81    42  0   1   .
0 15.3        12 9   81    60  0   0   .
0 12.925      12 6   36    57  0   0   .
0 15.83       10 5   25    38  0   2   .
0 30.2        12 5   25    56  0   0   .
0 16.6        12 8   64    32  0   3   .
0 11          7  2   4     49  0   1   .
0 15          12 6   36    55  0   0   .
0 20.528      9  0   0     36  1   1   .
0 13.126      12 3   9     44  0   3   .
0 15.55       10 7   49    44  0   1   .
0 18.01       14 3   9     35  1   2   .
0 18.874      14 10  100   44  2   3   .
0 24.8        12 3   9     45  0   1   .
0 17.5        12 2   4     34  1   0   .
0 16.15       17 12  144   30  2   0   .
0 15.189      8  15  225   39  0   1   .
0 6           12 5   25    36  0   2   .
```

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0 37.25       17 4   16    38  0   2   .
0 27.76       12 10  100   53  0   0   .
0 9.09        12 1   1     36  0   2   .
0 14.5        12 8   64    32  1   1   .
0 19.7        9  20  400   51  0   3   .
0 16.788      11 4   16    38  0   0   .
0 18.52       12 7   49    33  2   0   .
0 20.95       12 10  100   54  0   0   .
0 7.574       9  3   9     38  0   3   .
0 10.027      11 5   25    30  2   2   .
0 5           12 10  100   34  2   3   .
0 7.04        9  0   0     34  0   1   .
0 40.8        12 3   9     50  0   2   .
0 16.05       17 10  100   30  2   0   .
0 33.1        12 2   4     38  0   2   .
0 33.856      14 10  100   54  0   0   .
0 20.5        12 4   16    30  1   2   .
0 28.6        12 0   0     55  0   0   .
0 18.75       10 10  100   51  0   1   .
0 20.3        12 5   25    44  0   1   .
0 13.42       12 0   0     53  0   0   .
0 18.4        10 0   0     42  0   2   .
0 16.682      12 19  361   38  0   2   .
0 32.685      13 2   4     38  1   3   .
0 7.05        12 12  144   41  1   4   .
0 10.867      8  5   25    35  0   3   .
0 18.22       12 5   25    33  1   2   .
0 26.613      13 5   25    48  0   0   .
0 25          12 10  100   47  0   0   .
0 15.7        12 0   0     34  0   5   .
0 40.25       13 4   16    33  2   1   .
0 73.6        13 3   9     31  3   1   .
0 10.592      8  2   4     58  0   0   .
0 8           12 1   1     49  0   0   .
0 13.4        8  0   0     55  0   1   .
0 23.7        14 1   1     44  0   0   .
0 18.9        9  1   1     44  0   0   .
0 48.3        16 6   36    36  0   3   .
0 24.47       12 12  144   38  0   3   .
0 28.63       16 6   36    37  0   3   .
0 25.32       12 9   81    47  0   0   .
0 13.53       12 14  196   47  0   3   .
0 14.8        12 13  169   32  1   1   .
0 17.4        12 8   64    43  1   2   .
0 15.98       11 0   0     42  1   4   .
0 16.576      12 1   1     56  0   0   .
0 21.85       13 3   9     38  0   5   .
0 14.6        12 13  169   52  0   2   .
0 21.6        12 3   9     50  0   0   .
0 24          16 8   64    33  0   0   .
0 20.883      16 8   64    44  0   2   .
0 19.5        12 18  324   41  0   1   .
0 42.8        12 2   4     45  0   1   .
0 41.5        14 3   9     53  0   0   .
0 18.965      14 5   25    53  0   0   .
0 16.1        12 2   4     42  0   1   .
```

```
0 14.7        13 10  100   32  2   0   .
0 18.8        12 30  900   56  0   0   .
0 14.75       11 1   1     37  1   3   .
0 21          12 5   25    40  1   2   .
0 35.4        15 8   64    54  0   3   .
0 10.7        7  0   0     53  0   0   .
0 24.5        12 4   16    48  0   1   .
0 17.045      12 2   4     36  1   2   .
0 18.8        12 30  900   57  0   0   .
0 14          12 25  625   51  0   0   .
0 18.214      13 3   9     33  0   4   .
0 20.177      12 20  400   52  0   0   .
0 8.3         10 20  400   56  0   0   .
0 14.2        12 0   0     36  1   2   .
0 21.768      14 15  225   36  1   0   .
0 29.553      12 10  100   46  0   1   .
0 4.35        10 4   16    31  0   3   .
0 24          11 3   9     52  0   0   .
0 18.3        12 10  100   46  0   2   .
0 17.2        12 9   81    35  2   0   .
0 16.476      12 7   49    59  0   0   .
0 13.4        8  12  144   36  0   1   .
0 44.988      7  0   0     51  1   3   .
0 18.2        16 16  256   31  1   0   .
0 28          14 4   16    31  0   2   .
0 11.55       12 7   49    32  1   1   .
0 28.45       16 7   49    35  1   2   .
0 15.096      12 14  196   40  0   3   .
0 8.009       10 2   4     33  1   2   .
0 10.04       7  20  400   54  0   0   .
0 16.7        12 5   25    36  1   1   .
0 8.4         10 10  100   50  0   1   .
0 13          8  20  400   54  0   0   .
0 17.97       11 10  100   48  0   1   .
0 18.45       15 8   64    41  0   4   .
0 31          12 11  121   50  0   4   .
0 24.135      12 3   9     46  0   2   .
0 31.7        13 6   36    42  0   1   .
0 10.19       9  4   16    31  1   2   .
0 21.574      12 4   16    53  0   0   .
0 26.68       12 9   81    51  0   1   .
0 17.7        12 10  100   47  0   1   .
0 29.4        12 3   9     50  0   1   .
0 22.159      6  2   4     37  0   1   .
0 35          12 2   4     30  2   2   .
0 8.63        12 0   0     49  0   0   .
0 17.08       12 8   64    52  0   2   .
0 32.5        12 6   36    47  0   2   .
0 16          12 15  225   49  0   0   .
0 18.85       12 15  225   44  0   4   .
0 17.5        8  9   81    53  0   0   .
0 19.392      12 8   64    30  1   0   .
0 14.45       12 18  324   54  0   2   .
0 21.8        7  3   9     47  1   1   .
0 7.7         15 10  100   56  0   0   .
0 31.8        12 6   36    49  0   1   .
```

```
0 17.258      6  20  400   48  0   0   .
0 13.399      12 8   64    49  0   1   .
0 16.073      12 3   9     56  0   1   .
0 23.26       12 4   16    46  0   0   .
0 37.3        12 13  169   45  0   2   .
0 11          12 4   16    32  0   2   .
0 13.075      12 17  289   43  1   1   .
0 13.7        12 4   16    34  1   1   .
0 25.1        12 0   0     30  1   1   .
0 18.6        17 15  225   38  2   0   .
0 29          16 11  121   33  1   1   .
0 19.237      12 23  529   52  0   0   .
0 19.855      11 1   1     43  0   3   .
0 9.45        12 5   25    33  1   1   .
0 30          10 1   1     45  0   0   .
0 15          10 5   25    36  2   1   .
0 24.701      12 3   9     34  1   1   .
0 15.9        14 3   9     37  0   2   .
0 16.24       10 19  361   46  0   1   .
0 21.1        12 20  400   47  0   0   .
0 23          16 5   25    31  2   1   .
0 6.34        5  0   0     57  0   0   .
0 42.25       12 3   9     30  1   1   .
0 14.694      12 3   9     30  0   0   .
0 21.417      12 7   49    44  0   3   .
0 20.2        13 7   49    53  0   0   .
0 12.09       8  1   1     51  0   0   .
0 24.76       12 13  169   39  1   3   .
0 23          8  0   0     52  0   0   .
0 19.365      8  0   0     46  0   4   .
0 5.55        12 12  144   47  0   5   .
0 68.035      8  0   0     52  0   2   .
0 29.3        12 5   25    45  0   2   .
0 18.5        11 45  2025  60  0   0   .
0 22.582      13 10  100   41  0   2   .
0 21.5        8  2   4     39  0   3   .
0 28.07       12 3   9     49  0   1   .
0 50.3        15 1   1     32  1   1   .
0 23.5        12 5   25    33  1   3   .
0 15.5        10 10  100   36  0   4   .
0 13.44       13 4   16    37  3   3   .
0 8.1         12 7   49    30  1   2   .
0 9.8         11 9   81    44  1   1   .
0 20.3        12 5   25    48  0   1   .
0 15          11 4   16    40  0   4   .
0 56.1        13 11  121   47  0   0   .
0 22.846      12 9   81    36  0   2   .
0 22.225      11 4   16    40  0   2   .
0 17.635      12 2   4     46  0   1   .
0 18.5        12 23  529   52  0   0   .
0 13.39       12 3   9     44  0   1   .
0 15.15       10 15  225   45  0   1   .
0 16.2        7  8   64    30  2   1   .
0 33.92       12 3   9     40  1   3   .
0 14          12 25  625   43  0   1   .
0 16.736      12 2   4     49  0   2   .
```

```
0 30.65       12 0   0     46  1   4   .
0 12.4        11 19  361   52  0   0   .
0 19.022      12 3   9     31  1   1   .
0 11.203      10 7   49    42  1   1   .
0 19.876      11 1   1     33  0   3   .
0 57          16 9   81    57  0   0   .
0 18.29       10 3   9     49  0   0   .
0 20.22       14 8   64    45  0   1   .
0 22.15       11 0   0     56  0   0   .
0 30.623      12 5   25    41  1   3   .
0 9.38        5  20  400   56  0   0   .
0 22          10 3   9     48  0   1   .
0 23.675      16 12  144   52  0   2   .
0 33.671      12 5   25    51  0   0   .
0 12.367      11 1   1     35  0   3   .
0 21.95       12 0   0     45  0   0   .
0 32          12 7   49    54  0   0   .
0 22.61       12 13  169   54  0   2   .
0 12.092      12 3   9     31  1   0   .
0 3.777       6  0   0     53  0   3   .
0 36          14 2   4     35  2   2   .
0 26.9        12 0   0     36  1   3   .
0 32.242      12 2   4     59  0   0   .
0 35.02       16 1   1     54  0   0   .
0 37.6        12 10  100   37  1   1   .
0 1.5         12 10  100   44  0   0   .
0 96          17 1   1     34  1   2   .
0 18.15       12 3   9     49  0   0   .
0 15.5        12 32  1024  49  0   0   .
0 14          9  0   0     60  0   0   .
0 14.756      12 7   49    51  0   0   .
0 22          12 5   25    30  1   1   .
0 24.466      12 2   4     47  0   2   .
0 24.4        12 5   25    36  0   4   .
0 24          12 3   9     35  1   3   .
0 15.5        12 25  625   58  0   0   .
0 30.8        14 0   0     41  1   3   .
0 10.66       10 3   9     51  0   1   .
0 13.35       12 10  100   47  0   0   .
0 10.09       9  10  100   45  1   2   .
0 55.6        14 7   49    60  0   0   .
0 25.7        16 5   25    30  1   1   .
0 29          11 15  225   55  0   0   .
0 7.286       12 1   1     32  1   2   .
0 37.752      12 5   25    36  0   2   .
0 13.072      12 9   81    55  0   0   .
0 7.044       12 18  324   47  0   0   .
0 18.2        12 1   1     47  0   1   .
0 27          11 0   0     37  0   1   .
0 30.3        12 6   36    50  0   2   .
0 12          12 1   1     30  0   3   .
0 31.5        17 2   4     48  0   1   .
0 27.092      10 15  225   43  0   2   .
0 20.968      11 25  625   48  1   0   .
0 27          14 1   1     41  1   2   .
0 11.225      12 0   0     50  0   0   .
```

```
0 37.7        8  0   0     58  0   0   .
0 28.2        13 0   0     38  0   5   .
0 34          12 8   64    37  0   1   .
0 63.2        16 22  484   50  0   0   .
0 7.5         8  5   25    42  0   4   .
0 17.41       9  10  100   37  1   3   .
0 51          16 1   1     41  0   2   .
0 12.916      12 1   1     31  0   2   .
0 21.9        12 6   36    51  0   0   .
0 17.64       12 4   16    36  1   2   .
0 20          15 6   36    54  0   0   .
0 15          12 0   0     49  0   0   .
0 14.06       9  1   1     48  1   1   .
0 15.825      9  3   9     42  0   2   .
0 16.51       12 15  225   41  1   2   .
0 13          16 33  1089  55  0   0   .
0 10          9  2   4     42  0   0   .
0 22          15 1   1     32  0   1   .
0 29.8        12 10  100   43  0   2   .
0 15          12 0   0     33  1   3   .
0 22.3        15 14  196   48  0   1   .
0 14.55       12 15  225   43  0   2   .
0 19.73       17 15  225   47  1   3   .
0 35          12 10  100   54  0   0   .
0 21.014      12 6   36    51  0   1   .
0 10.876      10 18  324   51  0   1   .
0 27.85       13 15  225   43  1   1   .
0 9.56        12 30  900   53  0   0   .
0 30.3        11 15  225   34  1   1   .
0 7.72        8  10  100   31  1   1   .
0 10.55       12 0   0     56  0   0   .
0 24.106      16 0   0     42  0   1   .
0 22.995      12 4   16    32  0   2   .
0 6           12 0   0     35  1   3   .
0 24.35       12 3   9     30  1   1   .
0 7.608       10 20  400   51  0   0   .
0 28.2        12 3   9     47  0   3   .
0 16.15       12 1   1     54  0   1   .
0 51.2        15 5   25    31  3   0   .
0 12.646      10 7   49    47  0   0   .
0 19          14 6   36    47  0   3   .
0 19          12 2   4     40  0   3   .
0 14.4        8  0   0     48  0   0   .
0 7.232       8  10  100   34  0   7   .
0 21.943      12 6   36    38  0   3   .
0 47.5        12 4   16    32  1   3   .
0 28.9        16 8   64    48  0   1   .
0 12.4        12 18  324   41  0   2   .
0 6.531       5  7   49    49  0   2   .
0 22.422      8  15  225   59  0   0   .
0 22.2        13 7   49    58  0   0   .
0 77          12 8   64    41  0   3   .
0 88          12 8   64    45  0   2   .
0 26.04       14 3   9     30  1   1   .
0 63.5        12 10  100   41  0   1   .
0 12.1        12 9   81    30  2   0   .
```

```
0 17.505      12 24  576   53  0   1   .
0 18          12 12  144   31  0   0   .
0 28.069      14 2   4     43  0   2   .
0 14          12 6   36    31  1   1   .
0 8.117       12 18  324   51  0   0   .
0 11.895      9  17  289   43  0   0   .
0 45.25       14 7   49    31  1   2   .
0 31.106      11 6   36    48  0   0   .
0 4           12 10  100   31  1   1   .
0 40.5        12 5   25    44  0   1   .
0 21.62       11 7   49    48  0   1   .
0 23.426      12 11  121   53  0   1   .
0 26          10 14  196   42  0   3   .
0 7.84        12 5   25    39  2   6   .
0 6.8         10 2   4     32  1   2   .
0 5.33        12 4   16    36  0   2   .
0 28.2        13 5   25    40  0   2   .
0 10          12 14  196   31  2   3   .
0 9.952       12 4   16    43  0   0   .
0 24.984      12 15  225   60  0   0   .
0 28.363      9  12  144   39  0   3   .
;
```

Click **Run** to create the Work.Mroz table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-sectional Data Models** to add the step to your flow.

3 Add the Work.Mroz table to your flow and connect it to the Cross-Sectional Data Models node.For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

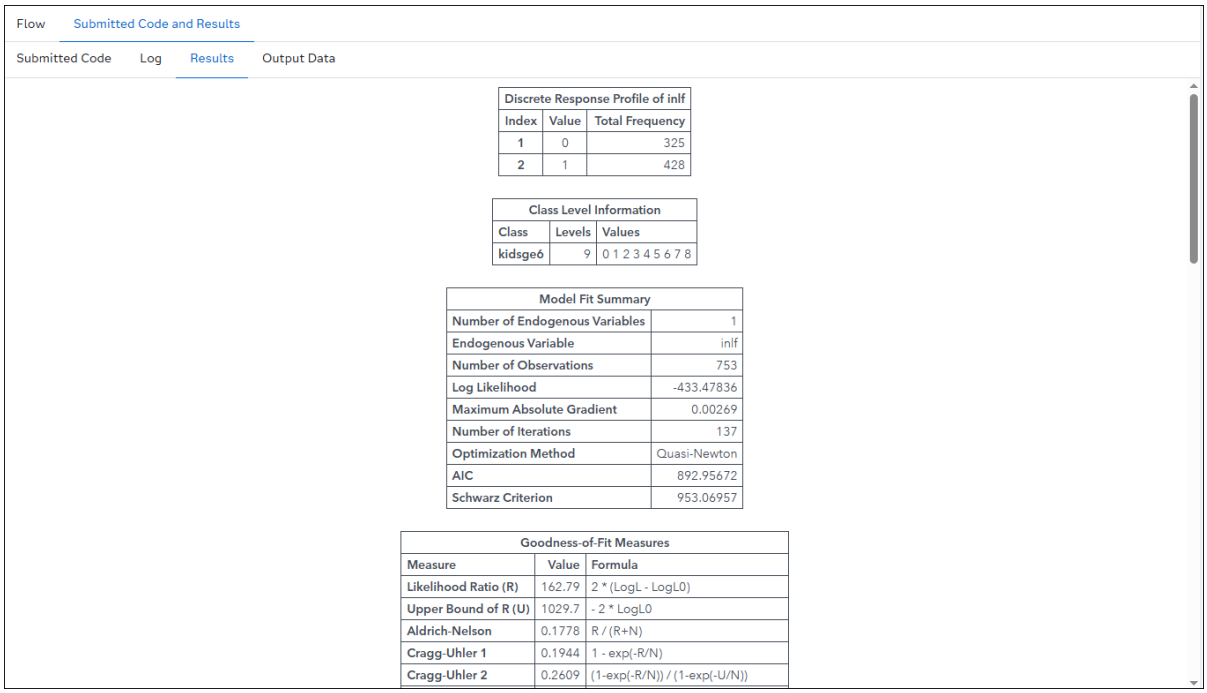
5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **inlf**.
- To the **Continuous variables** role, assign **nwifeinc**, **educ**, **exper**, and **expersq**.
- To the **Categorical variables** role, assign **kidsge6**.

6 On the **Model** tab, select **Logit** as the model type.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Discrete Response Profile of inlf

Index	Value	Total Frequency
1	0	325
2	1	428

Class Level Information

Class	Levels	Values
kidsge6	9	0 1 2 3 4 5 6 7 8

Model Fit Summary

Number of Endogenous Variables	1
Endogenous Variable	inlf
Number of Observations	753
Log Likelihood	-433.47836
Maximum Absolute Gradient	0.00269
Number of Iterations	137
Optimization Method	Quasi-Newton
AIC	892.95672
Schwarz Criterion	953.06957

Goodness-of-Fit Measures

Measure	Value	Formula
Likelihood Ratio (R)	162.79	2 * (LogL - LogL0)
Upper Bound of R (U)	1029.7	- 2 * LogL0
Aldrich-Nelson	0.1778	R / (R+N)
Cragg-Uhler 1	0.1944	1 - exp(-R/N)
Cragg-Uhler 2	0.2609	(1-exp(-R/N)) / (1-exp(-U/N))

Logit Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric variable for the analysis.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the linear model.

1 From the **Model type** drop-down list, select **Logit**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 (SAS Compute Server only) Specify whether to analyze the heteroscedasticity. You can specify the variables on the variance function and the form of the variance function.

4 (SAS Compute Server only) Specify the threshold for the first category for the logit model. By default, this value is zero, but you can use an estimated value.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available:

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 (CAS Server only) Specify the variables that are related to the heteroscedasticity of the residuals and how these variables are used to model the error variance.

3 Specify the optimization method to use.

4 Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

5 Select the statistics to display in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates

- covariances of the parameter estimates
- (SAS Compute Server) iteration history of the objective function and parameter estimates

Note: This option is available only if the **Analyze heteroscedasticity** option is selected on the **Models** tab.

6 Select the plots to include in the results.

7 (CAS Server only) Specify the code generation method to use. You can choose from these options:

- **Use Econometrics procedures**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- a table that contains the default statistics from the analysis and any selected statistics such as the probability of the dependent variable taking the current value, the probability of the dependent variable for all possible responses, and the error standard deviation. If you are running the step on a CAS server, you must specify a CAS engine libref when naming the table.
- a table of parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Probit Models

Example: Probit Model

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data mroz;
   input inlf nwifeinc educ exper expersq age kidslt6 kidsge6 lwage;
datalines;
1 10.91006    12 14   196    32  1    0    1.210154
1 19.49998    12 5    25     30  0    2    0.3285121
```

```
1 12.03991    12 15  225   35  1   3   1.514138
1 6.799996    12 6   36    34  0   3   0.0921233
1 20.10006    14 7   49    31  1   2   1.524272
1 9.859054    12 33  1089  54  0   0   1.55648
1 9.152048    16 11  121   37  0   2   2.12026
1 10.90004    12 35  1225  54  0   0   2.059634
1 17.305      12 24  576   48  0   2   0.7543364
1 12.925      12 21  441   39  0   2   1.544899
1 24.29995    12 15  225   33  0   1   1.401922
1 19.70007    11 14  196   42  0   1   1.524272
1 15.00001    12 0   0     30  1   2   0.7339532
1 14.6        12 14  196   43  0   2   0.8183691
1 24.63091    10 6   36    43  0   1   1.302831
1 17.53103    11 9   81    35  0   3   0.2980284
1 14.09998    12 20  400   43  0   2   1.16761
1 15.839      12 6   36    39  0   5   1.643839
1 14.1        12 23  529   45  0   0   0.6931472
1 10.29996    12 9   81    35  0   4   2.021932
1 22.65498    16 5   25    42  0   2   1.254248
1 8.090048    12 11  121   30  0   0   1.272958
1 17.479      13 18  324   48  0   0   1.178655
1 9.56        12 15  225   45  0   0   1.178655
1 8.274953    12 4   16    31  1   1   0.7675587
1 27.34999    17 21  441   43  0   2   1.331812
1 16          12 31  961   59  0   0   1.386294
1 16.99998    12 9   81    32  0   3   1.55327
1 15.10006    17 7   49    31  1   0   1.981815
1 15.69998    12 7   49    42  0   0   1.76936
1 5.11896     11 32  1024  50  0   0   0.4308079
1 16.75001    16 11  121   59  0   0   0.8997548
1 13.59993    13 16  256   36  0   2   1.76663
1 17.10005    12 14  196   51  0   1   1.272958
1 16.73405    16 27  729   45  0   3   1.336789
1 14.19698    11 0   0     42  0   1   0.9017048
1 10.31999    12 17  289   46  0   0   0.8651237
1 11.3841     10 28  784   46  0   1   1.511847
1 14.59408    14 24  576   51  0   0   1.726029
1 17.50044    17 11  121   30  0   0   2.683142
1 15.51       12 1   1     30  1   2   0.9852943
1 21.99998    12 14  196   57  0   0   1.365939
1 22.5        16 6   36    31  1   2   0.9450337
1 19.994      12 10  100   48  0   2   1.512376
1 14.13       12 6   36    30  0   3   0.6931472
1 5.000013    12 4   16    34  0   2   1.244788
1 21.1549     16 10  100   48  0   2   0.7011649
1 7.141946    12 22  484   45  0   0   1.519863
1 16.65007    12 16  256   51  0   0   0.8209686
1 6.352       12 6   36    30  0   2   0.9698315
1 27.31395    12 12  144   46  0   1   0.8285082
1 14.5        12 32  1024  58  0   0   0.0943096
1 16.25799    12 15  225   37  0   8   0.1625439
1 9.5         8  17  289   52  0   0   0.4700036
1 7.999956    10 34  1156  52  0   0   0.6292484
1 12.50003    16 9   81    31  0   0   1.39716
1 14.00003    14 37  1369  55  0   0   2.265444
1 20.80007    17 10  100   34  0   0   2.084541
```

```
1 19.38511    14 35  1225  55  0   0   1.525839
1 12.38699    12 6   36    39  0   2   0.7621601
1 28.5        14 19  361   40  0   3   1.481605
1 15.04991    12 10  100   43  0   4   1.262826
1 10.49998    8  11  121   48  0   0   0.9996756
1 11.81       12 15  225   47  0   0   1.832582
1 6.950073    12 12  144   41  0   4   2.479308
1 12.41997    8  12  144   36  0   0   1.279015
1 17.4        17 14  196   46  0   2   1.937936
1 15.5        12 11  121   34  0   0   1.070453
1 21.21704    12 9   81    41  0   3   1.123923
1 18          12 24  576   51  0   1   1.321756
1 11.89992    12 12  144   33  0   0   1.745
1 26.75196    12 13  169   52  0   0   1.301744
1 12.14996    9  29  841   58  0   0   1.641866
1 10.19999    10 11  121   34  2   4   2.10702
1 8.120015    12 13  169   31  0   1   1.467068
1 10.65996    12 19  361   48  0   1   1.605811
1 18.10001    12 2   4     32  0   2   -1.029739
1 8.599986    17 24  576   49  0   0   1.087686
1 13.665      15 9   81    32  2   2   0
1 32.34996    12 6   36    58  0   0   0.9382087
1 12.08501    6  22  484   50  0   0   -0.1505904
1 12.15       14 30  900   60  0   0   0
1 17.69502    12 10  100   50  0   1   1.073671
1 24.7        14 6   36    56  0   0   1.265848
1 2.133992    9  29  841   51  0   0   0.486369
1 20.95005    17 29  841   54  0   1   2.12026
1 10.50008    13 36  1296  59  0   0   1.129853
1 10.55       9  19  361   46  0   2   0.9932518
1 45.75       15 8   64    46  0   1   1.658628
1 13.63204    12 13  169   39  1   3   0.3474122
1 18.23894    12 16  256   44  0   2   1.568324
1 17.09       12 11  121   33  2   0   0.5108456
1 30.2349     12 15  225   33  1   2   0.1148454
1 28.7        12 6   36    48  0   2   -0.6931472
1 19.63       12 13  169   31  0   4   -0.3364523
1 12.82494    12 22  484   45  0   1   1.028226
1 23.8        12 24  576   45  0   1   1.580689
1 26.30003    13 2   4     32  0   2   0.5558946
1 20.69991    12 6   36    47  0   0   0.9014207
1 26          13 2   4     34  0   2   0.8843046
1 10.87702    12 2   4     37  0   1   0.4282046
1 25.61206    12 14  196   36  0   1   1.058415
1 20.98899    12 9   81    47  1   2   0.8783396
1 70.74993    16 11  121   48  0   1   1.654908
1 17.05       12 9   81    42  0   2   1.321756
1 21          13 6   36    33  0   3   0.3285121
1 8.12        11 19  361   46  0   0   1.386294
1 20.88599    12 26  676   47  0   3   1.172885
1 17.66892    12 19  361   44  0   1   1.224187
1 25.20003    12 3   9     36  0   4   0.2876571
1 14.24501    17 7   49    31  2   0   2.230262
1 14.3        14 28  784   55  0   0   1.504077
1 23.70001    16 13  169   45  0   1   1.531152
1 46          17 9   81    47  0   0   1.375158
```

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1 42.9999     12 15  225   46  0   3   1.760269
1 14.749      11 20  400   49  0   0   -0.6931472
1 16.15005    12 29  841   49  0   0   1.406489
1 17.774      12 9   81    45  0   2   1.791759
1 91          17 1   1     38  1   3   1.299292
1 22.29993    10 8   64    47  0   0   1.351004
1 34.60001    13 19  361   54  0   3   1.016281
1 9.620002    11 23  529   41  0   0   1.075344
1 10.89995    12 3   9     43  0   2   1.478965
1 14.49994    16 13  169   31  1   1   1.689487
1 22.00002    17 8   64    47  0   0   2.288598
1 17.90008    12 17  289   35  0   2   -1.822631
1 23.67506    16 4   16    45  0   3   -0.9607652
1 11.79996    12 15  225   33  1   0   1.290994
1 16.14195    16 11  121   54  0   1   0.8648711
1 18.39997    8  7   49    35  0   4   1.540452
1 15.49995    12 0   0     31  1   2   0.6162121
1 17.324      12 0   0     55  0   0   1.648659
1 19.205      12 10  100   34  0   2   1.193498
1 21.30006    13 8   64    38  0   1   2.143976
1 23.56       11 2   4     45  0   1   0.7244036
1 20.85       12 4   16    47  0   1   0.9416075
1 26.15       12 6   36    39  0   2   0.7827594
1 17          14 18  324   36  1   0   1.832582
1 20.72       12 3   9     33  1   2   1.203963
1 17.00009    12 22  484   50  0   0   1.491645
1 16          12 33  1089  58  0   0   1.892133
1 19.50005    17 28  784   49  0   0   2.130895
1 12          14 23  529   41  0   2   1.480604
1 13.73191    12 27  729   51  0   1   0.8943313
1 27.19999    9  11  121   53  0   0   0.2025325
1 5.315       12 6   36    36  1   2   0.4855078
1 16          12 11  121   46  0   2   1.098612
1 27.87198    12 14  196   36  0   2   1.55327
1 40.00001    14 17  289   53  0   1   0.121598
1 15.90003    16 17  289   40  0   3   2.001804
1 27.49997    17 14  196   42  0   2   1.495037
1 17.02005    15 11  121   33  1   1   0.9052298
1 22.39494    12 7   49    43  0   3   0.6325476
1 11.1        16 8   64    31  1   0   1.386294
1 32.70001    17 6   36    47  0   0   2.102914
1 27.79996    17 8   64    54  0   0   1.959644
1 2.199994    12 4   16    33  1   3   0.5108456
1 19.72095    16 25  625   43  0   0   1.236924
1 9.999988    13 24  576   46  0   1   1.443313
1 13.19997    12 11  121   35  0   3   1.021659
1 12.70897    11 19  361   37  0   3   0.6361535
1 27.30005    16 9   81    37  0   2   1.616453
1 21.2        14 19  361   34  0   3   0.2231435
1 14.4        16 14  196   43  1   0   1.049807
1 20.57596    12 22  484   46  0   0   1.415052
1 12.49999    9  6   36    35  0   3   0.5753766
1 17.50022    17 23  529   46  0   0   2.606682
1 44.00004    14 15  225   46  0   0   1.517915
1 13.11895    12 6   36    43  0   2   0.7550416
1 14.00006    12 11  121   30  0   0   1.094972
```

```
1 9.645086    11 2   4     41  0   2   0.9421144
1 17.39705    12 22  484   54  0   1   1.724943
1 7.799889    12 10  100   31  0   1   1.031546
1 13.13398    10 14  196   44  0   0   0.4743691
1 25.6        12 12  144   32  0   1   0.8109302
1 13.90003    5  9   81    47  0   0   0.7092666
1 19.29794    17 13  169   46  0   1   1.710549
1 9.200016    11 18  324   37  0   0   0.4602689
1 37.99999    12 8   64    51  0   2   1.331812
1 44          12 11  121   49  0   1   1.098612
1 21.37202    14 9   81    36  0   4   2.157999
1 23.66802    11 9   81    39  0   1   1.437581
1 9           12 14  196   48  0   2   1.544899
1 25.19995    14 9   81    38  0   2   1.410597
1 21.22       12 2   4     40  0   2   3.218876
1 33.96991    10 12  144   39  1   5   0.9681619
1 17.07       16 15  225   37  0   0   1.791759
1 6.016024    13 11  121   49  0   1   1.68873
1 17.10001    12 7   49    33  0   3   -0.409172
1 8.237       12 9   81    30  0   0   0.2231435
1 13.30008    12 19  361   54  0   0   0.8221558
1 16.00002    11 11  121   39  0   4   1.241702
1 12.53999    12 8   64    43  0   3   1.427124
1 18.00004    9  13  169   31  0   3   1.497097
1 31.2        13 4   16    33  0   3   0.5596158
1 20.74991    12 7   49    40  0   3   1.300028
1 11.09992    12 19  361   36  0   1   1.88443
1 20.68       12 14  196   51  0   0   0.9555114
1 18.00001    13 14  196   44  0   1   1.582087
1 32.43007    16 3   9     42  0   3   1.755614
1 32.90003    12 9   81    40  0   1   1.513103
1 24.10001    16 7   49    34  1   1   2.251892
1 17.80039    17 7   49    30  0   0   2.364432
1 20.50002    12 14  196   54  0   0   0.1053505
1 10.4999     12 29  841   51  0   0   1.399729
1 10.43703    9  19  361   44  0   2   0.9884625
1 18.19499    12 14  196   43  0   1   1.090647
1 12.84508    12 16  256   34  0   1   1.154614
1 13.8        13 10  100   45  0   0   1.266948
1 22.2        12 12  144   39  0   0   2.885192
1 6.699941    12 24  576   50  0   0   1.22888
1 6.250016    12 6   36    52  0   0   1.203963
1 15.60001    12 9   81    41  0   2   1.35738
1 3.30001     10 14  196   59  0   0   0.8377236
1 3.670978    12 26  676   52  0   0   0.5369611
1 7.789997    16 7   49    46  0   0   0.7487238
1 18.27199    12 4   16    41  1   5   2.295873
1 10.95398    11 15  225   33  0   2   1.107803
1 13.49999    12 23  529   45  0   0   0.6208453
1 11.20001    10 1   1     36  1   2   -2.054164
1 20.99991    12 29  841   48  0   1   1.892012
1 25.7        12 9   81    47  0   1   1.729725
1 8.932994    12 6   36    45  0   0   0.4693784
1 19.15998    12 11  121   37  0   2   0.9808417
1 26.58999    16 17  289   46  0   4   2.069492
1 22.40001    17 6   36    43  0   3   1.675188
```

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1 20.633      12 7   49    42  0   2   1.386294
1 28.20001    17 2   4     34  1   2   1.799215
1 28.8        12 24  576   52  0   0   1.832582
1 8.999997    12 4   16    37  0   3   1.090647
1 11.39994    12 11  121   37  0   1   1.443124
1 10.40001    8  25  625   52  0   0   1.25036
1 19.08006    12 11  121   30  1   0   1.602313
1 9.46604     13 2   4     31  0   1   1.018559
1 6.50006     12 19  361   38  0   1   1.297053
1 29.11701    12 7   49    43  0   3   1.685194
1 19.10302    8  2   4     49  0   1   -0.4209849
1 16.34997    12 20  400   55  0   0   1.562095
1 32.02502    17 10  100   38  0   2   2.146528
1 16.70006    17 19  361   52  0   0   2.347463
1 4.811038    12 17  289   48  0   0   0.9698315
1 24.62601    13 12  144   32  0   2   1.924146
1 17.40001    12 11  121   32  0   1   1.626728
1 13.02504    12 6   36    38  0   2   -0.0392607
1 19.00698    12 10  100   46  0   3   1.460149
1 14.03       12 4   16    40  0   3   1.955394
1 14.89991    9  2   4     31  0   4   0.9263599
1 25.00006    10 13  169   43  0   1   2.066192
1 10.70007    12 21  441   51  0   0   1.422843
1 24.25       16 9   81    30  1   0   2.101032
1 39.13997    13 4   16    52  0   0   2.261461
1 7.199973    8  2   4     30  1   5   0.7013138
1 31.811      16 19  361   51  0   0   2.031013
1 10.00005    13 4   16    31  0   2   1.162369
1 20.66       12 9   81    34  0   4   0.4700036
1 13.49998    11 14  196   49  0   0   1.410597
1 25.38       13 6   36    35  1   3   0.3930551
1 18.27498    12 24  576   53  1   0   1.290994
1 39.213      12 1   1     32  0   3   0
1 10.49994    10 13  169   38  0   3   0.9571255
1 34.857      12 3   9     54  0   0   0.5596158
1 28.502      17 10  100   47  0   1   1.568616
1 12.99996    15 16  256   45  0   1   1.710188
1 41.39991    16 9   81    47  0   1   1.410597
1 14.78       10 19  361   59  0   0   0.2231435
1 15.05       11 4   16    32  0   1   0.5108456
1 29.69998    12 10  100   45  0   1   1.332392
1 16.16502    12 5   25    40  0   4   0.8601859
1 25.20516    14 7   49    47  0   2   2.32278
1 14.2        16 3   9     36  1   2   1.919595
1 18.15897    14 38  1444  56  0   0   1.976107
1 28.98106    8  16  256   41  0   1   0.8954347
1 13.392      7  13  169   48  0   3   0.1812376
1 9.17502     12 1   1     36  1   2   0.4953058
1 27.03985    12 7   49    41  0   0   0.5777924
1 13.14995    14 15  225   41  0   0   1.078818
1 16.40007    12 10  100   36  0   3   1.603199
1 21.29999    12 2   4     37  0   3   0.6208453
1 17.20102    12 19  361   38  0   0   2.083894
1 8.560026    14 25  625   43  0   2   1.379169
1 6.49084     16 25  625   54  0   0   1.112384
1 12.49997    12 7   49    38  0   1   1.067122
```

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1 27.00002    12 15  225   30  1   0   1.118807
1 53.50005    12 11  121   49  0   0   1.588541
1 52.49995    13 25  625   45  0   1   1.390311
1 38.39998    13 19  361   51  0   0   1.714806
1 13.89194    10 4   16    34  0   0   0.2010615
1 3.899993    12 14  196   34  0   2   0.987271
1 34.2        12 19  361   41  0   1   0.9835007
1 19.70008    12 18  324   49  0   1   2.233171
1 18.49995    12 14  196   32  0   0   1.143618
1 10.99998    14 11  121   32  0   0   -0.6113829
1 43.30001    17 4   16    32  0   2   2.153052
1 18.76001    10 29  841   47  0   0   1.299837
1 4.800096    9  21  441   39  0   1   0.8409204
1 21.5        12 24  576   49  0   0   1.058484
1 28.03994    12 19  361   37  0   3   1.152658
1 26          16 31  961   59  0   0   1.293576
1 27          12 28  784   50  0   0   1.832582
1 17.79969    17 15  225   32  0   1   2.32718
1 17.40195    12 27  729   46  0   0   1.166146
1 19.30999    17 13  169   43  0   2   2.034993
1 9.99998     11 4   16    37  0   3   0.6792511
1 11.17998    16 10  100   32  0   2   1.547137
1 18.85696    11 8   64    39  0   1   0.7530186
1 12.30002    13 4   16    34  0   2   0.8472836
1 13.67712    11 18  324   39  0   1   0.871126
1 9.559997    8  3   9     45  0   3   0.2282505
1 24.49998    11 11  121   50  0   0   0.0896578
1 23.15       12 8   64    40  0   1   1.321756
1 15.59088    10 10  100   30  0   1   1.196102
1 14.42092    17 33  1089  57  0   0   1.636119
1 17.45491    12 19  361   39  0   1   1.892012
1 9.800019    12 35  1225  53  0   0   1.518309
1 17.57446    17 21  441   48  0   1   2.472159
1 16.555      14 7   49    46  0   1   1.321756
1 13.29497    12 18  324   47  0   0   1.473641
1 11.844      12 4   16    43  0   1   1.369479
1 46.64506    12 12  144   47  0   0   1.203963
1 14.69999    12 16  256   47  0   1   1.198729
1 26.09008    12 14  196   47  0   0   1.27021
1 9.9         12 3   9     46  0   0   0.4700036
1 9.048026    9  1   1     34  0   4   0.7999817
1 30.75006    10 27  729   48  0   0   1.565946
1 8.49994     12 12  144   30  0   1   1.758978
1 22.24999    12 6   36    51  0   1   0.8580258
1 42.91       12 9   81    52  0   5   0.6931472
1 33.3        12 2   4     37  0   2   0.6418539
1 13.8199     12 6   36    32  0   2   1.63374
1 23.60001    17 9   81    36  0   2   1.703748
1 13.00007    12 16  256   35  0   2   1.844004
1 20.74994    17 22  484   45  0   0   1.966119
1 6.3         12 26  676   56  0   0   0.8649974
1 7.788925    10 11  121   40  0   2   0.9333052
1 10.47004    12 11  121   45  1   2   0.7792332
1 12          12 15  225   32  0   2   0.9555114
1 16.97992    12 13  169   45  0   0   1.316247
1 17.9        12 6   36    40  0   2   1.475906
```

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1 15.53994    12 20  400   38  0   1   1.491397
1 9.883986    12 17  289   49  0   4   1.45575
1 28.59995    16 8   64    47  0   1   0.5108456
1 17.66001    13 13  169   52  0   0   1.180438
1 25.99992    13 15  225   34  0   1   1.688489
1 13.60201    12 14  196   44  0   2   0.7907275
1 15.8        16 14  196   36  0   3   1.401799
1 41.09999    17 6   36    50  0   0   -0.433556
1 10.77504    12 24  576   45  0   0   1.683172
1 9.000047    14 10  100   44  0   2   -1.766677
1 24.39899    12 2   4     57  0   2   3.155595
1 37.30009    17 9   81    35  0   0   2.259521
1 27.99995    12 23  529   46  0   0   1.306926
1 13.7        14 12  144   30  2   1   0.7984977
1 17.20994    12 8   64    42  0   3   0.5590442
1 14.00001    12 16  256   34  0   1   0.1479026
1 35.75502    17 10  100   45  0   2   1.944495
1 23.5        16 7   49    35  1   2   1.378338
1 31.99993    16 19  361   40  0   0   3.064745
1 17.15       12 2   4     32  0   1   -0.7419173
1 20.25002    9  9   81    54  0   0   0.7657004
1 5.485985    12 14  196   38  0   3   0.619393
1 25.07504    12 9   81    43  0   3   1.465452
1 18.21995    16 16  256   54  0   0   2.18926
1 26          14 7   49    39  0   3   1.021659
1 34.50007    12 6   36    37  0   1   0.9770095
1 12.4        12 22  484   46  0   2   0.9162908
1 10.78685    11 9   81    56  0   0   2.905096
1 16.32301    12 9   81    41  0   3   -0.1996712
1 30.5        16 14  196   45  0   1   0.6931472
1 51.29963    17 17  289   44  0   1   2.733393
1 33.04997    17 12  144   50  0   1   1.868335
1 34.75001    14 13  169   37  0   5   2.12026
1 16.40004    12 8   64    44  0   1   1.515193
1 19.70007    14 10  100   32  0   2   0.9146093
1 6.600003    12 16  256   34  1   1   1.499556
1 9.020008    10 1   1     32  0   2   0.8030772
1 10.40001    12 6   36    37  0   3   0.7280316
1 14.51999    13 4   16    44  0   1   0.51641
1 17.2        16 8   64    34  0   2   1.226448
1 43          12 4   16    33  1   3   0.9162908
1 13.87196    7  15  225   43  0   3   1.376471
1 -0.0290575  16 7   49    35  0   2   1.828975
1 16.76994    14 14  196   43  0   1   1.368283
1 7.8         12 16  256   34  0   0   1.064711
1 14.50006    10 15  225   36  0   3   1.406489
1 7.9         12 23  529   41  0   2   1.047319
1 79.80001    16 19  361   41  0   0   1.948093
1 7.17597     10 4   16    35  0   3   1.078001
1 17.50698    12 12  144   32  1   3   0.6539385
1 20.6        14 12  144   30  0   0   1.927892
1 18.55992    12 25  625   43  0   0   1.361028
1 9.3         6  14  196   54  0   0   0.6931472
1 5.120008    15 14  196   35  0   2   1.604687
1 14.50004    12 11  121   50  0   0   0.1839036
1 19.8        17 7   49    34  1   1   3.113515
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1 18.29995    14 18  324   52  0   0   1.926829
1 33.99994    13 4   16    35  0   3   1.270126
1 11.62794    6  37  1369  55  0   0   0.6826927
1 11.80005    16 13  169   35  0   0   1.68107
1 39.09998    14 14  196   49  0   1   0.556296
1 18.43007    15 17  289   38  2   2   1.62822
1 21          14 5   25    42  0   2   0.9162908
1 59          8  2   4     48  0   1   1.341558
1 25.3        14 0   0     51  0   0   0
1 23.24899    12 3   9     43  0   2   1.122231
1 24.92809    12 21  441   43  0   1   0.5401708
1 14.78199    12 20  400   38  0   1   1.391506
1 18.90003    12 19  361   44  0   1   1.697174
1 21          12 4   16    36  1   3   3.218876
1 10.00001    12 19  361   38  0   0   0.8711678
1 29.30997    8  11  121   47  0   0   1.16733
1 13.14003    12 14  196   34  0   2   1.216988
1 25.08999    17 8   64    40  1   2   0.5753766
1 14.59993    12 13  169   31  0   1   1.151616
1 1.200001    12 24  576   46  0   0   0.9942513
1 32          14 1   1     36  0   3   0.5263249
1 16.11997    13 1   1     39  1   2   -1.543182
1 26.50002    17 3   9     36  0   2   1.912043
1 12.75006    8  4   16    37  0   4   0.5542873
1 12.9        12 21  441   39  0   4   0.9162908
1 10.69998    11 10  100   36  1   3   1.500939
1 14.43403    12 13  169   49  0   2   0.9446838
1 23.709      12 9   81    45  1   1   1.241269
1 15.1        17 14  196   32  2   0   1.564984
1 18.19998    10 2   4     36  0   5   0.8380265
1 22.64106    12 21  441   40  0   1   1.668857
1 21.64008    13 22  484   43  0   2   1.769429
1 23.99998    12 14  196   33  0   1   1.226448
1 16.00002    12 7   49    30  0   1   1.406489
0 21.025      12 2   4     49  0   1   .
0 23.6        16 5   25    30  2   0   .
0 22.8        12 12  144   30  1   0   .
0 35.91       12 1   1     41  0   4   .
0 21.7        12 12  144   45  0   1   .
0 21.823      12 4   16    43  0   5   .
0 31          13 9   81    42  0   1   .
0 15.3        12 9   81    60  0   0   .
0 12.925      12 6   36    57  0   0   .
0 15.83       10 5   25    38  0   2   .
0 30.2        12 5   25    56  0   0   .
0 16.6        12 8   64    32  0   3   .
0 11          7  2   4     49  0   1   .
0 15          12 6   36    55  0   0   .
0 20.528      9  0   0     36  1   1   .
0 13.126      12 3   9     44  0   3   .
0 15.55       10 7   49    44  0   1   .
0 18.01       14 3   9     35  1   2   .
0 18.874      14 10  100   44  2   3   .
0 24.8        12 3   9     45  0   1   .
0 17.5        12 2   4     34  1   0   .
0 16.15       17 12  144   30  2   0   .
```

```
0 15.189      8  15  225   39  0   1   .
0 6           12 5   25    36  0   2   .
0 37.25       17 4   16    38  0   2   .
0 27.76       12 10  100   53  0   0   .
0 9.09        12 1   1     36  0   2   .
0 14.5        12 8   64    32  1   1   .
0 19.7        9  20  400   51  0   3   .
0 16.788      11 4   16    38  0   0   .
0 18.52       12 7   49    33  2   0   .
0 20.95       12 10  100   54  0   0   .
0 7.574       9  3   9     38  0   3   .
0 10.027      11 5   25    30  2   2   .
0 5           12 10  100   34  2   3   .
0 7.04        9  0   0     34  0   1   .
0 40.8        12 3   9     50  0   2   .
0 16.05       17 10  100   30  2   0   .
0 33.1        12 2   4     38  0   2   .
0 33.856      14 10  100   54  0   0   .
0 20.5        12 4   16    30  1   2   .
0 28.6        12 0   0     55  0   0   .
0 18.75       10 10  100   51  0   1   .
0 20.3        12 5   25    44  0   1   .
0 13.42       12 0   0     53  0   0   .
0 18.4        10 0   0     42  0   2   .
0 16.682      12 19  361   38  0   2   .
0 32.685      13 2   4     38  1   3   .
0 7.05        12 12  144   41  1   4   .
0 10.867      8  5   25    35  0   3   .
0 18.22       12 5   25    33  1   2   .
0 26.613      13 5   25    48  0   0   .
0 25          12 10  100   47  0   0   .
0 15.7        12 0   0     34  0   5   .
0 40.25       13 4   16    33  2   1   .
0 73.6        13 3   9     31  3   1   .
0 10.592      8  2   4     58  0   0   .
0 8           12 1   1     49  0   0   .
0 13.4        8  0   0     55  0   1   .
0 23.7        14 1   1     44  0   0   .
0 18.9        9  1   1     44  0   0   .
0 48.3        16 6   36    36  0   3   .
0 24.47       12 12  144   38  0   3   .
0 28.63       16 6   36    37  0   3   .
0 25.32       12 9   81    47  0   0   .
0 13.53       12 14  196   47  0   3   .
0 14.8        12 13  169   32  1   1   .
0 17.4        12 8   64    43  1   2   .
0 15.98       11 0   0     42  1   4   .
0 16.576      12 1   1     56  0   0   .
0 21.85       13 3   9     38  0   5   .
0 14.6        12 13  169   52  0   2   .
0 21.6        12 3   9     50  0   0   .
0 24          16 8   64    33  0   0   .
0 20.883      16 8   64    44  0   2   .
0 19.5        12 18  324   41  0   1   .
0 42.8        12 2   4     45  0   1   .
0 41.5        14 3   9     53  0   0   .
```

```
0 18.965      14 5   25    53  0   0   .
0 16.1        12 2   4     42  0   1   .
0 14.7        13 10  100   32  2   0   .
0 18.8        12 30  900   56  0   0   .
0 14.75       11 1   1     37  1   3   .
0 21          12 5   25    40  1   2   .
0 35.4        15 8   64    54  0   3   .
0 10.7        7  0   0     53  0   0   .
0 24.5        12 4   16    48  0   1   .
0 17.045      12 2   4     36  1   2   .
0 18.8        12 30  900   57  0   0   .
0 14          12 25  625   51  0   0   .
0 18.214      13 3   9     33  0   4   .
0 20.177      12 20  400   52  0   0   .
0 8.3         10 20  400   56  0   0   .
0 14.2        12 0   0     36  1   2   .
0 21.768      14 15  225   36  1   0   .
0 29.553      12 10  100   46  0   1   .
0 4.35        10 4   16    31  0   3   .
0 24          11 3   9     52  0   0   .
0 18.3        12 10  100   46  0   2   .
0 17.2        12 9   81    35  2   0   .
0 16.476      12 7   49    59  0   0   .
0 13.4        8  12  144   36  0   1   .
0 44.988      7  0   0     51  1   3   .
0 18.2        16 16  256   31  1   0   .
0 28          14 4   16    31  0   2   .
0 11.55       12 7   49    32  1   1   .
0 28.45       16 7   49    35  1   2   .
0 15.096      12 14  196   40  0   3   .
0 8.009       10 2   4     33  1   2   .
0 10.04       7  20  400   54  0   0   .
0 16.7        12 5   25    36  1   1   .
0 8.4         10 10  100   50  0   1   .
0 13          8  20  400   54  0   0   .
0 17.97       11 10  100   48  0   1   .
0 18.45       15 8   64    41  0   4   .
0 31          12 11  121   50  0   4   .
0 24.135      12 3   9     46  0   2   .
0 31.7        13 6   36    42  0   1   .
0 10.19       9  4   16    31  1   2   .
0 21.574      12 4   16    53  0   0   .
0 26.68       12 9   81    51  0   1   .
0 17.7        12 10  100   47  0   1   .
0 29.4        12 3   9     50  0   1   .
0 22.159      6  2   4     37  0   1   .
0 35          12 2   4     30  2   2   .
0 8.63        12 0   0     49  0   0   .
0 17.08       12 8   64    52  0   2   .
0 32.5        12 6   36    47  0   2   .
0 16          12 15  225   49  0   0   .
0 18.85       12 15  225   44  0   4   .
0 17.5        8  9   81    53  0   0   .
0 19.392      12 8   64    30  1   0   .
0 14.45       12 18  324   54  0   2   .
0 21.8        7  3   9     47  1   1   .
```

```
0 7.7          15 10  100   56  0   0   .
0 31.8         12 6   36    49  0   1   .
0 17.258       6  20  400   48  0   0   .
0 13.399       12 8   64    49  0   1   .
0 16.073       12 3   9     56  0   1   .
0 23.26        12 4   16    46  0   0   .
0 37.3         12 13  169   45  0   2   .
0 11           12 4   16    32  0   2   .
0 13.075       12 17  289   43  1   1   .
0 13.7         12 4   16    34  1   1   .
0 25.1         12 0   0     30  1   1   .
0 18.6         17 15  225   38  2   0   .
0 29           16 11  121   33  1   1   .
0 19.237       12 23  529   52  0   0   .
0 19.855       11 1   1     43  0   3   .
0 9.45         12 5   25    33  1   1   .
0 30           10 1   1     45  0   0   .
0 15           10 5   25    36  2   1   .
0 24.701       12 3   9     34  1   1   .
0 15.9         14 3   9     37  0   2   .
0 16.24        10 19  361   46  0   1   .
0 21.1         12 20  400   47  0   0   .
0 23           16 5   25    31  2   1   .
0 6.34         5  0   0     57  0   0   .
0 42.25        12 3   9     30  1   1   .
0 14.694       12 3   9     30  0   0   .
0 21.417       12 7   49    44  0   3   .
0 20.2         13 7   49    53  0   0   .
0 12.09        8  1   1     51  0   0   .
0 24.76        12 13  169   39  1   3   .
0 23           8  0   0     52  0   0   .
0 19.365       8  0   0     46  0   4   .
0 5.55         12 12  144   47  0   5   .
0 68.035       8  0   0     52  0   2   .
0 29.3         12 5   25    45  0   2   .
0 18.5         11 45  2025  60  0   0   .
0 22.582       13 10  100   41  0   2   .
0 21.5         8  2   4     39  0   3   .
0 28.07        12 3   9     49  0   1   .
0 50.3         15 1   1     32  1   1   .
0 23.5         12 5   25    33  1   3   .
0 15.5         10 10  100   36  0   4   .
0 13.44        13 4   16    37  3   3   .
0 8.1          12 7   49    30  1   2   .
0 9.8          11 9   81    44  1   1   .
0 20.3         12 5   25    48  0   1   .
0 15           11 4   16    40  0   4   .
0 56.1         13 11  121   47  0   0   .
0 22.846       12 9   81    36  0   2   .
0 22.225       11 4   16    40  0   2   .
0 17.635       12 2   4     46  0   1   .
0 18.5         12 23  529   52  0   0   .
0 13.39        12 3   9     44  0   1   .
0 15.15        10 15  225   45  0   1   .
0 16.2         7  8   64    30  2   1   .
0 33.92        12 3   9     40  1   3   .
```

```
0 14          12 25  625   43  0   1   .
0 16.736      12 2   4     49  0   2   .
0 30.65       12 0   0     46  1   4   .
0 12.4        11 19  361   52  0   0   .
0 19.022      12 3   9     31  1   1   .
0 11.203      10 7   49    42  1   1   .
0 19.876      11 1   1     33  0   3   .
0 57          16 9   81    57  0   0   .
0 18.29       10 3   9     49  0   0   .
0 20.22       14 8   64    45  0   1   .
0 22.15       11 0   0     56  0   0   .
0 30.623      12 5   25    41  1   3   .
0 9.38        5  20  400   56  0   0   .
0 22          10 3   9     48  0   1   .
0 23.675      16 12  144   52  0   2   .
0 33.671      12 5   25    51  0   0   .
0 12.367      11 1   1     35  0   3   .
0 21.95       12 0   0     45  0   0   .
0 32          12 7   49    54  0   0   .
0 22.61       12 13  169   54  0   2   .
0 12.092      12 3   9     31  1   0   .
0 3.777       6  0   0     53  0   3   .
0 36          14 2   4     35  2   2   .
0 26.9        12 0   0     36  1   3   .
0 32.242      12 2   4     59  0   0   .
0 35.02       16 1   1     54  0   0   .
0 37.6        12 10  100   37  1   1   .
0 1.5         12 10  100   44  0   0   .
0 96          17 1   1     34  1   2   .
0 18.15       12 3   9     49  0   0   .
0 15.5        12 32  1024  49  0   0   .
0 14          9  0   0     60  0   0   .
0 14.756      12 7   49    51  0   0   .
0 22          12 5   25    30  1   1   .
0 24.466      12 2   4     47  0   2   .
0 24.4        12 5   25    36  0   4   .
0 24          12 3   9     35  1   3   .
0 15.5        12 25  625   58  0   0   .
0 30.8        14 0   0     41  1   3   .
0 10.66       10 3   9     51  0   1   .
0 13.35       12 10  100   47  0   0   .
0 10.09       9  10  100   45  1   2   .
0 55.6        14 7   49    60  0   0   .
0 25.7        16 5   25    30  1   1   .
0 29          11 15  225   55  0   0   .
0 7.286       12 1   1     32  1   2   .
0 37.752      12 5   25    36  0   2   .
0 13.072      12 9   81    55  0   0   .
0 7.044       12 18  324   47  0   0   .
0 18.2        12 1   1     47  0   1   .
0 27          11 0   0     37  0   1   .
0 30.3        12 6   36    50  0   2   .
0 12          12 1   1     30  0   3   .
0 31.5        17 2   4     48  0   1   .
0 27.092      10 15  225   43  0   2   .
0 20.968      11 25  625   48  1   0   .
```

```
0 27          14 1   1     41  1   2   .
0 11.225      12 0   0     50  0   0   .
0 37.7        8  0   0     58  0   0   .
0 28.2        13 0   0     38  0   5   .
0 34          12 8   64    37  0   1   .
0 63.2        16 22  484   50  0   0   .
0 7.5         8  5   25    42  0   4   .
0 17.41       9  10  100   37  1   3   .
0 51          16 1   1     41  0   2   .
0 12.916      12 1   1     31  0   2   .
0 21.9        12 6   36    51  0   0   .
0 17.64       12 4   16    36  1   2   .
0 20          15 6   36    54  0   0   .
0 15          12 0   0     49  0   0   .
0 14.06       9  1   1     48  1   1   .
0 15.825      9  3   9     42  0   2   .
0 16.51       12 15  225   41  1   2   .
0 13          16 33  1089  55  0   0   .
0 10          9  2   4     42  0   0   .
0 22          15 1   1     32  0   1   .
0 29.8        12 10  100   43  0   2   .
0 15          12 0   0     33  1   3   .
0 22.3        15 14  196   48  0   1   .
0 14.55       12 15  225   43  0   2   .
0 19.73       17 15  225   47  1   3   .
0 35          12 10  100   54  0   0   .
0 21.014      12 6   36    51  0   1   .
0 10.876      10 18  324   51  0   1   .
0 27.85       13 15  225   43  1   1   .
0 9.56        12 30  900   53  0   0   .
0 30.3        11 15  225   34  1   1   .
0 7.72        8  10  100   31  1   1   .
0 10.55       12 0   0     56  0   0   .
0 24.106      16 0   0     42  0   1   .
0 22.995      12 4   16    32  0   2   .
0 6           12 0   0     35  1   3   .
0 24.35       12 3   9     30  1   1   .
0 7.608       10 20  400   51  0   0   .
0 28.2        12 3   9     47  0   3   .
0 16.15       12 1   1     54  0   1   .
0 51.2        15 5   25    31  3   0   .
0 12.646      10 7   49    47  0   0   .
0 19          14 6   36    47  0   3   .
0 19          12 2   4     40  0   3   .
0 14.4        8  0   0     48  0   0   .
0 7.232       8  10  100   34  0   7   .
0 21.943      12 6   36    38  0   3   .
0 47.5        12 4   16    32  1   3   .
0 28.9        16 8   64    48  0   1   .
0 12.4        12 18  324   41  0   2   .
0 6.531       5  7   49    49  0   2   .
0 22.422      8  15  225   59  0   0   .
0 22.2        13 7   49    58  0   0   .
0 77          12 8   64    41  0   3   .
0 88          12 8   64    45  0   2   .
0 26.04       14 3   9     30  1   1   .
```

```
0 63.5        12 10  100   41  0   1   .
0 12.1        12 9   81    30  2   0   .
0 17.505      12 24  576   53  0   1   .
0 18          12 12  144   31  0   0   .
0 28.069      14 2   4     43  0   2   .
0 14          12 6   36    31  1   1   .
0 8.117       12 18  324   51  0   0   .
0 11.895      9  17  289   43  0   0   .
0 45.25       14 7   49    31  1   2   .
0 31.106      11 6   36    48  0   0   .
0 4           12 10  100   31  1   1   .
0 40.5        12 5   25    44  0   1   .
0 21.62       11 7   49    48  0   1   .
0 23.426      12 11  121   53  0   1   .
0 26          10 14  196   42  0   3   .
0 7.84        12 5   25    39  2   6   .
0 6.8         10 2   4     32  1   2   .
0 5.33        12 4   16    36  0   2   .
0 28.2        13 5   25    40  0   2   .
0 10          12 14  196   31  2   3   .
0 9.952       12 4   16    43  0   0   .
0 24.984      12 15  225   60  0   0   .
0 28.363      9  12  144   39  0   3   .
;
```

Click **Run** to create the Work.Mroz table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-Sectional Data Models** to add the step to your flow.

3 Add the Work.Mroz table to your flow and connect it to the Cross-Sectional Data Models node. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

5 On the **Data** tab, assign columns to these roles:

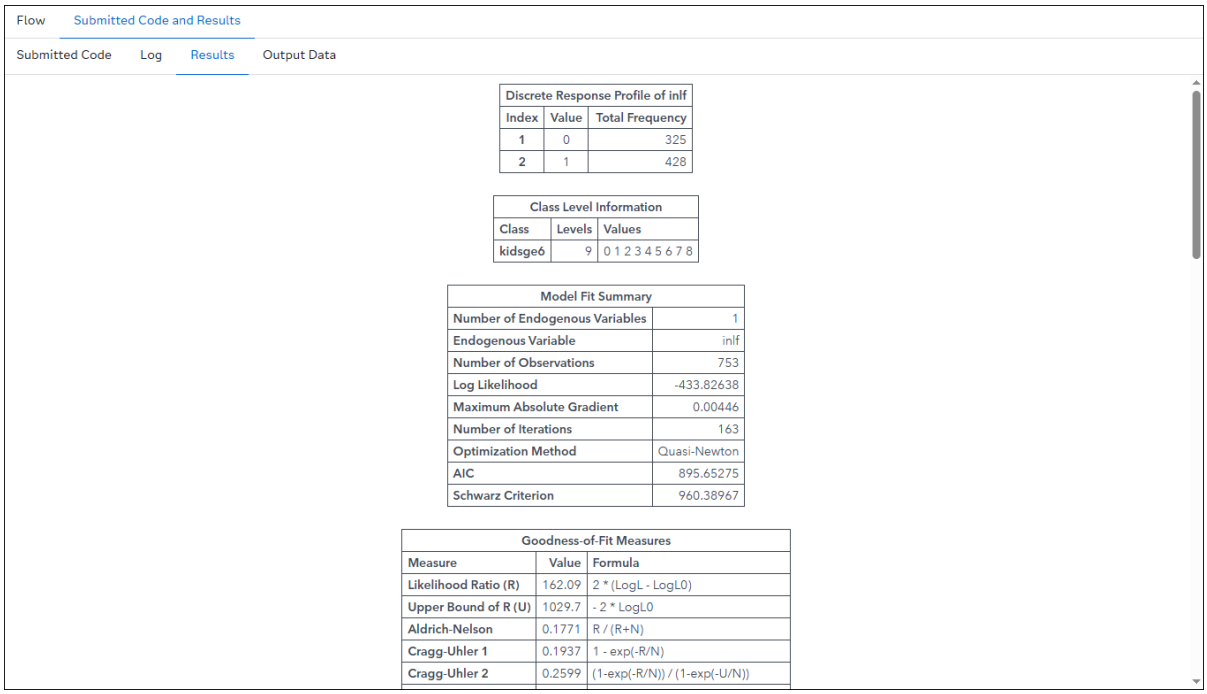
- To the **Dependent variable** role, assign **inlf**.
- To the **Continuous variables** role, assign **nwifeinc**, **educ**, **exper**, and **expersq**.
- To the **Categorical variables** role, assign **kidsge6**.

6 On the **Model** tab, select **Probit** as the model type.

7 Expand the **Heteroscedasticity** heading, and then select the **Analyze heteroscedasticity** check box. Assign the **nwifeinc** variable to the **Variables on the variance function** role.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Probit Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric variable for the analysis.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the probit model.

1 From the **Model type** drop-down list, select **Probit**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 (SAS Compute Server only) Specify whether to analyze the heteroscedasticity. You can specify the variables on the variance function and the form of the variance function.

4 (SAS Compute Server only) Specify the threshold for the first category for the probit model. By default, this value is zero, but you can use an estimated value.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available:

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 (CAS Server only) Specify the variables that are related to the heteroscedasticity of the residuals and how these variables are used to model the error variance.

3 Specify the optimization method to use.

4 Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

5 Select the statistics to be displayed in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates

- covariances of the parameter estimates
- (SAS Compute Server) iteration history of the objective function and parameter estimates

Note: This option is available only if the **Analyze heteroscedasticity** option is selected on the **Models** tab.

6 Select the plots to include in the results.

7 (CAS Server only) Specify the code generation method to use. You can choose from these options:

- **Use Econometrics procedures**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- a table that contains the default statistics from the analysis and any selected statistics such as the probability of the dependent variable taking the current value, the probability of the dependent variable for all possible responses, and the error standard deviation. If you are running the step on a CAS server, you must specify a CAS engine libref when naming the table.
- a table of parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Poisson Models

Example: Poisson Model

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data long97data;
   input fem ment phd mar kid5 art lnart;
datalines;
0   7.99999860   1.38000000  1  2  3   1.25276290
0   6.99999950   4.29000000  0  0  0  -0.69314720
```

0	47.00000760	3.84999990	0	0	4	1.50407740
0	19.00000190	3.58999990	1	1	1	0.40546510
0	0.00000000	1.80999990	1	0	1	0.40546510
0	6.00000050	3.58999990	1	1	1	0.40546510
0	9.99999900	2.11999990	1	1	0	-0.69314720
0	1.99999990	4.29000000	1	0	0	-0.69314720
0	1.99999990	2.57999990	1	2	3	1.25276290
0	3.99999900	1.80000000	1	1	3	1.25276290
0	0.00000000	4.29000000	1	2	1	0.40546510
0	3.00000000	2.76000000	1	1	0	-0.69314720
0	9.99999900	3.41000010	1	1	1	0.40546510
0	6.99999950	4.34000020	1	3	2	0.91629080
0	15.00000100	3.84999990	1	2	5	1.70474800
0	1.99999990	2.09999990	1	0	2	0.91629080
0	13.00000000	4.29000000	1	0	2	0.91629080
0	15.00000100	4.29000000	0	0	1	0.40546510
0	4.99999810	2.26000000	1	1	0	-0.69314720
0	6.00000050	2.09999990	0	0	0	-0.69314720
0	12.00000000	2.26000000	1	0	3	1.25276290
0	15.99999810	3.84999990	1	1	6	1.87180220
0	6.99999950	4.29000000	0	0	4	1.50407740
0	6.00000050	1.80000000	1	2	2	0.91629080
0	1.99999990	2.26000000	0	0	2	0.91629080
0	0.00000000	2.09999990	0	0	0	-0.69314720
0	30.00000190	4.29000000	1	0	4	1.50407740
0	9.99999900	4.29000000	1	2	1	0.40546510
0	1.99999990	2.09999990	1	0	1	0.40546510
0	0.99999990	3.58999990	1	0	7	2.01490310
0	3.00000000	3.42000010	1	1	2	0.91629080
0	9.99999900	4.29000000	1	2	2	0.91629080
0	9.99999900	4.29000000	0	0	2	0.91629080
0	0.99999990	3.33999990	1	2	0	-0.69314720
0	1.99999990	4.29000000	0	0	0	-0.69314720
0	10.99999710	4.29000000	1	0	1	0.40546510
0	4.99999810	3.61999990	1	0	4	1.50407740
0	0.00000000	4.29000000	1	3	1	0.40546510
0	3.99999900	4.34000020	1	1	1	0.40546510
0	1.99999990	1.25000000	1	1	2	0.91629080
0	19.00000190	4.34000020	0	0	7	2.01490310
0	3.00000000	1.67000000	1	3	1	0.40546510
0	0.00000000	3.47000000	0	0	0	-0.69314720
0	0.99999990	2.26000000	1	1	1	0.40546510
0	0.99999990	1.80000000	1	0	1	0.40546510
0	17.00000000	4.34000020	1	2	2	0.91629080
0	3.00000000	3.58999990	0	0	2	0.91629080
0	0.99999990	1.75000000	1	2	1	0.40546510
0	6.00000050	4.29000000	0	0	1	0.40546510
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	15.00000100	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	26.99999810	3.31999990	1	2	2	0.91629080
0	4.99999810	4.34000020	1	0	2	0.91629080
0	6.99999950	3.41000010	0	0	4	1.50407740
0	0.00000000	4.29000000	1	0	1	0.40546510
0	10.99999710	3.19000010	1	0	2	0.91629080
0	13.00000000	4.29000000	1	0	2	0.91629080

0	3.99999900	1.74000000	1	2	1	0.40546510
0	3.99999900	2.76000000	0	0	1	0.40546510
0	26.99999810	3.58999990	1	1	7	2.01490310
0	9.99999900	1.80999990	1	0	4	1.50407740
0	13.00000000	4.29000000	1	1	2	0.91629080
0	0.99999990	4.29000000	1	1	1	0.40546510
0	6.00000050	2.76000000	0	0	1	0.40546510
0	6.00000050	3.47000000	0	0	6	1.87180220
0	4.99999810	2.50000000	1	2	2	0.91629080
0	1.99999990	1.25000000	1	0	5	1.70474800
0	13.99999710	3.58999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	12.00000000	3.58999990	1	0	1	0.40546510
0	6.99999950	3.58999990	1	3	0	-0.69314720
0	3.00000000	1.75000000	1	0	1	0.40546510
0	1.99999990	1.75000000	1	2	1	0.40546510
0	1.99999990	3.58999990	1	1	1	0.40546510
0	1.99999990	4.29000000	0	0	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	0.00000000	2.60999990	1	0	3	1.25276290
0	30.00000190	4.29000000	1	0	5	1.70474800
0	21.00000000	1.74000000	1	0	16	2.80336050
0	4.99999810	2.76000000	1	0	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	7.99999860	2.76000000	1	2	1	0.40546510
0	25.00000000	4.29000000	1	2	3	1.25276290
0	0.00000000	3.47000000	1	1	5	1.70474800
0	4.99999810	2.57999990	1	2	0	-0.69314720
0	0.99999990	2.14000010	1	0	0	-0.69314720
0	4.99999810	2.26000000	0	0	0	-0.69314720
0	0.00000000	4.29000000	1	2	3	1.25276290
0	15.00000100	4.29000000	1	0	3	1.25276290
0	30.00000190	4.29000000	0	0	3	1.25276290
0	1.99999990	2.20000000	1	0	0	-0.69314720
0	6.00000050	1.80000000	1	2	3	1.25276290
0	0.00000000	2.09999990	1	2	1	0.40546510
0	13.00000000	4.29000000	1	1	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	12.00000000	2.09999990	1	1	0	-0.69314720
0	30.00000190	4.29000000	1	2	2	0.91629080
0	4.99999810	1.80999990	1	1	1	0.40546510
0	9.99999900	4.34000020	1	0	1	0.40546510
0	4.99999810	4.29000000	1	1	0	-0.69314720
0	3.99999900	2.50000000	1	2	1	0.40546510
0	13.00000000	2.05000000	1	2	4	1.50407740
0	7.99999860	3.47000000	1	0	3	1.25276290
0	6.00000050	2.60999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	2	1	0.40546510
0	25.00000000	4.29000000	0	0	2	0.91629080
0	1.99999990	4.29000000	1	1	2	0.91629080
0	9.00000000	4.34000020	1	0	6	1.87180220
0	9.99999900	2.11999990	1	1	0	-0.69314720
0	3.00000000	2.76000000	1	0	2	0.91629080
0	1.99999990	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.50000000	1	0	1	0.40546510

0	6.00000050	4.34000020	1	0	5	1.70474800
0	7.99999860	2.76000000	1	1	2	0.91629080
0	9.99999900	3.19000010	1	1	2	0.91629080
0	7.99999860	4.61999990	0	0	3	1.25276290
0	6.00000050	3.15000010	1	2	0	-0.69314720
0	21.00000000	2.55000000	1	1	4	1.50407740
0	3.99999900	1.52000000	1	0	0	-0.69314720
0	1.99999990	1.72000000	1	2	4	1.50407740
0	0.99999990	1.78000000	1	1	2	0.91629080
0	17.00000000	2.85999990	1	1	1	0.40546510
0	30.00000190	4.61999990	1	2	0	-0.69314720
0	4.99999810	4.13999990	0	0	1	0.40546510
0	13.00000000	2.96000000	1	1	6	1.87180220
0	10.99999710	2.55000000	1	0	1	0.40546510
0	19.00000190	2.21000000	1	1	0	-0.69314720
0	4.99999810	3.08999990	1	0	3	1.25276290
0	66.00000760	4.54000000	1	2	4	1.50407740
0	0.00000000	1.78000000	1	0	3	1.25276290
0	3.00000000	2.21000000	1	3	0	-0.69314720
0	3.00000000	2.39000010	1	1	1	0.40546510
0	0.00000000	2.96000000	1	0	0	-0.69314720
0	7.99999860	2.51000000	1	1	0	-0.69314720
0	0.00000000	1.97000000	1	2	2	0.91629080
0	4.99999810	4.13999990	0	0	0	-0.69314720
0	29.00000000	4.25000000	1	1	4	1.50407740
0	10.99999710	2.85999990	1	2	0	-0.69314720
0	22.99999620	2.96000000	1	1	9	2.25129180
0	45.99999240	2.96000000	1	2	2	0.91629080
0	7.99999860	4.61999990	1	1	6	1.87180220
0	4.99999810	3.69000010	1	2	0	-0.69314720
0	0.99999990	3.15000010	1	1	0	-0.69314720
0	9.00000000	4.61999990	0	0	2	0.91629080
0	1.99999990	3.35999990	1	0	0	-0.69314720
0	6.99999950	3.69000010	0	0	4	1.50407740
0	10.99999710	3.54000000	1	0	1	0.40546510
0	56.99999620	2.96000000	1	1	4	1.50407740
0	15.99999810	2.55999990	1	1	1	0.40546510
0	0.00000000	2.31999990	1	0	0	-0.69314720
0	3.00000000	2.31999990	1	0	0	-0.69314720
0	0.99999990	0.92000000	1	2	0	-0.69314720
0	9.99999900	4.54000000	1	0	0	-0.69314720
0	10.99999710	4.54000000	1	3	0	-0.69314720
0	10.99999710	1.76000000	1	1	5	1.70474800
0	15.99999810	2.55999990	0	0	1	0.40546510
0	4.99999810	2.39000010	1	1	0	-0.69314720
0	9.00000000	3.40000010	1	0	2	0.91629080
0	19.99999620	2.86999990	1	2	2	0.91629080
0	21.00000000	4.54000000	1	2	4	1.50407740
0	4.99999810	2.82999990	1	0	4	1.50407740
0	6.00000050	1.67999990	1	0	0	-0.69314720
0	12.00000000	3.54000000	0	0	3	1.25276290
0	0.00000000	1.76000000	1	0	2	0.91629080
0	10.99999710	3.15000010	1	3	1	0.40546510
0	3.00000000	2.51000000	1	0	0	-0.69314720
0	15.99999810	3.69000010	1	1	0	-0.69314720
0	10.99999710	1.76000000	1	1	4	1.50407740

```
0   4.99999810   1.86000000  1  1 12   2.52572870
0   0.99999990   2.76000000  1  3  0  -0.69314720
0  15.99999810   4.61999990  1  1  1   0.40546510
0  12.00000000   4.25000000  1  0  5   1.70474800
0  10.99999710   2.54000000  1  0  4   1.50407740
0   0.00000000   2.20000000  1  1  0  -0.69314720
0   0.00000000   1.76000000  1  0  2   0.91629080
0   3.00000000   2.85999990  1  3  3   1.25276290
0  13.00000000   3.40000010  1  2  0  -0.69314720
0  45.00000000   4.54000000  1  1  1   0.40546510
0  47.00000760   1.86000000  1  1  9   2.25129180
0   6.99999950   1.52000000  1  0  0  -0.69314720
0   6.99999950   2.55999990  1  1  2   0.91629080
0  19.00000190   2.21000000  1  0  0  -0.69314720
0   9.00000000   3.69000010  1  0  7   2.01490310
0  76.99998470   1.78000000  1  1  1   0.40546510
0   0.00000000   1.17999990  1  1  0  -0.69314720
0   3.99999900   2.00000000  1  0  1   0.40546510
0  19.00000190   2.21000000  1  0  0  -0.69314720
0  12.00000000   4.13999990  1  2  0  -0.69314720
0   0.99999990   2.85999990  1  3  0  -0.69314720
0  17.00000000   2.85999990  1  1  1   0.40546510
0   6.00000050   2.54000000  0  0  7   2.01490310
0   3.99999900   2.85999990  1  1  0  -0.69314720
0   6.00000050   2.52000000  0  0  4   1.50407740
0   3.00000000   1.52000000  1  1  2   0.91629080
0   4.99999810   3.08999990  1  1  3   1.25276290
0   3.00000000   1.17999990  1  1  0  -0.69314720
0   3.00000000   1.42000000  1  0  0  -0.69314720
0  15.00000100   4.61999990  0  0  7   2.01490310
0   0.00000000   2.96000000  1  2  1   0.40546510
0   9.99999900   4.54000000  0  0  2   0.91629080
0  41.99999620   4.54000000  0  0  7   2.01490310
0   3.00000000   2.51000000  1  2  1   0.40546510
0   6.99999950   3.15000010  1  1  2   0.91629080
0   0.00000000   2.50000000  1  0  1   0.40546510
0   6.00000050   2.96000000  1  3  1   0.40546510
0   3.99999900   1.67999990  1  0  0  -0.69314720
0   0.00000000   1.22000000  1  1  1   0.40546510
0   1.99999990   1.52000000  1  0  1   0.40546510
0   4.99999810   2.21000000  1  1  0  -0.69314720
0   0.99999990   3.92000010  1  1  0  -0.69314720
0  13.00000000   4.54000000  1  0  5   1.70474800
0   0.00000000   1.17999990  1  0  2   0.91629080
0  26.00000000   3.69000010  1  0  3   1.25276290
0   0.99999990   1.72000000  1  0  2   0.91629080
0  25.00000000   2.57999990  1  1  5   1.70474800
0   3.00000000   1.52000000  0  0  3   1.25276290
0  47.00000760   1.86000000  1  1  4   1.50407740
0   3.99999900   2.50000000  1  0  5   1.70474800
0   0.99999990   4.61999990  1  0  1   0.40546510
0   6.99999950   1.40000000  1  2  0  -0.69314720
0   4.99999810   4.54000000  1  0  3   1.25276290
0  26.99999810   1.67999990  1  1  0  -0.69314720
0   0.99999990   2.82999990  1  0  2   0.91629080
0   4.99999810   3.35999990  0  0  1   0.40546510
```

0	0.00000000	1.97000000	1	1	7	2.01490310
0	12.00000000	3.40000010	0	0	1	0.40546510
0	3.99999900	1.74000000	1	1	1	0.40546510
0	0.00000000	2.96000000	0	0	0	-0.69314720
0	25.00000000	2.57999990	1	1	4	1.50407740
0	3.00000000	4.54000000	1	1	1	0.40546510
0	1.99999990	3.15000010	1	1	0	-0.69314720
0	12.00000000	2.96000000	1	2	0	-0.69314720
0	15.99999810	3.54000000	1	2	2	0.91629080
0	4.99999810	2.96000000	1	1	3	1.25276290
0	12.00000000	4.25000000	1	0	1	0.40546510
0	4.99999810	2.55999990	1	1	2	0.91629080
0	4.99999810	1.86000000	1	0	1	0.40546510
0	3.00000000	4.61999990	1	1	1	0.40546510
0	3.99999900	2.85999990	0	0	2	0.91629080
0	4.99999810	3.15000010	1	1	5	1.70474800
0	0.00000000	2.51000000	1	0	2	0.91629080
0	26.99999810	3.15000010	1	1	5	1.70474800
0	4.99999810	2.51000000	1	0	2	0.91629080
0	0.00000000	1.52000000	1	1	0	-0.69314720
0	17.99999810	4.29000000	0	0	6	1.87180220
0	4.99999810	4.29000000	1	1	4	1.50407740
0	7.99999860	4.29000000	1	2	2	0.91629080
0	3.99999900	2.09999990	1	0	2	0.91629080
0	35.00000760	4.29000000	1	1	12	2.52572870
0	4.99999810	4.29000000	0	0	2	0.91629080
0	9.00000000	3.58999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	0	1	0.40546510
0	24.00000190	4.29000000	1	0	2	0.91629080
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	4.99999810	1.80999990	1	1	0	-0.69314720
0	19.00000190	4.29000000	0	0	7	2.01490310
0	3.00000000	4.29000000	0	0	1	0.40546510
0	1.99999990	4.29000000	1	1	1	0.40546510
0	3.99999900	1.25000000	1	0	3	1.25276290
0	9.99999900	3.58999990	1	0	1	0.40546510
0	7.99999860	2.09999990	1	1	1	0.40546510
0	1.99999990	4.29000000	1	0	4	1.50407740
0	19.00000190	4.29000000	1	1	3	1.25276290
0	0.99999990	3.47000000	1	1	1	0.40546510
0	3.00000000	3.19000010	1	0	1	0.40546510
0	4.99999810	3.19000010	1	2	1	0.40546510
0	0.00000000	2.09999990	1	0	1	0.40546510
0	21.00000000	3.58999990	1	1	5	1.70474800
0	13.99999710	4.29000000	1	1	1	0.40546510
0	0.00000000	2.09999990	1	0	0	-0.69314720
0	6.99999950	2.76000000	1	1	1	0.40546510
0	4.99999810	2.60999990	1	0	3	1.25276290
0	22.00000000	4.29000000	1	0	4	1.50407740
0	19.99999620	3.41000010	0	0	7	2.01490310
0	38.00000380	4.29000000	1	0	3	1.25276290
0	19.00000190	4.29000000	0	0	4	1.50407740
0	3.00000000	2.26000000	0	0	2	0.91629080
0	15.99999810	3.58999990	0	0	3	1.25276290
0	1.99999990	4.29000000	1	1	0	-0.69314720
0	3.00000000	2.05000000	0	0	1	0.40546510

0	12.00000000	4.29000000	1	2	1	0.40546510
0	35.00000760	4.29000000	0	0	0	-0.69314720
0	19.00000190	4.29000000	1	0	0	-0.69314720
0	1.99999990	4.29000000	0	0	0	-0.69314720
0	6.99999950	2.76000000	0	0	1	0.40546510
0	3.99999900	2.09999990	1	2	3	1.25276290
0	13.99999710	2.35999990	0	0	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	7.99999860	3.58999990	0	0	0	-0.69314720
0	12.00000000	4.29000000	1	1	2	0.91629080
0	3.00000000	4.29000000	1	1	0	-0.69314720
0	0.99999990	4.29000000	1	0	1	0.40546510
0	9.99999900	4.29000000	0	0	1	0.40546510
0	21.00000000	3.41000010	0	0	4	1.50407740
0	13.00000000	4.29000000	1	1	0	-0.69314720
0	17.00000000	4.29000000	1	0	2	0.91629080
0	4.99999810	4.29000000	0	0	0	-0.69314720
0	1.99999990	2.14000010	0	0	0	-0.69314720
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	1.99999990	2.50000000	1	1	2	0.91629080
0	4.99999810	2.60999990	1	1	3	1.25276290
0	0.99999990	1.80999990	1	2	0	-0.69314720
0	1.99999990	2.26000000	1	1	0	-0.69314720
0	3.99999900	3.61999990	1	2	1	0.40546510
0	9.00000000	4.29000000	1	2	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	17.00000000	4.29000000	0	0	2	0.91629080
0	24.00000190	4.29000000	1	2	0	-0.69314720
0	3.99999900	3.47000000	1	0	4	1.50407740
0	13.99999710	4.29000000	1	1	2	0.91629080
0	4.99999810	3.58999990	1	1	1	0.40546510
0	9.99999900	1.80999990	0	0	1	0.40546510
0	17.99999810	4.29000000	1	1	3	1.25276290
0	0.99999990	4.29000000	1	1	0	-0.69314720
0	0.00000000	2.09999990	1	0	1	0.40546510
0	3.99999900	2.15000010	1	2	0	-0.69314720
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	0.99999990	2.26000000	1	0	1	0.40546510
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	13.00000000	4.29000000	1	2	0	-0.69314720
0	4.99999810	3.58999990	1	2	0	-0.69314720
0	6.99999950	3.41000010	1	2	0	-0.69314720
0	6.99999950	3.58999990	0	0	3	1.25276290
0	4.99999810	3.61999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	3	1	0.40546510
0	13.99999710	4.29000000	0	0	1	0.40546510
0	6.00000050	4.29000000	1	0	0	-0.69314720
0	4.99999810	2.26000000	1	1	1	0.40546510
0	7.99999860	2.76000000	1	0	3	1.25276290
0	3.99999900	2.60999990	1	1	1	0.40546510
0	9.00000000	4.29000000	0	0	2	0.91629080
0	3.00000000	2.09999990	1	1	2	0.91629080
0	1.99999990	3.47000000	1	1	0	-0.69314720
0	0.00000000	2.09999990	0	0	0	-0.69314720
0	10.99999710	4.29000000	0	0	1	0.40546510
0	9.00000000	4.29000000	0	0	1	0.40546510

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0   7.99999860   2.96000000  1  0  1   0.40546510
0   1.99999990   2.96000000  1  0  2   0.91629080
0  17.99999810   4.61999990  1  0  3   1.25276290
0   3.00000000   1.42000000  1  0  3   1.25276290
0   1.99999990   4.54000000  1  0  1   0.40546510
0   6.99999950   2.52000000  1  0  0  -0.69314720
0   9.99999900   4.54000000  1  1  2   0.91629080
0  15.99999810   2.00000000  1  1  1   0.40546510
0   4.99999810   2.54000000  1  0  0  -0.69314720
0   0.00000000   2.50000000  1  0  2   0.91629080
0   7.99999860   4.54000000  0  0  0  -0.69314720
0   9.99999900   3.35999990  0  0  1   0.40546510
0  17.99999810   3.40000010  1  1  0  -0.69314720
0  12.00000000   1.67999990  1  1  1   0.40546510
0   9.00000000   2.00000000  0  0  1   0.40546510
0  39.00000000   2.85999990  1  0  1   0.40546510
0  17.99999810   4.61999990  1  0  1   0.40546510
0  15.00000100   4.13999990  1  0  1   0.40546510
0  15.99999810   4.13999990  1  0  2   0.91629080
0   1.99999990   2.96000000  0  0  0  -0.69314720
0   6.99999950   2.82999990  1  2  3   1.25276290
0  24.00000190   2.55000000  1  0  2   0.91629080
0   7.99999860   1.67999990  1  0  1   0.40546510
0   6.99999950   2.00000000  0  0  1   0.40546510
0  10.99999710   2.00000000  1  1  1   0.40546510
0   0.00000000   2.96000000  1  1  4   1.50407740
0   3.99999900   1.50500000  1  0  4   1.50407740
0  21.00000000   3.54000000  1  0  2   0.91629080
0   6.00000050   3.40000010  0  0  1   0.40546510
0   6.00000050   4.61999990  0  0  0  -0.69314720
0   7.99999860   2.82999990  0  0  3   1.25276290
0   3.99999900   2.54000000  1  0  1   0.40546510
0  12.00000000   2.86999990  0  0  1   0.40546510
0  15.00000100   1.86000000  0  0  1   0.40546510
0   0.00000000   3.92000010  1  1  1   0.40546510
0   4.99999810   3.69000010  1  1  1   0.40546510
0  15.00000100   2.85999990  1  2  4   1.50407740
0   4.99999810   4.54000000  0  0  0  -0.69314720
0   7.99999860   4.61999990  0  0  0  -0.69314720
0  13.00000000   2.85999990  1  1  0  -0.69314720
0   1.99999990   3.40000010  0  0  1   0.40546510
0   6.00000050   2.57999990  1  2  4   1.50407740
0  19.99999620   4.25000000  1  0  3   1.25276290
0   6.99999950   1.76000000  1  1  2   0.91629080
0   6.99999950   2.85999990  1  3  0  -0.69314720
0  15.99999810   3.69000010  1  2  4   1.50407740
0  13.00000000   3.40000010  1  0  0  -0.69314720
0   0.00000000   3.40000010  1  2  0  -0.69314720
0   0.99999990   4.54000000  1  2  0  -0.69314720
0  12.00000000   2.86999990  0  0  3   1.25276290
0   6.99999950   1.76000000  1  0  4   1.50407740
0   3.99999900   4.25000000  0  0  1   0.40546510
0   0.00000000   3.92000010  0  0  3   1.25276290
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0   3.99999900   2.31999990  1  0  1   0.40546510
0  36.99999240   4.54000000  0  0  2   0.91629080
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0	22.99999620	3.35999990	1	1	0	-0.69314720
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0	1.99999990	3.92000010	0	0	1	0.40546510
0	0.00000000	3.35999990	0	0	1	0.40546510
0	0.99999990	1.78000000	1	0	1	0.40546510
0	21.00000000	3.54000000	1	1	1	0.40546510
0	9.99999900	3.92000010	0	0	2	0.91629080
0	7.99999860	2.31999990	0	0	3	1.25276290
0	33.99999240	1.67999990	1	0	1	0.40546510
0	13.99999710	3.08999990	0	0	2	0.91629080
0	6.00000050	2.57999990	1	1	0	-0.69314720
0	13.99999710	3.40000010	0	0	6	1.87180220
0	12.00000000	2.86999990	0	0	3	1.25276290
0	17.99999810	4.61999990	0	0	4	1.50407740
0	3.00000000	2.96000000	1	3	0	-0.69314720
0	6.00000050	1.86000000	1	2	2	0.91629080
0	1.99999990	1.22000000	1	1	0	-0.69314720
0	10.99999710	2.51000000	1	2	6	1.87180220
0	10.99999710	2.51000000	1	0	8	2.14006610
0	4.99999810	3.69000010	1	0	2	0.91629080
0	7.99999860	2.96000000	1	0	3	1.25276290
0	3.99999900	1.78000000	1	0	1	0.40546510
0	0.99999990	1.22000000	1	1	1	0.40546510
0	7.99999860	2.85999990	1	0	0	-0.69314720
0	19.00000190	3.69000010	0	0	7	2.01490310
0	1.99999990	2.11999990	0	0	0	-0.69314720
0	9.99999900	2.52000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	1	0.40546510
0	3.00000000	4.61999990	1	0	2	0.91629080
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0	0.99999990	2.50000000	1	0	0	-0.69314720
0	4.99999810	1.67999990	0	0	0	-0.69314720
0	1.99999990	3.40000010	1	1	1	0.40546510
0	4.99999810	3.92000010	0	0	0	-0.69314720
0	52.99998090	4.54000000	1	1	5	1.70474800
0	54.99998860	4.54000000	0	0	2	0.91629080
0	0.00000000	2.50000000	0	0	0	-0.69314720
0	10.99999710	4.54000000	1	0	2	0.91629080
0	25.00000000	3.54000000	0	0	3	1.25276290
0	4.99999810	1.52000000	1	0	2	0.91629080
0	1.99999990	3.92000010	1	2	0	-0.69314720
0	7.99999860	4.61999990	1	0	2	0.91629080
0	0.00000000	3.92000010	1	0	3	1.25276290
0	4.99999810	2.31999990	1	2	0	-0.69314720
0	7.99999860	2.96000000	1	2	2	0.91629080
0	6.99999950	2.85999990	1	2	1	0.40546510
0	13.99999710	1.95000000	1	1	3	1.25276290
0	1.99999990	3.92000010	1	2	1	0.40546510
0	4.99999810	2.86999990	0	0	1	0.40546510
0	24.00000190	3.69000010	1	0	3	1.25276290
0	3.00000000	3.69000010	1	0	0	-0.69314720
0	3.99999900	2.39000010	0	0	2	0.91629080
0	3.00000000	1.95000000	1	2	3	1.25276290
0	10.99999710	3.35999990	0	0	5	1.70474800
0	3.99999900	2.39000010	1	1	2	0.91629080

0	26.00000000	3.69000010	0	0	2	0.91629080
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0	1.99999990	3.21000000	1	0	0	-0.69314720
0	0.00000000	2.11999990	1	2	0	-0.69314720
0	52.99998090	4.54000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	3	1.25276290
0	6.00000050	2.54000000	1	1	3	1.25276290
0	1.99999990	2.85999990	1	1	1	0.40546510
0	13.99999710	3.47000000	1	0	3	1.25276290
0	15.00000100	2.86999990	0	0	4	1.50407740
0	3.99999900	2.31999990	1	0	0	-0.69314720
0	15.00000100	1.86000000	1	2	4	1.50407740
0	3.99999900	1.95000000	1	0	2	0.91629080
0	1.99999990	2.31999990	1	2	0	-0.69314720
0	19.99999620	4.25000000	1	2	1	0.40546510
0	3.99999900	1.97000000	0	0	6	1.87180220
0	41.99999620	1.86000000	1	0	19	2.97041440
0	7.99999860	3.69000010	1	1	0	-0.69314720
0	3.00000000	4.54000000	1	1	0	-0.69314720
0	9.00000000	3.54000000	1	0	4	1.50407740
0	9.99999900	4.54000000	1	1	1	0.40546510
0	6.99999950	2.85999990	1	2	11	2.44234700
0	25.00000000	3.35999990	1	0	0	-0.69314720
0	3.00000000	2.85999990	0	0	0	-0.69314720
0	3.99999900	2.96000000	1	2	0	-0.69314720
0	22.00000000	2.55999990	1	2	1	0.40546510
0	7.99999860	1.63000000	1	0	2	0.91629080
0	13.99999710	2.96000000	0	0	0	-0.69314720
0	0.00000000	2.96000000	1	0	1	0.40546510
0	7.99999860	1.63000000	1	1	1	0.40546510
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0	21.00000000	2.96000000	1	2	2	0.91629080
0	6.99999950	2.96000000	1	0	1	0.40546510
0	30.99998860	4.54000000	1	2	3	1.25276290
0	1.99999990	4.54000000	1	2	2	0.91629080
0	9.99999900	2.15000010	0	0	1	0.40546510
0	6.00000050	4.54000000	1	1	2	0.91629080
0	12.00000000	2.21000000	1	2	2	0.91629080
0	0.99999990	2.21000000	1	1	0	-0.69314720
0	29.00000000	4.54000000	0	0	2	0.91629080
0	9.99999900	2.21000000	1	1	3	1.25276290
0	6.00000050	2.21000000	1	0	0	-0.69314720
0	36.99999240	4.54000000	1	0	3	1.25276290
0	4.99999810	4.54000000	0	0	4	1.50407740
1	9.00000000	2.11999990	0	0	0	-0.69314720
1	1.99999990	2.11999990	1	0	0	-0.69314720
1	1.99999990	2.11999990	1	0	2	0.91629080
1	3.00000000	2.11999990	1	0	3	1.25276290
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1	10.99999710	2.39000010	0	0	3	1.25276290
1	4.99999810	2.57999990	0	0	2	0.91629080
1	6.99999950	3.19000010	1	0	4	1.50407740
1	4.99999810	3.75000000	0	0	0	-0.69314720
1	3.00000000	3.58999990	0	0	1	0.40546510
1	1.99999990	2.57999990	0	0	2	0.91629080
1	0.00000000	3.75000000	0	0	3	1.25276290

1	4.99999810	3.75000000	1	0	0	-0.69314720
1	0.99999990	3.75000000	0	0	0	-0.69314720
1	3.99999900	1.22000000	1	2	2	0.91629080
1	13.99999710	3.75000000	0	0	0	-0.69314720
1	6.99999950	3.75000000	1	0	0	-0.69314720
1	26.00000000	3.75000000	0	0	0	-0.69314720
1	7.99999860	3.75000000	0	0	2	0.91629080
1	3.00000000	3.75000000	0	0	4	1.50407740
1	6.00000050	3.75000000	0	0	0	-0.69314720
1	21.00000000	3.75000000	0	0	1	0.40546510
1	7.99999860	3.75000000	1	0	2	0.91629080
1	3.99999900	3.75000000	0	0	0	-0.69314720
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1	13.99999710	1.40000000	0	0	0	-0.69314720
1	12.00000000	1.40000000	0	0	1	0.40546510
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1	6.00000050	2.00000000	0	0	1	0.40546510
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1	6.00000050	4.34000020	1	0	4	1.50407740
1	0.00000000	1.75000000	0	0	0	-0.69314720
1	36.00000000	2.09999990	1	0	6	1.87180220
1	7.99999860	2.09999990	0	0	1	0.40546510
1	1.99999990	2.09999990	0	0	0	-0.69314720
1	10.99999710	3.58999990	1	0	2	0.91629080
1	10.99999710	3.58999990	1	2	2	0.91629080
1	17.99999810	3.58999990	0	0	0	-0.69314720
1	3.99999900	3.58999990	0	0	0	-0.69314720
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1	7.99999860	3.58999990	0	0	1	0.40546510
1	19.00000190	3.41000010	1	0	3	1.25276290
1	3.99999900	3.41000010	1	0	4	1.50407740
1	4.99999810	3.41000010	1	2	0	-0.69314720
1	6.99999950	3.40000010	0	0	1	0.40546510
1	3.99999900	3.40000010	1	1	2	0.91629080
1	4.99999810	3.40000010	1	0	4	1.50407740
1	13.99999710	3.40000010	1	0	1	0.40546510
1	3.99999900	3.40000010	1	0	0	-0.69314720
1	3.99999900	2.52000000	0	0	3	1.25276290
1	0.00000000	2.52000000	0	0	1	0.40546510
1	15.00000100	3.69000010	1	1	2	0.91629080
1	0.99999990	3.69000010	1	0	1	0.40546510
1	3.00000000	3.69000010	1	1	0	-0.69314720

1	17.99999810	3.69000010	0	0	1	0.40546510
1	15.00000100	2.86999990	0	0	0	-0.69314720
1	4.99999810	2.86999990	1	0	1	0.40546510
1	17.99999810	2.86999990	1	0	1	0.40546510
1	9.00000000	2.86999990	0	0	2	0.91629080
1	6.00000050	2.86999990	0	0	4	1.50407740
1	15.00000100	2.86999990	1	0	1	0.40546510
1	3.99999900	3.35999990	0	0	2	0.91629080
1	1.99999990	3.35999990	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	2	0.91629080
1	6.99999950	3.35999990	0	0	0	-0.69314720
1	15.99999810	4.54000000	1	0	4	1.50407740
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1	36.99999240	4.54000000	0	0	1	0.40546510
1	9.99999900	4.54000000	1	0	2	0.91629080
1	13.00000000	4.54000000	0	0	2	0.91629080
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1	9.00000000	4.54000000	1	0	2	0.91629080
1	4.99999810	4.54000000	0	0	2	0.91629080
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1	3.00000000	4.54000000	0	0	3	1.25276290
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1	29.00000000	3.84999990	1	0	1	0.40546510
1	0.99999990	3.84999990	1	1	5	1.70474800
1	17.99999810	3.84999990	0	0	1	0.40546510
1	13.00000000	2.05000000	0	0	1	0.40546510
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1	1.99999990	2.05000000	0	0	2	0.91629080
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1	0.99999990	1.17999990	1	0	1	0.40546510
1	3.00000000	1.52000000	1	0	0	-0.69314720
1	9.00000000	1.48000000	1	0	2	0.91629080
1	12.00000000	4.29000000	0	0	0	-0.69314720
1	17.00000000	4.29000000	0	0	1	0.40546510
1	4.99999810	4.29000000	0	0	3	1.25276290
1	1.99999990	3.08999990	1	0	2	0.91629080
1	0.00000000	3.08999990	0	0	2	0.91629080
1	3.00000000	3.61999990	0	0	5	1.70474800
1	6.99999950	3.61999990	0	0	0	-0.69314720
1	7.99999860	3.61999990	0	0	0	-0.69314720
1	0.00000000	4.29000000	0	0	0	-0.69314720
1	6.00000050	2.60999990	1	1	1	0.40546510
1	6.99999950	2.60999990	1	0	1	0.40546510
1	9.00000000	2.09999990	0	0	0	-0.69314720
1	7.99999860	2.96000000	1	0	2	0.91629080
1	9.99999900	2.39000010	0	0	0	-0.69314720
1	3.00000000	1.95000000	1	0	1	0.40546510
1	13.99999710	3.41000010	0	0	2	0.91629080

1	0.99999990	4.29000000	0	0	2	0.91629080
1	10.99999710	3.58999990	0	0	2	0.91629080
1	9.99999900	4.61999990	0	0	1	0.40546510
1	6.00000050	2.14000010	0	0	1	0.40546510
1	10.99999710	2.85999990	0	0	0	-0.69314720
1	4.99999810	3.47000000	0	0	2	0.91629080
1	13.99999710	4.61999990	1	1	3	1.25276290
1	9.00000000	3.19000010	1	3	1	0.40546510
1	0.99999990	2.51000000	0	0	1	0.40546510
1	0.00000000	2.11999990	0	0	0	-0.69314720
1	3.00000000	3.19000010	0	0	0	-0.69314720
1	3.99999900	1.74000000	1	1	2	0.91629080
1	0.00000000	1.25000000	1	0	0	-0.69314720
1	6.99999950	3.69000010	1	0	0	-0.69314720
1	4.99999810	3.21000000	0	0	0	-0.69314720
1	15.00000100	4.61999990	1	1	0	-0.69314720
1	24.00000190	2.85999990	1	0	5	1.70474800
1	9.00000000	2.39000010	1	1	1	0.40546510
1	0.00000000	1.17999990	1	0	3	1.25276290
1	6.99999950	3.35999990	0	0	2	0.91629080
1	7.99999860	1.97000000	0	0	2	0.91629080
1	22.00000000	1.64000000	1	0	1	0.40546510
1	6.99999950	3.92000010	1	0	2	0.91629080
1	6.00000050	3.31999990	0	0	6	1.87180220
1	6.00000050	2.57999990	0	0	5	1.70474800
1	22.99999620	4.54000000	0	0	2	0.91629080
1	1.99999990	2.39000010	1	0	0	-0.69314720
1	9.00000000	3.58999990	0	0	4	1.50407740
1	6.99999950	3.69000010	0	0	2	0.91629080
1	9.99999900	3.19000010	0	0	2	0.91629080
1	3.99999900	2.31999990	0	0	2	0.91629080
1	10.99999710	3.47000000	1	1	2	0.91629080
1	3.99999900	3.69000010	0	0	2	0.91629080
1	4.99999810	2.31999990	1	1	3	1.25276290
1	10.99999710	3.19000010	0	0	1	0.40546510
1	19.00000190	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	4.99999810	2.57999990	1	0	2	0.91629080
1	6.99999950	3.21000000	1	1	2	0.91629080
1	3.00000000	1.40000000	0	0	1	0.40546510
1	9.99999900	2.50000000	0	0	4	1.50407740
1	0.00000000	3.19000010	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	0	-0.69314720
1	9.00000000	3.15000010	0	0	6	1.87180220
1	6.99999950	1.45000000	1	0	2	0.91629080
1	6.99999950	2.85999990	1	2	1	0.40546510
1	48.99999240	4.61999990	1	1	3	1.25276290
1	1.99999990	3.69000010	1	0	0	-0.69314720
1	19.00000190	2.96000000	1	0	1	0.40546510
1	12.00000000	3.08999990	1	1	1	0.40546510
1	0.99999990	3.08999990	0	0	0	-0.69314720
1	12.00000000	4.61999990	0	0	2	0.91629080
1	13.00000000	2.85999990	1	0	0	-0.69314720
1	1.99999990	3.21000000	0	0	0	-0.69314720
1	3.00000000	2.82999990	1	0	2	0.91629080
1	22.00000000	4.29000000	0	0	1	0.40546510

1	35.00000760	4.29000000	0	0	0	-0.69314720
1	0.99999990	3.08999990	1	0	2	0.91629080
1	3.99999900	3.69000010	0	0	0	-0.69314720
1	0.99999990	1.79000000	1	0	0	-0.69314720
1	1.99999990	3.35999990	1	1	0	-0.69314720
1	13.99999710	2.57999990	1	0	4	1.50407740
1	24.00000190	3.75000000	0	0	1	0.40546510
1	4.99999810	3.19000010	0	0	2	0.91629080
1	0.99999990	2.09999990	0	0	0	-0.69314720
1	7.99999860	3.58999990	1	1	0	-0.69314720
1	0.99999990	3.92000010	0	0	0	-0.69314720
1	24.00000190	3.31999990	1	1	1	0.40546510
1	1.99999990	2.00000000	0	0	0	-0.69314720
1	1.99999990	3.47000000	1	0	0	-0.69314720
1	13.99999710	3.21000000	1	0	4	1.50407740
1	4.99999810	2.05000000	0	0	3	1.25276290
1	0.99999990	2.52000000	0	0	0	-0.69314720
1	6.99999950	3.15000010	1	0	0	-0.69314720
1	38.00000380	1.86000000	1	2	6	1.87180220
1	3.00000000	2.85999990	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	4	1.50407740
1	0.00000000	1.25500000	1	2	0	-0.69314720
1	19.00000190	3.21000000	1	0	5	1.70474800
1	4.99999810	2.31999990	1	1	1	0.40546510
1	3.00000000	3.19000010	0	0	4	1.50407740
1	1.99999990	3.19000010	1	0	1	0.40546510
1	10.99999710	3.35999990	1	0	3	1.25276290
1	13.99999710	3.54000000	1	1	1	0.40546510
1	6.00000050	1.86000000	1	0	0	-0.69314720
1	13.00000000	1.50500000	0	0	0	-0.69314720
1	6.99999950	2.39000010	1	0	1	0.40546510
1	10.99999710	4.29000000	1	1	2	0.91629080
1	9.00000000	2.00000000	1	1	0	-0.69314720
1	3.99999900	3.92000010	0	0	1	0.40546510
1	6.00000050	4.29000000	1	0	2	0.91629080
1	6.00000050	3.35999990	0	0	1	0.40546510
1	13.99999710	4.61999990	1	0	3	1.25276290
1	6.00000050	2.00000000	0	0	1	0.40546510
1	4.99999810	3.58999990	1	0	2	0.91629080
1	6.00000050	2.86999990	0	0	1	0.40546510
1	3.99999900	2.96000000	0	0	0	-0.69314720
1	10.99999710	3.47000000	1	0	0	-0.69314720
1	7.99999860	3.19000010	1	0	4	1.50407740
1	3.00000000	2.85999990	1	1	0	-0.69314720
1	15.99999810	2.52000000	1	0	2	0.91629080
1	6.00000050	4.29000000	0	0	1	0.40546510
1	0.00000000	1.25500000	0	0	1	0.40546510
1	1.99999990	1.83000000	1	0	0	-0.69314720
1	12.00000000	4.29000000	0	0	3	1.25276290
1	7.99999860	2.96000000	1	0	0	-0.69314720
1	0.99999990	2.31999990	1	0	1	0.40546510
1	10.99999710	1.22000000	1	1	0	-0.69314720
1	10.99999710	4.29000000	1	0	1	0.40546510
1	1.99999990	4.25000000	0	0	1	0.40546510
1	36.00000000	2.55000000	0	0	2	0.91629080
1	10.99999710	1.95000000	1	0	1	0.40546510

1	1.99999990	3.69000010	0	0	0	-0.69314720
1	25.00000000	4.29000000	0	0	1	0.40546510
1	4.99999810	3.19000010	1	0	2	0.91629080
1	12.00000000	3.54000000	1	1	4	1.50407740
1	4.99999810	3.54000000	1	0	4	1.50407740
1	7.99999860	3.54000000	1	1	0	-0.69314720
1	0.99999990	1.86000000	1	1	3	1.25276290
1	3.00000000	4.61999990	0	0	4	1.50407740
1	15.99999810	4.61999990	1	0	1	0.40546510
1	9.99999900	4.61999990	1	0	3	1.25276290
1	13.00000000	4.54000000	1	0	1	0.40546510
1	0.99999990	3.47000000	1	0	0	-0.69314720
1	15.99999810	2.85999990	0	0	0	-0.69314720
1	6.99999950	2.00000000	1	0	0	-0.69314720
1	1.99999990	2.00000000	0	0	0	-0.69314720
1	3.00000000	2.60999990	1	0	0	-0.69314720
1	6.00000050	2.05000000	0	0	0	-0.69314720
1	6.00000050	2.05000000	0	0	0	-0.69314720
1	4.99999810	3.54000000	0	0	0	-0.69314720
1	0.00000000	0.92000000	1	0	2	0.91629080
1	0.00000000	1.79000000	1	0	0	-0.69314720
1	6.00000050	2.00000000	1	0	0	-0.69314720
1	7.99999860	3.15000010	0	0	4	1.50407740
1	15.99999810	2.26000000	1	0	5	1.70474800
1	3.99999900	2.26000000	0	0	1	0.40546510
1	0.99999990	4.29000000	1	0	6	1.87180220
1	21.00000000	4.29000000	1	0	1	0.40546510
1	9.00000000	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	1.99999990	2.52000000	0	0	0	-0.69314720
1	9.99999900	4.29000000	0	0	3	1.25276290
1	9.00000000	4.29000000	0	0	0	-0.69314720
1	12.00000000	4.54000000	0	0	2	0.91629080
1	0.00000000	2.50000000	0	0	0	-0.69314720
1	1.99999990	2.76000000	0	0	1	0.40546510
1	0.00000000	2.55000000	1	1	0	-0.69314720
1	0.00000000	4.61999990	1	0	0	-0.69314720
1	6.00000050	1.63000000	0	0	2	0.91629080
1	3.00000000	3.47000000	1	0	1	0.40546510
1	30.99998860	3.41000010	1	0	2	0.91629080
1	0.99999990	4.29000000	0	0	0	-0.69314720
1	6.99999950	2.96000000	1	0	0	-0.69314720
1	0.00000000	4.61999990	1	0	5	1.70474800
1	12.00000000	3.58999990	1	0	0	-0.69314720
1	12.00000000	3.69000010	1	0	3	1.25276290
1	1.99999990	4.54000000	1	0	1	0.40546510
1	10.99999710	3.33999990	0	0	4	1.50407740
1	1.99999990	2.51000000	1	1	4	1.50407740
1	3.99999900	3.15000010	1	0	3	1.25276290
1	3.00000000	3.19000010	1	0	1	0.40546510
1	17.99999810	3.19000010	0	0	1	0.40546510
1	1.99999990	3.84999990	0	0	1	0.40546510
1	3.99999900	3.33999990	1	1	2	0.91629080
1	15.00000100	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	0	0	2	0.91629080
1	21.00000000	4.29000000	0	0	2	0.91629080

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1   3.99999900   4.29000000  1  1  0  -0.69314720
1   0.00000000   2.96000000  1  0  0  -0.69314720
1   0.99999990   1.78000000  1  0  0  -0.69314720
1  17.00000000   3.54000000  1  2  1   0.40546510
1   3.00000000   3.69000010  1  0  0  -0.69314720
1   1.99999990   3.35999990  0  0  3   1.25276290
1   1.99999990   3.54000000  1  0  0  -0.69314720
1   0.99999990   3.54000000  1  1  0  -0.69314720
1   3.00000000   1.22000000  1  1  3   1.25276290
1   3.99999900   3.35999990  0  0  1   0.40546510
1   1.99999990   2.21000000  0  0  1   0.40546510
1   3.99999900   2.25000000  0  0  1   0.40546510
1  17.00000000   4.61999990  1  1  2   0.91629080
1   4.99999810   3.58999990  1  0  1   0.40546510
1   0.99999990   4.29000000  1  0  0  -0.69314720
1   1.99999990   2.11999990  0  0  2   0.91629080
1   3.00000000   2.26000000  0  0  2   0.91629080
1   3.00000000   2.26000000  1  0  4   1.50407740
1   4.99999810   4.29000000  0  0  0  -0.69314720
1   3.00000000   3.58999990  1  1  3   1.25276290
1  13.00000000   4.29000000  1  2  1   0.40546510
1   1.99999990   2.00000000  0  0  1   0.40546510
1   0.00000000   1.97000000  1  2  0  -0.69314720
1   7.99999860   3.92000010  1  0  0  -0.69314720
1  39.00000000   2.85999990  0  0  4   1.50407740
1  26.00000000   2.82999990  0  0  2   0.91629080
1   3.00000000   3.35999990  1  1  3   1.25276290
1  22.99999620   2.55999990  0  0  4   1.50407740
1   7.99999860   1.63000000  0  0  1   0.40546510
1  22.00000000   4.61999990  0  0  3   1.25276290
1   4.99999810   4.61999990  0  0  1   0.40546510
1  21.00000000   4.29000000  1  0  3   1.25276290
1   6.00000050   4.29000000  1  1  0  -0.69314720
1   3.99999900   4.29000000  1  1  2   0.91629080
1  24.00000190   4.29000000  1  0  6   1.87180220
1   6.00000050   4.29000000  1  0  1   0.40546510
1  33.99999240   3.35999990  0  0  1   0.40546510
1   0.00000000   3.21000000  0  0  2   0.91629080
1   9.99999900   2.00000000  0  0  1   0.40546510
1   1.99999990   3.21000000  1  2  2   0.91629080
1   3.00000000   2.57999990  1  2  2   0.91629080
1   3.00000000   2.57999990  1  0  0  -0.69314720
1   0.99999990   2.82999990  0  0  0  -0.69314720
1   6.00000050   3.19000010  0  0  1   0.40546510
1   3.00000000   3.47000000  0  0  1   0.40546510
1  22.99999620   4.61999990  1  0  2   0.91629080
1  13.00000000   4.25000000  1  0  4   1.50407740
1   4.99999810   1.86000000  1  0  2   0.91629080
1   9.00000000   4.29000000  1  1  0  -0.69314720
1   9.00000000   3.35999990  0  0  0  -0.69314720
1   9.99999900   1.80000000  1  0  2   0.91629080
1   0.00000000   1.65500000  0  0  1   0.40546510
1   6.00000050   2.85999990  0  0  0  -0.69314720
1  13.99999710   4.61999990  0  0  2   0.91629080
1   3.00000000   4.29000000  0  0  0  -0.69314720
1   4.99999810   2.35999990  1  0  4   1.50407740
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1  10.99999710   1.80999990  1  0  1   0.40546510
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1   9.99999900   1.76000000  0  0  0  -0.69314720
1   4.99999810   2.00000000  1  0  1   0.40546510
1  13.99999710   3.58999990  0  0  5   1.70474800
1   6.00000050   2.26000000  1  0  3   1.25276290
1   3.99999900   2.26000000  0  0  1   0.40546510
1   3.99999900   1.76000000  1  1  1   0.40546510
1   0.99999990   3.58999990  1  0  1   0.40546510
1   0.99999990   3.58999990  1  0  0  -0.69314720
1   4.99999810   2.82999990  1  1  1   0.40546510
1   1.99999990   2.57999990  0  0  1   0.40546510
1  17.99999810   4.61999990  1  0  1   0.40546510
1  15.00000100   2.31999990  0  0  1   0.40546510
1   0.00000000   2.39000010  1  0  0  -0.69314720
1  22.00000000   2.96000000  1  0  3   1.25276290
1  10.99999710   2.11999990  0  0  0  -0.69314720
1  17.99999810   4.61999990  1  0  1   0.40546510
1   3.00000000   2.25000000  1  0  1   0.40546510
1   7.99999860   1.76000000  1  0  1   0.40546510
1  12.00000000   4.54000000  0  0  6   1.87180220
1   9.99999900   3.69000010  1  1  2   0.91629080
1   1.99999990   1.25000000  0  0  0  -0.69314720
1   4.99999810   1.25000000  1  0  1   0.40546510
1   3.99999900   3.19000010  1  0  0  -0.69314720
1   0.00000000   2.57999990  1  2  0  -0.69314720
1   6.99999950   2.00000000  1  1  2   0.91629080
1   0.99999990   2.76000000  0  0  0  -0.69314720
1   3.99999900   2.54000000  0  0  2   0.91629080
1   0.00000000   3.19000010  0  0  0  -0.69314720
1   9.00000000   3.08999990  1  2  1   0.40546510
1   3.99999900   3.19000010  0  0  2   0.91629080
1   0.00000000   3.08999990  0  0  0  -0.69314720
1   7.99999860   2.26000000  0  0  2   0.91629080
1   9.00000000   2.26000000  1  1  1   0.40546510
1   7.99999860   3.35999990  1  0  2   0.91629080
1   9.00000000   3.15000010  1  0  1   0.40546510
1   3.99999900   4.54000000  1  0  0  -0.69314720
1   0.00000000   3.58999990  1  0  2   0.91629080
1   3.00000000   3.47000000  1  0  1   0.40546510
1   1.99999990   2.85999990  1  1  1   0.40546510
1   6.00000050   2.26000000  1  0  0  -0.69314720
1   3.99999900   3.47000000  1  1  2   0.91629080
1   0.00000000   2.76000000  1  0  0  -0.69314720
1   1.99999990   3.58999990  1  2  0  -0.69314720
1  13.00000000   3.75000000  0  0  5   1.70474800
1   1.99999990   2.57999990  1  2  1   0.40546510
1   1.99999990   3.58999990  1  1  2   0.91629080
1  15.99999810   1.89000000  1  2  3   1.25276290
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1  12.00000000   2.86999990  0  0  5   1.70474800
1   0.99999990   2.11999990  1  2  0  -0.69314720
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1   0.00000000   2.39000010  0  0  0  -0.69314720
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1   4.99999810   1.80999990  1  0  0  -0.69314720
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1   7.99999860   2.31999990  0  0  4   1.50407740
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1   6.00000050   3.75000000  1  0  3   1.25276290
1   0.00000000   2.00000000  0  0  0  -0.69314720
1  13.99999710   3.58999990  1  1  0  -0.69314720
1   4.99999810   4.29000000  0  0  2   0.91629080
1   0.00000000   2.57999990  1  0  0  -0.69314720
1   4.99999810   4.61999990  1  0  0  -0.69314720
1   3.00000000   1.50500000  0  0  0  -0.69314720
1   3.99999900   3.75000000  1  0  2   0.91629080
1   3.99999900   3.75000000  1  2  0  -0.69314720
1   0.00000000   1.75000000  1  0  1   0.40546510
1   0.00000000   2.11999990  1  0  1   0.40546510
1   4.99999810   3.75000000  0  0  2   0.91629080
1   0.00000000   0.75500000  0  0  0  -0.69314720
1   6.99999950   2.25000000  0  0  1   0.40546510
1   3.00000000   3.19000010  0  0  1   0.40546510
;
```

Click **Run** to create the Work.Long97Data table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-Sectional Data Models** to add the step to your flow.

3 Add the Work.Long97Data table to your flow and connect it to the Cross-Sectional Data Models node. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

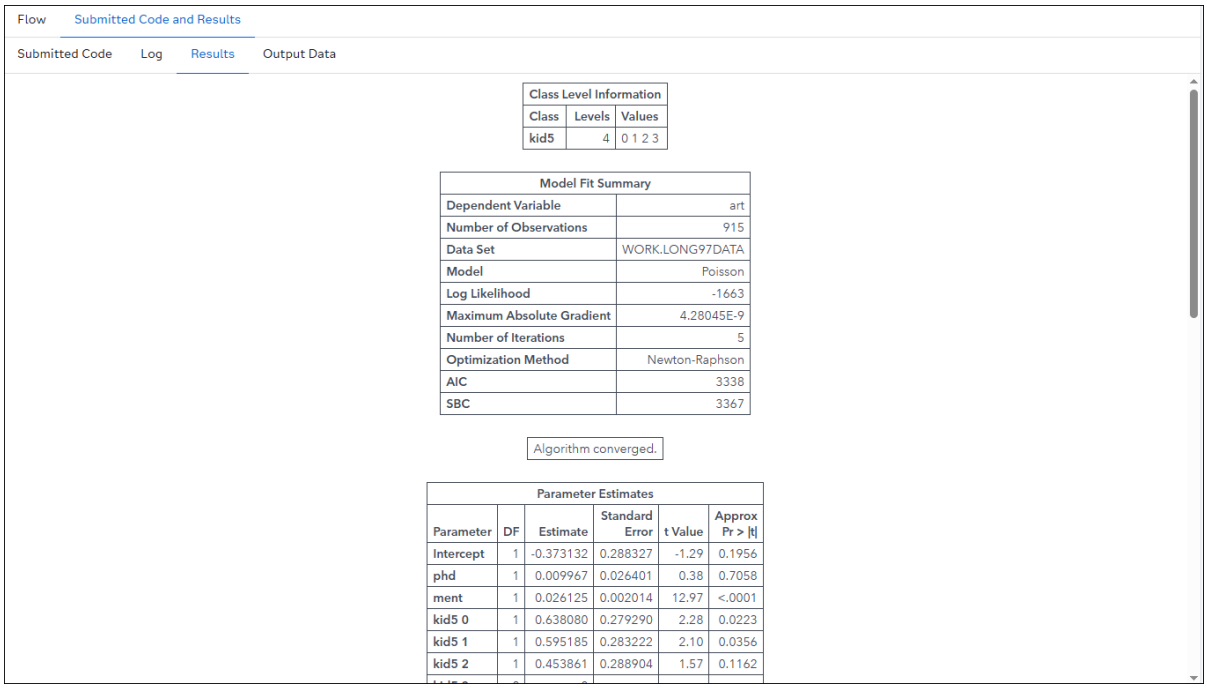
5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **art**.
- To the **Continuous variables** role, assign **ment** and **phd**.
- To the **Categorical variables** role, assign **kid5**.

6 On the **Model** tab, select **Poisson** as the model type.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Poisson Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric column that contains the count values. In the input data set, this variable must contain only nonnegative integer values.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the Poisson model.

1 From the **Model type** drop-down list, select **Poisson**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available:

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Specify the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

4 Select the statistics to be displayed in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of the parameter estimates
- (SAS Compute Server) iteration history of the objective function and parameter estimates

5 Select the plots to include in the results.

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- a table that contains the default statistics from the analysis and any selected statistics such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor. If you are running the step on a CAS server, you must specify a CAS engine libref when naming the table.
- a table of parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Negative Binomial Models

Example: Negative Binomial Model

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data long97data;
   input fem ment phd mar kid5 art lnart;
datalines;
0   7.99999860   1.38000000  1  2  3   1.25276290
0   6.99999950   4.29000000  0  0  0  -0.69314720
0  47.00000760   3.84999990  0  0  4   1.50407740
0  19.00000190   3.58999990  1  1  1   0.40546510
0   0.00000000   1.80999990  1  0  1   0.40546510
0   6.00000050   3.58999990  1  1  1   0.40546510
0   9.99999900   2.11999990  1  1  0  -0.69314720
0   1.99999990   4.29000000  1  0  0  -0.69314720
0   1.99999990   2.57999990  1  2  3   1.25276290
0   3.99999900   1.80000000  1  1  3   1.25276290
0   0.00000000   4.29000000  1  2  1   0.40546510
0   3.00000000   2.76000000  1  1  0  -0.69314720
0   9.99999900   3.41000010  1  1  1   0.40546510
0   6.99999950   4.34000020  1  3  2   0.91629080
0  15.00000100   3.84999990  1  2  5   1.70474800
0   1.99999990   2.09999990  1  0  2   0.91629080
0  13.00000000   4.29000000  1  0  2   0.91629080
0  15.00000100   4.29000000  0  0  1   0.40546510
0   4.99999810   2.26000000  1  1  0  -0.69314720
0   6.00000050   2.09999990  0  0  0  -0.69314720
0  12.00000000   2.26000000  1  0  3   1.25276290
0  15.99999810   3.84999990  1  1  6   1.87180220
0   6.99999950   4.29000000  0  0  4   1.50407740
0   6.00000050   1.80000000  1  2  2   0.91629080
0   1.99999990   2.26000000  0  0  2   0.91629080
```

```
0   0.00000000   2.09999990  0  0  0  -0.69314720
0  30.00000190   4.29000000  1  0  4   1.50407740
0   9.99999900   4.29000000  1  2  1   0.40546510
0   1.99999990   2.09999990  1  0  1   0.40546510
0   0.99999990   3.58999990  1  0  7   2.01490310
0   3.00000000   3.42000010  1  1  2   0.91629080
0   9.99999900   4.29000000  1  2  2   0.91629080
0   9.99999900   4.29000000  0  0  2   0.91629080
0   0.99999990   3.33999990  1  2  0  -0.69314720
0   1.99999990   4.29000000  0  0  0  -0.69314720
0  10.99999710   4.29000000  1  0  1   0.40546510
0   4.99999810   3.61999990  1  0  4   1.50407740
0   0.00000000   4.29000000  1  3  1   0.40546510
0   3.99999900   4.34000020  1  1  1   0.40546510
0   1.99999990   1.25000000  1  1  2   0.91629080
0  19.00000190   4.34000020  0  0  7   2.01490310
0   3.00000000   1.67000000  1  3  1   0.40546510
0   0.00000000   3.47000000  0  0  0  -0.69314720
0   0.99999990   2.26000000  1  1  1   0.40546510
0   0.99999990   1.80000000  1  0  1   0.40546510
0  17.00000000   4.34000020  1  2  2   0.91629080
0   3.00000000   3.58999990  0  0  2   0.91629080
0   0.99999990   1.75000000  1  2  1   0.40546510
0   6.00000050   4.29000000  0  0  1   0.40546510
0   0.00000000   2.09999990  1  1  0  -0.69314720
0  15.00000100   4.29000000  1  2  0  -0.69314720
0   0.00000000   2.09999990  1  1  0  -0.69314720
0  26.99999810   3.31999990  1  2  2   0.91629080
0   4.99999810   4.34000020  1  0  2   0.91629080
0   6.99999950   3.41000010  0  0  4   1.50407740
0   0.00000000   4.29000000  1  0  1   0.40546510
0  10.99999710   3.19000010  1  0  2   0.91629080
0  13.00000000   4.29000000  1  0  2   0.91629080
0   3.99999900   1.74000000  1  2  1   0.40546510
0   3.99999900   2.76000000  0  0  1   0.40546510
0  26.99999810   3.58999990  1  1  7   2.01490310
0   9.99999900   1.80999990  1  0  4   1.50407740
0  13.00000000   4.29000000  1  1  2   0.91629080
0   0.99999990   4.29000000  1  1  1   0.40546510
0   6.00000050   2.76000000  0  0  1   0.40546510
0   6.00000050   3.47000000  0  0  6   1.87180220
0   4.99999810   2.50000000  1  2  2   0.91629080
0   1.99999990   1.25000000  1  0  5   1.70474800
0  13.99999710   3.58999990  1  1  3   1.25276290
0   0.00000000   2.09999990  1  1  0  -0.69314720
0  12.00000000   3.58999990  1  0  1   0.40546510
0   6.99999950   3.58999990  1  3  0  -0.69314720
0   3.00000000   1.75000000  1  0  1   0.40546510
0   1.99999990   1.75000000  1  2  1   0.40546510
0   1.99999990   3.58999990  1  1  1   0.40546510
0   1.99999990   4.29000000  0  0  1   0.40546510
0   0.00000000   4.29000000  0  0  0  -0.69314720
0   0.00000000   2.09999990  1  1  0  -0.69314720
0   0.00000000   2.60999990  1  0  3   1.25276290
0  30.00000190   4.29000000  1  0  5   1.70474800
0  21.00000000   1.74000000  1  0 16   2.80336050
```

0	4.99999810	2.76000000	1	0	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	7.99999860	2.76000000	1	2	1	0.40546510
0	25.00000000	4.29000000	1	2	3	1.25276290
0	0.00000000	3.47000000	1	1	5	1.70474800
0	4.99999810	2.57999990	1	2	0	-0.69314720
0	0.99999990	2.14000010	1	0	0	-0.69314720
0	4.99999810	2.26000000	0	0	0	-0.69314720
0	0.00000000	4.29000000	1	2	3	1.25276290
0	15.00000100	4.29000000	1	0	3	1.25276290
0	30.00000190	4.29000000	0	0	3	1.25276290
0	1.99999990	2.20000000	1	0	0	-0.69314720
0	6.00000050	1.80000000	1	2	3	1.25276290
0	0.00000000	2.09999990	1	2	1	0.40546510
0	13.00000000	4.29000000	1	1	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	12.00000000	2.09999990	1	1	0	-0.69314720
0	30.00000190	4.29000000	1	2	2	0.91629080
0	4.99999810	1.80999990	1	1	1	0.40546510
0	9.99999900	4.34000020	1	0	1	0.40546510
0	4.99999810	4.29000000	1	1	0	-0.69314720
0	3.99999900	2.50000000	1	2	1	0.40546510
0	13.00000000	2.05000000	1	2	4	1.50407740
0	7.99999860	3.47000000	1	0	3	1.25276290
0	6.00000050	2.60999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	2	1	0.40546510
0	25.00000000	4.29000000	0	0	2	0.91629080
0	1.99999990	4.29000000	1	1	2	0.91629080
0	9.00000000	4.34000020	1	0	6	1.87180220
0	9.99999900	2.11999990	1	1	0	-0.69314720
0	3.00000000	2.76000000	1	0	2	0.91629080
0	1.99999990	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	4.34000020	1	0	5	1.70474800
0	7.99999860	2.76000000	1	1	2	0.91629080
0	9.99999900	3.19000010	1	1	2	0.91629080
0	7.99999860	4.61999990	0	0	3	1.25276290
0	6.00000050	3.15000010	1	2	0	-0.69314720
0	21.00000000	2.55000000	1	1	4	1.50407740
0	3.99999900	1.52000000	1	0	0	-0.69314720
0	1.99999990	1.72000000	1	2	4	1.50407740
0	0.99999990	1.78000000	1	1	2	0.91629080
0	17.00000000	2.85999990	1	1	1	0.40546510
0	30.00000190	4.61999990	1	2	0	-0.69314720
0	4.99999810	4.13999990	0	0	1	0.40546510
0	13.00000000	2.96000000	1	1	6	1.87180220
0	10.99999710	2.55000000	1	0	1	0.40546510
0	19.00000190	2.21000000	1	1	0	-0.69314720
0	4.99999810	3.08999990	1	0	3	1.25276290
0	66.00000760	4.54000000	1	2	4	1.50407740
0	0.00000000	1.78000000	1	0	3	1.25276290
0	3.00000000	2.21000000	1	3	0	-0.69314720
0	3.00000000	2.39000010	1	1	1	0.40546510
0	0.00000000	2.96000000	1	0	0	-0.69314720
0	7.99999860	2.51000000	1	1	0	-0.69314720
0	0.00000000	1.97000000	1	2	2	0.91629080

0	4.99999810	4.13999990	0	0	0	-0.69314720
0	29.00000000	4.25000000	1	1	4	1.50407740
0	10.99999710	2.85999990	1	2	0	-0.69314720
0	22.99999620	2.96000000	1	1	9	2.25129180
0	45.99999240	2.96000000	1	2	2	0.91629080
0	7.99999860	4.61999990	1	1	6	1.87180220
0	4.99999810	3.69000010	1	2	0	-0.69314720
0	0.99999990	3.15000010	1	1	0	-0.69314720
0	9.00000000	4.61999990	0	0	2	0.91629080
0	1.99999990	3.35999990	1	0	0	-0.69314720
0	6.99999950	3.69000010	0	0	4	1.50407740
0	10.99999710	3.54000000	1	0	1	0.40546510
0	56.99999620	2.96000000	1	1	4	1.50407740
0	15.99999810	2.55999990	1	1	1	0.40546510
0	0.00000000	2.31999990	1	0	0	-0.69314720
0	3.00000000	2.31999990	1	0	0	-0.69314720
0	0.99999990	0.92000000	1	2	0	-0.69314720
0	9.99999900	4.54000000	1	0	0	-0.69314720
0	10.99999710	4.54000000	1	3	0	-0.69314720
0	10.99999710	1.76000000	1	1	5	1.70474800
0	15.99999810	2.55999990	0	0	1	0.40546510
0	4.99999810	2.39000010	1	1	0	-0.69314720
0	9.00000000	3.40000010	1	0	2	0.91629080
0	19.99999620	2.86999990	1	2	2	0.91629080
0	21.00000000	4.54000000	1	2	4	1.50407740
0	4.99999810	2.82999990	1	0	4	1.50407740
0	6.00000050	1.67999990	1	0	0	-0.69314720
0	12.00000000	3.54000000	0	0	3	1.25276290
0	0.00000000	1.76000000	1	0	2	0.91629080
0	10.99999710	3.15000010	1	3	1	0.40546510
0	3.00000000	2.51000000	1	0	0	-0.69314720
0	15.99999810	3.69000010	1	1	0	-0.69314720
0	10.99999710	1.76000000	1	1	4	1.50407740
0	4.99999810	1.86000000	1	1	12	2.52572870
0	0.99999990	2.76000000	1	3	0	-0.69314720
0	15.99999810	4.61999990	1	1	1	0.40546510
0	12.00000000	4.25000000	1	0	5	1.70474800
0	10.99999710	2.54000000	1	0	4	1.50407740
0	0.00000000	2.20000000	1	1	0	-0.69314720
0	0.00000000	1.76000000	1	0	2	0.91629080
0	3.00000000	2.85999990	1	3	3	1.25276290
0	13.00000000	3.40000010	1	2	0	-0.69314720
0	45.00000000	4.54000000	1	1	1	0.40546510
0	47.00000760	1.86000000	1	1	9	2.25129180
0	6.99999950	1.52000000	1	0	0	-0.69314720
0	6.99999950	2.55999990	1	1	2	0.91629080
0	19.00000190	2.21000000	1	0	0	-0.69314720
0	9.00000000	3.69000010	1	0	7	2.01490310
0	76.99998470	1.78000000	1	1	1	0.40546510
0	0.00000000	1.17999990	1	1	0	-0.69314720
0	3.99999900	2.00000000	1	0	1	0.40546510
0	19.00000190	2.21000000	1	0	0	-0.69314720
0	12.00000000	4.13999990	1	2	0	-0.69314720
0	0.99999990	2.85999990	1	3	0	-0.69314720
0	17.00000000	2.85999990	1	1	1	0.40546510
0	6.00000050	2.54000000	0	0	7	2.01490310

0	3.99999900	2.85999990	1	1	0	-0.69314720
0	6.00000050	2.52000000	0	0	4	1.50407740
0	3.00000000	1.52000000	1	1	2	0.91629080
0	4.99999810	3.08999990	1	1	3	1.25276290
0	3.00000000	1.17999990	1	1	0	-0.69314720
0	3.00000000	1.42000000	1	0	0	-0.69314720
0	15.00000100	4.61999990	0	0	7	2.01490310
0	0.00000000	2.96000000	1	2	1	0.40546510
0	9.99999900	4.54000000	0	0	2	0.91629080
0	41.99999620	4.54000000	0	0	7	2.01490310
0	3.00000000	2.51000000	1	2	1	0.40546510
0	6.99999950	3.15000010	1	1	2	0.91629080
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	2.96000000	1	3	1	0.40546510
0	3.99999900	1.67999990	1	0	0	-0.69314720
0	0.00000000	1.22000000	1	1	1	0.40546510
0	1.99999990	1.52000000	1	0	1	0.40546510
0	4.99999810	2.21000000	1	1	0	-0.69314720
0	0.99999990	3.92000010	1	1	0	-0.69314720
0	13.00000000	4.54000000	1	0	5	1.70474800
0	0.00000000	1.17999990	1	0	2	0.91629080
0	26.00000000	3.69000010	1	0	3	1.25276290
0	0.99999990	1.72000000	1	0	2	0.91629080
0	25.00000000	2.57999990	1	1	5	1.70474800
0	3.00000000	1.52000000	0	0	3	1.25276290
0	47.00000760	1.86000000	1	1	4	1.50407740
0	3.99999900	2.50000000	1	0	5	1.70474800
0	0.99999990	4.61999990	1	0	1	0.40546510
0	6.99999950	1.40000000	1	2	0	-0.69314720
0	4.99999810	4.54000000	1	0	3	1.25276290
0	26.99999810	1.67999990	1	1	0	-0.69314720
0	0.99999990	2.82999990	1	0	2	0.91629080
0	4.99999810	3.35999990	0	0	1	0.40546510
0	0.00000000	1.97000000	1	1	7	2.01490310
0	12.00000000	3.40000010	0	0	1	0.40546510
0	3.99999900	1.74000000	1	1	1	0.40546510
0	0.00000000	2.96000000	0	0	0	-0.69314720
0	25.00000000	2.57999990	1	1	4	1.50407740
0	3.00000000	4.54000000	1	1	1	0.40546510
0	1.99999990	3.15000010	1	1	0	-0.69314720
0	12.00000000	2.96000000	1	2	0	-0.69314720
0	15.99999810	3.54000000	1	2	2	0.91629080
0	4.99999810	2.96000000	1	1	3	1.25276290
0	12.00000000	4.25000000	1	0	1	0.40546510
0	4.99999810	2.55999990	1	1	2	0.91629080
0	4.99999810	1.86000000	1	0	1	0.40546510
0	3.00000000	4.61999990	1	1	1	0.40546510
0	3.99999900	2.85999990	0	0	2	0.91629080
0	4.99999810	3.15000010	1	1	5	1.70474800
0	0.00000000	2.51000000	1	0	2	0.91629080
0	26.99999810	3.15000010	1	1	5	1.70474800
0	4.99999810	2.51000000	1	0	2	0.91629080
0	0.00000000	1.52000000	1	1	0	-0.69314720
0	17.99999810	4.29000000	0	0	6	1.87180220
0	4.99999810	4.29000000	1	1	4	1.50407740
0	7.99999860	4.29000000	1	2	2	0.91629080

```
0   3.99999900   2.09999990  1  0  2   0.91629080
0  35.00000760   4.29000000  1  1 12   2.52572870
0   4.99999810   4.29000000  0  0  2   0.91629080
0   9.00000000   3.58999990  1  1  1   0.40546510
0   6.00000050   4.29000000  1  0  1   0.40546510
0  24.00000190   4.29000000  1  0  2   0.91629080
0   0.00000000   2.09999990  1  1  0  -0.69314720
0   4.99999810   1.80999990  1  1  0  -0.69314720
0  19.00000190   4.29000000  0  0  7   2.01490310
0   3.00000000   4.29000000  0  0  1   0.40546510
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0   7.99999860   2.09999990  1  1  1   0.40546510
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0  21.00000000   3.58999990  1  1  5   1.70474800
0  13.99999710   4.29000000  1  1  1   0.40546510
0   0.00000000   2.09999990  1  0  0  -0.69314720
0   6.99999950   2.76000000  1  1  1   0.40546510
0   4.99999810   2.60999990  1  0  3   1.25276290
0  22.00000000   4.29000000  1  0  4   1.50407740
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0  15.99999810   3.58999990  0  0  3   1.25276290
0   1.99999990   4.29000000  1  1  0  -0.69314720
0   3.00000000   2.05000000  0  0  1   0.40546510
0  12.00000000   4.29000000  1  2  1   0.40546510
0  35.00000760   4.29000000  0  0  0  -0.69314720
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0   1.99999990   4.29000000  0  0  0  -0.69314720
0   6.99999950   2.76000000  0  0  1   0.40546510
0   3.99999900   2.09999990  1  2  3   1.25276290
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0   9.00000000   4.29000000  0  0  0  -0.69314720
0   7.99999860   3.58999990  0  0  0  -0.69314720
0  12.00000000   4.29000000  1  1  2   0.91629080
0   3.00000000   4.29000000  1  1  0  -0.69314720
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0  21.00000000   3.41000010  0  0  4   1.50407740
0  13.00000000   4.29000000  1  1  0  -0.69314720
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0   4.99999810   4.29000000  0  0  0  -0.69314720
0   1.99999990   2.14000010  0  0  0  -0.69314720
0   7.99999860   4.29000000  1  0  0  -0.69314720
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0	17.00000000	4.29000000	0	0	2	0.91629080
0	24.00000190	4.29000000	1	2	0	-0.69314720
0	3.99999900	3.47000000	1	0	4	1.50407740
0	13.99999710	4.29000000	1	1	2	0.91629080
0	4.99999810	3.58999990	1	1	1	0.40546510
0	9.99999900	1.80999990	0	0	1	0.40546510
0	17.99999810	4.29000000	1	1	3	1.25276290
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0	7.99999860	4.29000000	1	0	0	-0.69314720
0	0.99999990	2.26000000	1	0	1	0.40546510
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	13.00000000	4.29000000	1	2	0	-0.69314720
0	4.99999810	3.58999990	1	2	0	-0.69314720
0	6.99999950	3.41000010	1	2	0	-0.69314720
0	6.99999950	3.58999990	0	0	3	1.25276290
0	4.99999810	3.61999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	3	1	0.40546510
0	13.99999710	4.29000000	0	0	1	0.40546510
0	6.00000050	4.29000000	1	0	0	-0.69314720
0	4.99999810	2.26000000	1	1	1	0.40546510
0	7.99999860	2.76000000	1	0	3	1.25276290
0	3.99999900	2.60999990	1	1	1	0.40546510
0	9.00000000	4.29000000	0	0	2	0.91629080
0	3.00000000	2.09999990	1	1	2	0.91629080
0	1.99999990	3.47000000	1	1	0	-0.69314720
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0	9.00000000	4.29000000	0	0	1	0.40546510
0	7.99999860	2.96000000	1	0	1	0.40546510
0	1.99999990	2.96000000	1	0	2	0.91629080
0	17.99999810	4.61999990	1	0	3	1.25276290
0	3.00000000	1.42000000	1	0	3	1.25276290
0	1.99999990	4.54000000	1	0	1	0.40546510
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0	9.99999900	4.54000000	1	1	2	0.91629080
0	15.99999810	2.00000000	1	1	1	0.40546510
0	4.99999810	2.54000000	1	0	0	-0.69314720
0	0.00000000	2.50000000	1	0	2	0.91629080
0	7.99999860	4.54000000	0	0	0	-0.69314720
0	9.99999900	3.35999990	0	0	1	0.40546510
0	17.99999810	3.40000010	1	1	0	-0.69314720
0	12.00000000	1.67999990	1	1	1	0.40546510
0	9.00000000	2.00000000	0	0	1	0.40546510
0	39.00000000	2.85999990	1	0	1	0.40546510
0	17.99999810	4.61999990	1	0	1	0.40546510
0	15.00000100	4.13999990	1	0	1	0.40546510
0	15.99999810	4.13999990	1	0	2	0.91629080
0	1.99999990	2.96000000	0	0	0	-0.69314720
0	6.99999950	2.82999990	1	2	3	1.25276290
0	24.00000190	2.55000000	1	0	2	0.91629080
0	7.99999860	1.67999990	1	0	1	0.40546510

0	6.99999950	2.00000000	0	0	1	0.40546510
0	10.99999710	2.00000000	1	1	1	0.40546510
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0	3.99999900	1.50500000	1	0	4	1.50407740
0	21.00000000	3.54000000	1	0	2	0.91629080
0	6.00000050	3.40000010	0	0	1	0.40546510
0	6.00000050	4.61999990	0	0	0	-0.69314720
0	7.99999860	2.82999990	0	0	3	1.25276290
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0	12.00000000	2.86999990	0	0	1	0.40546510
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0	4.99999810	3.69000010	1	1	1	0.40546510
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0	13.00000000	2.85999990	1	1	0	-0.69314720
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0	19.99999620	4.25000000	1	0	3	1.25276290
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0	15.99999810	3.69000010	1	2	4	1.50407740
0	13.00000000	3.40000010	1	0	0	-0.69314720
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0	22.99999620	3.35999990	1	1	0	-0.69314720
0	7.99999860	2.00000000	1	3	2	0.91629080
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0	0.00000000	3.35999990	0	0	1	0.40546510
0	0.99999990	1.78000000	1	0	1	0.40546510
0	21.00000000	3.54000000	1	1	1	0.40546510
0	9.99999900	3.92000010	0	0	2	0.91629080
0	7.99999860	2.31999990	0	0	3	1.25276290
0	33.99999240	1.67999990	1	0	1	0.40546510
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0	13.99999710	3.40000010	0	0	6	1.87180220
0	12.00000000	2.86999990	0	0	3	1.25276290
0	17.99999810	4.61999990	0	0	4	1.50407740
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0	6.00000050	1.86000000	1	2	2	0.91629080
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0	7.99999860	2.96000000	1	0	3	1.25276290
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0	0.99999990	1.22000000	1	1	1	0.40546510
0	7.99999860	2.85999990	1	0	0	-0.69314720
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0	3.99999900	2.31999990	1	0	1	0.40546510
0	3.00000000	4.61999990	1	0	2	0.91629080
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0	24.00000190	3.69000010	1	0	3	1.25276290
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0	15.00000100	1.86000000	1	2	4	1.50407740
0	3.99999900	1.95000000	1	0	2	0.91629080
0	1.99999990	2.31999990	1	2	0	-0.69314720
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0	7.99999860	3.69000010	1	1	0	-0.69314720
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0	9.00000000	3.54000000	1	0	4	1.50407740
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0	25.00000000	3.35999990	1	0	0	-0.69314720

0	3.00000000	2.85999990	0	0	0	-0.69314720
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0	9.99999900	2.21000000	1	1	3	1.25276290
0	6.00000050	2.21000000	1	0	0	-0.69314720
0	36.99999240	4.54000000	1	0	3	1.25276290
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1	7.99999860	3.75000000	0	0	2	0.91629080
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1	21.00000000	3.75000000	0	0	1	0.40546510
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1	0.00000000	3.75000000	1	0	2	0.91629080
1	0.00000000	2.54000000	1	1	0	-0.69314720
1	0.99999990	2.54000000	1	0	0	-0.69314720
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1	0.00000000	1.00500000	0	0	0	-0.69314720
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1	3.00000000	1.40000000	0	0	1	0.40546510
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1	1.99999990	2.09999990	0	0	0	-0.69314720
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1	10.99999710	3.58999990	1	2	2	0.91629080
1	17.99999810	3.58999990	0	0	0	-0.69314720
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1	7.99999860	3.58999990	0	0	1	0.40546510
1	19.00000190	3.41000010	1	0	3	1.25276290
1	3.99999900	3.41000010	1	0	4	1.50407740
1	4.99999810	3.41000010	1	2	0	-0.69314720
1	6.99999950	3.40000010	0	0	1	0.40546510
1	3.99999900	3.40000010	1	1	2	0.91629080
1	4.99999810	3.40000010	1	0	4	1.50407740
1	13.99999710	3.40000010	1	0	1	0.40546510
1	3.99999900	3.40000010	1	0	0	-0.69314720
1	3.99999900	2.52000000	0	0	3	1.25276290
1	0.00000000	2.52000000	0	0	1	0.40546510
1	15.00000100	3.69000010	1	1	2	0.91629080
1	0.99999990	3.69000010	1	0	1	0.40546510
1	3.00000000	3.69000010	1	1	0	-0.69314720
1	17.99999810	3.69000010	0	0	1	0.40546510
1	15.00000100	2.86999990	0	0	0	-0.69314720
1	4.99999810	2.86999990	1	0	1	0.40546510
1	17.99999810	2.86999990	1	0	1	0.40546510
1	9.00000000	2.86999990	0	0	2	0.91629080
1	6.00000050	2.86999990	0	0	4	1.50407740
1	15.00000100	2.86999990	1	0	1	0.40546510
1	3.99999900	3.35999990	0	0	2	0.91629080
1	1.99999990	3.35999990	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	2	0.91629080
1	6.99999950	3.35999990	0	0	0	-0.69314720
1	15.99999810	4.54000000	1	0	4	1.50407740
1	48.00000000	4.54000000	1	2	2	0.91629080
1	15.00000100	4.54000000	1	0	5	1.70474800
1	36.99999240	4.54000000	0	0	1	0.40546510
1	9.99999900	4.54000000	1	0	2	0.91629080
1	13.00000000	4.54000000	0	0	2	0.91629080
1	6.00000050	4.54000000	1	2	0	-0.69314720
1	13.00000000	0.75500000	0	0	0	-0.69314720
1	6.99999950	4.54000000	1	1	2	0.91629080
1	9.00000000	4.54000000	1	0	2	0.91629080
1	4.99999810	4.54000000	0	0	2	0.91629080
1	15.00000100	4.54000000	0	0	6	1.87180220

```
1   3.00000000   4.54000000  0  0  3   1.25276290
1  13.99999710   4.54000000  0  0  0  -0.69314720
1   1.99999990   1.28000000  1  0  1   0.40546510
1   3.99999900   1.28000000  1  0  4   1.50407740
1   3.99999900   1.28000000  1  0  0  -0.69314720
1   0.00000000   2.50000000  1  1  0  -0.69314720
1  47.00000760   3.84999990  1  2  2   0.91629080
1  29.00000000   3.84999990  1  0  1   0.40546510
1   0.99999990   3.84999990  1  1  5   1.70474800
1  17.99999810   3.84999990  0  0  1   0.40546510
1  13.00000000   2.05000000  0  0  1   0.40546510
1  17.00000000   2.05000000  0  0  1   0.40546510
1   1.99999990   2.05000000  0  0  2   0.91629080
1   3.99999900   1.78000000  1  0  4   1.50407740
1   0.99999990   1.17999990  1  0  1   0.40546510
1   3.00000000   1.52000000  1  0  0  -0.69314720
1   9.00000000   1.48000000  1  0  2   0.91629080
1  12.00000000   4.29000000  0  0  0  -0.69314720
1  17.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   4.29000000  0  0  3   1.25276290
1   1.99999990   3.08999990  1  0  2   0.91629080
1   0.00000000   3.08999990  0  0  2   0.91629080
1   3.00000000   3.61999990  0  0  5   1.70474800
1   6.99999950   3.61999990  0  0  0  -0.69314720
1   7.99999860   3.61999990  0  0  0  -0.69314720
1   0.00000000   4.29000000  0  0  0  -0.69314720
1   6.00000050   2.60999990  1  1  1   0.40546510
1   6.99999950   2.60999990  1  0  1   0.40546510
1   9.00000000   2.09999990  0  0  0  -0.69314720
1   7.99999860   2.96000000  1  0  2   0.91629080
1   9.99999900   2.39000010  0  0  0  -0.69314720
1   3.00000000   1.95000000  1  0  1   0.40546510
1  13.99999710   3.41000010  0  0  2   0.91629080
1   0.99999990   4.29000000  0  0  2   0.91629080
1  10.99999710   3.58999990  0  0  2   0.91629080
1   9.99999900   4.61999990  0  0  1   0.40546510
1   6.00000050   2.14000010  0  0  1   0.40546510
1  10.99999710   2.85999990  0  0  0  -0.69314720
1   4.99999810   3.47000000  0  0  2   0.91629080
1  13.99999710   4.61999990  1  1  3   1.25276290
1   9.00000000   3.19000010  1  3  1   0.40546510
1   0.99999990   2.51000000  0  0  1   0.40546510
1   0.00000000   2.11999990  0  0  0  -0.69314720
1   3.00000000   3.19000010  0  0  0  -0.69314720
1   3.99999900   1.74000000  1  1  2   0.91629080
1   0.00000000   1.25000000  1  0  0  -0.69314720
1   6.99999950   3.69000010  1  0  0  -0.69314720
1   4.99999810   3.21000000  0  0  0  -0.69314720
1  15.00000100   4.61999990  1  1  0  -0.69314720
1  24.00000190   2.85999990  1  0  5   1.70474800
1   9.00000000   2.39000010  1  1  1   0.40546510
1   0.00000000   1.17999990  1  0  3   1.25276290
1   6.99999950   3.35999990  0  0  2   0.91629080
1   7.99999860   1.97000000  0  0  2   0.91629080
1  22.00000000   1.64000000  1  0  1   0.40546510
1   6.99999950   3.92000010  1  0  2   0.91629080
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1	6.00000050	3.31999990	0	0	6	1.87180220
1	6.00000050	2.57999990	0	0	5	1.70474800
1	22.99999620	4.54000000	0	0	2	0.91629080
1	1.99999990	2.39000010	1	0	0	-0.69314720
1	9.00000000	3.58999990	0	0	4	1.50407740
1	6.99999950	3.69000010	0	0	2	0.91629080
1	9.99999900	3.19000010	0	0	2	0.91629080
1	3.99999900	2.31999990	0	0	2	0.91629080
1	10.99999710	3.47000000	1	1	2	0.91629080
1	3.99999900	3.69000010	0	0	2	0.91629080
1	4.99999810	2.31999990	1	1	3	1.25276290
1	10.99999710	3.19000010	0	0	1	0.40546510
1	19.00000190	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	4.99999810	2.57999990	1	0	2	0.91629080
1	6.99999950	3.21000000	1	1	2	0.91629080
1	3.00000000	1.40000000	0	0	1	0.40546510
1	9.99999900	2.50000000	0	0	4	1.50407740
1	0.00000000	3.19000010	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	0	-0.69314720
1	9.00000000	3.15000010	0	0	6	1.87180220
1	6.99999950	1.45000000	1	0	2	0.91629080
1	6.99999950	2.85999990	1	2	1	0.40546510
1	48.99999240	4.61999990	1	1	3	1.25276290
1	1.99999990	3.69000010	1	0	0	-0.69314720
1	19.00000190	2.96000000	1	0	1	0.40546510
1	12.00000000	3.08999990	1	1	1	0.40546510
1	0.99999990	3.08999990	0	0	0	-0.69314720
1	12.00000000	4.61999990	0	0	2	0.91629080
1	13.00000000	2.85999990	1	0	0	-0.69314720
1	1.99999990	3.21000000	0	0	0	-0.69314720
1	3.00000000	2.82999990	1	0	2	0.91629080
1	22.00000000	4.29000000	0	0	1	0.40546510
1	35.00000760	4.29000000	0	0	0	-0.69314720
1	0.99999990	3.08999990	1	0	2	0.91629080
1	3.99999900	3.69000010	0	0	0	-0.69314720
1	0.99999990	1.79000000	1	0	0	-0.69314720
1	1.99999990	3.35999990	1	1	0	-0.69314720
1	13.99999710	2.57999990	1	0	4	1.50407740
1	24.00000190	3.75000000	0	0	1	0.40546510
1	4.99999810	3.19000010	0	0	2	0.91629080
1	0.99999990	2.09999990	0	0	0	-0.69314720
1	7.99999860	3.58999990	1	1	0	-0.69314720
1	0.99999990	3.92000010	0	0	0	-0.69314720
1	24.00000190	3.31999990	1	1	1	0.40546510
1	1.99999990	2.00000000	0	0	0	-0.69314720
1	1.99999990	3.47000000	1	0	0	-0.69314720
1	13.99999710	3.21000000	1	0	4	1.50407740
1	4.99999810	2.05000000	0	0	3	1.25276290
1	0.99999990	2.52000000	0	0	0	-0.69314720
1	6.99999950	3.15000010	1	0	0	-0.69314720
1	38.00000380	1.86000000	1	2	6	1.87180220
1	3.00000000	2.85999990	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	4	1.50407740
1	0.00000000	1.25500000	1	2	0	-0.69314720
1	19.00000190	3.21000000	1	0	5	1.70474800

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1   4.99999810   2.31999990  1  1  1   0.40546510
1   3.00000000   3.19000010  0  0  4   1.50407740
1   1.99999990   3.19000010  1  0  1   0.40546510
1  10.99999710   3.35999990  1  0  3   1.25276290
1  13.99999710   3.54000000  1  1  1   0.40546510
1   6.00000050   1.86000000  1  0  0  -0.69314720
1  13.00000000   1.50500000  0  0  0  -0.69314720
1   6.99999950   2.39000010  1  0  1   0.40546510
1  10.99999710   4.29000000  1  1  2   0.91629080
1   9.00000000   2.00000000  1  1  0  -0.69314720
1   3.99999900   3.92000010  0  0  1   0.40546510
1   6.00000050   4.29000000  1  0  2   0.91629080
1   6.00000050   3.35999990  0  0  1   0.40546510
1  13.99999710   4.61999990  1  0  3   1.25276290
1   6.00000050   2.00000000  0  0  1   0.40546510
1   4.99999810   3.58999990  1  0  2   0.91629080
1   6.00000050   2.86999990  0  0  1   0.40546510
1   3.99999900   2.96000000  0  0  0  -0.69314720
1  10.99999710   3.47000000  1  0  0  -0.69314720
1   7.99999860   3.19000010  1  0  4   1.50407740
1   3.00000000   2.85999990  1  1  0  -0.69314720
1  15.99999810   2.52000000  1  0  2   0.91629080
1   6.00000050   4.29000000  0  0  1   0.40546510
1   0.00000000   1.25500000  0  0  1   0.40546510
1   1.99999990   1.83000000  1  0  0  -0.69314720
1  12.00000000   4.29000000  0  0  3   1.25276290
1   7.99999860   2.96000000  1  0  0  -0.69314720
1   0.99999990   2.31999990  1  0  1   0.40546510
1  10.99999710   1.22000000  1  1  0  -0.69314720
1  10.99999710   4.29000000  1  0  1   0.40546510
1   1.99999990   4.25000000  0  0  1   0.40546510
1  36.00000000   2.55000000  0  0  2   0.91629080
1  10.99999710   1.95000000  1  0  1   0.40546510
1   1.99999990   3.69000010  0  0  0  -0.69314720
1  25.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   3.19000010  1  0  2   0.91629080
1  12.00000000   3.54000000  1  1  4   1.50407740
1   4.99999810   3.54000000  1  0  4   1.50407740
1   7.99999860   3.54000000  1  1  0  -0.69314720
1   0.99999990   1.86000000  1  1  3   1.25276290
1   3.00000000   4.61999990  0  0  4   1.50407740
1  15.99999810   4.61999990  1  0  1   0.40546510
1   9.99999900   4.61999990  1  0  3   1.25276290
1  13.00000000   4.54000000  1  0  1   0.40546510
1   0.99999990   3.47000000  1  0  0  -0.69314720
1  15.99999810   2.85999990  0  0  0  -0.69314720
1   6.99999950   2.00000000  1  0  0  -0.69314720
1   1.99999990   2.00000000  0  0  0  -0.69314720
1   3.00000000   2.60999990  1  0  0  -0.69314720
1   6.00000050   2.05000000  0  0  0  -0.69314720
1   6.00000050   2.05000000  0  0  0  -0.69314720
1   4.99999810   3.54000000  0  0  0  -0.69314720
1   0.00000000   0.92000000  1  0  2   0.91629080
1   0.00000000   1.79000000  1  0  0  -0.69314720
1   6.00000050   2.00000000  1  0  0  -0.69314720
1   7.99999860   3.15000010  0  0  4   1.50407740
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1	15.99999810	2.26000000	1	0	5	1.70474800
1	3.99999900	2.26000000	0	0	1	0.40546510
1	0.99999990	4.29000000	1	0	6	1.87180220
1	21.00000000	4.29000000	1	0	1	0.40546510
1	9.00000000	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	1.99999990	2.52000000	0	0	0	-0.69314720
1	9.99999900	4.29000000	0	0	3	1.25276290
1	9.00000000	4.29000000	0	0	0	-0.69314720
1	12.00000000	4.54000000	0	0	2	0.91629080
1	0.00000000	2.50000000	0	0	0	-0.69314720
1	1.99999990	2.76000000	0	0	1	0.40546510
1	0.00000000	2.55000000	1	1	0	-0.69314720
1	0.00000000	4.61999990	1	0	0	-0.69314720
1	6.00000050	1.63000000	0	0	2	0.91629080
1	3.00000000	3.47000000	1	0	1	0.40546510
1	30.99998860	3.41000010	1	0	2	0.91629080
1	0.99999990	4.29000000	0	0	0	-0.69314720
1	6.99999950	2.96000000	1	0	0	-0.69314720
1	0.00000000	4.61999990	1	0	5	1.70474800
1	12.00000000	3.58999990	1	0	0	-0.69314720
1	12.00000000	3.69000010	1	0	3	1.25276290
1	1.99999990	4.54000000	1	0	1	0.40546510
1	10.99999710	3.33999990	0	0	4	1.50407740
1	1.99999990	2.51000000	1	1	4	1.50407740
1	3.99999900	3.15000010	1	0	3	1.25276290
1	3.00000000	3.19000010	1	0	1	0.40546510
1	17.99999810	3.19000010	0	0	1	0.40546510
1	1.99999990	3.84999990	0	0	1	0.40546510
1	3.99999900	3.33999990	1	1	2	0.91629080
1	15.00000100	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	0	0	2	0.91629080
1	21.00000000	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	0	-0.69314720
1	0.00000000	2.96000000	1	0	0	-0.69314720
1	0.99999990	1.78000000	1	0	0	-0.69314720
1	17.00000000	3.54000000	1	2	1	0.40546510
1	3.00000000	3.69000010	1	0	0	-0.69314720
1	1.99999990	3.35999990	0	0	3	1.25276290
1	1.99999990	3.54000000	1	0	0	-0.69314720
1	0.99999990	3.54000000	1	1	0	-0.69314720
1	3.00000000	1.22000000	1	1	3	1.25276290
1	3.99999900	3.35999990	0	0	1	0.40546510
1	1.99999990	2.21000000	0	0	1	0.40546510
1	3.99999900	2.25000000	0	0	1	0.40546510
1	17.00000000	4.61999990	1	1	2	0.91629080
1	4.99999810	3.58999990	1	0	1	0.40546510
1	0.99999990	4.29000000	1	0	0	-0.69314720
1	1.99999990	2.11999990	0	0	2	0.91629080
1	3.00000000	2.26000000	0	0	2	0.91629080
1	3.00000000	2.26000000	1	0	4	1.50407740
1	4.99999810	4.29000000	0	0	0	-0.69314720
1	3.00000000	3.58999990	1	1	3	1.25276290
1	13.00000000	4.29000000	1	2	1	0.40546510
1	1.99999990	2.00000000	0	0	1	0.40546510
1	0.00000000	1.97000000	1	2	0	-0.69314720

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1   7.99999860   3.92000010  1  0  0  -0.69314720
1  39.00000000   2.85999990  0  0  4   1.50407740
1  26.00000000   2.82999990  0  0  2   0.91629080
1   3.00000000   3.35999990  1  1  3   1.25276290
1  22.99999620   2.55999990  0  0  4   1.50407740
1   7.99999860   1.63000000  0  0  1   0.40546510
1  22.00000000   4.61999990  0  0  3   1.25276290
1   4.99999810   4.61999990  0  0  1   0.40546510
1  21.00000000   4.29000000  1  0  3   1.25276290
1   6.00000050   4.29000000  1  1  0  -0.69314720
1   3.99999900   4.29000000  1  1  2   0.91629080
1  24.00000190   4.29000000  1  0  6   1.87180220
1   6.00000050   4.29000000  1  0  1   0.40546510
1  33.99999240   3.35999990  0  0  1   0.40546510
1   0.00000000   3.21000000  0  0  2   0.91629080
1   9.99999900   2.00000000  0  0  1   0.40546510
1   1.99999990   3.21000000  1  2  2   0.91629080
1   3.00000000   2.57999990  1  2  2   0.91629080
1   3.00000000   2.57999990  1  0  0  -0.69314720
1   0.99999990   2.82999990  0  0  0  -0.69314720
1   6.00000050   3.19000010  0  0  1   0.40546510
1   3.00000000   3.47000000  0  0  1   0.40546510
1  22.99999620   4.61999990  1  0  2   0.91629080
1  13.00000000   4.25000000  1  0  4   1.50407740
1   4.99999810   1.86000000  1  0  2   0.91629080
1   9.00000000   4.29000000  1  1  0  -0.69314720
1   9.00000000   3.35999990  0  0  0  -0.69314720
1   9.99999900   1.80000000  1  0  2   0.91629080
1   0.00000000   1.65500000  0  0  1   0.40546510
1   6.00000050   2.85999990  0  0  0  -0.69314720
1  13.99999710   4.61999990  0  0  2   0.91629080
1   3.00000000   4.29000000  0  0  0  -0.69314720
1   4.99999810   2.35999990  1  0  4   1.50407740
1  10.99999710   1.80999990  1  0  1   0.40546510
1  32.00001140   3.58999990  1  0  1   0.40546510
1   9.99999900   1.76000000  0  0  0  -0.69314720
1   4.99999810   2.00000000  1  0  1   0.40546510
1  13.99999710   3.58999990  0  0  5   1.70474800
1   6.00000050   2.26000000  1  0  3   1.25276290
1   3.99999900   2.26000000  0  0  1   0.40546510
1   3.99999900   1.76000000  1  1  1   0.40546510
1   0.99999990   3.58999990  1  0  1   0.40546510
1   0.99999990   3.58999990  1  0  0  -0.69314720
1   4.99999810   2.82999990  1  1  1   0.40546510
1   1.99999990   2.57999990  0  0  1   0.40546510
1  17.99999810   4.61999990  1  0  1   0.40546510
1  15.00000100   2.31999990  0  0  1   0.40546510
1   0.00000000   2.39000010  1  0  0  -0.69314720
1  22.00000000   2.96000000  1  0  3   1.25276290
1  10.99999710   2.11999990  0  0  0  -0.69314720
1  17.99999810   4.61999990  1  0  1   0.40546510
1   3.00000000   2.25000000  1  0  1   0.40546510
1   7.99999860   1.76000000  1  0  1   0.40546510
1  12.00000000   4.54000000  0  0  6   1.87180220
1   9.99999900   3.69000010  1  1  2   0.91629080
1   1.99999990   1.25000000  0  0  0  -0.69314720
```

```
1   4.99999810   1.25000000  1  0  1   0.40546510
1   3.99999900   3.19000010  1  0  0  -0.69314720
1   0.00000000   2.57999990  1  2  0  -0.69314720
1   6.99999950   2.00000000  1  1  2   0.91629080
1   0.99999990   2.76000000  0  0  0  -0.69314720
1   3.99999900   2.54000000  0  0  2   0.91629080
1   0.00000000   3.19000010  0  0  0  -0.69314720
1   9.00000000   3.08999990  1  2  1   0.40546510
1   3.99999900   3.19000010  0  0  2   0.91629080
1   0.00000000   3.08999990  0  0  0  -0.69314720
1   7.99999860   2.26000000  0  0  2   0.91629080
1   9.00000000   2.26000000  1  1  1   0.40546510
1   7.99999860   3.35999990  1  0  2   0.91629080
1   9.00000000   3.15000010  1  0  1   0.40546510
1   3.99999900   4.54000000  1  0  0  -0.69314720
1   0.00000000   3.58999990  1  0  2   0.91629080
1   3.00000000   3.47000000  1  0  1   0.40546510
1   1.99999990   2.85999990  1  1  1   0.40546510
1   6.00000050   2.26000000  1  0  0  -0.69314720
1   3.99999900   3.47000000  1  1  2   0.91629080
1   0.00000000   2.76000000  1  0  0  -0.69314720
1   1.99999990   3.58999990  1  2  0  -0.69314720
1  13.00000000   3.75000000  0  0  5   1.70474800
1   1.99999990   2.57999990  1  2  1   0.40546510
1   1.99999990   3.58999990  1  1  2   0.91629080
1  15.99999810   1.89000000  1  2  3   1.25276290
1   9.00000000   3.15000010  0  0  7   2.01490310
1  12.00000000   2.86999990  0  0  5   1.70474800
1   0.99999990   2.11999990  1  2  0  -0.69314720
1   3.99999900   4.61999990  1  0  1   0.40546510
1   0.00000000   2.39000010  0  0  0  -0.69314720
1  10.99999710   2.11999990  0  0  0  -0.69314720
1   4.99999810   1.80999990  1  0  0  -0.69314720
1   7.99999860   2.31999990  0  0  4   1.50407740
1  15.00000100   2.39000010  0  0  0  -0.69314720
1   6.00000050   3.75000000  1  0  3   1.25276290
1   0.00000000   2.00000000  0  0  0  -0.69314720
1  13.99999710   3.58999990  1  1  0  -0.69314720
1   4.99999810   4.29000000  0  0  2   0.91629080
1   0.00000000   2.57999990  1  0  0  -0.69314720
1   4.99999810   4.61999990  1  0  0  -0.69314720
1   3.00000000   1.50500000  0  0  0  -0.69314720
1   3.99999900   3.75000000  1  0  2   0.91629080
1   3.99999900   3.75000000  1  2  0  -0.69314720
1   0.00000000   1.75000000  1  0  1   0.40546510
1   0.00000000   2.11999990  1  0  1   0.40546510
1   4.99999810   3.75000000  0  0  2   0.91629080
1   0.00000000   0.75500000  0  0  0  -0.69314720
1   6.99999950   2.25000000  0  0  1   0.40546510
1   3.00000000   3.19000010  0  0  1   0.40546510
;
```

Click **Run** to create the Work.Long97Data table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-Sectional Data Models** to add the step to your flow.

3 Add the Work.Long97Data table to your flow and connect it to the Cross-Sectional Data Models node. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

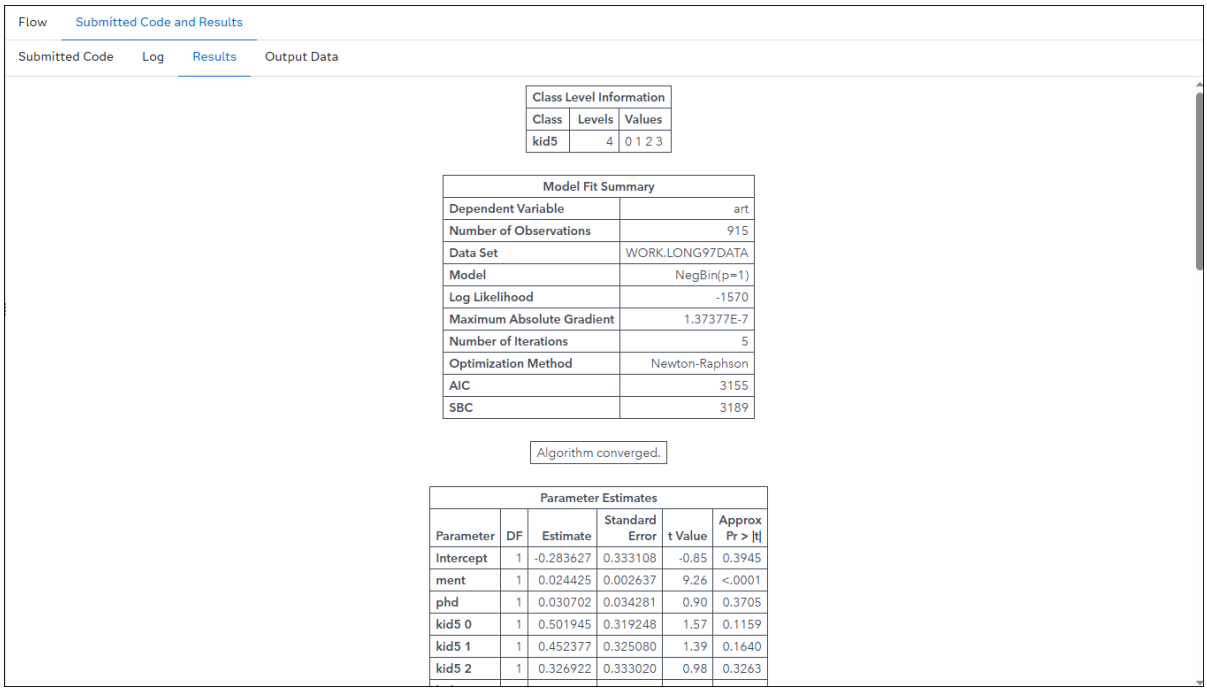
5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **art**.
- To the **Continuous variables** role, assign **ment** and **phd**.
- To the **Categorical variables** role, assign **kid5**.

6 On the **Model** tab, select **Negative binomial** as the model type.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Negative Binomial Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric column that contains the count values. In the input data set, this variable must contain only nonnegative integer values.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the negative binomial model. This step supports both the negative binomial model with linear variance model and the negative binomial with quadratic model.

1 From the **Model type** drop-down list, select **Negative binomial**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Specify the model settings.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available:

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Specify the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

4 Select the statistics to be displayed in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of the parameter estimates
- (SAS Compute Server) iteration history of the objective function and parameter estimates

5 Select the plots to include in the results.

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- a table that contains the default statistics from the analysis and any selected statistics such as the probability of the dependent variable taking the current value and the linear predictor. When naming this table, you must specify a CAS engine libref.
- a table of parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Censored Regression Models

Example: Censored Regression

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data cigar;
   input state year price pop pop_16 cpi ndi sales pimin;
   label
   state  = 'State abbreviation'
   year   = 'YEAR'
   price  = 'Price per pack of cigarettes'
   pop    = 'Population'
   pop_16 = 'Population above the age of 16'
   cpi    = 'Consumer price index with (1983=100)'
   ndi    = 'Per capita disposable income'
   sales  = 'Cigarette sales in packs per capita'
   pimin  = 'Minimum price in adjoining states per pack of cigarettes';
datalines;
1 63 28.6 3383 2236.5 30.6 1558.3045298 93.9 26.1
1 64 29.8 3431 2276.7 31.0 1684.0732025 95.4 27.5
1 65 29.8 3486 2327.5 31.5 1809.8418752 98.5 28.9
1 66 31.5 3524 2369.7 32.4 1915.1603572 96.4 29.5
1 67 31.6 3533 2393.7 33.4 2023.5463678 95.5 29.6
1 68 35.6 3522 2405.2 34.8 2202.4855362 88.4 32
1 69 36.6 3531 2411.9 36.7 2377.3346665 90.1 32.8
1 70 39.6 3444 2394.6 38.8 2591.0391591 89.8 34.3
1 71 42.7 3481 2443.5 40.5 2785.3159706 95.4 35.8
1 72 42.3 3511 2484.7 41.8 3034.8082969 101.1 37.4
1 73 42.1 3540 2526 44.4 3387.5740861 102.9 37.3
1 74 43.1 3574 2573.9 49.3 3718.8671751 108.2 41.4
1 75 46.6 3614 2623.7 53.8 4087.9931169 111.7 43
1 76 50.4 3657 2677.4 56.9 4486.7718352 116.2 46.4
1 77 50.1 3690 2719.6 60.6 4899.8656869 117.1 48.8
1 78 55.1 3728 2764.6 65.2 5450.9983257 123 53.6
1 79 56.8 3769 2810.7 72.6 5957.1405451 121.4 56.5
1 80 60.6 3894 2898.9 82.4 6466.350293 123.2 59.3
1 81 68.8 3917 2924.7 90.9 7042.0231606 119.6 62.6
1 82 73.1 3943 2953.5 96.5 7505.2199795 119.1 67.8
1 83 84.4 3959 2977.5 99.6 7974.5518556 116.3 78.6
1 84 90.8 3990 3009.1 103.9 8693.376058 113 86.8
1 85 99 4020 3039.8 107.6 9059.4344712 114.5 90.7
1 86 103 4050 3072.4 109.6 9674.9852107 116.3 98.8
1 87 110 4083 3104 113.6 10213.847735 114 103.5
1 88 114.4 4102 3124 118.3 10993 112.1 109.2
1 89 122.3 4118 3140 124 11634 105.6 121.5
1 90 139.1 4129.2 3148.6 130.7 12806 108.6 132.3
1 91 144.4 4178.3 3185.1 136.2 13360 107.9 137.4
1 92 172.2 4226.3 3226.7 140.3 14533 109.1 159.5
3 63 23.9 1517 982.4 30.6 1944.7450576 125 24.9
3 64 24 1549 1005.6 31 2063.5159984 121 25.5
3 65 24.2 1575 1024.9 31.5 2162.6639143 123.2 25.3
3 66 29.6 1609 1051.9 32.4 2318.6153235 113.9 25.5
3 67 29.2 1637 1078.9 33.4 2446.6813815 117.1 26
3 68 31.3 1667 1106 34.8 2720.3709408 115.6 32.3
3 69 36.1 1693 1117.5 36.7 2979.6014291 113.8 33.3
3 70 37.1 1772 1226.6 38.8 3269.8156411 115.2 34.6
3 71 38.5 1878 1313.5 40.5 3549.7019452 109.6 36.6
3 72 38 1975 1393.6 41.8 3800.6701072 125 37.2
3 73 38.7 2075 1476.5 44.4 4219.9831679 128.3 36.5
3 74 39.2 2156 1547 49.3 4508.1317983 133.1 37.8
```

```
3 75 47.7 2200 1591.4 53.8 4742.5753077 121.8 40.5
3 76 49.1 2244 1635.8 56.9 5158.789996 122.3 43.4
3 77 48.7 2304 1690.8 60.6 5567.7751489 121.7 44.7
3 78 53.6 2373 1750.6 65.2 6283.4991663 124.7 49.5
3 79 58.6 2450 1812.4 72.6 7099.4038904 124.6 53.7
3 80 60.8 2718 2044 82.4 7823.3902342 126.8 57.2
3 81 63.3 2794 2103.8 90.9 8647.5572846 113.8 62.7
3 82 73.3 2860 2153.1 96.5 8879.9352124 113.5 68.1
3 83 80.5 2963 2231.2 99.6 9579.1345772 111.1 79.6
3 84 92.8 3053 2300.7 103.9 10549.95792 107.1 90.2
3 85 98.8 3161 2384.7 107.6 11256.38682 107.1 97.5
3 86 106.7 3279 2483.1 109.6 11796.536403 107.9 101.2
3 87 113.5 3386 2569 113.6 12367.66971 106.1 103.9
3 88 113.5 3489 2638 118.3 13008 102.2 113.7
3 89 125.6 3556 2672 124 13625 96.8 126.4
3 90 130.2 3598.2 2703.7 130.7 13826 88.9 133.6
3 91 151.4 3681.7 2759.1 136.2 14232 81.2 146.9
3 92 165.7 3762.2 2804.8 140.3 15179 79 165.4
4 63 27 1907 1296.7 30.6 1480.3334935 103.4 25.8
4 64 27.3 1939 1320.7 31 1610.0797693 102.6 25.7
4 65 27.2 1941 1323.6 31.5 1710.1989428 100.3 26.1
4 66 30.3 1963 1344.8 32.4 1883.8750601 98.9 26.2
4 67 30.4 1972 1357.3 33.4 2004.4267179 102.9 27.5
4 68 30.9 1983 1374.6 34.8 2143.3676117 104 29.2
4 69 30.9 1995 1389 36.7 2286.3950024 102.9 29.9
4 70 36.7 1923 1366.9 38.8 2493.7847189 100.3 34.3
4 71 38.8 1961 1405.4 40.5 2710.3690533 104.1 36.8
4 72 44.1 1999 1442.9 41.8 2950.4507448 103.9 37.4
4 73 45.1 2030 1474.6 44.4 3410.1816434 108 37.3
4 74 45.5 2063 1508.3 49.3 3807.5934647 109.7 38
4 75 48.6 2112 1552.5 53.8 4057.8913984 114.8 43
4 76 50.9 2113 1565.1 56.9 4362.3354157 119.1 44.7
4 77 52.6 2143 1596.8 60.6 4859.8664104 122.6 45.9
4 78 56.5 2167 1623.7 65.2 5467.7328208 127.3 49.9
4 79 58.4 2180 1641 72.6 6015.3234022 126.5 52.2
4 80 61.5 2286 1715.1 82.4 6278.9024507 131.8 57.3
4 81 64.7 2296 1725.7 90.9 7101.3099471 128.7 59.9
4 82 72.1 2291 1724.7 96.5 7390.4296012 127.4 64.7
4 83 82 2328 1757.4 99.6 7886.9389716 128 74.8
4 84 93.6 2349 1776.7 103.9 8546.9082172 123.1 84.8
4 85 98.5 2359 1790.1 107.6 9134.3421432 125.8 92.5
4 86 103.6 2371 1804.6 109.6 9550.1432004 126 98.8
4 87 113 2388 1819 113.6 9886.2575685 122.3 103.5
4 88 119.9 2395 1823 118.3 10630 121.5 112.1
4 89 127.7 2406 1831 124 11243 118.3 118.9
4 90 141.2 2411.1 1834.9 130.7 12370 113.1 129.1
4 91 146.5 2432.7 1851.2 136.2 12917 116.8 132.5
4 92 177.3 2460.4 1876.7 140.3 13879 126 153.1
5 63 25.3 17556 12072 30.6 2776.0965615 142 23.9
5 64 25.5 18003 12384.3 31 2974.9294798 138.3 24
5 65 25.3 18403 12673.3 31.5 3107.8449633 140 24.2
5 66 25.5 18669 12898.5 32.4 3296.9523585 136.8 29.6
5 67 26 18992 13181.8 33.4 3462.2862526 135.8 29.2
5 68 35.4 19179 13370.3 34.8 3690.2957405 124.3 31.3
5 69 36.6 19443 13681.6 36.7 3919.3858421 123.9 33.3
5 70 38.8 19953 14317.6 38.8 4192.7811049 123 37.1
```

```
5 71 39.7 20266 14670.5 40.5 4414.3069107 121 38.5
5 72 39.9 20447 14938.3 41.8 4650.9613081 123.5 38
5 73 39.9 20670 15243.7 44.4 5103.7384429 124.4 38.7
5 74 41.9 20915 15566.6 49.3 5607.304421 126.7 39.2
5 75 45 21216 15933 53.8 6138.9663549 127.1 44.5
5 76 48.3 21550 16318.7 56.9 6630.6455824 128 44.9
5 77 49 21900 16697.6 60.6 7234.7086333 126.4 48.7
5 78 58.7 22314 17117.2 65.2 8021.3953973 126.1 53.6
5 79 60.1 22694 17481.6 72.6 8957.2068501 121.9 57.1
5 80 62.1 23669 20853.4 82.4 9891.9376893 120.2 60.8
5 81 66.4 24196 18670.6 90.9 10816.943005 118.6 63.3
5 82 72.8 24724 19064.1 96.5 11361.572303 115.4 71.6
5 83 84.9 25174 19419.8 99.6 12027.230334 110.8 80.5
5 84 94.9 25622 19776.5 103.9 13019.233699 104.8 92.8
5 85 98 26358 20215.4 107.6 13755.13162 102.8 98.8
5 86 104.4 27001 20695.9 109.6 14350.549761 99.7 106.6
5 87 103.9 27663 21156 113.6 15016.207792 97.5 113.5
5 88 117.4 28314 21591 118.3 16059 90.1 113.5
5 89 126.4 29063 22081 124 16779 82.4 125.6
5 90 163.8 29602.1 22490.6 130.7 17384 77.8 130.2
5 91 186.8 30218.8 22694 136.2 17705 68.7 151.4
5 92 201.9 30703.3 22920 140.3 18495 67.5 165.7
7 63 26.8 2716 1883.5 30.6 2913.6800153 156.2 26.2
7 64 27.8 2784 1929.7 31 3104.1445922 143.5 26.9
7 65 28.1 2830 1961.5 31.5 3249.6680891 147 26.5
7 66 30.1 2886 2004.9 32.4 3493.6339515 144.5 30
7 67 31.1 2918 2034.8 33.4 3763.2804311 145.6 31
7 68 31.3 2961 2075.2 34.8 3897.0336452 143.2 32.1
7 69 32.2 3000 2127.2 36.7 4135.6493791 144.7 35
7 70 42.2 3032 2155.2 38.8 4482.3377099 120 39.3
7 71 45.5 3063 2201.4 40.5 4715.6033153 117.6 40.2
7 72 51.3 3074 2234.2 41.8 4948.8689206 110.8 41.6
7 73 50.6 3076 2258.3 44.4 5496.7220855 109.3 40.6
7 74 52.5 3085 2292.9 49.3 5949.3429619 112.4 41.3
7 75 54.5 3097 2327.6 53.8 6407.3139668 110.2 44.3
7 76 57.6 3101 2356.5 56.9 6838.534329 113.4 52.2
7 77 58.4 3107 2384.5 60.6 7505.1603479 117.3 52.3
7 78 61.7 3116 2415.3 65.2 8309.8196838 117.5 56.3
7 79 64.4 3115 2435.5 72.6 9295.3133651 117.4 58.7
7 80 67 3108 2424 82.4 10384.59954 118 60
7 81 80.1 3134 2461.5 90.9 11470.675639 116.4 64.5
7 82 85.6 3153 2487.6 96.5 12380.197494 114.7 71.6
7 83 95.6 3138 2487.6 99.6 13485.534055 114.1 83.1
7 84 113.5 3154 2505.9 103.9 14927.928716 112.5 94.8
7 85 118.6 3175 2525.1 107.6 15685.506921 111 100.3
7 86 118.5 3193 2541.5 109.6 16486.956179 108.5 101.8
7 87 122.7 3211 2555 113.6 17762.426829 109 113.5
7 88 129.7 3233 2568 118.3 19559 104.8 121.5
7 89 142 3239 2564 124 20687 100.6 134.8
7 90 171.2 3242.9 2567.1 130.7 21447 91.5 150.9
7 91 169.5 3246.9 2555.4 136.2 21967 86.7 163.3
7 92 193.5 3237 2536.7 140.3 22891 83.6 175.9
8 63 26.8 480 317.7 30.6 2261.4623685 165.8 26.8
8 64 27.1 494 326.3 31 2325.3400998 170.9 28.5
8 65 27.2 503 332.1 31.5 2529.3674804 170.8 27.9
8 66 31 514 343.6 32.4 2691.4453062 161.3 28.2
```

```
8 67 30.7 524 353.2 33.4 2864.0105206 158.2 29.4
8 68 32 533 359 34.8 3061.3641084 164.8 30.9
8 69 32.2 540 362.8 36.7 3287.3196655 175.5 30.7
8 70 39 584 378.2 38.8 3495.160642 155 32.6
8 71 41.3 563 392.6 40.5 3730.6501888 161.1 34.2
8 72 44.7 570 403.1 41.8 4015.7164823 156.3 34.3
8 73 44 573 409.9 44.4 4438.0722282 154.7 35.3
8 74 44.2 576 416.6 49.3 4755.5540869 151.3 35.8
8 75 45.9 579 424.3 53.8 5112.1253035 147.6 39.5
8 76 50.1 582 431 56.9 5440.0945508 153 46.1
8 77 51.7 582 434.8 60.6 5850.0561101 153.3 49.2
8 78 58.7 584 440.6 65.2 6407.7945104 155.5 52.1
8 79 60 582 441.5 72.6 7017.0164554 150.2 56.2
8 80 62.7 595 454 82.4 7773.0618425 150.5 58.1
8 81 66 598 458.8 90.9 8492.8780685 152.6 62.8
8 82 74.1 602 463.6 96.5 9213.6476936 154.1 65.4
8 83 82 606 469.4 99.6 10081.240761 149.6 74.9
8 84 91.1 613 476.1 103.9 10806.777381 144 84.2
8 85 98.7 622 481.8 107.6 11563.776167 144.5 90.1
8 86 105.2 633 492.4 109.6 12062.403831 142.4 93.3
8 87 111.4 644 502 113.6 12960.505665 141 100.3
8 88 119.3 660 513 118.3 14137 137.1 109.2
8 89 124 673 522 124 14949 131.7 120.2
8 90 140 681.2 528.3 130.7 16435 127.2 131.5
8 91 143.2 695.5 537.5 136.2 16732 118.8 141.6
8 92 174.7 704.7 543.6 140.3 18300 120 159.1
9 63 23.4 792 563.1 30.6 2733.226538 246.4 24.7
9 64 23.9 795 559.3 31 2894.0045696 235.3 25.2
9 65 24.1 802 560.2 31.5 3068.4434798 246.5 25.1
9 66 24.1 806 559.3 32.4 3215.5606329 295.9 24.7
9 67 26.6 808 559.3 33.4 3479.3206717 249.8 26.3
9 68 26.7 802 554.4 34.8 3752.5382418 224.3 27.1
9 69 27.2 798 561.2 36.7 3907.0112526 212.2 28.3
9 70 28.5 756 563.1 38.8 4202.2963957 200.4 28.8
9 71 32.6 750 560.2 40.5 4600.563546 213 30.2
9 72 33.7 744 558.3 41.8 4964.1530816 220.6 29.9
9 73 34.5 734 553.4 44.4 5310.9292283 209.4 30.1
9 74 36 721 547.6 49.3 5894.1436568 182.7 31.3
9 75 39.4 711 543.7 53.8 6587.6959502 176.5 33.6
9 76 47.8 697 536.9 56.9 7003.8273262 167.7 37.9
9 77 51.9 683 529.2 60.6 7770.9381962 136.7 38.4
9 78 59.8 671 523.3 65.2 8369.9151768 130.3 42.8
9 79 59.3 656 514.6 72.6 9306.2107728 128.5 45.8
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43 86 98.8 4800 3709.3 109.6 10592.860465 129 85.4
43 87 103.5 4855 3763 113.6 11367.565321 130.6 90.5
43 88 112.1 4895 3798 118.3 12228 125.3 94.4
43 89 121.5 4940 3832 124 12854 124.7 103.8
43 90 135 4963.4 3850.2 130.7 13857 121.8 115.6
43 91 137.4 5040.8 3912 136.2 14328 120.6 120.5
43 92 163.9 5113 3967.7 140.3 15820 121 135.8
44 63 29.5 10257 6807.7 30.6 1896.9264812 113.4 27
44 64 29.7 10401 6910.9 31 2043.8787782 110.7 27.3
44 65 29.5 10591 7067.3 31.5 2179.4474465 120.5 27.2
44 66 33.8 10714 7190.8 32.4 2331.5741201 106.1 30
44 67 34.4 10858 7333.6 33.4 2530.2701836 109 30.4
44 68 34.9 11013 7495.8 34.8 2721.7221198 108.4 30.9
44 69 34.4 11187 7606.7 36.7 2928.6971859 111.3 30.9
44 70 40.4 11196 7817.1 38.8 3185.3462679 106.4 34.3
44 71 42 11445 8056.5 40.5 3350.9263209 108.9 38.8
44 72 46.9 11644 8261.1 41.8 3570.319891 108.6 39.8
44 73 46.4 11853 8474.4 44.4 4029.8045378 110.4 39.9
44 74 47.5 12049 8682.8 49.3 4427.1966648 114.7 41
44 75 50.6 12293 8926 53.8 4954.9830835 116 43.6
44 76 53.3 12571 9194.3 56.9 5447.5837409 121.4 46.4
44 77 53.3 12801 9419.2 60.6 5970.1957829 124.2 47.9
44 78 59.1 13047 9646 65.2 6739.1081536 126.6 53.1
44 79 62.2 13380 9924.9 72.6 7525.613405 126.4 55.5
44 80 63.7 14228 10564.7 82.4 8363.8624228 129.7 60
44 81 66.9 14766 10960.4 90.9 9404.9470055 129 62.6
44 82 73.8 15280 11331.9 96.5 9983.4423154 131.2 69.4
44 83 84.1 15724 11655.2 99.6 10367.381063 126.4 79.6
44 84 93.8 15989 11856.9 103.9 11138.363184 117.2 90.2
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44 85 102.1 16389 12077 107.6 11755.148882 115.9 95.1
44 86 105.5 16689 12300.9 109.6 11910.380181 113.7 101.2
44 87 114.4 16789 12353 113.6 12184.622144 105.8 110.2
44 88 128 16841 12390 118.3 12908 96.5 113.7
44 89 137 16991 12545 124 13687 94.5 127.2
44 90 145.7 17173 12679.4 130.7 14590 85.6 133.6
44 91 173.6 17538.9 12913.8 136.2 15187 79.6 146.5
44 92 186 17849.3 13123.2 140.3 15965 77.2 165.4
45 63 24.9 973 592 30.6 2060.7057057 72 23.9
45 64 29.4 977 594.8 31 2181.1711712 62.3 24
45 65 29.7 994 609.9 31.5 2282.4474474 65 24.2
45 66 30.8 1010 624.9 32.4 2365.6006006 65.7 26.5
45 67 31.5 1022 637.1 33.4 2454.0840841 64.3 27.4
45 68 32.3 1031 649.4 34.8 2573.4834835 64.3 31.3
45 69 33.3 1045 644.7 36.7 2706.7417417 65.6 31.9
45 70 34.6 1059 686.9 38.8 2975.3903904 65.5 33.8
45 71 36.6 1094 716.1 40.5 3192.8678679 67.7 33.6
45 72 37.2 1123 740.5 41.8 3449.7897898 71.3 33.7
45 73 36.5 1152 764.9 44.4 3757.8828829 72.7 34.4
45 74 37.8 1177 784.7 49.3 4094.7597598 75.6 35.8
45 75 40.5 1206 806.3 53.8 4488.1381381 75.8 38.6
45 76 43.4 1239 828.8 56.9 4868.7237237 77.9 42.5
45 77 44.7 1276 852.3 60.6 5311.1411411 78 43.4
45 78 49.5 1317 875.8 65.2 5899.6096096 79.6 49.8
45 79 53.7 1367 904 72.6 6426.2462462 79.1 51.7
45 80 57.2 1461 961.3 82.4 6981.6666667 74.8 55.3
45 81 62.7 1518 991.4 90.9 7545.6156156 77.6 55.9
45 82 68.1 1554 1009.3 96.5 7796.1411411 73.6 64.3
45 83 82 1619 1045.9 99.6 8251.3513514 69 71
45 84 95.3 1652 1065.7 103.9 8831.2912913 66.3 81.7
45 85 104.6 1644 1081.6 107.6 9230 66.5 87.4
45 86 103.5 1664 1099.5 109.6 9647.8978979 64.4 97.8
45 87 108.6 1680 1107 113.6 10035.945946 67.7 102.7
45 88 122.9 1690 1116 118.3 10650 55 112.9
45 89 135.6 1707 1131 124 11425 57 118.6
45 90 151.9 1724 1142.3 130.7 12012 53.4 129.5
45 91 167.1 1771 1178.9 136.2 12492 53.5 127
45 92 170.1 1814.1 1214.5 140.3 13355 55 155.1
46 63 28.2 397 269.5 30.6 2042.5026784 133.5 24.2
46 64 29.3 399 272.4 31 2188.8007603 129.1 24.7
46 65 29.4 404 276.3 31.5 2400.8762744 122.9 24.7
46 66 32.5 410 282 32.4 2634.499568 130.4 25.9
46 67 31.8 420 289.8 33.4 2786.4681182 127.4 26.5
46 68 33.9 429 298.5 34.8 2990.6049767 128.8 29.9
46 69 34.2 439 307.2 36.7 3161.8531191 134.6 29.9
46 70 37.7 444 311 38.8 3393.2082253 122.6 31.4
46 71 39.5 453 319.7 40.5 3668.7929843 124.4 34.1
46 72 40 460 327.4 41.8 3778.8000691 138 36.1
46 73 39.8 464 333.2 44.4 4167.7941939 146.8 36.9
46 74 41.3 468 339 49.3 4485.3404182 151.8 37.9
46 75 41.8 473 346.8 53.8 4816.4957664 155.5 40.8
46 76 47.1 477 353.5 56.9 5304.1560394 171.1 43.9
46 77 47 483 360.3 60.6 5630.775013 169.4 45
46 78 52.5 487 367 65.2 6338.4494557 162.4 49.7
46 79 54.8 493 373.8 72.6 6920.2395023 160.9 53.2
46 80 58.9 511 390.2 82.4 7519.0409539 161.6 55.3
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46 81 61 516 395.1 90.9 8392.2930707 163.8 58.4
46 82 66.8 516 396 96.5 9596.7005357 162.3 67
46 83 77 525 404.7 99.6 9335.8589943 153.8 74.7
46 84 90.6 530 407.6 103.9 10134.26093 144.3 90.5
46 85 95.5 535 413.4 107.6 10719.453257 144.5 89.2
46 86 104.9 541 419.2 109.6 11288.768274 131.2 100
46 87 113.8 548 425 113.6 12070.158804 128.3 102
46 88 123.7 557 433 118.3 13126 128.7 113.5
46 89 129.7 567 441 124 13945 120.9 125.9
46 90 143.7 572.1 445 130.7 14896 124.3 135.9
46 91 150.1 576.1 447 136.2 15121 120.9 153.9
46 92 168 579.2 452.1 140.3 16640 126.5 164.4
47 63 24.7 4288 2899.7 30.6 1936.0331153 122.8 23.4
47 64 25.2 4371 2962.3 31 2134.439961 118.5 23.9
47 65 25.1 4420 3001.8 31.5 2267.0592737 123.3 24.1
47 66 24.7 4481 3056.7 32.4 2404.8998191 120.2 24.1
47 67 26.3 4541 3119.3 33.4 2580.3332406 120.9 25
47 68 27.1 4604 3182 34.8 2794.4037846 122.8 26.3
47 69 28.3 4669 3251.3 36.7 3024.138027 123.9 27
47 70 28.8 4648 3292.8 38.8 3284.1554195 124.3 28.3
47 71 30.2 4736 3383.3 40.5 3562.96925 128.4 30.1
47 72 29.9 4799 3456.5 41.8 3840.738834 137 30.6
47 73 30.1 4865 3538.4 44.4 4290.8090998 143.1 30.6
47 74 31.3 4924 3616.4 49.3 4677.1803256 149.6 31.5
47 75 33.6 4989 3701.2 53.8 5154.4010018 152.7 33.3
47 76 37.9 5052 3784.1 56.9 5570.0111312 158.1 36
47 77 38.4 5112 3865 60.6 6093.1786559 157.7 36.9
47 78 42.8 5177 3566.3 65.2 6684.2222068 155.9 41.4
47 79 45.8 5197 3993.1 72.6 7396.3983581 151.8 43.4
47 80 48.5 5346 4100 82.4 8230.7513566 148.9 46.3
47 81 51.8 5430 4187.7 90.9 9028.5557256 149.9 49.4
47 82 56.4 5491 4247.4 96.5 9754.3070822 147.4 56.3
47 83 68.8 5550 4310.1 99.6 10561.50967 144.7 66.4
47 84 76 5636 4391 103.9 11529.526228 136.8 75.4
47 85 83.6 5701 4453.6 107.6 12246.923612 134.6 79.3
47 86 91.3 5795 4540.3 109.6 13127.223459 135.8 85.4
47 87 94.6 5904 4627 113.6 13942.780019 133 90.5
47 88 102.1 6015 4725 118.3 15010 129.5 94.4
47 89 109.4 6098 4782 124 15936 122.5 103.8
47 90 128.6 6164.8 4834.4 130.7 16698 118.9 115.6
47 91 136.5 6263.4 4898.2 136.2 17038 109.1 120.5
47 92 157.9 6354.1 4965.1 140.3 18010 108.2 135.8
48 63 30.1 2961 2030.7 30.6 2409.3326822 99.1 28
48 64 29.9 2971 2045.2 31 2569.1936184 95.4 29.4
48 65 30 2973 2057.8 31.5 2764.3485276 98.3 29.1
48 66 34.7 3074 2140 32.4 3003.101874 86.9 29.8
48 67 35 3208 2250.3 33.4 3143.2397077 99.7 30.1
48 68 37.1 3296 2333.5 34.8 3363.3080096 101.5 32
48 69 37.6 3402 2421.5 36.7 3529.397294 100.2 31.9
48 70 38.7 3409 2438 38.8 3664.3448376 96.7 33.8
48 71 40.3 3433 2477.6 40.5 3829.396064 97 33.6
48 72 46.1 3423 2489.2 41.8 4072.3016424 88.5 33.7
48 73 45.9 3443 2528.9 44.4 4593.4067723 91 36.3
48 74 46.9 3503 2597.6 49.3 5079.2179292 98.6 38
48 75 49 3563 2667.3 53.8 5631.4647999 99.5 40.3
48 76 53 3623 2735 56.9 6166.0646842 100.3 42.5
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48 77 53.7 3693 2806.6 60.6 6674.7131177 99.3 45.6
48 78 58.6 3793 2899.4 65.2 7521.7684683 101.3 51.5
48 79 61.6 3926 3014.6 72.6 8311.7306273 101.4 55.4
48 80 63.8 4132 3165.5 82.4 9105.8450185 101.4 56.4
48 81 66.6 4217 3233.2 90.9 9940.4436727 112.7 59.2
48 82 80.3 4245 3252.6 96.5 10492.690543 106.6 67.6
48 83 93.1 4300 3299 99.6 11018.985963 102.4 76.5
48 84 105.9 4349 3345.4 103.9 11805.833948 96.2 88.5
48 85 114.4 4406 3394.8 107.6 12336.2816 96.5 97.6
48 86 125.7 4463 3450.9 109.6 12946.659721 94.2 99.9
48 87 134.2 4538 3507 113.6 13522.781926 91.3 107.1
48 88 141.4 4648 3591 118.3 14347 88.2 121.9
48 89 150.6 4761 3669 124 15438 86.1 133.6
48 90 167.5 4882.4 3762.5 130.7 16252 83.4 141.3
48 91 177.4 5033.9 3866.5 136.2 16967 78.7 144.4
48 92 199.2 5152.2 3950.2 140.3 18038 81.1 167.2
49 63 27.7 1815 1247 30.6 1598.0632813 111.8 24.1
49 64 28 1823 1260.4 31 1721.5317383 109 25
49 65 28.2 1815 1264.3 31.5 1855.0382813 110.5 24.5
49 66 28.4 1815 1275.8 32.4 1962.4458008 111.2 24.7
49 67 29.5 1807 1280.6 33.4 2097.9599609 113.6 25
49 68 31.3 1819 1301.8 34.8 2202.3560547 119.8 26.3
49 69 32.1 1819 1310.4 36.7 2358.9501953 112.1 27
49 70 33.7 1744 1255.6 38.8 2659.0889648 114.5 28.3
49 71 41.6 1761 1277.7 40.5 2868.8849609 111.5 30.1
49 72 41.3 1781 1300.8 41.8 3118.8333008 117.5 29.9
49 73 39.9 1782 1310.4 44.4 3424.9949219 116.6 30.1
49 74 42 1784 1320 49.3 3815.4764648 119.9 31.3
49 75 45.2 1803 1340.2 53.8 4251.1293945 123.2 33.3
49 76 48.4 1833 1369.1 56.9 4646.6299805 129.7 36
49 77 48.9 1853 1389.2 60.6 5074.2524414 133.9 36.9
49 78 53.9 1861 1399.8 65.2 5525.9663086 131.6 41.4
49 79 62.4 1878 1416.2 72.6 6080.0686523 122.1 43.4
49 80 64.3 1950 1467.1 82.4 6593.0148437 122.3 46.3
49 81 66.2 1952 1471.9 90.9 7108.9724609 120.5 49.4
49 82 75.1 1948 1473.8 96.5 7632.9605469 119.8 56.3
49 83 88.2 1965 1490.2 99.6 7830.7108398 115.7 66.4
49 84 97.2 1952 1487.3 103.9 8338.6379883 111.9 75.4
49 85 103.2 1936 1484.4 107.6 8780.3137695 109.1 79.3
49 86 104.1 1917 1477.7 109.6 9173.8067383 112.1 85.4
49 87 112.8 1897 1470 113.6 9599.421582 107.5 90.5
49 88 122.2 1876 1460 118.3 10279 109.1 94.4
49 89 131.2 1857 1452 124 10901 104 103.8
49 90 142.9 1842.6 1440.8 130.7 11946 104.1 115.6
49 91 144.1 1850.8 1454.1 136.2 12381 100.1 120.5
49 92 158.2 1862.1 1465.4 140.3 13526 98 135.8
50 63 27.6 4059 2702.5 30.6 2146.2878788 110.4 25.4
50 64 29.5 4100 2735.1 31 2307.5212121 106.2 25.6
50 65 29.8 4140 2773.5 31.5 2456.1909091 109.4 26.2
50 66 32.1 4178 2812.8 32.4 2633.1287879 106.3 30
50 67 32.8 4194 2841.6 33.4 2726.3090909 108.3 30.1
50 68 33.6 4211 2878 34.8 2939.8909091 111.4 32.7
50 69 33.6 4233 2898.1 36.7 3109.5 111.5 32.8
50 70 38.5 4417 3059.2 38.8 3339.8333333 106.4 37.7
50 71 40.2 4466 3129.2 40.5 3582.730303 105.4 38.5
50 72 40.3 4510 3197.2 41.8 3814.1106061 108.8 41.9
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50 73 42.6 4537 3253.8 44.4 4269.5424242 109.5 41
50 74 43.9 4563 3310.4 49.3 4634.9348485 111.8 41.9
50 75 46.6 4601 3377.5 53.8 5039.0651515 113.5 45.2
50 76 51.3 4623 3430.2 56.9 5487.1681818 115.4 47.8
50 77 52.1 4658 3489.6 60.6 6063.0015152 117.2 49.4
50 78 57.1 4683 3537.6 65.2 6728.8742424 116.7 54.6
50 79 58.7 4720 3590.3 72.6 7622.9863636 117.1 56.4
50 80 61.2 4705 3551 82.4 8173.6924242 117.6 58.8
50 81 64.9 4742 3592.2 90.9 8663.6742424 119.9 61.4
50 82 75 4765 3617.1 96.5 9196.5818182 115.6 69.6
50 83 92 4751 3616.2 99.6 9815.3409091 106.3 80.8
50 84 100.8 4766 3639.2 103.9 10641.4 105.6 89.6
50 85 106.8 4775 3657.4 107.6 11228.75 107 96.7
50 86 110.8 4783 3670.8 109.6 11763.751515 105.4 104.8
50 87 116.3 4807 3690 113.6 12336.443939 106 116.2
50 88 128.6 4855 3728 118.3 13129 102.6 124.1
50 89 138.3 4867 3745 124 13933 100.3 132.7
50 90 151.1 4902.1 3772 130.7 14958 94.1 147.3
50 91 158.6 4965.2 3817.4 136.2 15438 95.5 154.4
50 92 176.5 5017.3 3853.8 140.3 16351 96.2 178.5
51 63 26.2 335 221.9 30.6 2212.8687965 125.6 24.9
51 64 26.2 338 224.8 31 2323.4089278 134 27.5
51 65 26.1 330 220 31.5 2468.0408753 137.6 27.6
51 66 26.5 320 215.2 32.4 2593.0442013 133.3 29.6
51 67 27.4 319 216.1 33.4 2775.9003063 137.4 30.1
51 68 32.5 322 221.9 34.8 2921.5653392 136.5 32
51 69 32.6 320 228.7 36.7 3066.1972867 135.7 31.9
51 70 34.1 332 231.6 38.8 3269.7150985 132.2 33.8
51 71 34.4 339 240.3 40.5 3514.5563239 131.7 33.6
51 72 34.4 345 247 41.8 3975.3123851 140 33.7
51 73 34.4 351 253.8 44.4 4505.2851641 141.2 36.3
51 74 35.8 362 263.4 49.3 4980.5044201 145.8 37.8
51 75 38.6 377 276 53.8 5455.7236761 160.7 40.3
51 76 42.6 392 288.5 56.9 5985.6964551 161.5 42.5
51 77 43.4 407 300.1 60.6 6640.6725602 160.4 44.7
51 78 49.8 425 314.5 65.2 7609.7066083 160.3 49.5
51 79 51.7 450 332.9 72.6 8482.6637199 168.6 53.7
51 80 55.3 470 343.5 82.4 9402.1096718 158.1 56.4
51 81 55.9 492 358 90.9 10046.754923 163.1 59.2
51 82 64.3 502 364.7 96.5 10180.022932 157.7 65.7
51 83 71 514 371.5 99.6 9855.6341357 141.2 76.5
51 84 81.7 511 370.5 103.9 10382.507659 128.9 88.5
51 85 87.4 510 369.5 107.6 10839.131379 125.7 92.3
51 86 97.8 507 368.6 109.6 11089.138031 124.8 99.9
51 87 102.7 490 357 113.6 11113.932079 110.4 106.2
51 88 112.9 479 353 118.3 11803 114.3 115.3
51 89 118.6 475 352 124 12399 111.4 123
51 90 129.5 470.9 348.9 130.7 13871 96.9 138.9
51 91 127 477.1 355.2 136.2 14675 109.1 143.6
51 92 155.1 483.3 360.5 140.3 15607 110.8 160
;
```

Click **Run** to create the Work.Cigar table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-Sectional Data Models** to add the step to your flow.

3 Add the Work.Cigar table to your flow and connect it to the Cross-Sectional Data Models node. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **sales**.
- To the **Continuous variables** role, assign **price**, **cpi**, and **ndi**.
- To the **Categorical variables** role, assign **state**.

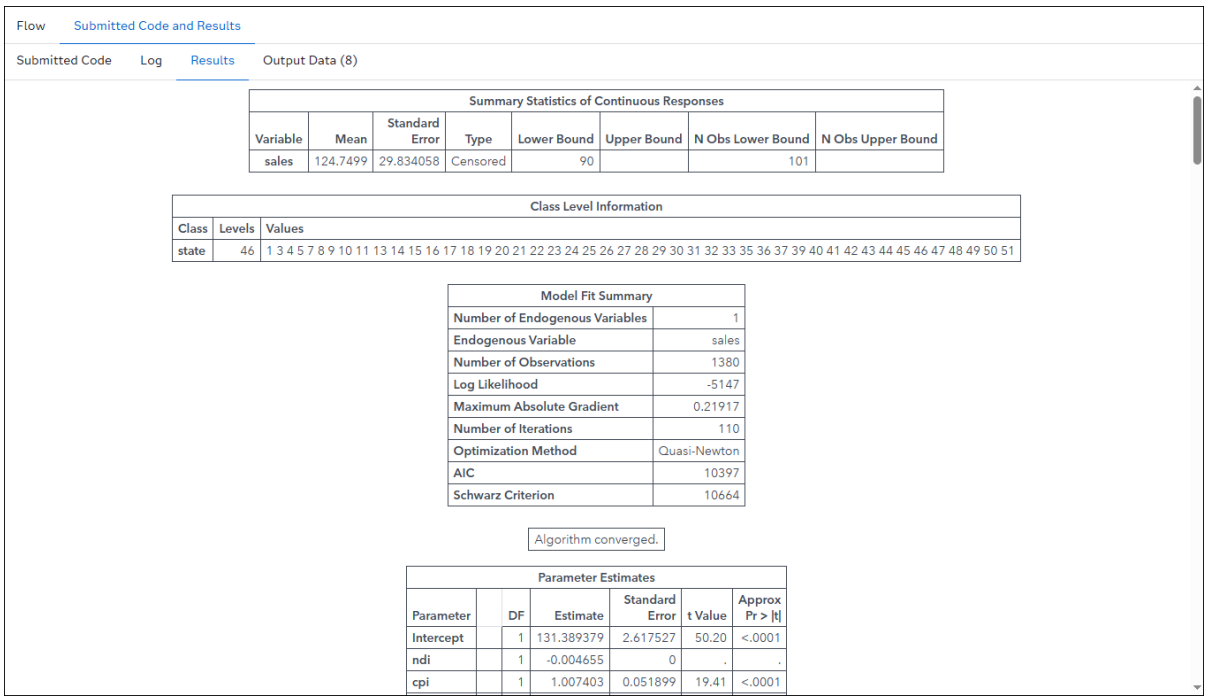
6 On the **Model** tab, select **Censored regression** as the model type.

7 Expand the **Heteroscedasticity** heading, and then select the **Analyze heteroscedasticity** check box. Assign the **price** variable to the **Variables on the variance function** role.

8 Select the **Set the lower bound** check box. From the **Lower bound method** drop-down list, select **Specify by value**. In the **Lower bound value** box, enter `90`.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Censored Regression Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric variable for the analysis.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the censored regression model.

1 From the **Model type** drop-down list, select **Censored regression**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 (SAS Compute Server only) Specify whether to analyze the heteroscedasticity. You can specify the variables on the variance function and the form of the variance function.

4 Set the upper and lower bounds of the censored variables.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available:

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Specify the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

4 Select the statistics to be displayed in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of the parameter estimates
- (SAS Compute Server) iteration history of the objective function and parameter estimates

5 Select the plots to include in the results.

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- a table that contains the default statistics from the analysis and any selected statistics such as the error standard deviation.
- a table of parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Truncated Regression Models

Example: Truncated Regression

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data cigar;
   input state year price pop pop_16 cpi ndi sales pimin;
   label
   state  = 'State abbreviation'
   year   = 'YEAR'
   price  = 'Price per pack of cigarettes'
   pop    = 'Population'
   pop_16 = 'Population above the age of 16'
   cpi    = 'Consumer price index with (1983=100)'
   ndi    = 'Per capita disposable income'
   sales  = 'Cigarette sales in packs per capita'
   pimin  = 'Minimum price in adjoining states per pack of cigarettes';
datalines;
1 63 28.6 3383 2236.5 30.6 1558.3045298 93.9 26.1
1 64 29.8 3431 2276.7 31.0 1684.0732025 95.4 27.5
1 65 29.8 3486 2327.5 31.5 1809.8418752 98.5 28.9
1 66 31.5 3524 2369.7 32.4 1915.1603572 96.4 29.5
1 67 31.6 3533 2393.7 33.4 2023.5463678 95.5 29.6
1 68 35.6 3522 2405.2 34.8 2202.4855362 88.4 32
1 69 36.6 3531 2411.9 36.7 2377.3346665 90.1 32.8
1 70 39.6 3444 2394.6 38.8 2591.0391591 89.8 34.3
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47 88 102.1 6015 4725 118.3 15010 129.5 94.4
47 89 109.4 6098 4782 124 15936 122.5 103.8
47 90 128.6 6164.8 4834.4 130.7 16698 118.9 115.6
47 91 136.5 6263.4 4898.2 136.2 17038 109.1 120.5
47 92 157.9 6354.1 4965.1 140.3 18010 108.2 135.8
48 63 30.1 2961 2030.7 30.6 2409.3326822 99.1 28
```

```
48 64 29.9 2971 2045.2 31 2569.1936184 95.4 29.4
48 65 30 2973 2057.8 31.5 2764.3485276 98.3 29.1
48 66 34.7 3074 2140 32.4 3003.101874 86.9 29.8
48 67 35 3208 2250.3 33.4 3143.2397077 99.7 30.1
48 68 37.1 3296 2333.5 34.8 3363.3080096 101.5 32
48 69 37.6 3402 2421.5 36.7 3529.397294 100.2 31.9
48 70 38.7 3409 2438 38.8 3664.3448376 96.7 33.8
48 71 40.3 3433 2477.6 40.5 3829.396064 97 33.6
48 72 46.1 3423 2489.2 41.8 4072.3016424 88.5 33.7
48 73 45.9 3443 2528.9 44.4 4593.4067723 91 36.3
48 74 46.9 3503 2597.6 49.3 5079.2179292 98.6 38
48 75 49 3563 2667.3 53.8 5631.4647999 99.5 40.3
48 76 53 3623 2735 56.9 6166.0646842 100.3 42.5
48 77 53.7 3693 2806.6 60.6 6674.7131177 99.3 45.6
48 78 58.6 3793 2899.4 65.2 7521.7684683 101.3 51.5
48 79 61.6 3926 3014.6 72.6 8311.7306273 101.4 55.4
48 80 63.8 4132 3165.5 82.4 9105.8450185 101.4 56.4
48 81 66.6 4217 3233.2 90.9 9940.4436727 112.7 59.2
48 82 80.3 4245 3252.6 96.5 10492.690543 106.6 67.6
48 83 93.1 4300 3299 99.6 11018.985963 102.4 76.5
48 84 105.9 4349 3345.4 103.9 11805.833948 96.2 88.5
48 85 114.4 4406 3394.8 107.6 12336.2816 96.5 97.6
48 86 125.7 4463 3450.9 109.6 12946.659721 94.2 99.9
48 87 134.2 4538 3507 113.6 13522.781926 91.3 107.1
48 88 141.4 4648 3591 118.3 14347 88.2 121.9
48 89 150.6 4761 3669 124 15438 86.1 133.6
48 90 167.5 4882.4 3762.5 130.7 16252 83.4 141.3
48 91 177.4 5033.9 3866.5 136.2 16967 78.7 144.4
48 92 199.2 5152.2 3950.2 140.3 18038 81.1 167.2
49 63 27.7 1815 1247 30.6 1598.0632813 111.8 24.1
49 64 28 1823 1260.4 31 1721.5317383 109 25
49 65 28.2 1815 1264.3 31.5 1855.0382813 110.5 24.5
49 66 28.4 1815 1275.8 32.4 1962.4458008 111.2 24.7
49 67 29.5 1807 1280.6 33.4 2097.9599609 113.6 25
49 68 31.3 1819 1301.8 34.8 2202.3560547 119.8 26.3
49 69 32.1 1819 1310.4 36.7 2358.9501953 112.1 27
49 70 33.7 1744 1255.6 38.8 2659.0889648 114.5 28.3
49 71 41.6 1761 1277.7 40.5 2868.8849609 111.5 30.1
49 72 41.3 1781 1300.8 41.8 3118.8333008 117.5 29.9
49 73 39.9 1782 1310.4 44.4 3424.9949219 116.6 30.1
49 74 42 1784 1320 49.3 3815.4764648 119.9 31.3
49 75 45.2 1803 1340.2 53.8 4251.1293945 123.2 33.3
49 76 48.4 1833 1369.1 56.9 4646.6299805 129.7 36
49 77 48.9 1853 1389.2 60.6 5074.2524414 133.9 36.9
49 78 53.9 1861 1399.8 65.2 5525.9663086 131.6 41.4
49 79 62.4 1878 1416.2 72.6 6080.0686523 122.1 43.4
49 80 64.3 1950 1467.1 82.4 6593.0148437 122.3 46.3
49 81 66.2 1952 1471.9 90.9 7108.9724609 120.5 49.4
49 82 75.1 1948 1473.8 96.5 7632.9605469 119.8 56.3
49 83 88.2 1965 1490.2 99.6 7830.7108398 115.7 66.4
49 84 97.2 1952 1487.3 103.9 8338.6379883 111.9 75.4
49 85 103.2 1936 1484.4 107.6 8780.3137695 109.1 79.3
49 86 104.1 1917 1477.7 109.6 9173.8067383 112.1 85.4
49 87 112.8 1897 1470 113.6 9599.421582 107.5 90.5
49 88 122.2 1876 1460 118.3 10279 109.1 94.4
49 89 131.2 1857 1452 124 10901 104 103.8
```

```
49 90 142.9 1842.6 1440.8 130.7 11946 104.1 115.6
49 91 144.1 1850.8 1454.1 136.2 12381 100.1 120.5
49 92 158.2 1862.1 1465.4 140.3 13526 98 135.8
50 63 27.6 4059 2702.5 30.6 2146.2878788 110.4 25.4
50 64 29.5 4100 2735.1 31 2307.5212121 106.2 25.6
50 65 29.8 4140 2773.5 31.5 2456.1909091 109.4 26.2
50 66 32.1 4178 2812.8 32.4 2633.1287879 106.3 30
50 67 32.8 4194 2841.6 33.4 2726.3090909 108.3 30.1
50 68 33.6 4211 2878 34.8 2939.8909091 111.4 32.7
50 69 33.6 4233 2898.1 36.7 3109.5 111.5 32.8
50 70 38.5 4417 3059.2 38.8 3339.8333333 106.4 37.7
50 71 40.2 4466 3129.2 40.5 3582.730303 105.4 38.5
50 72 40.3 4510 3197.2 41.8 3814.1106061 108.8 41.9
50 73 42.6 4537 3253.8 44.4 4269.5424242 109.5 41
50 74 43.9 4563 3310.4 49.3 4634.9348485 111.8 41.9
50 75 46.6 4601 3377.5 53.8 5039.0651515 113.5 45.2
50 76 51.3 4623 3430.2 56.9 5487.1681818 115.4 47.8
50 77 52.1 4658 3489.6 60.6 6063.0015152 117.2 49.4
50 78 57.1 4683 3537.6 65.2 6728.8742424 116.7 54.6
50 79 58.7 4720 3590.3 72.6 7622.9863636 117.1 56.4
50 80 61.2 4705 3551 82.4 8173.6924242 117.6 58.8
50 81 64.9 4742 3592.2 90.9 8663.6742424 119.9 61.4
50 82 75 4765 3617.1 96.5 9196.5818182 115.6 69.6
50 83 92 4751 3616.2 99.6 9815.3409091 106.3 80.8
50 84 100.8 4766 3639.2 103.9 10641.4 105.6 89.6
50 85 106.8 4775 3657.4 107.6 11228.75 107 96.7
50 86 110.8 4783 3670.8 109.6 11763.751515 105.4 104.8
50 87 116.3 4807 3690 113.6 12336.443939 106 116.2
50 88 128.6 4855 3728 118.3 13129 102.6 124.1
50 89 138.3 4867 3745 124 13933 100.3 132.7
50 90 151.1 4902.1 3772 130.7 14958 94.1 147.3
50 91 158.6 4965.2 3817.4 136.2 15438 95.5 154.4
50 92 176.5 5017.3 3853.8 140.3 16351 96.2 178.5
51 63 26.2 335 221.9 30.6 2212.8687965 125.6 24.9
51 64 26.2 338 224.8 31 2323.4089278 134 27.5
51 65 26.1 330 220 31.5 2468.0408753 137.6 27.6
51 66 26.5 320 215.2 32.4 2593.0442013 133.3 29.6
51 67 27.4 319 216.1 33.4 2775.9003063 137.4 30.1
51 68 32.5 322 221.9 34.8 2921.5653392 136.5 32
51 69 32.6 320 228.7 36.7 3066.1972867 135.7 31.9
51 70 34.1 332 231.6 38.8 3269.7150985 132.2 33.8
51 71 34.4 339 240.3 40.5 3514.5563239 131.7 33.6
51 72 34.4 345 247 41.8 3975.3123851 140 33.7
51 73 34.4 351 253.8 44.4 4505.2851641 141.2 36.3
51 74 35.8 362 263.4 49.3 4980.5044201 145.8 37.8
51 75 38.6 377 276 53.8 5455.7236761 160.7 40.3
51 76 42.6 392 288.5 56.9 5985.6964551 161.5 42.5
51 77 43.4 407 300.1 60.6 6640.6725602 160.4 44.7
51 78 49.8 425 314.5 65.2 7609.7066083 160.3 49.5
51 79 51.7 450 332.9 72.6 8482.6637199 168.6 53.7
51 80 55.3 470 343.5 82.4 9402.1096718 158.1 56.4
51 81 55.9 492 358 90.9 10046.754923 163.1 59.2
51 82 64.3 502 364.7 96.5 10180.022932 157.7 65.7
51 83 71 514 371.5 99.6 9855.6341357 141.2 76.5
51 84 81.7 511 370.5 103.9 10382.507659 128.9 88.5
51 85 87.4 510 369.5 107.6 10839.131379 125.7 92.3
```

```
51 86 97.8 507 368.6 109.6 11089.138031 124.8 99.9
51 87 102.7 490 357 113.6 11113.932079 110.4 106.2
51 88 112.9 479 353 118.3 11803 114.3 115.3
51 89 118.6 475 352 124 12399 111.4 123
51 90 129.5 470.9 348.9 130.7 13871 96.9 138.9
51 91 127 477.1 355.2 136.2 14675 109.1 143.6
51 92 155.1 483.3 360.5 140.3 15607 110.8 160
;
```

Click **Run** to create the Work.Cigar table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-Sectional Data Models** to add the step to your flow.

3 Add the Work.Cigar table to your flow and connect it to the Cross-Sectional Data Models node. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **sales**.
- To the **Continuous variables** role, assign **price**, **cpi**, and **ndi**.
- To the **Categorical variables** role, assign **state**.

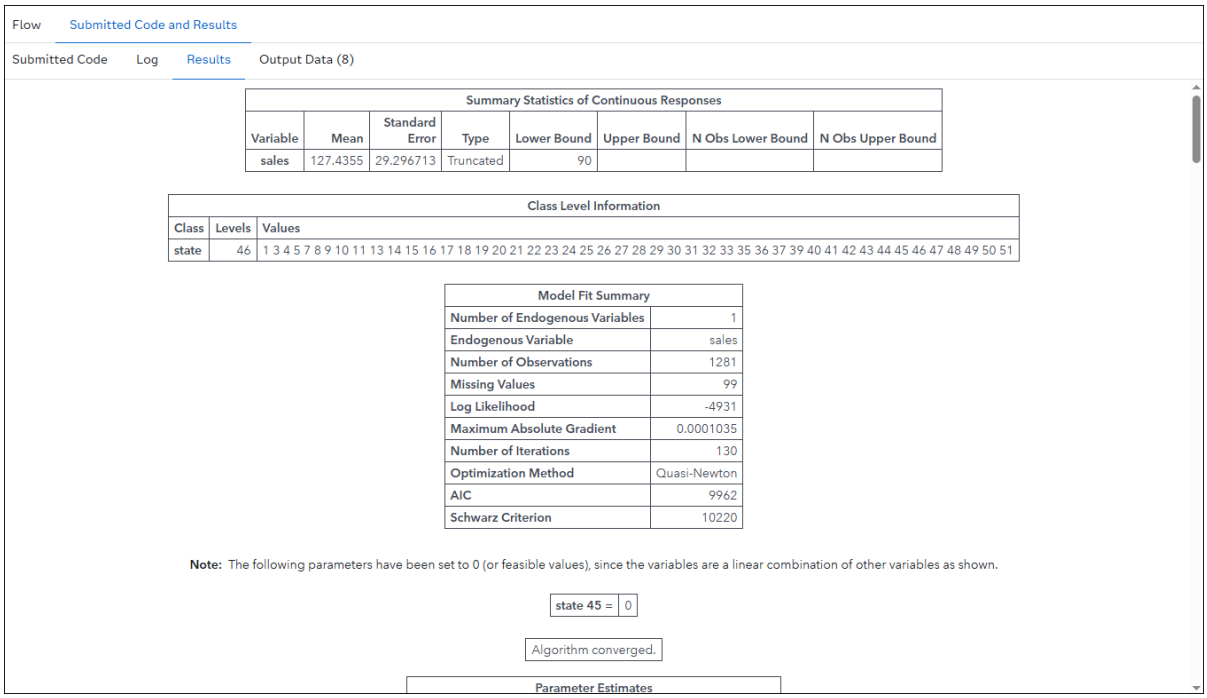
6 On the **Model** tab, select **Truncated regression** as the model type.

7 Expand the **Heteroscedasticity** heading, and then select the **Analyze heteroscedasticity** check box. Assign the **price** variable to the **Variables on the variance function** role.

8 Select the **Set the lower bound** check box. From the **Lower bound method** drop-down list, select **Specify by value**. In the **Lower bound value** box, enter `90`.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (8)

Summary Statistics of Continuous Responses

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
sales	127.4355	29.296713	Truncated	90			

Class Level Information

Class	Levels	Values
state	46	1 3 4 5 7 8 9 10 11 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 35 36 37 39 40 41 42 43 44 45 46 47 48 49 50 51

Model Fit Summary

Number of Endogenous Variables	1
Endogenous Variable	sales
Number of Observations	1281
Missing Values	99
Log Likelihood	-4931
Maximum Absolute Gradient	0.0001035
Number of Iterations	130
Optimization Method	Quasi-Newton
AIC	9962
Schwarz Criterion	10220

Note: The following parameters have been set to 0 (or feasible values), since the variables are a linear combination of other variables as shown.

state 45 =	0

Algorithm converged.

Parameter Estimates

Truncated Regression Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric variable for the analysis.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the truncated regression model.

1 From the **Model type** drop-down list, select **Truncated regression**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 (SAS Compute Server only) Specify whether to analyze the heteroscedasticity. You can specify the variables on the variance function and the form of the variance function.

4 Set the upper and lower bounds of the truncated variables.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available:

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Specify the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

4 Select the statistics to be displayed in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of the parameter estimates
- (SAS Compute Server) iteration history of the objective function and parameter estimates

5 Select the plots to include in the results.

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- a table that contains the default statistics from the analysis and any selected statistics such as the error standard deviation.
- a table of parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Zero-Inflated Poisson Models

Example: Zero-Inflated Poisson Model

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data long97data;
   input fem ment phd mar kid5 art lnart;
datalines;
0   7.99999860   1.38000000  1  2  3   1.25276290
0   6.99999950   4.29000000  0  0  0  -0.69314720
0  47.00000760   3.84999990  0  0  4   1.50407740
0  19.00000190   3.58999990  1  1  1   0.40546510
0   0.00000000   1.80999990  1  0  1   0.40546510
0   6.00000050   3.58999990  1  1  1   0.40546510
0   9.99999900   2.11999990  1  1  0  -0.69314720
0   1.99999990   4.29000000  1  0  0  -0.69314720
0   1.99999990   2.57999990  1  2  3   1.25276290
0   3.99999900   1.80000000  1  1  3   1.25276290
0   0.00000000   4.29000000  1  2  1   0.40546510
0   3.00000000   2.76000000  1  1  0  -0.69314720
0   9.99999900   3.41000010  1  1  1   0.40546510
0   6.99999950   4.34000020  1  3  2   0.91629080
0  15.00000100   3.84999990  1  2  5   1.70474800
0   1.99999990   2.09999990  1  0  2   0.91629080
0  13.00000000   4.29000000  1  0  2   0.91629080
0  15.00000100   4.29000000  0  0  1   0.40546510
0   4.99999810   2.26000000  1  1  0  -0.69314720
0   6.00000050   2.09999990  0  0  0  -0.69314720
```

0	12.00000000	2.26000000	1	0	3	1.25276290
0	15.99999810	3.84999990	1	1	6	1.87180220
0	6.99999950	4.29000000	0	0	4	1.50407740
0	6.00000050	1.80000000	1	2	2	0.91629080
0	1.99999990	2.26000000	0	0	2	0.91629080
0	0.00000000	2.09999990	0	0	0	-0.69314720
0	30.00000190	4.29000000	1	0	4	1.50407740
0	9.99999900	4.29000000	1	2	1	0.40546510
0	1.99999990	2.09999990	1	0	1	0.40546510
0	0.99999990	3.58999990	1	0	7	2.01490310
0	3.00000000	3.42000010	1	1	2	0.91629080
0	9.99999900	4.29000000	1	2	2	0.91629080
0	9.99999900	4.29000000	0	0	2	0.91629080
0	0.99999990	3.33999990	1	2	0	-0.69314720
0	1.99999990	4.29000000	0	0	0	-0.69314720
0	10.99999710	4.29000000	1	0	1	0.40546510
0	4.99999810	3.61999990	1	0	4	1.50407740
0	0.00000000	4.29000000	1	3	1	0.40546510
0	3.99999900	4.34000020	1	1	1	0.40546510
0	1.99999990	1.25000000	1	1	2	0.91629080
0	19.00000190	4.34000020	0	0	7	2.01490310
0	3.00000000	1.67000000	1	3	1	0.40546510
0	0.00000000	3.47000000	0	0	0	-0.69314720
0	0.99999990	2.26000000	1	1	1	0.40546510
0	0.99999990	1.80000000	1	0	1	0.40546510
0	17.00000000	4.34000020	1	2	2	0.91629080
0	3.00000000	3.58999990	0	0	2	0.91629080
0	0.99999990	1.75000000	1	2	1	0.40546510
0	6.00000050	4.29000000	0	0	1	0.40546510
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	15.00000100	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	26.99999810	3.31999990	1	2	2	0.91629080
0	4.99999810	4.34000020	1	0	2	0.91629080
0	6.99999950	3.41000010	0	0	4	1.50407740
0	0.00000000	4.29000000	1	0	1	0.40546510
0	10.99999710	3.19000010	1	0	2	0.91629080
0	13.00000000	4.29000000	1	0	2	0.91629080
0	3.99999900	1.74000000	1	2	1	0.40546510
0	3.99999900	2.76000000	0	0	1	0.40546510
0	26.99999810	3.58999990	1	1	7	2.01490310
0	9.99999900	1.80999990	1	0	4	1.50407740
0	13.00000000	4.29000000	1	1	2	0.91629080
0	0.99999990	4.29000000	1	1	1	0.40546510
0	6.00000050	2.76000000	0	0	1	0.40546510
0	6.00000050	3.47000000	0	0	6	1.87180220
0	4.99999810	2.50000000	1	2	2	0.91629080
0	1.99999990	1.25000000	1	0	5	1.70474800
0	13.99999710	3.58999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	12.00000000	3.58999990	1	0	1	0.40546510
0	6.99999950	3.58999990	1	3	0	-0.69314720
0	3.00000000	1.75000000	1	0	1	0.40546510
0	1.99999990	1.75000000	1	2	1	0.40546510
0	1.99999990	3.58999990	1	1	1	0.40546510
0	1.99999990	4.29000000	0	0	1	0.40546510

0	0.00000000	4.29000000	0	0	0	-0.69314720
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	0.00000000	2.60999990	1	0	3	1.25276290
0	30.00000190	4.29000000	1	0	5	1.70474800
0	21.00000000	1.74000000	1	0	16	2.80336050
0	4.99999810	2.76000000	1	0	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	7.99999860	2.76000000	1	2	1	0.40546510
0	25.00000000	4.29000000	1	2	3	1.25276290
0	0.00000000	3.47000000	1	1	5	1.70474800
0	4.99999810	2.57999990	1	2	0	-0.69314720
0	0.99999990	2.14000010	1	0	0	-0.69314720
0	4.99999810	2.26000000	0	0	0	-0.69314720
0	0.00000000	4.29000000	1	2	3	1.25276290
0	15.00000100	4.29000000	1	0	3	1.25276290
0	30.00000190	4.29000000	0	0	3	1.25276290
0	1.99999990	2.20000000	1	0	0	-0.69314720
0	6.00000050	1.80000000	1	2	3	1.25276290
0	0.00000000	2.09999990	1	2	1	0.40546510
0	13.00000000	4.29000000	1	1	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	12.00000000	2.09999990	1	1	0	-0.69314720
0	30.00000190	4.29000000	1	2	2	0.91629080
0	4.99999810	1.80999990	1	1	1	0.40546510
0	9.99999900	4.34000020	1	0	1	0.40546510
0	4.99999810	4.29000000	1	1	0	-0.69314720
0	3.99999900	2.50000000	1	2	1	0.40546510
0	13.00000000	2.05000000	1	2	4	1.50407740
0	7.99999860	3.47000000	1	0	3	1.25276290
0	6.00000050	2.60999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	2	1	0.40546510
0	25.00000000	4.29000000	0	0	2	0.91629080
0	1.99999990	4.29000000	1	1	2	0.91629080
0	9.00000000	4.34000020	1	0	6	1.87180220
0	9.99999900	2.11999990	1	1	0	-0.69314720
0	3.00000000	2.76000000	1	0	2	0.91629080
0	1.99999990	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	4.34000020	1	0	5	1.70474800
0	7.99999860	2.76000000	1	1	2	0.91629080
0	9.99999900	3.19000010	1	1	2	0.91629080
0	7.99999860	4.61999990	0	0	3	1.25276290
0	6.00000050	3.15000010	1	2	0	-0.69314720
0	21.00000000	2.55000000	1	1	4	1.50407740
0	3.99999900	1.52000000	1	0	0	-0.69314720
0	1.99999990	1.72000000	1	2	4	1.50407740
0	0.99999990	1.78000000	1	1	2	0.91629080
0	17.00000000	2.85999990	1	1	1	0.40546510
0	30.00000190	4.61999990	1	2	0	-0.69314720
0	4.99999810	4.13999990	0	0	1	0.40546510
0	13.00000000	2.96000000	1	1	6	1.87180220
0	10.99999710	2.55000000	1	0	1	0.40546510
0	19.00000190	2.21000000	1	1	0	-0.69314720
0	4.99999810	3.08999990	1	0	3	1.25276290
0	66.00000760	4.54000000	1	2	4	1.50407740
0	0.00000000	1.78000000	1	0	3	1.25276290

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0   3.00000000   2.21000000  1  3  0  -0.69314720
0   3.00000000   2.39000010  1  1  1   0.40546510
0   0.00000000   2.96000000  1  0  0  -0.69314720
0   7.99999860   2.51000000  1  1  0  -0.69314720
0   0.00000000   1.97000000  1  2  2   0.91629080
0   4.99999810   4.13999990  0  0  0  -0.69314720
0  29.00000000   4.25000000  1  1  4   1.50407740
0  10.99999710   2.85999990  1  2  0  -0.69314720
0  22.99999620   2.96000000  1  1  9   2.25129180
0  45.99999240   2.96000000  1  2  2   0.91629080
0   7.99999860   4.61999990  1  1  6   1.87180220
0   4.99999810   3.69000010  1  2  0  -0.69314720
0   0.99999990   3.15000010  1  1  0  -0.69314720
0   9.00000000   4.61999990  0  0  2   0.91629080
0   1.99999990   3.35999990  1  0  0  -0.69314720
0   6.99999950   3.69000010  0  0  4   1.50407740
0  10.99999710   3.54000000  1  0  1   0.40546510
0  56.99999620   2.96000000  1  1  4   1.50407740
0  15.99999810   2.55999990  1  1  1   0.40546510
0   0.00000000   2.31999990  1  0  0  -0.69314720
0   3.00000000   2.31999990  1  0  0  -0.69314720
0   0.99999990   0.92000000  1  2  0  -0.69314720
0   9.99999900   4.54000000  1  0  0  -0.69314720
0  10.99999710   4.54000000  1  3  0  -0.69314720
0  10.99999710   1.76000000  1  1  5   1.70474800
0  15.99999810   2.55999990  0  0  1   0.40546510
0   4.99999810   2.39000010  1  1  0  -0.69314720
0   9.00000000   3.40000010  1  0  2   0.91629080
0  19.99999620   2.86999990  1  2  2   0.91629080
0  21.00000000   4.54000000  1  2  4   1.50407740
0   4.99999810   2.82999990  1  0  4   1.50407740
0   6.00000050   1.67999990  1  0  0  -0.69314720
0  12.00000000   3.54000000  0  0  3   1.25276290
0   0.00000000   1.76000000  1  0  2   0.91629080
0  10.99999710   3.15000010  1  3  1   0.40546510
0   3.00000000   2.51000000  1  0  0  -0.69314720
0  15.99999810   3.69000010  1  1  0  -0.69314720
0  10.99999710   1.76000000  1  1  4   1.50407740
0   4.99999810   1.86000000  1  1 12   2.52572870
0   0.99999990   2.76000000  1  3  0  -0.69314720
0  15.99999810   4.61999990  1  1  1   0.40546510
0  12.00000000   4.25000000  1  0  5   1.70474800
0  10.99999710   2.54000000  1  0  4   1.50407740
0   0.00000000   2.20000000  1  1  0  -0.69314720
0   0.00000000   1.76000000  1  0  2   0.91629080
0   3.00000000   2.85999990  1  3  3   1.25276290
0  13.00000000   3.40000010  1  2  0  -0.69314720
0  45.00000000   4.54000000  1  1  1   0.40546510
0  47.00000760   1.86000000  1  1  9   2.25129180
0   6.99999950   1.52000000  1  0  0  -0.69314720
0   6.99999950   2.55999990  1  1  2   0.91629080
0  19.00000190   2.21000000  1  0  0  -0.69314720
0   9.00000000   3.69000010  1  0  7   2.01490310
0  76.99998470   1.78000000  1  1  1   0.40546510
0   0.00000000   1.17999990  1  1  0  -0.69314720
0   3.99999900   2.00000000  1  0  1   0.40546510
```

0	19.00000190	2.21000000	1	0	0	-0.69314720
0	12.00000000	4.13999990	1	2	0	-0.69314720
0	0.99999990	2.85999990	1	3	0	-0.69314720
0	17.00000000	2.85999990	1	1	1	0.40546510
0	6.00000050	2.54000000	0	0	7	2.01490310
0	3.99999900	2.85999990	1	1	0	-0.69314720
0	6.00000050	2.52000000	0	0	4	1.50407740
0	3.00000000	1.52000000	1	1	2	0.91629080
0	4.99999810	3.08999990	1	1	3	1.25276290
0	3.00000000	1.17999990	1	1	0	-0.69314720
0	3.00000000	1.42000000	1	0	0	-0.69314720
0	15.00000100	4.61999990	0	0	7	2.01490310
0	0.00000000	2.96000000	1	2	1	0.40546510
0	9.99999900	4.54000000	0	0	2	0.91629080
0	41.99999620	4.54000000	0	0	7	2.01490310
0	3.00000000	2.51000000	1	2	1	0.40546510
0	6.99999950	3.15000010	1	1	2	0.91629080
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	2.96000000	1	3	1	0.40546510
0	3.99999900	1.67999990	1	0	0	-0.69314720
0	0.00000000	1.22000000	1	1	1	0.40546510
0	1.99999990	1.52000000	1	0	1	0.40546510
0	4.99999810	2.21000000	1	1	0	-0.69314720
0	0.99999990	3.92000010	1	1	0	-0.69314720
0	13.00000000	4.54000000	1	0	5	1.70474800
0	0.00000000	1.17999990	1	0	2	0.91629080
0	26.00000000	3.69000010	1	0	3	1.25276290
0	0.99999990	1.72000000	1	0	2	0.91629080
0	25.00000000	2.57999990	1	1	5	1.70474800
0	3.00000000	1.52000000	0	0	3	1.25276290
0	47.00000760	1.86000000	1	1	4	1.50407740
0	3.99999900	2.50000000	1	0	5	1.70474800
0	0.99999990	4.61999990	1	0	1	0.40546510
0	6.99999950	1.40000000	1	2	0	-0.69314720
0	4.99999810	4.54000000	1	0	3	1.25276290
0	26.99999810	1.67999990	1	1	0	-0.69314720
0	0.99999990	2.82999990	1	0	2	0.91629080
0	4.99999810	3.35999990	0	0	1	0.40546510
0	0.00000000	1.97000000	1	1	7	2.01490310
0	12.00000000	3.40000010	0	0	1	0.40546510
0	3.99999900	1.74000000	1	1	1	0.40546510
0	0.00000000	2.96000000	0	0	0	-0.69314720
0	25.00000000	2.57999990	1	1	4	1.50407740
0	3.00000000	4.54000000	1	1	1	0.40546510
0	1.99999990	3.15000010	1	1	0	-0.69314720
0	12.00000000	2.96000000	1	2	0	-0.69314720
0	15.99999810	3.54000000	1	2	2	0.91629080
0	4.99999810	2.96000000	1	1	3	1.25276290
0	12.00000000	4.25000000	1	0	1	0.40546510
0	4.99999810	2.55999990	1	1	2	0.91629080
0	4.99999810	1.86000000	1	0	1	0.40546510
0	3.00000000	4.61999990	1	1	1	0.40546510
0	3.99999900	2.85999990	0	0	2	0.91629080
0	4.99999810	3.15000010	1	1	5	1.70474800
0	0.00000000	2.51000000	1	0	2	0.91629080
0	26.99999810	3.15000010	1	1	5	1.70474800

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0   4.99999810   2.51000000  1  0  2   0.91629080
0   0.00000000   1.52000000  1  1  0  -0.69314720
0  17.99999810   4.29000000  0  0  6   1.87180220
0   4.99999810   4.29000000  1  1  4   1.50407740
0   7.99999860   4.29000000  1  2  2   0.91629080
0   3.99999900   2.09999990  1  0  2   0.91629080
0  35.00000760   4.29000000  1  1 12   2.52572870
0   4.99999810   4.29000000  0  0  2   0.91629080
0   9.00000000   3.58999990  1  1  1   0.40546510
0   6.00000050   4.29000000  1  0  1   0.40546510
0  24.00000190   4.29000000  1  0  2   0.91629080
0   0.00000000   2.09999990  1  1  0  -0.69314720
0   4.99999810   1.80999990  1  1  0  -0.69314720
0  19.00000190   4.29000000  0  0  7   2.01490310
0   3.00000000   4.29000000  0  0  1   0.40546510
0   1.99999990   4.29000000  1  1  1   0.40546510
0   3.99999900   1.25000000  1  0  3   1.25276290
0   9.99999900   3.58999990  1  0  1   0.40546510
0   7.99999860   2.09999990  1  1  1   0.40546510
0   1.99999990   4.29000000  1  0  4   1.50407740
0  19.00000190   4.29000000  1  1  3   1.25276290
0   0.99999990   3.47000000  1  1  1   0.40546510
0   3.00000000   3.19000010  1  0  1   0.40546510
0   4.99999810   3.19000010  1  2  1   0.40546510
0   0.00000000   2.09999990  1  0  1   0.40546510
0  21.00000000   3.58999990  1  1  5   1.70474800
0  13.99999710   4.29000000  1  1  1   0.40546510
0   0.00000000   2.09999990  1  0  0  -0.69314720
0   6.99999950   2.76000000  1  1  1   0.40546510
0   4.99999810   2.60999990  1  0  3   1.25276290
0  22.00000000   4.29000000  1  0  4   1.50407740
0  19.99999620   3.41000010  0  0  7   2.01490310
0  38.00000380   4.29000000  1  0  3   1.25276290
0  19.00000190   4.29000000  0  0  4   1.50407740
0   3.00000000   2.26000000  0  0  2   0.91629080
0  15.99999810   3.58999990  0  0  3   1.25276290
0   1.99999990   4.29000000  1  1  0  -0.69314720
0   3.00000000   2.05000000  0  0  1   0.40546510
0  12.00000000   4.29000000  1  2  1   0.40546510
0  35.00000760   4.29000000  0  0  0  -0.69314720
0  19.00000190   4.29000000  1  0  0  -0.69314720
0   1.99999990   4.29000000  0  0  0  -0.69314720
0   6.99999950   2.76000000  0  0  1   0.40546510
0   3.99999900   2.09999990  1  2  3   1.25276290
0  13.99999710   2.35999990  0  0  1   0.40546510
0   9.00000000   4.29000000  0  0  0  -0.69314720
0   7.99999860   3.58999990  0  0  0  -0.69314720
0  12.00000000   4.29000000  1  1  2   0.91629080
0   3.00000000   4.29000000  1  1  0  -0.69314720
0   0.99999990   4.29000000  1  0  1   0.40546510
0   9.99999900   4.29000000  0  0  1   0.40546510
0  21.00000000   3.41000010  0  0  4   1.50407740
0  13.00000000   4.29000000  1  1  0  -0.69314720
0  17.00000000   4.29000000  1  0  2   0.91629080
0   4.99999810   4.29000000  0  0  0  -0.69314720
0   1.99999990   2.14000010  0  0  0  -0.69314720
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0	7.99999860	4.29000000	1	0	0	-0.69314720
0	1.99999990	2.50000000	1	1	2	0.91629080
0	4.99999810	2.60999990	1	1	3	1.25276290
0	0.99999990	1.80999990	1	2	0	-0.69314720
0	1.99999990	2.26000000	1	1	0	-0.69314720
0	3.99999900	3.61999990	1	2	1	0.40546510
0	9.00000000	4.29000000	1	2	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	17.00000000	4.29000000	0	0	2	0.91629080
0	24.00000190	4.29000000	1	2	0	-0.69314720
0	3.99999900	3.47000000	1	0	4	1.50407740
0	13.99999710	4.29000000	1	1	2	0.91629080
0	4.99999810	3.58999990	1	1	1	0.40546510
0	9.99999900	1.80999990	0	0	1	0.40546510
0	17.99999810	4.29000000	1	1	3	1.25276290
0	0.99999990	4.29000000	1	1	0	-0.69314720
0	0.00000000	2.09999990	1	0	1	0.40546510
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0	7.99999860	4.29000000	1	0	0	-0.69314720
0	0.99999990	2.26000000	1	0	1	0.40546510
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	13.00000000	4.29000000	1	2	0	-0.69314720
0	4.99999810	3.58999990	1	2	0	-0.69314720
0	6.99999950	3.41000010	1	2	0	-0.69314720
0	6.99999950	3.58999990	0	0	3	1.25276290
0	4.99999810	3.61999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	3	1	0.40546510
0	13.99999710	4.29000000	0	0	1	0.40546510
0	6.00000050	4.29000000	1	0	0	-0.69314720
0	4.99999810	2.26000000	1	1	1	0.40546510
0	7.99999860	2.76000000	1	0	3	1.25276290
0	3.99999900	2.60999990	1	1	1	0.40546510
0	9.00000000	4.29000000	0	0	2	0.91629080
0	3.00000000	2.09999990	1	1	2	0.91629080
0	1.99999990	3.47000000	1	1	0	-0.69314720
0	0.00000000	2.09999990	0	0	0	-0.69314720
0	10.99999710	4.29000000	0	0	1	0.40546510
0	9.00000000	4.29000000	0	0	1	0.40546510
0	7.99999860	2.96000000	1	0	1	0.40546510
0	1.99999990	2.96000000	1	0	2	0.91629080
0	17.99999810	4.61999990	1	0	3	1.25276290
0	3.00000000	1.42000000	1	0	3	1.25276290
0	1.99999990	4.54000000	1	0	1	0.40546510
0	6.99999950	2.52000000	1	0	0	-0.69314720
0	9.99999900	4.54000000	1	1	2	0.91629080
0	15.99999810	2.00000000	1	1	1	0.40546510
0	4.99999810	2.54000000	1	0	0	-0.69314720
0	0.00000000	2.50000000	1	0	2	0.91629080
0	7.99999860	4.54000000	0	0	0	-0.69314720
0	9.99999900	3.35999990	0	0	1	0.40546510
0	17.99999810	3.40000010	1	1	0	-0.69314720
0	12.00000000	1.67999990	1	1	1	0.40546510
0	9.00000000	2.00000000	0	0	1	0.40546510
0	39.00000000	2.85999990	1	0	1	0.40546510
0	17.99999810	4.61999990	1	0	1	0.40546510
0	15.00000100	4.13999990	1	0	1	0.40546510

0	15.99999810	4.13999990	1	0	2	0.91629080
0	1.99999990	2.96000000	0	0	0	-0.69314720
0	6.99999950	2.82999990	1	2	3	1.25276290
0	24.00000190	2.55000000	1	0	2	0.91629080
0	7.99999860	1.67999990	1	0	1	0.40546510
0	6.99999950	2.00000000	0	0	1	0.40546510
0	10.99999710	2.00000000	1	1	1	0.40546510
0	0.00000000	2.96000000	1	1	4	1.50407740
0	3.99999900	1.50500000	1	0	4	1.50407740
0	21.00000000	3.54000000	1	0	2	0.91629080
0	6.00000050	3.40000010	0	0	1	0.40546510
0	6.00000050	4.61999990	0	0	0	-0.69314720
0	7.99999860	2.82999990	0	0	3	1.25276290
0	3.99999900	2.54000000	1	0	1	0.40546510
0	12.00000000	2.86999990	0	0	1	0.40546510
0	15.00000100	1.86000000	0	0	1	0.40546510
0	0.00000000	3.92000010	1	1	1	0.40546510
0	4.99999810	3.69000010	1	1	1	0.40546510
0	15.00000100	2.85999990	1	2	4	1.50407740
0	4.99999810	4.54000000	0	0	0	-0.69314720
0	7.99999860	4.61999990	0	0	0	-0.69314720
0	13.00000000	2.85999990	1	1	0	-0.69314720
0	1.99999990	3.40000010	0	0	1	0.40546510
0	6.00000050	2.57999990	1	2	4	1.50407740
0	19.99999620	4.25000000	1	0	3	1.25276290
0	6.99999950	1.76000000	1	1	2	0.91629080
0	6.99999950	2.85999990	1	3	0	-0.69314720
0	15.99999810	3.69000010	1	2	4	1.50407740
0	13.00000000	3.40000010	1	0	0	-0.69314720
0	0.00000000	3.40000010	1	2	0	-0.69314720
0	0.99999990	4.54000000	1	2	0	-0.69314720
0	12.00000000	2.86999990	0	0	3	1.25276290
0	6.99999950	1.76000000	1	0	4	1.50407740
0	3.99999900	4.25000000	0	0	1	0.40546510
0	0.00000000	3.92000010	0	0	3	1.25276290
0	3.99999900	3.35999990	1	0	2	0.91629080
0	3.99999900	2.31999990	1	0	1	0.40546510
0	36.99999240	4.54000000	0	0	2	0.91629080
0	22.99999620	3.35999990	1	1	0	-0.69314720
0	7.99999860	2.00000000	1	3	2	0.91629080
0	7.99999860	3.92000010	1	1	1	0.40546510
0	1.99999990	3.92000010	0	0	1	0.40546510
0	0.00000000	3.35999990	0	0	1	0.40546510
0	0.99999990	1.78000000	1	0	1	0.40546510
0	21.00000000	3.54000000	1	1	1	0.40546510
0	9.99999900	3.92000010	0	0	2	0.91629080
0	7.99999860	2.31999990	0	0	3	1.25276290
0	33.99999240	1.67999990	1	0	1	0.40546510
0	13.99999710	3.08999990	0	0	2	0.91629080
0	6.00000050	2.57999990	1	1	0	-0.69314720
0	13.99999710	3.40000010	0	0	6	1.87180220
0	12.00000000	2.86999990	0	0	3	1.25276290
0	17.99999810	4.61999990	0	0	4	1.50407740
0	3.00000000	2.96000000	1	3	0	-0.69314720
0	6.00000050	1.86000000	1	2	2	0.91629080
0	1.99999990	1.22000000	1	1	0	-0.69314720

0	10.99999710	2.51000000	1	2	6	1.87180220
0	10.99999710	2.51000000	1	0	8	2.14006610
0	4.99999810	3.69000010	1	0	2	0.91629080
0	7.99999860	2.96000000	1	0	3	1.25276290
0	3.99999900	1.78000000	1	0	1	0.40546510
0	0.99999990	1.22000000	1	1	1	0.40546510
0	7.99999860	2.85999990	1	0	0	-0.69314720
0	19.00000190	3.69000010	0	0	7	2.01490310
0	1.99999990	2.11999990	0	0	0	-0.69314720
0	9.99999900	2.52000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	1	0.40546510
0	3.00000000	4.61999990	1	0	2	0.91629080
0	1.99999990	3.54000000	1	2	4	1.50407740
0	0.99999990	2.50000000	1	0	0	-0.69314720
0	4.99999810	1.67999990	0	0	0	-0.69314720
0	1.99999990	3.40000010	1	1	1	0.40546510
0	4.99999810	3.92000010	0	0	0	-0.69314720
0	52.99998090	4.54000000	1	1	5	1.70474800
0	54.99998860	4.54000000	0	0	2	0.91629080
0	0.00000000	2.50000000	0	0	0	-0.69314720
0	10.99999710	4.54000000	1	0	2	0.91629080
0	25.00000000	3.54000000	0	0	3	1.25276290
0	4.99999810	1.52000000	1	0	2	0.91629080
0	1.99999990	3.92000010	1	2	0	-0.69314720
0	7.99999860	4.61999990	1	0	2	0.91629080
0	0.00000000	3.92000010	1	0	3	1.25276290
0	4.99999810	2.31999990	1	2	0	-0.69314720
0	7.99999860	2.96000000	1	2	2	0.91629080
0	6.99999950	2.85999990	1	2	1	0.40546510
0	13.99999710	1.95000000	1	1	3	1.25276290
0	1.99999990	3.92000010	1	2	1	0.40546510
0	4.99999810	2.86999990	0	0	1	0.40546510
0	24.00000190	3.69000010	1	0	3	1.25276290
0	3.00000000	3.69000010	1	0	0	-0.69314720
0	3.99999900	2.39000010	0	0	2	0.91629080
0	3.00000000	1.95000000	1	2	3	1.25276290
0	10.99999710	3.35999990	0	0	5	1.70474800
0	3.99999900	2.39000010	1	1	2	0.91629080
0	26.00000000	3.69000010	0	0	2	0.91629080
0	3.99999900	2.96000000	1	1	5	1.70474800
0	1.99999990	3.21000000	1	0	0	-0.69314720
0	0.00000000	2.11999990	1	2	0	-0.69314720
0	52.99998090	4.54000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	3	1.25276290
0	6.00000050	2.54000000	1	1	3	1.25276290
0	1.99999990	2.85999990	1	1	1	0.40546510
0	13.99999710	3.47000000	1	0	3	1.25276290
0	15.00000100	2.86999990	0	0	4	1.50407740
0	3.99999900	2.31999990	1	0	0	-0.69314720
0	15.00000100	1.86000000	1	2	4	1.50407740
0	3.99999900	1.95000000	1	0	2	0.91629080
0	1.99999990	2.31999990	1	2	0	-0.69314720
0	19.99999620	4.25000000	1	2	1	0.40546510
0	3.99999900	1.97000000	0	0	6	1.87180220
0	41.99999620	1.86000000	1	0	19	2.97041440
0	7.99999860	3.69000010	1	1	0	-0.69314720

```
0   3.00000000   4.54000000  1  1  0  -0.69314720
0   9.00000000   3.54000000  1  0  4   1.50407740
0   9.99999900   4.54000000  1  1  1   0.40546510
0   6.99999950   2.85999990  1  2 11   2.44234700
0  25.00000000   3.35999990  1  0  0  -0.69314720
0   3.00000000   2.85999990  0  0  0  -0.69314720
0   3.99999900   2.96000000  1  2  0  -0.69314720
0  22.00000000   2.55999990  1  2  1   0.40546510
0   7.99999860   1.63000000  1  0  2   0.91629080
0  13.99999710   2.96000000  0  0  0  -0.69314720
0   0.00000000   2.96000000  1  0  1   0.40546510
0   7.99999860   1.63000000  1  1  1   0.40546510
0   0.00000000   2.96000000  0  0  0  -0.69314720
0  21.00000000   2.96000000  1  2  2   0.91629080
0   6.99999950   2.96000000  1  0  1   0.40546510
0  30.99998860   4.54000000  1  2  3   1.25276290
0   1.99999990   4.54000000  1  2  2   0.91629080
0   9.99999900   2.15000010  0  0  1   0.40546510
0   6.00000050   4.54000000  1  1  2   0.91629080
0  12.00000000   2.21000000  1  2  2   0.91629080
0   0.99999990   2.21000000  1  1  0  -0.69314720
0  29.00000000   4.54000000  0  0  2   0.91629080
0   9.99999900   2.21000000  1  1  3   1.25276290
0   6.00000050   2.21000000  1  0  0  -0.69314720
0  36.99999240   4.54000000  1  0  3   1.25276290
0   4.99999810   4.54000000  0  0  4   1.50407740
1   9.00000000   2.11999990  0  0  0  -0.69314720
1   1.99999990   2.11999990  1  0  0  -0.69314720
1   1.99999990   2.11999990  1  0  2   0.91629080
1   3.00000000   2.11999990  1  0  3   1.25276290
1   9.00000000   2.11999990  1  1  1   0.40546510
1  10.99999710   2.39000010  0  0  3   1.25276290
1   4.99999810   2.57999990  0  0  2   0.91629080
1   6.99999950   3.19000010  1  0  4   1.50407740
1   4.99999810   3.75000000  0  0  0  -0.69314720
1   3.00000000   3.58999990  0  0  1   0.40546510
1   1.99999990   2.57999990  0  0  2   0.91629080
1   0.00000000   3.75000000  0  0  3   1.25276290
1   4.99999810   3.75000000  1  0  0  -0.69314720
1   0.99999990   3.75000000  0  0  0  -0.69314720
1   3.99999900   1.22000000  1  2  2   0.91629080
1  13.99999710   3.75000000  0  0  0  -0.69314720
1   6.99999950   3.75000000  1  0  0  -0.69314720
1  26.00000000   3.75000000  0  0  0  -0.69314720
1   7.99999860   3.75000000  0  0  2   0.91629080
1   3.00000000   3.75000000  0  0  4   1.50407740
1   6.00000050   3.75000000  0  0  0  -0.69314720
1  21.00000000   3.75000000  0  0  1   0.40546510
1   7.99999860   3.75000000  1  0  2   0.91629080
1   3.99999900   3.75000000  0  0  0  -0.69314720
1   6.99999950   3.75000000  1  1  1   0.40546510
1   0.00000000   3.75000000  1  0  2   0.91629080
1   0.00000000   2.54000000  1  1  0  -0.69314720
1   0.99999990   2.54000000  1  0  0  -0.69314720
1   3.99999900   2.76000000  0  0  0  -0.69314720
1   1.99999990   4.13999990  0  0  0  -0.69314720
```

```
1   3.99999900   0.92000000  0  0  1   0.40546510
1   0.00000000   1.00500000  0  0  0  -0.69314720
1   6.00000050   3.08999990  0  0  2   0.91629080
1   3.00000000   3.08999990  1  1  2   0.91629080
1   0.00000000   1.79000000  0  0  0  -0.69314720
1   3.00000000   1.40000000  0  0  1   0.40546510
1   3.00000000   1.40000000  0  0  4   1.50407740
1   0.00000000   1.40000000  1  0  2   0.91629080
1   0.00000000   1.40000000  0  0  2   0.91629080
1  13.99999710   1.40000000  0  0  0  -0.69314720
1  12.00000000   1.40000000  0  0  1   0.40546510
1   1.99999990   1.40000000  0  0  1   0.40546510
1   6.00000050   2.00000000  0  0  1   0.40546510
1  10.99999710   4.34000020  1  0  2   0.91629080
1   6.00000050   4.34000020  1  0  4   1.50407740
1   0.00000000   1.75000000  0  0  0  -0.69314720
1  36.00000000   2.09999990  1  0  6   1.87180220
1   7.99999860   2.09999990  0  0  1   0.40546510
1   1.99999990   2.09999990  0  0  0  -0.69314720
1  10.99999710   3.58999990  1  0  2   0.91629080
1  10.99999710   3.58999990  1  2  2   0.91629080
1  17.99999810   3.58999990  0  0  0  -0.69314720
1   3.99999900   3.58999990  0  0  0  -0.69314720
1  17.99999810   3.58999990  1  0 10   2.35137530
1   7.99999860   3.58999990  0  0  1   0.40546510
1  19.00000190   3.41000010  1  0  3   1.25276290
1   3.99999900   3.41000010  1  0  4   1.50407740
1   4.99999810   3.41000010  1  2  0  -0.69314720
1   6.99999950   3.40000010  0  0  1   0.40546510
1   3.99999900   3.40000010  1  1  2   0.91629080
1   4.99999810   3.40000010  1  0  4   1.50407740
1  13.99999710   3.40000010  1  0  1   0.40546510
1   3.99999900   3.40000010  1  0  0  -0.69314720
1   3.99999900   2.52000000  0  0  3   1.25276290
1   0.00000000   2.52000000  0  0  1   0.40546510
1  15.00000100   3.69000010  1  1  2   0.91629080
1   0.99999990   3.69000010  1  0  1   0.40546510
1   3.00000000   3.69000010  1  1  0  -0.69314720
1  17.99999810   3.69000010  0  0  1   0.40546510
1  15.00000100   2.86999990  0  0  0  -0.69314720
1   4.99999810   2.86999990  1  0  1   0.40546510
1  17.99999810   2.86999990  1  0  1   0.40546510
1   9.00000000   2.86999990  0  0  2   0.91629080
1   6.00000050   2.86999990  0  0  4   1.50407740
1  15.00000100   2.86999990  1  0  1   0.40546510
1   3.99999900   3.35999990  0  0  2   0.91629080
1   1.99999990   3.35999990  1  2  0  -0.69314720
1   3.00000000   3.35999990  0  0  2   0.91629080
1   6.99999950   3.35999990  0  0  0  -0.69314720
1  15.99999810   4.54000000  1  0  4   1.50407740
1  48.00000000   4.54000000  1  2  2   0.91629080
1  15.00000100   4.54000000  1  0  5   1.70474800
1  36.99999240   4.54000000  0  0  1   0.40546510
1   9.99999900   4.54000000  1  0  2   0.91629080
1  13.00000000   4.54000000  0  0  2   0.91629080
1   6.00000050   4.54000000  1  2  0  -0.69314720
```

```
1  13.00000000   0.75500000  0  0  0  -0.69314720
1   6.99999950   4.54000000  1  1  2   0.91629080
1   9.00000000   4.54000000  1  0  2   0.91629080
1   4.99999810   4.54000000  0  0  2   0.91629080
1  15.00000100   4.54000000  0  0  6   1.87180220
1   3.00000000   4.54000000  0  0  3   1.25276290
1  13.99999710   4.54000000  0  0  0  -0.69314720
1   1.99999990   1.28000000  1  0  1   0.40546510
1   3.99999900   1.28000000  1  0  4   1.50407740
1   3.99999900   1.28000000  1  0  0  -0.69314720
1   0.00000000   2.50000000  1  1  0  -0.69314720
1  47.00000760   3.84999990  1  2  2   0.91629080
1  29.00000000   3.84999990  1  0  1   0.40546510
1   0.99999990   3.84999990  1  1  5   1.70474800
1  17.99999810   3.84999990  0  0  1   0.40546510
1  13.00000000   2.05000000  0  0  1   0.40546510
1  17.00000000   2.05000000  0  0  1   0.40546510
1   1.99999990   2.05000000  0  0  2   0.91629080
1   3.99999900   1.78000000  1  0  4   1.50407740
1   0.99999990   1.17999990  1  0  1   0.40546510
1   3.00000000   1.52000000  1  0  0  -0.69314720
1   9.00000000   1.48000000  1  0  2   0.91629080
1  12.00000000   4.29000000  0  0  0  -0.69314720
1  17.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   4.29000000  0  0  3   1.25276290
1   1.99999990   3.08999990  1  0  2   0.91629080
1   0.00000000   3.08999990  0  0  2   0.91629080
1   3.00000000   3.61999990  0  0  5   1.70474800
1   6.99999950   3.61999990  0  0  0  -0.69314720
1   7.99999860   3.61999990  0  0  0  -0.69314720
1   0.00000000   4.29000000  0  0  0  -0.69314720
1   6.00000050   2.60999990  1  1  1   0.40546510
1   6.99999950   2.60999990  1  0  1   0.40546510
1   9.00000000   2.09999990  0  0  0  -0.69314720
1   7.99999860   2.96000000  1  0  2   0.91629080
1   9.99999900   2.39000010  0  0  0  -0.69314720
1   3.00000000   1.95000000  1  0  1   0.40546510
1  13.99999710   3.41000010  0  0  2   0.91629080
1   0.99999990   4.29000000  0  0  2   0.91629080
1  10.99999710   3.58999990  0  0  2   0.91629080
1   9.99999900   4.61999990  0  0  1   0.40546510
1   6.00000050   2.14000010  0  0  1   0.40546510
1  10.99999710   2.85999990  0  0  0  -0.69314720
1   4.99999810   3.47000000  0  0  2   0.91629080
1  13.99999710   4.61999990  1  1  3   1.25276290
1   9.00000000   3.19000010  1  3  1   0.40546510
1   0.99999990   2.51000000  0  0  1   0.40546510
1   0.00000000   2.11999990  0  0  0  -0.69314720
1   3.00000000   3.19000010  0  0  0  -0.69314720
1   3.99999900   1.74000000  1  1  2   0.91629080
1   0.00000000   1.25000000  1  0  0  -0.69314720
1   6.99999950   3.69000010  1  0  0  -0.69314720
1   4.99999810   3.21000000  0  0  0  -0.69314720
1  15.00000100   4.61999990  1  1  0  -0.69314720
1  24.00000190   2.85999990  1  0  5   1.70474800
1   9.00000000   2.39000010  1  1  1   0.40546510
```

1	0.00000000	1.17999990	1	0	3	1.25276290
1	6.99999950	3.35999990	0	0	2	0.91629080
1	7.99999860	1.97000000	0	0	2	0.91629080
1	22.00000000	1.64000000	1	0	1	0.40546510
1	6.99999950	3.92000010	1	0	2	0.91629080
1	6.00000050	3.31999990	0	0	6	1.87180220
1	6.00000050	2.57999990	0	0	5	1.70474800
1	22.99999620	4.54000000	0	0	2	0.91629080
1	1.99999990	2.39000010	1	0	0	-0.69314720
1	9.00000000	3.58999990	0	0	4	1.50407740
1	6.99999950	3.69000010	0	0	2	0.91629080
1	9.99999900	3.19000010	0	0	2	0.91629080
1	3.99999900	2.31999990	0	0	2	0.91629080
1	10.99999710	3.47000000	1	1	2	0.91629080
1	3.99999900	3.69000010	0	0	2	0.91629080
1	4.99999810	2.31999990	1	1	3	1.25276290
1	10.99999710	3.19000010	0	0	1	0.40546510
1	19.00000190	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	4.99999810	2.57999990	1	0	2	0.91629080
1	6.99999950	3.21000000	1	1	2	0.91629080
1	3.00000000	1.40000000	0	0	1	0.40546510
1	9.99999900	2.50000000	0	0	4	1.50407740
1	0.00000000	3.19000010	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	0	-0.69314720
1	9.00000000	3.15000010	0	0	6	1.87180220
1	6.99999950	1.45000000	1	0	2	0.91629080
1	6.99999950	2.85999990	1	2	1	0.40546510
1	48.99999240	4.61999990	1	1	3	1.25276290
1	1.99999990	3.69000010	1	0	0	-0.69314720
1	19.00000190	2.96000000	1	0	1	0.40546510
1	12.00000000	3.08999990	1	1	1	0.40546510
1	0.99999990	3.08999990	0	0	0	-0.69314720
1	12.00000000	4.61999990	0	0	2	0.91629080
1	13.00000000	2.85999990	1	0	0	-0.69314720
1	1.99999990	3.21000000	0	0	0	-0.69314720
1	3.00000000	2.82999990	1	0	2	0.91629080
1	22.00000000	4.29000000	0	0	1	0.40546510
1	35.00000760	4.29000000	0	0	0	-0.69314720
1	0.99999990	3.08999990	1	0	2	0.91629080
1	3.99999900	3.69000010	0	0	0	-0.69314720
1	0.99999990	1.79000000	1	0	0	-0.69314720
1	1.99999990	3.35999990	1	1	0	-0.69314720
1	13.99999710	2.57999990	1	0	4	1.50407740
1	24.00000190	3.75000000	0	0	1	0.40546510
1	4.99999810	3.19000010	0	0	2	0.91629080
1	0.99999990	2.09999990	0	0	0	-0.69314720
1	7.99999860	3.58999990	1	1	0	-0.69314720
1	0.99999990	3.92000010	0	0	0	-0.69314720
1	24.00000190	3.31999990	1	1	1	0.40546510
1	1.99999990	2.00000000	0	0	0	-0.69314720
1	1.99999990	3.47000000	1	0	0	-0.69314720
1	13.99999710	3.21000000	1	0	4	1.50407740
1	4.99999810	2.05000000	0	0	3	1.25276290
1	0.99999990	2.52000000	0	0	0	-0.69314720
1	6.99999950	3.15000010	1	0	0	-0.69314720

1	38.00000380	1.86000000	1	2	6	1.87180220
1	3.00000000	2.85999990	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	4	1.50407740
1	0.00000000	1.25500000	1	2	0	-0.69314720
1	19.00000190	3.21000000	1	0	5	1.70474800
1	4.99999810	2.31999990	1	1	1	0.40546510
1	3.00000000	3.19000010	0	0	4	1.50407740
1	1.99999990	3.19000010	1	0	1	0.40546510
1	10.99999710	3.35999990	1	0	3	1.25276290
1	13.99999710	3.54000000	1	1	1	0.40546510
1	6.00000050	1.86000000	1	0	0	-0.69314720
1	13.00000000	1.50500000	0	0	0	-0.69314720
1	6.99999950	2.39000010	1	0	1	0.40546510
1	10.99999710	4.29000000	1	1	2	0.91629080
1	9.00000000	2.00000000	1	1	0	-0.69314720
1	3.99999900	3.92000010	0	0	1	0.40546510
1	6.00000050	4.29000000	1	0	2	0.91629080
1	6.00000050	3.35999990	0	0	1	0.40546510
1	13.99999710	4.61999990	1	0	3	1.25276290
1	6.00000050	2.00000000	0	0	1	0.40546510
1	4.99999810	3.58999990	1	0	2	0.91629080
1	6.00000050	2.86999990	0	0	1	0.40546510
1	3.99999900	2.96000000	0	0	0	-0.69314720
1	10.99999710	3.47000000	1	0	0	-0.69314720
1	7.99999860	3.19000010	1	0	4	1.50407740
1	3.00000000	2.85999990	1	1	0	-0.69314720
1	15.99999810	2.52000000	1	0	2	0.91629080
1	6.00000050	4.29000000	0	0	1	0.40546510
1	0.00000000	1.25500000	0	0	1	0.40546510
1	1.99999990	1.83000000	1	0	0	-0.69314720
1	12.00000000	4.29000000	0	0	3	1.25276290
1	7.99999860	2.96000000	1	0	0	-0.69314720
1	0.99999990	2.31999990	1	0	1	0.40546510
1	10.99999710	1.22000000	1	1	0	-0.69314720
1	10.99999710	4.29000000	1	0	1	0.40546510
1	1.99999990	4.25000000	0	0	1	0.40546510
1	36.00000000	2.55000000	0	0	2	0.91629080
1	10.99999710	1.95000000	1	0	1	0.40546510
1	1.99999990	3.69000010	0	0	0	-0.69314720
1	25.00000000	4.29000000	0	0	1	0.40546510
1	4.99999810	3.19000010	1	0	2	0.91629080
1	12.00000000	3.54000000	1	1	4	1.50407740
1	4.99999810	3.54000000	1	0	4	1.50407740
1	7.99999860	3.54000000	1	1	0	-0.69314720
1	0.99999990	1.86000000	1	1	3	1.25276290
1	3.00000000	4.61999990	0	0	4	1.50407740
1	15.99999810	4.61999990	1	0	1	0.40546510
1	9.99999900	4.61999990	1	0	3	1.25276290
1	13.00000000	4.54000000	1	0	1	0.40546510
1	0.99999990	3.47000000	1	0	0	-0.69314720
1	15.99999810	2.85999990	0	0	0	-0.69314720
1	6.99999950	2.00000000	1	0	0	-0.69314720
1	1.99999990	2.00000000	0	0	0	-0.69314720
1	3.00000000	2.60999990	1	0	0	-0.69314720
1	6.00000050	2.05000000	0	0	0	-0.69314720
1	6.00000050	2.05000000	0	0	0	-0.69314720

1	4.99999810	3.54000000	0	0	0	-0.69314720
1	0.00000000	0.92000000	1	0	2	0.91629080
1	0.00000000	1.79000000	1	0	0	-0.69314720
1	6.00000050	2.00000000	1	0	0	-0.69314720
1	7.99999860	3.15000010	0	0	4	1.50407740
1	15.99999810	2.26000000	1	0	5	1.70474800
1	3.99999900	2.26000000	0	0	1	0.40546510
1	0.99999990	4.29000000	1	0	6	1.87180220
1	21.00000000	4.29000000	1	0	1	0.40546510
1	9.00000000	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	1.99999990	2.52000000	0	0	0	-0.69314720
1	9.99999900	4.29000000	0	0	3	1.25276290
1	9.00000000	4.29000000	0	0	0	-0.69314720
1	12.00000000	4.54000000	0	0	2	0.91629080
1	0.00000000	2.50000000	0	0	0	-0.69314720
1	1.99999990	2.76000000	0	0	1	0.40546510
1	0.00000000	2.55000000	1	1	0	-0.69314720
1	0.00000000	4.61999990	1	0	0	-0.69314720
1	6.00000050	1.63000000	0	0	2	0.91629080
1	3.00000000	3.47000000	1	0	1	0.40546510
1	30.99998860	3.41000010	1	0	2	0.91629080
1	0.99999990	4.29000000	0	0	0	-0.69314720
1	6.99999950	2.96000000	1	0	0	-0.69314720
1	0.00000000	4.61999990	1	0	5	1.70474800
1	12.00000000	3.58999990	1	0	0	-0.69314720
1	12.00000000	3.69000010	1	0	3	1.25276290
1	1.99999990	4.54000000	1	0	1	0.40546510
1	10.99999710	3.33999990	0	0	4	1.50407740
1	1.99999990	2.51000000	1	1	4	1.50407740
1	3.99999900	3.15000010	1	0	3	1.25276290
1	3.00000000	3.19000010	1	0	1	0.40546510
1	17.99999810	3.19000010	0	0	1	0.40546510
1	1.99999990	3.84999990	0	0	1	0.40546510
1	3.99999900	3.33999990	1	1	2	0.91629080
1	15.00000100	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	0	0	2	0.91629080
1	21.00000000	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	0	-0.69314720
1	0.00000000	2.96000000	1	0	0	-0.69314720
1	0.99999990	1.78000000	1	0	0	-0.69314720
1	17.00000000	3.54000000	1	2	1	0.40546510
1	3.00000000	3.69000010	1	0	0	-0.69314720
1	1.99999990	3.35999990	0	0	3	1.25276290
1	1.99999990	3.54000000	1	0	0	-0.69314720
1	0.99999990	3.54000000	1	1	0	-0.69314720
1	3.00000000	1.22000000	1	1	3	1.25276290
1	3.99999900	3.35999990	0	0	1	0.40546510
1	1.99999990	2.21000000	0	0	1	0.40546510
1	3.99999900	2.25000000	0	0	1	0.40546510
1	17.00000000	4.61999990	1	1	2	0.91629080
1	4.99999810	3.58999990	1	0	1	0.40546510
1	0.99999990	4.29000000	1	0	0	-0.69314720
1	1.99999990	2.11999990	0	0	2	0.91629080
1	3.00000000	2.26000000	0	0	2	0.91629080
1	3.00000000	2.26000000	1	0	4	1.50407740

1	4.99999810	4.29000000	0	0	0	-0.69314720
1	3.00000000	3.58999990	1	1	3	1.25276290
1	13.00000000	4.29000000	1	2	1	0.40546510
1	1.99999990	2.00000000	0	0	1	0.40546510
1	0.00000000	1.97000000	1	2	0	-0.69314720
1	7.99999860	3.92000010	1	0	0	-0.69314720
1	39.00000000	2.85999990	0	0	4	1.50407740
1	26.00000000	2.82999990	0	0	2	0.91629080
1	3.00000000	3.35999990	1	1	3	1.25276290
1	22.99999620	2.55999990	0	0	4	1.50407740
1	7.99999860	1.63000000	0	0	1	0.40546510
1	22.00000000	4.61999990	0	0	3	1.25276290
1	4.99999810	4.61999990	0	0	1	0.40546510
1	21.00000000	4.29000000	1	0	3	1.25276290
1	6.00000050	4.29000000	1	1	0	-0.69314720
1	3.99999900	4.29000000	1	1	2	0.91629080
1	24.00000190	4.29000000	1	0	6	1.87180220
1	6.00000050	4.29000000	1	0	1	0.40546510
1	33.99999240	3.35999990	0	0	1	0.40546510
1	0.00000000	3.21000000	0	0	2	0.91629080
1	9.99999900	2.00000000	0	0	1	0.40546510
1	1.99999990	3.21000000	1	2	2	0.91629080
1	3.00000000	2.57999990	1	2	2	0.91629080
1	3.00000000	2.57999990	1	0	0	-0.69314720
1	0.99999990	2.82999990	0	0	0	-0.69314720
1	6.00000050	3.19000010	0	0	1	0.40546510
1	3.00000000	3.47000000	0	0	1	0.40546510
1	22.99999620	4.61999990	1	0	2	0.91629080
1	13.00000000	4.25000000	1	0	4	1.50407740
1	4.99999810	1.86000000	1	0	2	0.91629080
1	9.00000000	4.29000000	1	1	0	-0.69314720
1	9.00000000	3.35999990	0	0	0	-0.69314720
1	9.99999900	1.80000000	1	0	2	0.91629080
1	0.00000000	1.65500000	0	0	1	0.40546510
1	6.00000050	2.85999990	0	0	0	-0.69314720
1	13.99999710	4.61999990	0	0	2	0.91629080
1	3.00000000	4.29000000	0	0	0	-0.69314720
1	4.99999810	2.35999990	1	0	4	1.50407740
1	10.99999710	1.80999990	1	0	1	0.40546510
1	32.00001140	3.58999990	1	0	1	0.40546510
1	9.99999900	1.76000000	0	0	0	-0.69314720
1	4.99999810	2.00000000	1	0	1	0.40546510
1	13.99999710	3.58999990	0	0	5	1.70474800
1	6.00000050	2.26000000	1	0	3	1.25276290
1	3.99999900	2.26000000	0	0	1	0.40546510
1	3.99999900	1.76000000	1	1	1	0.40546510
1	0.99999990	3.58999990	1	0	1	0.40546510
1	0.99999990	3.58999990	1	0	0	-0.69314720
1	4.99999810	2.82999990	1	1	1	0.40546510
1	1.99999990	2.57999990	0	0	1	0.40546510
1	17.99999810	4.61999990	1	0	1	0.40546510
1	15.00000100	2.31999990	0	0	1	0.40546510
1	0.00000000	2.39000010	1	0	0	-0.69314720
1	22.00000000	2.96000000	1	0	3	1.25276290
1	10.99999710	2.11999990	0	0	0	-0.69314720
1	17.99999810	4.61999990	1	0	1	0.40546510

```
1   3.00000000   2.25000000  1  0  1   0.40546510
1   7.99999860   1.76000000  1  0  1   0.40546510
1  12.00000000   4.54000000  0  0  6   1.87180220
1   9.99999900   3.69000010  1  1  2   0.91629080
1   1.99999990   1.25000000  0  0  0  -0.69314720
1   4.99999810   1.25000000  1  0  1   0.40546510
1   3.99999900   3.19000010  1  0  0  -0.69314720
1   0.00000000   2.57999990  1  2  0  -0.69314720
1   6.99999950   2.00000000  1  1  2   0.91629080
1   0.99999990   2.76000000  0  0  0  -0.69314720
1   3.99999900   2.54000000  0  0  2   0.91629080
1   0.00000000   3.19000010  0  0  0  -0.69314720
1   9.00000000   3.08999990  1  2  1   0.40546510
1   3.99999900   3.19000010  0  0  2   0.91629080
1   0.00000000   3.08999990  0  0  0  -0.69314720
1   7.99999860   2.26000000  0  0  2   0.91629080
1   9.00000000   2.26000000  1  1  1   0.40546510
1   7.99999860   3.35999990  1  0  2   0.91629080
1   9.00000000   3.15000010  1  0  1   0.40546510
1   3.99999900   4.54000000  1  0  0  -0.69314720
1   0.00000000   3.58999990  1  0  2   0.91629080
1   3.00000000   3.47000000  1  0  1   0.40546510
1   1.99999990   2.85999990  1  1  1   0.40546510
1   6.00000050   2.26000000  1  0  0  -0.69314720
1   3.99999900   3.47000000  1  1  2   0.91629080
1   0.00000000   2.76000000  1  0  0  -0.69314720
1   1.99999990   3.58999990  1  2  0  -0.69314720
1  13.00000000   3.75000000  0  0  5   1.70474800
1   1.99999990   2.57999990  1  2  1   0.40546510
1   1.99999990   3.58999990  1  1  2   0.91629080
1  15.99999810   1.89000000  1  2  3   1.25276290
1   9.00000000   3.15000010  0  0  7   2.01490310
1  12.00000000   2.86999990  0  0  5   1.70474800
1   0.99999990   2.11999990  1  2  0  -0.69314720
1   3.99999900   4.61999990  1  0  1   0.40546510
1   0.00000000   2.39000010  0  0  0  -0.69314720
1  10.99999710   2.11999990  0  0  0  -0.69314720
1   4.99999810   1.80999990  1  0  0  -0.69314720
1   7.99999860   2.31999990  0  0  4   1.50407740
1  15.00000100   2.39000010  0  0  0  -0.69314720
1   6.00000050   3.75000000  1  0  3   1.25276290
1   0.00000000   2.00000000  0  0  0  -0.69314720
1  13.99999710   3.58999990  1  1  0  -0.69314720
1   4.99999810   4.29000000  0  0  2   0.91629080
1   0.00000000   2.57999990  1  0  0  -0.69314720
1   4.99999810   4.61999990  1  0  0  -0.69314720
1   3.00000000   1.50500000  0  0  0  -0.69314720
1   3.99999900   3.75000000  1  0  2   0.91629080
1   3.99999900   3.75000000  1  2  0  -0.69314720
1   0.00000000   1.75000000  1  0  1   0.40546510
1   0.00000000   2.11999990  1  0  1   0.40546510
1   4.99999810   3.75000000  0  0  2   0.91629080
1   0.00000000   0.75500000  0  0  0  -0.69314720
1   6.99999950   2.25000000  0  0  1   0.40546510
1   3.00000000   3.19000010  0  0  1   0.40546510
;
```

Click **Run** to create the Work.Long97Data table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-Sectional Data Models** to add the step to your flow.

3 Add the Work.Long97Data table to your flow and connect it to the Cross-Sectional Data Models node. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

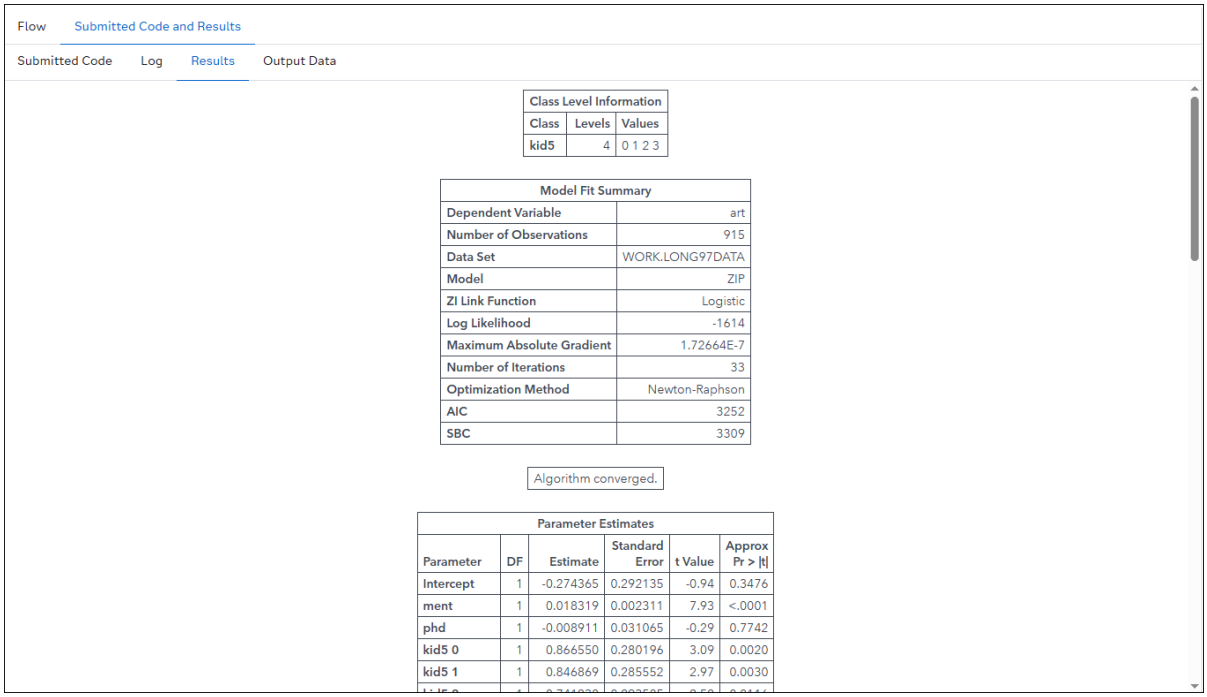
5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **art**.
- To the **Continuous variables** role, assign **ment** and **phd**.
- To the **Categorical variables** role, assign **kid5**.

6 On the **Model** tab, select **Zero-inflated Poisson** as the model type.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Zero-Inflated Poisson Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric column that contains the count values. In the input data set, this variable must contain only nonnegative integer values.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the zero-inflated Poisson model.

1 From the **Model type** drop-down list, select **Poisson**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Specify the link function to use to compute the probability of zeros. You can choose from the logistic function (default) or the normal function.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available:

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Specify the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

4 Select the statistics to be displayed in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of the parameter estimates
- (SAS Compute Server) iteration history of the objective function and parameter estimates

5 Select the plots to include in the results.

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- a table that contains the default statistics from the analysis and any selected statistics such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor. If you are running the step on a CAS server, you must specify a CAS engine libref when naming the table.
- a table of parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Zero-Inflated Negative Binomial Models

Example: Zero-Inflated Negative Binomial Model

To create this example:

1 Copy and paste this code on a **SAS program** tab:

```
data long97data;
   input fem ment phd mar kid5 art lnart;
datalines;
0   7.99999860   1.38000000  1  2  3   1.25276290
0   6.99999950   4.29000000  0  0  0  -0.69314720
0  47.00000760   3.84999990  0  0  4   1.50407740
0  19.00000190   3.58999990  1  1  1   0.40546510
0   0.00000000   1.80999990  1  0  1   0.40546510
0   6.00000050   3.58999990  1  1  1   0.40546510
0   9.99999900   2.11999990  1  1  0  -0.69314720
0   1.99999990   4.29000000  1  0  0  -0.69314720
0   1.99999990   2.57999990  1  2  3   1.25276290
0   3.99999900   1.80000000  1  1  3   1.25276290
0   0.00000000   4.29000000  1  2  1   0.40546510
0   3.00000000   2.76000000  1  1  0  -0.69314720
0   9.99999900   3.41000010  1  1  1   0.40546510
0   6.99999950   4.34000020  1  3  2   0.91629080
0  15.00000100   3.84999990  1  2  5   1.70474800
0   1.99999990   2.09999990  1  0  2   0.91629080
0  13.00000000   4.29000000  1  0  2   0.91629080
0  15.00000100   4.29000000  0  0  1   0.40546510
0   4.99999810   2.26000000  1  1  0  -0.69314720
0   6.00000050   2.09999990  0  0  0  -0.69314720
0  12.00000000   2.26000000  1  0  3   1.25276290
0  15.99999810   3.84999990  1  1  6   1.87180220
0   6.99999950   4.29000000  0  0  4   1.50407740
0   6.00000050   1.80000000  1  2  2   0.91629080
0   1.99999990   2.26000000  0  0  2   0.91629080
0   0.00000000   2.09999990  0  0  0  -0.69314720
0  30.00000190   4.29000000  1  0  4   1.50407740
0   9.99999900   4.29000000  1  2  1   0.40546510
0   1.99999990   2.09999990  1  0  1   0.40546510
0   0.99999990   3.58999990  1  0  7   2.01490310
0   3.00000000   3.42000010  1  1  2   0.91629080
0   9.99999900   4.29000000  1  2  2   0.91629080
0   9.99999900   4.29000000  0  0  2   0.91629080
0   0.99999990   3.33999990  1  2  0  -0.69314720
0   1.99999990   4.29000000  0  0  0  -0.69314720
0  10.99999710   4.29000000  1  0  1   0.40546510
0   4.99999810   3.61999990  1  0  4   1.50407740
0   0.00000000   4.29000000  1  3  1   0.40546510
0   3.99999900   4.34000020  1  1  1   0.40546510
```

0	1.99999990	1.25000000	1	1	2	0.91629080
0	19.00000190	4.34000020	0	0	7	2.01490310
0	3.00000000	1.67000000	1	3	1	0.40546510
0	0.00000000	3.47000000	0	0	0	-0.69314720
0	0.99999990	2.26000000	1	1	1	0.40546510
0	0.99999990	1.80000000	1	0	1	0.40546510
0	17.00000000	4.34000020	1	2	2	0.91629080
0	3.00000000	3.58999990	0	0	2	0.91629080
0	0.99999990	1.75000000	1	2	1	0.40546510
0	6.00000050	4.29000000	0	0	1	0.40546510
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	15.00000100	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	26.99999810	3.31999990	1	2	2	0.91629080
0	4.99999810	4.34000020	1	0	2	0.91629080
0	6.99999950	3.41000010	0	0	4	1.50407740
0	0.00000000	4.29000000	1	0	1	0.40546510
0	10.99999710	3.19000010	1	0	2	0.91629080
0	13.00000000	4.29000000	1	0	2	0.91629080
0	3.99999900	1.74000000	1	2	1	0.40546510
0	3.99999900	2.76000000	0	0	1	0.40546510
0	26.99999810	3.58999990	1	1	7	2.01490310
0	9.99999900	1.80999990	1	0	4	1.50407740
0	13.00000000	4.29000000	1	1	2	0.91629080
0	0.99999990	4.29000000	1	1	1	0.40546510
0	6.00000050	2.76000000	0	0	1	0.40546510
0	6.00000050	3.47000000	0	0	6	1.87180220
0	4.99999810	2.50000000	1	2	2	0.91629080
0	1.99999990	1.25000000	1	0	5	1.70474800
0	13.99999710	3.58999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	12.00000000	3.58999990	1	0	1	0.40546510
0	6.99999950	3.58999990	1	3	0	-0.69314720
0	3.00000000	1.75000000	1	0	1	0.40546510
0	1.99999990	1.75000000	1	2	1	0.40546510
0	1.99999990	3.58999990	1	1	1	0.40546510
0	1.99999990	4.29000000	0	0	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	0.00000000	2.60999990	1	0	3	1.25276290
0	30.00000190	4.29000000	1	0	5	1.70474800
0	21.00000000	1.74000000	1	0	16	2.80336050
0	4.99999810	2.76000000	1	0	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	7.99999860	2.76000000	1	2	1	0.40546510
0	25.00000000	4.29000000	1	2	3	1.25276290
0	0.00000000	3.47000000	1	1	5	1.70474800
0	4.99999810	2.57999990	1	2	0	-0.69314720
0	0.99999990	2.14000010	1	0	0	-0.69314720
0	4.99999810	2.26000000	0	0	0	-0.69314720
0	0.00000000	4.29000000	1	2	3	1.25276290
0	15.00000100	4.29000000	1	0	3	1.25276290
0	30.00000190	4.29000000	0	0	3	1.25276290
0	1.99999990	2.20000000	1	0	0	-0.69314720
0	6.00000050	1.80000000	1	2	3	1.25276290
0	0.00000000	2.09999990	1	2	1	0.40546510

0	13.00000000	4.29000000	1	1	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	12.00000000	2.09999990	1	1	0	-0.69314720
0	30.00000190	4.29000000	1	2	2	0.91629080
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0	9.99999900	4.34000020	1	0	1	0.40546510
0	4.99999810	4.29000000	1	1	0	-0.69314720
0	3.99999900	2.50000000	1	2	1	0.40546510
0	13.00000000	2.05000000	1	2	4	1.50407740
0	7.99999860	3.47000000	1	0	3	1.25276290
0	6.00000050	2.60999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	2	1	0.40546510
0	25.00000000	4.29000000	0	0	2	0.91629080
0	1.99999990	4.29000000	1	1	2	0.91629080
0	9.00000000	4.34000020	1	0	6	1.87180220
0	9.99999900	2.11999990	1	1	0	-0.69314720
0	3.00000000	2.76000000	1	0	2	0.91629080
0	1.99999990	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	4.34000020	1	0	5	1.70474800
0	7.99999860	2.76000000	1	1	2	0.91629080
0	9.99999900	3.19000010	1	1	2	0.91629080
0	7.99999860	4.61999990	0	0	3	1.25276290
0	6.00000050	3.15000010	1	2	0	-0.69314720
0	21.00000000	2.55000000	1	1	4	1.50407740
0	3.99999900	1.52000000	1	0	0	-0.69314720
0	1.99999990	1.72000000	1	2	4	1.50407740
0	0.99999990	1.78000000	1	1	2	0.91629080
0	17.00000000	2.85999990	1	1	1	0.40546510
0	30.00000190	4.61999990	1	2	0	-0.69314720
0	4.99999810	4.13999990	0	0	1	0.40546510
0	13.00000000	2.96000000	1	1	6	1.87180220
0	10.99999710	2.55000000	1	0	1	0.40546510
0	19.00000190	2.21000000	1	1	0	-0.69314720
0	4.99999810	3.08999990	1	0	3	1.25276290
0	66.00000760	4.54000000	1	2	4	1.50407740
0	0.00000000	1.78000000	1	0	3	1.25276290
0	3.00000000	2.21000000	1	3	0	-0.69314720
0	3.00000000	2.39000010	1	1	1	0.40546510
0	0.00000000	2.96000000	1	0	0	-0.69314720
0	7.99999860	2.51000000	1	1	0	-0.69314720
0	0.00000000	1.97000000	1	2	2	0.91629080
0	4.99999810	4.13999990	0	0	0	-0.69314720
0	29.00000000	4.25000000	1	1	4	1.50407740
0	10.99999710	2.85999990	1	2	0	-0.69314720
0	22.99999620	2.96000000	1	1	9	2.25129180
0	45.99999240	2.96000000	1	2	2	0.91629080
0	7.99999860	4.61999990	1	1	6	1.87180220
0	4.99999810	3.69000010	1	2	0	-0.69314720
0	0.99999990	3.15000010	1	1	0	-0.69314720
0	9.00000000	4.61999990	0	0	2	0.91629080
0	1.99999990	3.35999990	1	0	0	-0.69314720
0	6.99999950	3.69000010	0	0	4	1.50407740
0	10.99999710	3.54000000	1	0	1	0.40546510
0	56.99999620	2.96000000	1	1	4	1.50407740
0	15.99999810	2.55999990	1	1	1	0.40546510

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0   3.00000000   2.31999990  1  0  0  -0.69314720
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0   9.99999900   4.54000000  1  0  0  -0.69314720
0  10.99999710   4.54000000  1  3  0  -0.69314720
0  10.99999710   1.76000000  1  1  5   1.70474800
0  15.99999810   2.55999990  0  0  1   0.40546510
0   4.99999810   2.39000010  1  1  0  -0.69314720
0   9.00000000   3.40000010  1  0  2   0.91629080
0  19.99999620   2.86999990  1  2  2   0.91629080
0  21.00000000   4.54000000  1  2  4   1.50407740
0   4.99999810   2.82999990  1  0  4   1.50407740
0   6.00000050   1.67999990  1  0  0  -0.69314720
0  12.00000000   3.54000000  0  0  3   1.25276290
0   0.00000000   1.76000000  1  0  2   0.91629080
0  10.99999710   3.15000010  1  3  1   0.40546510
0   3.00000000   2.51000000  1  0  0  -0.69314720
0  15.99999810   3.69000010  1  1  0  -0.69314720
0  10.99999710   1.76000000  1  1  4   1.50407740
0   4.99999810   1.86000000  1  1 12   2.52572870
0   0.99999990   2.76000000  1  3  0  -0.69314720
0  15.99999810   4.61999990  1  1  1   0.40546510
0  12.00000000   4.25000000  1  0  5   1.70474800
0  10.99999710   2.54000000  1  0  4   1.50407740
0   0.00000000   2.20000000  1  1  0  -0.69314720
0   0.00000000   1.76000000  1  0  2   0.91629080
0   3.00000000   2.85999990  1  3  3   1.25276290
0  13.00000000   3.40000010  1  2  0  -0.69314720
0  45.00000000   4.54000000  1  1  1   0.40546510
0  47.00000760   1.86000000  1  1  9   2.25129180
0   6.99999950   1.52000000  1  0  0  -0.69314720
0   6.99999950   2.55999990  1  1  2   0.91629080
0  19.00000190   2.21000000  1  0  0  -0.69314720
0   9.00000000   3.69000010  1  0  7   2.01490310
0  76.99998470   1.78000000  1  1  1   0.40546510
0   0.00000000   1.17999990  1  1  0  -0.69314720
0   3.99999900   2.00000000  1  0  1   0.40546510
0  19.00000190   2.21000000  1  0  0  -0.69314720
0  12.00000000   4.13999990  1  2  0  -0.69314720
0   0.99999990   2.85999990  1  3  0  -0.69314720
0  17.00000000   2.85999990  1  1  1   0.40546510
0   6.00000050   2.54000000  0  0  7   2.01490310
0   3.99999900   2.85999990  1  1  0  -0.69314720
0   6.00000050   2.52000000  0  0  4   1.50407740
0   3.00000000   1.52000000  1  1  2   0.91629080
0   4.99999810   3.08999990  1  1  3   1.25276290
0   3.00000000   1.17999990  1  1  0  -0.69314720
0   3.00000000   1.42000000  1  0  0  -0.69314720
0  15.00000100   4.61999990  0  0  7   2.01490310
0   0.00000000   2.96000000  1  2  1   0.40546510
0   9.99999900   4.54000000  0  0  2   0.91629080
0  41.99999620   4.54000000  0  0  7   2.01490310
0   3.00000000   2.51000000  1  2  1   0.40546510
0   6.99999950   3.15000010  1  1  2   0.91629080
0   0.00000000   2.50000000  1  0  1   0.40546510
0   6.00000050   2.96000000  1  3  1   0.40546510
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0	3.99999900	1.67999990	1	0	0	-0.69314720
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0	4.99999810	2.21000000	1	1	0	-0.69314720
0	0.99999990	3.92000010	1	1	0	-0.69314720
0	13.00000000	4.54000000	1	0	5	1.70474800
0	0.00000000	1.17999990	1	0	2	0.91629080
0	26.00000000	3.69000010	1	0	3	1.25276290
0	0.99999990	1.72000000	1	0	2	0.91629080
0	25.00000000	2.57999990	1	1	5	1.70474800
0	3.00000000	1.52000000	0	0	3	1.25276290
0	47.00000760	1.86000000	1	1	4	1.50407740
0	3.99999900	2.50000000	1	0	5	1.70474800
0	0.99999990	4.61999990	1	0	1	0.40546510
0	6.99999950	1.40000000	1	2	0	-0.69314720
0	4.99999810	4.54000000	1	0	3	1.25276290
0	26.99999810	1.67999990	1	1	0	-0.69314720
0	0.99999990	2.82999990	1	0	2	0.91629080
0	4.99999810	3.35999990	0	0	1	0.40546510
0	0.00000000	1.97000000	1	1	7	2.01490310
0	12.00000000	3.40000010	0	0	1	0.40546510
0	3.99999900	1.74000000	1	1	1	0.40546510
0	0.00000000	2.96000000	0	0	0	-0.69314720
0	25.00000000	2.57999990	1	1	4	1.50407740
0	3.00000000	4.54000000	1	1	1	0.40546510
0	1.99999990	3.15000010	1	1	0	-0.69314720
0	12.00000000	2.96000000	1	2	0	-0.69314720
0	15.99999810	3.54000000	1	2	2	0.91629080
0	4.99999810	2.96000000	1	1	3	1.25276290
0	12.00000000	4.25000000	1	0	1	0.40546510
0	4.99999810	2.55999990	1	1	2	0.91629080
0	4.99999810	1.86000000	1	0	1	0.40546510
0	3.00000000	4.61999990	1	1	1	0.40546510
0	3.99999900	2.85999990	0	0	2	0.91629080
0	4.99999810	3.15000010	1	1	5	1.70474800
0	0.00000000	2.51000000	1	0	2	0.91629080
0	26.99999810	3.15000010	1	1	5	1.70474800
0	4.99999810	2.51000000	1	0	2	0.91629080
0	0.00000000	1.52000000	1	1	0	-0.69314720
0	17.99999810	4.29000000	0	0	6	1.87180220
0	4.99999810	4.29000000	1	1	4	1.50407740
0	7.99999860	4.29000000	1	2	2	0.91629080
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0	35.00000760	4.29000000	1	1	12	2.52572870
0	4.99999810	4.29000000	0	0	2	0.91629080
0	9.00000000	3.58999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	0	1	0.40546510
0	24.00000190	4.29000000	1	0	2	0.91629080
0	0.00000000	2.09999990	1	1	0	-0.69314720
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0	19.00000190	4.29000000	0	0	7	2.01490310
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0	9.99999900	3.58999990	1	0	1	0.40546510
0	7.99999860	2.09999990	1	1	1	0.40546510

0	1.99999990	4.29000000	1	0	4	1.50407740
0	19.00000190	4.29000000	1	1	3	1.25276290
0	0.99999990	3.47000000	1	1	1	0.40546510
0	3.00000000	3.19000010	1	0	1	0.40546510
0	4.99999810	3.19000010	1	2	1	0.40546510
0	0.00000000	2.09999990	1	0	1	0.40546510
0	21.00000000	3.58999990	1	1	5	1.70474800
0	13.99999710	4.29000000	1	1	1	0.40546510
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0	6.99999950	2.76000000	1	1	1	0.40546510
0	4.99999810	2.60999990	1	0	3	1.25276290
0	22.00000000	4.29000000	1	0	4	1.50407740
0	19.99999620	3.41000010	0	0	7	2.01490310
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0	19.00000190	4.29000000	0	0	4	1.50407740
0	3.00000000	2.26000000	0	0	2	0.91629080
0	15.99999810	3.58999990	0	0	3	1.25276290
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0	3.00000000	2.05000000	0	0	1	0.40546510
0	12.00000000	4.29000000	1	2	1	0.40546510
0	35.00000760	4.29000000	0	0	0	-0.69314720
0	19.00000190	4.29000000	1	0	0	-0.69314720
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0	7.99999860	3.58999990	0	0	0	-0.69314720
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0	3.00000000	4.29000000	1	1	0	-0.69314720
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0	21.00000000	3.41000010	0	0	4	1.50407740
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0	17.00000000	4.29000000	1	0	2	0.91629080
0	4.99999810	4.29000000	0	0	0	-0.69314720
0	1.99999990	2.14000010	0	0	0	-0.69314720
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0	1.99999990	2.50000000	1	1	2	0.91629080
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0	9.00000000	4.29000000	0	0	0	-0.69314720
0	17.00000000	4.29000000	0	0	2	0.91629080
0	24.00000190	4.29000000	1	2	0	-0.69314720
0	3.99999900	3.47000000	1	0	4	1.50407740
0	13.99999710	4.29000000	1	1	2	0.91629080
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0	7.99999860	4.29000000	1	0	0	-0.69314720

0	0.99999990	2.26000000	1	0	1	0.40546510
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	13.00000000	4.29000000	1	2	0	-0.69314720
0	4.99999810	3.58999990	1	2	0	-0.69314720
0	6.99999950	3.41000010	1	2	0	-0.69314720
0	6.99999950	3.58999990	0	0	3	1.25276290
0	4.99999810	3.61999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	3	1	0.40546510
0	13.99999710	4.29000000	0	0	1	0.40546510
0	6.00000050	4.29000000	1	0	0	-0.69314720
0	4.99999810	2.26000000	1	1	1	0.40546510
0	7.99999860	2.76000000	1	0	3	1.25276290
0	3.99999900	2.60999990	1	1	1	0.40546510
0	9.00000000	4.29000000	0	0	2	0.91629080
0	3.00000000	2.09999990	1	1	2	0.91629080
0	1.99999990	3.47000000	1	1	0	-0.69314720
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0	9.00000000	4.29000000	0	0	1	0.40546510
0	7.99999860	2.96000000	1	0	1	0.40546510
0	1.99999990	2.96000000	1	0	2	0.91629080
0	17.99999810	4.61999990	1	0	3	1.25276290
0	3.00000000	1.42000000	1	0	3	1.25276290
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0	6.99999950	2.52000000	1	0	0	-0.69314720
0	9.99999900	4.54000000	1	1	2	0.91629080
0	15.99999810	2.00000000	1	1	1	0.40546510
0	4.99999810	2.54000000	1	0	0	-0.69314720
0	0.00000000	2.50000000	1	0	2	0.91629080
0	7.99999860	4.54000000	0	0	0	-0.69314720
0	9.99999900	3.35999990	0	0	1	0.40546510
0	17.99999810	3.40000010	1	1	0	-0.69314720
0	12.00000000	1.67999990	1	1	1	0.40546510
0	9.00000000	2.00000000	0	0	1	0.40546510
0	39.00000000	2.85999990	1	0	1	0.40546510
0	17.99999810	4.61999990	1	0	1	0.40546510
0	15.00000100	4.13999990	1	0	1	0.40546510
0	15.99999810	4.13999990	1	0	2	0.91629080
0	1.99999990	2.96000000	0	0	0	-0.69314720
0	6.99999950	2.82999990	1	2	3	1.25276290
0	24.00000190	2.55000000	1	0	2	0.91629080
0	7.99999860	1.67999990	1	0	1	0.40546510
0	6.99999950	2.00000000	0	0	1	0.40546510
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0	3.99999900	1.50500000	1	0	4	1.50407740
0	21.00000000	3.54000000	1	0	2	0.91629080
0	6.00000050	3.40000010	0	0	1	0.40546510
0	6.00000050	4.61999990	0	0	0	-0.69314720
0	7.99999860	2.82999990	0	0	3	1.25276290
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0	12.00000000	2.86999990	0	0	1	0.40546510
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0	0.00000000	3.92000010	1	1	1	0.40546510
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0	15.00000100	2.85999990	1	2	4	1.50407740

0	4.99999810	4.54000000	0	0	0	-0.69314720
0	7.99999860	4.61999990	0	0	0	-0.69314720
0	13.00000000	2.85999990	1	1	0	-0.69314720
0	1.99999990	3.40000010	0	0	1	0.40546510
0	6.00000050	2.57999990	1	2	4	1.50407740
0	19.99999620	4.25000000	1	0	3	1.25276290
0	6.99999950	1.76000000	1	1	2	0.91629080
0	6.99999950	2.85999990	1	3	0	-0.69314720
0	15.99999810	3.69000010	1	2	4	1.50407740
0	13.00000000	3.40000010	1	0	0	-0.69314720
0	0.00000000	3.40000010	1	2	0	-0.69314720
0	0.99999990	4.54000000	1	2	0	-0.69314720
0	12.00000000	2.86999990	0	0	3	1.25276290
0	6.99999950	1.76000000	1	0	4	1.50407740
0	3.99999900	4.25000000	0	0	1	0.40546510
0	0.00000000	3.92000010	0	0	3	1.25276290
0	3.99999900	3.35999990	1	0	2	0.91629080
0	3.99999900	2.31999990	1	0	1	0.40546510
0	36.99999240	4.54000000	0	0	2	0.91629080
0	22.99999620	3.35999990	1	1	0	-0.69314720
0	7.99999860	2.00000000	1	3	2	0.91629080
0	7.99999860	3.92000010	1	1	1	0.40546510
0	1.99999990	3.92000010	0	0	1	0.40546510
0	0.00000000	3.35999990	0	0	1	0.40546510
0	0.99999990	1.78000000	1	0	1	0.40546510
0	21.00000000	3.54000000	1	1	1	0.40546510
0	9.99999900	3.92000010	0	0	2	0.91629080
0	7.99999860	2.31999990	0	0	3	1.25276290
0	33.99999240	1.67999990	1	0	1	0.40546510
0	13.99999710	3.08999990	0	0	2	0.91629080
0	6.00000050	2.57999990	1	1	0	-0.69314720
0	13.99999710	3.40000010	0	0	6	1.87180220
0	12.00000000	2.86999990	0	0	3	1.25276290
0	17.99999810	4.61999990	0	0	4	1.50407740
0	3.00000000	2.96000000	1	3	0	-0.69314720
0	6.00000050	1.86000000	1	2	2	0.91629080
0	1.99999990	1.22000000	1	1	0	-0.69314720
0	10.99999710	2.51000000	1	2	6	1.87180220
0	10.99999710	2.51000000	1	0	8	2.14006610
0	4.99999810	3.69000010	1	0	2	0.91629080
0	7.99999860	2.96000000	1	0	3	1.25276290
0	3.99999900	1.78000000	1	0	1	0.40546510
0	0.99999990	1.22000000	1	1	1	0.40546510
0	7.99999860	2.85999990	1	0	0	-0.69314720
0	19.00000190	3.69000010	0	0	7	2.01490310
0	1.99999990	2.11999990	0	0	0	-0.69314720
0	9.99999900	2.52000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	1	0.40546510
0	3.00000000	4.61999990	1	0	2	0.91629080
0	1.99999990	3.54000000	1	2	4	1.50407740
0	0.99999990	2.50000000	1	0	0	-0.69314720
0	4.99999810	1.67999990	0	0	0	-0.69314720
0	1.99999990	3.40000010	1	1	1	0.40546510
0	4.99999810	3.92000010	0	0	0	-0.69314720
0	52.99998090	4.54000000	1	1	5	1.70474800
0	54.99998860	4.54000000	0	0	2	0.91629080

0	0.00000000	2.50000000	0	0	0	-0.69314720
0	10.99999710	4.54000000	1	0	2	0.91629080
0	25.00000000	3.54000000	0	0	3	1.25276290
0	4.99999810	1.52000000	1	0	2	0.91629080
0	1.99999990	3.92000010	1	2	0	-0.69314720
0	7.99999860	4.61999990	1	0	2	0.91629080
0	0.00000000	3.92000010	1	0	3	1.25276290
0	4.99999810	2.31999990	1	2	0	-0.69314720
0	7.99999860	2.96000000	1	2	2	0.91629080
0	6.99999950	2.85999990	1	2	1	0.40546510
0	13.99999710	1.95000000	1	1	3	1.25276290
0	1.99999990	3.92000010	1	2	1	0.40546510
0	4.99999810	2.86999990	0	0	1	0.40546510
0	24.00000190	3.69000010	1	0	3	1.25276290
0	3.00000000	3.69000010	1	0	0	-0.69314720
0	3.99999900	2.39000010	0	0	2	0.91629080
0	3.00000000	1.95000000	1	2	3	1.25276290
0	10.99999710	3.35999990	0	0	5	1.70474800
0	3.99999900	2.39000010	1	1	2	0.91629080
0	26.00000000	3.69000010	0	0	2	0.91629080
0	3.99999900	2.96000000	1	1	5	1.70474800
0	1.99999990	3.21000000	1	0	0	-0.69314720
0	0.00000000	2.11999990	1	2	0	-0.69314720
0	52.99998090	4.54000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	3	1.25276290
0	6.00000050	2.54000000	1	1	3	1.25276290
0	1.99999990	2.85999990	1	1	1	0.40546510
0	13.99999710	3.47000000	1	0	3	1.25276290
0	15.00000100	2.86999990	0	0	4	1.50407740
0	3.99999900	2.31999990	1	0	0	-0.69314720
0	15.00000100	1.86000000	1	2	4	1.50407740
0	3.99999900	1.95000000	1	0	2	0.91629080
0	1.99999990	2.31999990	1	2	0	-0.69314720
0	19.99999620	4.25000000	1	2	1	0.40546510
0	3.99999900	1.97000000	0	0	6	1.87180220
0	41.99999620	1.86000000	1	0	19	2.97041440
0	7.99999860	3.69000010	1	1	0	-0.69314720
0	3.00000000	4.54000000	1	1	0	-0.69314720
0	9.00000000	3.54000000	1	0	4	1.50407740
0	9.99999900	4.54000000	1	1	1	0.40546510
0	6.99999950	2.85999990	1	2	11	2.44234700
0	25.00000000	3.35999990	1	0	0	-0.69314720
0	3.00000000	2.85999990	0	0	0	-0.69314720
0	3.99999900	2.96000000	1	2	0	-0.69314720
0	22.00000000	2.55999990	1	2	1	0.40546510
0	7.99999860	1.63000000	1	0	2	0.91629080
0	13.99999710	2.96000000	0	0	0	-0.69314720
0	0.00000000	2.96000000	1	0	1	0.40546510
0	7.99999860	1.63000000	1	1	1	0.40546510
0	0.00000000	2.96000000	0	0	0	-0.69314720
0	21.00000000	2.96000000	1	2	2	0.91629080
0	6.99999950	2.96000000	1	0	1	0.40546510
0	30.99998860	4.54000000	1	2	3	1.25276290
0	1.99999990	4.54000000	1	2	2	0.91629080
0	9.99999900	2.15000010	0	0	1	0.40546510
0	6.00000050	4.54000000	1	1	2	0.91629080

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0  12.00000000   2.21000000  1  2  2   0.91629080
0   0.99999990   2.21000000  1  1  0  -0.69314720
0  29.00000000   4.54000000  0  0  2   0.91629080
0   9.99999900   2.21000000  1  1  3   1.25276290
0   6.00000050   2.21000000  1  0  0  -0.69314720
0  36.99999240   4.54000000  1  0  3   1.25276290
0   4.99999810   4.54000000  0  0  4   1.50407740
1   9.00000000   2.11999990  0  0  0  -0.69314720
1   1.99999990   2.11999990  1  0  0  -0.69314720
1   1.99999990   2.11999990  1  0  2   0.91629080
1   3.00000000   2.11999990  1  0  3   1.25276290
1   9.00000000   2.11999990  1  1  1   0.40546510
1  10.99999710   2.39000010  0  0  3   1.25276290
1   4.99999810   2.57999990  0  0  2   0.91629080
1   6.99999950   3.19000010  1  0  4   1.50407740
1   4.99999810   3.75000000  0  0  0  -0.69314720
1   3.00000000   3.58999990  0  0  1   0.40546510
1   1.99999990   2.57999990  0  0  2   0.91629080
1   0.00000000   3.75000000  0  0  3   1.25276290
1   4.99999810   3.75000000  1  0  0  -0.69314720
1   0.99999990   3.75000000  0  0  0  -0.69314720
1   3.99999900   1.22000000  1  2  2   0.91629080
1  13.99999710   3.75000000  0  0  0  -0.69314720
1   6.99999950   3.75000000  1  0  0  -0.69314720
1  26.00000000   3.75000000  0  0  0  -0.69314720
1   7.99999860   3.75000000  0  0  2   0.91629080
1   3.00000000   3.75000000  0  0  4   1.50407740
1   6.00000050   3.75000000  0  0  0  -0.69314720
1  21.00000000   3.75000000  0  0  1   0.40546510
1   7.99999860   3.75000000  1  0  2   0.91629080
1   3.99999900   3.75000000  0  0  0  -0.69314720
1   6.99999950   3.75000000  1  1  1   0.40546510
1   0.00000000   3.75000000  1  0  2   0.91629080
1   0.00000000   2.54000000  1  1  0  -0.69314720
1   0.99999990   2.54000000  1  0  0  -0.69314720
1   3.99999900   2.76000000  0  0  0  -0.69314720
1   1.99999990   4.13999990  0  0  0  -0.69314720
1   3.99999900   0.92000000  0  0  1   0.40546510
1   0.00000000   1.00500000  0  0  0  -0.69314720
1   6.00000050   3.08999990  0  0  2   0.91629080
1   3.00000000   3.08999990  1  1  2   0.91629080
1   0.00000000   1.79000000  0  0  0  -0.69314720
1   3.00000000   1.40000000  0  0  1   0.40546510
1   3.00000000   1.40000000  0  0  4   1.50407740
1   0.00000000   1.40000000  1  0  2   0.91629080
1   0.00000000   1.40000000  0  0  2   0.91629080
1  13.99999710   1.40000000  0  0  0  -0.69314720
1  12.00000000   1.40000000  0  0  1   0.40546510
1   1.99999990   1.40000000  0  0  1   0.40546510
1   6.00000050   2.00000000  0  0  1   0.40546510
1  10.99999710   4.34000020  1  0  2   0.91629080
1   6.00000050   4.34000020  1  0  4   1.50407740
1   0.00000000   1.75000000  0  0  0  -0.69314720
1  36.00000000   2.09999990  1  0  6   1.87180220
1   7.99999860   2.09999990  0  0  1   0.40546510
1   1.99999990   2.09999990  0  0  0  -0.69314720
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1	10.99999710	3.58999990	1	0	2	0.91629080
1	10.99999710	3.58999990	1	2	2	0.91629080
1	17.99999810	3.58999990	0	0	0	-0.69314720
1	3.99999900	3.58999990	0	0	0	-0.69314720
1	17.99999810	3.58999990	1	0	10	2.35137530
1	7.99999860	3.58999990	0	0	1	0.40546510
1	19.00000190	3.41000010	1	0	3	1.25276290
1	3.99999900	3.41000010	1	0	4	1.50407740
1	4.99999810	3.41000010	1	2	0	-0.69314720
1	6.99999950	3.40000010	0	0	1	0.40546510
1	3.99999900	3.40000010	1	1	2	0.91629080
1	4.99999810	3.40000010	1	0	4	1.50407740
1	13.99999710	3.40000010	1	0	1	0.40546510
1	3.99999900	3.40000010	1	0	0	-0.69314720
1	3.99999900	2.52000000	0	0	3	1.25276290
1	0.00000000	2.52000000	0	0	1	0.40546510
1	15.00000100	3.69000010	1	1	2	0.91629080
1	0.99999990	3.69000010	1	0	1	0.40546510
1	3.00000000	3.69000010	1	1	0	-0.69314720
1	17.99999810	3.69000010	0	0	1	0.40546510
1	15.00000100	2.86999990	0	0	0	-0.69314720
1	4.99999810	2.86999990	1	0	1	0.40546510
1	17.99999810	2.86999990	1	0	1	0.40546510
1	9.00000000	2.86999990	0	0	2	0.91629080
1	6.00000050	2.86999990	0	0	4	1.50407740
1	15.00000100	2.86999990	1	0	1	0.40546510
1	3.99999900	3.35999990	0	0	2	0.91629080
1	1.99999990	3.35999990	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	2	0.91629080
1	6.99999950	3.35999990	0	0	0	-0.69314720
1	15.99999810	4.54000000	1	0	4	1.50407740
1	48.00000000	4.54000000	1	2	2	0.91629080
1	15.00000100	4.54000000	1	0	5	1.70474800
1	36.99999240	4.54000000	0	0	1	0.40546510
1	9.99999900	4.54000000	1	0	2	0.91629080
1	13.00000000	4.54000000	0	0	2	0.91629080
1	6.00000050	4.54000000	1	2	0	-0.69314720
1	13.00000000	0.75500000	0	0	0	-0.69314720
1	6.99999950	4.54000000	1	1	2	0.91629080
1	9.00000000	4.54000000	1	0	2	0.91629080
1	4.99999810	4.54000000	0	0	2	0.91629080
1	15.00000100	4.54000000	0	0	6	1.87180220
1	3.00000000	4.54000000	0	0	3	1.25276290
1	13.99999710	4.54000000	0	0	0	-0.69314720
1	1.99999990	1.28000000	1	0	1	0.40546510
1	3.99999900	1.28000000	1	0	4	1.50407740
1	3.99999900	1.28000000	1	0	0	-0.69314720
1	0.00000000	2.50000000	1	1	0	-0.69314720
1	47.00000760	3.84999990	1	2	2	0.91629080
1	29.00000000	3.84999990	1	0	1	0.40546510
1	0.99999990	3.84999990	1	1	5	1.70474800
1	17.99999810	3.84999990	0	0	1	0.40546510
1	13.00000000	2.05000000	0	0	1	0.40546510
1	17.00000000	2.05000000	0	0	1	0.40546510
1	1.99999990	2.05000000	0	0	2	0.91629080
1	3.99999900	1.78000000	1	0	4	1.50407740

```
1   0.99999990   1.17999990  1  0  1   0.40546510
1   3.00000000   1.52000000  1  0  0  -0.69314720
1   9.00000000   1.48000000  1  0  2   0.91629080
1  12.00000000   4.29000000  0  0  0  -0.69314720
1  17.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   4.29000000  0  0  3   1.25276290
1   1.99999990   3.08999990  1  0  2   0.91629080
1   0.00000000   3.08999990  0  0  2   0.91629080
1   3.00000000   3.61999990  0  0  5   1.70474800
1   6.99999950   3.61999990  0  0  0  -0.69314720
1   7.99999860   3.61999990  0  0  0  -0.69314720
1   0.00000000   4.29000000  0  0  0  -0.69314720
1   6.00000050   2.60999990  1  1  1   0.40546510
1   6.99999950   2.60999990  1  0  1   0.40546510
1   9.00000000   2.09999990  0  0  0  -0.69314720
1   7.99999860   2.96000000  1  0  2   0.91629080
1   9.99999900   2.39000010  0  0  0  -0.69314720
1   3.00000000   1.95000000  1  0  1   0.40546510
1  13.99999710   3.41000010  0  0  2   0.91629080
1   0.99999990   4.29000000  0  0  2   0.91629080
1  10.99999710   3.58999990  0  0  2   0.91629080
1   9.99999900   4.61999990  0  0  1   0.40546510
1   6.00000050   2.14000010  0  0  1   0.40546510
1  10.99999710   2.85999990  0  0  0  -0.69314720
1   4.99999810   3.47000000  0  0  2   0.91629080
1  13.99999710   4.61999990  1  1  3   1.25276290
1   9.00000000   3.19000010  1  3  1   0.40546510
1   0.99999990   2.51000000  0  0  1   0.40546510
1   0.00000000   2.11999990  0  0  0  -0.69314720
1   3.00000000   3.19000010  0  0  0  -0.69314720
1   3.99999900   1.74000000  1  1  2   0.91629080
1   0.00000000   1.25000000  1  0  0  -0.69314720
1   6.99999950   3.69000010  1  0  0  -0.69314720
1   4.99999810   3.21000000  0  0  0  -0.69314720
1  15.00000100   4.61999990  1  1  0  -0.69314720
1  24.00000190   2.85999990  1  0  5   1.70474800
1   9.00000000   2.39000010  1  1  1   0.40546510
1   0.00000000   1.17999990  1  0  3   1.25276290
1   6.99999950   3.35999990  0  0  2   0.91629080
1   7.99999860   1.97000000  0  0  2   0.91629080
1  22.00000000   1.64000000  1  0  1   0.40546510
1   6.99999950   3.92000010  1  0  2   0.91629080
1   6.00000050   3.31999990  0  0  6   1.87180220
1   6.00000050   2.57999990  0  0  5   1.70474800
1  22.99999620   4.54000000  0  0  2   0.91629080
1   1.99999990   2.39000010  1  0  0  -0.69314720
1   9.00000000   3.58999990  0  0  4   1.50407740
1   6.99999950   3.69000010  0  0  2   0.91629080
1   9.99999900   3.19000010  0  0  2   0.91629080
1   3.99999900   2.31999990  0  0  2   0.91629080
1  10.99999710   3.47000000  1  1  2   0.91629080
1   3.99999900   3.69000010  0  0  2   0.91629080
1   4.99999810   2.31999990  1  1  3   1.25276290
1  10.99999710   3.19000010  0  0  1   0.40546510
1  19.00000190   4.54000000  0  0  1   0.40546510
1   3.00000000   3.35999990  1  1  0  -0.69314720
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1	4.99999810	2.57999990	1	0	2	0.91629080
1	6.99999950	3.21000000	1	1	2	0.91629080
1	3.00000000	1.40000000	0	0	1	0.40546510
1	9.99999900	2.50000000	0	0	4	1.50407740
1	0.00000000	3.19000010	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	0	-0.69314720
1	9.00000000	3.15000010	0	0	6	1.87180220
1	6.99999950	1.45000000	1	0	2	0.91629080
1	6.99999950	2.85999990	1	2	1	0.40546510
1	48.99999240	4.61999990	1	1	3	1.25276290
1	1.99999990	3.69000010	1	0	0	-0.69314720
1	19.00000190	2.96000000	1	0	1	0.40546510
1	12.00000000	3.08999990	1	1	1	0.40546510
1	0.99999990	3.08999990	0	0	0	-0.69314720
1	12.00000000	4.61999990	0	0	2	0.91629080
1	13.00000000	2.85999990	1	0	0	-0.69314720
1	1.99999990	3.21000000	0	0	0	-0.69314720
1	3.00000000	2.82999990	1	0	2	0.91629080
1	22.00000000	4.29000000	0	0	1	0.40546510
1	35.00000760	4.29000000	0	0	0	-0.69314720
1	0.99999990	3.08999990	1	0	2	0.91629080
1	3.99999900	3.69000010	0	0	0	-0.69314720
1	0.99999990	1.79000000	1	0	0	-0.69314720
1	1.99999990	3.35999990	1	1	0	-0.69314720
1	13.99999710	2.57999990	1	0	4	1.50407740
1	24.00000190	3.75000000	0	0	1	0.40546510
1	4.99999810	3.19000010	0	0	2	0.91629080
1	0.99999990	2.09999990	0	0	0	-0.69314720
1	7.99999860	3.58999990	1	1	0	-0.69314720
1	0.99999990	3.92000010	0	0	0	-0.69314720
1	24.00000190	3.31999990	1	1	1	0.40546510
1	1.99999990	2.00000000	0	0	0	-0.69314720
1	1.99999990	3.47000000	1	0	0	-0.69314720
1	13.99999710	3.21000000	1	0	4	1.50407740
1	4.99999810	2.05000000	0	0	3	1.25276290
1	0.99999990	2.52000000	0	0	0	-0.69314720
1	6.99999950	3.15000010	1	0	0	-0.69314720
1	38.00000380	1.86000000	1	2	6	1.87180220
1	3.00000000	2.85999990	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	4	1.50407740
1	0.00000000	1.25500000	1	2	0	-0.69314720
1	19.00000190	3.21000000	1	0	5	1.70474800
1	4.99999810	2.31999990	1	1	1	0.40546510
1	3.00000000	3.19000010	0	0	4	1.50407740
1	1.99999990	3.19000010	1	0	1	0.40546510
1	10.99999710	3.35999990	1	0	3	1.25276290
1	13.99999710	3.54000000	1	1	1	0.40546510
1	6.00000050	1.86000000	1	0	0	-0.69314720
1	13.00000000	1.50500000	0	0	0	-0.69314720
1	6.99999950	2.39000010	1	0	1	0.40546510
1	10.99999710	4.29000000	1	1	2	0.91629080
1	9.00000000	2.00000000	1	1	0	-0.69314720
1	3.99999900	3.92000010	0	0	1	0.40546510
1	6.00000050	4.29000000	1	0	2	0.91629080
1	6.00000050	3.35999990	0	0	1	0.40546510
1	13.99999710	4.61999990	1	0	3	1.25276290

```
1   6.00000050   2.00000000  0  0  1   0.40546510
1   4.99999810   3.58999990  1  0  2   0.91629080
1   6.00000050   2.86999990  0  0  1   0.40546510
1   3.99999900   2.96000000  0  0  0  -0.69314720
1  10.99999710   3.47000000  1  0  0  -0.69314720
1   7.99999860   3.19000010  1  0  4   1.50407740
1   3.00000000   2.85999990  1  1  0  -0.69314720
1  15.99999810   2.52000000  1  0  2   0.91629080
1   6.00000050   4.29000000  0  0  1   0.40546510
1   0.00000000   1.25500000  0  0  1   0.40546510
1   1.99999990   1.83000000  1  0  0  -0.69314720
1  12.00000000   4.29000000  0  0  3   1.25276290
1   7.99999860   2.96000000  1  0  0  -0.69314720
1   0.99999990   2.31999990  1  0  1   0.40546510
1  10.99999710   1.22000000  1  1  0  -0.69314720
1  10.99999710   4.29000000  1  0  1   0.40546510
1   1.99999990   4.25000000  0  0  1   0.40546510
1  36.00000000   2.55000000  0  0  2   0.91629080
1  10.99999710   1.95000000  1  0  1   0.40546510
1   1.99999990   3.69000010  0  0  0  -0.69314720
1  25.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   3.19000010  1  0  2   0.91629080
1  12.00000000   3.54000000  1  1  4   1.50407740
1   4.99999810   3.54000000  1  0  4   1.50407740
1   7.99999860   3.54000000  1  1  0  -0.69314720
1   0.99999990   1.86000000  1  1  3   1.25276290
1   3.00000000   4.61999990  0  0  4   1.50407740
1  15.99999810   4.61999990  1  0  1   0.40546510
1   9.99999900   4.61999990  1  0  3   1.25276290
1  13.00000000   4.54000000  1  0  1   0.40546510
1   0.99999990   3.47000000  1  0  0  -0.69314720
1  15.99999810   2.85999990  0  0  0  -0.69314720
1   6.99999950   2.00000000  1  0  0  -0.69314720
1   1.99999990   2.00000000  0  0  0  -0.69314720
1   3.00000000   2.60999990  1  0  0  -0.69314720
1   6.00000050   2.05000000  0  0  0  -0.69314720
1   6.00000050   2.05000000  0  0  0  -0.69314720
1   4.99999810   3.54000000  0  0  0  -0.69314720
1   0.00000000   0.92000000  1  0  2   0.91629080
1   0.00000000   1.79000000  1  0  0  -0.69314720
1   6.00000050   2.00000000  1  0  0  -0.69314720
1   7.99999860   3.15000010  0  0  4   1.50407740
1  15.99999810   2.26000000  1  0  5   1.70474800
1   3.99999900   2.26000000  0  0  1   0.40546510
1   0.99999990   4.29000000  1  0  6   1.87180220
1  21.00000000   4.29000000  1  0  1   0.40546510
1   9.00000000   4.54000000  0  0  1   0.40546510
1   3.00000000   3.35999990  1  1  0  -0.69314720
1   1.99999990   2.52000000  0  0  0  -0.69314720
1   9.99999900   4.29000000  0  0  3   1.25276290
1   9.00000000   4.29000000  0  0  0  -0.69314720
1  12.00000000   4.54000000  0  0  2   0.91629080
1   0.00000000   2.50000000  0  0  0  -0.69314720
1   1.99999990   2.76000000  0  0  1   0.40546510
1   0.00000000   2.55000000  1  1  0  -0.69314720
1   0.00000000   4.61999990  1  0  0  -0.69314720
```

1	6.00000050	1.63000000	0	0	2	0.91629080
1	3.00000000	3.47000000	1	0	1	0.40546510
1	30.99998860	3.41000010	1	0	2	0.91629080
1	0.99999990	4.29000000	0	0	0	-0.69314720
1	6.99999950	2.96000000	1	0	0	-0.69314720
1	0.00000000	4.61999990	1	0	5	1.70474800
1	12.00000000	3.58999990	1	0	0	-0.69314720
1	12.00000000	3.69000010	1	0	3	1.25276290
1	1.99999990	4.54000000	1	0	1	0.40546510
1	10.99999710	3.33999990	0	0	4	1.50407740
1	1.99999990	2.51000000	1	1	4	1.50407740
1	3.99999900	3.15000010	1	0	3	1.25276290
1	3.00000000	3.19000010	1	0	1	0.40546510
1	17.99999810	3.19000010	0	0	1	0.40546510
1	1.99999990	3.84999990	0	0	1	0.40546510
1	3.99999900	3.33999990	1	1	2	0.91629080
1	15.00000100	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	0	0	2	0.91629080
1	21.00000000	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	0	-0.69314720
1	0.00000000	2.96000000	1	0	0	-0.69314720
1	0.99999990	1.78000000	1	0	0	-0.69314720
1	17.00000000	3.54000000	1	2	1	0.40546510
1	3.00000000	3.69000010	1	0	0	-0.69314720
1	1.99999990	3.35999990	0	0	3	1.25276290
1	1.99999990	3.54000000	1	0	0	-0.69314720
1	0.99999990	3.54000000	1	1	0	-0.69314720
1	3.00000000	1.22000000	1	1	3	1.25276290
1	3.99999900	3.35999990	0	0	1	0.40546510
1	1.99999990	2.21000000	0	0	1	0.40546510
1	3.99999900	2.25000000	0	0	1	0.40546510
1	17.00000000	4.61999990	1	1	2	0.91629080
1	4.99999810	3.58999990	1	0	1	0.40546510
1	0.99999990	4.29000000	1	0	0	-0.69314720
1	1.99999990	2.11999990	0	0	2	0.91629080
1	3.00000000	2.26000000	0	0	2	0.91629080
1	3.00000000	2.26000000	1	0	4	1.50407740
1	4.99999810	4.29000000	0	0	0	-0.69314720
1	3.00000000	3.58999990	1	1	3	1.25276290
1	13.00000000	4.29000000	1	2	1	0.40546510
1	1.99999990	2.00000000	0	0	1	0.40546510
1	0.00000000	1.97000000	1	2	0	-0.69314720
1	7.99999860	3.92000010	1	0	0	-0.69314720
1	39.00000000	2.85999990	0	0	4	1.50407740
1	26.00000000	2.82999990	0	0	2	0.91629080
1	3.00000000	3.35999990	1	1	3	1.25276290
1	22.99999620	2.55999990	0	0	4	1.50407740
1	7.99999860	1.63000000	0	0	1	0.40546510
1	22.00000000	4.61999990	0	0	3	1.25276290
1	4.99999810	4.61999990	0	0	1	0.40546510
1	21.00000000	4.29000000	1	0	3	1.25276290
1	6.00000050	4.29000000	1	1	0	-0.69314720
1	3.99999900	4.29000000	1	1	2	0.91629080
1	24.00000190	4.29000000	1	0	6	1.87180220
1	6.00000050	4.29000000	1	0	1	0.40546510
1	33.99999240	3.35999990	0	0	1	0.40546510

```
1   0.00000000   3.21000000  0  0  2   0.91629080
1   9.99999900   2.00000000  0  0  1   0.40546510
1   1.99999990   3.21000000  1  2  2   0.91629080
1   3.00000000   2.57999990  1  2  2   0.91629080
1   3.00000000   2.57999990  1  0  0  -0.69314720
1   0.99999990   2.82999990  0  0  0  -0.69314720
1   6.00000050   3.19000010  0  0  1   0.40546510
1   3.00000000   3.47000000  0  0  1   0.40546510
1  22.99999620   4.61999990  1  0  2   0.91629080
1  13.00000000   4.25000000  1  0  4   1.50407740
1   4.99999810   1.86000000  1  0  2   0.91629080
1   9.00000000   4.29000000  1  1  0  -0.69314720
1   9.00000000   3.35999990  0  0  0  -0.69314720
1   9.99999900   1.80000000  1  0  2   0.91629080
1   0.00000000   1.65500000  0  0  1   0.40546510
1   6.00000050   2.85999990  0  0  0  -0.69314720
1  13.99999710   4.61999990  0  0  2   0.91629080
1   3.00000000   4.29000000  0  0  0  -0.69314720
1   4.99999810   2.35999990  1  0  4   1.50407740
1  10.99999710   1.80999990  1  0  1   0.40546510
1  32.00001140   3.58999990  1  0  1   0.40546510
1   9.99999900   1.76000000  0  0  0  -0.69314720
1   4.99999810   2.00000000  1  0  1   0.40546510
1  13.99999710   3.58999990  0  0  5   1.70474800
1   6.00000050   2.26000000  1  0  3   1.25276290
1   3.99999900   2.26000000  0  0  1   0.40546510
1   3.99999900   1.76000000  1  1  1   0.40546510
1   0.99999990   3.58999990  1  0  1   0.40546510
1   0.99999990   3.58999990  1  0  0  -0.69314720
1   4.99999810   2.82999990  1  1  1   0.40546510
1   1.99999990   2.57999990  0  0  1   0.40546510
1  17.99999810   4.61999990  1  0  1   0.40546510
1  15.00000100   2.31999990  0  0  1   0.40546510
1   0.00000000   2.39000010  1  0  0  -0.69314720
1  22.00000000   2.96000000  1  0  3   1.25276290
1  10.99999710   2.11999990  0  0  0  -0.69314720
1  17.99999810   4.61999990  1  0  1   0.40546510
1   3.00000000   2.25000000  1  0  1   0.40546510
1   7.99999860   1.76000000  1  0  1   0.40546510
1  12.00000000   4.54000000  0  0  6   1.87180220
1   9.99999900   3.69000010  1  1  2   0.91629080
1   1.99999990   1.25000000  0  0  0  -0.69314720
1   4.99999810   1.25000000  1  0  1   0.40546510
1   3.99999900   3.19000010  1  0  0  -0.69314720
1   0.00000000   2.57999990  1  2  0  -0.69314720
1   6.99999950   2.00000000  1  1  2   0.91629080
1   0.99999990   2.76000000  0  0  0  -0.69314720
1   3.99999900   2.54000000  0  0  2   0.91629080
1   0.00000000   3.19000010  0  0  0  -0.69314720
1   9.00000000   3.08999990  1  2  1   0.40546510
1   3.99999900   3.19000010  0  0  2   0.91629080
1   0.00000000   3.08999990  0  0  0  -0.69314720
1   7.99999860   2.26000000  0  0  2   0.91629080
1   9.00000000   2.26000000  1  1  1   0.40546510
1   7.99999860   3.35999990  1  0  2   0.91629080
1   9.00000000   3.15000010  1  0  1   0.40546510
```

```
1   3.99999900   4.54000000  1  0  0  -0.69314720
1   0.00000000   3.58999990  1  0  2   0.91629080
1   3.00000000   3.47000000  1  0  1   0.40546510
1   1.99999990   2.85999990  1  1  1   0.40546510
1   6.00000050   2.26000000  1  0  0  -0.69314720
1   3.99999900   3.47000000  1  1  2   0.91629080
1   0.00000000   2.76000000  1  0  0  -0.69314720
1   1.99999990   3.58999990  1  2  0  -0.69314720
1  13.00000000   3.75000000  0  0  5   1.70474800
1   1.99999990   2.57999990  1  2  1   0.40546510
1   1.99999990   3.58999990  1  1  2   0.91629080
1  15.99999810   1.89000000  1  2  3   1.25276290
1   9.00000000   3.15000010  0  0  7   2.01490310
1  12.00000000   2.86999990  0  0  5   1.70474800
1   0.99999990   2.11999990  1  2  0  -0.69314720
1   3.99999900   4.61999990  1  0  1   0.40546510
1   0.00000000   2.39000010  0  0  0  -0.69314720
1  10.99999710   2.11999990  0  0  0  -0.69314720
1   4.99999810   1.80999990  1  0  0  -0.69314720
1   7.99999860   2.31999990  0  0  4   1.50407740
1  15.00000100   2.39000010  0  0  0  -0.69314720
1   6.00000050   3.75000000  1  0  3   1.25276290
1   0.00000000   2.00000000  0  0  0  -0.69314720
1  13.99999710   3.58999990  1  1  0  -0.69314720
1   4.99999810   4.29000000  0  0  2   0.91629080
1   0.00000000   2.57999990  1  0  0  -0.69314720
1   4.99999810   4.61999990  1  0  0  -0.69314720
1   3.00000000   1.50500000  0  0  0  -0.69314720
1   3.99999900   3.75000000  1  0  2   0.91629080
1   3.99999900   3.75000000  1  2  0  -0.69314720
1   0.00000000   1.75000000  1  0  1   0.40546510
1   0.00000000   2.11999990  1  0  1   0.40546510
1   4.99999810   3.75000000  0  0  2   0.91629080
1   0.00000000   0.75500000  0  0  0  -0.69314720
1   6.99999950   2.25000000  0  0  1   0.40546510
1   3.00000000   3.19000010  0  0  1   0.40546510
;
```

Click **Run** to create the Work.Long97Data table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Cross-Sectional Data Models** to add the step to your flow.

3 Add the Work.Long97Data table to your flow and connect it to the Cross-Sectional Data Models node. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cross-Sectional Data Models step, click the Cross-Sectional Data Models node.

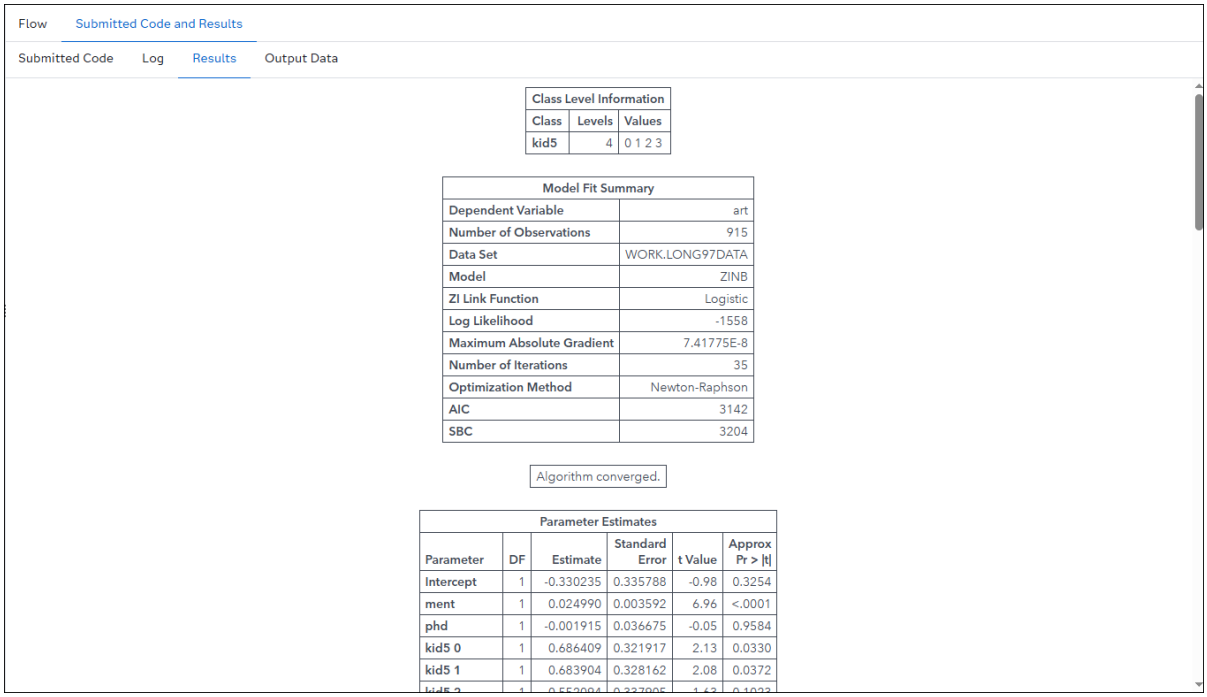
5 On the **Data** tab, assign columns to these roles:

- To the **Dependent variable** role, assign **art**.
- To the **Continuous variables** role, assign **ment** and **phd**.
- To the **Categorical variables** role, assign **kid5**.

6 On the **Model** tab, select **Zero-inflated negative binomial** as the model type.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Class Level Information		
Class	Levels	Values
kid5	4	0 1 2 3

Model Fit Summary	
Dependent Variable	art
Number of Observations	915
Data Set	WORK.LONG97DATA
Model	ZINB
ZI Link Function	Logistic
Log Likelihood	-1558
Maximum Absolute Gradient	7.41775E-8
Number of Iterations	35
Optimization Method	Newton-Raphson
AIC	3142
SBC	3204

Algorithm converged.

Parameter Estimates					
Parameter	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-0.330235	0.335788	-0.98	0.3254
ment	1	0.024990	0.003592	6.96	<.0001
phd	1	-0.001915	0.036675	-0.05	0.9584
kid5 0	1	0.686409	0.321917	2.13	0.0330
kid5 1	1	0.683904	0.328162	2.08	0.0372

Zero-Inflated Negative Binomial Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variables** role, assign the numeric column that contains the count values. In the input data set, this variable must contain only nonnegative integer values.

4 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

5 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

6 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Model** tab, create the zero-inflated negative binomial model.

1 From the **Model type** drop-down list, select **Zero-inflated negative binomial**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Specify the link function to use to compute the probability of zeros. You can choose from the logistic function (default) or the normal function.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the method to calculate the covariance matrix of parameter estimates.

These options are available:

- **Inverse Hessian matrix (default)** is the covariance from the inverse Hessian matrix.
- **Outer product matrix** is the covariance from the outer product matrix.
- **Outer product and Hessian matrices** is the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Specify the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

4 Select the statistics to be displayed in the results.

Here are the statistics that you can include in the results:

- correlations of the parameter estimates
- covariances of the parameter estimates

- (SAS Compute Server) iteration history of the objective function and parameter estimates

5 (SAS Compute Server) Select the plots to include in the results.

6 Specify the code generation for the step. You can choose from these options:

- **Use Econometrics procedures**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, specify whether to create any output tables.

- a table that contains the default statistics from the analysis and any selected statistics such as the probability of the dependent variable taking the current value.
- a table of parameter estimates. When naming this table, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Cross-Sectional Data Models node. For more information, see "Cross-Sectional Data Models: Connection Requirements for the Node" on page 502.

Hidden Markov Models

About the Hidden Markov Models Step

The Hidden Markov Models step analyzes the time series or panel data by using a statistical Markov model to infer hidden states through a Markov process.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Hidden Markov Models: Connection Requirements for the Node

In order to run the Hidden Markov Models step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Hidden Markov Models node and select ***name-of-output-table***. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Hidden Markov Models

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Enter this code on a **SAS Program** tab:

```
/* The following statements simulate the bivariate vector time series
from the previous model to provide test data for the HMM procedure: */
%let pi1 = 0.5;
%let a11 = 0.01;
```

```
%let a22 = 0.01;
%let mu1_1 = 1;
%let mu1_2 = 1;
%let sigma1_11 = 1;
%let sigma1_21 = 0;
%let sigma1_22 = 1;
%let mu2_1 = -1;
%let mu2_2 = -1;
%let sigma2_11 = 1;
%let sigma2_21 = 0;
%let sigma2_22 = 1;
%let T = 1000;
%let seed = 1234;

data DGPone;
    retain cd1_11 cd1_21 cd1_22 cd2_11 cd2_21 cd2_22;

    do t=1 to &T.;
        if(t=1) then
            do;
                /* initial probability distribution */
                p=&pi1.;

                /* Cholesky decomposition of sigma1 */
                cd1_11=sqrt(&sigma1_11.);
                cd1_21=&sigma1_21./sqrt(&sigma1_11.);
                cd1_22=sqrt(&sigma1_22.-&sigma1_21.*&sigma1_21./
&sigma1_11.);

                /* Cholesky decomposition of sigma2 */
                cd2_11=sqrt(&sigma2_11.);
                cd2_21=&sigma2_21./sqrt(&sigma2_11.);
                cd2_22=sqrt(&sigma2_22.-&sigma2_21.*&sigma2_21./
&sigma2_11.);
            end;
        else
            do;
                /* transition probability matrix */
                if(lags=1) then
                    p=&a11.;
                else
                    p=1-&a22.;
            end;
        u=uniform(&seed.);

        if(u<=p) then
            s=1;
        else
            s=2;
        e1=normal(&seed.);
        e2=normal(&seed.);

        if(s=1) then
            do;
                /* (x,y) ~ N(mu1, Sigma1) at state 1 */
                x=&mu1_1. + cd1_11*e1;
```

```
                y=&mu1_2. + cd1_21*e1+cd1_22*e2;
            end;
        else
            do;
                /* (x,y) ~ N(mu2, Sigma2) at state 2 */
                x=&mu2_1. + cd2_11*e1;
                y=&mu2_2. + cd2_21*e1+cd2_22*e2;
            end;
        output;
        lags=s;
    end;
run;

/* In general, the data generating process is unknown. What can be seen
is the data set One, but not the data set DGPone. */
data One;
    set DGPone;
    keep t x y;
run;

libname mycas cas;

data mycas.One;
    set One;
run;
```

Click **Run** to create the MyCas.One table.

3 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Hidden Markov Models** to add the step to your flow.

4 Add the MyCas.One table to your flow. Connect the input port of the Hidden Markov Models node to the data source. For more information, see "Connecting Nodes" on page 13.

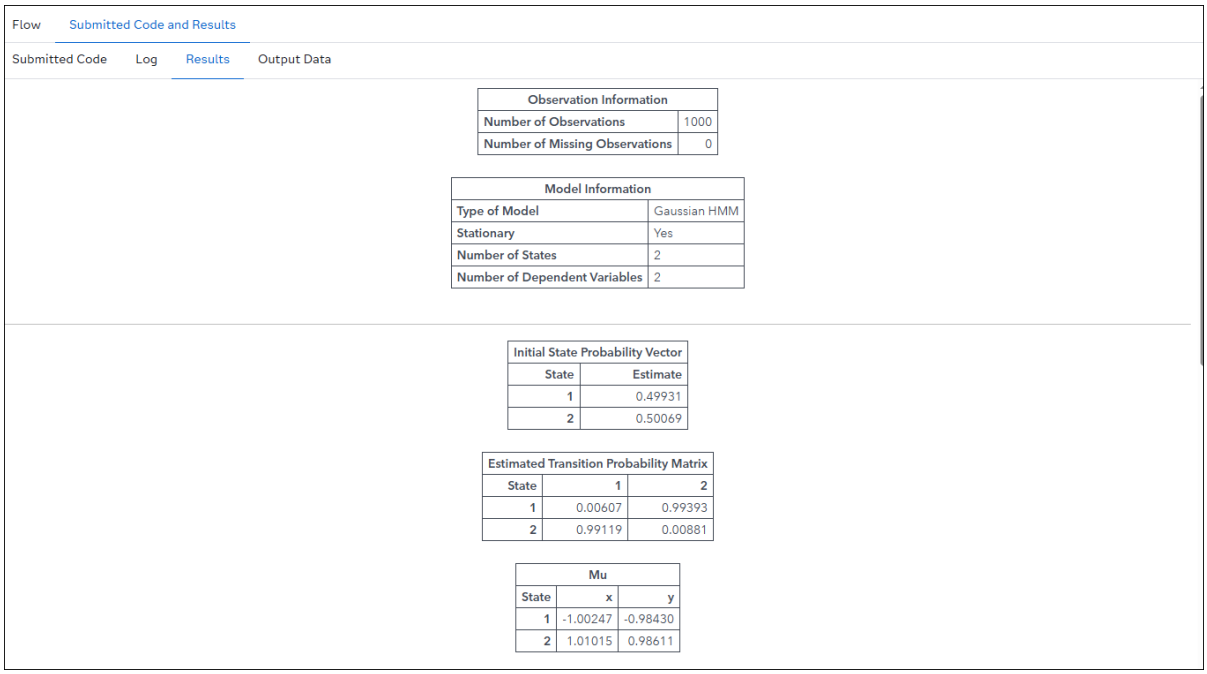
5 To set the options for the Hidden Markov Models step, click the Hidden Markov Models node.

6 On the **Data** tab, assign columns to these roles:

- To the **Dependent variables** role, assign **x** and **y**.
- To the **Time ID** role, assign **t**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Hidden Markov Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Dependent variables** role, assign the numeric variables to use in the analysis.

3 To the **Time ID** role, assign a numeric variable that identifies the time period for each observation.

4 To the **Cross-sectional ID**, assign the numeric variable that identifies the cross section for each observation.

Step 2: Set the Model Options

On the **Options** tab, you can set these options:

1 Specify the model type. You can choose from these options:

- **Gaussian** (default)
- **Gaussian mixture**

- **Regime-switching regression**
- **Regime-switching autoregression**

2 Specify the number of hidden states. The default value is 2.

3 Specifies the number of components in a state for a Gaussian mixture model. The default value is 1.

Note: This option is available for the Gaussian mixture model type.

4 Specify the options for the Regime-switching regression and Regime-switching autoregression model types.

a Specify the independent variables to use as regressors.

b Specify whether to add lags of the dependent variables. The default number of lags is 1.

Note: This option is available only for the Regime-switching autoregression model type.

c Specify whether to include the intercept parameters in the regression model.

d Specify whether to use seasonal dummies as regressors. You can specify the number of seasonal periods and whether to center the seasonal dummies.

e Specify whether to use time trends as regressors. You can add a linear time trend or both a linear and a quadratic time trend.

f Specify whether to add lags of the independent variables. The default number of lags is 1.

g Suppress the values of the independent variables and include only the lagged values.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the parameter estimation method. You can choose from these options:

- **Maximum likelihood** (default)
- **Maximum a posterioi**

2 Specify whether the initial state probability vector (ISPV) should be estimated and not be fixed to the stationary distribution of the Markov chain. This option is not selected by default.

3 Specify a random number seed for the analysis.

4 Specify whether to use the active set algorithm (which is the default) or the interior point algorithm.

5 Specify whether the local solver solves the problem from multiple starting points. This option is not selected by default.

Note: Computing costs can be larger in multistart mode.

6 Specify the maximum number of iterations. The default value is `128`.

7 Specify whether the initial parameter values are set to the parameter estimates of a matched model in the selected data set. This option is not selected by default, and the default initial values are used.

8 Specify the code to use to run the step. You can choose from these options:

- **Use HMM procedure**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create these output tables:

- a scoring model
- parameter estimates
- parameter estimates and the covariance matrix
- fit statistics
- forecasting results
- decoding results
- evaluation results
- filtering results
- smoothing results

Multivariate Time Series Analysis

About the Multivariate Time Series Analysis Step

The Multivariate Time Series Analysis step analyzes a vector of time series that are equally spaced.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Multivariate Time Series Analysis: Connection Requirements for the Node

In order to run the Multivariate Time Series Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. For more information, see "Step 4: Set the Output Options" on page 711. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Analyzing Stock Data Using a Vector Autoregressive Model

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
data grunfeld;
   input year y1 y2 y3 x1 x2 x3;
   label y1='Gross Investment GE'
         y2='Capital Stock Lagged GE'
         y3='Value of Outstanding Shares GE Lagged'
         x1='Gross Investment W'
         x2='Capital Stock Lagged W'
         x3='Value of Outstanding Shares Lagged W';
datalines;
1935  33.1 1170.6  97.8 12.93  191.5   1.8
1936  45.0 2015.8 104.4 25.90  516.0    .8
1937  77.2 2803.3 118.0 35.05  729.0   7.4
1938  44.6 2039.7 156.2 22.89  560.4  18.1
1939  48.1 2256.2 172.6 18.84  519.9  23.5
1940  74.4 2132.2 186.6 28.57  628.5  26.5
1941 113.0 1834.1 220.9 48.51  537.1  36.2
1942  91.9 1588.0 287.8 43.34  561.2  60.8
1943  61.3 1749.4 319.9 37.02  617.2  84.4
1944  56.8 1687.2 321.3 37.81  626.7  91.2
1945  93.6 2007.7 319.6 39.27  737.2  92.4
1946 159.9 2208.3 346.0 53.46  760.5  86.0
1947 147.2 1656.7 456.4 55.56  581.4 111.1
1948 146.3 1604.4 543.4 49.56  662.3 130.6
1949  98.3 1431.8 618.3 32.04  583.8 141.8
1950  93.5 1610.5 647.4 32.24  635.2 136.7
1951 135.2 1819.4 671.3 54.38  723.8 129.7
1952 157.3 2079.7 726.1 71.78  864.1 145.5
1953 179.5 2371.6 800.3 90.08 1193.5 174.8
1954 189.6 2759.9 888.9 68.60 1188.9 213.5
;
```

Click **Run** to create the Work.Grunfeld table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Multivariate Time Series Analysis** to add the step to your flow.

3 Add the Work.Grunfeld table to your flow. Connect the input port of the Multivariate Time Series Analysis node to the data source. For more information, see “Connecting Nodes” on page 13.

4 To set the options for the Multivariate Time Series Analysis step, click the Multivariate Time Series Analysis node.

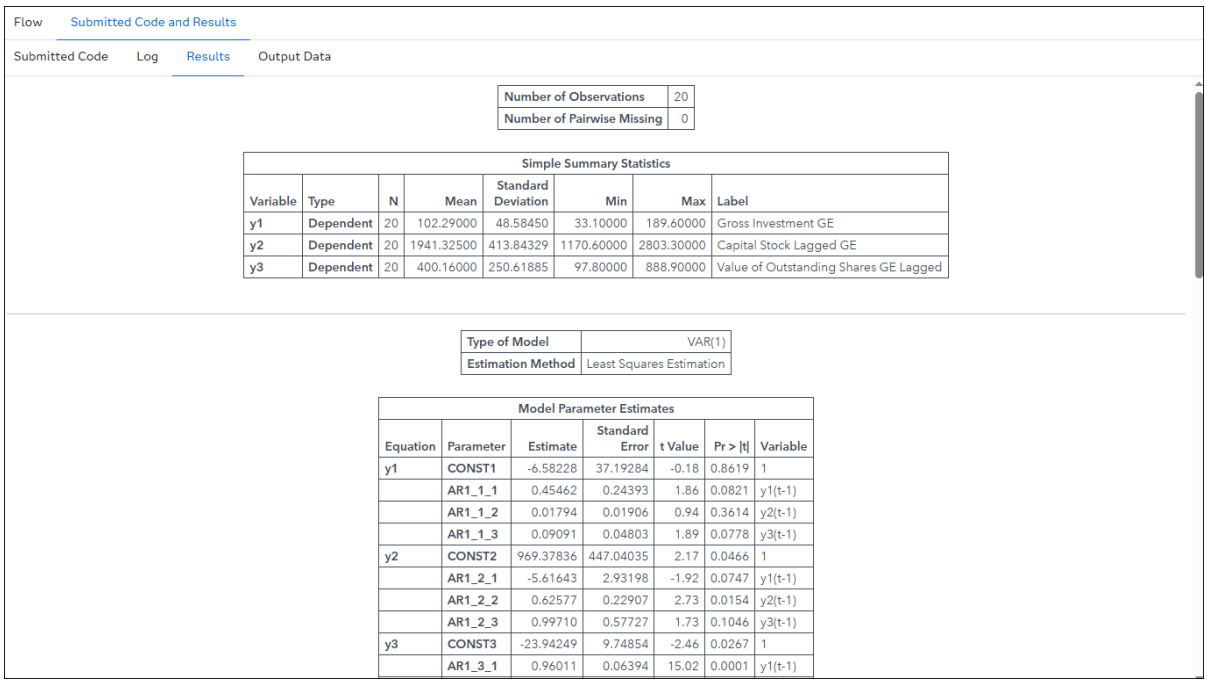
5 On the **Data** tab, assign columns to these roles:

- To the **Time ID** role, assign **year**.
- To the **Dependent variables** role, assign **y1**, **y2**, and **y3**.

6 Click the **Model** tab. From the **Model type** drop-down list, select **Vector autoregressive model**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data

Number of Observations	20
Number of Pairwise Missing	0

Simple Summary Statistics

Variable	Type	N	Mean	Standard Deviation	Min	Max	Label
y1	Dependent	20	102.29000	48.58450	33.10000	189.60000	Gross Investment GE
y2	Dependent	20	1941.32500	413.84329	1170.60000	2803.30000	Capital Stock Lagged GE
y3	Dependent	20	400.16000	250.61885	97.80000	888.90000	Value of Outstanding Shares GE Lagged

Type of Model	VAR(1)
Estimation Method	Least Squares Estimation

Model Parameter Estimates

Equation	Parameter	Estimate	Standard Error	t Value	Pr > |t|	Variable
y1	CONST1	-6.58228	37.19284	-0.18	0.8619	1
	AR1_1_1	0.45462	0.24393	1.86	0.0821	y1(t-1)
	AR1_1_2	0.01794	0.01906	0.94	0.3614	y2(t-1)
	AR1_1_3	0.09091	0.04803	1.89	0.0778	y3(t-1)
y2	CONST2	969.37836	447.04035	2.17	0.0466	1
	AR1_2_1	-5.61643	2.93198	-1.92	0.0747	y1(t-1)
	AR1_2_2	0.62577	0.22907	2.73	0.0154	y2(t-1)
	AR1_2_3	0.99710	0.57727	1.73	0.1046	y3(t-1)
y3	CONST3	-23.94249	9.74854	-2.46	0.0267	1
	AR1_3_1	0.96011	0.06394	15.02	0.0001	y1(t-1)

Multivariate Time Series Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Time ID** role, assign the datetime values for the series.

If you assign a SAS date or datetime variable to this role, the step automatically determines the time interval for these values. You can change this interval and also specify the multiplier, shift, and seasonal length.

3 To the **Dependent variables** role, assign the dependent variables for the analysis.

4 To the **Group analysis by** role, assign the variable to create a separate analysis for each group of observations.

Step 2: Set the Model Options

On the **Model** tab, you can set these options:

1 Select the model type.

- **Vector autoregressive model**
- **Regression with vector autoregressive model**
- **Vector error correlation model**

No model type is selected by default. The remaining options on the **Model** tab depend on the model type that you selected.

2 To the **Independent variables** role, assign the continuous and categorical variables to include in the analysis.

Note: This option is not available for the vector autoregressive model.

3 Specify whether to include the intercept in the model.

4 Specify whether to add a linear time trend or linear and quadratic time trends.

5 Specify the order of the autoregressive process. Valid values are 0–13 (inclusive).

6 Specify that the step should select the appropriate order for the error process. The maximum autoregressive order (p) is the starting point for the step.

7 Specify the GARCH conditional heteroscedasticity.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify the statistics to include in the results.

2 Select the plots to include in the results.

3 Select these forecasting options:

- **Number of periods to forecast**
- **Forecast confidence interval**
- **Number of periods to hold back**
- **Suppresses printed forecast values of each dependent (endogenous) variables**

4 Specify the optimization method to use.

5 Specify the maximum number of iterations. You can use the default value or specify a custom value. The default value is `100`.

Step 4: Set the Output Options

On the **Output** tab, you can specify whether to create these output tables:

- a data set that contains the actual values, forecast values, residuals, standard deviation of the forecasts, and the upper and lower confidence limits for the forecast
- a data set of the parameter estimates
- a data set of the residual diagnostics

If you are running this step in a flow, add an output table to the flow.

1 Select **Add** ⇨ **Table**.

2 Select the Table node. In the Table Properties, enter the library name and the table name.

3 Right-click the Multivariate Time Series Analysis node and select **Add output port** ⇨ `type-of-output-data`.

4 Connect the new output port to the Table node.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Multivariate Time Series Analysis node. For more information, see "Multivariate Time Series Analysis: Connection Requirements for the Node" on page 707.

Panel Data Models

About the Panel Data Models Step

Use this step to run analyses for a variety of model types.

You can analyze a class of linear econometric models that commonly arise when time series and cross-sectional data is combined. This type of pooled data on time series cross-sectional bases is often referred to as *panel data*. Typical examples of panel data include observations over time on households, countries, firms, trade, and so on. For example, in the case of survey data on household income, the panel

is created by repeatedly surveying the same households in different time periods (years).

This step also handles cross-sectional data (data without the time ID values). Cross-sectional data can be considered a special case of panel data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Panel Data Models: Connection Requirements for the Node

In order to run the Panel Data Models step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Panel Data Models node and select ***name-of-output-table***. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Linear Models

Example: Linear Regression with Fixed Effects

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
data cigar;
   input state year price pop pop_16 cpi ndi sales pimin;
   label
   state  = 'State abbreviation'
   year   = 'YEAR'
   price  = 'Price per pack of cigarettes'
   pop    = 'Population'
   pop_16 = 'Population above the age of 16'
   cpi    = 'Consumer price index with (1983=100)'
   ndi    = 'Per capita disposable income'
   sales  = 'Cigarette sales in packs per capita'
   pimin  = 'Minimum price in adjoining states per pack of cigarettes';
datalines;
1 63 28.6 3383 2236.5 30.6 1558.3045298 93.9 26.1
1 64 29.8 3431 2276.7 31.0 1684.0732025 95.4 27.5
1 65 29.8 3486 2327.5 31.5 1809.8418752 98.5 28.9
1 66 31.5 3524 2369.7 32.4 1915.1603572 96.4 29.5
1 67 31.6 3533 2393.7 33.4 2023.5463678 95.5 29.6
1 68 35.6 3522 2405.2 34.8 2202.4855362 88.4 32
1 69 36.6 3531 2411.9 36.7 2377.3346665 90.1 32.8
1 70 39.6 3444 2394.6 38.8 2591.0391591 89.8 34.3
1 71 42.7 3481 2443.5 40.5 2785.3159706 95.4 35.8
1 72 42.3 3511 2484.7 41.8 3034.8082969 101.1 37.4
1 73 42.1 3540 2526 44.4 3387.5740861 102.9 37.3
1 74 43.1 3574 2573.9 49.3 3718.8671751 108.2 41.4
1 75 46.6 3614 2623.7 53.8 4087.9931169 111.7 43
1 76 50.4 3657 2677.4 56.9 4486.7718352 116.2 46.4
1 77 50.1 3690 2719.6 60.6 4899.8656869 117.1 48.8
1 78 55.1 3728 2764.6 65.2 5450.9983257 123 53.6
1 79 56.8 3769 2810.7 72.6 5957.1405451 121.4 56.5
1 80 60.6 3894 2898.9 82.4 6466.350293 123.2 59.3
1 81 68.8 3917 2924.7 90.9 7042.0231606 119.6 62.6
1 82 73.1 3943 2953.5 96.5 7505.2199795 119.1 67.8
1 83 84.4 3959 2977.5 99.6 7974.5518556 116.3 78.6
1 84 90.8 3990 3009.1 103.9 8693.376058 113 86.8
1 85 99 4020 3039.8 107.6 9059.4344712 114.5 90.7
1 86 103 4050 3072.4 109.6 9674.9852107 116.3 98.8
1 87 110 4083 3104 113.6 10213.847735 114 103.5
1 88 114.4 4102 3124 118.3 10993 112.1 109.2
1 89 122.3 4118 3140 124 11634 105.6 121.5
1 90 139.1 4129.2 3148.6 130.7 12806 108.6 132.3
1 91 144.4 4178.3 3185.1 136.2 13360 107.9 137.4
1 92 172.2 4226.3 3226.7 140.3 14533 109.1 159.5
3 63 23.9 1517 982.4 30.6 1944.7450576 125 24.9
3 64 24 1549 1005.6 31 2063.5159984 121 25.5
3 65 24.2 1575 1024.9 31.5 2162.6639143 123.2 25.3
3 66 29.6 1609 1051.9 32.4 2318.6153235 113.9 25.5
3 67 29.2 1637 1078.9 33.4 2446.6813815 117.1 26
3 68 31.3 1667 1106 34.8 2720.3709408 115.6 32.3
3 69 36.1 1693 1117.5 36.7 2979.6014291 113.8 33.3
3 70 37.1 1772 1226.6 38.8 3269.8156411 115.2 34.6
3 71 38.5 1878 1313.5 40.5 3549.7019452 109.6 36.6
3 72 38 1975 1393.6 41.8 3800.6701072 125 37.2
3 73 38.7 2075 1476.5 44.4 4219.9831679 128.3 36.5
3 74 39.2 2156 1547 49.3 4508.1317983 133.1 37.8
```

```
3 75 47.7 2200 1591.4 53.8 4742.5753077 121.8 40.5
3 76 49.1 2244 1635.8 56.9 5158.789996 122.3 43.4
3 77 48.7 2304 1690.8 60.6 5567.7751489 121.7 44.7
3 78 53.6 2373 1750.6 65.2 6283.4991663 124.7 49.5
3 79 58.6 2450 1812.4 72.6 7099.4038904 124.6 53.7
3 80 60.8 2718 2044 82.4 7823.3902342 126.8 57.2
3 81 63.3 2794 2103.8 90.9 8647.5572846 113.8 62.7
3 82 73.3 2860 2153.1 96.5 8879.9352124 113.5 68.1
3 83 80.5 2963 2231.2 99.6 9579.1345772 111.1 79.6
3 84 92.8 3053 2300.7 103.9 10549.95792 107.1 90.2
3 85 98.8 3161 2384.7 107.6 11256.38682 107.1 97.5
3 86 106.7 3279 2483.1 109.6 11796.536403 107.9 101.2
3 87 113.5 3386 2569 113.6 12367.66971 106.1 103.9
3 88 113.5 3489 2638 118.3 13008 102.2 113.7
3 89 125.6 3556 2672 124 13625 96.8 126.4
3 90 130.2 3598.2 2703.7 130.7 13826 88.9 133.6
3 91 151.4 3681.7 2759.1 136.2 14232 81.2 146.9
3 92 165.7 3762.2 2804.8 140.3 15179 79 165.4
4 63 27 1907 1296.7 30.6 1480.3334935 103.4 25.8
4 64 27.3 1939 1320.7 31 1610.0797693 102.6 25.7
4 65 27.2 1941 1323.6 31.5 1710.1989428 100.3 26.1
4 66 30.3 1963 1344.8 32.4 1883.8750601 98.9 26.2
4 67 30.4 1972 1357.3 33.4 2004.4267179 102.9 27.5
4 68 30.9 1983 1374.6 34.8 2143.3676117 104 29.2
4 69 30.9 1995 1389 36.7 2286.3950024 102.9 29.9
4 70 36.7 1923 1366.9 38.8 2493.7847189 100.3 34.3
4 71 38.8 1961 1405.4 40.5 2710.3690533 104.1 36.8
4 72 44.1 1999 1442.9 41.8 2950.4507448 103.9 37.4
4 73 45.1 2030 1474.6 44.4 3410.1816434 108 37.3
4 74 45.5 2063 1508.3 49.3 3807.5934647 109.7 38
4 75 48.6 2112 1552.5 53.8 4057.8913984 114.8 43
4 76 50.9 2113 1565.1 56.9 4362.3354157 119.1 44.7
4 77 52.6 2143 1596.8 60.6 4859.8664104 122.6 45.9
4 78 56.5 2167 1623.7 65.2 5467.7328208 127.3 49.9
4 79 58.4 2180 1641 72.6 6015.3234022 126.5 52.2
4 80 61.5 2286 1715.1 82.4 6278.9024507 131.8 57.3
4 81 64.7 2296 1725.7 90.9 7101.3099471 128.7 59.9
4 82 72.1 2291 1724.7 96.5 7390.4296012 127.4 64.7
4 83 82 2328 1757.4 99.6 7886.9389716 128 74.8
4 84 93.6 2349 1776.7 103.9 8546.9082172 123.1 84.8
4 85 98.5 2359 1790.1 107.6 9134.3421432 125.8 92.5
4 86 103.6 2371 1804.6 109.6 9550.1432004 126 98.8
4 87 113 2388 1819 113.6 9886.2575685 122.3 103.5
4 88 119.9 2395 1823 118.3 10630 121.5 112.1
4 89 127.7 2406 1831 124 11243 118.3 118.9
4 90 141.2 2411.1 1834.9 130.7 12370 113.1 129.1
4 91 146.5 2432.7 1851.2 136.2 12917 116.8 132.5
4 92 177.3 2460.4 1876.7 140.3 13879 126 153.1
5 63 25.3 17556 12072 30.6 2776.0965615 142 23.9
5 64 25.5 18003 12384.3 31 2974.9294798 138.3 24
5 65 25.3 18403 12673.3 31.5 3107.8449633 140 24.2
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50 82 75 4765 3617.1 96.5 9196.5818182 115.6 69.6
50 83 92 4751 3616.2 99.6 9815.3409091 106.3 80.8
50 84 100.8 4766 3639.2 103.9 10641.4 105.6 89.6
50 85 106.8 4775 3657.4 107.6 11228.75 107 96.7
50 86 110.8 4783 3670.8 109.6 11763.751515 105.4 104.8
50 87 116.3 4807 3690 113.6 12336.443939 106 116.2
50 88 128.6 4855 3728 118.3 13129 102.6 124.1
50 89 138.3 4867 3745 124 13933 100.3 132.7
50 90 151.1 4902.1 3772 130.7 14958 94.1 147.3
50 91 158.6 4965.2 3817.4 136.2 15438 95.5 154.4
50 92 176.5 5017.3 3853.8 140.3 16351 96.2 178.5
51 63 26.2 335 221.9 30.6 2212.8687965 125.6 24.9
51 64 26.2 338 224.8 31 2323.4089278 134 27.5
51 65 26.1 330 220 31.5 2468.0408753 137.6 27.6
51 66 26.5 320 215.2 32.4 2593.0442013 133.3 29.6
51 67 27.4 319 216.1 33.4 2775.9003063 137.4 30.1
51 68 32.5 322 221.9 34.8 2921.5653392 136.5 32
51 69 32.6 320 228.7 36.7 3066.1972867 135.7 31.9
51 70 34.1 332 231.6 38.8 3269.7150985 132.2 33.8
51 71 34.4 339 240.3 40.5 3514.5563239 131.7 33.6
51 72 34.4 345 247 41.8 3975.3123851 140 33.7
51 73 34.4 351 253.8 44.4 4505.2851641 141.2 36.3
51 74 35.8 362 263.4 49.3 4980.5044201 145.8 37.8
51 75 38.6 377 276 53.8 5455.7236761 160.7 40.3
51 76 42.6 392 288.5 56.9 5985.6964551 161.5 42.5
51 77 43.4 407 300.1 60.6 6640.6725602 160.4 44.7
51 78 49.8 425 314.5 65.2 7609.7066083 160.3 49.5
51 79 51.7 450 332.9 72.6 8482.6637199 168.6 53.7
51 80 55.3 470 343.5 82.4 9402.1096718 158.1 56.4
51 81 55.9 492 358 90.9 10046.754923 163.1 59.2
51 82 64.3 502 364.7 96.5 10180.022932 157.7 65.7
51 83 71 514 371.5 99.6 9855.6341357 141.2 76.5
51 84 81.7 511 370.5 103.9 10382.507659 128.9 88.5
51 85 87.4 510 369.5 107.6 10839.131379 125.7 92.3
51 86 97.8 507 368.6 109.6 11089.138031 124.8 99.9
51 87 102.7 490 357 113.6 11113.932079 110.4 106.2
51 88 112.9 479 353 118.3 11803 114.3 115.3
51 89 118.6 475 352 124 12399 111.4 123
51 90 129.5 470.9 348.9 130.7 13871 96.9 138.9
51 91 127 477.1 355.2 136.2 14675 109.1 143.6
51 92 155.1 483.3 360.5 140.3 15607 110.8 160
;
```

Click **Run** to create the Work.Cigar table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Panel Data Models** to add the step to your flow.

3 Add the Work.Cigar table to your flow. Connect the input port of the Panel Data Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Panel Data Models step, click the Panel Data Models node.

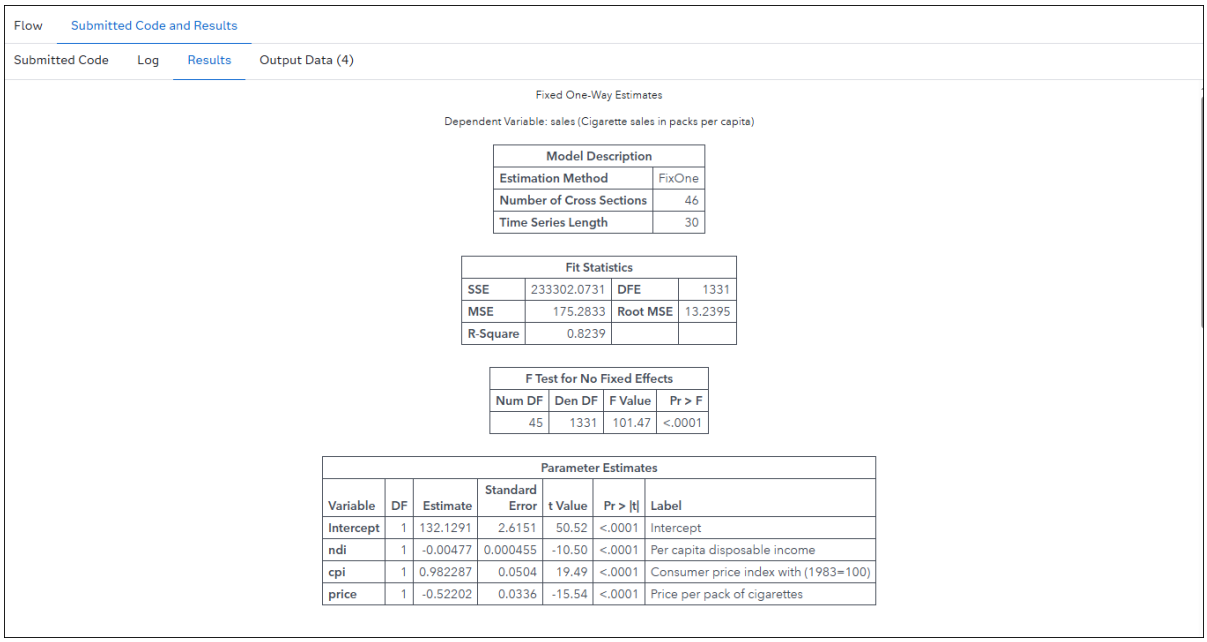
5 On the **Data** tab, assign columns to these roles:

- To the **Cross-sectional ID** role, assign **state**.
- To the **Time ID** role, assign **year**.
- To the **Dependent variable** role, assign **sales**.
- To the **Continuous variables** role, assign **price**, **cpi**, **ndi**.

6 Click the **Model** tab. From the **Model type** drop-down list, select **Linear**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data (4)

Fixed One-Way Estimates

Dependent Variable: sales (Cigarette sales in packs per capita)

Model Description	
Estimation Method	FixOne
Number of Cross Sections	46
Time Series Length	30

Fit Statistics			
SSE	233302.0731	DFE	1331
MSE	175.2833	Root MSE	13.2395
R-Square	0.8239		

F Test for No Fixed Effects			
Num DF	Den DF	F Value	Pr > F
45	1331	101.47	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Pr > |t|	Label
Intercept	1	132.1291	2.6151	50.52	<.0001	Intercept
ndi	1	-0.00477	0.000455	-10.50	<.0001	Per capita disposable income
cpi	1	0.982287	0.0504	19.49	<.0001	Consumer price index with (1983=100)
price	1	-0.52202	0.0336	-15.54	<.0001	Price per pack of cigarettes

Linear Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Cross-sectional ID**, assign the numeric variable that identifies the cross section for each observation. The step verifies that the input data is sorted by the cross-sectional ID and by the time series ID within each cross section.

4 To the **Time ID** role, assign a numeric variable that identifies the time period for each observation. For each cross section, the values of the time ID must be unique.

5 To the **Dependent variable** role, assign the numeric variable to use in the analysis.

6 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

7 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

8 To the **Group analysis by** role, assign variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 From the **Model type** drop-down list, select **Linear**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects using the continuous variables and categorical variables selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 From the **Linear model** drop-down list, select the type of linear model. You can choose from these options:

- **Fixed effects**. For the type of fixed effects, you can select from these options: **One-way fixed effects**, **One-way**, **time**, and **Two-way effects**. You can also specify whether to display the fixed effects.

- **Random effects**. For the type of random effects, you can select from a one-way or two-way effect. Then specify the method to use for estimating the variance component.
- **Hausman-Taylor**. In this type of model, the variables that you assigned to the **Continuous variables** role on the **Data** tab can be assigned to the **Correlated variables** role.
- **Amemiya-MaCurdy**. In this type of model, the variables that you assigned to the **Continuous variables** role on the **Data** tab can be assigned to the **Correlated variables** role.
- **First-order autoregressive**.
- **Moving average**. For the Da Silva method, you can specify the order of the moving average process and the method for estimating the variance component.

Note: This option is available only if you are running the step using the SAS Compute Server.

Step 3: Set the Options

On the **Options** tab, you can set these options.

If you are running the step using the SAS Compute Server, these options are available:

1 Specify the method to calculate the covariance matrix of parameter estimates. You can use the default value, or you can choose from these options:

- **Newey and West**
- **OLS estimator** specifies that the variance-covariance matrix is not corrected.
- **HCCME*n*** specifies a heteroscedasticity-corrected covariance matrix. *n* is a value from 0–4.

If you select one of the **HCCME0-3** options for the covariance matrix estimator, you can also specify whether to include the cluster correction for the variance-covariance matrix.

2 Select the statistics to display in the results.

Here are the available statistics:

- correlations of the parameter estimates
- covariances of the parameter estimates
- iteration history of the objective function and parameter estimates
- tests for random effects: one-way Breusch-Pagan test and two-way Breusch-Pagan test

These tests are also available for first-order autoregressive linear models:

- estimated covariances of the observations

- estimated autocorrelation coefficients

3 Select the plots to include in the results. By default, a histogram of residuals is included in the results. You can include these plots:

   - diagnostic plots: predicted and actual values by observation, QQ plot of residuals, residuals by observation, and a histogram of residuals
   - cross-section plots: actual values by time series, predicted values by time series, stacked residuals by time series, and residuals by time series

   You can display these as a panel of plots or as individual plots. If you select **Individual plots** from the **Display as** drop-down list, you can specify the number of cross sections in one time series plot.

If you are running the step using the SAS CAS Server, specify how to generate the code for the step. You can choose from these options:

- **Use Econometrics procedure**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, you can specify these options:

If you are running the step using the SAS Compute Server, you can create these output tables:

- an output table that contains the statistics from the analysis
- parameter estimates table
- transformed series table

  Note: This option is available only if you are creating a linear model that contains one-way fixed effects and one-way random effects.

If you are running the step using the SAS CAS Server, you can save the output data using a CAS libref. You can also save the parameter estimates data using a SAS libref.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Panel Data Models node. For more information, see "Panel Data Models: Connection Requirements for the Node" on page 712.

Logit Models

Example: Linear Regression with Fixed Effects

To create this example:

1 Enter this code on a **SAS Program** tab:

```
data mroz;
   input inlf nwifeinc educ exper expersq age kidslt6 kidsge6 lwage;
datalines;
1 10.91006    12 14  196   32  1   0   1.210154
1 19.49998    12 5   25    30  0   2   0.3285121
1 12.03991    12 15  225   35  1   3   1.514138
1 6.799996    12 6   36    34  0   3   0.0921233
1 20.10006    14 7   49    31  1   2   1.524272
1 9.859054    12 33  1089  54  0   0   1.55648
1 9.152048    16 11  121   37  0   2   2.12026
1 10.90004    12 35  1225  54  0   0   2.059634
1 17.305      12 24  576   48  0   2   0.7543364
1 12.925      12 21  441   39  0   2   1.544899
1 24.29995    12 15  225   33  0   1   1.401922
1 19.70007    11 14  196   42  0   1   1.524272
1 15.00001    12 0   0     30  1   2   0.7339532
1 14.6        12 14  196   43  0   2   0.8183691
1 24.63091    10 6   36    43  0   1   1.302831
1 17.53103    11 9   81    35  0   3   0.2980284
1 14.09998    12 20  400   43  0   2   1.16761
1 15.839      12 6   36    39  0   5   1.643839
1 14.1        12 23  529   45  0   0   0.6931472
1 10.29996    12 9   81    35  0   4   2.021932
1 22.65498    16 5   25    42  0   2   1.254248
1 8.090048    12 11  121   30  0   0   1.272958
1 17.479      13 18  324   48  0   0   1.178655
1 9.56        12 15  225   45  0   0   1.178655
1 8.274953    12 4   16    31  1   1   0.7675587
1 27.34999    17 21  441   43  0   2   1.331812
1 16          12 31  961   59  0   0   1.386294
1 16.99998    12 9   81    32  0   3   1.55327
1 15.10006    17 7   49    31  1   0   1.981815
1 15.69998    12 7   49    42  0   0   1.76936
1 5.11896     11 32  1024  50  0   0   0.4308079
1 16.75001    16 11  121   59  0   0   0.8997548
1 13.59993    13 16  256   36  0   2   1.76663
1 17.10005    12 14  196   51  0   1   1.272958
1 16.73405    16 27  729   45  0   3   1.336789
1 14.19698    11 0   0     42  0   1   0.9017048
1 10.31999    12 17  289   46  0   0   0.8651237
1 11.3841     10 28  784   46  0   1   1.511847
1 14.59408    14 24  576   51  0   0   1.726029
```

```
1 17.50044    17 11  121   30  0   0   2.683142
1 15.51       12 1   1     30  1   2   0.9852943
1 21.99998    12 14  196   57  0   0   1.365939
1 22.5        16 6   36    31  1   2   0.9450337
1 19.994      12 10  100   48  0   2   1.512376
1 14.13       12 6   36    30  0   3   0.6931472
1 5.000013    12 4   16    34  0   2   1.244788
1 21.1549     16 10  100   48  0   2   0.7011649
1 7.141946    12 22  484   45  0   0   1.519863
1 16.65007    12 16  256   51  0   0   0.8209686
1 6.352       12 6   36    30  0   2   0.9698315
1 27.31395    12 12  144   46  0   1   0.8285082
1 14.5        12 32  1024  58  0   0   0.0943096
1 16.25799    12 15  225   37  0   8   0.1625439
1 9.5         8  17  289   52  0   0   0.4700036
1 7.999956    10 34  1156  52  0   0   0.6292484
1 12.50003    16 9   81    31  0   0   1.39716
1 14.00003    14 37  1369  55  0   0   2.265444
1 20.80007    17 10  100   34  0   0   2.084541
1 19.38511    14 35  1225  55  0   0   1.525839
1 12.38699    12 6   36    39  0   2   0.7621601
1 28.5        14 19  361   40  0   3   1.481605
1 15.04991    12 10  100   43  0   4   1.262826
1 10.49998    8  11  121   48  0   0   0.9996756
1 11.81       12 15  225   47  0   0   1.832582
1 6.950073    12 12  144   41  0   4   2.479308
1 12.41997    8  12  144   36  0   0   1.279015
1 17.4        17 14  196   46  0   2   1.937936
1 15.5        12 11  121   34  0   0   1.070453
1 21.21704    12 9   81    41  0   3   1.123923
1 18          12 24  576   51  0   1   1.321756
1 11.89992    12 12  144   33  0   0   1.745
1 26.75196    12 13  169   52  0   0   1.301744
1 12.14996    9  29  841   58  0   0   1.641866
1 10.19999    10 11  121   34  2   4   2.10702
1 8.120015    12 13  169   31  0   1   1.467068
1 10.65996    12 19  361   48  0   1   1.605811
1 18.10001    12 2   4     32  0   2   -1.029739
1 8.599986    17 24  576   49  0   0   1.087686
1 13.665      15 9   81    32  2   2   0
1 32.34996    12 6   36    58  0   0   0.9382087
1 12.08501    6  22  484   50  0   0   -0.1505904
1 12.15       14 30  900   60  0   0   0
1 17.69502    12 10  100   50  0   1   1.073671
1 24.7        14 6   36    56  0   0   1.265848
1 2.133992    9  29  841   51  0   0   0.486369
1 20.95005    17 29  841   54  0   1   2.12026
1 10.50008    13 36  1296  59  0   0   1.129853
1 10.55       9  19  361   46  0   2   0.9932518
1 45.75       15 8   64    46  0   1   1.658628
1 13.63204    12 13  169   39  1   3   0.3474122
1 18.23894    12 16  256   44  0   2   1.568324
1 17.09       12 11  121   33  2   0   0.5108456
1 30.2349     12 15  225   33  1   2   0.1148454
1 28.7        12 6   36    48  0   2   -0.6931472
1 19.63       12 13  169   31  0   4   -0.3364523
```

```
1 12.82494    12 22  484   45  0   1   1.028226
1 23.8        12 24  576   45  0   1   1.580689
1 26.30003    13 2   4     32  0   2   0.5558946
1 20.69991    12 6   36    47  0   0   0.9014207
1 26          13 2   4     34  0   2   0.8843046
1 10.87702    12 2   4     37  0   1   0.4282046
1 25.61206    12 14  196   36  0   1   1.058415
1 20.98899    12 9   81    47  1   2   0.8783396
1 70.74993    16 11  121   48  0   1   1.654908
1 17.05       12 9   81    42  0   2   1.321756
1 21          13 6   36    33  0   3   0.3285121
1 8.12        11 19  361   46  0   0   1.386294
1 20.88599    12 26  676   47  0   3   1.172885
1 17.66892    12 19  361   44  0   1   1.224187
1 25.20003    12 3   9     36  0   4   0.2876571
1 14.24501    17 7   49    31  2   0   2.230262
1 14.3        14 28  784   55  0   0   1.504077
1 23.70001    16 13  169   45  0   1   1.531152
1 46          17 9   81    47  0   0   1.375158
1 42.9999     12 15  225   46  0   3   1.760269
1 14.749      11 20  400   49  0   0   -0.6931472
1 16.15005    12 29  841   49  0   0   1.406489
1 17.774      12 9   81    45  0   2   1.791759
1 91          17 1   1     38  1   3   1.299292
1 22.29993    10 8   64    47  0   0   1.351004
1 34.60001    13 19  361   54  0   3   1.016281
1 9.620002    11 23  529   41  0   0   1.075344
1 10.89995    12 3   9     43  0   2   1.478965
1 14.49994    16 13  169   31  1   1   1.689487
1 22.00002    17 8   64    47  0   0   2.288598
1 17.90008    12 17  289   35  0   2   -1.822631
1 23.67506    16 4   16    45  0   3   -0.9607652
1 11.79996    12 15  225   33  1   0   1.290994
1 16.14195    16 11  121   54  0   1   0.8648711
1 18.39997    8  7   49    35  0   4   1.540452
1 15.49995    12 0   0     31  1   2   0.6162121
1 17.324      12 0   0     55  0   0   1.648659
1 19.205      12 10  100   34  0   2   1.193498
1 21.30006    13 8   64    38  0   1   2.143976
1 23.56       11 2   4     45  0   1   0.7244036
1 20.85       12 4   16    47  0   1   0.9416075
1 26.15       12 6   36    39  0   2   0.7827594
1 17          14 18  324   36  1   0   1.832582
1 20.72       12 3   9     33  1   2   1.203963
1 17.00009    12 22  484   50  0   0   1.491645
1 16          12 33  1089  58  0   0   1.892133
1 19.50005    17 28  784   49  0   0   2.130895
1 12          14 23  529   41  0   2   1.480604
1 13.73191    12 27  729   51  0   1   0.8943313
1 27.19999    9  11  121   53  0   0   0.2025325
1 5.315       12 6   36    36  1   2   0.4855078
1 16          12 11  121   46  0   2   1.098612
1 27.87198    12 14  196   36  0   2   1.55327
1 40.00001    14 17  289   53  0   1   0.121598
1 15.90003    16 17  289   40  0   3   2.001804
1 27.49997    17 14  196   42  0   2   1.495037
```

```
1 17.02005    15 11  121   33  1   1   0.9052298
1 22.39494    12 7   49    43  0   3   0.6325476
1 11.1        16 8   64    31  1   0   1.386294
1 32.70001    17 6   36    47  0   0   2.102914
1 27.79996    17 8   64    54  0   0   1.959644
1 2.199994    12 4   16    33  1   3   0.5108456
1 19.72095    16 25  625   43  0   0   1.236924
1 9.999988    13 24  576   46  0   1   1.443313
1 13.19997    12 11  121   35  0   3   1.021659
1 12.70897    11 19  361   37  0   3   0.6361535
1 27.30005    16 9   81    37  0   2   1.616453
1 21.2        14 19  361   34  0   3   0.2231435
1 14.4        16 14  196   43  1   0   1.049807
1 20.57596    12 22  484   46  0   0   1.415052
1 12.49999    9  6   36    35  0   3   0.5753766
1 17.50022    17 23  529   46  0   0   2.606682
1 44.00004    14 15  225   46  0   0   1.517915
1 13.11895    12 6   36    43  0   2   0.7550416
1 14.00006    12 11  121   30  0   0   1.094972
1 9.645086    11 2   4     41  0   2   0.9421144
1 17.39705    12 22  484   54  0   1   1.724943
1 7.799889    12 10  100   31  0   1   1.031546
1 13.13398    10 14  196   44  0   0   0.4743691
1 25.6        12 12  144   32  0   1   0.8109302
1 13.90003    5  9   81    47  0   0   0.7092666
1 19.29794    17 13  169   46  0   1   1.710549
1 9.200016    11 18  324   37  0   0   0.4602689
1 37.99999    12 8   64    51  0   2   1.331812
1 44          12 11  121   49  0   1   1.098612
1 21.37202    14 9   81    36  0   4   2.157999
1 23.66802    11 9   81    39  0   1   1.437581
1 9           12 14  196   48  0   2   1.544899
1 25.19995    14 9   81    38  0   2   1.410597
1 21.22       12 2   4     40  0   2   3.218876
1 33.96991    10 12  144   39  1   5   0.9681619
1 17.07       16 15  225   37  0   0   1.791759
1 6.016024    13 11  121   49  0   1   1.68873
1 17.10001    12 7   49    33  0   3   -0.409172
1 8.237       12 9   81    30  0   0   0.2231435
1 13.30008    12 19  361   54  0   0   0.8221558
1 16.00002    11 11  121   39  0   4   1.241702
1 12.53999    12 8   64    43  0   3   1.427124
1 18.00004    9  13  169   31  0   3   1.497097
1 31.2        13 4   16    33  0   3   0.5596158
1 20.74991    12 7   49    40  0   3   1.300028
1 11.09992    12 19  361   36  0   1   1.88443
1 20.68       12 14  196   51  0   0   0.9555114
1 18.00001    13 14  196   44  0   1   1.582087
1 32.43007    16 3   9     42  0   3   1.755614
1 32.90003    12 9   81    40  0   1   1.513103
1 24.10001    16 7   49    34  1   1   2.251892
1 17.80039    17 7   49    30  0   0   2.364432
1 20.50002    12 14  196   54  0   0   0.1053505
1 10.4999     12 29  841   51  0   0   1.399729
1 10.43703    9  19  361   44  0   2   0.9884625
1 18.19499    12 14  196   43  0   1   1.090647
```

```
1 12.84508    12 16  256   34  0   1   1.154614
1 13.8        13 10  100   45  0   0   1.266948
1 22.2        12 12  144   39  0   0   2.885192
1 6.699941    12 24  576   50  0   0   1.22888
1 6.250016    12 6   36    52  0   0   1.203963
1 15.60001    12 9   81    41  0   2   1.35738
1 3.30001     10 14  196   59  0   0   0.8377236
1 3.670978    12 26  676   52  0   0   0.5369611
1 7.789997    16 7   49    46  0   0   0.7487238
1 18.27199    12 4   16    41  1   5   2.295873
1 10.95398    11 15  225   33  0   2   1.107803
1 13.49999    12 23  529   45  0   0   0.6208453
1 11.20001    10 1   1     36  1   2   -2.054164
1 20.99991    12 29  841   48  0   1   1.892012
1 25.7        12 9   81    47  0   1   1.729725
1 8.932994    12 6   36    45  0   0   0.4693784
1 19.15998    12 11  121   37  0   2   0.9808417
1 26.58999    16 17  289   46  0   4   2.069492
1 22.40001    17 6   36    43  0   3   1.675188
1 20.633      12 7   49    42  0   2   1.386294
1 28.20001    17 2   4     34  1   2   1.799215
1 28.8        12 24  576   52  0   0   1.832582
1 8.999997    12 4   16    37  0   3   1.090647
1 11.39994    12 11  121   37  0   1   1.443124
1 10.40001    8  25  625   52  0   0   1.25036
1 19.08006    12 11  121   30  1   0   1.602313
1 9.46604     13 2   4     31  0   1   1.018559
1 6.50006     12 19  361   38  0   1   1.297053
1 29.11701    12 7   49    43  0   3   1.685194
1 19.10302    8  2   4     49  0   1   -0.4209849
1 16.34997    12 20  400   55  0   0   1.562095
1 32.02502    17 10  100   38  0   2   2.146528
1 16.70006    17 19  361   52  0   0   2.347463
1 4.811038    12 17  289   48  0   0   0.9698315
1 24.62601    13 12  144   32  0   2   1.924146
1 17.40001    12 11  121   32  0   1   1.626728
1 13.02504    12 6   36    38  0   2   -0.0392607
1 19.00698    12 10  100   46  0   3   1.460149
1 14.03       12 4   16    40  0   3   1.955394
1 14.89991    9  2   4     31  0   4   0.9263599
1 25.00006    10 13  169   43  0   1   2.066192
1 10.70007    12 21  441   51  0   0   1.422843
1 24.25       16 9   81    30  1   0   2.101032
1 39.13997    13 4   16    52  0   0   2.261461
1 7.199973    8  2   4     30  1   5   0.7013138
1 31.811      16 19  361   51  0   0   2.031013
1 10.00005    13 4   16    31  0   2   1.162369
1 20.66       12 9   81    34  0   4   0.4700036
1 13.49998    11 14  196   49  0   0   1.410597
1 25.38       13 6   36    35  1   3   0.3930551
1 18.27498    12 24  576   53  1   0   1.290994
1 39.213      12 1   1     32  0   3   0
1 10.49994    10 13  169   38  0   3   0.9571255
1 34.857      12 3   9     54  0   0   0.5596158
1 28.502      17 10  100   47  0   1   1.568616
1 12.99996    15 16  256   45  0   1   1.710188
```

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1 41.39991    16 9   81    47  0   1   1.410597
1 14.78       10 19  361   59  0   0   0.2231435
1 15.05       11 4   16    32  0   1   0.5108456
1 29.69998    12 10  100   45  0   1   1.332392
1 16.16502    12 5   25    40  0   4   0.8601859
1 25.20516    14 7   49    47  0   2   2.32278
1 14.2        16 3   9     36  1   2   1.919595
1 18.15897    14 38  1444  56  0   0   1.976107
1 28.98106    8  16  256   41  0   1   0.8954347
1 13.392      7  13  169   48  0   3   0.1812376
1 9.17502     12 1   1     36  1   2   0.4953058
1 27.03985    12 7   49    41  0   0   0.5777924
1 13.14995    14 15  225   41  0   0   1.078818
1 16.40007    12 10  100   36  0   3   1.603199
1 21.29999    12 2   4     37  0   3   0.6208453
1 17.20102    12 19  361   38  0   0   2.083894
1 8.560026    14 25  625   43  0   2   1.379169
1 6.49084     16 25  625   54  0   0   1.112384
1 12.49997    12 7   49    38  0   1   1.067122
1 27.00002    12 15  225   30  1   0   1.118807
1 53.50005    12 11  121   49  0   0   1.588541
1 52.49995    13 25  625   45  0   1   1.390311
1 38.39998    13 19  361   51  0   0   1.714806
1 13.89194    10 4   16    34  0   0   0.2010615
1 3.899993    12 14  196   34  0   2   0.987271
1 34.2        12 19  361   41  0   1   0.9835007
1 19.70008    12 18  324   49  0   1   2.233171
1 18.49995    12 14  196   32  0   0   1.143618
1 10.99998    14 11  121   32  0   0   -0.6113829
1 43.30001    17 4   16    32  0   2   2.153052
1 18.76001    10 29  841   47  0   0   1.299837
1 4.800096    9  21  441   39  0   1   0.8409204
1 21.5        12 24  576   49  0   0   1.058484
1 28.03994    12 19  361   37  0   3   1.152658
1 26          16 31  961   59  0   0   1.293576
1 27          12 28  784   50  0   0   1.832582
1 17.79969    17 15  225   32  0   1   2.32718
1 17.40195    12 27  729   46  0   0   1.166146
1 19.30999    17 13  169   43  0   2   2.034993
1 9.99998     11 4   16    37  0   3   0.6792511
1 11.17998    16 10  100   32  0   2   1.547137
1 18.85696    11 8   64    39  0   1   0.7530186
1 12.30002    13 4   16    34  0   2   0.8472836
1 13.67712    11 18  324   39  0   1   0.871126
1 9.559997    8  3   9     45  0   3   0.2282505
1 24.49998    11 11  121   50  0   0   0.0896578
1 23.15       12 8   64    40  0   1   1.321756
1 15.59088    10 10  100   30  0   1   1.196102
1 14.42092    17 33  1089  57  0   0   1.636119
1 17.45491    12 19  361   39  0   1   1.892012
1 9.800019    12 35  1225  53  0   0   1.518309
1 17.57446    17 21  441   48  0   1   2.472159
1 16.555      14 7   49    46  0   1   1.321756
1 13.29497    12 18  324   47  0   0   1.473641
1 11.844      12 4   16    43  0   1   1.369479
1 46.64506    12 12  144   47  0   0   1.203963
```

```
1 14.69999    12 16  256   47  0   1   1.198729
1 26.09008    12 14  196   47  0   0   1.27021
1 9.9         12 3   9     46  0   0   0.4700036
1 9.048026    9  1   1     34  0   4   0.7999817
1 30.75006    10 27  729   48  0   0   1.565946
1 8.49994     12 12  144   30  0   1   1.758978
1 22.24999    12 6   36    51  0   1   0.8580258
1 42.91       12 9   81    52  0   5   0.6931472
1 33.3        12 2   4     37  0   2   0.6418539
1 13.8199     12 6   36    32  0   2   1.63374
1 23.60001    17 9   81    36  0   2   1.703748
1 13.00007    12 16  256   35  0   2   1.844004
1 20.74994    17 22  484   45  0   0   1.966119
1 6.3         12 26  676   56  0   0   0.8649974
1 7.788925    10 11  121   40  0   2   0.9333052
1 10.47004    12 11  121   45  1   2   0.7792332
1 12          12 15  225   32  0   2   0.9555114
1 16.97992    12 13  169   45  0   0   1.316247
1 17.9        12 6   36    40  0   2   1.475906
1 15.53994    12 20  400   38  0   1   1.491397
1 9.883986    12 17  289   49  0   4   1.45575
1 28.59995    16 8   64    47  0   1   0.5108456
1 17.66001    13 13  169   52  0   0   1.180438
1 25.99992    13 15  225   34  0   1   1.688489
1 13.60201    12 14  196   44  0   2   0.7907275
1 15.8        16 14  196   36  0   3   1.401799
1 41.09999    17 6   36    50  0   0   -0.433556
1 10.77504    12 24  576   45  0   0   1.683172
1 9.000047    14 10  100   44  0   2   -1.766677
1 24.39899    12 2   4     57  0   2   3.155595
1 37.30009    17 9   81    35  0   0   2.259521
1 27.99995    12 23  529   46  0   0   1.306926
1 13.7        14 12  144   30  2   1   0.7984977
1 17.20994    12 8   64    42  0   3   0.5590442
1 14.00001    12 16  256   34  0   1   0.1479026
1 35.75502    17 10  100   45  0   2   1.944495
1 23.5        16 7   49    35  1   2   1.378338
1 31.99993    16 19  361   40  0   0   3.064745
1 17.15       12 2   4     32  0   1   -0.7419173
1 20.25002    9  9   81    54  0   0   0.7657004
1 5.485985    12 14  196   38  0   3   0.619393
1 25.07504    12 9   81    43  0   3   1.465452
1 18.21995    16 16  256   54  0   0   2.18926
1 26          14 7   49    39  0   3   1.021659
1 34.50007    12 6   36    37  0   1   0.9770095
1 12.4        12 22  484   46  0   2   0.9162908
1 10.78685    11 9   81    56  0   0   2.905096
1 16.32301    12 9   81    41  0   3   -0.1996712
1 30.5        16 14  196   45  0   1   0.6931472
1 51.29963    17 17  289   44  0   1   2.733393
1 33.04997    17 12  144   50  0   1   1.868335
1 34.75001    14 13  169   37  0   5   2.12026
1 16.40004    12 8   64    44  0   1   1.515193
1 19.70007    14 10  100   32  0   2   0.9146093
1 6.600003    12 16  256   34  1   1   1.499556
1 9.020008    10 1   1     32  0   2   0.8030772
```

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1 10.40001    12 6   36    37  0   3   0.7280316
1 14.51999    13 4   16    44  0   1   0.51641
1 17.2        16 8   64    34  0   2   1.226448
1 43          12 4   16    33  1   3   0.9162908
1 13.87196    7  15  225   43  0   3   1.376471
1 -0.0290575  16 7   49    35  0   2   1.828975
1 16.76994    14 14  196   43  0   1   1.368283
1 7.8         12 16  256   34  0   0   1.064711
1 14.50006    10 15  225   36  0   3   1.406489
1 7.9         12 23  529   41  0   2   1.047319
1 79.80001    16 19  361   41  0   0   1.948093
1 7.17597     10 4   16    35  0   3   1.078001
1 17.50698    12 12  144   32  1   3   0.6539385
1 20.6        14 12  144   30  0   0   1.927892
1 18.55992    12 25  625   43  0   0   1.361028
1 9.3         6  14  196   54  0   0   0.6931472
1 5.120008    15 14  196   35  0   2   1.604687
1 14.50004    12 11  121   50  0   0   0.1839036
1 19.8        17 7   49    34  1   1   3.113515
1 18.29995    14 18  324   52  0   0   1.926829
1 33.99994    13 4   16    35  0   3   1.270126
1 11.62794    6  37  1369  55  0   0   0.6826927
1 11.80005    16 13  169   35  0   0   1.68107
1 39.09998    14 14  196   49  0   1   0.556296
1 18.43007    15 17  289   38  2   2   1.62822
1 21          14 5   25    42  0   2   0.9162908
1 59          8  2   4     48  0   1   1.341558
1 25.3        14 0   0     51  0   0   0
1 23.24899    12 3   9     43  0   2   1.122231
1 24.92809    12 21  441   43  0   1   0.5401708
1 14.78199    12 20  400   38  0   1   1.391506
1 18.90003    12 19  361   44  0   1   1.697174
1 21          12 4   16    36  1   3   3.218876
1 10.00001    12 19  361   38  0   0   0.8711678
1 29.30997    8  11  121   47  0   0   1.16733
1 13.14003    12 14  196   34  0   2   1.216988
1 25.08999    17 8   64    40  1   2   0.5753766
1 14.59993    12 13  169   31  0   1   1.151616
1 1.200001    12 24  576   46  0   0   0.9942513
1 32          14 1   1     36  0   3   0.5263249
1 16.11997    13 1   1     39  1   2   -1.543182
1 26.50002    17 3   9     36  0   2   1.912043
1 12.75006    8  4   16    37  0   4   0.5542873
1 12.9        12 21  441   39  0   4   0.9162908
1 10.69998    11 10  100   36  1   3   1.500939
1 14.43403    12 13  169   49  0   2   0.9446838
1 23.709      12 9   81    45  1   1   1.241269
1 15.1        17 14  196   32  2   0   1.564984
1 18.19998    10 2   4     36  0   5   0.8380265
1 22.64106    12 21  441   40  0   1   1.668857
1 21.64008    13 22  484   43  0   2   1.769429
1 23.99998    12 14  196   33  0   1   1.226448
1 16.00002    12 7   49    30  0   1   1.406489
0 21.025      12 2   4     49  0   1   .
0 23.6        16 5   25    30  2   0   .
0 22.8        12 12  144   30  1   0   .
```

```
0 35.91       12 1   1     41  0   4   .
0 21.7        12 12  144   45  0   1   .
0 21.823      12 4   16    43  0   5   .
0 31          13 9   81    42  0   1   .
0 15.3        12 9   81    60  0   0   .
0 12.925      12 6   36    57  0   0   .
0 15.83       10 5   25    38  0   2   .
0 30.2        12 5   25    56  0   0   .
0 16.6        12 8   64    32  0   3   .
0 11          7  2   4     49  0   1   .
0 15          12 6   36    55  0   0   .
0 20.528      9  0   0     36  1   1   .
0 13.126      12 3   9     44  0   3   .
0 15.55       10 7   49    44  0   1   .
0 18.01       14 3   9     35  1   2   .
0 18.874      14 10  100   44  2   3   .
0 24.8        12 3   9     45  0   1   .
0 17.5        12 2   4     34  1   0   .
0 16.15       17 12  144   30  2   0   .
0 15.189      8  15  225   39  0   1   .
0 6           12 5   25    36  0   2   .
0 37.25       17 4   16    38  0   2   .
0 27.76       12 10  100   53  0   0   .
0 9.09        12 1   1     36  0   2   .
0 14.5        12 8   64    32  1   1   .
0 19.7        9  20  400   51  0   3   .
0 16.788      11 4   16    38  0   0   .
0 18.52       12 7   49    33  2   0   .
0 20.95       12 10  100   54  0   0   .
0 7.574       9  3   9     38  0   3   .
0 10.027      11 5   25    30  2   2   .
0 5           12 10  100   34  2   3   .
0 7.04        9  0   0     34  0   1   .
0 40.8        12 3   9     50  0   2   .
0 16.05       17 10  100   30  2   0   .
0 33.1        12 2   4     38  0   2   .
0 33.856      14 10  100   54  0   0   .
0 20.5        12 4   16    30  1   2   .
0 28.6        12 0   0     55  0   0   .
0 18.75       10 10  100   51  0   1   .
0 20.3        12 5   25    44  0   1   .
0 13.42       12 0   0     53  0   0   .
0 18.4        10 0   0     42  0   2   .
0 16.682      12 19  361   38  0   2   .
0 32.685      13 2   4     38  1   3   .
0 7.05        12 12  144   41  1   4   .
0 10.867      8  5   25    35  0   3   .
0 18.22       12 5   25    33  1   2   .
0 26.613      13 5   25    48  0   0   .
0 25          12 10  100   47  0   0   .
0 15.7        12 0   0     34  0   5   .
0 40.25       13 4   16    33  2   1   .
0 73.6        13 3   9     31  3   1   .
0 10.592      8  2   4     58  0   0   .
0 8           12 1   1     49  0   0   .
0 13.4        8  0   0     55  0   1   .
```

```
0 23.7        14 1   1     44  0   0   .
0 18.9        9  1   1     44  0   0   .
0 48.3        16 6   36    36  0   3   .
0 24.47       12 12  144   38  0   3   .
0 28.63       16 6   36    37  0   3   .
0 25.32       12 9   81    47  0   0   .
0 13.53       12 14  196   47  0   3   .
0 14.8        12 13  169   32  1   1   .
0 17.4        12 8   64    43  1   2   .
0 15.98       11 0   0     42  1   4   .
0 16.576      12 1   1     56  0   0   .
0 21.85       13 3   9     38  0   5   .
0 14.6        12 13  169   52  0   2   .
0 21.6        12 3   9     50  0   0   .
0 24          16 8   64    33  0   0   .
0 20.883      16 8   64    44  0   2   .
0 19.5        12 18  324   41  0   1   .
0 42.8        12 2   4     45  0   1   .
0 41.5        14 3   9     53  0   0   .
0 18.965      14 5   25    53  0   0   .
0 16.1        12 2   4     42  0   1   .
0 14.7        13 10  100   32  2   0   .
0 18.8        12 30  900   56  0   0   .
0 14.75       11 1   1     37  1   3   .
0 21          12 5   25    40  1   2   .
0 35.4        15 8   64    54  0   3   .
0 10.7        7  0   0     53  0   0   .
0 24.5        12 4   16    48  0   1   .
0 17.045      12 2   4     36  1   2   .
0 18.8        12 30  900   57  0   0   .
0 14          12 25  625   51  0   0   .
0 18.214      13 3   9     33  0   4   .
0 20.177      12 20  400   52  0   0   .
0 8.3         10 20  400   56  0   0   .
0 14.2        12 0   0     36  1   2   .
0 21.768      14 15  225   36  1   0   .
0 29.553      12 10  100   46  0   1   .
0 4.35        10 4   16    31  0   3   .
0 24          11 3   9     52  0   0   .
0 18.3        12 10  100   46  0   2   .
0 17.2        12 9   81    35  2   0   .
0 16.476      12 7   49    59  0   0   .
0 13.4        8  12  144   36  0   1   .
0 44.988      7  0   0     51  1   3   .
0 18.2        16 16  256   31  1   0   .
0 28          14 4   16    31  0   2   .
0 11.55       12 7   49    32  1   1   .
0 28.45       16 7   49    35  1   2   .
0 15.096      12 14  196   40  0   3   .
0 8.009       10 2   4     33  1   2   .
0 10.04       7  20  400   54  0   0   .
0 16.7        12 5   25    36  1   1   .
0 8.4         10 10  100   50  0   1   .
0 13          8  20  400   54  0   0   .
0 17.97       11 10  100   48  0   1   .
0 18.45       15 8   64    41  0   4   .
```

```
0 31          12 11  121   50  0   4   .
0 24.135      12 3   9     46  0   2   .
0 31.7        13 6   36    42  0   1   .
0 10.19       9  4   16    31  1   2   .
0 21.574      12 4   16    53  0   0   .
0 26.68       12 9   81    51  0   1   .
0 17.7        12 10  100   47  0   1   .
0 29.4        12 3   9     50  0   1   .
0 22.159      6  2   4     37  0   1   .
0 35          12 2   4     30  2   2   .
0 8.63        12 0   0     49  0   0   .
0 17.08       12 8   64    52  0   2   .
0 32.5        12 6   36    47  0   2   .
0 16          12 15  225   49  0   0   .
0 18.85       12 15  225   44  0   4   .
0 17.5        8  9   81    53  0   0   .
0 19.392      12 8   64    30  1   0   .
0 14.45       12 18  324   54  0   2   .
0 21.8        7  3   9     47  1   1   .
0 7.7         15 10  100   56  0   0   .
0 31.8        12 6   36    49  0   1   .
0 17.258      6  20  400   48  0   0   .
0 13.399      12 8   64    49  0   1   .
0 16.073      12 3   9     56  0   1   .
0 23.26       12 4   16    46  0   0   .
0 37.3        12 13  169   45  0   2   .
0 11          12 4   16    32  0   2   .
0 13.075      12 17  289   43  1   1   .
0 13.7        12 4   16    34  1   1   .
0 25.1        12 0   0     30  1   1   .
0 18.6        17 15  225   38  2   0   .
0 29          16 11  121   33  1   1   .
0 19.237      12 23  529   52  0   0   .
0 19.855      11 1   1     43  0   3   .
0 9.45        12 5   25    33  1   1   .
0 30          10 1   1     45  0   0   .
0 15          10 5   25    36  2   1   .
0 24.701      12 3   9     34  1   1   .
0 15.9        14 3   9     37  0   2   .
0 16.24       10 19  361   46  0   1   .
0 21.1        12 20  400   47  0   0   .
0 23          16 5   25    31  2   1   .
0 6.34        5  0   0     57  0   0   .
0 42.25       12 3   9     30  1   1   .
0 14.694      12 3   9     30  0   0   .
0 21.417      12 7   49    44  0   3   .
0 20.2        13 7   49    53  0   0   .
0 12.09       8  1   1     51  0   0   .
0 24.76       12 13  169   39  1   3   .
0 23          8  0   0     52  0   0   .
0 19.365      8  0   0     46  0   4   .
0 5.55        12 12  144   47  0   5   .
0 68.035      8  0   0     52  0   2   .
0 29.3        12 5   25    45  0   2   .
0 18.5        11 45  2025  60  0   0   .
0 22.582      13 10  100   41  0   2   .
```

```
0 21.5        8  2   4     39  0   3   .
0 28.07       12 3   9     49  0   1   .
0 50.3        15 1   1     32  1   1   .
0 23.5        12 5   25    33  1   3   .
0 15.5        10 10  100   36  0   4   .
0 13.44       13 4   16    37  3   3   .
0 8.1         12 7   49    30  1   2   .
0 9.8         11 9   81    44  1   1   .
0 20.3        12 5   25    48  0   1   .
0 15          11 4   16    40  0   4   .
0 56.1        13 11  121   47  0   0   .
0 22.846      12 9   81    36  0   2   .
0 22.225      11 4   16    40  0   2   .
0 17.635      12 2   4     46  0   1   .
0 18.5        12 23  529   52  0   0   .
0 13.39       12 3   9     44  0   1   .
0 15.15       10 15  225   45  0   1   .
0 16.2        7  8   64    30  2   1   .
0 33.92       12 3   9     40  1   3   .
0 14          12 25  625   43  0   1   .
0 16.736      12 2   4     49  0   2   .
0 30.65       12 0   0     46  1   4   .
0 12.4        11 19  361   52  0   0   .
0 19.022      12 3   9     31  1   1   .
0 11.203      10 7   49    42  1   1   .
0 19.876      11 1   1     33  0   3   .
0 57          16 9   81    57  0   0   .
0 18.29       10 3   9     49  0   0   .
0 20.22       14 8   64    45  0   1   .
0 22.15       11 0   0     56  0   0   .
0 30.623      12 5   25    41  1   3   .
0 9.38        5  20  400   56  0   0   .
0 22          10 3   9     48  0   1   .
0 23.675      16 12  144   52  0   2   .
0 33.671      12 5   25    51  0   0   .
0 12.367      11 1   1     35  0   3   .
0 21.95       12 0   0     45  0   0   .
0 32          12 7   49    54  0   0   .
0 22.61       12 13  169   54  0   2   .
0 12.092      12 3   9     31  1   0   .
0 3.777       6  0   0     53  0   3   .
0 36          14 2   4     35  2   2   .
0 26.9        12 0   0     36  1   3   .
0 32.242      12 2   4     59  0   0   .
0 35.02       16 1   1     54  0   0   .
0 37.6        12 10  100   37  1   1   .
0 1.5         12 10  100   44  0   0   .
0 96          17 1   1     34  1   2   .
0 18.15       12 3   9     49  0   0   .
0 15.5        12 32  1024  49  0   0   .
0 14          9  0   0     60  0   0   .
0 14.756      12 7   49    51  0   0   .
0 22          12 5   25    30  1   1   .
0 24.466      12 2   4     47  0   2   .
0 24.4        12 5   25    36  0   4   .
0 24          12 3   9     35  1   3   .
```

```
0 15.5        12 25  625   58  0   0   .
0 30.8        14 0   0     41  1   3   .
0 10.66       10 3   9     51  0   1   .
0 13.35       12 10  100   47  0   0   .
0 10.09       9  10  100   45  1   2   .
0 55.6        14 7   49    60  0   0   .
0 25.7        16 5   25    30  1   1   .
0 29          11 15  225   55  0   0   .
0 7.286       12 1   1     32  1   2   .
0 37.752      12 5   25    36  0   2   .
0 13.072      12 9   81    55  0   0   .
0 7.044       12 18  324   47  0   0   .
0 18.2        12 1   1     47  0   1   .
0 27          11 0   0     37  0   1   .
0 30.3        12 6   36    50  0   2   .
0 12          12 1   1     30  0   3   .
0 31.5        17 2   4     48  0   1   .
0 27.092      10 15  225   43  0   2   .
0 20.968      11 25  625   48  1   0   .
0 27          14 1   1     41  1   2   .
0 11.225      12 0   0     50  0   0   .
0 37.7        8  0   0     58  0   0   .
0 28.2        13 0   0     38  0   5   .
0 34          12 8   64    37  0   1   .
0 63.2        16 22  484   50  0   0   .
0 7.5         8  5   25    42  0   4   .
0 17.41       9  10  100   37  1   3   .
0 51          16 1   1     41  0   2   .
0 12.916      12 1   1     31  0   2   .
0 21.9        12 6   36    51  0   0   .
0 17.64       12 4   16    36  1   2   .
0 20          15 6   36    54  0   0   .
0 15          12 0   0     49  0   0   .
0 14.06       9  1   1     48  1   1   .
0 15.825      9  3   9     42  0   2   .
0 16.51       12 15  225   41  1   2   .
0 13          16 33  1089  55  0   0   .
0 10          9  2   4     42  0   0   .
0 22          15 1   1     32  0   1   .
0 29.8        12 10  100   43  0   2   .
0 15          12 0   0     33  1   3   .
0 22.3        15 14  196   48  0   1   .
0 14.55       12 15  225   43  0   2   .
0 19.73       17 15  225   47  1   3   .
0 35          12 10  100   54  0   0   .
0 21.014      12 6   36    51  0   1   .
0 10.876      10 18  324   51  0   1   .
0 27.85       13 15  225   43  1   1   .
0 9.56        12 30  900   53  0   0   .
0 30.3        11 15  225   34  1   1   .
0 7.72        8  10  100   31  1   1   .
0 10.55       12 0   0     56  0   0   .
0 24.106      16 0   0     42  0   1   .
0 22.995      12 4   16    32  0   2   .
0 6           12 0   0     35  1   3   .
0 24.35       12 3   9     30  1   1   .
```

```
0 7.608       10 20  400   51  0   0   .
0 28.2        12 3   9     47  0   3   .
0 16.15       12 1   1     54  0   1   .
0 51.2        15 5   25    31  3   0   .
0 12.646      10 7   49    47  0   0   .
0 19          14 6   36    47  0   3   .
0 19          12 2   4     40  0   3   .
0 14.4        8  0   0     48  0   0   .
0 7.232       8  10  100   34  0   7   .
0 21.943      12 6   36    38  0   3   .
0 47.5        12 4   16    32  1   3   .
0 28.9        16 8   64    48  0   1   .
0 12.4        12 18  324   41  0   2   .
0 6.531       5  7   49    49  0   2   .
0 22.422      8  15  225   59  0   0   .
0 22.2        13 7   49    58  0   0   .
0 77          12 8   64    41  0   3   .
0 88          12 8   64    45  0   2   .
0 26.04       14 3   9     30  1   1   .
0 63.5        12 10  100   41  0   1   .
0 12.1        12 9   81    30  2   0   .
0 17.505      12 24  576   53  0   1   .
0 18          12 12  144   31  0   0   .
0 28.069      14 2   4     43  0   2   .
0 14          12 6   36    31  1   1   .
0 8.117       12 18  324   51  0   0   .
0 11.895      9  17  289   43  0   0   .
0 45.25       14 7   49    31  1   2   .
0 31.106      11 6   36    48  0   0   .
0 4           12 10  100   31  1   1   .
0 40.5        12 5   25    44  0   1   .
0 21.62       11 7   49    48  0   1   .
0 23.426      12 11  121   53  0   1   .
0 26          10 14  196   42  0   3   .
0 7.84        12 5   25    39  2   6   .
0 6.8         10 2   4     32  1   2   .
0 5.33        12 4   16    36  0   2   .
0 28.2        13 5   25    40  0   2   .
0 10          12 14  196   31  2   3   .
0 9.952       12 4   16    43  0   0   .
0 24.984      12 15  225   60  0   0   .
0 28.363      9  12  144   39  0   3   .
;
```

Click **Run** to create the Work.Mroz table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Panel Data Models** to add the step to your flow.

3 Add the Work.Mroz table to your flow. Connect the input port of the Panel Data Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Panel Data Models step, click the Panel Data Models node.

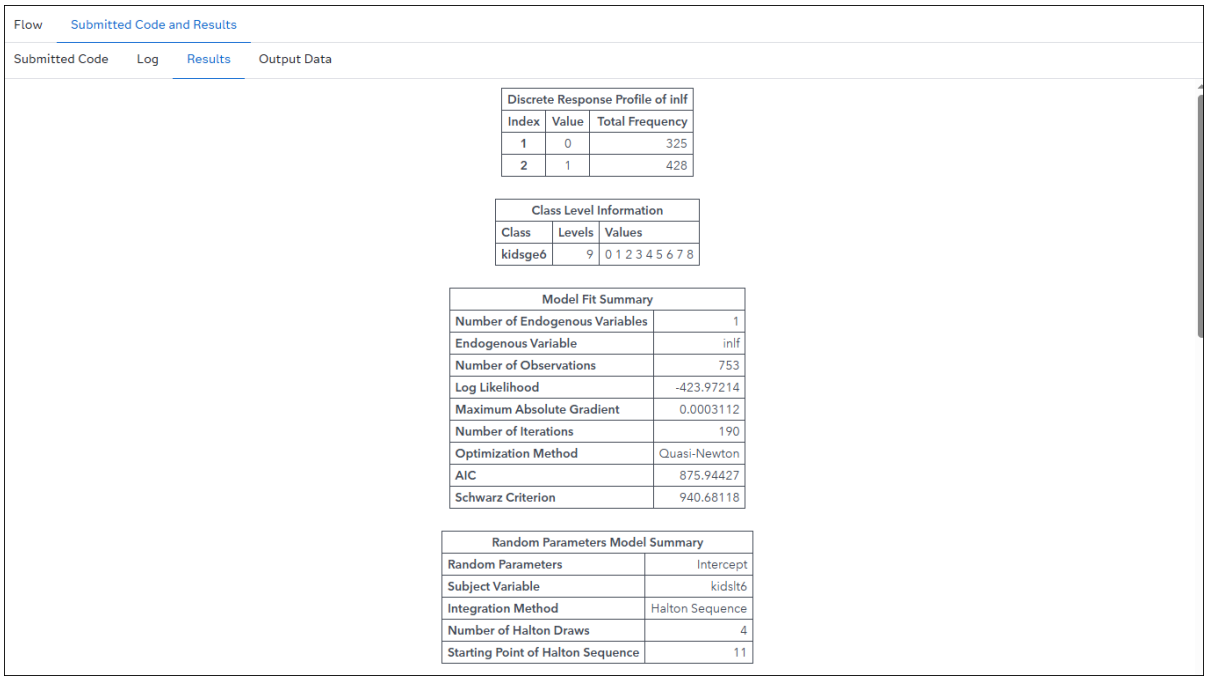
5 On the **Data** tab, assign columns to these roles:

- To the **Cross-sectional ID** role, assign **kidslt6**.
- To the **Dependent variable** role, assign **inlf**.
- To the **Continuous variables** role, assign **nwifeinc**, **educ**, **exper**, and **expersq**.
- To the **Categorical variables** role, assign **kidsge6**.

6 Click the **Model** tab. From the **Model type** drop-down list, select **Logit**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Discrete Response Profile of inlf		
Index	Value	Total Frequency
1	0	325
2	1	428

Class Level Information		
Class	Levels	Values
kidsge6	9	0 1 2 3 4 5 6 7 8

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	inlf
Number of Observations	753
Log Likelihood	-423.97214
Maximum Absolute Gradient	0.0003112
Number of Iterations	190
Optimization Method	Quasi-Newton
AIC	875.94427
Schwarz Criterion	940.68118

Random Parameters Model Summary	
Random Parameters	Intercept
Subject Variable	kidslt6
Integration Method	Halton Sequence
Number of Halton Draws	4
Starting Point of Halton Sequence	11

Logit Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the SAS Compute Server for this step.

Note: The logit model is not available if you are running on a CAS server.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Cross-sectional ID**, assign the numeric variable that identifies the cross section for each observation. The step verifies that the input data is sorted by the cross-sectional ID.

4 To the **Time ID** role, assign a numeric variable that identifies the time period for each observation. For each cross section, the values of the time ID must be unique.

Note: For the logit model, a time ID is not required and is ignored in the analysis.

5 To the **Dependent variable** role, assign the numeric variable that takes discrete values.

6 To the **Continuous variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

7 To the **Categorical variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

8 To the **Group analysis by** role, assign variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 From the **Model type** drop-down list, select **Logit**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects using the continuous variables and categorical variables selected on the **Data** tab.

Note: Random effects are automatically included in the model. This functionality is experimental.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Specify the threshold for the first category for the logit model. By default, this value is zero, but you can use an estimated value.

Step 3: Set the Options

On the **Options** tab, you can set these options.

1 Specify the method to calculate the covariance matrix of parameter estimates. You can use the default value, or you can choose from these options:

- **Inverse Hessian matrix** – the covariance from the inverse Hessian matrix.
- **Outer product matrix** – the covariance from the outer product matrix.

- **Outer product and Hessian matrices** – the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Select the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.

4 Select the statistics to display in the results.

Here are the available statistics:

- correlations of the parameter estimates
- covariances of the parameter estimates
- iteration history of the objective function and parameter estimates

5 Select the diagnostic and output plots to include in the results.

Step 4: Set the Output Options

On the **Output** tab, you can specify these options:

- an output data set that contains the default statistics from the analysis and any selected statistics, such as predicted values, the probability of the dependent variable taking the current value, the probability of the dependent variable for all possible responses, and the error standard deviation
- parameter estimates table

Note: If you are running the step in a flow, you must add output ports for the output tables to the Panel Data Models node. For more information, see "Panel Data Models: Connection Requirements for the Node" on page 712.

Probit Models

Example: Probit Model

To create this example:

1 Enter this code on a **SAS Program** tab:

```
data mroz;
   input inlf nwifeinc educ exper expersq age kidslt6 kidsge6 lwage;
datalines;
1 10.91006    12 14  196   32  1   0   1.210154
1 19.49998    12 5   25    30  0   2   0.3285121
1 12.03991    12 15  225   35  1   3   1.514138
1 6.799996    12 6   36    34  0   3   0.0921233
1 20.10006    14 7   49    31  1   2   1.524272
```

```
1 9.859054    12 33  1089  54  0   0   1.55648
1 9.152048    16 11  121   37  0   2   2.12026
1 10.90004    12 35  1225  54  0   0   2.059634
1 17.305      12 24  576   48  0   2   0.7543364
1 12.925      12 21  441   39  0   2   1.544899
1 24.29995    12 15  225   33  0   1   1.401922
1 19.70007    11 14  196   42  0   1   1.524272
1 15.00001    12 0   0     30  1   2   0.7339532
1 14.6        12 14  196   43  0   2   0.8183691
1 24.63091    10 6   36    43  0   1   1.302831
1 17.53103    11 9   81    35  0   3   0.2980284
1 14.09998    12 20  400   43  0   2   1.16761
1 15.839      12 6   36    39  0   5   1.643839
1 14.1        12 23  529   45  0   0   0.6931472
1 10.29996    12 9   81    35  0   4   2.021932
1 22.65498    16 5   25    42  0   2   1.254248
1 8.090048    12 11  121   30  0   0   1.272958
1 17.479      13 18  324   48  0   0   1.178655
1 9.56        12 15  225   45  0   0   1.178655
1 8.274953    12 4   16    31  1   1   0.7675587
1 27.34999    17 21  441   43  0   2   1.331812
1 16          12 31  961   59  0   0   1.386294
1 16.99998    12 9   81    32  0   3   1.55327
1 15.10006    17 7   49    31  1   0   1.981815
1 15.69998    12 7   49    42  0   0   1.76936
1 5.11896     11 32  1024  50  0   0   0.4308079
1 16.75001    16 11  121   59  0   0   0.8997548
1 13.59993    13 16  256   36  0   2   1.76663
1 17.10005    12 14  196   51  0   1   1.272958
1 16.73405    16 27  729   45  0   3   1.336789
1 14.19698    11 0   0     42  0   1   0.9017048
1 10.31999    12 17  289   46  0   0   0.8651237
1 11.3841     10 28  784   46  0   1   1.511847
1 14.59408    14 24  576   51  0   0   1.726029
1 17.50044    17 11  121   30  0   0   2.683142
1 15.51       12 1   1     30  1   2   0.9852943
1 21.99998    12 14  196   57  0   0   1.365939
1 22.5        16 6   36    31  1   2   0.9450337
1 19.994      12 10  100   48  0   2   1.512376
1 14.13       12 6   36    30  0   3   0.6931472
1 5.000013    12 4   16    34  0   2   1.244788
1 21.1549     16 10  100   48  0   2   0.7011649
1 7.141946    12 22  484   45  0   0   1.519863
1 16.65007    12 16  256   51  0   0   0.8209686
1 6.352       12 6   36    30  0   2   0.9698315
1 27.31395    12 12  144   46  0   1   0.8285082
1 14.5        12 32  1024  58  0   0   0.0943096
1 16.25799    12 15  225   37  0   8   0.1625439
1 9.5         8  17  289   52  0   0   0.4700036
1 7.999956    10 34  1156  52  0   0   0.6292484
1 12.50003    16 9   81    31  0   0   1.39716
1 14.00003    14 37  1369  55  0   0   2.265444
1 20.80007    17 10  100   34  0   0   2.084541
1 19.38511    14 35  1225  55  0   0   1.525839
1 12.38699    12 6   36    39  0   2   0.7621601
1 28.5        14 19  361   40  0   3   1.481605
```

```
1 15.04991    12 10  100   43  0   4   1.262826
1 10.49998    8  11  121   48  0   0   0.9996756
1 11.81       12 15  225   47  0   0   1.832582
1 6.950073    12 12  144   41  0   4   2.479308
1 12.41997    8  12  144   36  0   0   1.279015
1 17.4        17 14  196   46  0   2   1.937936
1 15.5        12 11  121   34  0   0   1.070453
1 21.21704    12 9   81    41  0   3   1.123923
1 18          12 24  576   51  0   1   1.321756
1 11.89992    12 12  144   33  0   0   1.745
1 26.75196    12 13  169   52  0   0   1.301744
1 12.14996    9  29  841   58  0   0   1.641866
1 10.19999    10 11  121   34  2   4   2.10702
1 8.120015    12 13  169   31  0   1   1.467068
1 10.65996    12 19  361   48  0   1   1.605811
1 18.10001    12 2   4     32  0   2   -1.029739
1 8.599986    17 24  576   49  0   0   1.087686
1 13.665      15 9   81    32  2   2   0
1 32.34996    12 6   36    58  0   0   0.9382087
1 12.08501    6  22  484   50  0   0   -0.1505904
1 12.15       14 30  900   60  0   0   0
1 17.69502    12 10  100   50  0   1   1.073671
1 24.7        14 6   36    56  0   0   1.265848
1 2.133992    9  29  841   51  0   0   0.486369
1 20.95005    17 29  841   54  0   1   2.12026
1 10.50008    13 36  1296  59  0   0   1.129853
1 10.55       9  19  361   46  0   2   0.9932518
1 45.75       15 8   64    46  0   1   1.658628
1 13.63204    12 13  169   39  1   3   0.3474122
1 18.23894    12 16  256   44  0   2   1.568324
1 17.09       12 11  121   33  2   0   0.5108456
1 30.2349     12 15  225   33  1   2   0.1148454
1 28.7        12 6   36    48  0   2   -0.6931472
1 19.63       12 13  169   31  0   4   -0.3364523
1 12.82494    12 22  484   45  0   1   1.028226
1 23.8        12 24  576   45  0   1   1.580689
1 26.30003    13 2   4     32  0   2   0.5558946
1 20.69991    12 6   36    47  0   0   0.9014207
1 26          13 2   4     34  0   2   0.8843046
1 10.87702    12 2   4     37  0   1   0.4282046
1 25.61206    12 14  196   36  0   1   1.058415
1 20.98899    12 9   81    47  1   2   0.8783396
1 70.74993    16 11  121   48  0   1   1.654908
1 17.05       12 9   81    42  0   2   1.321756
1 21          13 6   36    33  0   3   0.3285121
1 8.12        11 19  361   46  0   0   1.386294
1 20.88599    12 26  676   47  0   3   1.172885
1 17.66892    12 19  361   44  0   1   1.224187
1 25.20003    12 3   9     36  0   4   0.2876571
1 14.24501    17 7   49    31  2   0   2.230262
1 14.3        14 28  784   55  0   0   1.504077
1 23.70001    16 13  169   45  0   1   1.531152
1 46          17 9   81    47  0   0   1.375158
1 42.9999     12 15  225   46  0   3   1.760269
1 14.749      11 20  400   49  0   0   -0.6931472
1 16.15005    12 29  841   49  0   0   1.406489
```

```
1 17.774      12 9   81    45  0   2   1.791759
1 91          17 1   1     38  1   3   1.299292
1 22.29993    10 8   64    47  0   0   1.351004
1 34.60001    13 19  361   54  0   3   1.016281
1 9.620002    11 23  529   41  0   0   1.075344
1 10.89995    12 3   9     43  0   2   1.478965
1 14.49994    16 13  169   31  1   1   1.689487
1 22.00002    17 8   64    47  0   0   2.288598
1 17.90008    12 17  289   35  0   2   -1.822631
1 23.67506    16 4   16    45  0   3   -0.9607652
1 11.79996    12 15  225   33  1   0   1.290994
1 16.14195    16 11  121   54  0   1   0.8648711
1 18.39997    8  7   49    35  0   4   1.540452
1 15.49995    12 0   0     31  1   2   0.6162121
1 17.324      12 0   0     55  0   0   1.648659
1 19.205      12 10  100   34  0   2   1.193498
1 21.30006    13 8   64    38  0   1   2.143976
1 23.56       11 2   4     45  0   1   0.7244036
1 20.85       12 4   16    47  0   1   0.9416075
1 26.15       12 6   36    39  0   2   0.7827594
1 17          14 18  324   36  1   0   1.832582
1 20.72       12 3   9     33  1   2   1.203963
1 17.00009    12 22  484   50  0   0   1.491645
1 16          12 33  1089  58  0   0   1.892133
1 19.50005    17 28  784   49  0   0   2.130895
1 12          14 23  529   41  0   2   1.480604
1 13.73191    12 27  729   51  0   1   0.8943313
1 27.19999    9  11  121   53  0   0   0.2025325
1 5.315       12 6   36    36  1   2   0.4855078
1 16          12 11  121   46  0   2   1.098612
1 27.87198    12 14  196   36  0   2   1.55327
1 40.00001    14 17  289   53  0   1   0.121598
1 15.90003    16 17  289   40  0   3   2.001804
1 27.49997    17 14  196   42  0   2   1.495037
1 17.02005    15 11  121   33  1   1   0.9052298
1 22.39494    12 7   49    43  0   3   0.6325476
1 11.1        16 8   64    31  1   0   1.386294
1 32.70001    17 6   36    47  0   0   2.102914
1 27.79996    17 8   64    54  0   0   1.959644
1 2.199994    12 4   16    33  1   3   0.5108456
1 19.72095    16 25  625   43  0   0   1.236924
1 9.999988    13 24  576   46  0   1   1.443313
1 13.19997    12 11  121   35  0   3   1.021659
1 12.70897    11 19  361   37  0   3   0.6361535
1 27.30005    16 9   81    37  0   2   1.616453
1 21.2        14 19  361   34  0   3   0.2231435
1 14.4        16 14  196   43  1   0   1.049807
1 20.57596    12 22  484   46  0   0   1.415052
1 12.49999    9  6   36    35  0   3   0.5753766
1 17.50022    17 23  529   46  0   0   2.606682
1 44.00004    14 15  225   46  0   0   1.517915
1 13.11895    12 6   36    43  0   2   0.7550416
1 14.00006    12 11  121   30  0   0   1.094972
1 9.645086    11 2   4     41  0   2   0.9421144
1 17.39705    12 22  484   54  0   1   1.724943
1 7.799889    12 10  100   31  0   1   1.031546
```

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1 13.13398    10 14  196   44  0   0   0.4743691
1 25.6        12 12  144   32  0   1   0.8109302
1 13.90003    5  9   81    47  0   0   0.7092666
1 19.29794    17 13  169   46  0   1   1.710549
1 9.200016    11 18  324   37  0   0   0.4602689
1 37.99999    12 8   64    51  0   2   1.331812
1 44          12 11  121   49  0   1   1.098612
1 21.37202    14 9   81    36  0   4   2.157999
1 23.66802    11 9   81    39  0   1   1.437581
1 9           12 14  196   48  0   2   1.544899
1 25.19995    14 9   81    38  0   2   1.410597
1 21.22       12 2   4     40  0   2   3.218876
1 33.96991    10 12  144   39  1   5   0.9681619
1 17.07       16 15  225   37  0   0   1.791759
1 6.016024    13 11  121   49  0   1   1.68873
1 17.10001    12 7   49    33  0   3   -0.409172
1 8.237       12 9   81    30  0   0   0.2231435
1 13.30008    12 19  361   54  0   0   0.8221558
1 16.00002    11 11  121   39  0   4   1.241702
1 12.53999    12 8   64    43  0   3   1.427124
1 18.00004    9  13  169   31  0   3   1.497097
1 31.2        13 4   16    33  0   3   0.5596158
1 20.74991    12 7   49    40  0   3   1.300028
1 11.09992    12 19  361   36  0   1   1.88443
1 20.68       12 14  196   51  0   0   0.9555114
1 18.00001    13 14  196   44  0   1   1.582087
1 32.43007    16 3   9     42  0   3   1.755614
1 32.90003    12 9   81    40  0   1   1.513103
1 24.10001    16 7   49    34  1   1   2.251892
1 17.80039    17 7   49    30  0   0   2.364432
1 20.50002    12 14  196   54  0   0   0.1053505
1 10.4999     12 29  841   51  0   0   1.399729
1 10.43703    9  19  361   44  0   2   0.9884625
1 18.19499    12 14  196   43  0   1   1.090647
1 12.84508    12 16  256   34  0   1   1.154614
1 13.8        13 10  100   45  0   0   1.266948
1 22.2        12 12  144   39  0   0   2.885192
1 6.699941    12 24  576   50  0   0   1.22888
1 6.250016    12 6   36    52  0   0   1.203963
1 15.60001    12 9   81    41  0   2   1.35738
1 3.30001     10 14  196   59  0   0   0.8377236
1 3.670978    12 26  676   52  0   0   0.5369611
1 7.789997    16 7   49    46  0   0   0.7487238
1 18.27199    12 4   16    41  1   5   2.295873
1 10.95398    11 15  225   33  0   2   1.107803
1 13.49999    12 23  529   45  0   0   0.6208453
1 11.20001    10 1   1     36  1   2   -2.054164
1 20.99991    12 29  841   48  0   1   1.892012
1 25.7        12 9   81    47  0   1   1.729725
1 8.932994    12 6   36    45  0   0   0.4693784
1 19.15998    12 11  121   37  0   2   0.9808417
1 26.58999    16 17  289   46  0   4   2.069492
1 22.40001    17 6   36    43  0   3   1.675188
1 20.633      12 7   49    42  0   2   1.386294
1 28.20001    17 2   4     34  1   2   1.799215
1 28.8        12 24  576   52  0   0   1.832582
```

```
1 8.999997    12 4   16    37  0   3   1.090647
1 11.39994    12 11  121   37  0   1   1.443124
1 10.40001    8  25  625   52  0   0   1.25036
1 19.08006    12 11  121   30  1   0   1.602313
1 9.46604     13 2   4     31  0   1   1.018559
1 6.50006     12 19  361   38  0   1   1.297053
1 29.11701    12 7   49    43  0   3   1.685194
1 19.10302    8  2   4     49  0   1   -0.4209849
1 16.34997    12 20  400   55  0   0   1.562095
1 32.02502    17 10  100   38  0   2   2.146528
1 16.70006    17 19  361   52  0   0   2.347463
1 4.811038    12 17  289   48  0   0   0.9698315
1 24.62601    13 12  144   32  0   2   1.924146
1 17.40001    12 11  121   32  0   1   1.626728
1 13.02504    12 6   36    38  0   2   -0.0392607
1 19.00698    12 10  100   46  0   3   1.460149
1 14.03       12 4   16    40  0   3   1.955394
1 14.89991    9  2   4     31  0   4   0.9263599
1 25.00006    10 13  169   43  0   1   2.066192
1 10.70007    12 21  441   51  0   0   1.422843
1 24.25       16 9   81    30  1   0   2.101032
1 39.13997    13 4   16    52  0   0   2.261461
1 7.199973    8  2   4     30  1   5   0.7013138
1 31.811      16 19  361   51  0   0   2.031013
1 10.00005    13 4   16    31  0   2   1.162369
1 20.66       12 9   81    34  0   4   0.4700036
1 13.49998    11 14  196   49  0   0   1.410597
1 25.38       13 6   36    35  1   3   0.3930551
1 18.27498    12 24  576   53  1   0   1.290994
1 39.213      12 1   1     32  0   3   0
1 10.49994    10 13  169   38  0   3   0.9571255
1 34.857      12 3   9     54  0   0   0.5596158
1 28.502      17 10  100   47  0   1   1.568616
1 12.99996    15 16  256   45  0   1   1.710188
1 41.39991    16 9   81    47  0   1   1.410597
1 14.78       10 19  361   59  0   0   0.2231435
1 15.05       11 4   16    32  0   1   0.5108456
1 29.69998    12 10  100   45  0   1   1.332392
1 16.16502    12 5   25    40  0   4   0.8601859
1 25.20516    14 7   49    47  0   2   2.32278
1 14.2        16 3   9     36  1   2   1.919595
1 18.15897    14 38  1444  56  0   0   1.976107
1 28.98106    8  16  256   41  0   1   0.8954347
1 13.392      7  13  169   48  0   3   0.1812376
1 9.17502     12 1   1     36  1   2   0.4953058
1 27.03985    12 7   49    41  0   0   0.5777924
1 13.14995    14 15  225   41  0   0   1.078818
1 16.40007    12 10  100   36  0   3   1.603199
1 21.29999    12 2   4     37  0   3   0.6208453
1 17.20102    12 19  361   38  0   0   2.083894
1 8.560026    14 25  625   43  0   2   1.379169
1 6.49084     16 25  625   54  0   0   1.112384
1 12.49997    12 7   49    38  0   1   1.067122
1 27.00002    12 15  225   30  1   0   1.118807
1 53.50005    12 11  121   49  0   0   1.588541
1 52.49995    13 25  625   45  0   1   1.390311
```

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1 38.39998    13 19  361   51  0   0   1.714806
1 13.89194    10 4   16    34  0   0   0.2010615
1 3.899993    12 14  196   34  0   2   0.987271
1 34.2        12 19  361   41  0   1   0.9835007
1 19.70008    12 18  324   49  0   1   2.233171
1 18.49995    12 14  196   32  0   0   1.143618
1 10.99998    14 11  121   32  0   0   -0.6113829
1 43.30001    17 4   16    32  0   2   2.153052
1 18.76001    10 29  841   47  0   0   1.299837
1 4.800096    9  21  441   39  0   1   0.8409204
1 21.5        12 24  576   49  0   0   1.058484
1 28.03994    12 19  361   37  0   3   1.152658
1 26          16 31  961   59  0   0   1.293576
1 27          12 28  784   50  0   0   1.832582
1 17.79969    17 15  225   32  0   1   2.32718
1 17.40195    12 27  729   46  0   0   1.166146
1 19.30999    17 13  169   43  0   2   2.034993
1 9.99998     11 4   16    37  0   3   0.6792511
1 11.17998    16 10  100   32  0   2   1.547137
1 18.85696    11 8   64    39  0   1   0.7530186
1 12.30002    13 4   16    34  0   2   0.8472836
1 13.67712    11 18  324   39  0   1   0.871126
1 9.559997    8  3   9     45  0   3   0.2282505
1 24.49998    11 11  121   50  0   0   0.0896578
1 23.15       12 8   64    40  0   1   1.321756
1 15.59088    10 10  100   30  0   1   1.196102
1 14.42092    17 33  1089  57  0   0   1.636119
1 17.45491    12 19  361   39  0   1   1.892012
1 9.800019    12 35  1225  53  0   0   1.518309
1 17.57446    17 21  441   48  0   1   2.472159
1 16.555      14 7   49    46  0   1   1.321756
1 13.29497    12 18  324   47  0   0   1.473641
1 11.844      12 4   16    43  0   1   1.369479
1 46.64506    12 12  144   47  0   0   1.203963
1 14.69999    12 16  256   47  0   1   1.198729
1 26.09008    12 14  196   47  0   0   1.27021
1 9.9         12 3   9     46  0   0   0.4700036
1 9.048026    9  1   1     34  0   4   0.7999817
1 30.75006    10 27  729   48  0   0   1.565946
1 8.49994     12 12  144   30  0   1   1.758978
1 22.24999    12 6   36    51  0   1   0.8580258
1 42.91       12 9   81    52  0   5   0.6931472
1 33.3        12 2   4     37  0   2   0.6418539
1 13.8199     12 6   36    32  0   2   1.63374
1 23.60001    17 9   81    36  0   2   1.703748
1 13.00007    12 16  256   35  0   2   1.844004
1 20.74994    17 22  484   45  0   0   1.966119
1 6.3         12 26  676   56  0   0   0.8649974
1 7.788925    10 11  121   40  0   2   0.9333052
1 10.47004    12 11  121   45  1   2   0.7792332
1 12          12 15  225   32  0   2   0.9555114
1 16.97992    12 13  169   45  0   0   1.316247
1 17.9        12 6   36    40  0   2   1.475906
1 15.53994    12 20  400   38  0   1   1.491397
1 9.883986    12 17  289   49  0   4   1.45575
1 28.59995    16 8   64    47  0   1   0.5108456
```

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1 17.66001    13 13  169   52  0   0   1.180438
1 25.99992    13 15  225   34  0   1   1.688489
1 13.60201    12 14  196   44  0   2   0.7907275
1 15.8        16 14  196   36  0   3   1.401799
1 41.09999    17 6   36    50  0   0   -0.433556
1 10.77504    12 24  576   45  0   0   1.683172
1 9.000047    14 10  100   44  0   2   -1.766677
1 24.39899    12 2   4     57  0   2   3.155595
1 37.30009    17 9   81    35  0   0   2.259521
1 27.99995    12 23  529   46  0   0   1.306926
1 13.7        14 12  144   30  2   1   0.7984977
1 17.20994    12 8   64    42  0   3   0.5590442
1 14.00001    12 16  256   34  0   1   0.1479026
1 35.75502    17 10  100   45  0   2   1.944495
1 23.5        16 7   49    35  1   2   1.378338
1 31.99993    16 19  361   40  0   0   3.064745
1 17.15       12 2   4     32  0   1   -0.7419173
1 20.25002    9  9   81    54  0   0   0.7657004
1 5.485985    12 14  196   38  0   3   0.619393
1 25.07504    12 9   81    43  0   3   1.465452
1 18.21995    16 16  256   54  0   0   2.18926
1 26          14 7   49    39  0   3   1.021659
1 34.50007    12 6   36    37  0   1   0.9770095
1 12.4        12 22  484   46  0   2   0.9162908
1 10.78685    11 9   81    56  0   0   2.905096
1 16.32301    12 9   81    41  0   3   -0.1996712
1 30.5        16 14  196   45  0   1   0.6931472
1 51.29963    17 17  289   44  0   1   2.733393
1 33.04997    17 12  144   50  0   1   1.868335
1 34.75001    14 13  169   37  0   5   2.12026
1 16.40004    12 8   64    44  0   1   1.515193
1 19.70007    14 10  100   32  0   2   0.9146093
1 6.600003    12 16  256   34  1   1   1.499556
1 9.020008    10 1   1     32  0   2   0.8030772
1 10.40001    12 6   36    37  0   3   0.7280316
1 14.51999    13 4   16    44  0   1   0.51641
1 17.2        16 8   64    34  0   2   1.226448
1 43          12 4   16    33  1   3   0.9162908
1 13.87196    7  15  225   43  0   3   1.376471
1 -0.0290575  16 7   49    35  0   2   1.828975
1 16.76994    14 14  196   43  0   1   1.368283
1 7.8         12 16  256   34  0   0   1.064711
1 14.50006    10 15  225   36  0   3   1.406489
1 7.9         12 23  529   41  0   2   1.047319
1 79.80001    16 19  361   41  0   0   1.948093
1 7.17597     10 4   16    35  0   3   1.078001
1 17.50698    12 12  144   32  1   3   0.6539385
1 20.6        14 12  144   30  0   0   1.927892
1 18.55992    12 25  625   43  0   0   1.361028
1 9.3         6  14  196   54  0   0   0.6931472
1 5.120008    15 14  196   35  0   2   1.604687
1 14.50004    12 11  121   50  0   0   0.1839036
1 19.8        17 7   49    34  1   1   3.113515
1 18.29995    14 18  324   52  0   0   1.926829
1 33.99994    13 4   16    35  0   3   1.270126
1 11.62794    6  37  1369  55  0   0   0.6826927
```

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1 11.80005    16 13  169   35  0   0   1.68107
1 39.09998    14 14  196   49  0   1   0.556296
1 18.43007    15 17  289   38  2   2   1.62822
1 21          14 5   25    42  0   2   0.9162908
1 59          8  2   4     48  0   1   1.341558
1 25.3        14 0   0     51  0   0   0
1 23.24899    12 3   9     43  0   2   1.122231
1 24.92809    12 21  441   43  0   1   0.5401708
1 14.78199    12 20  400   38  0   1   1.391506
1 18.90003    12 19  361   44  0   1   1.697174
1 21          12 4   16    36  1   3   3.218876
1 10.00001    12 19  361   38  0   0   0.8711678
1 29.30997    8  11  121   47  0   0   1.16733
1 13.14003    12 14  196   34  0   2   1.216988
1 25.08999    17 8   64    40  1   2   0.5753766
1 14.59993    12 13  169   31  0   1   1.151616
1 1.200001    12 24  576   46  0   0   0.9942513
1 32          14 1   1     36  0   3   0.5263249
1 16.11997    13 1   1     39  1   2   -1.543182
1 26.50002    17 3   9     36  0   2   1.912043
1 12.75006    8  4   16    37  0   4   0.5542873
1 12.9        12 21  441   39  0   4   0.9162908
1 10.69998    11 10  100   36  1   3   1.500939
1 14.43403    12 13  169   49  0   2   0.9446838
1 23.709      12 9   81    45  1   1   1.241269
1 15.1        17 14  196   32  2   0   1.564984
1 18.19998    10 2   4     36  0   5   0.8380265
1 22.64106    12 21  441   40  0   1   1.668857
1 21.64008    13 22  484   43  0   2   1.769429
1 23.99998    12 14  196   33  0   1   1.226448
1 16.00002    12 7   49    30  0   1   1.406489
0 21.025      12 2   4     49  0   1   .
0 23.6        16 5   25    30  2   0   .
0 22.8        12 12  144   30  1   0   .
0 35.91       12 1   1     41  0   4   .
0 21.7        12 12  144   45  0   1   .
0 21.823      12 4   16    43  0   5   .
0 31          13 9   81    42  0   1   .
0 15.3        12 9   81    60  0   0   .
0 12.925      12 6   36    57  0   0   .
0 15.83       10 5   25    38  0   2   .
0 30.2        12 5   25    56  0   0   .
0 16.6        12 8   64    32  0   3   .
0 11          7  2   4     49  0   1   .
0 15          12 6   36    55  0   0   .
0 20.528      9  0   0     36  1   1   .
0 13.126      12 3   9     44  0   3   .
0 15.55       10 7   49    44  0   1   .
0 18.01       14 3   9     35  1   2   .
0 18.874      14 10  100   44  2   3   .
0 24.8        12 3   9     45  0   1   .
0 17.5        12 2   4     34  1   0   .
0 16.15       17 12  144   30  2   0   .
0 15.189      8  15  225   39  0   1   .
0 6           12 5   25    36  0   2   .
0 37.25       17 4   16    38  0   2   .
```

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0 27.76       12 10  100   53  0   0   .
0 9.09        12 1   1     36  0   2   .
0 14.5        12 8   64    32  1   1   .
0 19.7        9  20  400   51  0   3   .
0 16.788      11 4   16    38  0   0   .
0 18.52       12 7   49    33  2   0   .
0 20.95       12 10  100   54  0   0   .
0 7.574       9  3   9     38  0   3   .
0 10.027      11 5   25    30  2   2   .
0 5           12 10  100   34  2   3   .
0 7.04        9  0   0     34  0   1   .
0 40.8        12 3   9     50  0   2   .
0 16.05       17 10  100   30  2   0   .
0 33.1        12 2   4     38  0   2   .
0 33.856      14 10  100   54  0   0   .
0 20.5        12 4   16    30  1   2   .
0 28.6        12 0   0     55  0   0   .
0 18.75       10 10  100   51  0   1   .
0 20.3        12 5   25    44  0   1   .
0 13.42       12 0   0     53  0   0   .
0 18.4        10 0   0     42  0   2   .
0 16.682      12 19  361   38  0   2   .
0 32.685      13 2   4     38  1   3   .
0 7.05        12 12  144   41  1   4   .
0 10.867      8  5   25    35  0   3   .
0 18.22       12 5   25    33  1   2   .
0 26.613      13 5   25    48  0   0   .
0 25          12 10  100   47  0   0   .
0 15.7        12 0   0     34  0   5   .
0 40.25       13 4   16    33  2   1   .
0 73.6        13 3   9     31  3   1   .
0 10.592      8  2   4     58  0   0   .
0 8           12 1   1     49  0   0   .
0 13.4        8  0   0     55  0   1   .
0 23.7        14 1   1     44  0   0   .
0 18.9        9  1   1     44  0   0   .
0 48.3        16 6   36    36  0   3   .
0 24.47       12 12  144   38  0   3   .
0 28.63       16 6   36    37  0   3   .
0 25.32       12 9   81    47  0   0   .
0 13.53       12 14  196   47  0   3   .
0 14.8        12 13  169   32  1   1   .
0 17.4        12 8   64    43  1   2   .
0 15.98       11 0   0     42  1   4   .
0 16.576      12 1   1     56  0   0   .
0 21.85       13 3   9     38  0   5   .
0 14.6        12 13  169   52  0   2   .
0 21.6        12 3   9     50  0   0   .
0 24          16 8   64    33  0   0   .
0 20.883      16 8   64    44  0   2   .
0 19.5        12 18  324   41  0   1   .
0 42.8        12 2   4     45  0   1   .
0 41.5        14 3   9     53  0   0   .
0 18.965      14 5   25    53  0   0   .
0 16.1        12 2   4     42  0   1   .
0 14.7        13 10  100   32  2   0   .
```

```
0 18.8        12 30  900   56  0   0   .
0 14.75       11 1   1     37  1   3   .
0 21          12 5   25    40  1   2   .
0 35.4        15 8   64    54  0   3   .
0 10.7        7  0   0     53  0   0   .
0 24.5        12 4   16    48  0   1   .
0 17.045      12 2   4     36  1   2   .
0 18.8        12 30  900   57  0   0   .
0 14          12 25  625   51  0   0   .
0 18.214      13 3   9     33  0   4   .
0 20.177      12 20  400   52  0   0   .
0 8.3         10 20  400   56  0   0   .
0 14.2        12 0   0     36  1   2   .
0 21.768      14 15  225   36  1   0   .
0 29.553      12 10  100   46  0   1   .
0 4.35        10 4   16    31  0   3   .
0 24          11 3   9     52  0   0   .
0 18.3        12 10  100   46  0   2   .
0 17.2        12 9   81    35  2   0   .
0 16.476      12 7   49    59  0   0   .
0 13.4        8  12  144   36  0   1   .
0 44.988      7  0   0     51  1   3   .
0 18.2        16 16  256   31  1   0   .
0 28          14 4   16    31  0   2   .
0 11.55       12 7   49    32  1   1   .
0 28.45       16 7   49    35  1   2   .
0 15.096      12 14  196   40  0   3   .
0 8.009       10 2   4     33  1   2   .
0 10.04       7  20  400   54  0   0   .
0 16.7        12 5   25    36  1   1   .
0 8.4         10 10  100   50  0   1   .
0 13          8  20  400   54  0   0   .
0 17.97       11 10  100   48  0   1   .
0 18.45       15 8   64    41  0   4   .
0 31          12 11  121   50  0   4   .
0 24.135      12 3   9     46  0   2   .
0 31.7        13 6   36    42  0   1   .
0 10.19       9  4   16    31  1   2   .
0 21.574      12 4   16    53  0   0   .
0 26.68       12 9   81    51  0   1   .
0 17.7        12 10  100   47  0   1   .
0 29.4        12 3   9     50  0   1   .
0 22.159      6  2   4     37  0   1   .
0 35          12 2   4     30  2   2   .
0 8.63        12 0   0     49  0   0   .
0 17.08       12 8   64    52  0   2   .
0 32.5        12 6   36    47  0   2   .
0 16          12 15  225   49  0   0   .
0 18.85       12 15  225   44  0   4   .
0 17.5        8  9   81    53  0   0   .
0 19.392      12 8   64    30  1   0   .
0 14.45       12 18  324   54  0   2   .
0 21.8        7  3   9     47  1   1   .
0 7.7         15 10  100   56  0   0   .
0 31.8        12 6   36    49  0   1   .
0 17.258      6  20  400   48  0   0   .
```

```
0 13.399      12 8   64    49  0   1   .
0 16.073      12 3   9     56  0   1   .
0 23.26       12 4   16    46  0   0   .
0 37.3        12 13  169   45  0   2   .
0 11          12 4   16    32  0   2   .
0 13.075      12 17  289   43  1   1   .
0 13.7        12 4   16    34  1   1   .
0 25.1        12 0   0     30  1   1   .
0 18.6        17 15  225   38  2   0   .
0 29          16 11  121   33  1   1   .
0 19.237      12 23  529   52  0   0   .
0 19.855      11 1   1     43  0   3   .
0 9.45        12 5   25    33  1   1   .
0 30          10 1   1     45  0   0   .
0 15          10 5   25    36  2   1   .
0 24.701      12 3   9     34  1   1   .
0 15.9        14 3   9     37  0   2   .
0 16.24       10 19  361   46  0   1   .
0 21.1        12 20  400   47  0   0   .
0 23          16 5   25    31  2   1   .
0 6.34        5  0   0     57  0   0   .
0 42.25       12 3   9     30  1   1   .
0 14.694      12 3   9     30  0   0   .
0 21.417      12 7   49    44  0   3   .
0 20.2        13 7   49    53  0   0   .
0 12.09       8  1   1     51  0   0   .
0 24.76       12 13  169   39  1   3   .
0 23          8  0   0     52  0   0   .
0 19.365      8  0   0     46  0   4   .
0 5.55        12 12  144   47  0   5   .
0 68.035      8  0   0     52  0   2   .
0 29.3        12 5   25    45  0   2   .
0 18.5        11 45  2025  60  0   0   .
0 22.582      13 10  100   41  0   2   .
0 21.5        8  2   4     39  0   3   .
0 28.07       12 3   9     49  0   1   .
0 50.3        15 1   1     32  1   1   .
0 23.5        12 5   25    33  1   3   .
0 15.5        10 10  100   36  0   4   .
0 13.44       13 4   16    37  3   3   .
0 8.1         12 7   49    30  1   2   .
0 9.8         11 9   81    44  1   1   .
0 20.3        12 5   25    48  0   1   .
0 15          11 4   16    40  0   4   .
0 56.1        13 11  121   47  0   0   .
0 22.846      12 9   81    36  0   2   .
0 22.225      11 4   16    40  0   2   .
0 17.635      12 2   4     46  0   1   .
0 18.5        12 23  529   52  0   0   .
0 13.39       12 3   9     44  0   1   .
0 15.15       10 15  225   45  0   1   .
0 16.2        7  8   64    30  2   1   .
0 33.92       12 3   9     40  1   3   .
0 14          12 25  625   43  0   1   .
0 16.736      12 2   4     49  0   2   .
0 30.65       12 0   0     46  1   4   .
```

```
0 12.4        11 19  361   52  0   0   .
0 19.022      12 3   9     31  1   1   .
0 11.203      10 7   49    42  1   1   .
0 19.876      11 1   1     33  0   3   .
0 57          16 9   81    57  0   0   .
0 18.29       10 3   9     49  0   0   .
0 20.22       14 8   64    45  0   1   .
0 22.15       11 0   0     56  0   0   .
0 30.623      12 5   25    41  1   3   .
0 9.38        5  20  400   56  0   0   .
0 22          10 3   9     48  0   1   .
0 23.675      16 12  144   52  0   2   .
0 33.671      12 5   25    51  0   0   .
0 12.367      11 1   1     35  0   3   .
0 21.95       12 0   0     45  0   0   .
0 32          12 7   49    54  0   0   .
0 22.61       12 13  169   54  0   2   .
0 12.092      12 3   9     31  1   0   .
0 3.777       6  0   0     53  0   3   .
0 36          14 2   4     35  2   2   .
0 26.9        12 0   0     36  1   3   .
0 32.242      12 2   4     59  0   0   .
0 35.02       16 1   1     54  0   0   .
0 37.6        12 10  100   37  1   1   .
0 1.5         12 10  100   44  0   0   .
0 96          17 1   1     34  1   2   .
0 18.15       12 3   9     49  0   0   .
0 15.5        12 32  1024  49  0   0   .
0 14          9  0   0     60  0   0   .
0 14.756      12 7   49    51  0   0   .
0 22          12 5   25    30  1   1   .
0 24.466      12 2   4     47  0   2   .
0 24.4        12 5   25    36  0   4   .
0 24          12 3   9     35  1   3   .
0 15.5        12 25  625   58  0   0   .
0 30.8        14 0   0     41  1   3   .
0 10.66       10 3   9     51  0   1   .
0 13.35       12 10  100   47  0   0   .
0 10.09       9  10  100   45  1   2   .
0 55.6        14 7   49    60  0   0   .
0 25.7        16 5   25    30  1   1   .
0 29          11 15  225   55  0   0   .
0 7.286       12 1   1     32  1   2   .
0 37.752      12 5   25    36  0   2   .
0 13.072      12 9   81    55  0   0   .
0 7.044       12 18  324   47  0   0   .
0 18.2        12 1   1     47  0   1   .
0 27          11 0   0     37  0   1   .
0 30.3        12 6   36    50  0   2   .
0 12          12 1   1     30  0   3   .
0 31.5        17 2   4     48  0   1   .
0 27.092      10 15  225   43  0   2   .
0 20.968      11 25  625   48  1   0   .
0 27          14 1   1     41  1   2   .
0 11.225      12 0   0     50  0   0   .
0 37.7        8  0   0     58  0   0   .
```

```
0 28.2        13 0   0     38 0  5  .
0 34          12 8   64    37 0  1  .
0 63.2        16 22  484   50 0  0  .
0 7.5         8  5   25    42 0  4  .
0 17.41       9  10  100   37 1  3  .
0 51          16 1   1     41 0  2  .
0 12.916      12 1   1     31 0  2  .
0 21.9        12 6   36    51 0  0  .
0 17.64       12 4   16    36 1  2  .
0 20          15 6   36    54 0  0  .
0 15          12 0   0     49 0  0  .
0 14.06       9  1   1     48 1  1  .
0 15.825      9  3   9     42 0  2  .
0 16.51       12 15  225   41 1  2  .
0 13          16 33  1089  55 0  0  .
0 10          9  2   4     42 0  0  .
0 22          15 1   1     32 0  1  .
0 29.8        12 10  100   43 0  2  .
0 15          12 0   0     33 1  3  .
0 22.3        15 14  196   48 0  1  .
0 14.55       12 15  225   43 0  2  .
0 19.73       17 15  225   47 1  3  .
0 35          12 10  100   54 0  0  .
0 21.014      12 6   36    51 0  1  .
0 10.876      10 18  324   51 0  1  .
0 27.85       13 15  225   43 1  1  .
0 9.56        12 30  900   53 0  0  .
0 30.3        11 15  225   34 1  1  .
0 7.72        8  10  100   31 1  1  .
0 10.55       12 0   0     56 0  0  .
0 24.106      16 0   0     42 0  1  .
0 22.995      12 4   16    32 0  2  .
0 6           12 0   0     35 1  3  .
0 24.35       12 3   9     30 1  1  .
0 7.608       10 20  400   51 0  0  .
0 28.2        12 3   9     47 0  3  .
0 16.15       12 1   1     54 0  1  .
0 51.2        15 5   25    31 3  0  .
0 12.646      10 7   49    47 0  0  .
0 19          14 6   36    47 0  3  .
0 19          12 2   4     40 0  3  .
0 14.4        8  0   0     48 0  0  .
0 7.232       8  10  100   34 0  7  .
0 21.943      12 6   36    38 0  3  .
0 47.5        12 4   16    32 1  3  .
0 28.9        16 8   64    48 0  1  .
0 12.4        12 18  324   41 0  2  .
0 6.531       5  7   49    49 0  2  .
0 22.422      8  15  225   59 0  0  .
0 22.2        13 7   49    58 0  0  .
0 77          12 8   64    41 0  3  .
0 88          12 8   64    45 0  2  .
0 26.04       14 3   9     30 1  1  .
0 63.5        12 10  100   41 0  1  .
0 12.1        12 9   81    30 2  0  .
0 17.505      12 24  576   53 0  1  .
```

```
0 18          12 12  144   31  0   0   .
0 28.069      14 2   4     43  0   2   .
0 14          12 6   36    31  1   1   .
0 8.117       12 18  324   51  0   0   .
0 11.895      9  17  289   43  0   0   .
0 45.25       14 7   49    31  1   2   .
0 31.106      11 6   36    48  0   0   .
0 4           12 10  100   31  1   1   .
0 40.5        12 5   25    44  0   1   .
0 21.62       11 7   49    48  0   1   .
0 23.426      12 11  121   53  0   1   .
0 26          10 14  196   42  0   3   .
0 7.84        12 5   25    39  2   6   .
0 6.8         10 2   4     32  1   2   .
0 5.33        12 4   16    36  0   2   .
0 28.2        13 5   25    40  0   2   .
0 10          12 14  196   31  2   3   .
0 9.952       12 4   16    43  0   0   .
0 24.984      12 15  225   60  0   0   .
0 28.363      9  12  144   39  0   3   .
;
```

Click **Run** to create the Work.Mroz table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Panel Data Models** to add the step to your flow.

3 Add the Work.Mroz table to your flow. Connect the input port of the Panel Data Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Panel Data Models step, click the Panel Data Models node.

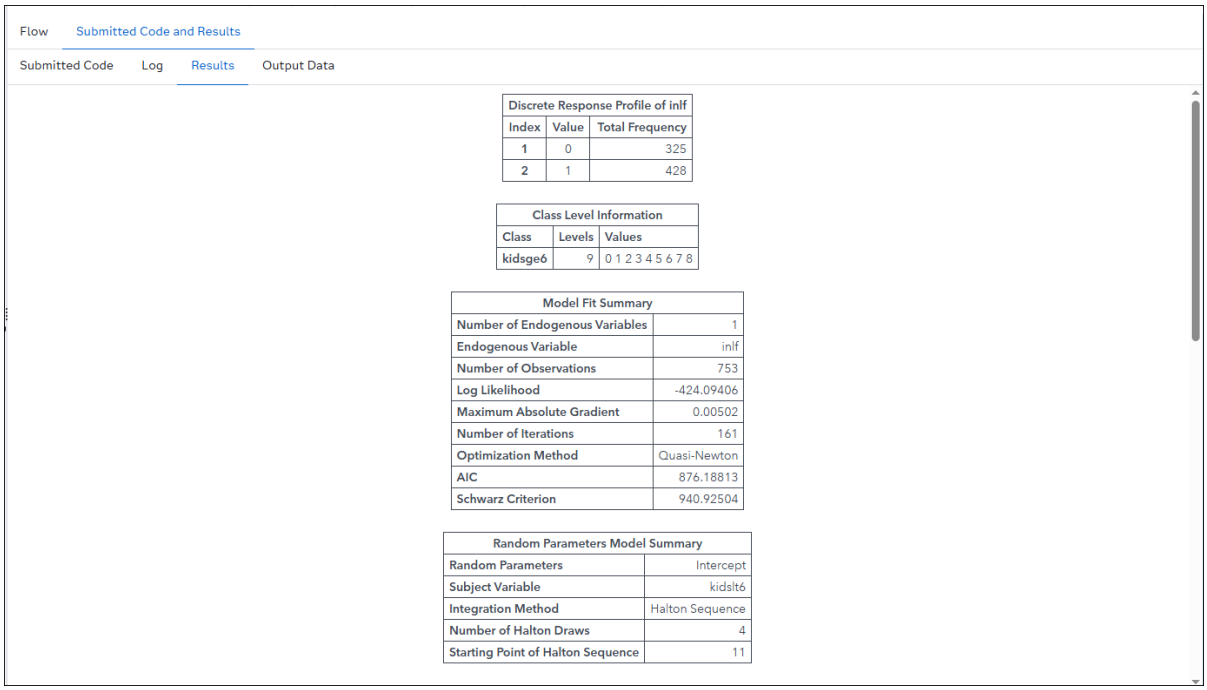
5 On the **Data** tab, assign columns to these roles:

- To the **Cross-sectional ID** role, assign **kidslt6**.
- To the **Dependent variable** role, assign **inlf**.
- To the **Continuous variables** role, assign **nwifeinc**, **educ**, **exper**, and **expersq**.
- To the **Categorical variables** role, assign **kidsge6**.

6 Click the **Model** tab. From the **Model type** drop-down list, select **Probit**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Probit Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the SAS Compute Server for this step.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Cross-sectional ID**, assign the numeric variable that identifies the cross section for each observation. The step verifies that the input data is sorted by the cross-sectional ID.

Note: For the probit model, character variables are not supported.

4 To the **Time ID** role, assign a numeric variable that identifies the time period for each observation. For each cross section, the values of the time ID must be unique.

Note: For the probit model, a time ID is not required and is ignored in the analysis.

5 To the **Dependent variable** role, assign the numeric variable that takes discrete values.

6 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

7 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

8 To the **Group analysis by** role, assign variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 From the **Model type** drop-down list, select **Probit**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects using the continuous variables and categorical variables selected on the **Data** tab.

Note: Random effects are automatically included in the model. This functionality is experimental.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Specify the threshold for the first category for the logit model. By default, this value is zero, but you can use an estimated value.

Step 3: Set the Options

On the **Options** tab, you can set these options.

1 Specify the method to calculate the covariance matrix of parameter estimates. You can use the default value, or you can choose from these options:

- **Inverse Hessian matrix** – the covariance from the inverse Hessian matrix.
- **Outer product matrix** – the covariance from the outer product matrix.
- **Outer product and Hessian matrices** – the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Select the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.

4 Select the statistics to display in the results.

Here are the available statistics:

- correlations of the parameter estimates
- covariances of the parameter estimates
- iteration history of the objective function and parameter estimates

5 Select the diagnostic and output plots to include in the results.

Step 4: Set the Output Options

On the **Output** tab, you can specify these options:

- an output data set that contains the default statistics from the analysis and any selected statistics, such as predicted values, the probability of the dependent variable taking the current value, the probability of the dependent variable for all possible responses, and the error standard deviation
- parameter estimates table

Note: If you are running the step in a flow, you must add output ports for the output tables to the Panel Data Models node. For more information, see "Panel Data Models: Connection Requirements for the Node" on page 712.

Poisson Models

Example: Poisson Model

To create this example:

1 Enter this code on a **SAS Program** tab:

```
data long97data;
   input fem ment phd mar kid5 art lnart;
datalines;
0   7.99999860   1.38000000  1  2  3   1.25276290
0   6.99999950   4.29000000  0  0  0  -0.69314720
0  47.00000760   3.84999990  0  0  4   1.50407740
0  19.00000190   3.58999990  1  1  1   0.40546510
0   0.00000000   1.80999990  1  0  1   0.40546510
0   6.00000050   3.58999990  1  1  1   0.40546510
0   9.99999900   2.11999990  1  1  0  -0.69314720
0   1.99999990   4.29000000  1  0  0  -0.69314720
0   1.99999990   2.57999990  1  2  3   1.25276290
0   3.99999900   1.80000000  1  1  3   1.25276290
0   0.00000000   4.29000000  1  2  1   0.40546510
0   3.00000000   2.76000000  1  1  0  -0.69314720
0   9.99999900   3.41000010  1  1  1   0.40546510
0   6.99999950   4.34000020  1  3  2   0.91629080
0  15.00000100   3.84999990  1  2  5   1.70474800
```

0	1.99999990	2.09999990	1	0	2	0.91629080
0	13.00000000	4.29000000	1	0	2	0.91629080
0	15.00000100	4.29000000	0	0	1	0.40546510
0	4.99999810	2.26000000	1	1	0	-0.69314720
0	6.00000050	2.09999990	0	0	0	-0.69314720
0	12.00000000	2.26000000	1	0	3	1.25276290
0	15.99999810	3.84999990	1	1	6	1.87180220
0	6.99999950	4.29000000	0	0	4	1.50407740
0	6.00000050	1.80000000	1	2	2	0.91629080
0	1.99999990	2.26000000	0	0	2	0.91629080
0	0.00000000	2.09999990	0	0	0	-0.69314720
0	30.00000190	4.29000000	1	0	4	1.50407740
0	9.99999900	4.29000000	1	2	1	0.40546510
0	1.99999990	2.09999990	1	0	1	0.40546510
0	0.99999990	3.58999990	1	0	7	2.01490310
0	3.00000000	3.42000010	1	1	2	0.91629080
0	9.99999900	4.29000000	1	2	2	0.91629080
0	9.99999900	4.29000000	0	0	2	0.91629080
0	0.99999990	3.33999990	1	2	0	-0.69314720
0	1.99999990	4.29000000	0	0	0	-0.69314720
0	10.99999710	4.29000000	1	0	1	0.40546510
0	4.99999810	3.61999990	1	0	4	1.50407740
0	0.00000000	4.29000000	1	3	1	0.40546510
0	3.99999900	4.34000020	1	1	1	0.40546510
0	1.99999990	1.25000000	1	1	2	0.91629080
0	19.00000190	4.34000020	0	0	7	2.01490310
0	3.00000000	1.67000000	1	3	1	0.40546510
0	0.00000000	3.47000000	0	0	0	-0.69314720
0	0.99999990	2.26000000	1	1	1	0.40546510
0	0.99999990	1.80000000	1	0	1	0.40546510
0	17.00000000	4.34000020	1	2	2	0.91629080
0	3.00000000	3.58999990	0	0	2	0.91629080
0	0.99999990	1.75000000	1	2	1	0.40546510
0	6.00000050	4.29000000	0	0	1	0.40546510
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	15.00000100	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	26.99999810	3.31999990	1	2	2	0.91629080
0	4.99999810	4.34000020	1	0	2	0.91629080
0	6.99999950	3.41000010	0	0	4	1.50407740
0	0.00000000	4.29000000	1	0	1	0.40546510
0	10.99999710	3.19000010	1	0	2	0.91629080
0	13.00000000	4.29000000	1	0	2	0.91629080
0	3.99999900	1.74000000	1	2	1	0.40546510
0	3.99999900	2.76000000	0	0	1	0.40546510
0	26.99999810	3.58999990	1	1	7	2.01490310
0	9.99999900	1.80999990	1	0	4	1.50407740
0	13.00000000	4.29000000	1	1	2	0.91629080
0	0.99999990	4.29000000	1	1	1	0.40546510
0	6.00000050	2.76000000	0	0	1	0.40546510
0	6.00000050	3.47000000	0	0	6	1.87180220
0	4.99999810	2.50000000	1	2	2	0.91629080
0	1.99999990	1.25000000	1	0	5	1.70474800
0	13.99999710	3.58999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	12.00000000	3.58999990	1	0	1	0.40546510

0	6.99999950	3.58999990	1	3	0	-0.69314720
0	3.00000000	1.75000000	1	0	1	0.40546510
0	1.99999990	1.75000000	1	2	1	0.40546510
0	1.99999990	3.58999990	1	1	1	0.40546510
0	1.99999990	4.29000000	0	0	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	0.00000000	2.60999990	1	0	3	1.25276290
0	30.00000190	4.29000000	1	0	5	1.70474800
0	21.00000000	1.74000000	1	0	16	2.80336050
0	4.99999810	2.76000000	1	0	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	7.99999860	2.76000000	1	2	1	0.40546510
0	25.00000000	4.29000000	1	2	3	1.25276290
0	0.00000000	3.47000000	1	1	5	1.70474800
0	4.99999810	2.57999990	1	2	0	-0.69314720
0	0.99999990	2.14000010	1	0	0	-0.69314720
0	4.99999810	2.26000000	0	0	0	-0.69314720
0	0.00000000	4.29000000	1	2	3	1.25276290
0	15.00000100	4.29000000	1	0	3	1.25276290
0	30.00000190	4.29000000	0	0	3	1.25276290
0	1.99999990	2.20000000	1	0	0	-0.69314720
0	6.00000050	1.80000000	1	2	3	1.25276290
0	0.00000000	2.09999990	1	2	1	0.40546510
0	13.00000000	4.29000000	1	1	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	12.00000000	2.09999990	1	1	0	-0.69314720
0	30.00000190	4.29000000	1	2	2	0.91629080
0	4.99999810	1.80999990	1	1	1	0.40546510
0	9.99999900	4.34000020	1	0	1	0.40546510
0	4.99999810	4.29000000	1	1	0	-0.69314720
0	3.99999900	2.50000000	1	2	1	0.40546510
0	13.00000000	2.05000000	1	2	4	1.50407740
0	7.99999860	3.47000000	1	0	3	1.25276290
0	6.00000050	2.60999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	2	1	0.40546510
0	25.00000000	4.29000000	0	0	2	0.91629080
0	1.99999990	4.29000000	1	1	2	0.91629080
0	9.00000000	4.34000020	1	0	6	1.87180220
0	9.99999900	2.11999990	1	1	0	-0.69314720
0	3.00000000	2.76000000	1	0	2	0.91629080
0	1.99999990	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	4.34000020	1	0	5	1.70474800
0	7.99999860	2.76000000	1	1	2	0.91629080
0	9.99999900	3.19000010	1	1	2	0.91629080
0	7.99999860	4.61999990	0	0	3	1.25276290
0	6.00000050	3.15000010	1	2	0	-0.69314720
0	21.00000000	2.55000000	1	1	4	1.50407740
0	3.99999900	1.52000000	1	0	0	-0.69314720
0	1.99999990	1.72000000	1	2	4	1.50407740
0	0.99999990	1.78000000	1	1	2	0.91629080
0	17.00000000	2.85999990	1	1	1	0.40546510
0	30.00000190	4.61999990	1	2	0	-0.69314720
0	4.99999810	4.13999990	0	0	1	0.40546510
0	13.00000000	2.96000000	1	1	6	1.87180220

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0  10.99999710   2.55000000  1  0  1   0.40546510
0  19.00000190   2.21000000  1  1  0  -0.69314720
0   4.99999810   3.08999990  1  0  3   1.25276290
0  66.00000760   4.54000000  1  2  4   1.50407740
0   0.00000000   1.78000000  1  0  3   1.25276290
0   3.00000000   2.21000000  1  3  0  -0.69314720
0   3.00000000   2.39000010  1  1  1   0.40546510
0   0.00000000   2.96000000  1  0  0  -0.69314720
0   7.99999860   2.51000000  1  1  0  -0.69314720
0   0.00000000   1.97000000  1  2  2   0.91629080
0   4.99999810   4.13999990  0  0  0  -0.69314720
0  29.00000000   4.25000000  1  1  4   1.50407740
0  10.99999710   2.85999990  1  2  0  -0.69314720
0  22.99999620   2.96000000  1  1  9   2.25129180
0  45.99999240   2.96000000  1  2  2   0.91629080
0   7.99999860   4.61999990  1  1  6   1.87180220
0   4.99999810   3.69000010  1  2  0  -0.69314720
0   0.99999990   3.15000010  1  1  0  -0.69314720
0   9.00000000   4.61999990  0  0  2   0.91629080
0   1.99999990   3.35999990  1  0  0  -0.69314720
0   6.99999950   3.69000010  0  0  4   1.50407740
0  10.99999710   3.54000000  1  0  1   0.40546510
0  56.99999620   2.96000000  1  1  4   1.50407740
0  15.99999810   2.55999990  1  1  1   0.40546510
0   0.00000000   2.31999990  1  0  0  -0.69314720
0   3.00000000   2.31999990  1  0  0  -0.69314720
0   0.99999990   0.92000000  1  2  0  -0.69314720
0   9.99999900   4.54000000  1  0  0  -0.69314720
0  10.99999710   4.54000000  1  3  0  -0.69314720
0  10.99999710   1.76000000  1  1  5   1.70474800
0  15.99999810   2.55999990  0  0  1   0.40546510
0   4.99999810   2.39000010  1  1  0  -0.69314720
0   9.00000000   3.40000010  1  0  2   0.91629080
0  19.99999620   2.86999990  1  2  2   0.91629080
0  21.00000000   4.54000000  1  2  4   1.50407740
0   4.99999810   2.82999990  1  0  4   1.50407740
0   6.00000050   1.67999990  1  0  0  -0.69314720
0  12.00000000   3.54000000  0  0  3   1.25276290
0   0.00000000   1.76000000  1  0  2   0.91629080
0  10.99999710   3.15000010  1  3  1   0.40546510
0   3.00000000   2.51000000  1  0  0  -0.69314720
0  15.99999810   3.69000010  1  1  0  -0.69314720
0  10.99999710   1.76000000  1  1  4   1.50407740
0   4.99999810   1.86000000  1  1 12   2.52572870
0   0.99999990   2.76000000  1  3  0  -0.69314720
0  15.99999810   4.61999990  1  1  1   0.40546510
0  12.00000000   4.25000000  1  0  5   1.70474800
0  10.99999710   2.54000000  1  0  4   1.50407740
0   0.00000000   2.20000000  1  1  0  -0.69314720
0   0.00000000   1.76000000  1  0  2   0.91629080
0   3.00000000   2.85999990  1  3  3   1.25276290
0  13.00000000   3.40000010  1  2  0  -0.69314720
0  45.00000000   4.54000000  1  1  1   0.40546510
0  47.00000760   1.86000000  1  1  9   2.25129180
0   6.99999950   1.52000000  1  0  0  -0.69314720
0   6.99999950   2.55999990  1  1  2   0.91629080
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0	19.00000190	2.21000000	1	0	0	-0.69314720
0	9.00000000	3.69000010	1	0	7	2.01490310
0	76.99998470	1.78000000	1	1	1	0.40546510
0	0.00000000	1.17999990	1	1	0	-0.69314720
0	3.99999900	2.00000000	1	0	1	0.40546510
0	19.00000190	2.21000000	1	0	0	-0.69314720
0	12.00000000	4.13999990	1	2	0	-0.69314720
0	0.99999990	2.85999990	1	3	0	-0.69314720
0	17.00000000	2.85999990	1	1	1	0.40546510
0	6.00000050	2.54000000	0	0	7	2.01490310
0	3.99999900	2.85999990	1	1	0	-0.69314720
0	6.00000050	2.52000000	0	0	4	1.50407740
0	3.00000000	1.52000000	1	1	2	0.91629080
0	4.99999810	3.08999990	1	1	3	1.25276290
0	3.00000000	1.17999990	1	1	0	-0.69314720
0	3.00000000	1.42000000	1	0	0	-0.69314720
0	15.00000100	4.61999990	0	0	7	2.01490310
0	0.00000000	2.96000000	1	2	1	0.40546510
0	9.99999900	4.54000000	0	0	2	0.91629080
0	41.99999620	4.54000000	0	0	7	2.01490310
0	3.00000000	2.51000000	1	2	1	0.40546510
0	6.99999950	3.15000010	1	1	2	0.91629080
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	2.96000000	1	3	1	0.40546510
0	3.99999900	1.67999990	1	0	0	-0.69314720
0	0.00000000	1.22000000	1	1	1	0.40546510
0	1.99999990	1.52000000	1	0	1	0.40546510
0	4.99999810	2.21000000	1	1	0	-0.69314720
0	0.99999990	3.92000010	1	1	0	-0.69314720
0	13.00000000	4.54000000	1	0	5	1.70474800
0	0.00000000	1.17999990	1	0	2	0.91629080
0	26.00000000	3.69000010	1	0	3	1.25276290
0	0.99999990	1.72000000	1	0	2	0.91629080
0	25.00000000	2.57999990	1	1	5	1.70474800
0	3.00000000	1.52000000	0	0	3	1.25276290
0	47.00000760	1.86000000	1	1	4	1.50407740
0	3.99999900	2.50000000	1	0	5	1.70474800
0	0.99999990	4.61999990	1	0	1	0.40546510
0	6.99999950	1.40000000	1	2	0	-0.69314720
0	4.99999810	4.54000000	1	0	3	1.25276290
0	26.99999810	1.67999990	1	1	0	-0.69314720
0	0.99999990	2.82999990	1	0	2	0.91629080
0	4.99999810	3.35999990	0	0	1	0.40546510
0	0.00000000	1.97000000	1	1	7	2.01490310
0	12.00000000	3.40000010	0	0	1	0.40546510
0	3.99999900	1.74000000	1	1	1	0.40546510
0	0.00000000	2.96000000	0	0	0	-0.69314720
0	25.00000000	2.57999990	1	1	4	1.50407740
0	3.00000000	4.54000000	1	1	1	0.40546510
0	1.99999990	3.15000010	1	1	0	-0.69314720
0	12.00000000	2.96000000	1	2	0	-0.69314720
0	15.99999810	3.54000000	1	2	2	0.91629080
0	4.99999810	2.96000000	1	1	3	1.25276290
0	12.00000000	4.25000000	1	0	1	0.40546510
0	4.99999810	2.55999990	1	1	2	0.91629080
0	4.99999810	1.86000000	1	0	1	0.40546510

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0   3.00000000   4.61999990  1  1  1   0.40546510
0   3.99999900   2.85999990  0  0  2   0.91629080
0   4.99999810   3.15000010  1  1  5   1.70474800
0   0.00000000   2.51000000  1  0  2   0.91629080
0  26.99999810   3.15000010  1  1  5   1.70474800
0   4.99999810   2.51000000  1  0  2   0.91629080
0   0.00000000   1.52000000  1  1  0  -0.69314720
0  17.99999810   4.29000000  0  0  6   1.87180220
0   4.99999810   4.29000000  1  1  4   1.50407740
0   7.99999860   4.29000000  1  2  2   0.91629080
0   3.99999900   2.09999990  1  0  2   0.91629080
0  35.00000760   4.29000000  1  1 12   2.52572870
0   4.99999810   4.29000000  0  0  2   0.91629080
0   9.00000000   3.58999990  1  1  1   0.40546510
0   6.00000050   4.29000000  1  0  1   0.40546510
0  24.00000190   4.29000000  1  0  2   0.91629080
0   0.00000000   2.09999990  1  1  0  -0.69314720
0   4.99999810   1.80999990  1  1  0  -0.69314720
0  19.00000190   4.29000000  0  0  7   2.01490310
0   3.00000000   4.29000000  0  0  1   0.40546510
0   1.99999990   4.29000000  1  1  1   0.40546510
0   3.99999900   1.25000000  1  0  3   1.25276290
0   9.99999900   3.58999990  1  0  1   0.40546510
0   7.99999860   2.09999990  1  1  1   0.40546510
0   1.99999990   4.29000000  1  0  4   1.50407740
0  19.00000190   4.29000000  1  1  3   1.25276290
0   0.99999990   3.47000000  1  1  1   0.40546510
0   3.00000000   3.19000010  1  0  1   0.40546510
0   4.99999810   3.19000010  1  2  1   0.40546510
0   0.00000000   2.09999990  1  0  1   0.40546510
0  21.00000000   3.58999990  1  1  5   1.70474800
0  13.99999710   4.29000000  1  1  1   0.40546510
0   0.00000000   2.09999990  1  0  0  -0.69314720
0   6.99999950   2.76000000  1  1  1   0.40546510
0   4.99999810   2.60999990  1  0  3   1.25276290
0  22.00000000   4.29000000  1  0  4   1.50407740
0  19.99999620   3.41000010  0  0  7   2.01490310
0  38.00000380   4.29000000  1  0  3   1.25276290
0  19.00000190   4.29000000  0  0  4   1.50407740
0   3.00000000   2.26000000  0  0  2   0.91629080
0  15.99999810   3.58999990  0  0  3   1.25276290
0   1.99999990   4.29000000  1  1  0  -0.69314720
0   3.00000000   2.05000000  0  0  1   0.40546510
0  12.00000000   4.29000000  1  2  1   0.40546510
0  35.00000760   4.29000000  0  0  0  -0.69314720
0  19.00000190   4.29000000  1  0  0  -0.69314720
0   1.99999990   4.29000000  0  0  0  -0.69314720
0   6.99999950   2.76000000  0  0  1   0.40546510
0   3.99999900   2.09999990  1  2  3   1.25276290
0  13.99999710   2.35999990  0  0  1   0.40546510
0   9.00000000   4.29000000  0  0  0  -0.69314720
0   7.99999860   3.58999990  0  0  0  -0.69314720
0  12.00000000   4.29000000  1  1  2   0.91629080
0   3.00000000   4.29000000  1  1  0  -0.69314720
0   0.99999990   4.29000000  1  0  1   0.40546510
0   9.99999900   4.29000000  0  0  1   0.40546510
```

0	21.00000000	3.41000010	0	0	4	1.50407740
0	13.00000000	4.29000000	1	1	0	-0.69314720
0	17.00000000	4.29000000	1	0	2	0.91629080
0	4.99999810	4.29000000	0	0	0	-0.69314720
0	1.99999990	2.14000010	0	0	0	-0.69314720
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	1.99999990	2.50000000	1	1	2	0.91629080
0	4.99999810	2.60999990	1	1	3	1.25276290
0	0.99999990	1.80999990	1	2	0	-0.69314720
0	1.99999990	2.26000000	1	1	0	-0.69314720
0	3.99999900	3.61999990	1	2	1	0.40546510
0	9.00000000	4.29000000	1	2	1	0.40546510
0	9.00000000	4.29000000	0	0	0	-0.69314720
0	17.00000000	4.29000000	0	0	2	0.91629080
0	24.00000190	4.29000000	1	2	0	-0.69314720
0	3.99999900	3.47000000	1	0	4	1.50407740
0	13.99999710	4.29000000	1	1	2	0.91629080
0	4.99999810	3.58999990	1	1	1	0.40546510
0	9.99999900	1.80999990	0	0	1	0.40546510
0	17.99999810	4.29000000	1	1	3	1.25276290
0	0.99999990	4.29000000	1	1	0	-0.69314720
0	0.00000000	2.09999990	1	0	1	0.40546510
0	3.99999900	2.15000010	1	2	0	-0.69314720
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	0.99999990	2.26000000	1	0	1	0.40546510
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	13.00000000	4.29000000	1	2	0	-0.69314720
0	4.99999810	3.58999990	1	2	0	-0.69314720
0	6.99999950	3.41000010	1	2	0	-0.69314720
0	6.99999950	3.58999990	0	0	3	1.25276290
0	4.99999810	3.61999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	3	1	0.40546510
0	13.99999710	4.29000000	0	0	1	0.40546510
0	6.00000050	4.29000000	1	0	0	-0.69314720
0	4.99999810	2.26000000	1	1	1	0.40546510
0	7.99999860	2.76000000	1	0	3	1.25276290
0	3.99999900	2.60999990	1	1	1	0.40546510
0	9.00000000	4.29000000	0	0	2	0.91629080
0	3.00000000	2.09999990	1	1	2	0.91629080
0	1.99999990	3.47000000	1	1	0	-0.69314720
0	0.00000000	2.09999990	0	0	0	-0.69314720
0	10.99999710	4.29000000	0	0	1	0.40546510
0	9.00000000	4.29000000	0	0	1	0.40546510
0	7.99999860	2.96000000	1	0	1	0.40546510
0	1.99999990	2.96000000	1	0	2	0.91629080
0	17.99999810	4.61999990	1	0	3	1.25276290
0	3.00000000	1.42000000	1	0	3	1.25276290
0	1.99999990	4.54000000	1	0	1	0.40546510
0	6.99999950	2.52000000	1	0	0	-0.69314720
0	9.99999900	4.54000000	1	1	2	0.91629080
0	15.99999810	2.00000000	1	1	1	0.40546510
0	4.99999810	2.54000000	1	0	0	-0.69314720
0	0.00000000	2.50000000	1	0	2	0.91629080
0	7.99999860	4.54000000	0	0	0	-0.69314720
0	9.99999900	3.35999990	0	0	1	0.40546510
0	17.99999810	3.40000010	1	1	0	-0.69314720

0	12.00000000	1.67999990	1	1	1	0.40546510
0	9.00000000	2.00000000	0	0	1	0.40546510
0	39.00000000	2.85999990	1	0	1	0.40546510
0	17.99999810	4.61999990	1	0	1	0.40546510
0	15.00000100	4.13999990	1	0	1	0.40546510
0	15.99999810	4.13999990	1	0	2	0.91629080
0	1.99999990	2.96000000	0	0	0	-0.69314720
0	6.99999950	2.82999990	1	2	3	1.25276290
0	24.00000190	2.55000000	1	0	2	0.91629080
0	7.99999860	1.67999990	1	0	1	0.40546510
0	6.99999950	2.00000000	0	0	1	0.40546510
0	10.99999710	2.00000000	1	1	1	0.40546510
0	0.00000000	2.96000000	1	1	4	1.50407740
0	3.99999900	1.50500000	1	0	4	1.50407740
0	21.00000000	3.54000000	1	0	2	0.91629080
0	6.00000050	3.40000010	0	0	1	0.40546510
0	6.00000050	4.61999990	0	0	0	-0.69314720
0	7.99999860	2.82999990	0	0	3	1.25276290
0	3.99999900	2.54000000	1	0	1	0.40546510
0	12.00000000	2.86999990	0	0	1	0.40546510
0	15.00000100	1.86000000	0	0	1	0.40546510
0	0.00000000	3.92000010	1	1	1	0.40546510
0	4.99999810	3.69000010	1	1	1	0.40546510
0	15.00000100	2.85999990	1	2	4	1.50407740
0	4.99999810	4.54000000	0	0	0	-0.69314720
0	7.99999860	4.61999990	0	0	0	-0.69314720
0	13.00000000	2.85999990	1	1	0	-0.69314720
0	1.99999990	3.40000010	0	0	1	0.40546510
0	6.00000050	2.57999990	1	2	4	1.50407740
0	19.99999620	4.25000000	1	0	3	1.25276290
0	6.99999950	1.76000000	1	1	2	0.91629080
0	6.99999950	2.85999990	1	3	0	-0.69314720
0	15.99999810	3.69000010	1	2	4	1.50407740
0	13.00000000	3.40000010	1	0	0	-0.69314720
0	0.00000000	3.40000010	1	2	0	-0.69314720
0	0.99999990	4.54000000	1	2	0	-0.69314720
0	12.00000000	2.86999990	0	0	3	1.25276290
0	6.99999950	1.76000000	1	0	4	1.50407740
0	3.99999900	4.25000000	0	0	1	0.40546510
0	0.00000000	3.92000010	0	0	3	1.25276290
0	3.99999900	3.35999990	1	0	2	0.91629080
0	3.99999900	2.31999990	1	0	1	0.40546510
0	36.99999240	4.54000000	0	0	2	0.91629080
0	22.99999620	3.35999990	1	1	0	-0.69314720
0	7.99999860	2.00000000	1	3	2	0.91629080
0	7.99999860	3.92000010	1	1	1	0.40546510
0	1.99999990	3.92000010	0	0	1	0.40546510
0	0.00000000	3.35999990	0	0	1	0.40546510
0	0.99999990	1.78000000	1	0	1	0.40546510
0	21.00000000	3.54000000	1	1	1	0.40546510
0	9.99999900	3.92000010	0	0	2	0.91629080
0	7.99999860	2.31999990	0	0	3	1.25276290
0	33.99999240	1.67999990	1	0	1	0.40546510
0	13.99999710	3.08999990	0	0	2	0.91629080
0	6.00000050	2.57999990	1	1	0	-0.69314720
0	13.99999710	3.40000010	0	0	6	1.87180220

0	12.00000000	2.86999990	0	0	3	1.25276290
0	17.99999810	4.61999990	0	0	4	1.50407740
0	3.00000000	2.96000000	1	3	0	-0.69314720
0	6.00000050	1.86000000	1	2	2	0.91629080
0	1.99999990	1.22000000	1	1	0	-0.69314720
0	10.99999710	2.51000000	1	2	6	1.87180220
0	10.99999710	2.51000000	1	0	8	2.14006610
0	4.99999810	3.69000010	1	0	2	0.91629080
0	7.99999860	2.96000000	1	0	3	1.25276290
0	3.99999900	1.78000000	1	0	1	0.40546510
0	0.99999990	1.22000000	1	1	1	0.40546510
0	7.99999860	2.85999990	1	0	0	-0.69314720
0	19.00000190	3.69000010	0	0	7	2.01490310
0	1.99999990	2.11999990	0	0	0	-0.69314720
0	9.99999900	2.52000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	1	0.40546510
0	3.00000000	4.61999990	1	0	2	0.91629080
0	1.99999990	3.54000000	1	2	4	1.50407740
0	0.99999990	2.50000000	1	0	0	-0.69314720
0	4.99999810	1.67999990	0	0	0	-0.69314720
0	1.99999990	3.40000010	1	1	1	0.40546510
0	4.99999810	3.92000010	0	0	0	-0.69314720
0	52.99998090	4.54000000	1	1	5	1.70474800
0	54.99998860	4.54000000	0	0	2	0.91629080
0	0.00000000	2.50000000	0	0	0	-0.69314720
0	10.99999710	4.54000000	1	0	2	0.91629080
0	25.00000000	3.54000000	0	0	3	1.25276290
0	4.99999810	1.52000000	1	0	2	0.91629080
0	1.99999990	3.92000010	1	2	0	-0.69314720
0	7.99999860	4.61999990	1	0	2	0.91629080
0	0.00000000	3.92000010	1	0	3	1.25276290
0	4.99999810	2.31999990	1	2	0	-0.69314720
0	7.99999860	2.96000000	1	2	2	0.91629080
0	6.99999950	2.85999990	1	2	1	0.40546510
0	13.99999710	1.95000000	1	1	3	1.25276290
0	1.99999990	3.92000010	1	2	1	0.40546510
0	4.99999810	2.86999990	0	0	1	0.40546510
0	24.00000190	3.69000010	1	0	3	1.25276290
0	3.00000000	3.69000010	1	0	0	-0.69314720
0	3.99999900	2.39000010	0	0	2	0.91629080
0	3.00000000	1.95000000	1	2	3	1.25276290
0	10.99999710	3.35999990	0	0	5	1.70474800
0	3.99999900	2.39000010	1	1	2	0.91629080
0	26.00000000	3.69000010	0	0	2	0.91629080
0	3.99999900	2.96000000	1	1	5	1.70474800
0	1.99999990	3.21000000	1	0	0	-0.69314720
0	0.00000000	2.11999990	1	2	0	-0.69314720
0	52.99998090	4.54000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	3	1.25276290
0	6.00000050	2.54000000	1	1	3	1.25276290
0	1.99999990	2.85999990	1	1	1	0.40546510
0	13.99999710	3.47000000	1	0	3	1.25276290
0	15.00000100	2.86999990	0	0	4	1.50407740
0	3.99999900	2.31999990	1	0	0	-0.69314720
0	15.00000100	1.86000000	1	2	4	1.50407740
0	3.99999900	1.95000000	1	0	2	0.91629080

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0   1.99999990   2.31999990  1  2  0  -0.69314720
0  19.99999620   4.25000000  1  2  1   0.40546510
0   3.99999900   1.97000000  0  0  6   1.87180220
0  41.99999620   1.86000000  1  0 19   2.97041440
0   7.99999860   3.69000010  1  1  0  -0.69314720
0   3.00000000   4.54000000  1  1  0  -0.69314720
0   9.00000000   3.54000000  1  0  4   1.50407740
0   9.99999900   4.54000000  1  1  1   0.40546510
0   6.99999950   2.85999990  1  2 11   2.44234700
0  25.00000000   3.35999990  1  0  0  -0.69314720
0   3.00000000   2.85999990  0  0  0  -0.69314720
0   3.99999900   2.96000000  1  2  0  -0.69314720
0  22.00000000   2.55999990  1  2  1   0.40546510
0   7.99999860   1.63000000  1  0  2   0.91629080
0  13.99999710   2.96000000  0  0  0  -0.69314720
0   0.00000000   2.96000000  1  0  1   0.40546510
0   7.99999860   1.63000000  1  1  1   0.40546510
0   0.00000000   2.96000000  0  0  0  -0.69314720
0  21.00000000   2.96000000  1  2  2   0.91629080
0   6.99999950   2.96000000  1  0  1   0.40546510
0  30.99998860   4.54000000  1  2  3   1.25276290
0   1.99999990   4.54000000  1  2  2   0.91629080
0   9.99999900   2.15000010  0  0  1   0.40546510
0   6.00000050   4.54000000  1  1  2   0.91629080
0  12.00000000   2.21000000  1  2  2   0.91629080
0   0.99999990   2.21000000  1  1  0  -0.69314720
0  29.00000000   4.54000000  0  0  2   0.91629080
0   9.99999900   2.21000000  1  1  3   1.25276290
0   6.00000050   2.21000000  1  0  0  -0.69314720
0  36.99999240   4.54000000  1  0  3   1.25276290
0   4.99999810   4.54000000  0  0  4   1.50407740
1   9.00000000   2.11999990  0  0  0  -0.69314720
1   1.99999990   2.11999990  1  0  0  -0.69314720
1   1.99999990   2.11999990  1  0  2   0.91629080
1   3.00000000   2.11999990  1  0  3   1.25276290
1   9.00000000   2.11999990  1  1  1   0.40546510
1  10.99999710   2.39000010  0  0  3   1.25276290
1   4.99999810   2.57999990  0  0  2   0.91629080
1   6.99999950   3.19000010  1  0  4   1.50407740
1   4.99999810   3.75000000  0  0  0  -0.69314720
1   3.00000000   3.58999990  0  0  1   0.40546510
1   1.99999990   2.57999990  0  0  2   0.91629080
1   0.00000000   3.75000000  0  0  3   1.25276290
1   4.99999810   3.75000000  1  0  0  -0.69314720
1   0.99999990   3.75000000  0  0  0  -0.69314720
1   3.99999900   1.22000000  1  2  2   0.91629080
1  13.99999710   3.75000000  0  0  0  -0.69314720
1   6.99999950   3.75000000  1  0  0  -0.69314720
1  26.00000000   3.75000000  0  0  0  -0.69314720
1   7.99999860   3.75000000  0  0  2   0.91629080
1   3.00000000   3.75000000  0  0  4   1.50407740
1   6.00000050   3.75000000  0  0  0  -0.69314720
1  21.00000000   3.75000000  0  0  1   0.40546510
1   7.99999860   3.75000000  1  0  2   0.91629080
1   3.99999900   3.75000000  0  0  0  -0.69314720
1   6.99999950   3.75000000  1  1  1   0.40546510
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1	0.00000000	3.75000000	1	0	2	0.91629080
1	0.00000000	2.54000000	1	1	0	-0.69314720
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1	3.99999900	2.76000000	0	0	0	-0.69314720
1	1.99999990	4.13999990	0	0	0	-0.69314720
1	3.99999900	0.92000000	0	0	1	0.40546510
1	0.00000000	1.00500000	0	0	0	-0.69314720
1	6.00000050	3.08999990	0	0	2	0.91629080
1	3.00000000	3.08999990	1	1	2	0.91629080
1	0.00000000	1.79000000	0	0	0	-0.69314720
1	3.00000000	1.40000000	0	0	1	0.40546510
1	3.00000000	1.40000000	0	0	4	1.50407740
1	0.00000000	1.40000000	1	0	2	0.91629080
1	0.00000000	1.40000000	0	0	2	0.91629080
1	13.99999710	1.40000000	0	0	0	-0.69314720
1	12.00000000	1.40000000	0	0	1	0.40546510
1	1.99999990	1.40000000	0	0	1	0.40546510
1	6.00000050	2.00000000	0	0	1	0.40546510
1	10.99999710	4.34000020	1	0	2	0.91629080
1	6.00000050	4.34000020	1	0	4	1.50407740
1	0.00000000	1.75000000	0	0	0	-0.69314720
1	36.00000000	2.09999990	1	0	6	1.87180220
1	7.99999860	2.09999990	0	0	1	0.40546510
1	1.99999990	2.09999990	0	0	0	-0.69314720
1	10.99999710	3.58999990	1	0	2	0.91629080
1	10.99999710	3.58999990	1	2	2	0.91629080
1	17.99999810	3.58999990	0	0	0	-0.69314720
1	3.99999900	3.58999990	0	0	0	-0.69314720
1	17.99999810	3.58999990	1	0	10	2.35137530
1	7.99999860	3.58999990	0	0	1	0.40546510
1	19.00000190	3.41000010	1	0	3	1.25276290
1	3.99999900	3.41000010	1	0	4	1.50407740
1	4.99999810	3.41000010	1	2	0	-0.69314720
1	6.99999950	3.40000010	0	0	1	0.40546510
1	3.99999900	3.40000010	1	1	2	0.91629080
1	4.99999810	3.40000010	1	0	4	1.50407740
1	13.99999710	3.40000010	1	0	1	0.40546510
1	3.99999900	3.40000010	1	0	0	-0.69314720
1	3.99999900	2.52000000	0	0	3	1.25276290
1	0.00000000	2.52000000	0	0	1	0.40546510
1	15.00000100	3.69000010	1	1	2	0.91629080
1	0.99999990	3.69000010	1	0	1	0.40546510
1	3.00000000	3.69000010	1	1	0	-0.69314720
1	17.99999810	3.69000010	0	0	1	0.40546510
1	15.00000100	2.86999990	0	0	0	-0.69314720
1	4.99999810	2.86999990	1	0	1	0.40546510
1	17.99999810	2.86999990	1	0	1	0.40546510
1	9.00000000	2.86999990	0	0	2	0.91629080
1	6.00000050	2.86999990	0	0	4	1.50407740
1	15.00000100	2.86999990	1	0	1	0.40546510
1	3.99999900	3.35999990	0	0	2	0.91629080
1	1.99999990	3.35999990	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	2	0.91629080
1	6.99999950	3.35999990	0	0	0	-0.69314720
1	15.99999810	4.54000000	1	0	4	1.50407740
1	48.00000000	4.54000000	1	2	2	0.91629080

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1  15.00000100   4.54000000  1  0  5   1.70474800
1  36.99999240   4.54000000  0  0  1   0.40546510
1   9.99999900   4.54000000  1  0  2   0.91629080
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1   6.99999950   4.54000000  1  1  2   0.91629080
1   9.00000000   4.54000000  1  0  2   0.91629080
1   4.99999810   4.54000000  0  0  2   0.91629080
1  15.00000100   4.54000000  0  0  6   1.87180220
1   3.00000000   4.54000000  0  0  3   1.25276290
1  13.99999710   4.54000000  0  0  0  -0.69314720
1   1.99999990   1.28000000  1  0  1   0.40546510
1   3.99999900   1.28000000  1  0  4   1.50407740
1   3.99999900   1.28000000  1  0  0  -0.69314720
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1  47.00000760   3.84999990  1  2  2   0.91629080
1  29.00000000   3.84999990  1  0  1   0.40546510
1   0.99999990   3.84999990  1  1  5   1.70474800
1  17.99999810   3.84999990  0  0  1   0.40546510
1  13.00000000   2.05000000  0  0  1   0.40546510
1  17.00000000   2.05000000  0  0  1   0.40546510
1   1.99999990   2.05000000  0  0  2   0.91629080
1   3.99999900   1.78000000  1  0  4   1.50407740
1   0.99999990   1.17999990  1  0  1   0.40546510
1   3.00000000   1.52000000  1  0  0  -0.69314720
1   9.00000000   1.48000000  1  0  2   0.91629080
1  12.00000000   4.29000000  0  0  0  -0.69314720
1  17.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   4.29000000  0  0  3   1.25276290
1   1.99999990   3.08999990  1  0  2   0.91629080
1   0.00000000   3.08999990  0  0  2   0.91629080
1   3.00000000   3.61999990  0  0  5   1.70474800
1   6.99999950   3.61999990  0  0  0  -0.69314720
1   7.99999860   3.61999990  0  0  0  -0.69314720
1   0.00000000   4.29000000  0  0  0  -0.69314720
1   6.00000050   2.60999990  1  1  1   0.40546510
1   6.99999950   2.60999990  1  0  1   0.40546510
1   9.00000000   2.09999990  0  0  0  -0.69314720
1   7.99999860   2.96000000  1  0  2   0.91629080
1   9.99999900   2.39000010  0  0  0  -0.69314720
1   3.00000000   1.95000000  1  0  1   0.40546510
1  13.99999710   3.41000010  0  0  2   0.91629080
1   0.99999990   4.29000000  0  0  2   0.91629080
1  10.99999710   3.58999990  0  0  2   0.91629080
1   9.99999900   4.61999990  0  0  1   0.40546510
1   6.00000050   2.14000010  0  0  1   0.40546510
1  10.99999710   2.85999990  0  0  0  -0.69314720
1   4.99999810   3.47000000  0  0  2   0.91629080
1  13.99999710   4.61999990  1  1  3   1.25276290
1   9.00000000   3.19000010  1  3  1   0.40546510
1   0.99999990   2.51000000  0  0  1   0.40546510
1   0.00000000   2.11999990  0  0  0  -0.69314720
1   3.00000000   3.19000010  0  0  0  -0.69314720
1   3.99999900   1.74000000  1  1  2   0.91629080
1   0.00000000   1.25000000  1  0  0  -0.69314720
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1	6.99999950	3.69000010	1	0	0	-0.69314720
1	4.99999810	3.21000000	0	0	0	-0.69314720
1	15.00000100	4.61999990	1	1	0	-0.69314720
1	24.00000190	2.85999990	1	0	5	1.70474800
1	9.00000000	2.39000010	1	1	1	0.40546510
1	0.00000000	1.17999990	1	0	3	1.25276290
1	6.99999950	3.35999990	0	0	2	0.91629080
1	7.99999860	1.97000000	0	0	2	0.91629080
1	22.00000000	1.64000000	1	0	1	0.40546510
1	6.99999950	3.92000010	1	0	2	0.91629080
1	6.00000050	3.31999990	0	0	6	1.87180220
1	6.00000050	2.57999990	0	0	5	1.70474800
1	22.99999620	4.54000000	0	0	2	0.91629080
1	1.99999990	2.39000010	1	0	0	-0.69314720
1	9.00000000	3.58999990	0	0	4	1.50407740
1	6.99999950	3.69000010	0	0	2	0.91629080
1	9.99999900	3.19000010	0	0	2	0.91629080
1	3.99999900	2.31999990	0	0	2	0.91629080
1	10.99999710	3.47000000	1	1	2	0.91629080
1	3.99999900	3.69000010	0	0	2	0.91629080
1	4.99999810	2.31999990	1	1	3	1.25276290
1	10.99999710	3.19000010	0	0	1	0.40546510
1	19.00000190	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	4.99999810	2.57999990	1	0	2	0.91629080
1	6.99999950	3.21000000	1	1	2	0.91629080
1	3.00000000	1.40000000	0	0	1	0.40546510
1	9.99999900	2.50000000	0	0	4	1.50407740
1	0.00000000	3.19000010	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	0	-0.69314720
1	9.00000000	3.15000010	0	0	6	1.87180220
1	6.99999950	1.45000000	1	0	2	0.91629080
1	6.99999950	2.85999990	1	2	1	0.40546510
1	48.99999240	4.61999990	1	1	3	1.25276290
1	1.99999990	3.69000010	1	0	0	-0.69314720
1	19.00000190	2.96000000	1	0	1	0.40546510
1	12.00000000	3.08999990	1	1	1	0.40546510
1	0.99999990	3.08999990	0	0	0	-0.69314720
1	12.00000000	4.61999990	0	0	2	0.91629080
1	13.00000000	2.85999990	1	0	0	-0.69314720
1	1.99999990	3.21000000	0	0	0	-0.69314720
1	3.00000000	2.82999990	1	0	2	0.91629080
1	22.00000000	4.29000000	0	0	1	0.40546510
1	35.00000760	4.29000000	0	0	0	-0.69314720
1	0.99999990	3.08999990	1	0	2	0.91629080
1	3.99999900	3.69000010	0	0	0	-0.69314720
1	0.99999990	1.79000000	1	0	0	-0.69314720
1	1.99999990	3.35999990	1	1	0	-0.69314720
1	13.99999710	2.57999990	1	0	4	1.50407740
1	24.00000190	3.75000000	0	0	1	0.40546510
1	4.99999810	3.19000010	0	0	2	0.91629080
1	0.99999990	2.09999990	0	0	0	-0.69314720
1	7.99999860	3.58999990	1	1	0	-0.69314720
1	0.99999990	3.92000010	0	0	0	-0.69314720
1	24.00000190	3.31999990	1	1	1	0.40546510
1	1.99999990	2.00000000	0	0	0	-0.69314720

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1   1.99999990   3.47000000  1  0  0  -0.69314720
1  13.99999710   3.21000000  1  0  4   1.50407740
1   4.99999810   2.05000000  0  0  3   1.25276290
1   0.99999990   2.52000000  0  0  0  -0.69314720
1   6.99999950   3.15000010  1  0  0  -0.69314720
1  38.00000380   1.86000000  1  2  6   1.87180220
1   3.00000000   2.85999990  0  0  2   0.91629080
1   3.99999900   4.29000000  1  1  4   1.50407740
1   0.00000000   1.25500000  1  2  0  -0.69314720
1  19.00000190   3.21000000  1  0  5   1.70474800
1   4.99999810   2.31999990  1  1  1   0.40546510
1   3.00000000   3.19000010  0  0  4   1.50407740
1   1.99999990   3.19000010  1  0  1   0.40546510
1  10.99999710   3.35999990  1  0  3   1.25276290
1  13.99999710   3.54000000  1  1  1   0.40546510
1   6.00000050   1.86000000  1  0  0  -0.69314720
1  13.00000000   1.50500000  0  0  0  -0.69314720
1   6.99999950   2.39000010  1  0  1   0.40546510
1  10.99999710   4.29000000  1  1  2   0.91629080
1   9.00000000   2.00000000  1  1  0  -0.69314720
1   3.99999900   3.92000010  0  0  1   0.40546510
1   6.00000050   4.29000000  1  0  2   0.91629080
1   6.00000050   3.35999990  0  0  1   0.40546510
1  13.99999710   4.61999990  1  0  3   1.25276290
1   6.00000050   2.00000000  0  0  1   0.40546510
1   4.99999810   3.58999990  1  0  2   0.91629080
1   6.00000050   2.86999990  0  0  1   0.40546510
1   3.99999900   2.96000000  0  0  0  -0.69314720
1  10.99999710   3.47000000  1  0  0  -0.69314720
1   7.99999860   3.19000010  1  0  4   1.50407740
1   3.00000000   2.85999990  1  1  0  -0.69314720
1  15.99999810   2.52000000  1  0  2   0.91629080
1   6.00000050   4.29000000  0  0  1   0.40546510
1   0.00000000   1.25500000  0  0  1   0.40546510
1   1.99999990   1.83000000  1  0  0  -0.69314720
1  12.00000000   4.29000000  0  0  3   1.25276290
1   7.99999860   2.96000000  1  0  0  -0.69314720
1   0.99999990   2.31999990  1  0  1   0.40546510
1  10.99999710   1.22000000  1  1  0  -0.69314720
1  10.99999710   4.29000000  1  0  1   0.40546510
1   1.99999990   4.25000000  0  0  1   0.40546510
1  36.00000000   2.55000000  0  0  2   0.91629080
1  10.99999710   1.95000000  1  0  1   0.40546510
1   1.99999990   3.69000010  0  0  0  -0.69314720
1  25.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   3.19000010  1  0  2   0.91629080
1  12.00000000   3.54000000  1  1  4   1.50407740
1   4.99999810   3.54000000  1  0  4   1.50407740
1   7.99999860   3.54000000  1  1  0  -0.69314720
1   0.99999990   1.86000000  1  1  3   1.25276290
1   3.00000000   4.61999990  0  0  4   1.50407740
1  15.99999810   4.61999990  1  0  1   0.40546510
1   9.99999900   4.61999990  1  0  3   1.25276290
1  13.00000000   4.54000000  1  0  1   0.40546510
1   0.99999990   3.47000000  1  0  0  -0.69314720
1  15.99999810   2.85999990  0  0  0  -0.69314720
```

1	6.99999950	2.00000000	1	0	0	-0.69314720
1	1.99999990	2.00000000	0	0	0	-0.69314720
1	3.00000000	2.60999990	1	0	0	-0.69314720
1	6.00000050	2.05000000	0	0	0	-0.69314720
1	6.00000050	2.05000000	0	0	0	-0.69314720
1	4.99999810	3.54000000	0	0	0	-0.69314720
1	0.00000000	0.92000000	1	0	2	0.91629080
1	0.00000000	1.79000000	1	0	0	-0.69314720
1	6.00000050	2.00000000	1	0	0	-0.69314720
1	7.99999860	3.15000010	0	0	4	1.50407740
1	15.99999810	2.26000000	1	0	5	1.70474800
1	3.99999900	2.26000000	0	0	1	0.40546510
1	0.99999990	4.29000000	1	0	6	1.87180220
1	21.00000000	4.29000000	1	0	1	0.40546510
1	9.00000000	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	1.99999990	2.52000000	0	0	0	-0.69314720
1	9.99999900	4.29000000	0	0	3	1.25276290
1	9.00000000	4.29000000	0	0	0	-0.69314720
1	12.00000000	4.54000000	0	0	2	0.91629080
1	0.00000000	2.50000000	0	0	0	-0.69314720
1	1.99999990	2.76000000	0	0	1	0.40546510
1	0.00000000	2.55000000	1	1	0	-0.69314720
1	0.00000000	4.61999990	1	0	0	-0.69314720
1	6.00000050	1.63000000	0	0	2	0.91629080
1	3.00000000	3.47000000	1	0	1	0.40546510
1	30.99998860	3.41000010	1	0	2	0.91629080
1	0.99999990	4.29000000	0	0	0	-0.69314720
1	6.99999950	2.96000000	1	0	0	-0.69314720
1	0.00000000	4.61999990	1	0	5	1.70474800
1	12.00000000	3.58999990	1	0	0	-0.69314720
1	12.00000000	3.69000010	1	0	3	1.25276290
1	1.99999990	4.54000000	1	0	1	0.40546510
1	10.99999710	3.33999990	0	0	4	1.50407740
1	1.99999990	2.51000000	1	1	4	1.50407740
1	3.99999900	3.15000010	1	0	3	1.25276290
1	3.00000000	3.19000010	1	0	1	0.40546510
1	17.99999810	3.19000010	0	0	1	0.40546510
1	1.99999990	3.84999990	0	0	1	0.40546510
1	3.99999900	3.33999990	1	1	2	0.91629080
1	15.00000100	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	0	0	2	0.91629080
1	21.00000000	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	0	-0.69314720
1	0.00000000	2.96000000	1	0	0	-0.69314720
1	0.99999990	1.78000000	1	0	0	-0.69314720
1	17.00000000	3.54000000	1	2	1	0.40546510
1	3.00000000	3.69000010	1	0	0	-0.69314720
1	1.99999990	3.35999990	0	0	3	1.25276290
1	1.99999990	3.54000000	1	0	0	-0.69314720
1	0.99999990	3.54000000	1	1	0	-0.69314720
1	3.00000000	1.22000000	1	1	3	1.25276290
1	3.99999900	3.35999990	0	0	1	0.40546510
1	1.99999990	2.21000000	0	0	1	0.40546510
1	3.99999900	2.25000000	0	0	1	0.40546510
1	17.00000000	4.61999990	1	1	2	0.91629080

```
1   4.99999810   3.58999990  1  0  1   0.40546510
1   0.99999990   4.29000000  1  0  0  -0.69314720
1   1.99999990   2.11999990  0  0  2   0.91629080
1   3.00000000   2.26000000  0  0  2   0.91629080
1   3.00000000   2.26000000  1  0  4   1.50407740
1   4.99999810   4.29000000  0  0  0  -0.69314720
1   3.00000000   3.58999990  1  1  3   1.25276290
1  13.00000000   4.29000000  1  2  1   0.40546510
1   1.99999990   2.00000000  0  0  1   0.40546510
1   0.00000000   1.97000000  1  2  0  -0.69314720
1   7.99999860   3.92000010  1  0  0  -0.69314720
1  39.00000000   2.85999990  0  0  4   1.50407740
1  26.00000000   2.82999990  0  0  2   0.91629080
1   3.00000000   3.35999990  1  1  3   1.25276290
1  22.99999620   2.55999990  0  0  4   1.50407740
1   7.99999860   1.63000000  0  0  1   0.40546510
1  22.00000000   4.61999990  0  0  3   1.25276290
1   4.99999810   4.61999990  0  0  1   0.40546510
1  21.00000000   4.29000000  1  0  3   1.25276290
1   6.00000050   4.29000000  1  1  0  -0.69314720
1   3.99999900   4.29000000  1  1  2   0.91629080
1  24.00000190   4.29000000  1  0  6   1.87180220
1   6.00000050   4.29000000  1  0  1   0.40546510
1  33.99999240   3.35999990  0  0  1   0.40546510
1   0.00000000   3.21000000  0  0  2   0.91629080
1   9.99999900   2.00000000  0  0  1   0.40546510
1   1.99999990   3.21000000  1  2  2   0.91629080
1   3.00000000   2.57999990  1  2  2   0.91629080
1   3.00000000   2.57999990  1  0  0  -0.69314720
1   0.99999990   2.82999990  0  0  0  -0.69314720
1   6.00000050   3.19000010  0  0  1   0.40546510
1   3.00000000   3.47000000  0  0  1   0.40546510
1  22.99999620   4.61999990  1  0  2   0.91629080
1  13.00000000   4.25000000  1  0  4   1.50407740
1   4.99999810   1.86000000  1  0  2   0.91629080
1   9.00000000   4.29000000  1  1  0  -0.69314720
1   9.00000000   3.35999990  0  0  0  -0.69314720
1   9.99999900   1.80000000  1  0  2   0.91629080
1   0.00000000   1.65500000  0  0  1   0.40546510
1   6.00000050   2.85999990  0  0  0  -0.69314720
1  13.99999710   4.61999990  0  0  2   0.91629080
1   3.00000000   4.29000000  0  0  0  -0.69314720
1   4.99999810   2.35999990  1  0  4   1.50407740
1  10.99999710   1.80999990  1  0  1   0.40546510
1  32.00001140   3.58999990  1  0  1   0.40546510
1   9.99999900   1.76000000  0  0  0  -0.69314720
1   4.99999810   2.00000000  1  0  1   0.40546510
1  13.99999710   3.58999990  0  0  5   1.70474800
1   6.00000050   2.26000000  1  0  3   1.25276290
1   3.99999900   2.26000000  0  0  1   0.40546510
1   3.99999900   1.76000000  1  1  1   0.40546510
1   0.99999990   3.58999990  1  0  1   0.40546510
1   0.99999990   3.58999990  1  0  0  -0.69314720
1   4.99999810   2.82999990  1  1  1   0.40546510
1   1.99999990   2.57999990  0  0  1   0.40546510
1  17.99999810   4.61999990  1  0  1   0.40546510
```

1	15.00000100	2.31999990	0	0	1	0.40546510
1	0.00000000	2.39000010	1	0	0	-0.69314720
1	22.00000000	2.96000000	1	0	3	1.25276290
1	10.99999710	2.11999990	0	0	0	-0.69314720
1	17.99999810	4.61999990	1	0	1	0.40546510
1	3.00000000	2.25000000	1	0	1	0.40546510
1	7.99999860	1.76000000	1	0	1	0.40546510
1	12.00000000	4.54000000	0	0	6	1.87180220
1	9.99999900	3.69000010	1	1	2	0.91629080
1	1.99999990	1.25000000	0	0	0	-0.69314720
1	4.99999810	1.25000000	1	0	1	0.40546510
1	3.99999900	3.19000010	1	0	0	-0.69314720
1	0.00000000	2.57999990	1	2	0	-0.69314720
1	6.99999950	2.00000000	1	1	2	0.91629080
1	0.99999990	2.76000000	0	0	0	-0.69314720
1	3.99999900	2.54000000	0	0	2	0.91629080
1	0.00000000	3.19000010	0	0	0	-0.69314720
1	9.00000000	3.08999990	1	2	1	0.40546510
1	3.99999900	3.19000010	0	0	2	0.91629080
1	0.00000000	3.08999990	0	0	0	-0.69314720
1	7.99999860	2.26000000	0	0	2	0.91629080
1	9.00000000	2.26000000	1	1	1	0.40546510
1	7.99999860	3.35999990	1	0	2	0.91629080
1	9.00000000	3.15000010	1	0	1	0.40546510
1	3.99999900	4.54000000	1	0	0	-0.69314720
1	0.00000000	3.58999990	1	0	2	0.91629080
1	3.00000000	3.47000000	1	0	1	0.40546510
1	1.99999990	2.85999990	1	1	1	0.40546510
1	6.00000050	2.26000000	1	0	0	-0.69314720
1	3.99999900	3.47000000	1	1	2	0.91629080
1	0.00000000	2.76000000	1	0	0	-0.69314720
1	1.99999990	3.58999990	1	2	0	-0.69314720
1	13.00000000	3.75000000	0	0	5	1.70474800
1	1.99999990	2.57999990	1	2	1	0.40546510
1	1.99999990	3.58999990	1	1	2	0.91629080
1	15.99999810	1.89000000	1	2	3	1.25276290
1	9.00000000	3.15000010	0	0	7	2.01490310
1	12.00000000	2.86999990	0	0	5	1.70474800
1	0.99999990	2.11999990	1	2	0	-0.69314720
1	3.99999900	4.61999990	1	0	1	0.40546510
1	0.00000000	2.39000010	0	0	0	-0.69314720
1	10.99999710	2.11999990	0	0	0	-0.69314720
1	4.99999810	1.80999990	1	0	0	-0.69314720
1	7.99999860	2.31999990	0	0	4	1.50407740
1	15.00000100	2.39000010	0	0	0	-0.69314720
1	6.00000050	3.75000000	1	0	3	1.25276290
1	0.00000000	2.00000000	0	0	0	-0.69314720
1	13.99999710	3.58999990	1	1	0	-0.69314720
1	4.99999810	4.29000000	0	0	2	0.91629080
1	0.00000000	2.57999990	1	0	0	-0.69314720
1	4.99999810	4.61999990	1	0	0	-0.69314720
1	3.00000000	1.50500000	0	0	0	-0.69314720
1	3.99999900	3.75000000	1	0	2	0.91629080
1	3.99999900	3.75000000	1	2	0	-0.69314720
1	0.00000000	1.75000000	1	0	1	0.40546510
1	0.00000000	2.11999990	1	0	1	0.40546510

```
1   4.99999810   3.75000000   0   0   2   0.91629080
1   0.00000000   0.75500000   0   0   0  -0.69314720
1   6.99999950   2.25000000   0   0   1   0.40546510
1   3.00000000   3.19000010   0   0   1   0.40546510
;
```

Click **Run** to create the Work.Long97Data table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Panel Data Models** to add the step to your flow.

3 Add the Work.Long97Data table to your flow. Connect the input port of the Panel Data Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Panel Data Models step, click the Panel Data Models node.

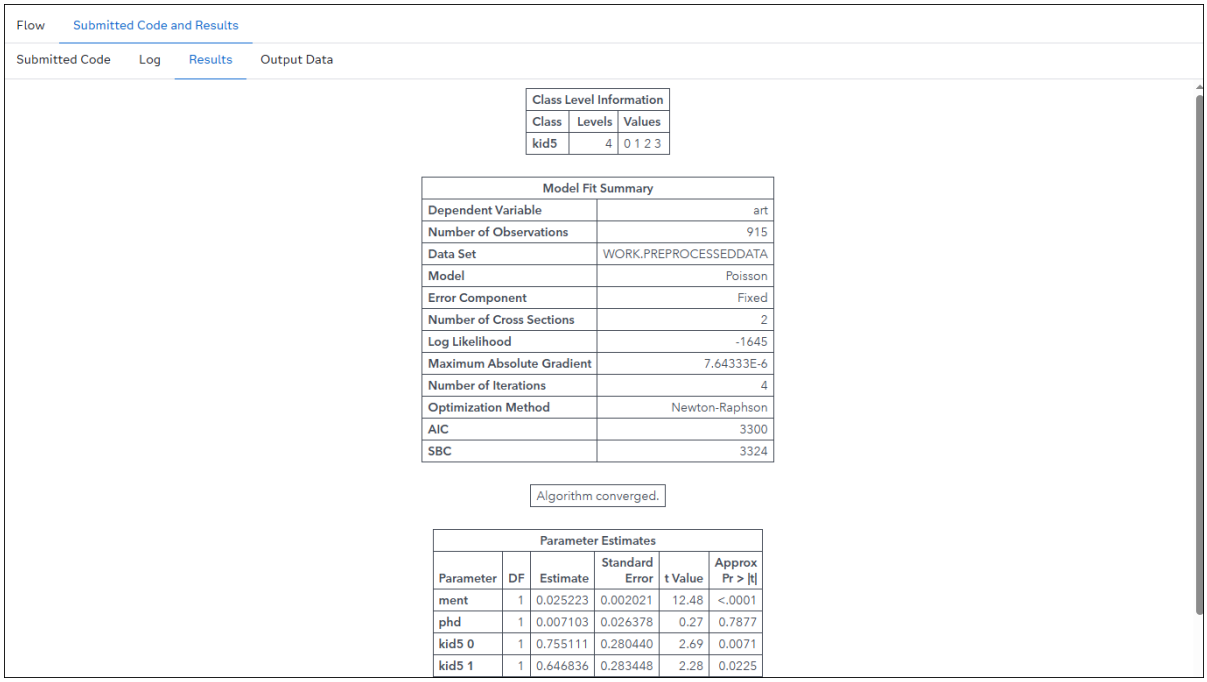
5 On the **Data** tab, assign columns to these roles:

- To the **Cross-sectional ID** role, assign **fem**.
- To the **Dependent variable** role, assign **art**.
- To the **Continuous variables** role, assign **ment** and **phd**.
- To the **Categorical variables** role, assign **kid5**.

6 Click the **Model** tab. From the **Model type** drop-down list, select **Poisson**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Poisson Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Cross-sectional ID**, assign the numeric variable that identifies the cross section for each observation. The step verifies that the input data is sorted by the cross-sectional ID.

4 To the **Time ID** role, assign a numeric variable that identifies the time period for each observation. For each cross section, the values of the time ID must be unique.

Note: For the Poisson model, a time ID is not required and is ignored in the analysis.

5 To the **Dependent variable** role, assign the numeric variable that contains the count values. In the input table, this variable must contain only nonnegative integer values.

6 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

7 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

8 To the **Group analysis by** role, assign variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 From the **Model type** drop-down list, select **Poisson**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects using the continuous variables and categorical variables selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Specify the error component to include in the model. The error component can be for fixed effects or random effects.

Note: This option is available if you are running the step using the SAS Compute Server.

Step 3: Set the Options

On the **Options** tab, you can set these options.

The covariance matrix estimator is the inverse Hessian matrix.

If you are running the step using the SAS Compute Server, you can set these options.

1 Select the optimization method to use.

2 Specify the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.

3 Select the statistics to display in the results.

Here are the available statistics:

- correlations of the parameter estimates
- covariances of the parameter estimates
- iteration history of the objective function and parameter estimates

If you are running the step using the CAS server, you can specify how to generate the code for the step. You can choose from these options:

- **Use Econometrics procedure**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, you can specify these options:

- an output data set that contains the statistics from the analysis
- parameter estimates table

Note: If you are running the step in a flow, you must add output ports for the output tables to the Panel Data Models node. For more information, see "Panel Data Models: Connection Requirements for the Node" on page 712.

Negative Binomial Models

Example: Negative Binomial Model

To create this example:

1 Enter this code on a **SAS Program** tab:

```
data long97data;
   input fem ment phd mar kid5 art lnart;
datalines;
0   7.99999860   1.38000000  1  2  3   1.25276290
0   6.99999950   4.29000000  0  0  0  -0.69314720
0  47.00000760   3.84999990  0  0  4   1.50407740
0  19.00000190   3.58999990  1  1  1   0.40546510
0   0.00000000   1.80999990  1  0  1   0.40546510
0   6.00000050   3.58999990  1  1  1   0.40546510
0   9.99999900   2.11999990  1  1  0  -0.69314720
0   1.99999990   4.29000000  1  0  0  -0.69314720
0   1.99999990   2.57999990  1  2  3   1.25276290
0   3.99999900   1.80000000  1  1  3   1.25276290
0   0.00000000   4.29000000  1  2  1   0.40546510
0   3.00000000   2.76000000  1  1  0  -0.69314720
0   9.99999900   3.41000010  1  1  1   0.40546510
0   6.99999950   4.34000020  1  3  2   0.91629080
0  15.00000100   3.84999990  1  2  5   1.70474800
0   1.99999990   2.09999990  1  0  2   0.91629080
0  13.00000000   4.29000000  1  0  2   0.91629080
0  15.00000100   4.29000000  0  0  1   0.40546510
0   4.99999810   2.26000000  1  1  0  -0.69314720
0   6.00000050   2.09999990  0  0  0  -0.69314720
0  12.00000000   2.26000000  1  0  3   1.25276290
0  15.99999810   3.84999990  1  1  6   1.87180220
0   6.99999950   4.29000000  0  0  4   1.50407740
0   6.00000050   1.80000000  1  2  2   0.91629080
0   1.99999990   2.26000000  0  0  2   0.91629080
0   0.00000000   2.09999990  0  0  0  -0.69314720
0  30.00000190   4.29000000  1  0  4   1.50407740
0   9.99999900   4.29000000  1  2  1   0.40546510
0   1.99999990   2.09999990  1  0  1   0.40546510
0   0.99999990   3.58999990  1  0  7   2.01490310
0   3.00000000   3.42000010  1  1  2   0.91629080
0   9.99999900   4.29000000  1  2  2   0.91629080
0   9.99999900   4.29000000  0  0  2   0.91629080
0   0.99999990   3.33999990  1  2  0  -0.69314720
```

```
0   1.99999990   4.29000000  0  0  0  -0.69314720
0  10.99999710   4.29000000  1  0  1   0.40546510
0   4.99999810   3.61999990  1  0  4   1.50407740
0   0.00000000   4.29000000  1  3  1   0.40546510
0   3.99999900   4.34000020  1  1  1   0.40546510
0   1.99999990   1.25000000  1  1  2   0.91629080
0  19.00000190   4.34000020  0  0  7   2.01490310
0   3.00000000   1.67000000  1  3  1   0.40546510
0   0.00000000   3.47000000  0  0  0  -0.69314720
0   0.99999990   2.26000000  1  1  1   0.40546510
0   0.99999990   1.80000000  1  0  1   0.40546510
0  17.00000000   4.34000020  1  2  2   0.91629080
0   3.00000000   3.58999990  0  0  2   0.91629080
0   0.99999990   1.75000000  1  2  1   0.40546510
0   6.00000050   4.29000000  0  0  1   0.40546510
0   0.00000000   2.09999990  1  1  0  -0.69314720
0  15.00000100   4.29000000  1  2  0  -0.69314720
0   0.00000000   2.09999990  1  1  0  -0.69314720
0  26.99999810   3.31999990  1  2  2   0.91629080
0   4.99999810   4.34000020  1  0  2   0.91629080
0   6.99999950   3.41000010  0  0  4   1.50407740
0   0.00000000   4.29000000  1  0  1   0.40546510
0  10.99999710   3.19000010  1  0  2   0.91629080
0  13.00000000   4.29000000  1  0  2   0.91629080
0   3.99999900   1.74000000  1  2  1   0.40546510
0   3.99999900   2.76000000  0  0  1   0.40546510
0  26.99999810   3.58999990  1  1  7   2.01490310
0   9.99999900   1.80999990  1  0  4   1.50407740
0  13.00000000   4.29000000  1  1  2   0.91629080
0   0.99999990   4.29000000  1  1  1   0.40546510
0   6.00000050   2.76000000  0  0  1   0.40546510
0   6.00000050   3.47000000  0  0  6   1.87180220
0   4.99999810   2.50000000  1  2  2   0.91629080
0   1.99999990   1.25000000  1  0  5   1.70474800
0  13.99999710   3.58999990  1  1  3   1.25276290
0   0.00000000   2.09999990  1  1  0  -0.69314720
0  12.00000000   3.58999990  1  0  1   0.40546510
0   6.99999950   3.58999990  1  3  0  -0.69314720
0   3.00000000   1.75000000  1  0  1   0.40546510
0   1.99999990   1.75000000  1  2  1   0.40546510
0   1.99999990   3.58999990  1  1  1   0.40546510
0   1.99999990   4.29000000  0  0  1   0.40546510
0   0.00000000   4.29000000  0  0  0  -0.69314720
0   0.00000000   2.09999990  1  1  0  -0.69314720
0   0.00000000   2.60999990  1  0  3   1.25276290
0  30.00000190   4.29000000  1  0  5   1.70474800
0  21.00000000   1.74000000  1  0 16   2.80336050
0   4.99999810   2.76000000  1  0  1   0.40546510
0   9.00000000   4.29000000  0  0  0  -0.69314720
0   7.99999860   2.76000000  1  2  1   0.40546510
0  25.00000000   4.29000000  1  2  3   1.25276290
0   0.00000000   3.47000000  1  1  5   1.70474800
0   4.99999810   2.57999990  1  2  0  -0.69314720
0   0.99999990   2.14000010  1  0  0  -0.69314720
0   4.99999810   2.26000000  0  0  0  -0.69314720
0   0.00000000   4.29000000  1  2  3   1.25276290
```

0	15.00000100	4.29000000	1	0	3	1.25276290
0	30.00000190	4.29000000	0	0	3	1.25276290
0	1.99999990	2.20000000	1	0	0	-0.69314720
0	6.00000050	1.80000000	1	2	3	1.25276290
0	0.00000000	2.09999990	1	2	1	0.40546510
0	13.00000000	4.29000000	1	1	1	0.40546510
0	0.00000000	4.29000000	0	0	0	-0.69314720
0	12.00000000	2.09999990	1	1	0	-0.69314720
0	30.00000190	4.29000000	1	2	2	0.91629080
0	4.99999810	1.80999990	1	1	1	0.40546510
0	9.99999900	4.34000020	1	0	1	0.40546510
0	4.99999810	4.29000000	1	1	0	-0.69314720
0	3.99999900	2.50000000	1	2	1	0.40546510
0	13.00000000	2.05000000	1	2	4	1.50407740
0	7.99999860	3.47000000	1	0	3	1.25276290
0	6.00000050	2.60999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	2	1	0.40546510
0	25.00000000	4.29000000	0	0	2	0.91629080
0	1.99999990	4.29000000	1	1	2	0.91629080
0	9.00000000	4.34000020	1	0	6	1.87180220
0	9.99999900	2.11999990	1	1	0	-0.69314720
0	3.00000000	2.76000000	1	0	2	0.91629080
0	1.99999990	4.29000000	1	2	0	-0.69314720
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	4.34000020	1	0	5	1.70474800
0	7.99999860	2.76000000	1	1	2	0.91629080
0	9.99999900	3.19000010	1	1	2	0.91629080
0	7.99999860	4.61999990	0	0	3	1.25276290
0	6.00000050	3.15000010	1	2	0	-0.69314720
0	21.00000000	2.55000000	1	1	4	1.50407740
0	3.99999900	1.52000000	1	0	0	-0.69314720
0	1.99999990	1.72000000	1	2	4	1.50407740
0	0.99999990	1.78000000	1	1	2	0.91629080
0	17.00000000	2.85999990	1	1	1	0.40546510
0	30.00000190	4.61999990	1	2	0	-0.69314720
0	4.99999810	4.13999990	0	0	1	0.40546510
0	13.00000000	2.96000000	1	1	6	1.87180220
0	10.99999710	2.55000000	1	0	1	0.40546510
0	19.00000190	2.21000000	1	1	0	-0.69314720
0	4.99999810	3.08999990	1	0	3	1.25276290
0	66.00000760	4.54000000	1	2	4	1.50407740
0	0.00000000	1.78000000	1	0	3	1.25276290
0	3.00000000	2.21000000	1	3	0	-0.69314720
0	3.00000000	2.39000010	1	1	1	0.40546510
0	0.00000000	2.96000000	1	0	0	-0.69314720
0	7.99999860	2.51000000	1	1	0	-0.69314720
0	0.00000000	1.97000000	1	2	2	0.91629080
0	4.99999810	4.13999990	0	0	0	-0.69314720
0	29.00000000	4.25000000	1	1	4	1.50407740
0	10.99999710	2.85999990	1	2	0	-0.69314720
0	22.99999620	2.96000000	1	1	9	2.25129180
0	45.99999240	2.96000000	1	2	2	0.91629080
0	7.99999860	4.61999990	1	1	6	1.87180220
0	4.99999810	3.69000010	1	2	0	-0.69314720
0	0.99999990	3.15000010	1	1	0	-0.69314720
0	9.00000000	4.61999990	0	0	2	0.91629080

```
0   1.99999990   3.35999990  1  0  0  -0.69314720
0   6.99999950   3.69000010  0  0  4   1.50407740
0  10.99999710   3.54000000  1  0  1   0.40546510
0  56.99999620   2.96000000  1  1  4   1.50407740
0  15.99999810   2.55999990  1  1  1   0.40546510
0   0.00000000   2.31999990  1  0  0  -0.69314720
0   3.00000000   2.31999990  1  0  0  -0.69314720
0   0.99999990   0.92000000  1  2  0  -0.69314720
0   9.99999900   4.54000000  1  0  0  -0.69314720
0  10.99999710   4.54000000  1  3  0  -0.69314720
0  10.99999710   1.76000000  1  1  5   1.70474800
0  15.99999810   2.55999990  0  0  1   0.40546510
0   4.99999810   2.39000010  1  1  0  -0.69314720
0   9.00000000   3.40000010  1  0  2   0.91629080
0  19.99999620   2.86999990  1  2  2   0.91629080
0  21.00000000   4.54000000  1  2  4   1.50407740
0   4.99999810   2.82999990  1  0  4   1.50407740
0   6.00000050   1.67999990  1  0  0  -0.69314720
0  12.00000000   3.54000000  0  0  3   1.25276290
0   0.00000000   1.76000000  1  0  2   0.91629080
0  10.99999710   3.15000010  1  3  1   0.40546510
0   3.00000000   2.51000000  1  0  0  -0.69314720
0  15.99999810   3.69000010  1  1  0  -0.69314720
0  10.99999710   1.76000000  1  1  4   1.50407740
0   4.99999810   1.86000000  1  1 12   2.52572870
0   0.99999990   2.76000000  1  3  0  -0.69314720
0  15.99999810   4.61999990  1  1  1   0.40546510
0  12.00000000   4.25000000  1  0  5   1.70474800
0  10.99999710   2.54000000  1  0  4   1.50407740
0   0.00000000   2.20000000  1  1  0  -0.69314720
0   0.00000000   1.76000000  1  0  2   0.91629080
0   3.00000000   2.85999990  1  3  3   1.25276290
0  13.00000000   3.40000010  1  2  0  -0.69314720
0  45.00000000   4.54000000  1  1  1   0.40546510
0  47.00000760   1.86000000  1  1  9   2.25129180
0   6.99999950   1.52000000  1  0  0  -0.69314720
0   6.99999950   2.55999990  1  1  2   0.91629080
0  19.00000190   2.21000000  1  0  0  -0.69314720
0   9.00000000   3.69000010  1  0  7   2.01490310
0  76.99998470   1.78000000  1  1  1   0.40546510
0   0.00000000   1.17999990  1  1  0  -0.69314720
0   3.99999900   2.00000000  1  0  1   0.40546510
0  19.00000190   2.21000000  1  0  0  -0.69314720
0  12.00000000   4.13999990  1  2  0  -0.69314720
0   0.99999990   2.85999990  1  3  0  -0.69314720
0  17.00000000   2.85999990  1  1  1   0.40546510
0   6.00000050   2.54000000  0  0  7   2.01490310
0   3.99999900   2.85999990  1  1  0  -0.69314720
0   6.00000050   2.52000000  0  0  4   1.50407740
0   3.00000000   1.52000000  1  1  2   0.91629080
0   4.99999810   3.08999990  1  1  3   1.25276290
0   3.00000000   1.17999990  1  1  0  -0.69314720
0   3.00000000   1.42000000  1  0  0  -0.69314720
0  15.00000100   4.61999990  0  0  7   2.01490310
0   0.00000000   2.96000000  1  2  1   0.40546510
0   9.99999900   4.54000000  0  0  2   0.91629080
```

0	41.99999620	4.54000000	0	0	7	2.01490310
0	3.00000000	2.51000000	1	2	1	0.40546510
0	6.99999950	3.15000010	1	1	2	0.91629080
0	0.00000000	2.50000000	1	0	1	0.40546510
0	6.00000050	2.96000000	1	3	1	0.40546510
0	3.99999900	1.67999990	1	0	0	-0.69314720
0	0.00000000	1.22000000	1	1	1	0.40546510
0	1.99999990	1.52000000	1	0	1	0.40546510
0	4.99999810	2.21000000	1	1	0	-0.69314720
0	0.99999990	3.92000010	1	1	0	-0.69314720
0	13.00000000	4.54000000	1	0	5	1.70474800
0	0.00000000	1.17999990	1	0	2	0.91629080
0	26.00000000	3.69000010	1	0	3	1.25276290
0	0.99999990	1.72000000	1	0	2	0.91629080
0	25.00000000	2.57999990	1	1	5	1.70474800
0	3.00000000	1.52000000	0	0	3	1.25276290
0	47.00000760	1.86000000	1	1	4	1.50407740
0	3.99999900	2.50000000	1	0	5	1.70474800
0	0.99999990	4.61999990	1	0	1	0.40546510
0	6.99999950	1.40000000	1	2	0	-0.69314720
0	4.99999810	4.54000000	1	0	3	1.25276290
0	26.99999810	1.67999990	1	1	0	-0.69314720
0	0.99999990	2.82999990	1	0	2	0.91629080
0	4.99999810	3.35999990	0	0	1	0.40546510
0	0.00000000	1.97000000	1	1	7	2.01490310
0	12.00000000	3.40000010	0	0	1	0.40546510
0	3.99999900	1.74000000	1	1	1	0.40546510
0	0.00000000	2.96000000	0	0	0	-0.69314720
0	25.00000000	2.57999990	1	1	4	1.50407740
0	3.00000000	4.54000000	1	1	1	0.40546510
0	1.99999990	3.15000010	1	1	0	-0.69314720
0	12.00000000	2.96000000	1	2	0	-0.69314720
0	15.99999810	3.54000000	1	2	2	0.91629080
0	4.99999810	2.96000000	1	1	3	1.25276290
0	12.00000000	4.25000000	1	0	1	0.40546510
0	4.99999810	2.55999990	1	1	2	0.91629080
0	4.99999810	1.86000000	1	0	1	0.40546510
0	3.00000000	4.61999990	1	1	1	0.40546510
0	3.99999900	2.85999990	0	0	2	0.91629080
0	4.99999810	3.15000010	1	1	5	1.70474800
0	0.00000000	2.51000000	1	0	2	0.91629080
0	26.99999810	3.15000010	1	1	5	1.70474800
0	4.99999810	2.51000000	1	0	2	0.91629080
0	0.00000000	1.52000000	1	1	0	-0.69314720
0	17.99999810	4.29000000	0	0	6	1.87180220
0	4.99999810	4.29000000	1	1	4	1.50407740
0	7.99999860	4.29000000	1	2	2	0.91629080
0	3.99999900	2.09999990	1	0	2	0.91629080
0	35.00000760	4.29000000	1	1	12	2.52572870
0	4.99999810	4.29000000	0	0	2	0.91629080
0	9.00000000	3.58999990	1	1	1	0.40546510
0	6.00000050	4.29000000	1	0	1	0.40546510
0	24.00000190	4.29000000	1	0	2	0.91629080
0	0.00000000	2.09999990	1	1	0	-0.69314720
0	4.99999810	1.80999990	1	1	0	-0.69314720
0	19.00000190	4.29000000	0	0	7	2.01490310

```
0   3.00000000   4.29000000  0  0  1   0.40546510
0   1.99999990   4.29000000  1  1  1   0.40546510
0   3.99999900   1.25000000  1  0  3   1.25276290
0   9.99999900   3.58999990  1  0  1   0.40546510
0   7.99999860   2.09999990  1  1  1   0.40546510
0   1.99999990   4.29000000  1  0  4   1.50407740
0  19.00000190   4.29000000  1  1  3   1.25276290
0   0.99999990   3.47000000  1  1  1   0.40546510
0   3.00000000   3.19000010  1  0  1   0.40546510
0   4.99999810   3.19000010  1  2  1   0.40546510
0   0.00000000   2.09999990  1  0  1   0.40546510
0  21.00000000   3.58999990  1  1  5   1.70474800
0  13.99999710   4.29000000  1  1  1   0.40546510
0   0.00000000   2.09999990  1  0  0  -0.69314720
0   6.99999950   2.76000000  1  1  1   0.40546510
0   4.99999810   2.60999990  1  0  3   1.25276290
0  22.00000000   4.29000000  1  0  4   1.50407740
0  19.99999620   3.41000010  0  0  7   2.01490310
0  38.00000380   4.29000000  1  0  3   1.25276290
0  19.00000190   4.29000000  0  0  4   1.50407740
0   3.00000000   2.26000000  0  0  2   0.91629080
0  15.99999810   3.58999990  0  0  3   1.25276290
0   1.99999990   4.29000000  1  1  0  -0.69314720
0   3.00000000   2.05000000  0  0  1   0.40546510
0  12.00000000   4.29000000  1  2  1   0.40546510
0  35.00000760   4.29000000  0  0  0  -0.69314720
0  19.00000190   4.29000000  1  0  0  -0.69314720
0   1.99999990   4.29000000  0  0  0  -0.69314720
0   6.99999950   2.76000000  0  0  1   0.40546510
0   3.99999900   2.09999990  1  2  3   1.25276290
0  13.99999710   2.35999990  0  0  1   0.40546510
0   9.00000000   4.29000000  0  0  0  -0.69314720
0   7.99999860   3.58999990  0  0  0  -0.69314720
0  12.00000000   4.29000000  1  1  2   0.91629080
0   3.00000000   4.29000000  1  1  0  -0.69314720
0   0.99999990   4.29000000  1  0  1   0.40546510
0   9.99999900   4.29000000  0  0  1   0.40546510
0  21.00000000   3.41000010  0  0  4   1.50407740
0  13.00000000   4.29000000  1  1  0  -0.69314720
0  17.00000000   4.29000000  1  0  2   0.91629080
0   4.99999810   4.29000000  0  0  0  -0.69314720
0   1.99999990   2.14000010  0  0  0  -0.69314720
0   7.99999860   4.29000000  1  0  0  -0.69314720
0   1.99999990   2.50000000  1  1  2   0.91629080
0   4.99999810   2.60999990  1  1  3   1.25276290
0   0.99999990   1.80999990  1  2  0  -0.69314720
0   1.99999990   2.26000000  1  1  0  -0.69314720
0   3.99999900   3.61999990  1  2  1   0.40546510
0   9.00000000   4.29000000  1  2  1   0.40546510
0   9.00000000   4.29000000  0  0  0  -0.69314720
0  17.00000000   4.29000000  0  0  2   0.91629080
0  24.00000190   4.29000000  1  2  0  -0.69314720
0   3.99999900   3.47000000  1  0  4   1.50407740
0  13.99999710   4.29000000  1  1  2   0.91629080
0   4.99999810   3.58999990  1  1  1   0.40546510
0   9.99999900   1.80999990  0  0  1   0.40546510
```

0	17.99999810	4.29000000	1	1	3	1.25276290
0	0.99999990	4.29000000	1	1	0	-0.69314720
0	0.00000000	2.09999990	1	0	1	0.40546510
0	3.99999900	2.15000010	1	2	0	-0.69314720
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	0.99999990	2.26000000	1	0	1	0.40546510
0	7.99999860	4.29000000	1	0	0	-0.69314720
0	13.00000000	4.29000000	1	2	0	-0.69314720
0	4.99999810	3.58999990	1	2	0	-0.69314720
0	6.99999950	3.41000010	1	2	0	-0.69314720
0	6.99999950	3.58999990	0	0	3	1.25276290
0	4.99999810	3.61999990	1	1	3	1.25276290
0	0.00000000	2.09999990	1	3	1	0.40546510
0	13.99999710	4.29000000	0	0	1	0.40546510
0	6.00000050	4.29000000	1	0	0	-0.69314720
0	4.99999810	2.26000000	1	1	1	0.40546510
0	7.99999860	2.76000000	1	0	3	1.25276290
0	3.99999900	2.60999990	1	1	1	0.40546510
0	9.00000000	4.29000000	0	0	2	0.91629080
0	3.00000000	2.09999990	1	1	2	0.91629080
0	1.99999990	3.47000000	1	1	0	-0.69314720
0	0.00000000	2.09999990	0	0	0	-0.69314720
0	10.99999710	4.29000000	0	0	1	0.40546510
0	9.00000000	4.29000000	0	0	1	0.40546510
0	7.99999860	2.96000000	1	0	1	0.40546510
0	1.99999990	2.96000000	1	0	2	0.91629080
0	17.99999810	4.61999990	1	0	3	1.25276290
0	3.00000000	1.42000000	1	0	3	1.25276290
0	1.99999990	4.54000000	1	0	1	0.40546510
0	6.99999950	2.52000000	1	0	0	-0.69314720
0	9.99999900	4.54000000	1	1	2	0.91629080
0	15.99999810	2.00000000	1	1	1	0.40546510
0	4.99999810	2.54000000	1	0	0	-0.69314720
0	0.00000000	2.50000000	1	0	2	0.91629080
0	7.99999860	4.54000000	0	0	0	-0.69314720
0	9.99999900	3.35999990	0	0	1	0.40546510
0	17.99999810	3.40000010	1	1	0	-0.69314720
0	12.00000000	1.67999990	1	1	1	0.40546510
0	9.00000000	2.00000000	0	0	1	0.40546510
0	39.00000000	2.85999990	1	0	1	0.40546510
0	17.99999810	4.61999990	1	0	1	0.40546510
0	15.00000100	4.13999990	1	0	1	0.40546510
0	15.99999810	4.13999990	1	0	2	0.91629080
0	1.99999990	2.96000000	0	0	0	-0.69314720
0	6.99999950	2.82999990	1	2	3	1.25276290
0	24.00000190	2.55000000	1	0	2	0.91629080
0	7.99999860	1.67999990	1	0	1	0.40546510
0	6.99999950	2.00000000	0	0	1	0.40546510
0	10.99999710	2.00000000	1	1	1	0.40546510
0	0.00000000	2.96000000	1	1	4	1.50407740
0	3.99999900	1.50500000	1	0	4	1.50407740
0	21.00000000	3.54000000	1	0	2	0.91629080
0	6.00000050	3.40000010	0	0	1	0.40546510
0	6.00000050	4.61999990	0	0	0	-0.69314720
0	7.99999860	2.82999990	0	0	3	1.25276290
0	3.99999900	2.54000000	1	0	1	0.40546510

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0  12.00000000   2.86999990  0  0  1   0.40546510
0  15.00000100   1.86000000  0  0  1   0.40546510
0   0.00000000   3.92000010  1  1  1   0.40546510
0   4.99999810   3.69000010  1  1  1   0.40546510
0  15.00000100   2.85999990  1  2  4   1.50407740
0   4.99999810   4.54000000  0  0  0  -0.69314720
0   7.99999860   4.61999990  0  0  0  -0.69314720
0  13.00000000   2.85999990  1  1  0  -0.69314720
0   1.99999990   3.40000010  0  0  1   0.40546510
0   6.00000050   2.57999990  1  2  4   1.50407740
0  19.99999620   4.25000000  1  0  3   1.25276290
0   6.99999950   1.76000000  1  1  2   0.91629080
0   6.99999950   2.85999990  1  3  0  -0.69314720
0  15.99999810   3.69000010  1  2  4   1.50407740
0  13.00000000   3.40000010  1  0  0  -0.69314720
0   0.00000000   3.40000010  1  2  0  -0.69314720
0   0.99999990   4.54000000  1  2  0  -0.69314720
0  12.00000000   2.86999990  0  0  3   1.25276290
0   6.99999950   1.76000000  1  0  4   1.50407740
0   3.99999900   4.25000000  0  0  1   0.40546510
0   0.00000000   3.92000010  0  0  3   1.25276290
0   3.99999900   3.35999990  1  0  2   0.91629080
0   3.99999900   2.31999990  1  0  1   0.40546510
0  36.99999240   4.54000000  0  0  2   0.91629080
0  22.99999620   3.35999990  1  1  0  -0.69314720
0   7.99999860   2.00000000  1  3  2   0.91629080
0   7.99999860   3.92000010  1  1  1   0.40546510
0   1.99999990   3.92000010  0  0  1   0.40546510
0   0.00000000   3.35999990  0  0  1   0.40546510
0   0.99999990   1.78000000  1  0  1   0.40546510
0  21.00000000   3.54000000  1  1  1   0.40546510
0   9.99999900   3.92000010  0  0  2   0.91629080
0   7.99999860   2.31999990  0  0  3   1.25276290
0  33.99999240   1.67999990  1  0  1   0.40546510
0  13.99999710   3.08999990  0  0  2   0.91629080
0   6.00000050   2.57999990  1  1  0  -0.69314720
0  13.99999710   3.40000010  0  0  6   1.87180220
0  12.00000000   2.86999990  0  0  3   1.25276290
0  17.99999810   4.61999990  0  0  4   1.50407740
0   3.00000000   2.96000000  1  3  0  -0.69314720
0   6.00000050   1.86000000  1  2  2   0.91629080
0   1.99999990   1.22000000  1  1  0  -0.69314720
0  10.99999710   2.51000000  1  2  6   1.87180220
0  10.99999710   2.51000000  1  0  8   2.14006610
0   4.99999810   3.69000010  1  0  2   0.91629080
0   7.99999860   2.96000000  1  0  3   1.25276290
0   3.99999900   1.78000000  1  0  1   0.40546510
0   0.99999990   1.22000000  1  1  1   0.40546510
0   7.99999860   2.85999990  1  0  0  -0.69314720
0  19.00000190   3.69000010  0  0  7   2.01490310
0   1.99999990   2.11999990  0  0  0  -0.69314720
0   9.99999900   2.52000000  1  1  2   0.91629080
0   3.99999900   2.31999990  1  0  1   0.40546510
0   3.00000000   4.61999990  1  0  2   0.91629080
0   1.99999990   3.54000000  1  2  4   1.50407740
0   0.99999990   2.50000000  1  0  0  -0.69314720
```

0	4.99999810	1.67999990	0	0	0	-0.69314720
0	1.99999990	3.40000010	1	1	1	0.40546510
0	4.99999810	3.92000010	0	0	0	-0.69314720
0	52.99998090	4.54000000	1	1	5	1.70474800
0	54.99998860	4.54000000	0	0	2	0.91629080
0	0.00000000	2.50000000	0	0	0	-0.69314720
0	10.99999710	4.54000000	1	0	2	0.91629080
0	25.00000000	3.54000000	0	0	3	1.25276290
0	4.99999810	1.52000000	1	0	2	0.91629080
0	1.99999990	3.92000010	1	2	0	-0.69314720
0	7.99999860	4.61999990	1	0	2	0.91629080
0	0.00000000	3.92000010	1	0	3	1.25276290
0	4.99999810	2.31999990	1	2	0	-0.69314720
0	7.99999860	2.96000000	1	2	2	0.91629080
0	6.99999950	2.85999990	1	2	1	0.40546510
0	13.99999710	1.95000000	1	1	3	1.25276290
0	1.99999990	3.92000010	1	2	1	0.40546510
0	4.99999810	2.86999990	0	0	1	0.40546510
0	24.00000190	3.69000010	1	0	3	1.25276290
0	3.00000000	3.69000010	1	0	0	-0.69314720
0	3.99999900	2.39000010	0	0	2	0.91629080
0	3.00000000	1.95000000	1	2	3	1.25276290
0	10.99999710	3.35999990	0	0	5	1.70474800
0	3.99999900	2.39000010	1	1	2	0.91629080
0	26.00000000	3.69000010	0	0	2	0.91629080
0	3.99999900	2.96000000	1	1	5	1.70474800
0	1.99999990	3.21000000	1	0	0	-0.69314720
0	0.00000000	2.11999990	1	2	0	-0.69314720
0	52.99998090	4.54000000	1	1	2	0.91629080
0	3.99999900	2.31999990	1	0	3	1.25276290
0	6.00000050	2.54000000	1	1	3	1.25276290
0	1.99999990	2.85999990	1	1	1	0.40546510
0	13.99999710	3.47000000	1	0	3	1.25276290
0	15.00000100	2.86999990	0	0	4	1.50407740
0	3.99999900	2.31999990	1	0	0	-0.69314720
0	15.00000100	1.86000000	1	2	4	1.50407740
0	3.99999900	1.95000000	1	0	2	0.91629080
0	1.99999990	2.31999990	1	2	0	-0.69314720
0	19.99999620	4.25000000	1	2	1	0.40546510
0	3.99999900	1.97000000	0	0	6	1.87180220
0	41.99999620	1.86000000	1	0	19	2.97041440
0	7.99999860	3.69000010	1	1	0	-0.69314720
0	3.00000000	4.54000000	1	1	0	-0.69314720
0	9.00000000	3.54000000	1	0	4	1.50407740
0	9.99999900	4.54000000	1	1	1	0.40546510
0	6.99999950	2.85999990	1	2	11	2.44234700
0	25.00000000	3.35999990	1	0	0	-0.69314720
0	3.00000000	2.85999990	0	0	0	-0.69314720
0	3.99999900	2.96000000	1	2	0	-0.69314720
0	22.00000000	2.55999990	1	2	1	0.40546510
0	7.99999860	1.63000000	1	0	2	0.91629080
0	13.99999710	2.96000000	0	0	0	-0.69314720
0	0.00000000	2.96000000	1	0	1	0.40546510
0	7.99999860	1.63000000	1	1	1	0.40546510
0	0.00000000	2.96000000	0	0	0	-0.69314720
0	21.00000000	2.96000000	1	2	2	0.91629080

0	6.99999950	2.96000000	1	0	1	0.40546510
0	30.99998860	4.54000000	1	2	3	1.25276290
0	1.99999990	4.54000000	1	2	2	0.91629080
0	9.99999900	2.15000010	0	0	1	0.40546510
0	6.00000050	4.54000000	1	1	2	0.91629080
0	12.00000000	2.21000000	1	2	2	0.91629080
0	0.99999990	2.21000000	1	1	0	-0.69314720
0	29.00000000	4.54000000	0	0	2	0.91629080
0	9.99999900	2.21000000	1	1	3	1.25276290
0	6.00000050	2.21000000	1	0	0	-0.69314720
0	36.99999240	4.54000000	1	0	3	1.25276290
0	4.99999810	4.54000000	0	0	4	1.50407740
1	9.00000000	2.11999990	0	0	0	-0.69314720
1	1.99999990	2.11999990	1	0	0	-0.69314720
1	1.99999990	2.11999990	1	0	2	0.91629080
1	3.00000000	2.11999990	1	0	3	1.25276290
1	9.00000000	2.11999990	1	1	1	0.40546510
1	10.99999710	2.39000010	0	0	3	1.25276290
1	4.99999810	2.57999990	0	0	2	0.91629080
1	6.99999950	3.19000010	1	0	4	1.50407740
1	4.99999810	3.75000000	0	0	0	-0.69314720
1	3.00000000	3.58999990	0	0	1	0.40546510
1	1.99999990	2.57999990	0	0	2	0.91629080
1	0.00000000	3.75000000	0	0	3	1.25276290
1	4.99999810	3.75000000	1	0	0	-0.69314720
1	0.99999990	3.75000000	0	0	0	-0.69314720
1	3.99999900	1.22000000	1	2	2	0.91629080
1	13.99999710	3.75000000	0	0	0	-0.69314720
1	6.99999950	3.75000000	1	0	0	-0.69314720
1	26.00000000	3.75000000	0	0	0	-0.69314720
1	7.99999860	3.75000000	0	0	2	0.91629080
1	3.00000000	3.75000000	0	0	4	1.50407740
1	6.00000050	3.75000000	0	0	0	-0.69314720
1	21.00000000	3.75000000	0	0	1	0.40546510
1	7.99999860	3.75000000	1	0	2	0.91629080
1	3.99999900	3.75000000	0	0	0	-0.69314720
1	6.99999950	3.75000000	1	1	1	0.40546510
1	0.00000000	3.75000000	1	0	2	0.91629080
1	0.00000000	2.54000000	1	1	0	-0.69314720
1	0.99999990	2.54000000	1	0	0	-0.69314720
1	3.99999900	2.76000000	0	0	0	-0.69314720
1	1.99999990	4.13999990	0	0	0	-0.69314720
1	3.99999900	0.92000000	0	0	1	0.40546510
1	0.00000000	1.00500000	0	0	0	-0.69314720
1	6.00000050	3.08999990	0	0	2	0.91629080
1	3.00000000	3.08999990	1	1	2	0.91629080
1	0.00000000	1.79000000	0	0	0	-0.69314720
1	3.00000000	1.40000000	0	0	1	0.40546510
1	3.00000000	1.40000000	0	0	4	1.50407740
1	0.00000000	1.40000000	1	0	2	0.91629080
1	0.00000000	1.40000000	0	0	2	0.91629080
1	13.99999710	1.40000000	0	0	0	-0.69314720
1	12.00000000	1.40000000	0	0	1	0.40546510
1	1.99999990	1.40000000	0	0	1	0.40546510
1	6.00000050	2.00000000	0	0	1	0.40546510
1	10.99999710	4.34000020	1	0	2	0.91629080

1	6.00000050	4.34000020	1	0	4	1.50407740
1	0.00000000	1.75000000	0	0	0	-0.69314720
1	36.00000000	2.09999990	1	0	6	1.87180220
1	7.99999860	2.09999990	0	0	1	0.40546510
1	1.99999990	2.09999990	0	0	0	-0.69314720
1	10.99999710	3.58999990	1	0	2	0.91629080
1	10.99999710	3.58999990	1	2	2	0.91629080
1	17.99999810	3.58999990	0	0	0	-0.69314720
1	3.99999900	3.58999990	0	0	0	-0.69314720
1	17.99999810	3.58999990	1	0	10	2.35137530
1	7.99999860	3.58999990	0	0	1	0.40546510
1	19.00000190	3.41000010	1	0	3	1.25276290
1	3.99999900	3.41000010	1	0	4	1.50407740
1	4.99999810	3.41000010	1	2	0	-0.69314720
1	6.99999950	3.40000010	0	0	1	0.40546510
1	3.99999900	3.40000010	1	1	2	0.91629080
1	4.99999810	3.40000010	1	0	4	1.50407740
1	13.99999710	3.40000010	1	0	1	0.40546510
1	3.99999900	3.40000010	1	0	0	-0.69314720
1	3.99999900	2.52000000	0	0	3	1.25276290
1	0.00000000	2.52000000	0	0	1	0.40546510
1	15.00000100	3.69000010	1	1	2	0.91629080
1	0.99999990	3.69000010	1	0	1	0.40546510
1	3.00000000	3.69000010	1	1	0	-0.69314720
1	17.99999810	3.69000010	0	0	1	0.40546510
1	15.00000100	2.86999990	0	0	0	-0.69314720
1	4.99999810	2.86999990	1	0	1	0.40546510
1	17.99999810	2.86999990	1	0	1	0.40546510
1	9.00000000	2.86999990	0	0	2	0.91629080
1	6.00000050	2.86999990	0	0	4	1.50407740
1	15.00000100	2.86999990	1	0	1	0.40546510
1	3.99999900	3.35999990	0	0	2	0.91629080
1	1.99999990	3.35999990	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	2	0.91629080
1	6.99999950	3.35999990	0	0	0	-0.69314720
1	15.99999810	4.54000000	1	0	4	1.50407740
1	48.00000000	4.54000000	1	2	2	0.91629080
1	15.00000100	4.54000000	1	0	5	1.70474800
1	36.99999240	4.54000000	0	0	1	0.40546510
1	9.99999900	4.54000000	1	0	2	0.91629080
1	13.00000000	4.54000000	0	0	2	0.91629080
1	6.00000050	4.54000000	1	2	0	-0.69314720
1	13.00000000	0.75500000	0	0	0	-0.69314720
1	6.99999950	4.54000000	1	1	2	0.91629080
1	9.00000000	4.54000000	1	0	2	0.91629080
1	4.99999810	4.54000000	0	0	2	0.91629080
1	15.00000100	4.54000000	0	0	6	1.87180220
1	3.00000000	4.54000000	0	0	3	1.25276290
1	13.99999710	4.54000000	0	0	0	-0.69314720
1	1.99999990	1.28000000	1	0	1	0.40546510
1	3.99999900	1.28000000	1	0	4	1.50407740
1	3.99999900	1.28000000	1	0	0	-0.69314720
1	0.00000000	2.50000000	1	1	0	-0.69314720
1	47.00000760	3.84999990	1	2	2	0.91629080
1	29.00000000	3.84999990	1	0	1	0.40546510
1	0.99999990	3.84999990	1	1	5	1.70474800

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1  17.99999810   3.84999990  0  0  1   0.40546510
1  13.00000000   2.05000000  0  0  1   0.40546510
1  17.00000000   2.05000000  0  0  1   0.40546510
1   1.99999990   2.05000000  0  0  2   0.91629080
1   3.99999900   1.78000000  1  0  4   1.50407740
1   0.99999990   1.17999990  1  0  1   0.40546510
1   3.00000000   1.52000000  1  0  0  -0.69314720
1   9.00000000   1.48000000  1  0  2   0.91629080
1  12.00000000   4.29000000  0  0  0  -0.69314720
1  17.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   4.29000000  0  0  3   1.25276290
1   1.99999990   3.08999990  1  0  2   0.91629080
1   0.00000000   3.08999990  0  0  2   0.91629080
1   3.00000000   3.61999990  0  0  5   1.70474800
1   6.99999950   3.61999990  0  0  0  -0.69314720
1   7.99999860   3.61999990  0  0  0  -0.69314720
1   0.00000000   4.29000000  0  0  0  -0.69314720
1   6.00000050   2.60999990  1  1  1   0.40546510
1   6.99999950   2.60999990  1  0  1   0.40546510
1   9.00000000   2.09999990  0  0  0  -0.69314720
1   7.99999860   2.96000000  1  0  2   0.91629080
1   9.99999900   2.39000010  0  0  0  -0.69314720
1   3.00000000   1.95000000  1  0  1   0.40546510
1  13.99999710   3.41000010  0  0  2   0.91629080
1   0.99999990   4.29000000  0  0  2   0.91629080
1  10.99999710   3.58999990  0  0  2   0.91629080
1   9.99999900   4.61999990  0  0  1   0.40546510
1   6.00000050   2.14000010  0  0  1   0.40546510
1  10.99999710   2.85999990  0  0  0  -0.69314720
1   4.99999810   3.47000000  0  0  2   0.91629080
1  13.99999710   4.61999990  1  1  3   1.25276290
1   9.00000000   3.19000010  1  3  1   0.40546510
1   0.99999990   2.51000000  0  0  1   0.40546510
1   0.00000000   2.11999990  0  0  0  -0.69314720
1   3.00000000   3.19000010  0  0  0  -0.69314720
1   3.99999900   1.74000000  1  1  2   0.91629080
1   0.00000000   1.25000000  1  0  0  -0.69314720
1   6.99999950   3.69000010  1  0  0  -0.69314720
1   4.99999810   3.21000000  0  0  0  -0.69314720
1  15.00000100   4.61999990  1  1  0  -0.69314720
1  24.00000190   2.85999990  1  0  5   1.70474800
1   9.00000000   2.39000010  1  1  1   0.40546510
1   0.00000000   1.17999990  1  0  3   1.25276290
1   6.99999950   3.35999990  0  0  2   0.91629080
1   7.99999860   1.97000000  0  0  2   0.91629080
1  22.00000000   1.64000000  1  0  1   0.40546510
1   6.99999950   3.92000010  1  0  2   0.91629080
1   6.00000050   3.31999990  0  0  6   1.87180220
1   6.00000050   2.57999990  0  0  5   1.70474800
1  22.99999620   4.54000000  0  0  2   0.91629080
1   1.99999990   2.39000010  1  0  0  -0.69314720
1   9.00000000   3.58999990  0  0  4   1.50407740
1   6.99999950   3.69000010  0  0  2   0.91629080
1   9.99999900   3.19000010  0  0  2   0.91629080
1   3.99999900   2.31999990  0  0  2   0.91629080
1  10.99999710   3.47000000  1  1  2   0.91629080
```

1	3.99999900	3.69000010	0	0	2	0.91629080
1	4.99999810	2.31999990	1	1	3	1.25276290
1	10.99999710	3.19000010	0	0	1	0.40546510
1	19.00000190	4.54000000	0	0	1	0.40546510
1	3.00000000	3.35999990	1	1	0	-0.69314720
1	4.99999810	2.57999990	1	0	2	0.91629080
1	6.99999950	3.21000000	1	1	2	0.91629080
1	3.00000000	1.40000000	0	0	1	0.40546510
1	9.99999900	2.50000000	0	0	4	1.50407740
1	0.00000000	3.19000010	1	2	0	-0.69314720
1	3.00000000	3.35999990	0	0	0	-0.69314720
1	9.00000000	3.15000010	0	0	6	1.87180220
1	6.99999950	1.45000000	1	0	2	0.91629080
1	6.99999950	2.85999990	1	2	1	0.40546510
1	48.99999240	4.61999990	1	1	3	1.25276290
1	1.99999990	3.69000010	1	0	0	-0.69314720
1	19.00000190	2.96000000	1	0	1	0.40546510
1	12.00000000	3.08999990	1	1	1	0.40546510
1	0.99999990	3.08999990	0	0	0	-0.69314720
1	12.00000000	4.61999990	0	0	2	0.91629080
1	13.00000000	2.85999990	1	0	0	-0.69314720
1	1.99999990	3.21000000	0	0	0	-0.69314720
1	3.00000000	2.82999990	1	0	2	0.91629080
1	22.00000000	4.29000000	0	0	1	0.40546510
1	35.00000760	4.29000000	0	0	0	-0.69314720
1	0.99999990	3.08999990	1	0	2	0.91629080
1	3.99999900	3.69000010	0	0	0	-0.69314720
1	0.99999990	1.79000000	1	0	0	-0.69314720
1	1.99999990	3.35999990	1	1	0	-0.69314720
1	13.99999710	2.57999990	1	0	4	1.50407740
1	24.00000190	3.75000000	0	0	1	0.40546510
1	4.99999810	3.19000010	0	0	2	0.91629080
1	0.99999990	2.09999990	0	0	0	-0.69314720
1	7.99999860	3.58999990	1	1	0	-0.69314720
1	0.99999990	3.92000010	0	0	0	-0.69314720
1	24.00000190	3.31999990	1	1	1	0.40546510
1	1.99999990	2.00000000	0	0	0	-0.69314720
1	1.99999990	3.47000000	1	0	0	-0.69314720
1	13.99999710	3.21000000	1	0	4	1.50407740
1	4.99999810	2.05000000	0	0	3	1.25276290
1	0.99999990	2.52000000	0	0	0	-0.69314720
1	6.99999950	3.15000010	1	0	0	-0.69314720
1	38.00000380	1.86000000	1	2	6	1.87180220
1	3.00000000	2.85999990	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	4	1.50407740
1	0.00000000	1.25500000	1	2	0	-0.69314720
1	19.00000190	3.21000000	1	0	5	1.70474800
1	4.99999810	2.31999990	1	1	1	0.40546510
1	3.00000000	3.19000010	0	0	4	1.50407740
1	1.99999990	3.19000010	1	0	1	0.40546510
1	10.99999710	3.35999990	1	0	3	1.25276290
1	13.99999710	3.54000000	1	1	1	0.40546510
1	6.00000050	1.86000000	1	0	0	-0.69314720
1	13.00000000	1.50500000	0	0	0	-0.69314720
1	6.99999950	2.39000010	1	0	1	0.40546510
1	10.99999710	4.29000000	1	1	2	0.91629080

```
1   9.00000000   2.00000000  1  1  0  -0.69314720
1   3.99999900   3.92000010  0  0  1   0.40546510
1   6.00000050   4.29000000  1  0  2   0.91629080
1   6.00000050   3.35999990  0  0  1   0.40546510
1  13.99999710   4.61999990  1  0  3   1.25276290
1   6.00000050   2.00000000  0  0  1   0.40546510
1   4.99999810   3.58999990  1  0  2   0.91629080
1   6.00000050   2.86999990  0  0  1   0.40546510
1   3.99999900   2.96000000  0  0  0  -0.69314720
1  10.99999710   3.47000000  1  0  0  -0.69314720
1   7.99999860   3.19000010  1  0  4   1.50407740
1   3.00000000   2.85999990  1  1  0  -0.69314720
1  15.99999810   2.52000000  1  0  2   0.91629080
1   6.00000050   4.29000000  0  0  1   0.40546510
1   0.00000000   1.25500000  0  0  1   0.40546510
1   1.99999990   1.83000000  1  0  0  -0.69314720
1  12.00000000   4.29000000  0  0  3   1.25276290
1   7.99999860   2.96000000  1  0  0  -0.69314720
1   0.99999990   2.31999990  1  0  1   0.40546510
1  10.99999710   1.22000000  1  1  0  -0.69314720
1  10.99999710   4.29000000  1  0  1   0.40546510
1   1.99999990   4.25000000  0  0  1   0.40546510
1  36.00000000   2.55000000  0  0  2   0.91629080
1  10.99999710   1.95000000  1  0  1   0.40546510
1   1.99999990   3.69000010  0  0  0  -0.69314720
1  25.00000000   4.29000000  0  0  1   0.40546510
1   4.99999810   3.19000010  1  0  2   0.91629080
1  12.00000000   3.54000000  1  1  4   1.50407740
1   4.99999810   3.54000000  1  0  4   1.50407740
1   7.99999860   3.54000000  1  1  0  -0.69314720
1   0.99999990   1.86000000  1  1  3   1.25276290
1   3.00000000   4.61999990  0  0  4   1.50407740
1  15.99999810   4.61999990  1  0  1   0.40546510
1   9.99999900   4.61999990  1  0  3   1.25276290
1  13.00000000   4.54000000  1  0  1   0.40546510
1   0.99999990   3.47000000  1  0  0  -0.69314720
1  15.99999810   2.85999990  0  0  0  -0.69314720
1   6.99999950   2.00000000  1  0  0  -0.69314720
1   1.99999990   2.00000000  0  0  0  -0.69314720
1   3.00000000   2.60999990  1  0  0  -0.69314720
1   6.00000050   2.05000000  0  0  0  -0.69314720
1   6.00000050   2.05000000  0  0  0  -0.69314720
1   4.99999810   3.54000000  0  0  0  -0.69314720
1   0.00000000   0.92000000  1  0  2   0.91629080
1   0.00000000   1.79000000  1  0  0  -0.69314720
1   6.00000050   2.00000000  1  0  0  -0.69314720
1   7.99999860   3.15000010  0  0  4   1.50407740
1  15.99999810   2.26000000  1  0  5   1.70474800
1   3.99999900   2.26000000  0  0  1   0.40546510
1   0.99999990   4.29000000  1  0  6   1.87180220
1  21.00000000   4.29000000  1  0  1   0.40546510
1   9.00000000   4.54000000  0  0  1   0.40546510
1   3.00000000   3.35999990  1  1  0  -0.69314720
1   1.99999990   2.52000000  0  0  0  -0.69314720
1   9.99999900   4.29000000  0  0  3   1.25276290
1   9.00000000   4.29000000  0  0  0  -0.69314720
```

1	12.00000000	4.54000000	0	0	2	0.91629080
1	0.00000000	2.50000000	0	0	0	-0.69314720
1	1.99999990	2.76000000	0	0	1	0.40546510
1	0.00000000	2.55000000	1	1	0	-0.69314720
1	0.00000000	4.61999990	1	0	0	-0.69314720
1	6.00000050	1.63000000	0	0	2	0.91629080
1	3.00000000	3.47000000	1	0	1	0.40546510
1	30.99998860	3.41000010	1	0	2	0.91629080
1	0.99999990	4.29000000	0	0	0	-0.69314720
1	6.99999950	2.96000000	1	0	0	-0.69314720
1	0.00000000	4.61999990	1	0	5	1.70474800
1	12.00000000	3.58999990	1	0	0	-0.69314720
1	12.00000000	3.69000010	1	0	3	1.25276290
1	1.99999990	4.54000000	1	0	1	0.40546510
1	10.99999710	3.33999990	0	0	4	1.50407740
1	1.99999990	2.51000000	1	1	4	1.50407740
1	3.99999900	3.15000010	1	0	3	1.25276290
1	3.00000000	3.19000010	1	0	1	0.40546510
1	17.99999810	3.19000010	0	0	1	0.40546510
1	1.99999990	3.84999990	0	0	1	0.40546510
1	3.99999900	3.33999990	1	1	2	0.91629080
1	15.00000100	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	0	0	2	0.91629080
1	21.00000000	4.29000000	0	0	2	0.91629080
1	3.99999900	4.29000000	1	1	0	-0.69314720
1	0.00000000	2.96000000	1	0	0	-0.69314720
1	0.99999990	1.78000000	1	0	0	-0.69314720
1	17.00000000	3.54000000	1	2	1	0.40546510
1	3.00000000	3.69000010	1	0	0	-0.69314720
1	1.99999990	3.35999990	0	0	3	1.25276290
1	1.99999990	3.54000000	1	0	0	-0.69314720
1	0.99999990	3.54000000	1	1	0	-0.69314720
1	3.00000000	1.22000000	1	1	3	1.25276290
1	3.99999900	3.35999990	0	0	1	0.40546510
1	1.99999990	2.21000000	0	0	1	0.40546510
1	3.99999900	2.25000000	0	0	1	0.40546510
1	17.00000000	4.61999990	1	1	2	0.91629080
1	4.99999810	3.58999990	1	0	1	0.40546510
1	0.99999990	4.29000000	1	0	0	-0.69314720
1	1.99999990	2.11999990	0	0	2	0.91629080
1	3.00000000	2.26000000	0	0	2	0.91629080
1	3.00000000	2.26000000	1	0	4	1.50407740
1	4.99999810	4.29000000	0	0	0	-0.69314720
1	3.00000000	3.58999990	1	1	3	1.25276290
1	13.00000000	4.29000000	1	2	1	0.40546510
1	1.99999990	2.00000000	0	0	1	0.40546510
1	0.00000000	1.97000000	1	2	0	-0.69314720
1	7.99999860	3.92000010	1	0	0	-0.69314720
1	39.00000000	2.85999990	0	0	4	1.50407740
1	26.00000000	2.82999990	0	0	2	0.91629080
1	3.00000000	3.35999990	1	1	3	1.25276290
1	22.99999620	2.55999990	0	0	4	1.50407740
1	7.99999860	1.63000000	0	0	1	0.40546510
1	22.00000000	4.61999990	0	0	3	1.25276290
1	4.99999810	4.61999990	0	0	1	0.40546510
1	21.00000000	4.29000000	1	0	3	1.25276290

```
1   6.00000050   4.29000000  1  1  0  -0.69314720
1   3.99999900   4.29000000  1  1  2   0.91629080
1  24.00000190   4.29000000  1  0  6   1.87180220
1   6.00000050   4.29000000  1  0  1   0.40546510
1  33.99999240   3.35999990  0  0  1   0.40546510
1   0.00000000   3.21000000  0  0  2   0.91629080
1   9.99999900   2.00000000  0  0  1   0.40546510
1   1.99999990   3.21000000  1  2  2   0.91629080
1   3.00000000   2.57999990  1  2  2   0.91629080
1   3.00000000   2.57999990  1  0  0  -0.69314720
1   0.99999990   2.82999990  0  0  0  -0.69314720
1   6.00000050   3.19000010  0  0  1   0.40546510
1   3.00000000   3.47000000  0  0  1   0.40546510
1  22.99999620   4.61999990  1  0  2   0.91629080
1  13.00000000   4.25000000  1  0  4   1.50407740
1   4.99999810   1.86000000  1  0  2   0.91629080
1   9.00000000   4.29000000  1  1  0  -0.69314720
1   9.00000000   3.35999990  0  0  0  -0.69314720
1   9.99999900   1.80000000  1  0  2   0.91629080
1   0.00000000   1.65500000  0  0  1   0.40546510
1   6.00000050   2.85999990  0  0  0  -0.69314720
1  13.99999710   4.61999990  0  0  2   0.91629080
1   3.00000000   4.29000000  0  0  0  -0.69314720
1   4.99999810   2.35999990  1  0  4   1.50407740
1  10.99999710   1.80999990  1  0  1   0.40546510
1  32.00001140   3.58999990  1  0  1   0.40546510
1   9.99999900   1.76000000  0  0  0  -0.69314720
1   4.99999810   2.00000000  1  0  1   0.40546510
1  13.99999710   3.58999990  0  0  5   1.70474800
1   6.00000050   2.26000000  1  0  3   1.25276290
1   3.99999900   2.26000000  0  0  1   0.40546510
1   3.99999900   1.76000000  1  1  1   0.40546510
1   0.99999990   3.58999990  1  0  1   0.40546510
1   0.99999990   3.58999990  1  0  0  -0.69314720
1   4.99999810   2.82999990  1  1  1   0.40546510
1   1.99999990   2.57999990  0  0  1   0.40546510
1  17.99999810   4.61999990  1  0  1   0.40546510
1  15.00000100   2.31999990  0  0  1   0.40546510
1   0.00000000   2.39000010  1  0  0  -0.69314720
1  22.00000000   2.96000000  1  0  3   1.25276290
1  10.99999710   2.11999990  0  0  0  -0.69314720
1  17.99999810   4.61999990  1  0  1   0.40546510
1   3.00000000   2.25000000  1  0  1   0.40546510
1   7.99999860   1.76000000  1  0  1   0.40546510
1  12.00000000   4.54000000  0  0  6   1.87180220
1   9.99999900   3.69000010  1  1  2   0.91629080
1   1.99999990   1.25000000  0  0  0  -0.69314720
1   4.99999810   1.25000000  1  0  1   0.40546510
1   3.99999900   3.19000010  1  0  0  -0.69314720
1   0.00000000   2.57999990  1  2  0  -0.69314720
1   6.99999950   2.00000000  1  1  2   0.91629080
1   0.99999990   2.76000000  0  0  0  -0.69314720
1   3.99999900   2.54000000  0  0  2   0.91629080
1   0.00000000   3.19000010  0  0  0  -0.69314720
1   9.00000000   3.08999990  1  2  1   0.40546510
1   3.99999900   3.19000010  0  0  2   0.91629080
```

```
1   0.00000000   3.08999990  0  0  0  -0.69314720
1   7.99999860   2.26000000  0  0  2   0.91629080
1   9.00000000   2.26000000  1  1  1   0.40546510
1   7.99999860   3.35999990  1  0  2   0.91629080
1   9.00000000   3.15000010  1  0  1   0.40546510
1   3.99999900   4.54000000  1  0  0  -0.69314720
1   0.00000000   3.58999990  1  0  2   0.91629080
1   3.00000000   3.47000000  1  0  1   0.40546510
1   1.99999990   2.85999990  1  1  1   0.40546510
1   6.00000050   2.26000000  1  0  0  -0.69314720
1   3.99999900   3.47000000  1  1  2   0.91629080
1   0.00000000   2.76000000  1  0  0  -0.69314720
1   1.99999990   3.58999990  1  2  0  -0.69314720
1  13.00000000   3.75000000  0  0  5   1.70474800
1   1.99999990   2.57999990  1  2  1   0.40546510
1   1.99999990   3.58999990  1  1  2   0.91629080
1  15.99999810   1.89000000  1  2  3   1.25276290
1   9.00000000   3.15000010  0  0  7   2.01490310
1  12.00000000   2.86999990  0  0  5   1.70474800
1   0.99999990   2.11999990  1  2  0  -0.69314720
1   3.99999900   4.61999990  1  0  1   0.40546510
1   0.00000000   2.39000010  0  0  0  -0.69314720
1  10.99999710   2.11999990  0  0  0  -0.69314720
1   4.99999810   1.80999990  1  0  0  -0.69314720
1   7.99999860   2.31999990  0  0  4   1.50407740
1  15.00000100   2.39000010  0  0  0  -0.69314720
1   6.00000050   3.75000000  1  0  3   1.25276290
1   0.00000000   2.00000000  0  0  0  -0.69314720
1  13.99999710   3.58999990  1  1  0  -0.69314720
1   4.99999810   4.29000000  0  0  2   0.91629080
1   0.00000000   2.57999990  1  0  0  -0.69314720
1   4.99999810   4.61999990  1  0  0  -0.69314720
1   3.00000000   1.50500000  0  0  0  -0.69314720
1   3.99999900   3.75000000  1  0  2   0.91629080
1   3.99999900   3.75000000  1  2  0  -0.69314720
1   0.00000000   1.75000000  1  0  1   0.40546510
1   0.00000000   2.11999990  1  0  1   0.40546510
1   4.99999810   3.75000000  0  0  2   0.91629080
1   0.00000000   0.75500000  0  0  0  -0.69314720
1   6.99999950   2.25000000  0  0  1   0.40546510
1   3.00000000   3.19000010  0  0  1   0.40546510
;
```

Click **Run** to create the Work.Long97Data table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Panel Data Models** to add the step to your flow.

3 Add the Work.Long97Data table to your flow. Connect the input port of the Panel Data Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Panel Data Models step, click the Panel Data Models node.

5 On the **Data** tab, assign columns to these roles:

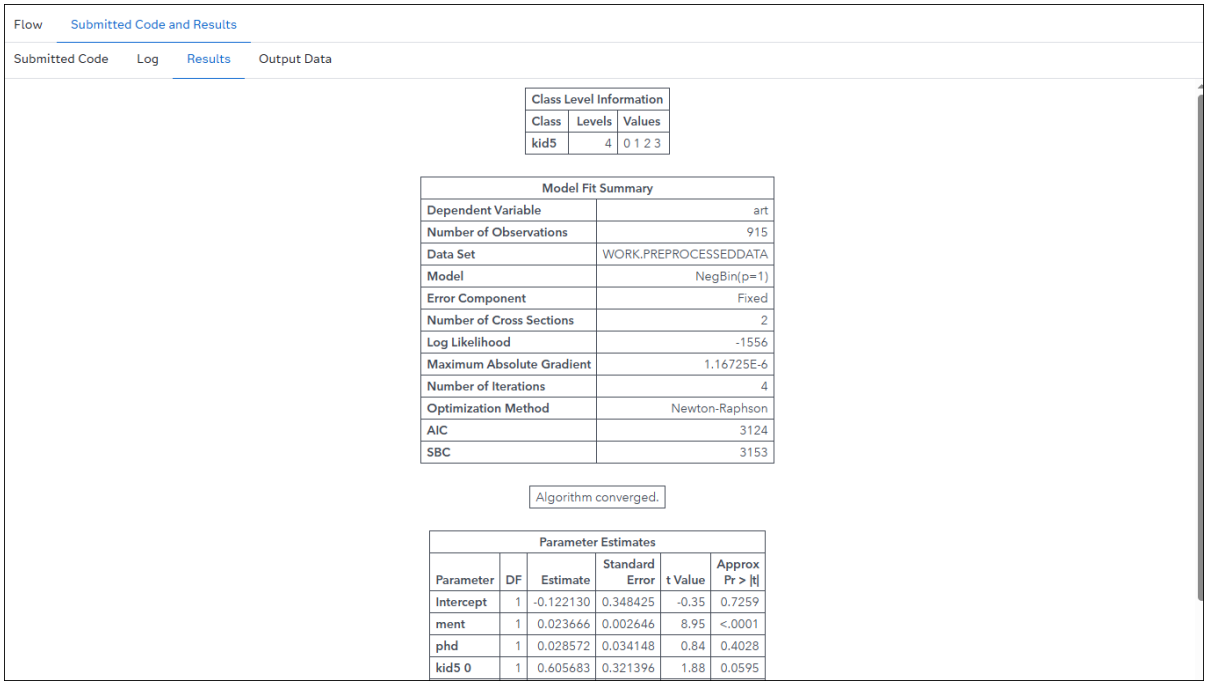
- To the **Cross-sectional ID** role, assign **fem**.

- To the **Dependent variable** role, assign **art**.
- To the **Continuous variables** role, assign **ment** and **phd**.
- To the **Categorical variables** role, assign **kid5**.

6 Click the **Model** tab. From the **Model type** drop-down list, select **Negative binomial**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Class Level Information		
Class	Levels	Values
kid5	4	0 1 2 3

Model Fit Summary	
Dependent Variable	art
Number of Observations	915
Data Set	WORK.PREPROCESSEDDATA
Model	NegBin(p=1)
Error Component	Fixed
Number of Cross Sections	2
Log Likelihood	-1556
Maximum Absolute Gradient	1.16725E-6
Number of Iterations	4
Optimization Method	Newton-Raphson
AIC	3124
SBC	3153

Algorithm converged.

Parameter Estimates					
Parameter	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-0.122130	0.348425	-0.35	0.7259
ment	1	0.023666	0.002646	8.95	<.0001
phd	1	0.028572	0.034148	0.84	0.4028
kid5 0	1	0.605683	0.321396	1.88	0.0595

Negative Binomial Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Cross-sectional ID**, assign the numeric variable that identifies the cross section for each observation. The step verifies that the input data is sorted by the cross-sectional ID.

4 To the **Time ID** role, assign a numeric variable that identifies the time period for each observation. For each cross section, the values of the time ID must be unique.

Note: For the negative binomial model, a time ID is not required and is ignored in the analysis.

5 To the **Dependent variable** role, assign the numeric variable that contains the count values. In the input table, this variable must contain only nonnegative integer values.

6 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

7 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

8 To the **Group analysis by** role, assign variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 From the **Model type** drop-down list, select **Negative binomial**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects using the continuous variables and categorical variables selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Specify the model type. You can choose from these options:

- **Fixed effect negative binomial with linear variance**
- **Random effect negative binomial with quadratic variance**

Step 3: Set the Options

On the **Options** tab, you can set these options.

The covariance matrix estimator is the inverse Hessian matrix.

If you are running the step using the SAS Compute Server, you can set these options.

1 Select the optimization method to use.

2 Specify the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.

3 Select the statistics to display in the results.

   Here are the available statistics:

   - correlations of the parameter estimates
   - covariances of the parameter estimates
   - iteration history of the objective function and parameter estimates

If you are running the step using the CAS server, you can also specify how to generate the code for the step. You can choose from these options:

- **Use Econometrics procedure**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, you can specify these options:

- an output data set that contains the default statistics from the analysis and any selected statistics, such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor
- parameter estimates table

Note: If you are running the step in a flow, you must add output ports for the output tables to the Panel Data Models node. For more information, see "Panel Data Models: Connection Requirements for the Node" on page 712.

Censored Regression

Example: Censored Regression

To create this example:

1 Enter this code on a **SAS Program** tab:

```
data cigar;
   input state year price pop pop_16 cpi ndi sales pimin;
   label
```

```
   state  = 'State abbreviation'
   year   = 'YEAR'
   price  = 'Price per pack of cigarettes'
   pop    = 'Population'
   pop_16 = 'Population above the age of 16'
   cpi    = 'Consumer price index with (1983=100)'
   ndi    = 'Per capita disposable income'
   sales  = 'Cigarette sales in packs per capita'
   pimin  = 'Minimum price in adjoining states per pack of cigarettes';
datalines;
1 63 28.6 3383 2236.5 30.6 1558.3045298 93.9 26.1
1 64 29.8 3431 2276.7 31.0 1684.0732025 95.4 27.5
1 65 29.8 3486 2327.5 31.5 1809.8418752 98.5 28.9
1 66 31.5 3524 2369.7 32.4 1915.1603572 96.4 29.5
1 67 31.6 3533 2393.7 33.4 2023.5463678 95.5 29.6
1 68 35.6 3522 2405.2 34.8 2202.4855362 88.4 32
1 69 36.6 3531 2411.9 36.7 2377.3346665 90.1 32.8
1 70 39.6 3444 2394.6 38.8 2591.0391591 89.8 34.3
1 71 42.7 3481 2443.5 40.5 2785.3159706 95.4 35.8
1 72 42.3 3511 2484.7 41.8 3034.8082969 101.1 37.4
1 73 42.1 3540 2526 44.4 3387.5740861 102.9 37.3
1 74 43.1 3574 2573.9 49.3 3718.8671751 108.2 41.4
1 75 46.6 3614 2623.7 53.8 4087.9931169 111.7 43
1 76 50.4 3657 2677.4 56.9 4486.7718352 116.2 46.4
1 77 50.1 3690 2719.6 60.6 4899.8656869 117.1 48.8
1 78 55.1 3728 2764.6 65.2 5450.9983257 123 53.6
1 79 56.8 3769 2810.7 72.6 5957.1405451 121.4 56.5
1 80 60.6 3894 2898.9 82.4 6466.350293 123.2 59.3
1 81 68.8 3917 2924.7 90.9 7042.0231606 119.6 62.6
1 82 73.1 3943 2953.5 96.5 7505.2199795 119.1 67.8
1 83 84.4 3959 2977.5 99.6 7974.5518556 116.3 78.6
1 84 90.8 3990 3009.1 103.9 8693.376058 113 86.8
1 85 99 4020 3039.8 107.6 9059.4344712 114.5 90.7
1 86 103 4050 3072.4 109.6 9674.9852107 116.3 98.8
1 87 110 4083 3104 113.6 10213.847735 114 103.5
1 88 114.4 4102 3124 118.3 10993 112.1 109.2
1 89 122.3 4118 3140 124 11634 105.6 121.5
1 90 139.1 4129.2 3148.6 130.7 12806 108.6 132.3
1 91 144.4 4178.3 3185.1 136.2 13360 107.9 137.4
1 92 172.2 4226.3 3226.7 140.3 14533 109.1 159.5
3 63 23.9 1517 982.4 30.6 1944.7450576 125 24.9
3 64 24 1549 1005.6 31 2063.5159984 121 25.5
3 65 24.2 1575 1024.9 31.5 2162.6639143 123.2 25.3
3 66 29.6 1609 1051.9 32.4 2318.6153235 113.9 25.5
3 67 29.2 1637 1078.9 33.4 2446.6813815 117.1 26
3 68 31.3 1667 1106 34.8 2720.3709408 115.6 32.3
3 69 36.1 1693 1117.5 36.7 2979.6014291 113.8 33.3
3 70 37.1 1772 1226.6 38.8 3269.8156411 115.2 34.6
3 71 38.5 1878 1313.5 40.5 3549.7019452 109.6 36.6
3 72 38 1975 1393.6 41.8 3800.6701072 125 37.2
3 73 38.7 2075 1476.5 44.4 4219.9831679 128.3 36.5
3 74 39.2 2156 1547 49.3 4508.1317983 133.1 37.8
3 75 47.7 2200 1591.4 53.8 4742.5753077 121.8 40.5
3 76 49.1 2244 1635.8 56.9 5158.789996 122.3 43.4
3 77 48.7 2304 1690.8 60.6 5567.7751489 121.7 44.7
3 78 53.6 2373 1750.6 65.2 6283.4991663 124.7 49.5
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3 79 58.6 2450 1812.4 72.6 7099.4038904 124.6 53.7
3 80 60.8 2718 2044 82.4 7823.3902342 126.8 57.2
3 81 63.3 2794 2103.8 90.9 8647.5572846 113.8 62.7
3 82 73.3 2860 2153.1 96.5 8879.9352124 113.5 68.1
3 83 80.5 2963 2231.2 99.6 9579.1345772 111.1 79.6
3 84 92.8 3053 2300.7 103.9 10549.95792 107.1 90.2
3 85 98.8 3161 2384.7 107.6 11256.38682 107.1 97.5
3 86 106.7 3279 2483.1 109.6 11796.536403 107.9 101.2
3 87 113.5 3386 2569 113.6 12367.66971 106.1 103.9
3 88 113.5 3489 2638 118.3 13008 102.2 113.7
3 89 125.6 3556 2672 124 13625 96.8 126.4
3 90 130.2 3598.2 2703.7 130.7 13826 88.9 133.6
3 91 151.4 3681.7 2759.1 136.2 14232 81.2 146.9
3 92 165.7 3762.2 2804.8 140.3 15179 79 165.4
4 63 27 1907 1296.7 30.6 1480.3334935 103.4 25.8
4 64 27.3 1939 1320.7 31 1610.0797693 102.6 25.7
4 65 27.2 1941 1323.6 31.5 1710.1989428 100.3 26.1
4 66 30.3 1963 1344.8 32.4 1883.8750601 98.9 26.2
4 67 30.4 1972 1357.3 33.4 2004.4267179 102.9 27.5
4 68 30.9 1983 1374.6 34.8 2143.3676117 104 29.2
4 69 30.9 1995 1389 36.7 2286.3950024 102.9 29.9
4 70 36.7 1923 1366.9 38.8 2493.7847189 100.3 34.3
4 71 38.8 1961 1405.4 40.5 2710.3690533 104.1 36.8
4 72 44.1 1999 1442.9 41.8 2950.4507448 103.9 37.4
4 73 45.1 2030 1474.6 44.4 3410.1816434 108 37.3
4 74 45.5 2063 1508.3 49.3 3807.5934647 109.7 38
4 75 48.6 2112 1552.5 53.8 4057.8913984 114.8 43
4 76 50.9 2113 1565.1 56.9 4362.3354157 119.1 44.7
4 77 52.6 2143 1596.8 60.6 4859.8664104 122.6 45.9
4 78 56.5 2167 1623.7 65.2 5467.7328208 127.3 49.9
4 79 58.4 2180 1641 72.6 6015.3234022 126.5 52.2
4 80 61.5 2286 1715.1 82.4 6278.9024507 131.8 57.3
4 81 64.7 2296 1725.7 90.9 7101.3099471 128.7 59.9
4 82 72.1 2291 1724.7 96.5 7390.4296012 127.4 64.7
4 83 82 2328 1757.4 99.6 7886.9389716 128 74.8
4 84 93.6 2349 1776.7 103.9 8546.9082172 123.1 84.8
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4 87 113 2388 1819 113.6 9886.2575685 122.3 103.5
4 88 119.9 2395 1823 118.3 10630 121.5 112.1
4 89 127.7 2406 1831 124 11243 118.3 118.9
4 90 141.2 2411.1 1834.9 130.7 12370 113.1 129.1
4 91 146.5 2432.7 1851.2 136.2 12917 116.8 132.5
4 92 177.3 2460.4 1876.7 140.3 13879 126 153.1
5 63 25.3 17556 12072 30.6 2776.0965615 142 23.9
5 64 25.5 18003 12384.3 31 2974.9294798 138.3 24
5 65 25.3 18403 12673.3 31.5 3107.8449633 140 24.2
5 66 25.5 18669 12898.5 32.4 3296.9523585 136.8 29.6
5 67 26 18992 13181.8 33.4 3462.2862526 135.8 29.2
5 68 35.4 19179 13370.3 34.8 3690.2957405 124.3 31.3
5 69 36.6 19443 13681.6 36.7 3919.3858421 123.9 33.3
5 70 38.8 19953 14317.6 38.8 4192.7811049 123 37.1
5 71 39.7 20266 14670.5 40.5 4414.3069107 121 38.5
5 72 39.9 20447 14938.3 41.8 4650.9613081 123.5 38
5 73 39.9 20670 15243.7 44.4 5103.7384429 124.4 38.7
5 74 41.9 20915 15566.6 49.3 5607.304421 126.7 39.2
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5 78 58.7 22314 17117.2 65.2 8021.3953973 126.1 53.6
5 79 60.1 22694 17481.6 72.6 8957.2068501 121.9 57.1
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5 81 66.4 24196 18670.6 90.9 10816.943005 118.6 63.3
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5 88 117.4 28314 21591 118.3 16059 90.1 113.5
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7 71 45.5 3063 2201.4 40.5 4715.6033153 117.6 40.2
7 72 51.3 3074 2234.2 41.8 4948.8689206 110.8 41.6
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7 77 58.4 3107 2384.5 60.6 7505.1603479 117.3 52.3
7 78 61.7 3116 2415.3 65.2 8309.8196838 117.5 56.3
7 79 64.4 3115 2435.5 72.6 9295.3133651 117.4 58.7
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7 81 80.1 3134 2461.5 90.9 11470.675639 116.4 64.5
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7 83 95.6 3138 2487.6 99.6 13485.534055 114.1 83.1
7 84 113.5 3154 2505.9 103.9 14927.928716 112.5 94.8
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7 88 129.7 3233 2568 118.3 19559 104.8 121.5
7 89 142 3239 2564 124 20687 100.6 134.8
7 90 171.2 3242.9 2567.1 130.7 21447 91.5 150.9
7 91 169.5 3246.9 2555.4 136.2 21967 86.7 163.3
7 92 193.5 3237 2536.7 140.3 22891 83.6 175.9
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8 68 32 533 359 34.8 3061.3641084 164.8 30.9
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8 70 39 584 378.2 38.8 3495.160642 155 32.6
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8 75 45.9 579 424.3 53.8 5112.1253035 147.6 39.5
8 76 50.1 582 431 56.9 5440.0945508 153 46.1
8 77 51.7 582 434.8 60.6 5850.0561101 153.3 49.2
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9 68 26.7 802 554.4 34.8 3752.5382418 224.3 27.1
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9 70 28.5 756 563.1 38.8 4202.2963957 200.4 28.8
9 71 32.6 750 560.2 40.5 4600.563546 213 30.2
9 72 33.7 744 558.3 41.8 4964.1530816 220.6 29.9
9 73 34.5 734 553.4 44.4 5310.9292283 209.4 30.1
9 74 36 721 547.6 49.3 5894.1436568 182.7 31.3
9 75 39.4 711 543.7 53.8 6587.6959502 176.5 33.6
9 76 47.8 697 536.9 56.9 7003.8273262 167.7 37.9
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9 81 69 631 512.7 90.9 11612.797567 131.9 51.8
9 82 74.8 631 512.7 96.5 12167.639401 132 56.4
9 83 86.3 623 505.9 99.6 13222.679557 124.5 68.8
9 84 98.5 623 505.9 103.9 14479.480379 124.6 76
9 85 100.4 623 502.9 107.6 15439.945222 122.1 83.6
9 86 109.3 625 502.9 109.6 15675.332667 117.2 91.3
9 87 112.5 622 501 113.6 16632.644999 113 94.6
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10 63 26.3 5532 3996.8 30.6 1980.6867784 137.5 26.9
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10 72 46.8 7407 5754.6 41.8 3978.2304655 126 40.9
10 73 47.4 7757 6073.1 44.4 4483.9377281 132.6 42.1
10 74 48.1 8087 6387.5 49.3 4813.7010056 136 42.4
10 75 51.7 8253 6572.3 53.8 5129.7680447 131.9 44.5
10 76 55.9 8348 6705.9 56.9 5436.3530726 130.3 47.9
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10 78 66.3 8661 7051.4 65.2 6677.4429795 133.4 54.7
10 79 66.5 8860 7251.3 72.6 7425.4683054 135.4 56.6
10 80 69.8 9749 8052.9 82.4 8227.2250279 139 59.3
10 81 72.8 10183 8426.6 90.9 9132.2303166 132.8 62.6
10 82 79 10416 8626.4 96.5 9545.224581 131.8 67.8
10 83 90.5 10680 8855.5 99.6 10352.249088 127.6 78.9
10 84 99.3 10976 9113.6 103.9 11091.845959 124.7 86.8
10 85 104.2 11053 9113.6 107.6 11764.015196 124.2 90.7
10 86 113.8 11373 9384.8 109.6 12378.238808 124.7 100.1
10 87 120.8 12023 9649 113.6 13193.691769 125.1 103.9
10 88 130.5 12335 9870 118.3 14144 119.5 109.2
10 89 139.8 12671 10113 124 15049 113.8 122.3
10 90 150.1 12971.8 10353.1 130.7 15859 110.1 132.3
10 91 174.8 13311.7 10561.6 136.2 16254 98.2 138.2
10 92 187 13523.2 10664.3 140.3 17246 95.9 159.5
11 63 26.9 4206 2768.4 30.6 1743.9394545 108.3 26.1
11 64 27.5 4304 2840 31 1865.9221787 107.6 26.5
11 65 30.9 4391 2903.9 31.5 2024.0862193 103.5 26.2
11 66 30.6 4462 2965 32.4 2193.6215308 104.8 26.2
11 67 31.5 4490 2996.5 33.4 2366.2580981 106.7 27.3
11 68 33.3 4579 3077.6 34.8 2530.6246501 105 29.5
11 69 34.2 4641 3113.9 36.7 2730.1387667 108.6 29
11 70 34.3 4589 3159.7 38.8 2955.4966808 109.9 32.5
11 71 35.8 4679 3243.7 40.5 3189.1246101 115.7 34.3
11 72 40.9 4751 3314.3 41.8 3467.2038711 117 34.1
11 73 42.4 4826 3392.5 44.4 3885.8733904 119.8 33.5
11 74 42.4 4888 3463.1 49.3 4188.762697 123.7 35.2
11 75 44.5 4926 3519.4 53.8 4493.7195073 122.9 38.1
11 76 47.9 4968 3581.5 56.9 4872.0727026 125.9 41
11 77 49.5 5027 3652.1 60.6 5279.370951 127.9 42.2
11 78 54.7 5075 3711.3 65.2 5893.4195793 130.6 49.2
11 79 56.6 5117 3764.7 72.6 6422.7005519 131 50.2
11 80 59.3 5464 4036.7 82.4 7014.0066384 134 52.3
11 81 62.6 5574 4133.1 90.9 7744.8692314 131.7 54.7
11 82 67.8 5639 4197 96.5 8357.8841078 131.2 61.9
11 83 78.9 5732 4283.8 99.6 9010.1815564 128.6 72.4
11 84 86.8 5837 4382.1 103.9 9955.0307926 126.3 81.3
11 85 90.7 5973 4486.1 107.6 10577.349436 128.8 83
11 86 100.1 6100 4595.9 109.6 11423.992242 129 88.7
11 87 103.9 6222 4698 113.6 12115.572263 129.3 95.3
11 88 109.2 6342 4778 118.3 12925 124.1 99.9
11 89 122.4 6436 4842 124 13464 117.1 111.9
11 90 132.3 6503.3 4892.6 130.7 14354 113.8 125.2
11 91 138.2 6648.8 4987.7 136.2 14694 109.6 129
11 92 159.5 6777.3 5088.7 140.3 15943 109.2 151.9
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46 70 37.7 444 311 38.8 3393.2082253 122.6 31.4
46 71 39.5 453 319.7 40.5 3668.7929843 124.4 34.1
46 72 40 460 327.4 41.8 3778.8000691 138 36.1
46 73 39.8 464 333.2 44.4 4167.7941939 146.8 36.9
46 74 41.3 468 339 49.3 4485.3404182 151.8 37.9
46 75 41.8 473 346.8 53.8 4816.4957664 155.5 40.8
46 76 47.1 477 353.5 56.9 5304.1560394 171.1 43.9
46 77 47 483 360.3 60.6 5630.775013 169.4 45
46 78 52.5 487 367 65.2 6338.4494557 162.4 49.7
46 79 54.8 493 373.8 72.6 6920.2395023 160.9 53.2
46 80 58.9 511 390.2 82.4 7519.0409539 161.6 55.3
46 81 61 516 395.1 90.9 8392.2930707 163.8 58.4
46 82 66.8 516 396 96.5 9596.7005357 162.3 67
46 83 77 525 404.7 99.6 9335.8589943 153.8 74.7
46 84 90.6 530 407.6 103.9 10134.26093 144.3 90.5
```

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46 85 95.5 535 413.4 107.6 10719.453257 144.5 89.2
46 86 104.9 541 419.2 109.6 11288.768274 131.2 100
46 87 113.8 548 425 113.6 12070.158804 128.3 102
46 88 123.7 557 433 118.3 13126 128.7 113.5
46 89 129.7 567 441 124 13945 120.9 125.9
46 90 143.7 572.1 445 130.7 14896 124.3 135.9
46 91 150.1 576.1 447 136.2 15121 120.9 153.9
46 92 168 579.2 452.1 140.3 16640 126.5 164.4
47 63 24.7 4288 2899.7 30.6 1936.0331153 122.8 23.4
47 64 25.2 4371 2962.3 31 2134.439961 118.5 23.9
47 65 25.1 4420 3001.8 31.5 2267.0592737 123.3 24.1
47 66 24.7 4481 3056.7 32.4 2404.8998191 120.2 24.1
47 67 26.3 4541 3119.3 33.4 2580.3332406 120.9 25
47 68 27.1 4604 3182 34.8 2794.4037846 122.8 26.3
47 69 28.3 4669 3251.3 36.7 3024.138027 123.9 27
47 70 28.8 4648 3292.8 38.8 3284.1554195 124.3 28.3
47 71 30.2 4736 3383.3 40.5 3562.96925 128.4 30.1
47 72 29.9 4799 3456.5 41.8 3840.738834 137 30.6
47 73 30.1 4865 3538.4 44.4 4290.8090998 143.1 30.6
47 74 31.3 4924 3616.4 49.3 4677.1803256 149.6 31.5
47 75 33.6 4989 3701.2 53.8 5154.4010018 152.7 33.3
47 76 37.9 5052 3784.1 56.9 5570.0111312 158.1 36
47 77 38.4 5112 3865 60.6 6093.1786559 157.7 36.9
47 78 42.8 5177 3566.3 65.2 6684.2222068 155.9 41.4
47 79 45.8 5197 3993.1 72.6 7396.3983581 151.8 43.4
47 80 48.5 5346 4100 82.4 8230.7513566 148.9 46.3
47 81 51.8 5430 4187.7 90.9 9028.5557256 149.9 49.4
47 82 56.4 5491 4247.4 96.5 9754.3070822 147.4 56.3
47 83 68.8 5550 4310.1 99.6 10561.50967 144.7 66.4
47 84 76 5636 4391 103.9 11529.526228 136.8 75.4
47 85 83.6 5701 4453.6 107.6 12246.923612 134.6 79.3
47 86 91.3 5795 4540.3 109.6 13127.223459 135.8 85.4
47 87 94.6 5904 4627 113.6 13942.780019 133 90.5
47 88 102.1 6015 4725 118.3 15010 129.5 94.4
47 89 109.4 6098 4782 124 15936 122.5 103.8
47 90 128.6 6164.8 4834.4 130.7 16698 118.9 115.6
47 91 136.5 6263.4 4898.2 136.2 17038 109.1 120.5
47 92 157.9 6354.1 4965.1 140.3 18010 108.2 135.8
48 63 30.1 2961 2030.7 30.6 2409.3326822 99.1 28
48 64 29.9 2971 2045.2 31 2569.1936184 95.4 29.4
48 65 30 2973 2057.8 31.5 2764.3485276 98.3 29.1
48 66 34.7 3074 2140 32.4 3003.101874 86.9 29.8
48 67 35 3208 2250.3 33.4 3143.2397077 99.7 30.1
48 68 37.1 3296 2333.5 34.8 3363.3080096 101.5 32
48 69 37.6 3402 2421.5 36.7 3529.397294 100.2 31.9
48 70 38.7 3409 2438 38.8 3664.3448376 96.7 33.8
48 71 40.3 3433 2477.6 40.5 3829.396064 97 33.6
48 72 46.1 3423 2489.2 41.8 4072.3016424 88.5 33.7
48 73 45.9 3443 2528.9 44.4 4593.4067723 91 36.3
48 74 46.9 3503 2597.6 49.3 5079.2179292 98.6 38
48 75 49 3563 2667.3 53.8 5631.4647999 99.5 40.3
48 76 53 3623 2735 56.9 6166.0646842 100.3 42.5
48 77 53.7 3693 2806.6 60.6 6674.7131177 99.3 45.6
48 78 58.6 3793 2899.4 65.2 7521.7684683 101.3 51.5
48 79 61.6 3926 3014.6 72.6 8311.7306273 101.4 55.4
48 80 63.8 4132 3165.5 82.4 9105.8450185 101.4 56.4
```

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48 81 66.6 4217 3233.2 90.9 9940.4436727 112.7 59.2
48 82 80.3 4245 3252.6 96.5 10492.690543 106.6 67.6
48 83 93.1 4300 3299 99.6 11018.985963 102.4 76.5
48 84 105.9 4349 3345.4 103.9 11805.833948 96.2 88.5
48 85 114.4 4406 3394.8 107.6 12336.2816 96.5 97.6
48 86 125.7 4463 3450.9 109.6 12946.659721 94.2 99.9
48 87 134.2 4538 3507 113.6 13522.781926 91.3 107.1
48 88 141.4 4648 3591 118.3 14347 88.2 121.9
48 89 150.6 4761 3669 124 15438 86.1 133.6
48 90 167.5 4882.4 3762.5 130.7 16252 83.4 141.3
48 91 177.4 5033.9 3866.5 136.2 16967 78.7 144.4
48 92 199.2 5152.2 3950.2 140.3 18038 81.1 167.2
49 63 27.7 1815 1247 30.6 1598.0632813 111.8 24.1
49 64 28 1823 1260.4 31 1721.5317383 109 25
49 65 28.2 1815 1264.3 31.5 1855.0382813 110.5 24.5
49 66 28.4 1815 1275.8 32.4 1962.4458008 111.2 24.7
49 67 29.5 1807 1280.6 33.4 2097.9599609 113.6 25
49 68 31.3 1819 1301.8 34.8 2202.3560547 119.8 26.3
49 69 32.1 1819 1310.4 36.7 2358.9501953 112.1 27
49 70 33.7 1744 1255.6 38.8 2659.0889648 114.5 28.3
49 71 41.6 1761 1277.7 40.5 2868.8849609 111.5 30.1
49 72 41.3 1781 1300.8 41.8 3118.8333008 117.5 29.9
49 73 39.9 1782 1310.4 44.4 3424.9949219 116.6 30.1
49 74 42 1784 1320 49.3 3815.4764648 119.9 31.3
49 75 45.2 1803 1340.2 53.8 4251.1293945 123.2 33.3
49 76 48.4 1833 1369.1 56.9 4646.6299805 129.7 36
49 77 48.9 1853 1389.2 60.6 5074.2524414 133.9 36.9
49 78 53.9 1861 1399.8 65.2 5525.9663086 131.6 41.4
49 79 62.4 1878 1416.2 72.6 6080.0686523 122.1 43.4
49 80 64.3 1950 1467.1 82.4 6593.0148437 122.3 46.3
49 81 66.2 1952 1471.9 90.9 7108.9724609 120.5 49.4
49 82 75.1 1948 1473.8 96.5 7632.9605469 119.8 56.3
49 83 88.2 1965 1490.2 99.6 7830.7108398 115.7 66.4
49 84 97.2 1952 1487.3 103.9 8338.6379883 111.9 75.4
49 85 103.2 1936 1484.4 107.6 8780.3137695 109.1 79.3
49 86 104.1 1917 1477.7 109.6 9173.8067383 112.1 85.4
49 87 112.8 1897 1470 113.6 9599.421582 107.5 90.5
49 88 122.2 1876 1460 118.3 10279 109.1 94.4
49 89 131.2 1857 1452 124 10901 104 103.8
49 90 142.9 1842.6 1440.8 130.7 11946 104.1 115.6
49 91 144.1 1850.8 1454.1 136.2 12381 100.1 120.5
49 92 158.2 1862.1 1465.4 140.3 13526 98 135.8
50 63 27.6 4059 2702.5 30.6 2146.2878788 110.4 25.4
50 64 29.5 4100 2735.1 31 2307.5212121 106.2 25.6
50 65 29.8 4140 2773.5 31.5 2456.1909091 109.4 26.2
50 66 32.1 4178 2812.8 32.4 2633.1287879 106.3 30
50 67 32.8 4194 2841.6 33.4 2726.3090909 108.3 30.1
50 68 33.6 4211 2878 34.8 2939.8909091 111.4 32.7
50 69 33.6 4233 2898.1 36.7 3109.5 111.5 32.8
50 70 38.5 4417 3059.2 38.8 3339.8333333 106.4 37.7
50 71 40.2 4466 3129.2 40.5 3582.730303 105.4 38.5
50 72 40.3 4510 3197.2 41.8 3814.1106061 108.8 41.9
50 73 42.6 4537 3253.8 44.4 4269.5424242 109.5 41
50 74 43.9 4563 3310.4 49.3 4634.9348485 111.8 41.9
50 75 46.6 4601 3377.5 53.8 5039.0651515 113.5 45.2
50 76 51.3 4623 3430.2 56.9 5487.1681818 115.4 47.8
```

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50 77 52.1 4658 3489.6 60.6 6063.0015152 117.2 49.4
50 78 57.1 4683 3537.6 65.2 6728.8742424 116.7 54.6
50 79 58.7 4720 3590.3 72.6 7622.9863636 117.1 56.4
50 80 61.2 4705 3551 82.4 8173.6924242 117.6 58.8
50 81 64.9 4742 3592.2 90.9 8663.6742424 119.9 61.4
50 82 75 4765 3617.1 96.5 9196.5818182 115.6 69.6
50 83 92 4751 3616.2 99.6 9815.3409091 106.3 80.8
50 84 100.8 4766 3639.2 103.9 10641.4 105.6 89.6
50 85 106.8 4775 3657.4 107.6 11228.75 107 96.7
50 86 110.8 4783 3670.8 109.6 11763.751515 105.4 104.8
50 87 116.3 4807 3690 113.6 12336.443939 106 116.2
50 88 128.6 4855 3728 118.3 13129 102.6 124.1
50 89 138.3 4867 3745 124 13933 100.3 132.7
50 90 151.1 4902.1 3772 130.7 14958 94.1 147.3
50 91 158.6 4965.2 3817.4 136.2 15438 95.5 154.4
50 92 176.5 5017.3 3853.8 140.3 16351 96.2 178.5
51 63 26.2 335 221.9 30.6 2212.8687965 125.6 24.9
51 64 26.2 338 224.8 31 2323.4089278 134 27.5
51 65 26.1 330 220 31.5 2468.0408753 137.6 27.6
51 66 26.5 320 215.2 32.4 2593.0442013 133.3 29.6
51 67 27.4 319 216.1 33.4 2775.9003063 137.4 30.1
51 68 32.5 322 221.9 34.8 2921.5653392 136.5 32
51 69 32.6 320 228.7 36.7 3066.1972867 135.7 31.9
51 70 34.1 332 231.6 38.8 3269.7150985 132.2 33.8
51 71 34.4 339 240.3 40.5 3514.5563239 131.7 33.6
51 72 34.4 345 247 41.8 3975.3123851 140 33.7
51 73 34.4 351 253.8 44.4 4505.2851641 141.2 36.3
51 74 35.8 362 263.4 49.3 4980.5044201 145.8 37.8
51 75 38.6 377 276 53.8 5455.7236761 160.7 40.3
51 76 42.6 392 288.5 56.9 5985.6964551 161.5 42.5
51 77 43.4 407 300.1 60.6 6640.6725602 160.4 44.7
51 78 49.8 425 314.5 65.2 7609.7066083 160.3 49.5
51 79 51.7 450 332.9 72.6 8482.6637199 168.6 53.7
51 80 55.3 470 343.5 82.4 9402.1096718 158.1 56.4
51 81 55.9 492 358 90.9 10046.754923 163.1 59.2
51 82 64.3 502 364.7 96.5 10180.022932 157.7 65.7
51 83 71 514 371.5 99.6 9855.6341357 141.2 76.5
51 84 81.7 511 370.5 103.9 10382.507659 128.9 88.5
51 85 87.4 510 369.5 107.6 10839.131379 125.7 92.3
51 86 97.8 507 368.6 109.6 11089.138031 124.8 99.9
51 87 102.7 490 357 113.6 11113.932079 110.4 106.2
51 88 112.9 479 353 118.3 11803 114.3 115.3
51 89 118.6 475 352 124 12399 111.4 123
51 90 129.5 470.9 348.9 130.7 13871 96.9 138.9
51 91 127 477.1 355.2 136.2 14675 109.1 143.6
51 92 155.1 483.3 360.5 140.3 15607 110.8 160
;
```

Click **Run** to create the Work.Cigar table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Panel Data Models** to add the step to your flow.

3 Add the Work.Cigar table to your flow. Connect the input port of the Panel Data Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Panel Data Models step, click the Panel Data Models node.

5 On the **Data** tab, assign columns to these roles:

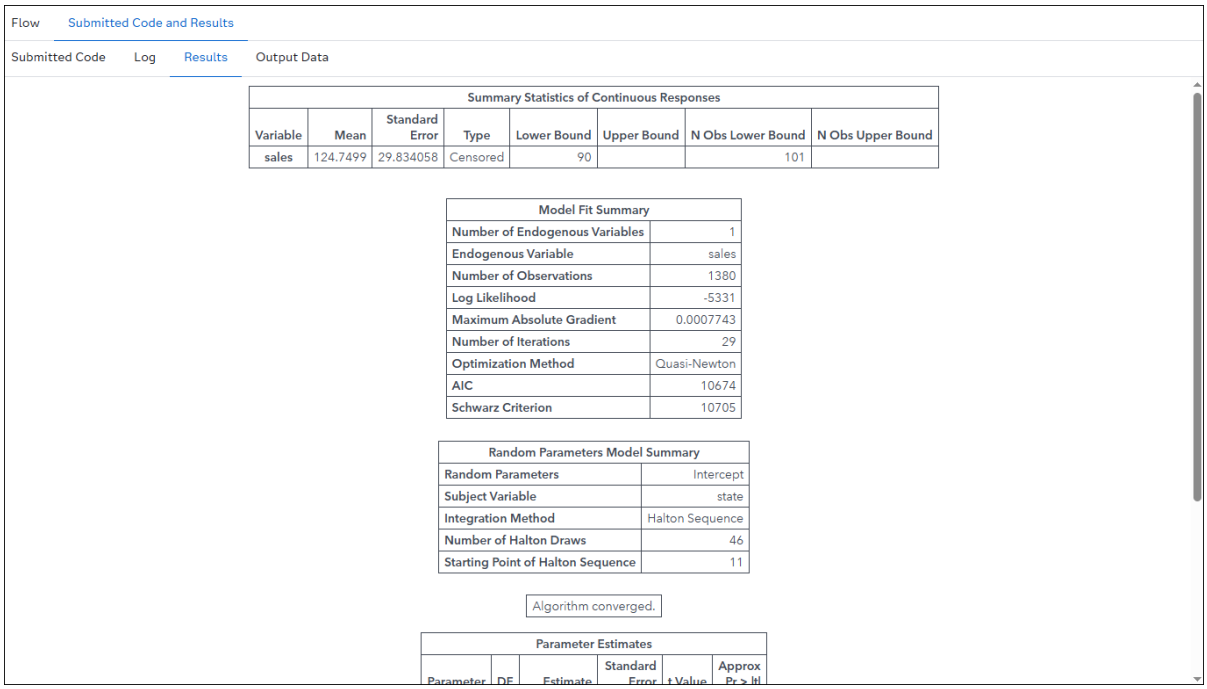
- To the **Cross-sectional ID** role, assign **state**.
- To the **Dependent variable** role, assign **sales**.
- To the **Continuous variables** role, assign **price**, **cpi**, and **ndi**.

6 Click the **Model** tab. From the **Model type** drop-down list, select **Censored regression**.

7 Select the **Set the lower bound** check box. From the **Lower bound method** drop-down list, select **Specify by value**. In the **Lower bound value** box, enter `90`.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Censored Regression: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the SAS Compute Server for this step.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Cross-sectional ID**, assign the numeric variable that identifies the cross section for each observation. The step verifies that the input data is sorted by the cross-sectional ID.

Note: For the censored regression model, character variables are not supported.

4 To the **Time ID** role, assign a numeric variable that identifies the time period for each observation. For each cross section, the values of the time ID must be unique.

Note: For the censored regression model, a time ID is not required and is ignored in the analysis.

5 To the **Dependent variable** role, assign the numeric variable for the analysis.

6 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

7 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

8 To the **Group analysis by** role, assign variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 From the **Model type** drop-down list, select **Censored regression**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects using the continuous variables and categorical variables selected on the **Data** tab.

Note: Random effects are automatically included in the model. This functionality is experimental.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Set the upper and lower bounds of the censored values.

Note: If you do not specify an upper bound or a lower bound, the result is a linear regression model.

Step 3: Set the Options

On the **Options** tab, you can set these options.

1 Select the method to calculate the covariance matrix of parameter estimates. You can use the default value, or you can choose from these covariance types:

- **Inverse Hessian matrix** – the covariance from the inverse Hessian matrix.
- **Outer product matrix** – the covariance from the outer product matrix.
- **Outer product and Hessian matrices** – the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Select the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.

4 Select the statistics to display in the results.

Here are the available statistics:

- correlations of the parameter estimates
- covariances of the parameter estimates
- iteration history of the objective function and parameter estimates

Step 4: Set the Output Options

On the **Output** tab, you can specify these options:

- an output data set that contains the default statistics from the analysis and any selected statistics, such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor
- parameter estimates table

Note: If you are running the step in a flow, you must add output ports for the output tables to the Panel Data Models node. For more information, see "Panel Data Models: Connection Requirements for the Node" on page 712.

Truncated Regression

Example: Truncated Regression

To create this example:

1 Enter this code on a **SAS Program** tab:

```
data cigar;
   input state year price pop pop_16 cpi ndi sales pimin;
   label
   state  = 'State abbreviation'
   year   = 'YEAR'
   price  = 'Price per pack of cigarettes'
   pop    = 'Population'
   pop_16 = 'Population above the age of 16'
   cpi    = 'Consumer price index with (1983=100)'
   ndi    = 'Per capita disposable income'
   sales  = 'Cigarette sales in packs per capita'
   pimin  = 'Minimum price in adjoining states per pack of cigarettes';
datalines;
1 63 28.6 3383 2236.5 30.6 1558.3045298 93.9 26.1
1 64 29.8 3431 2276.7 31.0 1684.0732025 95.4 27.5
1 65 29.8 3486 2327.5 31.5 1809.8418752 98.5 28.9
1 66 31.5 3524 2369.7 32.4 1915.1603572 96.4 29.5
1 67 31.6 3533 2393.7 33.4 2023.5463678 95.5 29.6
1 68 35.6 3522 2405.2 34.8 2202.4855362 88.4 32
1 69 36.6 3531 2411.9 36.7 2377.3346665 90.1 32.8
1 70 39.6 3444 2394.6 38.8 2591.0391591 89.8 34.3
1 71 42.7 3481 2443.5 40.5 2785.3159706 95.4 35.8
1 72 42.3 3511 2484.7 41.8 3034.8082969 101.1 37.4
1 73 42.1 3540 2526 44.4 3387.5740861 102.9 37.3
1 74 43.1 3574 2573.9 49.3 3718.8671751 108.2 41.4
1 75 46.6 3614 2623.7 53.8 4087.9931169 111.7 43
1 76 50.4 3657 2677.4 56.9 4486.7718352 116.2 46.4
1 77 50.1 3690 2719.6 60.6 4899.8656869 117.1 48.8
1 78 55.1 3728 2764.6 65.2 5450.9983257 123 53.6
1 79 56.8 3769 2810.7 72.6 5957.1405451 121.4 56.5
1 80 60.6 3894 2898.9 82.4 6466.350293 123.2 59.3
1 81 68.8 3917 2924.7 90.9 7042.0231606 119.6 62.6
1 82 73.1 3943 2953.5 96.5 7505.2199795 119.1 67.8
1 83 84.4 3959 2977.5 99.6 7974.5518556 116.3 78.6
1 84 90.8 3990 3009.1 103.9 8693.376058 113 86.8
1 85 99 4020 3039.8 107.6 9059.4344712 114.5 90.7
1 86 103 4050 3072.4 109.6 9674.9852107 116.3 98.8
1 87 110 4083 3104 113.6 10213.847735 114 103.5
1 88 114.4 4102 3124 118.3 10993 112.1 109.2
1 89 122.3 4118 3140 124 11634 105.6 121.5
1 90 139.1 4129.2 3148.6 130.7 12806 108.6 132.3
1 91 144.4 4178.3 3185.1 136.2 13360 107.9 137.4
1 92 172.2 4226.3 3226.7 140.3 14533 109.1 159.5
3 63 23.9 1517 982.4 30.6 1944.7450576 125 24.9
3 64 24 1549 1005.6 31 2063.5159984 121 25.5
3 65 24.2 1575 1024.9 31.5 2162.6639143 123.2 25.3
3 66 29.6 1609 1051.9 32.4 2318.6153235 113.9 25.5
3 67 29.2 1637 1078.9 33.4 2446.6813815 117.1 26
3 68 31.3 1667 1106 34.8 2720.3709408 115.6 32.3
3 69 36.1 1693 1117.5 36.7 2979.6014291 113.8 33.3
3 70 37.1 1772 1226.6 38.8 3269.8156411 115.2 34.6
3 71 38.5 1878 1313.5 40.5 3549.7019452 109.6 36.6
3 72 38 1975 1393.6 41.8 3800.6701072 125 37.2
3 73 38.7 2075 1476.5 44.4 4219.9831679 128.3 36.5
3 74 39.2 2156 1547 49.3 4508.1317983 133.1 37.8
3 75 47.7 2200 1591.4 53.8 4742.5753077 121.8 40.5
```

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3 76 49.1 2244 1635.8 56.9 5158.789996 122.3 43.4
3 77 48.7 2304 1690.8 60.6 5567.7751489 121.7 44.7
3 78 53.6 2373 1750.6 65.2 6283.4991663 124.7 49.5
3 79 58.6 2450 1812.4 72.6 7099.4038904 124.6 53.7
3 80 60.8 2718 2044 82.4 7823.3902342 126.8 57.2
3 81 63.3 2794 2103.8 90.9 8647.5572846 113.8 62.7
3 82 73.3 2860 2153.1 96.5 8879.9352124 113.5 68.1
3 83 80.5 2963 2231.2 99.6 9579.1345772 111.1 79.6
3 84 92.8 3053 2300.7 103.9 10549.95792 107.1 90.2
3 85 98.8 3161 2384.7 107.6 11256.38682 107.1 97.5
3 86 106.7 3279 2483.1 109.6 11796.536403 107.9 101.2
3 87 113.5 3386 2569 113.6 12367.66971 106.1 103.9
3 88 113.5 3489 2638 118.3 13008 102.2 113.7
3 89 125.6 3556 2672 124 13625 96.8 126.4
3 90 130.2 3598.2 2703.7 130.7 13826 88.9 133.6
3 91 151.4 3681.7 2759.1 136.2 14232 81.2 146.9
3 92 165.7 3762.2 2804.8 140.3 15179 79 165.4
4 63 27 1907 1296.7 30.6 1480.3334935 103.4 25.8
4 64 27.3 1939 1320.7 31 1610.0797693 102.6 25.7
4 65 27.2 1941 1323.6 31.5 1710.1989428 100.3 26.1
4 66 30.3 1963 1344.8 32.4 1883.8750601 98.9 26.2
4 67 30.4 1972 1357.3 33.4 2004.4267179 102.9 27.5
4 68 30.9 1983 1374.6 34.8 2143.3676117 104 29.2
4 69 30.9 1995 1389 36.7 2286.3950024 102.9 29.9
4 70 36.7 1923 1366.9 38.8 2493.7847189 100.3 34.3
4 71 38.8 1961 1405.4 40.5 2710.3690533 104.1 36.8
4 72 44.1 1999 1442.9 41.8 2950.4507448 103.9 37.4
4 73 45.1 2030 1474.6 44.4 3410.1816434 108 37.3
4 74 45.5 2063 1508.3 49.3 3807.5934647 109.7 38
4 75 48.6 2112 1552.5 53.8 4057.8913984 114.8 43
4 76 50.9 2113 1565.1 56.9 4362.3354157 119.1 44.7
4 77 52.6 2143 1596.8 60.6 4859.8664104 122.6 45.9
4 78 56.5 2167 1623.7 65.2 5467.7328208 127.3 49.9
4 79 58.4 2180 1641 72.6 6015.3234022 126.5 52.2
4 80 61.5 2286 1715.1 82.4 6278.9024507 131.8 57.3
4 81 64.7 2296 1725.7 90.9 7101.3099471 128.7 59.9
4 82 72.1 2291 1724.7 96.5 7390.4296012 127.4 64.7
4 83 82 2328 1757.4 99.6 7886.9389716 128 74.8
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50 74 43.9 4563 3310.4 49.3 4634.9348485 111.8 41.9
50 75 46.6 4601 3377.5 53.8 5039.0651515 113.5 45.2
50 76 51.3 4623 3430.2 56.9 5487.1681818 115.4 47.8
50 77 52.1 4658 3489.6 60.6 6063.0015152 117.2 49.4
50 78 57.1 4683 3537.6 65.2 6728.8742424 116.7 54.6
50 79 58.7 4720 3590.3 72.6 7622.9863636 117.1 56.4
50 80 61.2 4705 3551 82.4 8173.6924242 117.6 58.8
50 81 64.9 4742 3592.2 90.9 8663.6742424 119.9 61.4
50 82 75 4765 3617.1 96.5 9196.5818182 115.6 69.6
50 83 92 4751 3616.2 99.6 9815.3409091 106.3 80.8
50 84 100.8 4766 3639.2 103.9 10641.4 105.6 89.6
50 85 106.8 4775 3657.4 107.6 11228.75 107 96.7
50 86 110.8 4783 3670.8 109.6 11763.751515 105.4 104.8
50 87 116.3 4807 3690 113.6 12336.443939 106 116.2
50 88 128.6 4855 3728 118.3 13129 102.6 124.1
50 89 138.3 4867 3745 124 13933 100.3 132.7
50 90 151.1 4902.1 3772 130.7 14958 94.1 147.3
50 91 158.6 4965.2 3817.4 136.2 15438 95.5 154.4
50 92 176.5 5017.3 3853.8 140.3 16351 96.2 178.5
51 63 26.2 335 221.9 30.6 2212.8687965 125.6 24.9
51 64 26.2 338 224.8 31 2323.4089278 134 27.5
51 65 26.1 330 220 31.5 2468.0408753 137.6 27.6
51 66 26.5 320 215.2 32.4 2593.0442013 133.3 29.6
51 67 27.4 319 216.1 33.4 2775.9003063 137.4 30.1
51 68 32.5 322 221.9 34.8 2921.5653392 136.5 32
51 69 32.6 320 228.7 36.7 3066.1972867 135.7 31.9
51 70 34.1 332 231.6 38.8 3269.7150985 132.2 33.8
51 71 34.4 339 240.3 40.5 3514.5563239 131.7 33.6
51 72 34.4 345 247 41.8 3975.3123851 140 33.7
51 73 34.4 351 253.8 44.4 4505.2851641 141.2 36.3
51 74 35.8 362 263.4 49.3 4980.5044201 145.8 37.8
51 75 38.6 377 276 53.8 5455.7236761 160.7 40.3
51 76 42.6 392 288.5 56.9 5985.6964551 161.5 42.5
51 77 43.4 407 300.1 60.6 6640.6725602 160.4 44.7
51 78 49.8 425 314.5 65.2 7609.7066083 160.3 49.5
51 79 51.7 450 332.9 72.6 8482.6637199 168.6 53.7
51 80 55.3 470 343.5 82.4 9402.1096718 158.1 56.4
51 81 55.9 492 358 90.9 10046.754923 163.1 59.2
51 82 64.3 502 364.7 96.5 10180.022932 157.7 65.7
51 83 71 514 371.5 99.6 9855.6341357 141.2 76.5
51 84 81.7 511 370.5 103.9 10382.507659 128.9 88.5
51 85 87.4 510 369.5 107.6 10839.131379 125.7 92.3
51 86 97.8 507 368.6 109.6 11089.138031 124.8 99.9
51 87 102.7 490 357 113.6 11113.932079 110.4 106.2
51 88 112.9 479 353 118.3 11803 114.3 115.3
51 89 118.6 475 352 124 12399 111.4 123
51 90 129.5 470.9 348.9 130.7 13871 96.9 138.9
51 91 127 477.1 355.2 136.2 14675 109.1 143.6
51 92 155.1 483.3 360.5 140.3 15607 110.8 160
;
```

Click **Run** to create the Work.Cigar table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Panel Data Models** to add the step to your flow.

3 Add the Work.Cigar table to your flow. Connect the input port of the Panel Data Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Panel Data Models step, click the Panel Data Models node.

5 On the **Data** tab, assign columns to these roles:

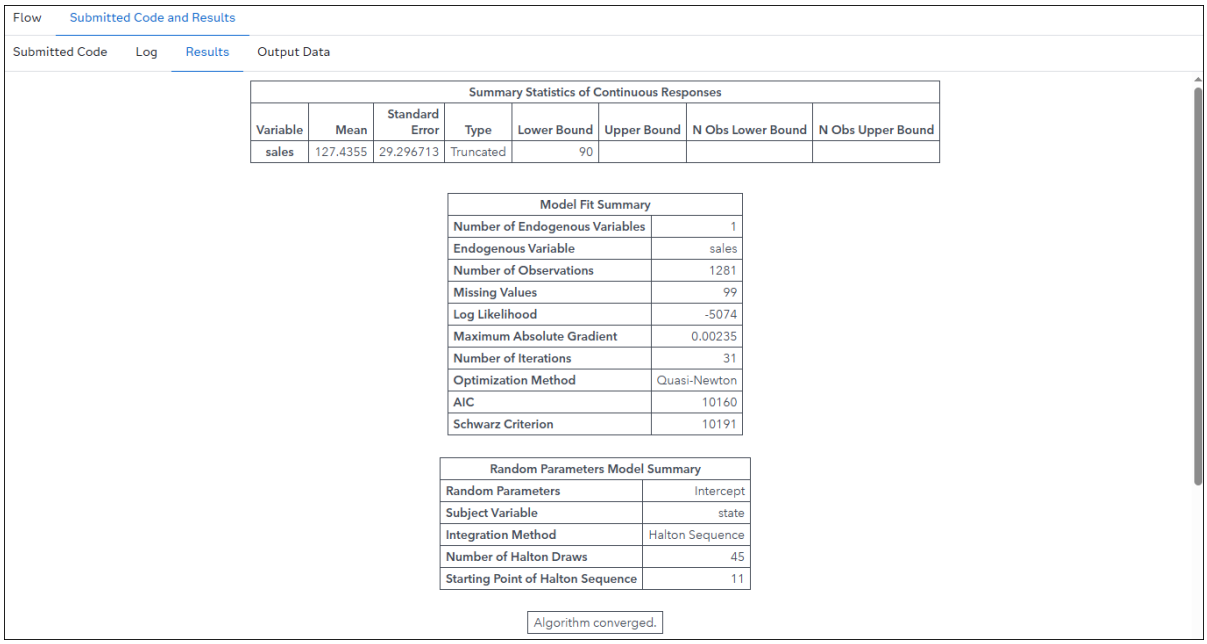
- To the **Cross-sectional ID** role, assign **state**.
- To the **Dependent variable** role, assign **sales**.
- To the **Continuous variables** role, assign **price**, **cpi**, and **ndi**.

6 Click the **Model** tab. From the **Model type** drop-down list, select **Truncated regression**.

7 Select the **Set the lower bound** check box. From the **Lower bound method** drop-down list, select **Specify by value**. In the **Lower bound value** box, enter `90`.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Summary Statistics of Continuous Responses

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
sales	127.4355	29.296713	Truncated	90			

Model Fit Summary

Number of Endogenous Variables	1
Endogenous Variable	sales
Number of Observations	1281
Missing Values	99
Log Likelihood	-5074
Maximum Absolute Gradient	0.00235
Number of Iterations	31
Optimization Method	Quasi-Newton
AIC	10160
Schwarz Criterion	10191

Random Parameters Model Summary

Random Parameters	Intercept
Subject Variable	state
Integration Method	Halton Sequence
Number of Halton Draws	45
Starting Point of Halton Sequence	11

Algorithm converged.

Truncated Regression: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the SAS Compute Server for this step.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Cross-sectional ID**, assign the numeric variable that identifies the cross section for each observation. The step verifies that the input data is sorted by the cross-sectional ID.

Note: For the truncated regression model, character variables are not supported.

4 To the **Time ID** role, assign a numeric variable that identifies the time period for each observation. For each cross section, the values of the time ID must be unique.

Note: For the truncated regression model, a time ID is not required and is ignored in the analysis.

5 To the **Dependent variable** role, assign the numeric variable for the analysis.

6 To the **Continuous variables** role, assign the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the step fits a model that contains only an intercept.

7 To the **Categorical variables** role, assign the classification variables. The step generates dummy variables for each level of the categorical variable.

8 To the **Group analysis by** role, assign variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 From the **Model type** drop-down list, select **Truncated regression**.

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects using the continuous variables and categorical variables selected on the **Data** tab.

Note: Random effects are automatically included in the model. This functionality is experimental.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 Set the upper and lower bounds of the censored values.

Note: If you do not specify an upper bound or a lower bound, the result is a linear regression model.

Step 3: Set the Options

On the **Options** tab, you can set these options.

1 Select the method to calculate the covariance matrix of parameter estimates. You can use the default value, or you can choose from these covariance types:

- **Inverse Hessian matrix** – the covariance from the inverse Hessian matrix.
- **Outer product matrix** – the covariance from the outer product matrix.
- **Outer product and Hessian matrices** – the covariance from the outer product and Hessian matrices (the quasi-maximum likelihood estimates).

2 Select the optimization method to use.

3 Specify the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.

4 Select the statistics to display in the results.

Here are the available statistics:

- correlations of the parameter estimates
- covariances of the parameter estimates
- iteration history of the objective function and parameter estimates

Step 4: Set the Output Options

On the **Output** tab, you can specify these options:

- an output data set that contains the default statistics from the analysis and any selected statistics, such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor
- parameter estimates table

Note: If you are running the step in a flow, you must add output ports for the output tables to the Panel Data Models node. For more information, see "Panel Data Models: Connection Requirements for the Node" on page 712.

Severity Models

About the Severity Models Step

The Severity Models step estimates parameters of any arbitrary continuous probability distribution that is used to model the magnitude (severity) of a continuous-valued event of interest.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Severity Models: Connection Requirements for the Node

In order to run the Severity Models step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
If you are running the step using the SAS Compute Server, the table can be either a SAS or CAS table. If you are running the step using the SAS CAS Server, the table must use a CAS engine libref. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output table. For more information, see "Step 5: Create the Output Data" on page 494. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Severity Models Step

To create this example:

1 Enter this code on a **SAS Program** tab:

```
data losses_severity(keep=gender carType education carSafety income
lossAmount
      deductible limit);
   call streaminit(12345);
   array sx{8} _temporary_;
   array sbeta{9} _TEMPORARY_ (5 0.6 0.4 -0.75 -0.3 0.4 0.7 -0.5 -0.3);

   length carType $8 education $16 gender $8;

   sigma = 0.5;
   do lossEventId=1 to 2500;
      /* simulate policyholder and vehicle attributes */
      do i=1 to dim(sx);
         sx(i) = 0;
      end;

      if (rand('UNIFORM') < 0.5) then do;
         gender = 'F'; * female;
         sx(2) = 1;
      end;
      else do;
         gender = 'M'; * male;
      end;

      if (rand('UNIFORM') < 0.7) then do;
         carInt = 1;
         carType = 'Sedan';
      end;
      else do;
         carInt = 2;
         carType = 'SUV';
         sx(1) = 1;
      end;

      educationLevel = rand('UNIFORM');
      if (educationLevel < 0.5) then do;
         eduInt = 1;
         education = 'High School';
      end;
      else if (educationLevel < 0.85) then do;
         eduInt = 2;
         education = 'College';
         if (carInt=1) then
            sx(8) = 1;
         else
            sx(6) = 1;
      end;
```

```
      else do;
         eduInt = 3;
         education = 'AdvancedDegree';
         if (carInt=1) then
            sx(7) = 1;
         else
            sx(5) = 1;
      end;

      carSafety = rand('UNIFORM'); /* scaled to be between 0 & 1 */
      sx(3) = carSafety;

      income = MAX(15000,int(rand('NORMAL', eduInt*30000, 50000)))/
100000;
      sx(4) = income;

      /* simulate lognormal severity */
      Mu = sbeta(1);
      do i=1 to dim(sx);
         Mu = Mu + sx(i) * sbeta(i+1);
      end;
      lossAmount = exp(Mu) * rand('LOGNORMAL')**Sigma;
      loglossAmount = log(lossAmount);

      deductible = lossAmount * rand('UNIFORM');
      if (rand('UNIFORM') < 0.25) then
         limit = lossAmount;

      output;
   end;
run;
```

Click **Run** to create the Work.Losses_Severity table.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Severity Models** to add the step to your flow.

3 Add the Work.Losses_Severity table to your flow. Connect the input port of the Severity Models node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Severity Models step, click the Severity Models node.

5 On the **Data** tab, assign **lossAmount** to the **Dependent variable** role.

6 Select the **Set the right-censoring limit** check box. Select **Specify variable** and assign **limit** to the **Right-censoring variable** role.

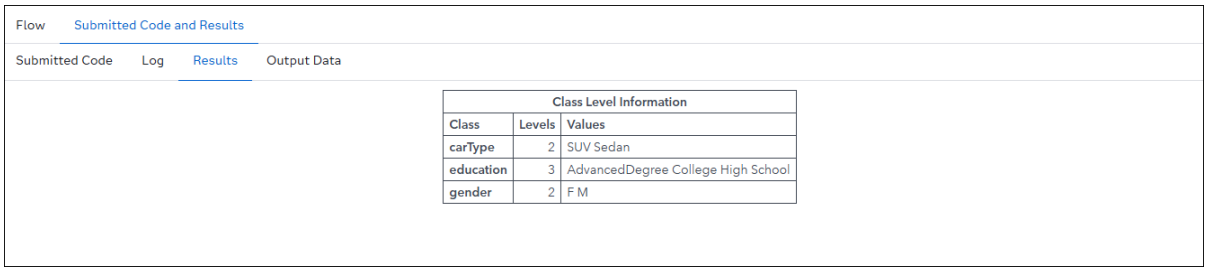
7 Select the **Set the left-truncation threshold** check box. Select **Specify variable** and assign **deductible** to the **Left-truncation variable** role.

8 To the **Continuous variables** role, assign **carSafety** and **income**.

9 To the **Classification variables** role, assign **carType**, **education**, and **gender**.

10 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Class Level Information		
Class	Levels	Values
carType	2	SUV Sedan
education	3	AdvancedDegree College High School
gender	2	F M

Severity Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on the SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use the SAS Compute Server. Using the SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variable** role, specify the name of the response or loss variable whose distribution needs to be modeled.

Note: A dependent variable is required if you do not set any of the censoring options.

4 Select the **Set the left-censoring limit** check box to specify the variable or value to use for setting the left-censoring limit. If the variable value is missing, the step assumes that the observation is not left-censored.

By the definition of left-censoring, an exact value of the response is not known when the value is less than or equal to the left-censoring limit.

- If you specify the response variable and the value of that variable is less than or equal to the value of the left-censoring limit for some observations, those observations are treated as left-censored and the value of the response variable is ignored.
- If you specify the response variable and the value of that variable is greater than the value of the left-censoring limit for some observations, those

observations are not left-censored and the value of the left-censoring limit is ignored.

- If you specify both right-censoring and left-censoring limits, the left-censoring limit must be greater than or equal to the right-censoring limit. If both limits are identical, the observation is assumed to be uncensored.

5 Select the **Set the right-censoring limit** check box to specify the variable or value to use for setting the right-censoring limit. If the variable value is missing, the step assumes that the observation is not right-censored.

By the definition of right-censoring, an exact value of the response is not known when the value is greater than or equal to the right-censoring limit.

- If you specify the response variable and the value of that variable is greater than or equal to the value of the right-censoring limit for some observations, those observations are treated as right-censored and the value of the response variable is ignored.
- If you specify the response variable and the value of that variable is less than the value of the right-censoring limit for some observations, those observations are not right-censored and the value of the right-censoring limit is ignored.
- If you specify both right-censoring and left-censoring limits, the left-censoring limit must be greater than or equal to the right-censoring limit. If both limits are identical, the observation is assumed to be uncensored.

6 Select the **Set the left-truncation threshold** check box to specify the variable or value to use for the left-truncation threshold. If the value is missing or 0, the observation is not left-truncated.

By the definition of left-truncation, you can observe only a value that is greater than the left-truncation threshold. If a response variable value is less than or equal to the left-truncation threshold, a warning is printed to the SAS log and the observation is ignored.

7 Select the **Set the right-truncation threshold** check box to specify the variable or value to use for the right-truncation threshold. If the variable value is missing, the observation is not right-truncated.

By the definition of right-truncation, you can observe only a value that is less than or equal to the right-truncation threshold. If a response variable value is greater than the right-truncation threshold, a warning is printed to the SAS log and the observation is ignored.

8 (Optional) To the **Continuous variables** role, assign the variables that specify the regression effects. A regression effect is formed from one or more regressor variables according to effect construction rules.

9 (Optional) To the **Classification variables** role, assign the classification variables to use as explanatory variables in the analysis.

10 (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

11 (Optional) To the **Group analysis by** role, assign the variables to obtain separate analyses of observations for each unique group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 Select the candidate distributions for the dependent variable. You can choose from these options:

- **Predefined distributions**.
- **All distributions**.
- **Selected distributions**. These distributions are available: **Burr**, **Exponential**, **Gamma**, **Generalized Pareto**, **Inverse Gaussian**, **Lognormal**, **Pareto**, **Weibull**, **Tweedie**, and **Scaled Tweedie**.
- **No distributions**.

> **Note:** The **No distributions** option is not available if you are running the step on a CAS server.

2 Specify the scaled effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and classification variables that you selected on the **Data** tab.

> **Note:** For more information, see Specification of Effects in *SAS/STAT User's Guide*.

3 To the **Offset variable** role, assign the variable to use as an offset to the linear predictor. An offset plays the role of an effect whose coefficient is known to be 1. Observations that have missing values for the offset variable are excluded from the analysis.

4 (CAS Server only) Specify the model selection method.

If you are running the step using the CAS server, you can also specify the model selection method.Here are the available options:

1 From the **Selection method** drop-down list, select the selection method for the model. The step performs model selection by examining whether effects should be added to or removed from the model according to the rules that are defined by the selection method.

Here are the valid values for the selection methods:

- **None** fits the full model.

- **Forward selection** starts with no effects in the model and adds effects based on the value of the specified criterion.
- **Backward elimination** starts with all the effects in the model and deletes effects based on the value of the specified criterion.
- **Stepwise regression** is similar to the forward selection method. However, effects that are already in the model do not necessarily stay there. Effects are added to the model based on the specified criterion and removed from the model based on the specified criterion.
- **Forward-swap selection** is an extension of the forward selection method. The forward-swap selection method incorporates steps that improve a model by replacing an effect in the model with an effect that is not in the model.

2 Specify the criterion to use to add or remove effects from the model.

3 Specify the criterion to use to stop adding or removing effects from the model.

4 Specify the criterion to use to identify the best fitting model.

5 Specify how much information about the selection process to include in the results. You can display a summary, details for each step of the selection process, or all of the information about the selection process.

6 Specify whether to add or remove a classification effect.

Here are the valid options:

- **An entire effect**
- **Individual single degree of freedom effects**

Note: This option is available only if you assign a variable to the **Classification variables** role.

7 Specify whether to maintain the hierarchy of the effects. In order for a term to be included in the model, all model effects that are contained in the term must be present in the model.

Step 3: Setting the Options

On the **Options** tab, you can set these options:

1 Specify the statistics to display in the output. By default, the output includes a model selection summary, information about the number of parameters in a distribution's model, the convergence status of the parameter estimation process, the optimization summary, the statistics of fit, and the final parameter estimates.

You can include additional statistics such as detailed information for each distribution, statistics of fit for all the distribution models, and so on.

2 Select the plots to display in the results. By default, the comparative cumulative distribution function plot and the comparative probability density function plot are displayed.

   You can also display these plots:

   - cumulative distribution function plot for each distribution
   - P-P plot for each distribution
   - Q-Q plot for each distribution
   - probability density function plot for each distribution

3 Under the **Nonlinear Optimization** heading, specify the method to use and the maximum number of iterations.

   In some cases, you might need to change the optimization method or the maximum number of iterations, but for most problems, the default settings are adequate.

4 Under the **Estimation** heading, specify these options:

   - the method to use for computing the nonparametric or empirical estimate of the cumulative distribution function of the data.
   - the denominator to use for computing the covariance estimates. You can choose from the degrees of freedom or the number of nonmissing observations.

If you are running the step using the CAS server, you can also specify how to generate the code. Here are the available options:

- **Use SEVSELECT procedure**
- **Use CAS procedure**

Step 4: Create the Output Data

On the **Output** tab, specify whether to create these output tables.

- a table of the parameter estimates and standard errors data.
- a table of the estimates of the scoring functions and quantiles data. For this table, you can select the scoring functions and quantiles to include. You can also include variables from the input table.
- a table of the severity model in item store format.

If you are running the step on a SAS CAS Server, you must use a SAS CAS engine libref for the output table.

Note: If you are running the step in a flow, you must add an output port to the Severity Models node. For more information, see "Severity Models: Connection Requirements for the Node" on page 871.

Spatial Regression Models

About the Spatial Regression Models Step

The Spatial Regression Models step analyzes a class of linear spatial econometric models for cross-sectional data whose observations are spatially referenced or georeferenced.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Spatial Regression Models: Connection Requirements for the Node

In order to run the Spatial Regression Models step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running the step using the SAS Compute Server, the data can be a SAS or CAS table. If you are running the step using the CAS server, the data must use a CAS libref. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table **Note:** The spatial weight table must be in a specified format.	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Hidden Markov Models node and select ***name-of-output-table***. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see

Input Port	Output Port
	"Adding a Table from a SAS Library to a Flow" on page 34.

Example: Spatial Regression Models

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
data work.CrimeOH;
  input crime income hvalue lat lon sid $;
datalines;
18.802 21.232 44.567 35.62 42.38 s1
32.388  4.477 33.200 36.50 40.52 s2
38.426 11.337 37.125 36.71 38.71 s3
 0.178  8.438 75.000 33.36 38.41 s4
15.726 19.531 80.467 38.80 44.07 s5
30.627 15.956 26.350 39.82 41.18 s6
50.732 11.252 23.225 40.01 38.00 s7
26.067 16.029 28.750 43.75 39.28 s8
48.585  9.873 18.000 39.61 34.91 s9
34.001 13.598 96.400 47.61 36.42 s10
36.869  9.798 41.750 48.58 34.46 s11
20.049 21.155 47.733 49.61 32.65 s12
19.146 18.942 40.300 50.11 29.91 s13
18.905 22.207 42.100 51.24 27.80 s14
27.823 18.950 42.500 50.89 25.24 s15
16.241 29.833 61.950 48.44 27.93 s16
 0.224 31.070 81.267 46.73 31.91 s17
30.516 17.586 52.600 43.44 35.92 s18
33.705 11.709 30.450 43.37 33.46 s19
40.970  8.085 20.300 41.13 33.14 s20
52.794 10.822 34.100 43.95 31.61 s21
41.968  9.918 23.600 44.10 30.40 s22
39.175 12.814 27.000 43.70 29.18 s23
53.711 11.107 22.700 41.04 28.78 s24
25.962 16.961 33.500 43.23 27.31 s25
22.541 18.796 35.800 42.67 24.96 s26
26.645 11.813 26.800 41.21 25.90 s27
29.028 14.135 27.733 39.32 25.85 s28
36.664 13.380 25.700 41.09 27.49 s29
42.445 17.017 43.300 38.32 28.82 s30
56.920  7.856 22.850 41.31 30.90 s31
61.299  8.461 17.900 39.36 32.88 s32
60.750  8.681 32.500 39.72 30.64 s33
68.892 13.906 22.500 38.29 30.35 s34
38.298 14.236 53.200 36.60 32.09 s35
54.839  7.625 18.800 37.60 34.08 s36
56.706 10.048 19.900 37.13 36.12 s37
```

```
62.275  7.467 19.700 37.85 36.30 s38
46.716  9.549 41.700 35.95 36.40 s39
57.066  9.963 42.900 35.72 35.60 s40
54.522 11.618 30.600 35.76 34.66 s41
43.962 13.185 60.000 36.15 33.92 s42
40.074 10.655 19.975 34.08 30.42 s43
23.974 14.948 28.450 30.32 28.26 s44
17.677 16.940 31.800 27.94 29.85 s45
14.306 18.739 36.300 27.27 28.21 s46
19.101 18.477 39.600 24.25 26.69 s47
16.531 18.324 76.100 25.47 25.71 s48
16.492 25.873 44.333 29.02 26.58 s49
;

data work.CrimeCList;
  input sid $ csid $ value @@;
datalines;
s1 s2 1 s1 s5 1 s1 s6 1
s2 s1 1 s2 s3 1 s2 s6 1 s2 s7 1
s3 s2 1 s3 s4 1 s3 s7 1 s3 s37 1 s3 s38 1 s3 s39 1
s4 s3 1 s4 s37 1 s4 s39 1 s4 s40 1
s5 s1 1 s5 s6 1
s6 s1 1 s6 s2 1 s6 s5 1 s6 s7 1
s7 s2 1 s7 s3 1 s7 s6 1 s7 s8 1 s7 s9 1 s7 s18 1 s7 s36 1 s7 s38 1
s8 s7 1 s8 s18 1
s9 s7 1 s9 s18 1 s9 s20 1 s9 s32 1 s9 s36 1 s9 s38 1
s10 s11 1 s10 s17 1 s10 s18 1 s10 s19 1
s11 s10 1 s11 s12 1 s11 s17 1
s12 s11 1 s12 s13 1 s12 s17 1
s13 s12 1 s13 s14 1 s13 s16 1 s13 s17 1
s14 s13 1 s14 s15 1 s14 s16 1
s15 s14 1 s15 s16 1
s16 s13 1 s16 s14 1 s16 s15 1 s16 s17 1 s16 s23 1
s17 s10 1 s17 s11 1 s17 s12 1 s17 s13 1 s17 s16 1
s17 s18 1 s17 s19 1 s17 s21 1 s17 s22 1 s17 s23 1
s18 s7 1 s18 s8 1 s18 s9 1 s18 s10 1 s18 s17 1 s18 s19 1 s18 s20 1
s19 s10 1 s19 s17 1 s19 s18 1 s19 s20 1 s19 s21 1 s19 s31 1
s20 s9 1 s20 s18 1 s20 s19 1 s20 s31 1 s20 s32 1
s21 s17 1 s21 s19 1 s21 s22 1 s21 s31 1
s22 s17 1 s22 s21 1 s22 s23 1 s22 s31 1
s23 s16 1 s23 s17 1 s23 s22 1 s23 s24 1 s23 s25 1 s23 s29 1 s23 s31 1
s24 s23 1 s24 s25 1 s24 s29 1 s24 s30 1 s24 s31 1 s24 s33 1
s25 s23 1 s25 s24 1 s25 s26 1 s25 s27 1 s25 s29 1
s26 s25 1 s26 s27 1 s26 s28 1
s27 s25 1 s27 s26 1 s27 s28 1 s27 s29 1
s28 s26 1 s28 s27 1 s28 s29 1 s28 s30 1
s29 s23 1 s29 s24 1 s29 s25 1 s29 s27 1 s29 s28 1 s29 s30 1
s30 s24 1 s30 s28 1 s30 s29 1 s30 s31 1 s30 s33 1 s30 s34 1
s31 s19 1 s31 s20 1 s31 s21 1 s31 s22 1 s31 s23 1 s31 s24 1
s31 s30 1 s31 s32 1 s31 s33 1
s32 s9 1 s32 s20 1 s32 s31 1 s32 s33 1 s32 s34 1 s32 s35 1 s32 s36 1
s33 s24 1 s33 s30 1 s33 s31 1 s33 s32 1 s33 s34 1 s33 s35 1
s34 s30 1 s34 s32 1 s34 s33 1 s34 s35 1 s34 s43 1
s35 s32 1 s35 s33 1 s35 s34 1 s35 s36 1 s35 s41 1 s35 s42 1 s35 s43 1
s36 s7 1 s36 s9 1 s36 s32 1 s36 s35 1 s36 s37 1 s36 s38 1 s36 s40 1
s36 s42 1
```

```
s37 s3 1 s37 s4 1 s37 s36 1 s37 s38 1 s37 s39 1 s37 s40 1 s37 s42 1
s38 s3 1 s38 s7 1 s38 s9 1 s38 s36 1 s38 s37 1
s39 s3 1 s39 s4 1 s39 s37 1 s39 s40 1
s40 s4 1 s40 s36 1 s40 s37 1 s40 s39 1 s40 s41 1 s40 s42 1
s41 s35 1 s41 s40 1 s41 s42 1
s42 s35 1 s42 s36 1 s42 s37 1 s42 s40 1 s42 s41 1
s43 s34 1 s43 s35 1 s43 s44 1
s44 s43 1 s44 s45 1 s44 s46 1 s44 s49 1
s45 s44 1 s45 s46 1
s46 s44 1 s46 s45 1 s46 s47 1 s46 s48 1 s46 s49 1
s47 s46 1 s47 s48 1
s48 s46 1 s48 s47 1
s49 s44 1 s49 s46 1
;
```

Click **Run** to create the Work.CrimeOH and Work.CrimeCList tables.

2 In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Spatial Regression Models** to add the step to your flow.

3 Add the input data to your flow and connect it to the Spatial Regression Models node.

- Add the Work.CrimeCList table to your flow. Connect the input port for Spatial Weights Data to the Work.CrimeCList node.
- Add the Work.CrimeOH table to your flow. Connect the input port for Input Data to the Work.CrimeOH node.

For more information, see “Connecting Nodes” on page 13.

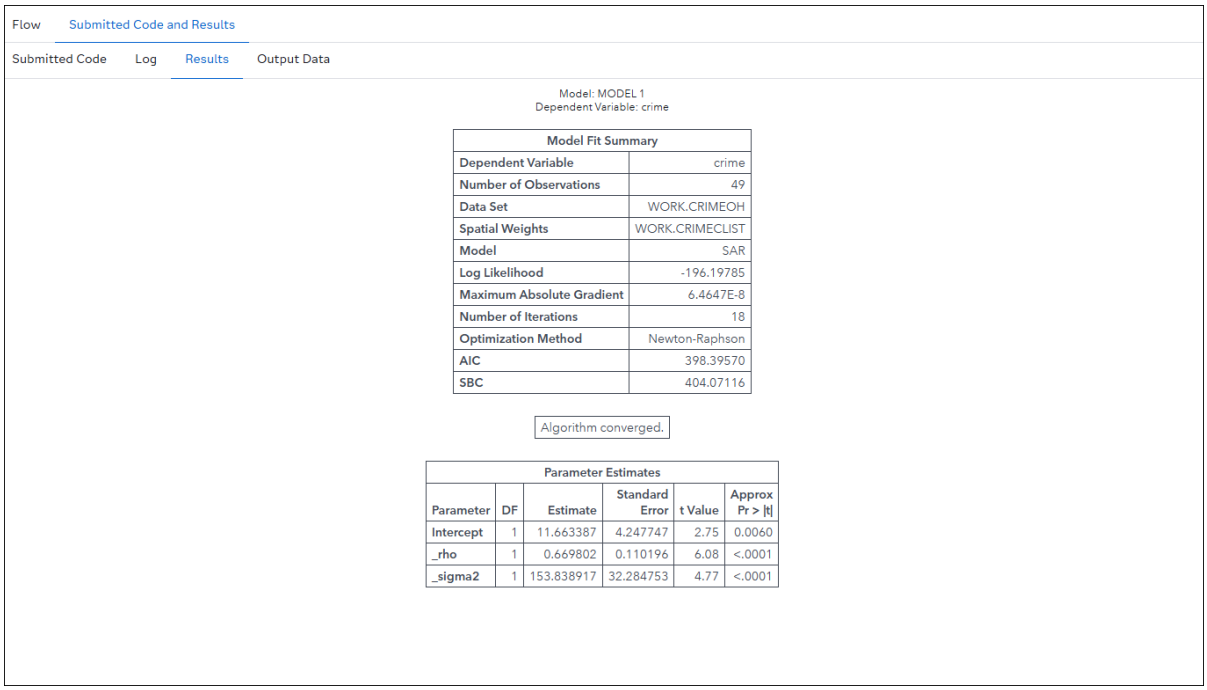
4 To set the options for the Spatial Regression Models step, click the Spatial Regression Models node.

5 On the **Data** tab, assign columns to these roles:

- To the **Spatial ID variable** role, assign **sid**.
- To the **Dependent variable** role, assign **crime**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Spatial Regression Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter spatial weights data, enter the filter expression in the **Filter spatial weights data** field.

3 (Optional) Select **Suppresses the row standardization of the spatial weights matrix** option to use the spatial weights as they appear in the data set. By default, this option is not selected and the spatial weights matrix is row standardized, which means the spatial weights matrix has a unit row sum.

4 To the **Spatial ID variable** role, assign the variable that identifies a spatial unit for each observation in the spatial weights data set and input data set.

Note: The **Spatial ID variable** is required when the spatial weights matrix is in the compact form. It is optional when the full spatial weights matrix is of the size n-by-n.

5 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

6 To the **Dependent variable** role, assign a numeric variable to use in the analysis.

7 To the **Continuous variables** role, assign the continuous variables.

8 To the **Categorical variables** role, assign the numeric or character variables to use as category variables.

9 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

On the **Models** tab, you can set these options:

1 Specify the model type. You can choose from these options:

- linear model
- spatial autoregressive (SAR) model
- spatial error model (SEM)
- spatial moving average (SMA) model
- spatial autoregressive moving average (SARMA) model
- spatial autoregressive confused (SAC) model

2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom model** option. Specify the effects by using the continuous variables and categorical variables that you selected on the **Data** tab.

Note: For more information, see Specification of Effects in *SAS/STAT User's Guide*.

Step 3: Set the Options

On the **Options** tab, you can set these options:

1 Specify whether to compute the approximations to the Jacobian. If this option is not selected, exact computation is computed and no additional approximation options are available.

Note: This option is available when the model type is spatial autoregressive (SAR) or spatial error (SEM).

2 Specify whether to use the Chebyshev approximation or the Taylor approximation. Depending on the approximation that you select, you must specify the order of the series. The default value for the Chebyshev series is `5`. The default value for the Taylor series is `50`.

3 Specify the number of standard random draws for the Monte Carlo simulation. The default value is `100`.

4 Specify the integer seed for the random number generator that is used for the Monte Carlo simulation.

5 Specify the method to use for nonlinear optimization.

6 Specify the maximum number of iterations. The default value is `100`.

7 Specify the statistics to be displayed in the output. You can also include these additional statistics:

- correlations of the parameter estimates
- covariances of the parameter estimates

If you are running the step using the CAS server, you can also specify how to generate the code. Here are the available options:

- **Use CSPATIALREG procedure**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, you can create an output table that contains these items:

- the predicted values
- the residuals
- the linear predictor (Xbeta)

If you are running the step using the SAS Compute Server, you must specify a SAS libref for the output table. If you are running the step using a CAS server, you must specify a CAS libref for the output table.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Spatial Regression Models node. For more information, see "Spatial Regression Models: Connection Requirements for the Node" on page 879.

Univariate Time Series Analysis

About the Univariate Time Series Analysis Step

The Univariate Time Series Analysis step analyzes a single time series in which the values are equally spaced. This step provides analysis for these model types: ARIMA (autoregressive integrated moving average), ARIMAX, unobserved components, and regression with autocorrelated and heteroscedastic errors.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Univariate Time Series Analysis: Connection Requirements for the Node

In order to run the Univariate Time Series Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-

Input Port	Output Port
Import node) that creates an output table	click the Univariate Time Series Analysis node and select ***name-of-output-table***.
Note: The spatial weight table must be in a specified format.	**Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Analyzing Sales Data by Using an ARIMA Model

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Econometrics** folder and double-click **Univariate Time Series Analysis** to add the step to your flow.
2. Add the Sashelp.Pricedata table to your flow and connect it to the Univariate Time Series Analysis node.For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Univariate Time Series Analysis step, click the Univariate Time Series Analysis node.
4. On the **Data** tab, assign columns to these roles:
   - To the **Time ID** role, assign **date**.
   - To the **Dependent variable** role, assign **sale**.
5. On the **Model** tab, select **ARIMA** as the model type.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Univariate Time Series Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter input data, enter the filter expression in the **Filter input data** field.

2 To the **Time ID** role, assign a variable to specify the datetime value for the series.

If you assign a SAS date or datetime variable to this role, the step automatically determines the time interval for these values. You can change this interval and also specify the multiplier, shift, and seasonal length.

3 To the **Dependent variables** role, assign the dependent variables for the analysis.

4 (Optional) To the **Group analysis by** role, assign the variable to sort the data and perform an analysis on each group.

Step 2: Set the Model Options

Create an ARIMA Model

On the **Models** tab, select **ARIMA** as the model type.

1. Specify the autoregressive order (p), differencing order (d), and moving average order (q) for the ARIMA model.
2. Specify the autoregressive order (P), differencing order (D), and moving average order (Q) for the seasonal ARIMA model.
3. Specify whether to include the intercept in the model. The intercept is included by default.

Create an ARIMAX Model

On the **Models** tab, select **ARIMAX** as the model type.

1. To the **Independent variables** role, specify the continuous variables to use in the analysis.
2. Specify the autoregressive order (p), differencing order (d), and moving average order (q) for the ARIMAX model.
3. Specify the autoregressive order (P), differencing order (D), and moving average order (Q) for the seasonal ARIMAX model.
4. Specify whether to include the intercept in the model. The intercept is included by default.

Create an Unobserved Components Model

On the **Models** tab, select **Unobserved components model** as the model type.

1. To the **Independent variables** role, specify the continuous variables to use in the analysis.
2. Specify whether to include an irregular component in the model. You can specify the initial variance during the parameter estimation process. This variance can be fixed.
3. Specify whether to include a level component in the model. For this component, you can specify the variance, check for level breaks, and include a slope component.
4. Specify whether to include a seasonal component. The type can be dummy or trigonometric. You can also specify the initial value of the variance.

Note: This option is available only when the seasonal length is greater than 1.

5 Specify whether to include a cycle component. You can specify the initial value for the cycle period, the damping factor, and the variance.

Create a Regression with Autocorrelated and Heteroscedastic Errors

On the **Models** tab, select **Regression with autocorrelated and heteroscedastic errors** as the model type.

1 To the **Independent variables** role, specify the continuous and categorical variables to use in the analysis.

2 Specify the autoregressive error. You can choose from these options:

- **No autoregressive error** specifies no autoregressive error component in the model. This is the default.
- **Specify the autoregressive order** specifies the order of the autoregressive process to be used.
- **Select autoregressive orders automatically** specifies that the step select the appropriate order of the error process. You can specify the maximum autoregressive order, which is the starting point for the step selection.

3 For the Garch conditional heteroscedasticity, select these options:

- Specify the order of the process or the subset of ARCH terms to be fitted.
- Specify the order of the process or the subset of GARCH terms to be fitted.

Note: This option is available only if you specify the ARCH process order greater than 0.

Step 3: Set the Options

ARIMA and ARIMAX Options

On the **Options** tab, set these options for ARIMA and ARIMAX models.

1 Specify the estimation method. The default value is **Conditional least squares**.

2 Select the plots to include in the results.

3 Specify the number of periods to forecast.

4 Specify the confidence level for the forecast. The default value is `95%`.

5 Specify the number of periods not to include in the forecast.

6 Specify whether to determine if there are outliers in the data. This check box is selected by default.

Unobserved Components Model Options

On the **Options** tab, set these options for unobserved components models.

1 Specify the number of observations at the end of the data to exclude during parameter estimation.

2 Select the plots to include in the results.

3 Specify the number of periods to forecast.

4 Specify the confidence level for the forecast. The default value is `95%`.

5 Specify the number of periods not to include in the forecast.

6 Specify whether to determine if there are outliers in the data. This check box is selected by default.

7 Specify the optimization method. The default is **Trust region**.

8 Specify the maximum number of iterations. The default value is `100`.

Regression with Autocorrelated and Heteroscedastic Errors Model

On the **Options** tab, set these options for regression with autocorrelated and heteroscedastic errors model.

1 Specify the covariance matrix estimator.

- If the model is an OLS or pure autoregressive error model, these options are available: **Default**, **Newey and West**, **HCCME0**, **HCCME1**, **HCCME2**, **HCCME3**, and **HCCME4**.
- If the model includes a GARCH or heteroscedasticity component, these options are available: **Outer product matrix (default)**, **Inverse Hessian matrix**, **Newey and West**, **HCCME0**, **HCCME1**, **HCCME2**, **HCCME3**, and **HCCME4**.

2 Select the estimation method.

3 Specify whether to run the Durbin-Watson test for the first order.

4 Specify the tests for the absence of ARCH effects.

Here are the valid tests:

- **Q and Engle's LM tests**
- **Lee and King's ARCH tests**
- **Wong and Li's ARCH tests**

5 Specify the Jarque-Bera's normality test statistic for regression residuals.

6 Specify the tests for independence.

   Here are the valid tests:

   - **Brock-Dechert-Scheinkman (BDS) test**
   - **Runs test**
   - **Turning point test**
   - **Rank version of the von Neumann ratio test**

7 Select the plots to include in the results.

8 Specify the optimization method. The default is **Trust region**.

9 Specify the maximum number of iterations. The default value is `100`.

Step 4: Set the Output Options

On the **Output** tab, the available output tables depend on the model type.

- For ARIMA and ARIMAX model types, you can create an output table, parameter estimates table, fit statistics table, covariances and correlations table, and model information table.
- For the Unobserved components model type, you can create a parameter estimates table and a forecasted values table.
- For the regression with autocorrelated and heteroscedastic errors model type, you can create an output table that includes a variety of statistics. You can also create a parameter estimates table.

Note: If you are running the step in a flow, you must add output ports for the output tables to the Univariate Time Series Analysis node. For more information, see "Univariate Time Series Analysis: Connection Requirements for the Node" on page 886.

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Forecasting Data

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Modeling and Forecasting

About the Modeling and Forecasting Step

The Modeling and Forecasting step creates forecasting models that use your time series data. This task requires data in a valid time series format.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Modeling and Forecasting: Connection Requirements for the Node

In order to run the Modeling and Forecasting step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running the step using SAS Compute Server, you can use any library for the input and output tables. If you are running the step using SAS CAS Server, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output table is created. However, you can create several output tables using the options on the **Output** tab. For more information, see "Step 4: Set the Output Options" on page 901. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Creating a Random Walk Model for Sashelp.PriceData Table

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Forecasting** folder and double-click **Modeling and Forecasting** to add the step to your flow.
2. Add the Sashelp.PriceData table to your flow. Connect the input port of the Modeling and Forecasting node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Modeling and Forecasting step, click the Modeling and Forecasting node.
4. On the **Data** tab, assign columns to these roles:
   - To the **Dependent variable** role, assign **sale**.
   - To the **Time ID** role, assign **date**.
5. On the **Model** tab, select these options:
   a. From the **Forecasting model type** drop-down list, select **Random walk**.
   b. Under the **Model Settings** heading, select the **Drift** and **Seasonal** check boxes.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Modeling and Forecasting: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Dependent variable** role, assign the dependent variable.

4 To the **Time ID** role, assign the column that contains the time ID values.

Note: This role is optional if you are running the step on SAS Compute Server. If you are running the step on a SAS CAS Server, a Time ID is required.

Set these properties for the time ID.

- **Interval** shows the interval for the time ID variable.
- **Mulitplier** shows the multiplier for the time interval. By default, the multiplier is 1.
- **Shift** shows the shift for the time interval. By default, the shift is 1.
- **Season length** specifies the seasonality of the time interval. The default value depends on the time interval.

5 (Optional) If you do not assign a time ID variable, specify the seasonality of the time interval in the **Season length** option.

6 (Optional) Specify whether to obtain separate analyses of observations for each unique group.

- If you are running the step on SAS Compute Server, use the **Group analysis by** role.
- If you are running the step on a SAS CAS Server, use the **By variable 1**, **By variable 2**, and **By variable 3** roles.

Step 2: Select the Forecasting Model

Random Walk

To create a random walk model:

1 From the **Forecasting model type** drop-down list, select **Random walk**.

2 Select one of these types of random walk models:

- **Drift** creates a random walk model with Drift, or in ARIMA notation ARIMA(0,1,0).
- **Trend**.
- **Seasonal** creates a seasonal random walk model, or ARIMA(0,1,0)(0,1,0)s with no intercept.

3 Under the **Plots** heading, select the plots to include in the results.

Moving Average

Here is the formula for the moving average model with width *k*:

$$y_t = \frac{[y_t - 1 + \ ... + y_t - k]}{k} + error$$

In ARIMA notation, this model is ARIMA(*k*,0,0) with no intercept and with the autoregressive parameters (AR) fixed: $AR = \frac{1}{k}, \frac{1}{k}, ..., \frac{1}{k}$

To create a moving average model:

1 From the **Forecasting model type** drop-down list, select **Moving average**.

2 In the **Window (periods)** box, specify the number of periods for the moving average. This value must be an integer greater than 0 and less than 14.

3 Under the **Plots** heading, select the plots to include in the results.

Exponential Smooth

Exponential smoothing is a forecasting technique that uses exponentially declining weights to produce a weighted moving average of time series values. You can choose from several forecasting models.

To create an exponential smoothing model:

1 From the **Forecasting model type** drop-down list, select **Exponential Smoothing**.

2 From the **Forecasting model** drop-down list, select the model that you want to use. You can choose from these models:

- Simple (single) exponential smoothing, which is the default
- Linear (Holt) exponential smoothing
- Damped trend exponential smoothing
- Additive seasonal exponential smoothing
- Multiplicative seasonal exponential smoothing
- Winters multiplicative model
- Winters additive model

3 From the **Transformation** drop-down list, select the transformation to apply to the time series. By default, no transformation is applied. If you select the Box-Cox transformation, then you must specify a parameter value between –5 and 5 in the **Box-Cox transformation parameter** box.

4 From the **Forecast type** drop-down list, specify whether the model uses the mean forecasts or the median forecasts.

5 Under the **Plots** heading, select the plots to include in the results.

ARIMA

When you create an Autoregressive Integrated Moving Average (ARIMA) model, you can specify the autoregressive and moving average polynomials of an ARIMA model.

To create an ARIMA model:

1 From the **Forecasting model type** drop-down list, select **ARIMA**.

2 Under the **ARIMA** heading, specify the autoregressive, differencing, and moving average orders for the ARIMA model.

Here are the options for the simple ARIMA:

- **Autoregressive order (p)** specifies the simple autoregressive order. You can specify an integer from 0 to 13. The default value is `0`.
- **Differencing order (d)** specifies the simple differencing order. You can specify an integer from 0 to 13. The default value is `0`.
- **Moving average order (q)** specifies the simple moving average. You can specify an integer from 0 to 13. The default value is `0`.

Here are the options for the seasonal ARIMA:

- **Autoregressive order (P)** specifies the seasonal autoregressive order. You can specify an integer from 0 to 5. The default value is `0`.
- **Differencing order (D)** specifies the seasonal differencing order. You can specify an integer from 0 to 3. The default value is `0`.
- **Moving average order (Q)** specifies the simple moving average. You can specify an integer from 0 to 5. The default value is `0`.

3 Specify whether to include the intercept in the model. The intercept is included by default.

4 Under the **Plots** heading, select the plots to include in the results.

ARIMAX

When you create an ARIMAX model, you can specify the autoregressive and moving average polynomials of an ARIMA model and also include independent variables in the model.

To create an ARIMAX model:

1 From the **Forecasting model type** drop-down list, select **ARIMAX**.

2 Under the **ARIMA** heading, specify the autoregressive, differencing, and moving average orders for the ARIMA model.

   Here are the options for the simple ARIMA:

   - **Autoregressive order (p)** specifies the simple autoregressive order. You can specify an integer from 0 to 13. The default value is `0`.
   - **Differencing order (d)** specifies the simple differencing order. You can specify an integer from 0 to 13. The default value is `0`.
   - **Moving average order (q)** specifies the simple moving average. You can specify an integer from 0 to 13. The default value is `0`.

   Here are the options for the seasonal ARIMA:

   - **Autoregressive order (P)** specifies the seasonal autoregressive order. You can specify an integer from 0 to 5. The default value is `0`.
   - **Differencing order (D)** specifies the seasonal differencing order. You can specify an integer from 0 to 3. The default value is `0`.
   - **Moving average order (Q)** specifies the simple moving average. You can specify an integer from 0 to 5. The default value is `0`.

3 In the **Independent variables** role, assign the variables from the input data that you want to include in the model.

4 Specify whether to include the intercept in the model. The intercept is included by default.

5 Under the **Plots** heading, select the plots to include in the results.

Unobserved Components

To create an unobserved components model:

1 From the **Forecasting model type** drop-down list, select **Unobserved components**.

2 (Optional) To include independent variables in the model, expand the **Regression Effects** heading and select the **Include independent variables** check box. Assign the variables that you want to include in the model to the **Independent variables** role.

3 To include an irregular component, expand the **Irregular Component** heading and select the **Include an irregular component** check box. An irregular component is included by default.

   The irregular component corresponds to the overall random error in the model. The initial variance is the value that is used as the initial value during the parameter estimation process. To change this value, select **Specify variance** and enter a different value. To keep this value as your initial variance, select **Fix variance value**.

4 To include a trend component, expand the **Trend Component** heading. The level component and the slope component combine to define the trend component for the model. If you specify both a level component and a slope component, then a locally linear trend is obtained. If you omit the slope component, then a local level is used.

   - To include a level component in the model, select the **Include a level component** check box. (The level component is included by default.) Then you can specify whether to change the initial variance (which is 0 by default) and whether to check for level breaks.
   - To include a slope component in the model, select the **Include a slope component** check box. Then you can specify whether to change the initial variance (which is 0 by default).

5 (Optional) To include a seasonal component, the season length must be greater than 1. Expand the **Seasonal Component** heading and select the **Include a seasonal component** check box. Specify the type of seasonal component. A seasonal component can be one of two types: dummy or trigonometric. You can also specify whether to change the initial variance (which is 0 by default).

6 (Optional) To include a cycle component, expand the **Cycle Component** heading and select the **Include a cycle component** check box. You can specify these options:

   - To specify an initial cycle period to use during the parameter estimation process, select the **Specify cycle period** check box. Then specify the initial value in the box. This value must be an integer greater than 2. By default, the initial value is `3`.
   - To specify an initial damping factor to use during the parameter estimation process, select the **Specify damping factor** check box, and then specify the initial value in the box. You can specify any value between 0 and 1 (excluding 0 but including 1). By default, the initial value is `0.01`.
   - To specify an initial value for the disturbance variance parameter that the task uses during the parameter estimation process, select the **Specify variance** check box. Then specify the initial value in the box. This value must be greater than or equal to 0. By default, the initial value is `0`.

7 Under the **Plots** heading, select the plots to include in the results.

Step 3: Set the Forecasting Options

On the **Output** tab, you can set these options.

1 Specify the number of periods into the future for which multistep forecasts are made. The larger the horizon value, the larger the prediction error variance at the end of the horizon. By default, the horizon is `12`. Valid values are integers greater than or equal to 0 and less than 32,768.

2 Specify the confidence level for the series. By default, this confidence level is 95% .

3 Specify a subset of actual time series values to hold back, starting from the end of the last nonmissing observation. Valid values are integers greater than or equal to 0 and less than 32,768.

4 Specify that any outliers that are automatically detected during the creation of the model are inputs in the model.

Note: This option is available only if you are using the SAS Compute Server and did not select **Exponential smoothing** as the forecasting model type.

5 If you are running the step using the CAS Server, specify how to generate the code for the step. You can choose from these options:

- **Use TSMODEL procedure**
- **Use CAS procedure**

Step 4: Set the Output Options

On the **Output** tab, you can specify the output tables for the step. The types of output tables that you can create depend on the forecasting model type.

For every output table that you created, you must first add an output table to the flow.

1 Click **Add** ⇨ **Table** .

2 Select the Table node. In the table properties, enter the library name and the table name.

Note: If your input data is a SAS table, you must specify a SAS libref for the output table. If your input data is a CAS table, you must specify a CAS libref for the output table.

3 Right-click the Modeling and Forecasting node and select **Add output port** ⇨ **`type-of-output-table`** .

4 Connect the output port on the Modeling and Forecasting node to the Table node.

Motif Discovery

About the Motif Discovery Step

The Motif Discovery step provides methods to discover frequent patterns or repeated subsequences in time series data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Motif Discovery: Connection Requirements for the Node

In order to run the Motif Discovery step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 907. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Motif Discovery

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
%let motif_length = 10;
%let sequence_length = 300;
%let motif_position = (50, 150, 250);
%let n_motifs = 3;

data SimuData;
   format time date9.;
   array start {&n_motifs} &motif_position;
   array end {&n_motifs} &motif_position;
   call streaminit(123);

   do j=1 to dim(start);
          end[j]=start[j]+&motif_length;
   end;
   startDate = '31dec1999'd;
   do i=1 to &sequence_length;
          time=startDate+i;
          signal=rand('NORMAL');

      do j=1 to dim(start);
               if i >=start[j] and i<end[j] then
            do;
               signal=signal+10*sin((i-start[j])/
&motif_length*(2*constant('pi')));
            end;
      end;
      output;
   end;
   keep time signal;
run;


libname mycas cas;

data mycas.SimuData;
   set SimuData;
run;
```

Click **Run** to create the MyCas.SimuData table.

2 In the **Steps** section of the navigation pane, expand the **Forecasting** folder and double-click **Motif Discovery** to add the step to your flow.

3 Add the MyCas.SimuData table to your flow. Connect the input port of the Motif Discovery node to the data source. For more information, see “Connecting Nodes” on page 13.

4 To set the options for the Motif Discovery step, click the Motif Discovery node.

5 On the **Data** tab, assign columns to these roles:

- To the **Time series** role, assign **signal**.
- To the **Time ID** role, assign **time**. Select **Specify time ID properties**, and then select **Day** as the interval type.

6 Click the **Options** tab. In the **Distance margin factor** box, enter `1`.

7 Click the **Output** tab. Select the **Create motif instances information table**.

Add an output table to the flow.

a Select **Add** ⇨ **Table**.

b Select the Table node. In the Table Properties, enter **`MyCas`** as the library name and **`Mtfoutput`** as the table name.

c Right-click the Motif Discovery node and select **Add output port** ⇨ **Motif Instances Information Table**.

d Connect the new output port to the MyCas.Mtfoutput table.

8 On the **Output** tab, select**Create motif series table**.

Add an output table to the flow.

a Select **Add** ⇨ **Table**.

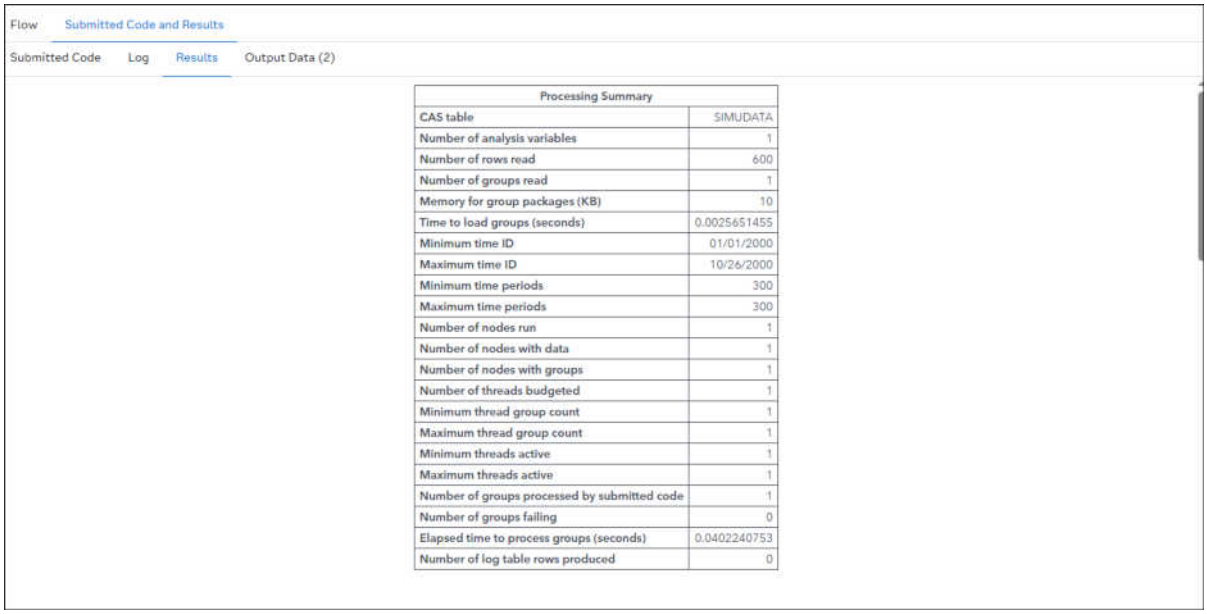
b Select the Table node. In the Table Properties, enter **`MyCas`** as the library name and **`Mtfseries`** as the table name.

c Right-click the Motif Discovery node and select **Add output port** ⇨ **Motif Series Table**.

d Connect the new output port to the MyCas.Mtfseries table.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Processing Summary	
CAS table	SIMUDATA
Number of analysis variables	1
Number of rows read	600
Number of groups read	1
Memory for group packages (KB)	10
Time to load groups (seconds)	0.0025651455
Minimum time ID	01/01/2000
Maximum time ID	10/26/2000
Minimum time periods	300
Maximum time periods	300
Number of nodes run	1
Number of nodes with data	1
Number of nodes with groups	1
Number of threads budgeted	1
Minimum thread group count	1
Maximum thread group count	1
Minimum threads active	1
Maximum threads active	1
Number of groups processed by submitted code	1
Number of groups failing	0
Elapsed time to process groups (seconds)	0.0402240753
Number of log table rows produced	0

Motif Discovery: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter motif data** field.

2 To the **Time series** role, assign the column that contains the time series data.

3 To the **Time ID** role, assign the column that contains the time ID values.

4 To specify the Time ID variable in a SAS date format, select **Specify Time ID properties**.

- **Interval** specifies the interval for the Time ID variable.
- **Multiplier** specifies the multiplier for the time interval. By default, the multiplier is 1. This value cannot be negative or 0.
- **Shift** specifies the shift for the time interval. By default, the shift is 1. This value cannot be negative or 0.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the motif discovery method. You can choose from these methods:

Brute-force (default)

For this method, you can specify these options:

- **Normalize the series** specifies whether to normalize the series. This option is selected by default.
- **Number of motifs** specifies the number of motifs. This value cannot be greater than 20. The default value is `1`.
- **Motif length** specifies the length of each motif instance. This value must be greater than 2. The default value is `10`.
- **Distance margin factor** specifies the value that is applied to searching for additional motif instances with a pair of motif instance candidates. A large value produces more motif instances. The default value is `0.01`.
- **Subsequence overlap proportion** specifies the amount of overlap. The default value is `0`, which means that no overlap is allowed. A value of 1 means complete overlap, but this value is not allowed. The actual offset value is offset=round(MOTIF LENGTH*(1–OVERLAP)).

Probabilistic model

- **Number of motifs** specifies the number of motifs. This value should not be greater than 20. The default value is `1`.
- **Motif length** specifies the length of each motif instance. This value must be greater than 2. The default value is `10`.
- **Number of quantile-based split points** specifies the number of quantile-based split points for symbolizing the time series. The default value is `10`.
- **Top k instances** requests that up to the top k motif instances in each motif set be in the output. Regardless of the value of the minimum inclusion probability, the first top instance of each motif is always in the output. The default value is `5`.
- **Minimum inclusion probability** specifies the minimum probability of starting time points to be included in each motif instance set. The default value is `0`.
- **Convergence criterion** specifies the convergence criterion for the EM algorithm. The default value is `0.01`.
- **Maximum number of iterations** specifies the maximum number of iterations. The default value is `200`. To specify a random seed, select **Specify random seed**.

2 Specify the statistics for the select motif discovery method. You can choose from these options:

- **Motif instances information**
- **Representative motif series**
- **Motif instances probabilities**

Note: This option is available only if you select the probabilistic model method.

3 Specify the plots to include in the results. By default, both a motif plot and a motif overlay plot are included in the results.

4 Specify how the code is generated for the step. You can choose from these options:

- **Use TSMODEL procedure**
- **Use CAS procedure**

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create these output tables: a motif instances information table, a motif series table, and a motif instances probabilities table.

If you are running this step in a flow, you must add the output table to the flow.

1 Select **Add** ⇨ **Table**.

2 Select the Table node. In the Table Properties, enter the library name and the table name.

3 Right-click the Motif Discovery node and select **Add output port** ⇨ **`type-of-output-table`**.

4 Connect the new output port to the Table node.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Motif Discovery node. For more information, see "Motif Discovery: Connection Requirements for the Node" on page 902.

Motif Scoring

About the Motif Scoring Step

The Motif Scoring step tries to find subsequences that are most similar to the target sequence in a new time series.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or

SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Motif Scoring: Connection Requirements for the Node

In order to run the Motif Scoring step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1124. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Motif Scoring

To create this example:

1 Run the Motif Discovery step to create the MyCas.MtfSeries data set.

2 Copy and paste this code on a **SAS Program** tab:

```
%let motif_length=10;
%let sequence_length=300;
%let motif_position=(100, 200);
%let n_motifs=2;

data ScoreData;
    format time date9.;
    array start {&n_motifs} &motif_position;
    array end {&n_motifs} &motif_position;
    call streaminit(123);
    do j=1 to dim(start);
        end[j]=start[j]+&motif_length;
```

```
    end;

    startDate = '31dec2009'd;

    do i=1 to &sequence_length;
        time=startDate+i;
        signal=rand('NORMAL');
        do j=1 to dim(start);
            if i >= start[j] and i<end[j] then do;
                signal=2*signal+5*sin((i-start[j])/
&motif_length*(2*constant('pi')));
            end;
        end;
        output;
    end;
    keep time signal;
run;

libname mycas cas;

data mycas.ScoreData;
   set ScoreData;
run;
```

Click **Run** to create the MyCas.ScoreData table.

3 In the **Steps** section of the navigation pane, expand the **Forecasting** folder and double-click **Motif Scoring** to add the step to your flow.

4 Add the MyCas.Mtfseriesand MyCas.ScoreData tables to your flow. Connect the input port of the Motif Scoring node to each data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Motif Scoring step, click the Motif Scoring node.

6 On the **Data** tab, assign columns to these roles:

- To the **Target** role, assign **MotifSeries**.
- To the **Motif ID** role, assign **MotifID**. From the **Motif identification number**, select `1`.

7 Under the **Score** heading, assign columns to these roles:

- To the **Input** role, assign **signal**.
- To the **Time ID** role, assign **time**. Select **Specify time ID properties**. For the interval type, select **Day**.

8 On the **Options** tab, enter `1` in the **Maximum distance** box.

9 Click the **Output** tab. Select the **Create motif scoring**.

Add an output table to the flow.

a Select **Add** ⇨ **Table**.

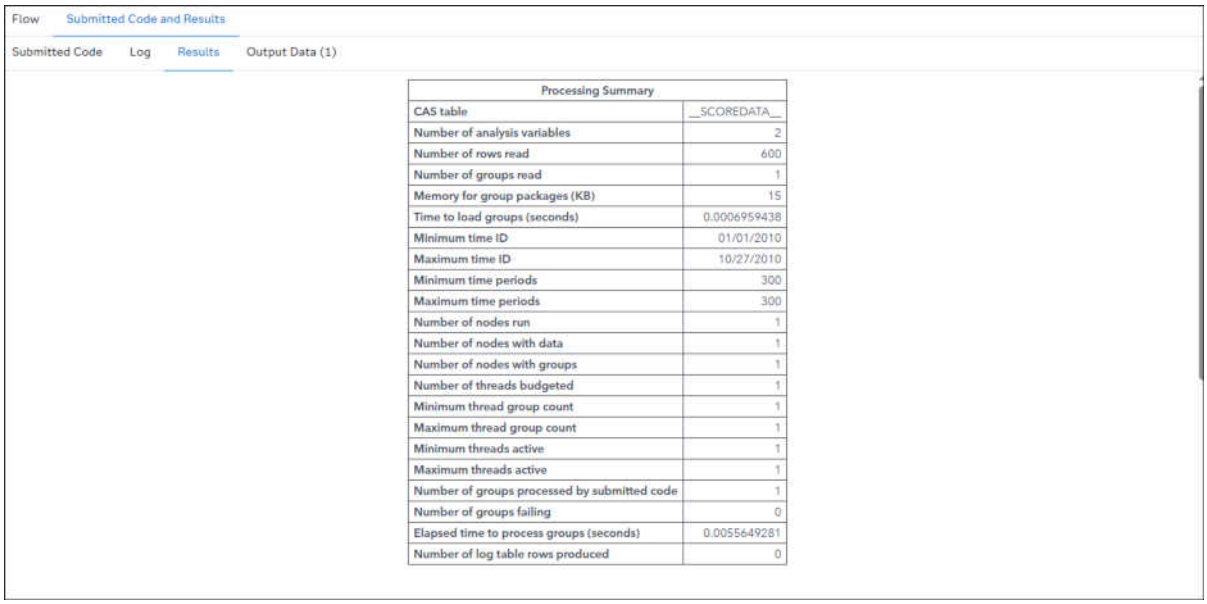
b Select the Table node. In the Table Properties, enter **`MyCas`** as the library name and **`Mtfscore`** as the table name.

c Right-click the Motif Scoring node and select **Add output port**.

d Connect the new output port to the MyCas.Mtfscore table.

10 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Processing Summary	
CAS table	_SCOREDATA_
Number of analysis variables	2
Number of rows read	600
Number of groups read	1
Memory for group packages (KB)	15
Time to load groups (seconds)	0.0006959438
Minimum time ID	01/01/2010
Maximum time ID	10/27/2010
Minimum time periods	300
Maximum time periods	300
Number of nodes run	1
Number of nodes with data	1
Number of nodes with groups	1
Number of threads budgeted	1
Minimum thread group count	1
Maximum thread group count	1
Minimum threads active	1
Maximum threads active	1
Number of groups processed by submitted code	1
Number of groups failing	0
Elapsed time to process groups (seconds)	0.0055649281
Number of log table rows produced	0

Motif Scoring: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter motif data** field.

2 Assign columns to these roles for the input data source that contains the target motif series.

- To the **Target** role, assign the variable with the target time series.
- To the **Motif ID** role, assign the variable that enables the user to select a specific motif. (The motif data set could contain multiple motifs.) Use **Motif identification number** to select a model.

3 Under the **Scores** heading, specify whether to filter the score data. Then assign columns to these roles for the input data source that contains the motif series to be scored.

- To the **Input** role, assign the time series variable.
- To the **Time ID** role, assign the column that contains the time ID values.

To specify the Time ID variable in a SAS date format, select **Specify time ID properties**.

- **Interval** specifies the interval for the Time ID variable.
- **Multiplier** specifies the multiplier for the time interval. By default, the multiplier is `1`. This value cannot be negative or 0.
- **Shift** specifies the shift for the time interval. By default, the shift is `1`. This value cannot be negative or 0.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1. (Optional) Specify whether to normalize the series.
2. Specify the maximum distance between the specified target motif series and the motif instances to be found. The default value is `100`.
3. (Optional) Specify the amount of overlap. The default value is `0`, which means no overlap is allowed. A value of 1 means complete overlap, but this value is not allowed. The actual offset value is offset=round(MOTIF LENGTH*(1–OVERLAP)).
4. Use the **Top k instances** option to specify the maximum number of motif instances to be found. The default value is `5`.
5. (Optional) Include a motif score table in the results.
6. (Optional) Include a motif score plot in the results.
7. Specify the code generation for the step. You can choose from these options:
   - **Use TSMODEL procedure**
   - **Use CAS procedure**

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to include a motif scoring table in the results.

If you are running this step in a flow, add an output table to the flow.

1. Select **Add** ⇨ **Table**.
2. Select the Table node. In the Table Properties, enter the library name and the table name.
3. Right-click the Motif Scoring node and select **Add output port**.
4. Connect the new output port to the Table node.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Motif Scoring node. For more information, see "Motif Scoring: Connection Requirements for the Node" on page 908.

Similarity Analysis

About the Similarity Analysis Step

The Similarity Analysis step provides methods to measure the similarity between two time series or among sequences in temporal data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Similarity Analysis: Connection Requirements for the Node

In order to run the Similarity Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 916. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Similarity Analysis

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
data DstTestData;
    input time x1 y1 @@;
    datalines;
1 3 2 2 2 4 3 3 6 4 3 7 5 4 3 6 6 8 7 3 9 8 8 3 9 6 7 10 7 9
;
run;

data DstTestData;
    format time date9.;
    set dsttestdata;
    x2=x1+rannor(122);
    x3=x1+rannor(233);
    y2=y1+rannor(565);
    y3=y1+rannor(585);
run;

data mycas.DstTestData;
    set DstTestData;
run;
```

Click **Run** to create the MyCas.DstTestData table.

2 In the **Steps** section of the navigation pane, expand the **Forecasting** folder and double-click **Similarity Analysis** to add the step to your flow.

3 Add the MyCas.DstTestData table to your flow. Connect the input port of the Similarity Analysis node to each data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Similarity Analysis step, click the Similarity Analysis node.

5 On the **Data** tab, assign columns to these roles:

- To the **Target** role, assign **y1**, **y2**, and **y3**.
- To the **Time ID** role, assign **time**. Select **Specify time ID properties**, and then select **Day** as the interval type.

6 Click the **Output** tab. Select **Save distance measure data**.

Add an output table to the flow.

a Select **Add** ⇨ **Table**.

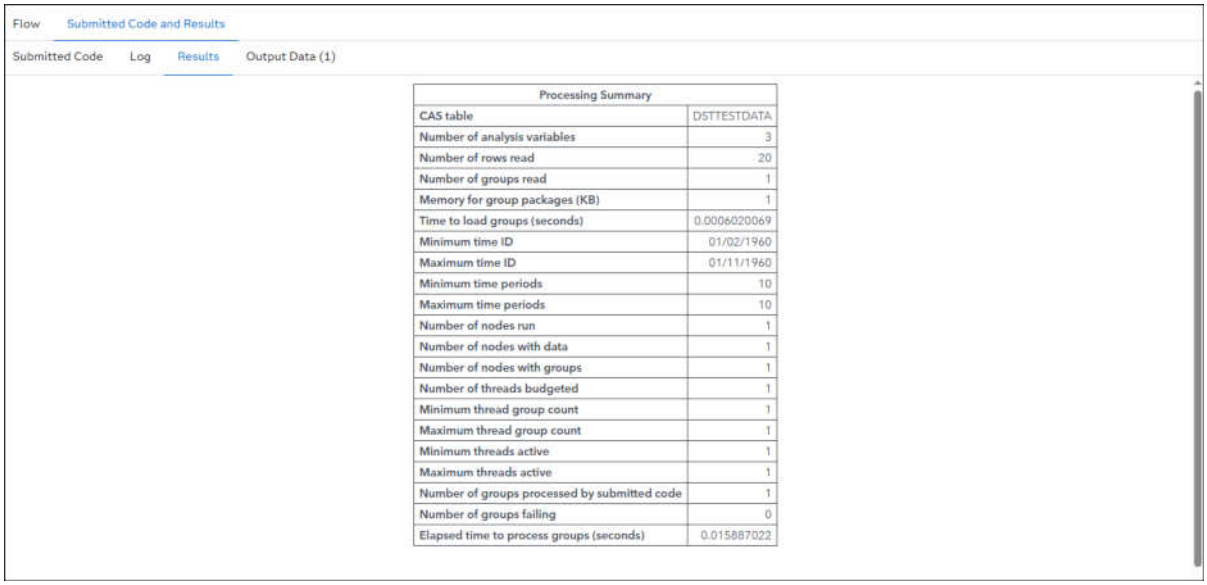
b Select the Table node. In the Table Properties, enter **`MyCas`** as the library name and **`Dstoutput`** as the table name.

c Right-click the Similarity Analysis node and select **Add output port** ⇨ **Distance Measure Table**.

d Connect the new output port to the MyCas.Dstoutput table.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Processing Summary	
CAS table	DSTTESTDATA
Number of analysis variables	3
Number of rows read	20
Number of groups read	1
Memory for group packages (KB)	1
Time to load groups (seconds)	0.0006020069
Minimum time ID	01/02/1960
Maximum time ID	01/11/1960
Minimum time periods	10
Maximum time periods	10
Number of nodes run	1
Number of nodes with data	1
Number of nodes with groups	1
Number of threads budgeted	1
Minimum thread group count	1
Maximum thread group count	1
Minimum threads active	1
Maximum threads active	1
Number of groups processed by submitted code	1
Number of groups failing	0
Elapsed time to process groups (seconds)	0.015887022

Similarity Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Target** role, assign the variable that contains the time series data.

Note: If only target variables are specified, the task calculates the distance of all pairwise combinations of the target series.

3 To the **Time ID** role, assign the variable that contains the time ID values.

To specify the Time ID variable in a SAS date format, select **Specify time ID properties**.

- **Interval** specifies the interval for the Time ID variable.
- **Multiplier** specifies the multiplier for the time interval. By default, the multiplier is 1. This value cannot be negative or 0.

- **Shift** specifies the shift for the time interval. By default, the shift is `1`. This value cannot be negative or 0.

4 To the **Inputs**, assign the variable that contains the input time series.

5 Specify how missing values are interpreted in the input and target time series.

6 Specify whether the missing values are trimmed from the time series.

7 Select the normalization method for the target and input series. By default, no normalization method is used.

8 Scale the input series by using the absolute or standard normalization of the target series. By default, no scaling is used.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the distance measure method. Here are the settings for each distance measure method:

- **Distance function** specifies whether to use the Hamming distance, Manhattan distance, Euclidean distance, Maximum deviation, or Cosine distance as the distance measure metric.
- **Dynamic time warping** specifies whether to use Absolute deviation, Mean absolute deviation, Mean square deviation, root square deviation, or square deviation as the distance measure metric. By default, the step uses root square deviation. For the input and target series, you can specify the size of the warping window and the percentage of the input or target series.
- **Longest common subsequence** specifies the fuzz value for matching two points. If two points are not exactly the same, but the distance between them is less than the fuzz value, the two points are considered matching. The default fuzz value is `0.1`.
- **Symbolic aggregate approximation** specifies either the lower bounding of the Euclidean distance or the minimum distance between SAX representations of the input and target series. You can also specify the number of bins for piecewise aggregate approximation and the number of breakpoints for symbols. The default value for both options is `10`.

2 Under the **Multivariate Distance** heading, specify whether to use the first principal component for the distance calculation.

Note: This option is applied only when there are two or more target series and the number of input series equals the number of target series.

3 Specify the statistics to include in the results. The additional statistics depend on the distance measure method that you previously selected.

4 Specify the code generation for the step. You can choose from these options:

- **Use TSMODEL procedure**
- **Use CAS procedure**

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create any output tables.

The output tables depend on the distance measure method that you selected. You can always create an output data table that contains the distance measure between the target and input series.

- For the dynamic time warping method, you can create a time warping path table if the number of input series equals the number of target series.
- For the longest common subsequence method, you can create a table that contains the longest common subsequence path if the number of input series equals the number of target series.
- For the symbolic aggregate approximation method, you can create a table that contains the PAA and SAX values for each bin.

If you are running this step in a flow, add an output table to the flow.

1. Select **Add** ⇨ **Table**.
2. Select the Table node. In the Table Properties, enter the library name and the table name.
3. Right-click the Similarity Analysis node and select **Add output port** ⇨ `type-of-output-data`.
4. Connect the new output port to the Table node.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Similarity Analysis node. For more information, see "Similarity Analysis: Connection Requirements for the Node" on page 912.

Subsequence Anomaly Detection

About the Subsequence Anomaly Detection Step

The Subsequence Anomaly Detection step is a motif-based technique that finds anomaly subsequences in a specified input sequence.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Subsequence Anomaly Detection: Connection Requirements for the Node

In order to run the Subsequence Anomaly Detection step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1124. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Subsequence Anomaly Detection

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
data SimuData2;
    format time date9.;
    startDate = '31dec2014'd;

    do i=1 to 300;
        time=startDate+i;
        signal = rand('NORMAL');
        if(200 < i <= 210) then signal=signal+5;
        if(100 < i <= 110) then signal=signal-3;
        output;
```

```
    end;
    keep time signal;
run;

libname mycas cas;

data mycas.SimuData2;
   set SimuData2;
run;
```

Click **Run** to create the MyCas.SimuData2 table.

2 In the **Steps** section of the navigation pane, expand the **Forecasting** folder and double-click **Subsequence Anomaly Detection** to add the step to your flow.

3 Add the MyCas.SimuData2 table to your flow. Connect the input port of the Subsequence Anomaly Detection node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Subsequence Anomaly Detection step, click the Subsequence Anomaly Detection node.

5 On the **Data** tab, assign columns to these roles:

- To the **Time series** role, assign **signal**.
- To the **Time ID**, assign **time**. Select **Specify time ID properties**, and then select **Day** as the interval type.

6 Click the **Output** tab. Select **Save anomaly subsequences**.

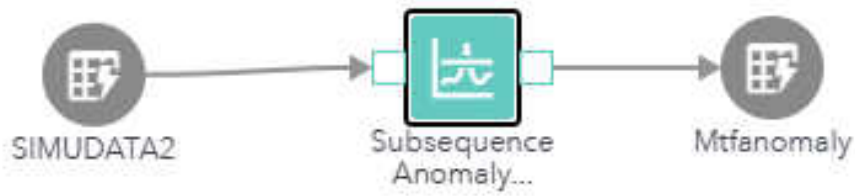
Add an output table to the flow.

a Select **Add** ⇨ **Table**.

b Select the Table node. In the Table Properties, enter **`MyCas`** as the library name and **`Mtfanomaly`**.

c Right-click the Subsequence Anomaly Detection node and select **Add output port**.

d Connect the new output port to the MyCas.Mtfanomaly table.



7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

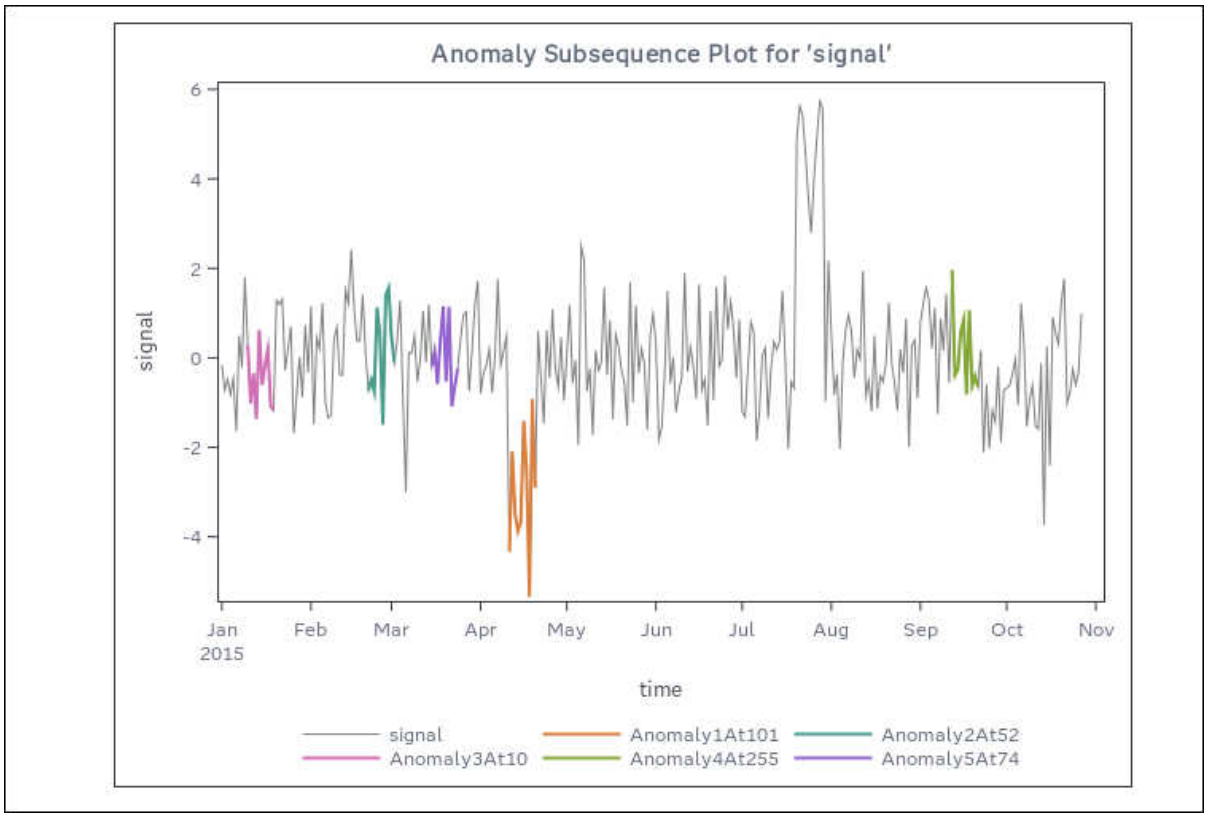
Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

Processing Summary	
CAS table	SIMUDATA2
Number of analysis variables	1
Number of rows read	600
Number of groups read	1
Memory for group packages (KB)	10
Time to load groups (seconds)	0.0035700798
Minimum time ID	01/01/2015
Maximum time ID	10/27/2015
Minimum time periods	300
Maximum time periods	300
Number of nodes run	1
Number of nodes with data	1
Number of nodes with groups	1
Number of threads budgeted	1
Minimum thread group count	1
Maximum thread group count	1
Minimum threads active	1
Maximum threads active	1
Number of groups processed by submitted code	1
Number of groups failing	0
Elapsed time to process groups (seconds)	0.0080070496
Number of log table rows produced	0

Subsequence Anomaly Detection for 'signal'

Obs	Anomaly Rank	Anomaly Start Position	Anomaly Start Time	Distance
1	1	101	04/11/2015	2.5312
2	2	52	02/21/2015	2.4640
3	3	10	01/10/2015	2.4243
4	4	255	09/12/2015	2.4234
5	5	74	03/15/2015	2.3990



Subsequence Anomaly Detection: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Time series** role, assign the variable that contains the time series data.

3 To the **Time ID** role, assign the column that contains the time ID values.

To specify the time ID variable in a SAS date format, select **Specify time ID properties**.

- **Interval** specifies the interval for the time ID variable.
- **Multiplier** specifies the multiplier for the time interval. By default, the multiplier is 1. This value cannot be negative or 0.
- **Shift** specifies the shift for the time interval. By default, the shift is 1. This value cannot be negative or 0.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1. (Optional) Specify whether to normalize the series. By default, the series is normalized.
2. (Optional) Specify the length of anomaly subsequence. The default value is `10`.
3. (Optional) Specify the amount of overlap. The default value is `0`, which means no overlap is allowed. A value of `1` means complete overlap, but this value is not allowed. The actual offset value is offset=round(MOTIF LENGTH*(1–OVERLAP)).
4. (Optional) Use the **Top k anomaly instances** option to specify the maximum number of anomaly instances to be found. The default value is `5`.
5. (Optional) Include the statistics for subsequence anomaly detection in the results.
6. (Optional) Include a plot of the input time series with the identified anomaly subsequences overlaid in the results.
7. Specify the code generation for the step. You can choose from these options:
   - **Use TSMODEL procedure**
   - **Use CAS procedure**

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to include an anomaly subsequences table in the results.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Subsequence Anomaly Detection node. For more information, see "Subsequence Anomaly Detection: Connection Requirements for the Node" on page 917.

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Visualizing Your Data

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Bar Chart

About Bar Chart Step

The Bar Chart step creates horizontal or vertical bar charts that compare numeric values or statistics between different values of a chart variable. Bar charts show the relative magnitude of data by displaying bars of varying height. Each bar represents a category of data.

The bar chart is a bi-directional plot. It uses Category and Measure as role names, and the corresponding axes are called Category Axis and Measure Axis.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Bar Chart: Connection Requirement for the Node

In order to run the Bar Chart step, you must connect a table to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Examples: Bar Chart

Total Sales for Each Product Line

1 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Bar Chart** to add the step to your flow.

2 Add the Sashelp.PriceData table to your flow. Connect the input port of the Bar Chart node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the Bar Chart step, click the Bar Chart node.

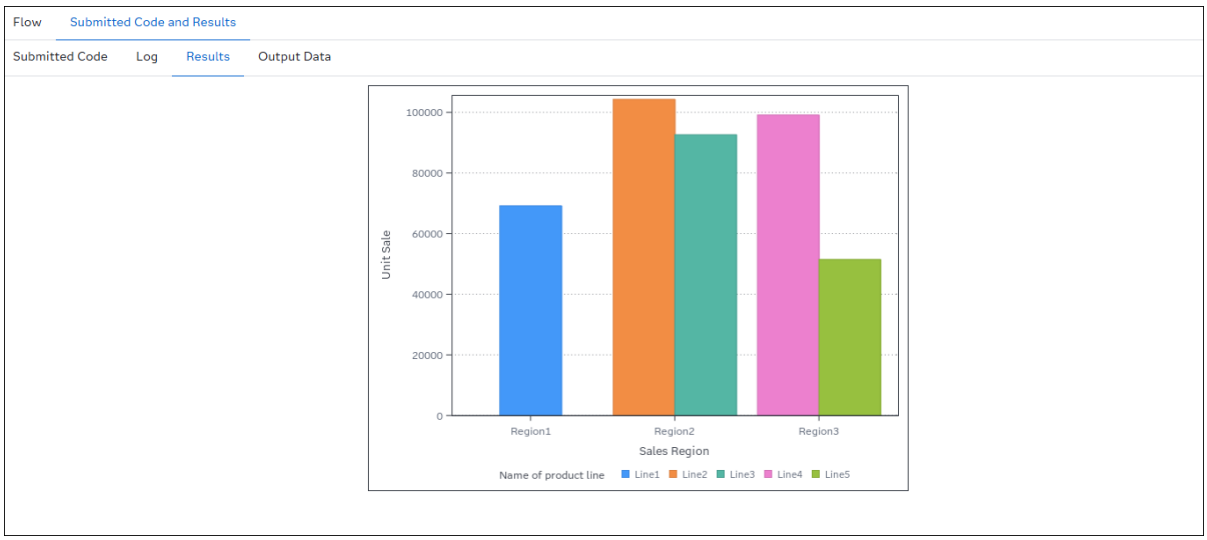
4 On the **Data** tab, assign columns to these roles:

- Assign the **regionName** column to the **Category** role.
- Assign the **productLine** column to the **Subcategory** role.

5 From the **Measure** drop-down list, select **Variable**. Assign **sale** to the **Measure variable** role. From the **Statistic** drop-down list, select **Sum (default)**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Total Sales by Frequency

1 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Bar Chart** to add the step to your flow.

2 Add the Sashelp.PriceData table to your flow. Connect the input port of the Bar Chart node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the Bar Chart step, click the Bar Chart node.

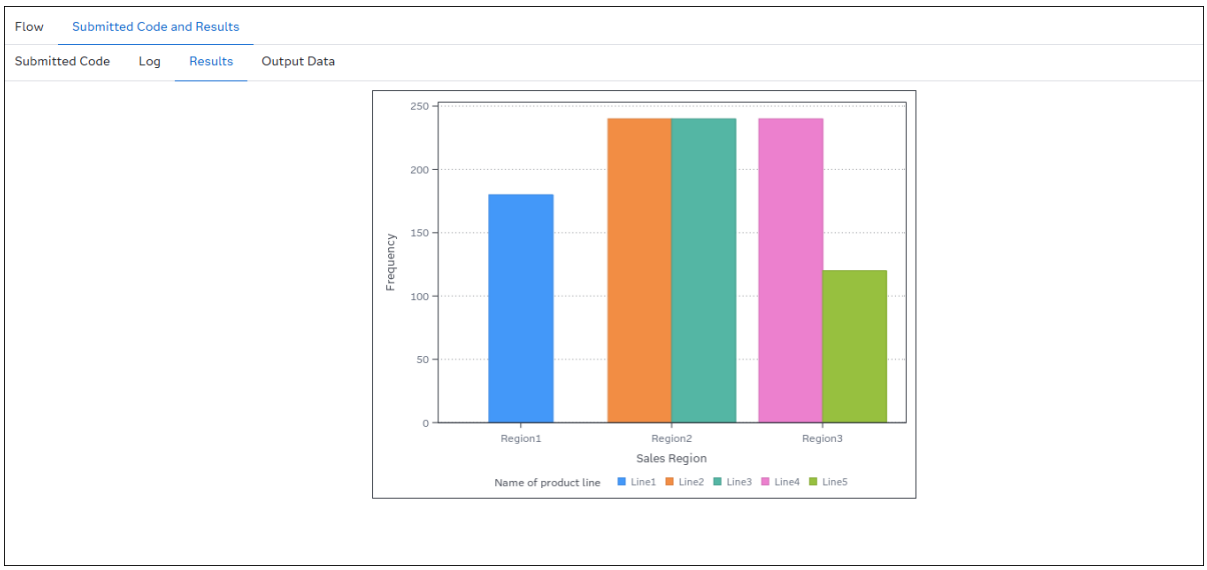
4 On the **Data** tab, assign columns to these roles:

- Assign the **regionName** column to the **Category** role.
- Assign the **productLine** column to the **Subcategory** role.

5 From the **Measure** drop-down list, select **Frequency count (default)**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Include Links in Your Bar Chart

1 Copy and paste this code in a **SAS Program** tab:

```
data class_url;
  length URL $300;
  set sashelp.class;
    if Sex='F'
      then URL='http://www.sas.com';
      else URL='http://support.sas.com/';
  run;
```

Run the to create the Work.class_url table.

2 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Bar Chart** to add the step to your flow.

3 Add the Work.class_url table to your flow. Connect the input port of the Bar Chart node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Bar Chart step, click the Bar Chart node.

5 On the **Data** tab, assign columns to these roles:

- Assign the **Age** column to the **Category** role.
- Assign the **Sex** column to the **Subcategory** role.

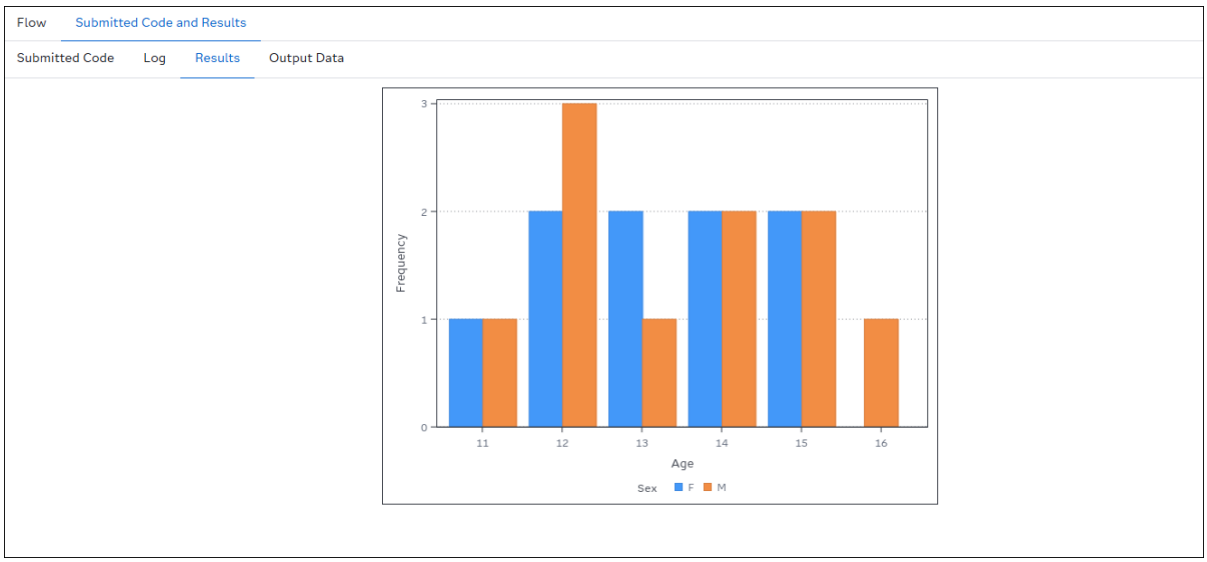
6 On the **Options** tab, expand the **Bars > Details**heading.

Assign **URL** to the **URL variable** role.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

In the SAS Data and AI Studio results, click a bar to view the associated website in the lower left corner of SAS Data and AI Studio.



Bar Chart: Step-by-Step Instructions

Step 1: Assign Data to Roles

You can create either a vertical or horizontal bar chart. To run the Bar Chart step, you must assign a column to the **Category** role.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Category** role, assign the variable that classifies the observations into distinct subsets.

3 (Optional) To the **Subcategory** role, assign a variable that is used to group the data.

   You can specify how the grouped bars are displayed and where the legend appears in relation to the graph.

4 To the **Measure** role, specify how to calculate the bar height. You can use the frequency count (the default), the frequency percent, or the value of a variable in the input data source.

   If you select **Variable** from the drop-down list, you must assign a column to the **Variable** role. Then you must specify the statistic to use in the calculation of the variable. You can choose from sum, mean, or percent of sum. The default statistic is sum.

   If you select **Mean**, you can include error bars on your chart.

5 (Optional) To the **Group analysis by** role, assign the variable to use to create a separate graph for each BY group.

6 (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

Step 2: Set the Appearance Options

On the **Appearance** tab, you can set these options:

1 Set the appearance options for the bars.

- (Optional) **Show labels** displays the measure values as data labels.
- (Optional) **Set color** specifies the color of the bars.

  Note: This option is not available if you assign a variable to the **Subcategory** role.

- **Color transparency** specifies the transparency for the bars. The range is from 0% (completely opaque) to 100% (completely transparent).
- (Optional) **Apply color gradient** applies a gradient to each bar.
- **Effect** specifies a special effect to be used on the plot. The data skin affects all filled graph elements. The effect that a data skin has on a filled area depends on the skin type, the graph style, and the color of the skinned element. Most of the skins work best with lighter colors over a medium-to-large filled area.
- (Optional) **URL variable** specifies a character variable that contains URLs for web pages. In the results, click the links to view the website that is associated with that graphical element.

2 Set the appearance options for the Category axis.

- (Optional) Specify whether the values for the tick marks be displayed in reverse (descending) order.
- (Optional) Specify whether to place the discrete values for the tick marks in the order in which they appear in the data.
- Display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- (Optional) Specify whether to rotate the labels on the X axis by 45 or 90 degrees to prevent the tick marks from overwriting the label text.
- (Optional) Specify whether to create a reference line for the axis. Select the value of the reference line from the drop-down list.

  Reference lines can be offset. Select the offset from the **Line offset** drop-down list.

  You can also specify the label for the reference line.

3 Set the appearance options for the Measure axis.

- (Optional) Specify the minimum value on the axis.
- (Optional)

  Specify the maximum value on the axis.
- (Optional) Specify whether to create grid lines at each tick mark on the measure axis.
- Specify whether to display labels on the measure axis.
- (Optional) Specify whether to use a logarithmic scale for the Measure axis. You can specify the base value for the scale as either **10 (default)**, **2**, or **e**. You must specify the baseline for the axis.
- (Optional) Specify whether to create a reference line for the Measure axis. Because only numerical variables can be assigned to the **Measure** role, you must specify the value of the reference line.

4 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

5 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Bar-Line Chart

About the Bar-Line Chart Step

The Bar-Line Chart step creates a vertical bar chart with a line chart overlay.

You can use the Bar-Line Chart step to perform these tasks:

- display and compare exact and relative magnitudes
- examine the contribution of each part to the whole
- determine trends and patterns in the data

Bar-Line Chart: Connection Requirement for the Node

In order to run the Bar-Line Chart step, you must connect a table to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: City and Highway Mileage by Country of Origin

You can create a bar-line chart that compares the number of miles per gallon (in the city and on the highway) that cars use depending on their country of origin. The step calculates the mean of the number of miles per gallon in the city and on the highway for each country. This bar-line chart shows that cars from Asia tend to get the highest number of miles per gallon in city and highway driving.

1 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Bar-line Chart** to add the step to your flow.

2 Add the SasHelp.Cars table to your flow. Connect the input port of the Bar-line Chart node to the data source. For more information, see "Connecting Nodes" on page 13.

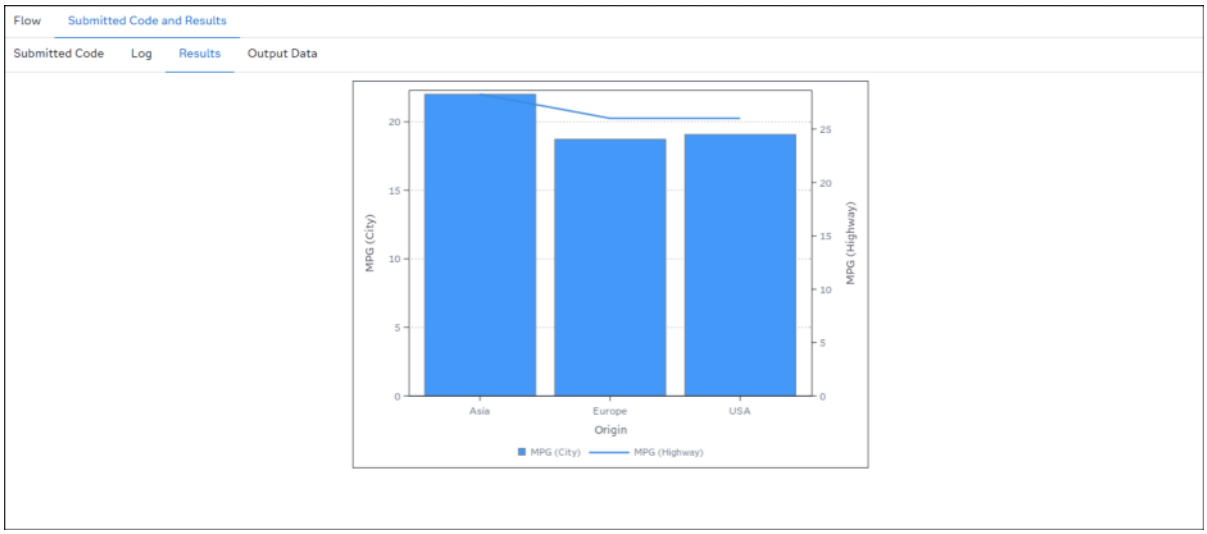
3 To set the options for the Bar-line Chart step, click the Bar-line Chart node.

4 On the **Data** tab, assign columns to these roles:

- Assign the **Origin** column to the **Category** role.
- Assign the **MPG_City** column to the **Bar variable** role.
- Assign the **MPG_Highway** column to the **Line variable** role.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Bar-Line Chart: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Bar-Line Chart step, you must assign a column to the **Category**, **Bar variable**, and **Line variable** roles.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Category** role, specifies the variable that classifies the observations into distinct subsets.

3 (Optional) To the **Subcategory** role, specifies how to group the categorized data.

   You can specify how the grouped bars are displayed and where the legend appears in relation to the graph.

4 To the **Bar variable** role, specifies a numeric response variable for the bar chart. You can calculate the mean or the sum for the bar variable. By default, the mean is used.

5 To the **Line variable** role, specifies a numeric response variable for the line plot. You can calculate the mean or sum for the line plot. By default, the mean is used.

6 (Optional) To the **Group analysis by** role, creates a separate graph for each BY group.

7 (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

Step 2: Set the Appearance Options

On the **Appearance** tab, you can set these options:

1 Set the appearance options for the bars.

- (Optional) **Show labels** displays the statistics on each bar.
- (Optional) **Set color** specifies the color of the bars.

  Note: This option is not available if you assign a variable to the **Subcategory** role.

- **Color transparency** specifies the transparency for the bars. The range is from 0% (completely opaque) to 100% (completely transparent).
- (Optional) **Apply color gradient** applies a gradient to each bar.
- **Effect** specifies a special effect to be used on the plot. The data skin affects all filled graph elements. The effect that a data skin has on a filled area depends on the skin type, the graph style, and the color of the skinned element. Most of the skins work best with lighter colors over a medium-to-large filled area.
- **URL variable** specifies a character variable that contains URLs for web pages. In the results, click the links to view the website that is associated with that graphical element.

2 Set the appearance options for the line.

- (Optional) **Show labels** displays the statistic for each data point in the line.
- (Optional) **Set color** enables you to specify the color of the line.

Note: This option is not available if you assign a variable to the **Subcategory** role.

- **Thickness** specifies the thickness (in pixels) of the line. The default is 1 pixel.
- **Color transparency** specifies the transparency for the line. The range is from 0% (completely opaque) to 100% (completely transparent).
- **Line style** specifies whether to use a solid line or a patterned line.
- (Optional) **URL variable** specifies a character variable that contains URLs for web pages. In the results, click the links to view the website that is associated with that graphical element.

3 Set the appearance options for the X axis.

- (Optional) Specify whether the values for the tick marks be displayed in reverse (descending) order.
- (Optional) Specify whether to place the discrete values for the tick marks in the order in which they appear in the data.
- Specify whether to display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- (Optional) Specify whether to rotate the labels on the X axis by 45 or 90 degrees to prevent the tick marks from overwriting the label text.
- (Optional) Specify whether to create a reference line for the axis. Select the value of the reference line from the drop-down list.

  Reference lines can be offset. Select the offset from the **Line offset** drop-down list.

  You can also specify the label for the reference line.

4 Set the appearance options for the Y axis.

- (Optional) **Use zero baseline** specifies that the minimum for the Y axis is 0. There is no offset for the lowest data value on the axis. If you do not select this option, the offset for the lowest data value is determined by the step.
- (Optional) **Use uniform scale** uses the same scale for both response axes.
- (Optional) **Show grid lines** creates grid lines at each tick mark on the Y axis.
- **Display label** enables you to display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- (Optional)

  Create a reference line enables you to create a reference line for the bar or line axis. You must specify the value of this line. You can also specify whether to label the reference line with this value or use a custom label.

5 (Optional) Specify the location of the legend and a custom title and footnote for the output. You can also specify the font size for this text.

6 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Box Plot

About Box Plot

The Box Plot step represents numeric values measured as intervals. The box plot is a bi-directional plot. It uses Category and Analysis as role names, and the corresponding axes are called Category Axis and Analysis Axis.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Box Plot: Connection Requirement for the Node

In order to run the Box Plot step, you must connect a table to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Box Plots Comparing MPG (City) for Cars

This example creates three groups of box plots that compare how many miles per gallon (city) cars consume depending on their area of origin (Asia, Europe, and the United States).

To create this example:

1 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Box Plot** to add the step to your flow.

2 Add the Sashelp.Cars table to your flow. Connect the input port of the Box Plot node to the data source. For more information, see "Connecting Nodes" on page 13.

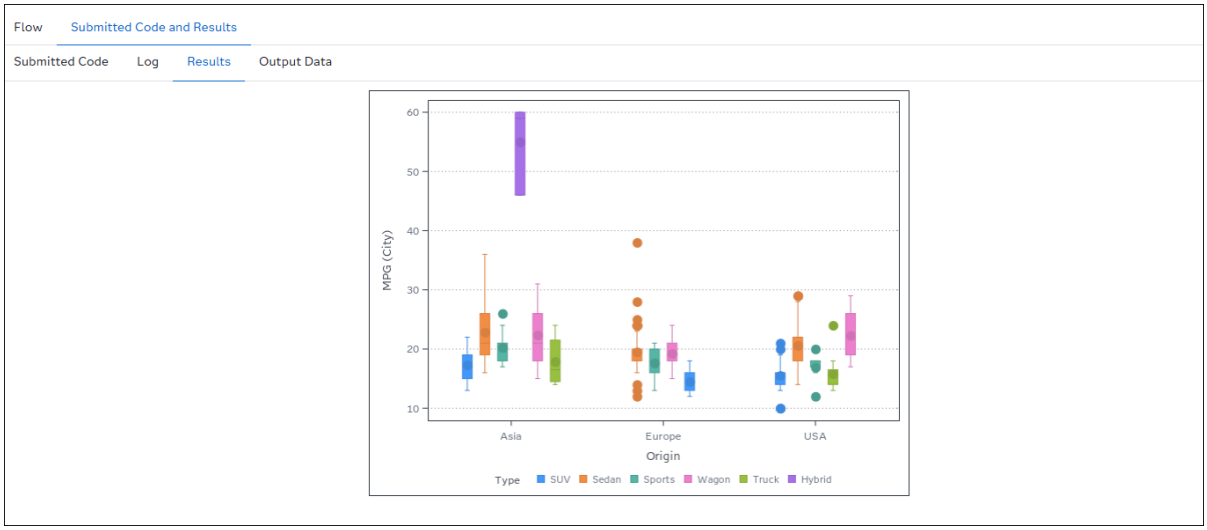
3 To set the options for the Box Plot step, click the Box Plot node.

4 On the **Data** tab, assign columns to these roles:

- To the **Analysis variable** role, assign **MPG_City**.
- To the **Category** role, assign **Origin**.
- To the **Subcategory** role, assign **Type**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Box Plot: Step-by-Step Instructions

Step 1: Assign Data to Roles

You can create a vertical or horizontal box plot. To run the Box Plot step, you must assign a column to the **Analysis variable** role.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Analysis variable** role, assign the analysis variable for the plot.

3 (Optional) To the **Category** role, assign the category variable. The step creates a box plot for each distinct value of the category variable.

4 (Optional) To the **Subcategory** role, assign the variable for the subcategory. The step creates a box plot for each distinct value of the subcategory within the category.

   If you assign a variable to this role, you can order the subcategories in these ways:

   - in the order in which subcategories appear in the data
   - in the reverse order that the subcategories appear in the data
   - in ascending alphabetical order
   - in descending alphabetical order

     To help distinguish between the subcategories, a legend is created. You can place this legend inside or outside the graph.

5 (Optional) To the **Group analysis by** role, assign the variable that creates a separate graph for each BY group.

6 (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1 Set the appearance options for the boxes.

   - Specify the width of each box.
   - (Optional) Specify the color of the boxes.
   - (Optional) Specify whether the boxes be notched.
   - Specify the transparency for the bars. The range is from 0% (completely opaque) to 100% (completely transparent).
   - Specify a special effect to be used on the plot. The data skin affects all filled graph elements. The effect that a data skin has on a filled area depends on the skin type, the graph style, and the color of the skinned element. Most of the skins work best with lighter colors over a medium-to-large filled area.
   - Specify whether to display the cap lines for the whiskers. If you select this option, you can select the shape of the whisker cap lines. Here are the valid values:
     - **Bracket** displays a straight line with brackets.
     - **Line** displays a straight line.

       Serif displays a short straight line.

2 Set the appearance options for the category axis.

- (Optional) Specify whether the values for the tick marks be displayed in reverse (descending) order.
- (Optional) Specify whether to place the discrete values for the tick marks in the order in which they appear in the data.
- Specify whether to display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- (Optional) Specify whether to rotate the labels on the X axis by 45 or 90 degrees to prevent the tick marks from overwriting the label text.
- (Optional) Specify whether to create a reference line for the axis. Select the value of the reference line from the drop-down list.

  Reference lines can be offset. Select the offset from the **Line offset** drop-down list.

  You can also specify the label for the reference line.

3 Set the appearance options for the analysis axis.

- (Optional) Specify the minimum value on the axis.
- (Optional) Specify the maximum value on the axis.
- (Optional) Specify whether to create grid lines at each tick mark on the measure axis.
- Specify whether to display a label on the axis.
- (Optional) Specify whether to use a logarithmic scale for the Measure axis. You can specify the base value for the scale as either **10 (default)**, **2**, or **e**. You must specify the baseline for the axis.
- (Optional) Specify whether to create a reference line for the Analysis axis. Specify a value for this line. You can also specify whether to label the reference line with this value or use a custom value.

4 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

5 (Optional) specify the width and height of the graph in inches, centimeters, or pixels.

Bubble Map

About the Bubble Map Step

The Bubble Map step creates a map that is overlaid with a bubble plot.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Bubble Map: Connection Requirement for the Node

In order to run the Bubble Map step, you must connect a table to the input node.

Input Port	Output Port
For the Bubble Map node, an input data source is required. You could also have input data sources for the map data and map response data. If you need to include either of these input data sources in the step, you must add an additional input port to the Bubble Map node. To add an input port, right-click the Bubble Map node and select **Add input port**. Then select **Map Data** or **Map Response Data**. For more information, see "Step 1: Assign Data to Roles " on page 943. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Here is an example of a Bubble Map node with three input ports:

Flow Submitted Code and Results

Example: Bubble Map

To create this example:

1 On a **SAS Program** tab, copy and paste this code:

```
data city_loc (label='Nevada Cities'
               keep=county city city2 lat long county_name);
  set mapsgfk.uscity_all(where=(state=32));
run;
proc sort data=city_loc;
  by city2;
run;
data city_pop (label='Nevada County Seat Populations');
  length city $65 city2 $55;
  infile datalines dlm=',';
  input city population_city county;
  label city            = 'County Seat'
        city2           = 'Normalized city name'
        population_city = 'City Population'
        county          = 'County FIPS Code';
  city2 = upcase(compress(city));
cards;
Fallon, 8458, 1
Las Vegas, 623747, 3
Minden, 3180, 5
Elko, 20279, 7
Goldfield, 443, 9
Eureka, 487, 11
Winnemucca, 7887, 13
Battle Mountain, 3276, 15
Pioche, 911, 17
Yerington, 3064, 19
```

```
Hawthorne, 3095, 21
Tonopah, 2360 , 23
Lovelock, 1878, 27
Virginia City, 717, 29
Reno, 241445, 31
Ely, 4134, 33
Carson City, 54521, 510
;
proc sort data=city_pop;
  by city2;
run;
data city_pop_loc;
  merge city_pop (in=a) city_loc;
  by city2;
  if a;
run;

data nevada;
  set mapsgfk.us_counties(where=(state=32)
                          drop=x y
                          rename=(long=x lat=y));
run;
data county_pop (label='Nevada Counties');
  length county_name $55;
  infile datalines dlm=',';
  state=32;
  input county_name county population_county;
  label state             = 'State FIPS Code'
        county_name       = 'County Name'
        county            = 'County FIPS Code'
        population_county = '2010 Census County Population'
        group             = 'Population range';
  /* Add five population ranges as groups to map response data. */
  if      population_county > 100000 then group='Greater than 100,000';
  else if population_county > 10000  then group='10,000 - 100,000';
  else if population_county > 5000   then group='5,000 - 10,000';
  else if population_county > 1000   then group='1,000 - 5,000';
  else                                    group='Less than 1,000';
cards;
Churchill, 1, 24877
Clark, 3, 2069681
Douglas, 5, 47710
Elko, 7, 52766
Esmeralda, 9, 783
Eureka, 11, 1987
Humboldt, 13, 17019
Lander, 15, 5775
Lincoln, 17, 5036
Lyon, 19, 52585
Mineral, 21, 4772
Nye, 23, 43946
Pershing, 27, 6753
Storey, 29, 3987
Washoe, 31, 446903
White Pine, 33, 10030
Carson City, 510, 54521
```

```
;
```

Click **Run**.

These tables are created:

- city_pop – a data set that contains the population for each county seat in Nevada.

  city_loc – a map data set that lists the location of the Nevada cities.

  city_pop_loc – a plot data set that contains Nevada city locations with population.

  nevada – a map data set that lists the Nevada county boundaries for the choropleth map.

- county_pop – a map response data set that contains the population for each Nevada county.

2 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Bubble Map** to add the step to your flow.

3 Add the Work.City_Pop_Loc table to your flow. Connect the input port of the Bubble Map node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Bubble Map step, click the Bubble Map node.

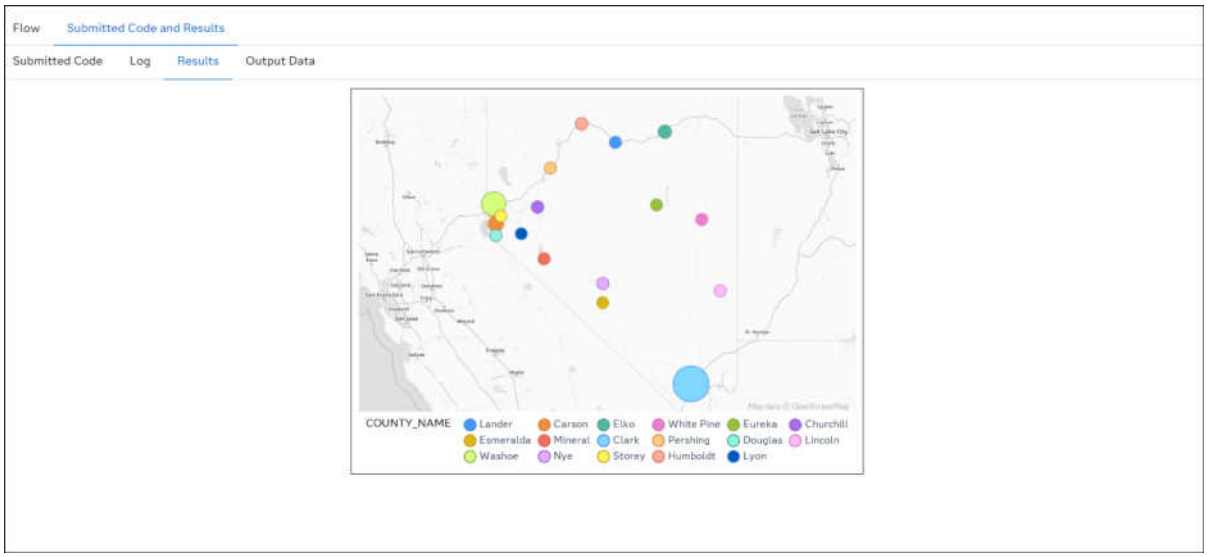
5 On the **Data** tab, set these options:

- To the **Latitude** role, assign **LAT**.
- To the **Longitude** role, assign **LONG**.
- To the **Bubble size** role, assign **population_city**.
- To the **Group** role, assign **COUNTY_NAME**.

6 Select **OpenStreetMap** as the base map.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Bubble Map: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Bubble Map step, you must assign a column to the **Latitude**, **Longitude**, and **Bubble size** roles.

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. To the **Latitude** role, assign the variable that contains the latitude values on the map.
3. To the **Longitude** role, assign the variable that contains the longitude values on the map.
4. To the **Bubble size** role, assign the numeric variable that controls the size of the bubbles.
5. (Optional) To the **Group** role, assign the variable that specifies how to group the data. Different groups have different markers.
6. (Optional) Select **Include choropleth map layer** to create a choropleth map. You must select the input data source that contains the shape polygons. Next, assign a column to the **ID variable** role, which identifies each shape in the map data set.

   If you include response data, you must specify the input data source that contains the response for each shape in the map data set. You also must assign a response variable whose values correspond to the shade of each shape and an ID variable that identifies each shape in the response data set.

Note: If you are running the step in flow, you must add input ports for the map data and map response data to the Bubble Map node. For more information, see "Bubble Map: Connection Requirement for the Node" on page 939.

For more information, see "Choropleth Map" on page 948.

7 Specify whether to use an OpenStreetMap or an Esri map as the base map. You must specify the URL for the Esri map that you want to use.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 (Optional) To the **Bubble label** role, assign the variable whose values are to be used as bubble labels. You can specify the font, size, and position of these labels.

2 (Optional) Specify whether to include a legend for the choromap.

Note: This option is available if you include response data for the choropleth map layer.

3 (Optional) Specify whether to include a legend. You can specify the legend title.

Note: This option is available if you assign a group variable.

4 (Optional) Specify whether the bubbles are solid and the color for these bubbles.

5 Specify the transparency for the bubbles on the map.

6 (Optional) For the chromo map, specify the line color, thickness, style, and transparency.

Note: These options are available if you select **Include choropleth map layer** on the **Data** tab.

7 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

8 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Bubble Plot

About the Bubble Plot Step

The Bubble Plot step explores the relationship between three or more variables. In a bubble plot, two variables determine the location of the bubble centers, and a third variable specifies the size of each bubble. A fourth variable can be used to determine the colors of the bubbles.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Bubble Plot: Connection Requirement for the Node

In order to run the Bubble Plot step, you must connect a table to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Bubble Plot

To create this example:

1 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Bubble Plot** to add the step to your flow.

2 Add the Sashelp.Class table to your flow. Connect the input port of the Bubble Plot node to the data source. For more information, see "Connecting Nodes" on page 13.

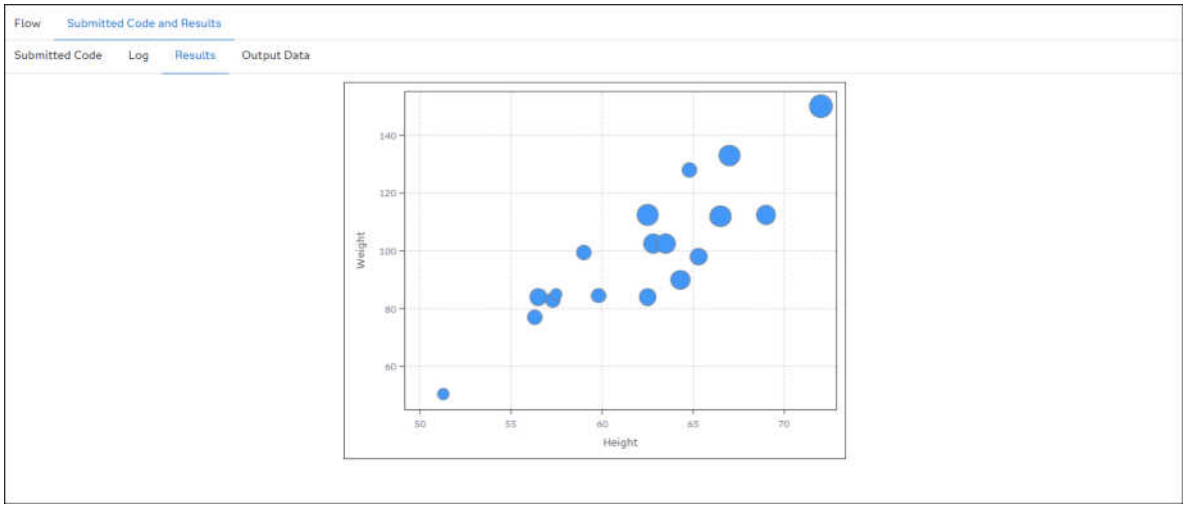
3 To set the options for the Bubble Plot step, click the Bubble Plot node.

4 On the **Data** tab:

- For the X axis, assign **Height** to the **Column** role.
- For the Y axis, assign **Weight** to the **Column** role.
- To the **Bubble size** role, assign the **Age** column.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Bubble Plot: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 For the X axis, specify the input column and variable type.

3 For the Y axis, specify the input column and variable type.

4 To the **Bubble size** role, assign a numeric variable that controls the size of the bubbles. The minimum and maximum values automatically provide the range that is used to determine bubble size. You can set these values on the **Options** tab.

5 For the bubble color, specify the numeric column that contains the colors for the bubbles.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1 Set the appearance options for the bubbles.

- (Optional) **Set color** specifies the color for the bubbles when a column is not assigned to the **Bubble color** role.
- **Minimum radius** specifies the radius of the smallest bubble.
- **Maximum radius** specifies the radius of the largest bubble.
- **Color transparency** specifies the transparency of the bars. The range is from 0% (completely opaque) to 100% (completely transparent).
- **Effect** specifies a special effect to be used on the plot. The data skin affects all filled graph elements. The effect that a data skin has on a filled area depends on the skin type, the graph style, and the color of the skinned element. Most of the skins work best with lighter colors over a medium to large filled area.
- (Optional) **URL variable** specifies a character variable that contains URLs for web pages. In the results, click the links to view the website associated with that graphical element.

  Note: If the step generates an "Other" bubble in the bubble plot, there is no URL associated with this bubble. Therefore, this bubble does not contain a link.

2 (Optional) To the **Bubble label**, assign the column that contains the values for the bubble labels. If you assign a variable to the **Bubble label** role, you can determine the label color, the font size for the label text, and the label position.

3 Set the options for the X and Y axes.

- (Optional) Specify the minimum value on the axis.
- (Optional) Specify the maximum value on the axis.
- (Optional) Specify whether to create grid lines at each tick on the axis.
- Specify whether to display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- (Optional) Specify whether to use a logarithmic scale on the axis. You can specify the base value for the scale as either **10 (default)**, **2**, or **e**.
- (Optional) Specify whether to rotate the labels on the X axis by 45 or 90 degrees to prevent the tick marks from overwriting the label text.

Note: This option is not available for the Y axis.

- (Optional) Specify whether to create a reference line for the axis. You must specify the value of this line. You can also specify whether to label the reference line with this value or use a custom value.

4 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

5 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Choropleth Map

About the Choropleth Map Step

The Choropleth Map step creates a map of polygonal areas.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Choropleth Map: Connection Requirement for the Node

In order to run the Choropleth Map step, you must connect a table to the input node.

Input Port	Output Port
For the Choropleth Map node, an input data source is required. You could also have input data source for the response data. If you need to include this input data source in the step, you must add an additional input port to the Choropleth node. To add an input port,	No output data is created.

Input Port	Output Port
right-click the Choropleth node and select **Add input port**. For more information, see "Step 1: Assign Data to Roles " on page 952. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	

Example: Choropleth Map

To create this example:

1 On a **SAS Program** tab, copy and paste this code:

```
data city_loc (label='Nevada Cities'
               keep=county city city2 lat long county_name);
  set mapsgfk.uscity_all(where=(state=32));
run;
proc sort data=city_loc;
  by city2;
run;
data city_pop (label='Nevada County Seat Populations');
  length city $65 city2 $55;
  infile datalines dlm=',';
  input city population_city county;
  label city            = 'County Seat'
        city2           = 'Normalized city name'
        population_city = 'City Population'
        county          = 'County FIPS Code';
  city2 = upcase(compress(city));
cards;
Fallon, 8458, 1
Las Vegas, 623747, 3
Minden, 3180, 5
Elko, 20279, 7
Goldfield, 443, 9
Eureka, 487, 11
Winnemucca, 7887, 13
Battle Mountain, 3276, 15
Pioche, 911, 17
Yerington, 3064, 19
Hawthorne, 3095, 21
Tonopah, 2360 , 23
Lovelock, 1878, 27
Virginia City, 717, 29
Reno, 241445, 31
Ely, 4134, 33
Carson City, 54521, 510
```

```
;
proc sort data=city_pop;
  by city2;
run;
data city_pop_loc;
  merge city_pop (in=a) city_loc;
  by city2;
  if a;
run;

data nevada;
  set mapsgfk.us_counties(where=(state=32)
                          drop=x y
                          rename=(long=x lat=y));
run;
data county_pop (label='Nevada Counties');
  length county_name $55;
  infile datalines dlm=',';
  state=32;
  input county_name county population_county;
  label state             = 'State FIPS Code'
        county_name       = 'County Name'
        county            = 'County FIPS Code'
        population_county = '2010 Census County Population'
        group             = 'Population range';
  /* Add five population ranges as groups to map response data. */
  if      population_county > 100000 then group='Greater than 100,000';
  else if population_county > 10000  then group='10,000 - 100,000';
  else if population_county > 5000   then group='5,000 - 10,000';
  else if population_county > 1000   then group='1,000 - 5,000';
  else                                    group='Less than 1,000';
cards;
Churchill, 1, 24877
Clark, 3, 2069681
Douglas, 5, 47710
Elko, 7, 52766
Esmeralda, 9, 783
Eureka, 11, 1987
Humboldt, 13, 17019
Lander, 15, 5775
Lincoln, 17, 5036
Lyon, 19, 52585
Mineral, 21, 4772
Nye, 23, 43946
Pershing, 27, 6753
Storey, 29, 3987
Washoe, 31, 446903
White Pine, 33, 10030
Carson City, 510, 54521
;
```

Click **Run**.

These tables are created:

- city_pop – a data set that contains the population for each county seat in Nevada.

city_loc – a map data set that lists the location of the Nevada cities.

city_pop_loc – a plot data set that contains Nevada city locations with population.

nevada – a map data set that lists the Nevada county boundaries for the choropleth map.

- county_pop – a map response data set that contains the population for each Nevada county.

2 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Choropleth Map** to add the step to your flow.

3 Add the Work.Nevada table to your flow. Connect the input port of the Choropleth Map node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Choropleth Map step, click the Choropleth Map node.

5 On the **Data** tab under the **Map Data** heading, set these options:

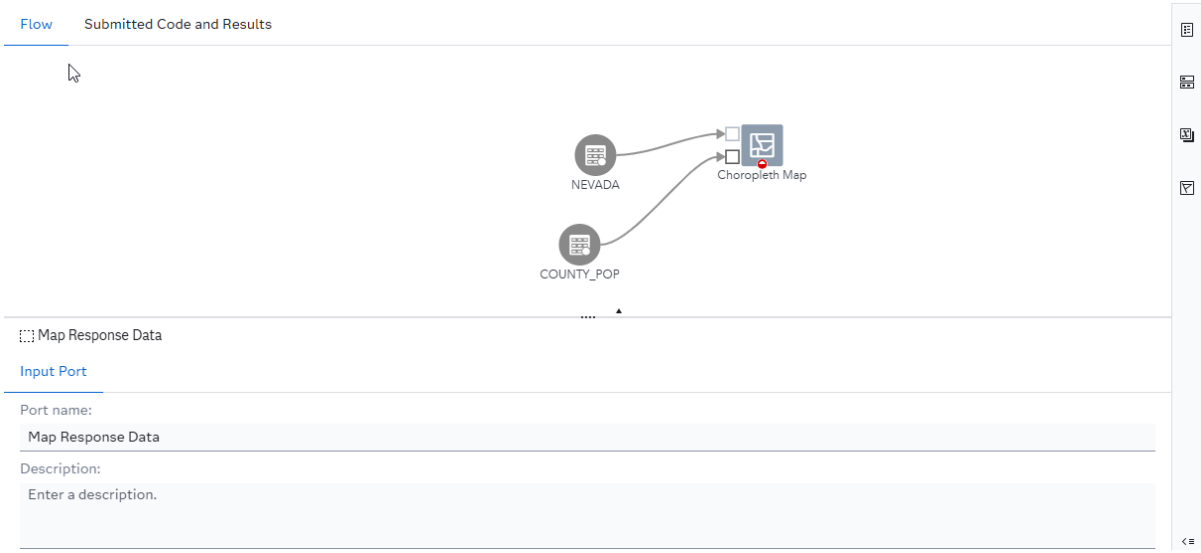
- To the **ID variable** role, assign **COUNTY**.
- Select **Include response data**.

6 Add the map response data to the flow. Because this is an optional table, you must first add an input port to the Choropleth Map node.

a Right-click the Choropleth Map node and select **Add input port**.

b Add the Work.County_Pop table to the flow.

c Connect the County_Pop table to the new input port.



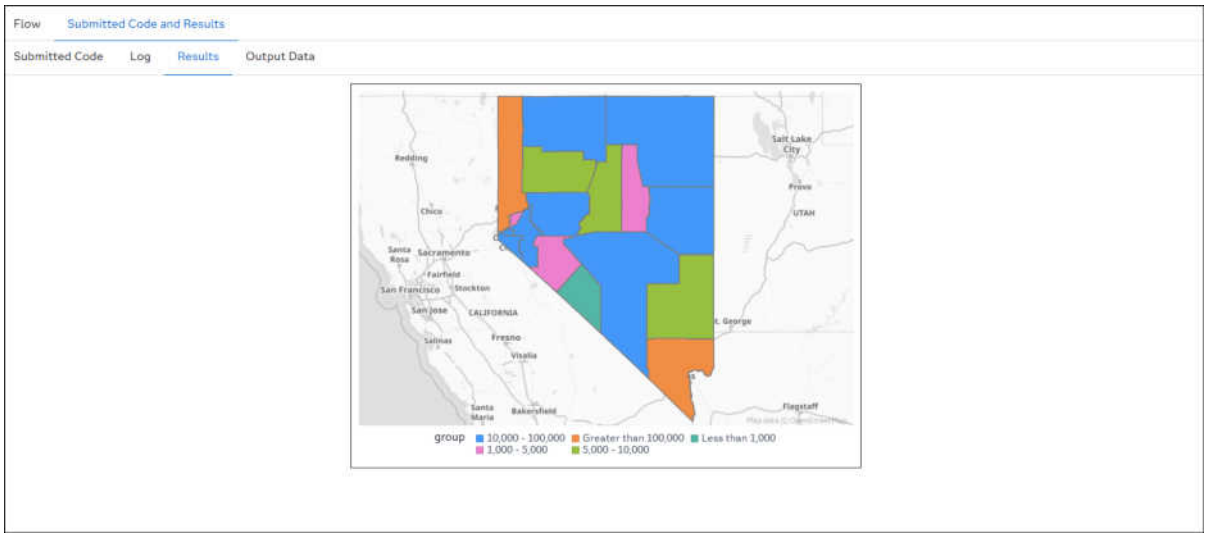
7 Click the Choropleth Map node and open the **Data** tab. For the map response data, assign columns to these roles:

- To the **Response variable** role, assign **group**.
- To the **ID variable** role, assign **county**.

8 Select **OpenStreetMap** as the base map.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Choropleth Map: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Choropleth step, you must assign a column to the **ID variable** role.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **ID variable** role, assign the variable that identifies each shape in the map data table.

3 (Optional) Select **Include response data** to include the map response data.

You must assign an input data source that contains the response for each shape in the map data set. The response variable contains the values that correspond to the shade of each shape. The ID variable identifies the shape in the response data set.

Note: When running this step in the flow, you must add an input port for the response data to the Choropleth Map node. For more information, see "Step 1: Assign Data to Roles " on page 952.

4 Specify whether to use an OpenStreetMap or an Esri map as the base map. You must specify the URL for the Esri map that you want to use.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1. If you selected the **Include response data** check box on the **Data** tab, set the legend options.
   - (Optional) **Generate choromap legend** specifies whether to include a legend for the choromap.
   - (Optional) Specify a label for the legend.
2. (Optional) For the chromo map, specify the line color, thickness, style, and transparency.
3. (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.
4. (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Heat Map

About the Heat Map Step

The Heat Map step displays the magnitude of the response based on two variables. The response is represented as a color value from a color gradient.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Heat Map: Connection Requirement for the Node

In order to run the Heat Map step, you must connect a table to the input node.

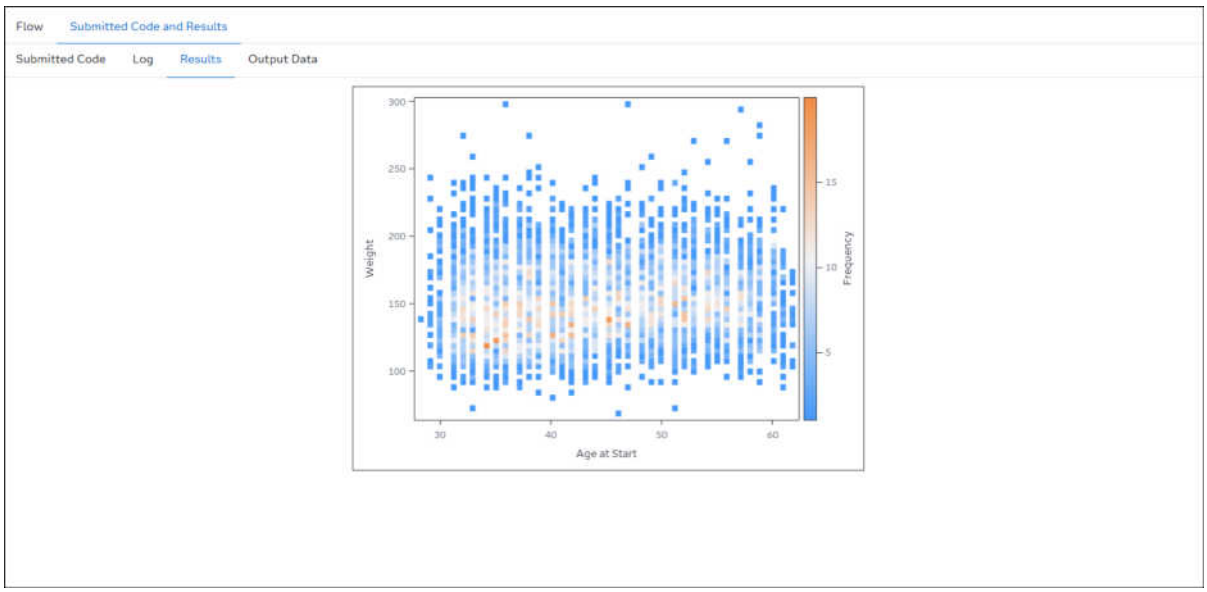
Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Heat Map

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Heat Map** to add the step to your flow.
2. Add the Sashelp.Heart table to your flow. Connect the input port of the Heat Map node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Heat Map step, click the Heat Map node.
4. On the **Data** tab, assign columns to these roles:
   - To the **X axis** role, assign **AgeAtStart**.
   - To the **Y axis** role, assign **Weight**.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Heat Map: Step-by-Step Instructions

Step 1: Assign Data to Roles

You can create a vertical or horizontal box plot. To run the Heat Map step, you must assign a column to the **X axis** role.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Specify the variable for the X axis. Specify the variable type and whether the values are discrete or continuous. If the values are continuous, you can specify the number of bins. The default number of bins is `30`.

3 Specify the variable for the Y axis. Specify whether the values are discrete or continuous. If the values are continuous, you can specify the number of bins. The default number of bins is `40`.

4 (Optional) For the **Color** role, assign the numeric variable to use as the color response variable. Use the **Statistic** drop-down list to specify the calculation for this variable. The default statistic is the sum.

5 (Optional) To the **Group analysis by** role, assign the variable that creates a separate graph for each BY group.

6 (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1 Specify whether to create a fitted regression line or curve.

Note: This option is available if you assigned variables to both the X-axis and Y-axis roles, and both roles contain continuous variables.

- Specify the degree of the polynomial fit. For example, 1 specifies a linear fit, 2 specifies a quadratic fit, and 3 specifies a cubic fit.
- Specify whether to create the prediction limits for the individual predicted values. You can specify the confidence level for the confidence limits.
- Specify whether the legend is placed outside or inside the axis area.

2 Specify the intensity color.

You can specify the color scheme for showing the response frequency in the heat map. The higher the frequency, the more saturated the color in the heat map.

- The default color model uses an intensity color scheme of blue and red. The default colors are white, green, yellow, and red.
- You can create a custom color scheme by selecting four colors.

3 Specify the appearance options for the X and Y axes.

- (Optional) Specify the minimum value on the axis.
- (Optional) Specify the maximum value on the axis.
- (Optional) Specify whether to create grid lines at each tick on the X or Y axis.
- Display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- Specify whether to use a logarithmic scale for the X or Y axis. You can specify the base value as either `10` (default), `2`, or `e`.
- On the X axis, specify whether to rotate the labels by 45 degrees or 90 degrees so that the labels are not overwritten when the ticks on the axis are close together.

  Note: This option is not available for the Y axis.

- (Optional) Create a reference line for the axis.
  - If the axis variable is discrete, select the value of the reference line from the drop-down list. These values are determined by the variable that you assigned to the axis. You can also specify whether to label the reference line with this value or use a custom label.
  - If the axis variable is continuous, specify the value of the reference line. You can also specify whether to label the reference line with this value or use a custom label.

4 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

5 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Histogram

About the Histogram Step

The Histogram step creates a chart that displays the frequency distribution of a numeric variable.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Histogram: Connection Requirement for the Node

In order to run the Histogram step, you must connect a table to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Histogram of Stock Volume

To create this example:

1 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Histogram** to add the step to your flow.

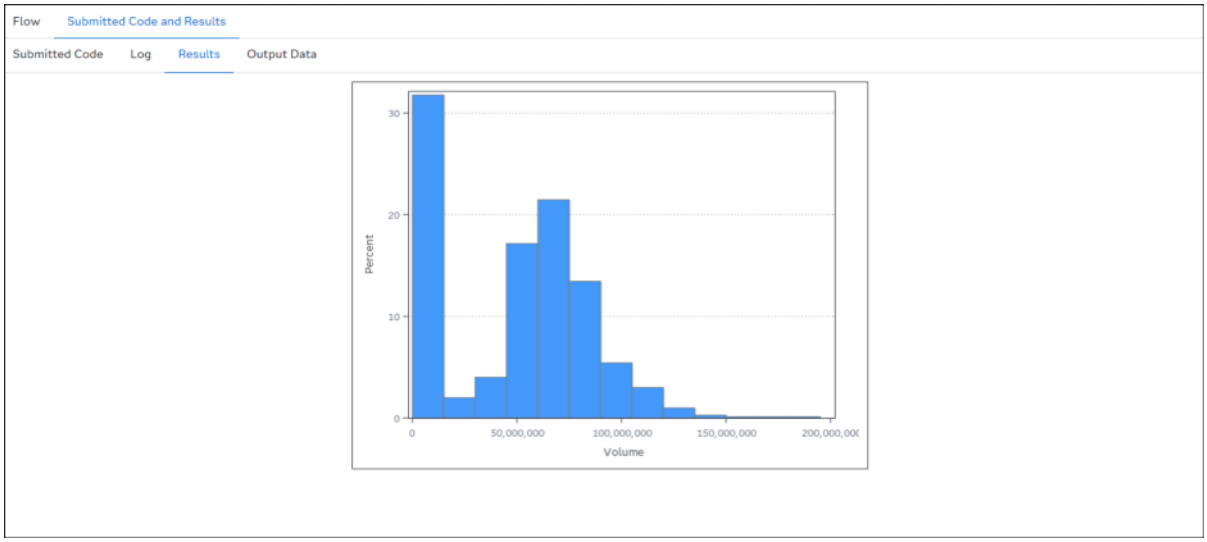
2 Add the Sashelp.Stocks table to your flow. Connect the input port of the Histogram node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the Histogram step, click the Histogram node.

4 To the **Analysis variable** role, assign the **Volume** column.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Histogram: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Analysis variable** role, assign the variable to use in the analysis.

Use the **Scale** option to specify the scaling that is applied to the vertical axis. You can choose from these options:

- **Percent (default)** - The axis displays values as a percentage of the total.
- **Count** - The axis displays the frequency count.
- **Proportion** - The axis displays values as proportions (0.0 to 1.0) of the total.

3 (Optional) To the **Group analysis by**m assign a variable to create a separate graph for each BY group.

4 (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1 Specify whether to create a density curve that shows the distribution of values for a numeric variable. You can create density curves for normal and kernel distributions.

2 Specify the bin options.

- (Optional) Specify the number of bins in the histogram. Valid values range from `2` to `10000`.

  The bins always span the range of data. The step tries to produce tick values that are easily interpreted (for example, `5`, `10`, `15`, `20`). Sometimes the location of the first bin and the bin width might be adjusted. By default, the step automatically determines the number of bins.
- (Optional) Specify the color of the bins in the histogram.
- Specify the transparency for the bars. The range is from 0% (completely opaque) to 100% (completely transparent).
- Specify whether to apply a gradient to the bins.
- Specify a special effect to be used on the plot. The data skin affects all filled graph elements. The effect that a data skin has on a filled area depends on the skin type, the graph style, and the color of the skinned element. Most of the skins work best with lighter colors over a medium to large filled area.

3 Specify the options for the X and Y axes.

- (Optional) Specify whether to create tick marks at the midpoints of the value bins on the X axis.

  Note: This option is not available on the Y axis.
- (Optional) Specify the minimum value on the axis.
- (Optional) Specify the maximum value on the axis.
- (Optional) Specify whether to create grid lines at each tick on the X or Y axis.
- Display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- Specify whether to use a logarithmic scale for the X or Y axis. You can specify the base value as either `10` (default), `2`, or `e`.

- On the X axis, specify whether to rotate the labels by 45 degrees or 90 degrees so that the labels are not overwritten when the ticks on the axis are close together.

  Note: This option is not available for the Y axis.

- (Optional) Create a reference line for the axis.
  - If the axis variable is discrete, select the value of the reference line from the drop-down list. These values are determined by the variable that you assigned to the axis. You can also specify whether to label the reference line with this value or use a custom label.
  - If the axis variable is continuous, specify the value of the reference line. You can also specify whether to label the reference line with this value or use a custom label.

4 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

5 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Line Chart

About Line Chart

The Line Chart step shows the mathematical relationships between variables by revealing trends or patterns of data points.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Line Chart: Connection Requirement for the Node

In order to run the Line Chart step, you must connect a table to the input node.

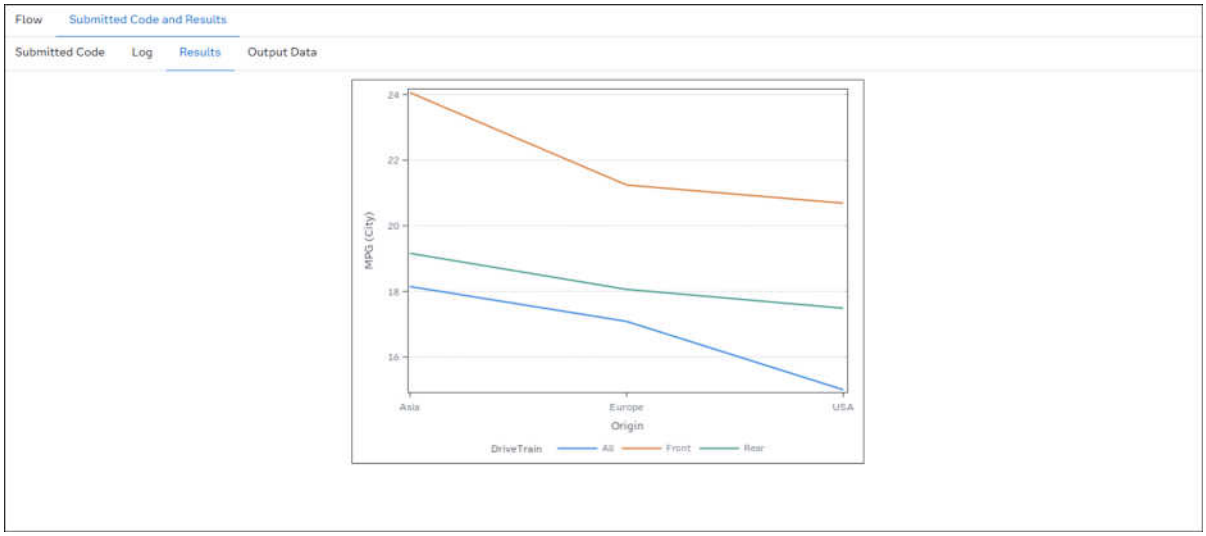
Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Displaying the Mean MPG per Origin and DriveTrain

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Line Chart** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the Line Chart node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Line Chart step, click the Line Chart node.
4. On the **Data** tab, assign columns to these roles:
   - To the **Category** role, assign **Origin**.
   - To the **Subcategory** role, assign **DriveTrain**.
5. Specify the measure for the analysis.
   a. From the **Measure** drop-down list, select **Select a column from the input data**.
   b. Select **MPG_City** as the column.
   c. From the **Statistic** drop-down list, select **Mean**.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Line Chart: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Line Chart step, you must assign a column to the **Category** role.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Category** role, assign the variable that classifies the observations into distinct categories.

3 (Optional) To the **Subcategory** role, assign a variable that further classifies the data into smaller subcategories.

If you assign a variable to this role, you can include a legend on the line chart or use labels to identify the lines.

You can place the legend inside or outside the graph.

4 From the **Measure** drop-down list, specify how to calculate the data point on the line chart. You can use the frequency count (the default), the frequency percent, or the value of a selected column.

After you select a column, you must specify the statistic to use in the calculation of the column. You can choose from sum (the default), mean, or percent of sum. If you select the mean, you can also include error bars on your chart.

5 (Optional) To the **Group analysis by** role, assign a column to create a separate graph for each BY group.

6 (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1 Specify the appearance options for the lines.

- (Optional) Specify whether to display the value of each data point on the line chart.
- (Optional) Specify whether to display on the line the label from the response variable (Y axis). You can also specify a custom label.

  Note: This option is not available if you assign a column to the **Subcategory** role.

- (Optional) Specify the color for the line.

  Note: This option is not available if you assign a column to the **Subcategory** role.

- Specify the thickness (in pixels) of the line.
- Specify the transparency for the bars. The range is from 0% (completely opaque) to 100% (completely transparent).
- Specify the type of line to use in the chart.
- (Optional) Specify a character variable that contains URLs for web pages. In the results, click the links to view the website associated with that graphical element.

2 Specify the options for the X axis.

- (Optional) Specify whether the values for the tick marks be displayed in reverse (descending) order.

  Note: This option is not available on the Y axis.

- (Optional) Specify whether to place the discrete values for the tick marks in the order in which they appear in the data.
- Display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- Specify whether to use a logarithmic scale for the X or Y axis. You can specify the base value as either `10` (default), `2`, or `e`.

- On the X axis, specify whether to rotate the labels by 45 degrees or 90 degrees so that the labels are not overwritten when the ticks on the axis are close together.

  Note: This option is not available for the Y axis.

- (Optional) Create a reference line for the axis.
  - If the axis variable is discrete, select the value of the reference line from the drop-down list. These values are determined by the variable that you assigned to the axis. You can also specify whether to label the reference line with this value or use a custom label.
  - If the axis variable is continuous, specify the value of the reference line. You can also specify whether to label the reference line with this value or use a custom label.

3 Specify the options for the Y axis.

- (Optional) Specify the minimum value on the axis.
- (Optional) Specify the maximum value on the axis.
- (Optional) Specify whether to create grid lines at each tick on the X or Y axis.
- Display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- Specify whether to use a logarithmic scale for the Y axis. You can specify the base value as either `10` (default), `2`, or `e`.
- (Optional) Create a reference line for the axis.
  - If the axis variable is discrete, select the value of the reference line from the drop-down list. These values are determined by the variable that you assigned to the axis. You can also specify whether to label the reference line with this value or use a custom label.
  - If the axis variable is continuous, specify the value of the reference line. You can also specify whether to label the reference line with this value or use a custom label.

4 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

5 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Mosaic Plot

About the Mosaic Plot Step

Mosaic plots display tiles that correspond to the crosstabulation table cells. The areas of the tiles are proportional to the frequencies of the table cells. The column variable is displayed on the X axis, and the tile widths are proportional to the relative frequencies of the column variable levels. The row variable is displayed on the Y axis, and the tile heights are proportional to the relative frequencies of the row levels within column levels.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Mosaic Plot: Connection Requirement for the Node

In order to run the Mosaic Plot step, you must connect a table to the input node.

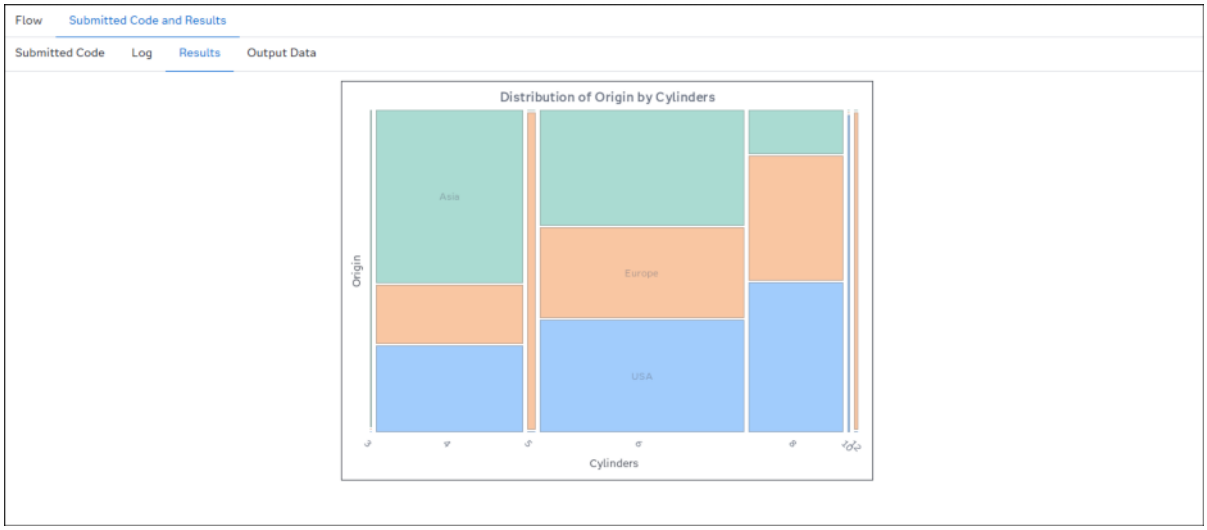
Example: Mosaic Plot

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Mosaic Plot** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the Mosaic Plot node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Mosaic Plot step, click the Mosaic Plot node.
4. On the **Data** tab, set these options:
   - To the **Y axis** role, assign **Origin**.
   - To the **X axis** role, assign **Cylinders**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Mosaic Plot: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Mosaic Plot step, you must assign a column to the **Y axis** and **X axis** roles.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Y axis** role, assign the variable for the Y axis in a two-way crosstabulation table.

3 To the **X axis** role, assign the variable for the X axis in a two-way crosstabulation table.

4 (Optional) To the **Stratify by** role, assign the variables to create a graph for each combination of the variables selected.

5 (Optional) To the **Group analysis by** role, assign the variable to create a separate graph for each BY group.

6 (Optional) To the **Frequency count** role, assign the numeric variable that provides a weight for each observation in the input table. This option is most commonly used to specify cell count data.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1. (Optional) Select **Square plot** to produce a square mosaic plot, where the height of the Y axis equals the width of the X axis. In a square mosaic plot, the scale of the relative frequencies is the same on both axes. By default, the step creates a rectangular mosaic plot.
2. (Optional) For the **Color tiles by** option, specify the colors for the mosaic plot according to the levels of the row variable or the values of residuals. If you select **Pearson residuals**, the tiles are colored according to the Pearson residuals of the corresponding table cells. If you select **Standardized residuals**, the tiles are colored according to the standardized residuals of the corresponding table cells.

Pie Chart

About the Pie Chart Step

The Pie Chart step creates pie charts that represent the relative contribution of the parts to the whole by displaying data as wedge-shaped "slices" of a circle. Each slice represents a category of data. The size of a slice represents the contribution of the data to the total chart statistic.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Pie Chart: Connection Requirement for the Node

In order to run the Pie Chart step, you must connect a table to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

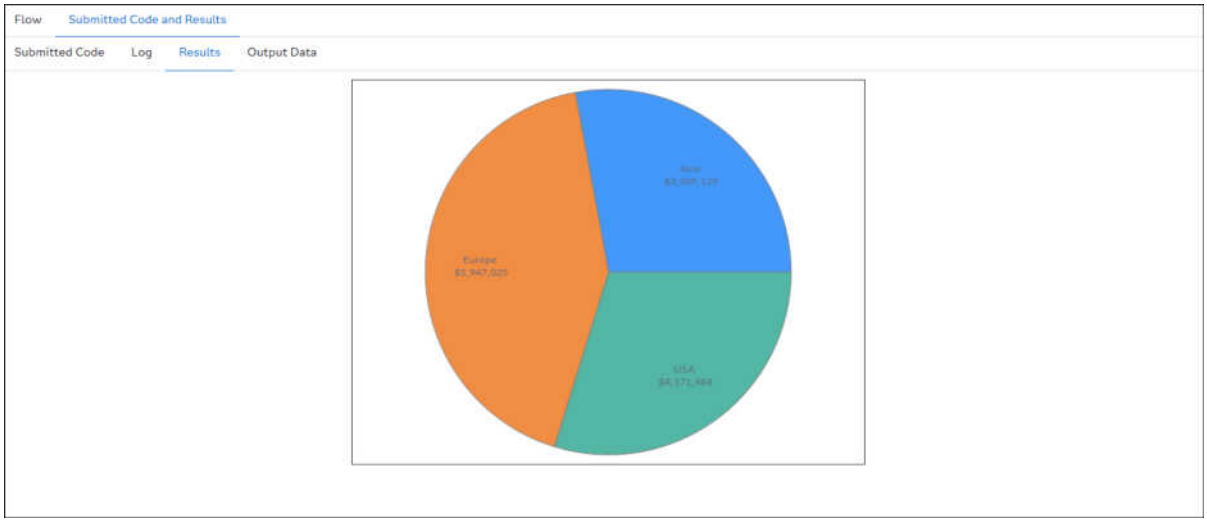
Example: Pie Chart That Shows Total MSRP by Region

In this example, you want to compare the manufacturer's suggested retail price (MSRP) by region of origin. The resulting pie chart consists of six rings—one for each car type. The rings are then subset into the MSRP values for the three regions: Asia, Europe, and USA. Using this chart, you can compare the total MSRP values for each region. The ring for the SUV car type shows that the USA has the highest MSRP and that Europe has the lowest MSRP.

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Pie Chart** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the Pie Chart node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Pie Chart step, click the Pie Chart node.
4. On the **Data** tab, assign **Origin** to the **Category** role.
5. From the **Measure** drop-down list, select **Select a column from input data**. Assign **MSRP** to the **Column** role. From the **Statistic** drop-down list, select **Sum (default)**.
6. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Pie Chart: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Category** role, assign the variable that classifies the observations into distinct subsets.

3 (Optional) To the **Subcategory** role, assign a variable that is used to group the data within each category.

4 From the **Measure** drop-down list, specify how to calculate the size of the slice. You can use the frequency count (the default), the frequency percent, or the value of a variable in the input data source.

If you select **Variable** from the drop-down list, you must assign a column to the **Variable** role. Then you must specify the statistic to use in the calculation of the variable. You can choose from sum or mean.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1 From the **Starting point** drop-down list, select where to create the first slice in the pie chart.

2 Specify the direction of the slices from the starting point.

3 Specify where to display the label for the pie slice. By default, the Pie Chart step determines the best location for the slice.

Note: This option is not available if you assign a variable to the **Subcategory** role.

4 (Optional) Specify the font size for the label.

5 (Optional) Specify the transparency for the bars. The range is from 0% (completely opaque) to 100% (completely transparent).

6 (Optional) Specify a special effect to be used on the plot. The data skin affects all filled graph elements. The effect that a data skin has on a filled area depends on the skin type, the graph style, and the color of the skinned element. Most of the skins work best with lighter colors over a medium to large filled area.

7 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

8 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Scatter Map

About the Scatter Map Step

The Scatter Map step creates a map that is overlaid with a scatter plot.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Scatter Map: Connection Requirement for the Node

In order to run the Scatter Map step, you must connect a table to the input node.

Input Port	Output Port
For the Scatter Map node, an input data source is required. You could also have input data sources for the map data and map response data. If you need to include either of these input data sources in the step, you must add an additional input port to the Scatter Map node. To add an input port, right-click the Scatter Map node and select **Add input port**. Then select **Map Input Data** or **Map Response Data**. For more information, see "Step 1: Assign Data to Roles " on page 974. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Scatter Map

To create this example:

1 On a **SAS Program** tab, copy and paste this code:

```
data city_loc (label='Nevada Cities'
               keep=county city city2 lat long county_name);
  set mapsgfk.uscity_all(where=(state=32));
run;
proc sort data=city_loc;
  by city2;
run;
data city_pop (label='Nevada County Seat Populations');
  length city $65 city2 $55;
  infile datalines dlm=',';
  input city population_city county;
  label city            = 'County Seat'
        city2           = 'Normalized city name'
        population_city = 'City Population'
        county          = 'County FIPS Code';
  city2 = upcase(compress(city));
cards;
Fallon, 8458, 1
Las Vegas, 623747, 3
Minden, 3180, 5
Elko, 20279, 7
Goldfield, 443, 9
Eureka, 487, 11
Winnemucca, 7887, 13
Battle Mountain, 3276, 15
Pioche, 911, 17
Yerington, 3064, 19
```

```
Hawthorne, 3095, 21
Tonopah, 2360 , 23
Lovelock, 1878, 27
Virginia City, 717, 29
Reno, 241445, 31
Ely, 4134, 33
Carson City, 54521, 510
;
proc sort data=city_pop;
  by city2;
run;
data city_pop_loc;
  merge city_pop (in=a) city_loc;
  by city2;
  if a;
run;

data nevada;
  set mapsgfk.us_counties(where=(state=32)
                          drop=x y
                          rename=(long=x lat=y));
run;
data county_pop (label='Nevada Counties');
  length county_name $55;
  infile datalines dlm=',';
  state=32;
  input county_name county population_county;
  label state             = 'State FIPS Code'
        county_name       = 'County Name'
        county            = 'County FIPS Code'
        population_county = '2010 Census County Population'
        group             = 'Population range';
  /* Add five population ranges as groups to map response data. */
  if      population_county > 100000 then group='Greater than 100,000';
  else if population_county > 10000  then group='10,000 - 100,000';
  else if population_county > 5000   then group='5,000 - 10,000';
  else if population_county > 1000   then group='1,000 - 5,000';
  else                                    group='Less than 1,000';
cards;
Churchill, 1, 24877
Clark, 3, 2069681
Douglas, 5, 47710
Elko, 7, 52766
Esmeralda, 9, 783
Eureka, 11, 1987
Humboldt, 13, 17019
Lander, 15, 5775
Lincoln, 17, 5036
Lyon, 19, 52585
Mineral, 21, 4772
Nye, 23, 43946
Pershing, 27, 6753
Storey, 29, 3987
Washoe, 31, 446903
White Pine, 33, 10030
Carson City, 510, 54521
```

;

Run the flow.

These tables are created:

- city_pop – a data set that contains the population for each county seat in Nevada.

  city_loc – a map data set that lists the location of the Nevada cities.

  city_pop_loc – a plot data set that contains Nevada city locations with population.

  nevada – a map data set that lists the Nevada county boundaries for the choropleth map.

- county_pop – a map response data set that contains the population for each Nevada county.

2 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Scatter Map** to add the step to your flow.

3 Add the Work.City_Pop_Loc table to your flow. Connect the input port of the Scatter Map node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Scatter Map step, click the Scatter Map node.

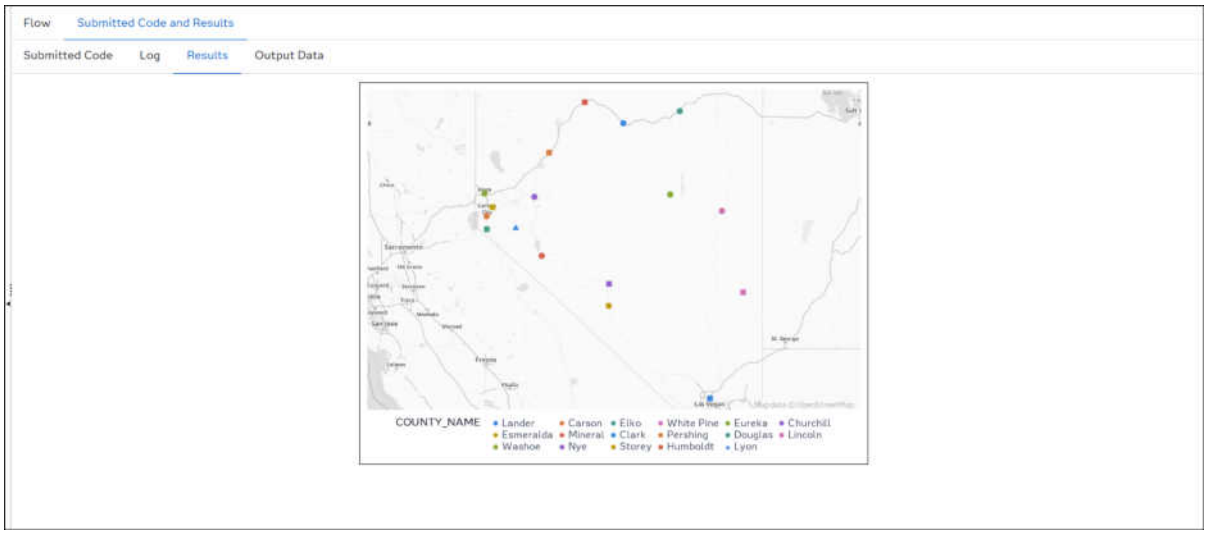
5 On the **Data** tab, set these options:

- To the **Latitude** role, assign **LAT**.
- To the **Longitude** role, assign **LONG**.
- To the **Group** role, assign **COUNTY_NAME**.

6 Select **OpenStreetMap** as the base map.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Scatter Map: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Scatter Map step, you must assign a column to the **Latitude** and **Longitude** roles.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Latitude** role, assign the variable that contains the latitude values on the map.

3 To the **Longitude** role, assign the variable that contains the longitude values on the map.

4 (Optional) To the **Group** role, assign the variable that specifies how to group the data. Different groups have different markers.

5 (Optional) Select **Include choropleth map layer** to create a choropleth map. You must select the input data source that contains the shape polygons. Next, assign a column to the **ID variable** role, which identifies each shape in the map data set.

   If you include response data, you must specify the input data source that contains the response for each shape in the map data set. You also must assign a response variable whose values correspond to the shade of each shape and an ID variable that identifies each shape in the response data set.

   Note: If you are running the step in a flow, you must add input ports for the map data and map response data to the Scatter Map node. For more information, see "Scatter Map: Connection Requirement for the Node" on page 970.

   For more information, see "Choropleth Map" on page 948.

6 Specify whether to use an OpenStreetMap or an Esri map as the base map. You must specify the URL for the Esri map that you want to use.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 (Optional) For the data labels, assign the variable that contains the labels for the data points.

2 (Optional) Specify whether to include a legend for the choromap. You can specify the legend title.

Note: This option is available if you include response data for the choropleth map layer.

3 (Optional) Specify whether to include a legend. You can specify the legend title.

Note: This option is available if you assign a group variable.

4 (Optional) Specify the color, symbol, and size of the markers.

5 (Optional) Specify the transparency of the plot.

6 (Optional) For the chromo map, specify the line color, thickness, style, and transparency.

Note: The Chromomap options are available if you select **Include choropleth map layer** on the **Data** tab.

7 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

8 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Scatter Plot

About the Scatter Plot Step

The Scatter Plot step creates plots that show the relationships between two or three variables by revealing patterns or concentrations of data points. For example, a two-dimensional scatter plot can display the heights and weights of all students in a class.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see “Summary of Flow Functionality” in *SAS Data and AI Studio: User’s Guide*.

Scatter Plot: Connection Requirement for the Node

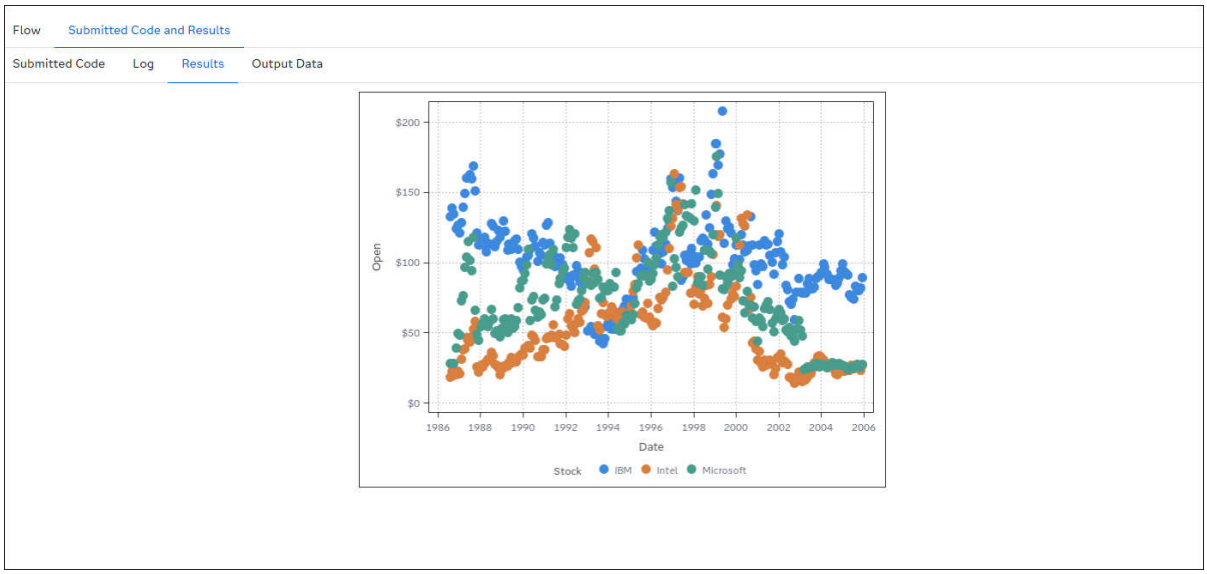
In order to run the Scatter Plot step, you must connect a table to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Scatter Plot of Stock Trends

1. In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Scatter Plot** to add the step to your flow.
2. Add the Sashelp.Stocks table to your flow. Connect the input port of the Scatter Plot node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Scatter Plot step, click the Scatter Plot node.
4. On the **Data** tab, assign columns to these roles:
   - Under the X Axis heading, select **Numeric (default)** as the variable type. Assign **Date** to the **Column** role.
   - Under the Y Axis heading, select **Numeric (default)** as the variable type. Assign **Open** to the **Column** role.
   - Assign the **Stock** column to the **Group** role.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Scatter Plot: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. Specify the column and variable type for the X axis.
3. Specify the column and variable type for the Y axis.
4. (Optional) To the **Group** role, specify the variable to use to group the data. The plot elements for each group value are automatically distinguished by different visual attributes.

   You can specify whether to include the legend outside or inside the axis area.
5. (Optional) To the **Group analysis by** role, specify the variable to use to create a separate graph for each BY group.

Step 2: Set the Appearance Options

1. Specify whether to include fit curves on the plot.
   - (Optional) Create a plot with the fitted regression line. You must specify the degree of the polynomial fit. The default value is 1.
   - (Optional) Create a fitted LOESS curve. You can specify a smoothing value and whether to include the confidence limits for the means.

- (Optional) Create a fitted penalized B-spline curve. You must specify the degree of the spline transformation. You can specify the prediction limits for the individual predicted values.

2 Specify the appearance of the markers on the scatter plot.

- (Optional) Display a label for each data point. If you specify a variable, the values of that variable are used for the data labels.
- You can specify the symbol type, color, and size of the markers. You can also specify the degree of transparency for the plot. The range is from 0% (completely opaque) to 100% (completely transparent).

  Note: The **Set color** option is not available if you assign a variable to the **Group** role.

- (Optional) Specify a character variable that contains URLs for web pages. In the results, click the links to view the website that is associated with that graphical element.

3 Set the appearance options for the X and Y axes.

- (Optional) Specify the minimum value on the axis.
- (Optional) Specify the maximum value on the axis.
- (Optional) Specify whether to create grid lines at each tick on the X or Y axis.
- Display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- (Optional) Specify whether to use a logarithmic scale for the Y axis. You can specify the base value as either `10` (default), `2`, or `e`.
- (Optional) Rotate the labels on the X axis by 45 or 90 degrees to prevent the tick marks from overwriting the label text.

  Note: This option is not available for the Y axis.

- (Optional) Create a reference line for the axis.
  - If the axis variable is discrete, select the value of the reference line from the drop-down list. These values are determined by the variable that you assigned to the axis. You can also specify whether to label the reference line with this value or use a custom label.
  - If the axis variable is continuous, specify the value of the reference line. You can also specify whether to label the reference line with this value or use a custom label.

4 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

5 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Series Map

About the Series Map Step

The Series Map creates a map overlaid with series plot.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Series Map: Connection Requirement for the Node

In order to run the Series Map step, you must connect a table to the input node.

Input Port	Output Port
For the Series Map node, an input data source is required. You could also have input data sources for the map data and map response data. If you need to include either of these input data sources in the step, you must add an additional input port to the Series Map node. To add an input port, right-click the Series Map node,select **Add input port**, and then select **Map Input Data** or **Map Response Data**. For more information, see "Step 1: Assign Data to Roles " on page 981. ■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	No output data is created.

Example: Series Map

To create this example:

1 On a **SAS Program** tab, enter this code:

```
data katrina (label='Hurricane Katrina Track');
  length datetime $16;
  infile datalines dlm=',';
  name='Katrina';
  input datetime y x wind;
  label datetime = 'Date and Time'
        y = 'Latitude'
        x = 'Longitude'
        wind = 'Wind Speed MPH';
datalines;
23AUG05:18:00:00,23.1,-75.1,30
24AUG05:00:00:00,23.4,-75.7,30
24AUG05:06:00:00,23.8,-76.2,30
24AUG05:12:00:00,24.5,-76.5,35
24AUG05:18:00:00,25.4,-76.9,40
25AUG05:00:00:00,26,-77.7,45
25AUG05:06:00:00,26.1,-78.4,50
25AUG05:12:00:00,26.2,-79,55
25AUG05:18:00:00,26.2,-79.6,60
25AUG05:22:30:00,26,-80.1,70
26AUG05:00:00:00,25.9,-80.3,70
26AUG05:06:00:00,25.4,-81.3,65
26AUG05:12:00:00,25.1,-82,75
26AUG05:18:00:00,24.9,-82.6,85
27AUG05:00:00:00,24.6,-83.3,90
27AUG05:06:00:00,24.4,-84,95
27AUG05:12:00:00,24.4,-84.7,100
27AUG05:18:00:00,24.5,-85.3,100
28AUG05:00:00:00,24.8,-85.9,100
28AUG05:06:00:00,25.2,-86.7,125
28AUG05:12:00:00,25.7,-87.7,145
28AUG05:18:00:00,26.3,-88.6,150
29AUG05:00:00:00,27.2,-89.2,140
29AUG05:06:00:00,28.2,-89.6,125
29AUG05:11:10:00,29.3,-89.6,110
29AUG05:12:00:00,29.5,-89.6,110
29AUG05:14:45:00,30.2,-89.6,105
29AUG05:18:00:00,31.1,-89.6,80
30AUG05:00:00:00,32.6,-89.1,50
30AUG05:06:00:00,34.1,-88.6,40
30AUG05:12:00:00,35.6,-88,30
30AUG05:18:00:00,37,-87,30
31AUG05:00:00:00,38.6,-85.3,30
31AUG05:06:00:00,40.1,-82.9,25
;
data katrina; set katrina end=last;
  if find(datetime,'06:00:00') or _n_=1 or last then do;
```

```
      date=substr(datetime,1,7);
      long=x; lat=y;
      end;
run;
```

2 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Series Map** to add the step to your flow.

3 Add the Work.Katrina table to your flow. Connect the input port of the Series Map node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Series Map step, click the Series Map node.

5 On the **Data** tab, set these options:

- To the **Latitude** role, assign **y**.
- To the **Longitude** role, assign **x**.

6 Select **OpenStreetMap** as the base map.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Series Map: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Series Map step, you must assign a column to the **Latitude** and **Longitude** roles.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Latitude** role, assign the variable that contains the latitude values on the map.

3 To the **Longitude** role, assign the variable that contains the longitude values on the map.

4 (Optional) To the **Group** role, assign the variable that specifies how to group the data. Different groups have different markers.

5 (Optional) Select **Include choropleth map layer** to create a choropleth map. You must select the input data source that contains the shape polygons. Next, assign a column to the **ID variable** role, which identifies each shape in the map data set.

   If you include response data, you must specify the input data source that contains the response for each shape in the map data set. You also must assign a response variable whose values correspond to the shade of each shape and an ID variable that identifies each shape in the response data set.

   Note: If you are running the step in a flow, you must add input ports for the map data and response data to the Series Map node. For more information, see "Series Map: Connection Requirement for the Node" on page 979.

   For more information, see "Choropleth Map" on page 948.

6 Specify whether to use an OpenStreetMap or an Esri map as the base map. You must specify the URL for the Esri map that you want to use.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options.

1 (Optional) Specify whether to start a new line when the value of the latitude variable is missing.

2 (Optional) Specify whether to create a smooth line through all data points.

3 (Optional) Specify the color, thickness, and style of the line.

4 (Optional) Specify whether to include a legend for the choromap.

   Note: This option is available if you include response data for the choropleth map layer.

5 (Optional) Specify whether to include a legend. You can specify the legend title.

   Note: This option is available if you assign a group variable.

6 (Optional) Specify the color, thickness, and style of the line on the choropleth map.

Note: These options are available if you select **Include choropleth map layer** on the **Data** tab.

7 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

8 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Series Plot

About the Series Plot Step

The Series Plot step creates plots that display a series of line segments that connect observations of input data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Series Plot: Connection Requirement for the Node

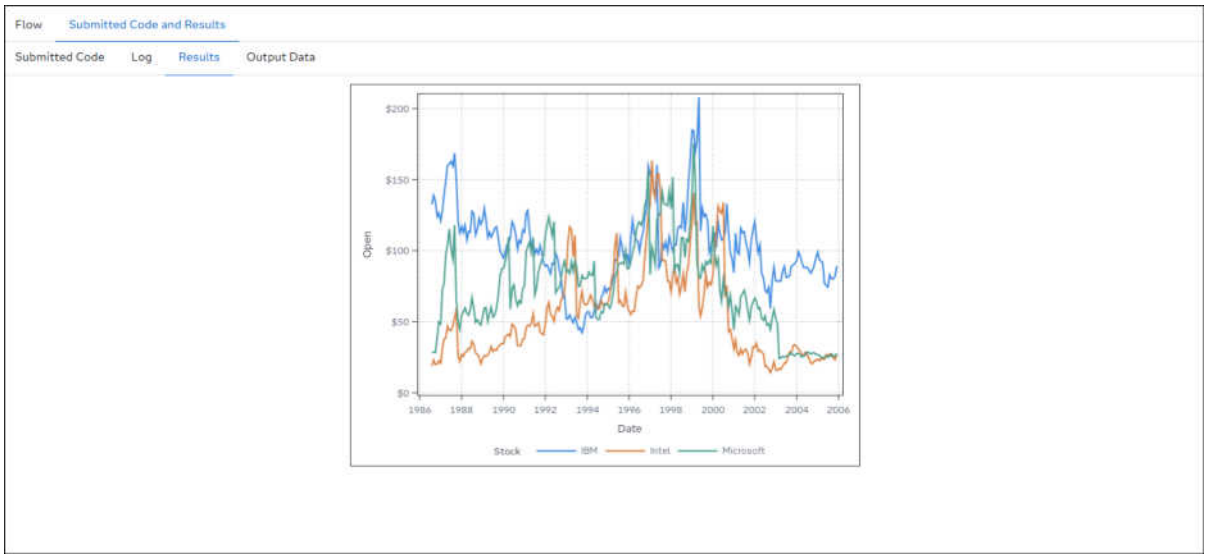
In order to run the Series Plot step, you must connect a table to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Series Plot of Stock Trends

1. In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Series Plot** to add the step to your flow.
2. Add the Sashelp.Stocks table to your flow. Connect the input port of the Series Plot node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Series Plot step, click the Series Plot node.
4. On the **Data** tab, assign columns to these roles:
   - Under the X Axis heading, select **Numeric** as the variable type. Assign **Date** to the **Column** role.
   - Under the Y Axis heading, select **Numeric** as the variable type. Assign **Open** to the **Column** role.
   - Assign the **Stock** column to the **Group** role.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Series Plot: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. Specify the column and variable type for the X axis.
3. Specify the column and variable type for the Y axis.
4. (Optional) To the **Group** role, specify the variable to use to group the data. The plot elements for each group value are automatically distinguished by different visual attributes.

   You can specify whether to include the legend outside or inside the axis area.
5. (Optional) To the **Group analysis by** role, specify the variable to use to create a separate graph for each BY group.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1. Set the options for the series.
   - (Optional) Specify whether to show the label for each series for each plot.
   - (Optional) Specify the color for the series.
   - Specify the thickness of the line. The default is 1 pixel.
   - Specify the transparency for the bars. The range is 0% (completely opaque) to 100% (completely transparent).
   - (Optional) Specify whether to include markers that represent the data points in the series. You can also choose the marker symbol and the size of the marker.
   - Specify the type of line to use in the plot.
   - (Optional) Specify a character variable that contains URLs for web pages. In the results, click the links to view the website that is associated with that graphical element.
2. Specify the options for the X and Y axes.
   - (Optional) Specify the minimum value on the axis.
   - (Optional) Specify the maximum value on the axis.

- (Optional) Specify whether to create grid lines at each tick on the X or Y axis.
- Display a label for the axis. By default, the axis label is the name of the variable. However, you can create a custom label. To suppress the label, select **No label**.
- (Optional) Specify whether to use a logarithmic scale for the Y axis. You can specify the base value as either `10` (default), `2`, or `e`.
- (Optional) Rotate the labels on the X axis by 45 or 90 degrees to prevent the tick marks from overwriting the label text.

  Note: This option is not available for the Y axis.

- (Optional) Create a reference line for the axis.
  - If the axis variable is discrete, select the value of the reference line from the drop-down list. These values are determined by the variable that you assigned to the axis. You can also specify whether to label the reference line with this value or use a custom label.
  - If the axis variable is continuous, specify the value of the reference line. You can also specify whether to label the reference line with this value or use a custom label.
- (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

3 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

Text Map

About the Text Map Step

The Text Map step creates a map that is overlaid with a text scatter plot.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Text Map: Connection Requirement for the Node

In order to run the Text Map step, you must connect a table to the input node.

Input Port	Output Port
For the Text Map node, an input data source is required. You could also have input data sources for the map data and map response data. If you need to include either of these input data sources in the step, you must add an additional input port to the Text Map node. To add an input port, right-click the Text Map node and select **Add input port**. Then select **Map Input Data** or **Map Response Data**. For more information, see "Step 1: Assign Data to Roles " on page 990. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Text Map

To create this example:

1 On a **SAS Program** tab, copy and paste this code:

```
data city_loc (label='Nevada Cities'
               keep=county city city2 lat long county_name);
  set mapsgfk.uscity_all(where=(state=32));
run;
proc sort data=city_loc;
  by city2;
run;
data city_pop (label='Nevada County Seat Populations');
  length city $65 city2 $55;
  infile datalines dlm=',';
  input city population_city county;
  label city            = 'County Seat'
        city2           = 'Normalized city name'
        population_city = 'City Population'
        county          = 'County FIPS Code';
  city2 = upcase(compress(city));
cards;
Fallon, 8458, 1
Las Vegas, 623747, 3
```

```
Minden, 3180, 5
Elko, 20279, 7
Goldfield, 443, 9
Eureka, 487, 11
Winnemucca, 7887, 13
Battle Mountain, 3276, 15
Pioche, 911, 17
Yerington, 3064, 19
Hawthorne, 3095, 21
Tonopah, 2360 , 23
Lovelock, 1878, 27
Virginia City, 717, 29
Reno, 241445, 31
Ely, 4134, 33
Carson City, 54521, 510
;
proc sort data=city_pop;
  by city2;
run;
data city_pop_loc;
  merge city_pop (in=a) city_loc;
  by city2;
  if a;
run;

data nevada;
  set mapsgfk.us_counties(where=(state=32)
                          drop=x y
                          rename=(long=x lat=y));
run;
data county_pop (label='Nevada Counties');
  length county_name $55;
  infile datalines dlm=',';
  state=32;
  input county_name county population_county;
  label state             = 'State FIPS Code'
        county_name       = 'County Name'
        county            = 'County FIPS Code'
        population_county = '2010 Census County Population'
        group             = 'Population range';
  /* Add five population ranges as groups to map response data. */
  if      population_county > 100000 then group='Greater than 100,000';
  else if population_county > 10000  then group='10,000 - 100,000';
  else if population_county > 5000   then group='5,000 - 10,000';
  else if population_county > 1000   then group='1,000 - 5,000';
  else                                    group='Less than 1,000';
cards;
Churchill, 1, 24877
Clark, 3, 2069681
Douglas, 5, 47710
Elko, 7, 52766
Esmeralda, 9, 783
Eureka, 11, 1987
Humboldt, 13, 17019
Lander, 15, 5775
Lincoln, 17, 5036
```

```
Lyon, 19, 52585
Mineral, 21, 4772
Nye, 23, 43946
Pershing, 27, 6753
Storey, 29, 3987
Washoe, 31, 446903
White Pine, 33, 10030
Carson City, 510, 54521
;
```

Click **Run**.

These tables are created:

- city_pop – a data set that contains the population for each county seat in Nevada.

  city_loc – a map data set that lists the location of the Nevada cities.

  city_pop_loc – a plot data set that contains Nevada city locations with population.

  nevada – a map data set that lists the Nevada county boundaries for the choropleth map.

- county_pop – a map response data set that contains the population for each Nevada county.

2 In the **Steps** section of the navigation pane, expand the **Visualize Data** folder and double-click **Text Map** to add the step to your flow.

3 Add the Work.City_Pop_Loc table to your flow. Connect the input port of the Text Map node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Text Map step, click the Text Map node.

5 On the **Data** tab, set these options:

- To the **Latitude** role, assign **LAT**.
- To the **Longitude** role, assign **LONG**.
- To the **Text** role, assign **city**.

6 Select **OpenStreetMap** as the base map.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Text Map: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Text Map step, you must assign a column to the **Latitude**, **Longitude**, and **Text** roles.

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. To the **Latitude** role, assign the variable that contains the latitude values on the map.
3. To the **Longitude** role, assign the variable that contains the longitude values on the map.
4. (Optional) To the **Text** role, assign the variable that contains the text for each data point.
5. (Optional) Select **Include choropleth map layer** to create a choropleth map. You must select the input data source that contains the shape polygons. Next, assign a column to the **ID variable** role, which identifies each shape in the map data set.

   If you include response data, you must specify the input data source that contains the response for each shape in the map data set. You also must assign a response variable whose values correspond to the shade of each shape and an ID variable that identifies each shape in the response data set.

Note: If you are running the step in a flow, you must add input ports for the map data and response data to the Text Map node. For more information, see "Text Map: Connection Requirement for the Node" on page 987.

For more information, see "Choropleth Map" on page 948.

6 (Optional) Clear the **Include base map layer** check box if you do not want to display a base map layer. The base map layer is displayed by default. If a choropleth map is also displayed, the base map layer is under the choropleth map.

7 Specify whether to use an OpenStreetMap or an Esri map as the base map. You must specify the URL for the Esri map that you want to use.

Step 2: Set the Appearance Options

On the **Options** tab, you can set these options:

1 (Optional) For the text, you can specify the predefined style. You can choose the style, font color, size, and weight. You can also specify where to position the label in relation to the data point.

2 (Optional) For the chromo map, specify the line color, thickness, style, and transparency.

Note: These options are available if you select **Include choropleth map layer** on the **Data** tab.

3 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

4 (Optional) Specify the width and height of the graph in inches, centimeters, or pixels.

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Characterize Data

About the Characterize Data Step

The Characterize Data step creates a summary report of tables and graphs that describe the variables in the input data set. This step can also create frequency and univariate output tables that describe the main characteristics of the data.

The Characterize Data step is useful when you are working with a new data source. This step enables you to better understand the scope and range of the variables in the data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Characterize Data: Connection Requirements for the Node

In order to run the Characterize Data step, you must create connections to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Contents of Sashelp.PriceData

In this example, you want a better understanding of the contents in the Sashelp.PriceData table.

1 In the **Steps** section of the navigation pane, expand the **Examine Data** folder and double-click **Characterize Data**.

2 Add the Sashelp.PriceData table to your flow. Connect the input port of the Characterize Data node to the data source. For more information, see "Connecting Nodes" on page 13.

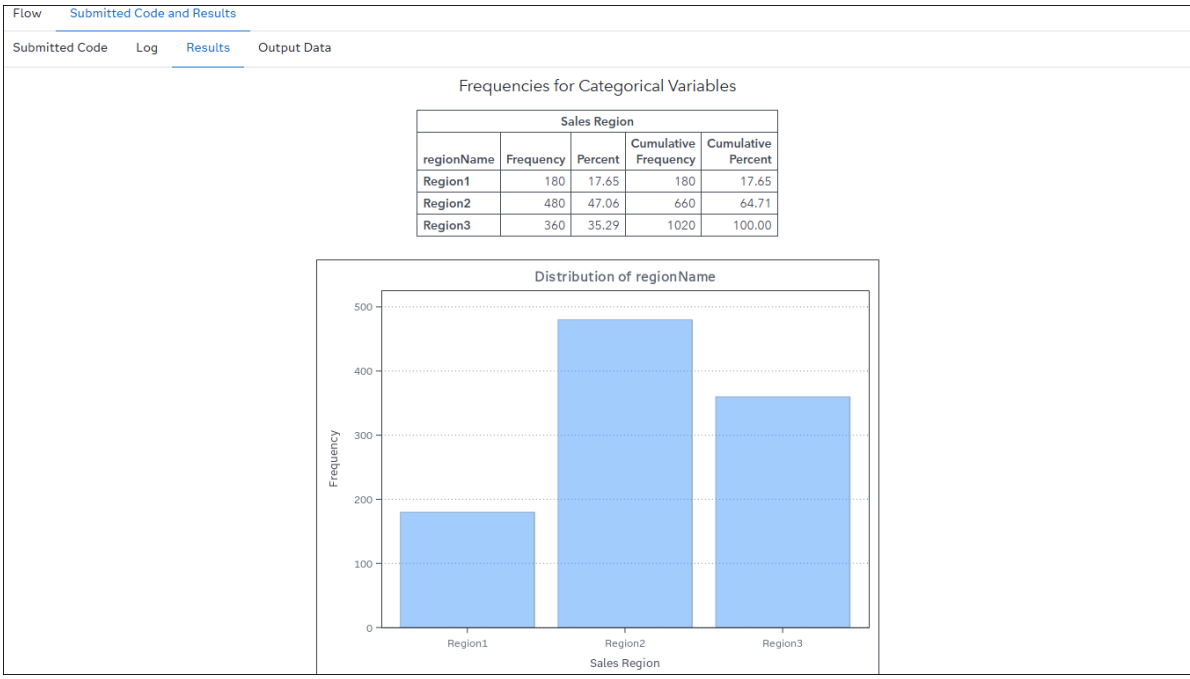
3 To set the options for the Characterize Data step, click the Characterize Data node.

4 On the **Data** tab, assign columns to these roles:

- To the **Variables** role, assign **sale**.
- Expand the Custom Categorization heading.
  - To the **Categorical variables** role, assign **regionName**.
  - To the **Date variables** role, assign **date**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a sample of the results:



Characterize Data: Step-by-Step Instructions

Step 1: Assign Data to Roles

You must select at least one variable to characterize. This step uses automatic characterization to determine the type for your variable. However, you can override this characterization by using the Custom Characterization options.

For example, in the Sashelp.Class table, Age is automatically treated as a numeric variable. You could override this characterization and specify that Age should be treated as a categorical variable. As a result, the step treats each value of Age as a group.

1. (Optional) To filter the input data source, enter the filter expression in the **Filter** field.
2. To the **Variables** role, assign the variables that you want to automatically characterize.
   - Character variables are categorized as categorical variables.
   - If the numeric variable has a date format, it is categorized as a date variable.
   - All other variables are categorized as numeric variables.
3. (Optional) To view the Custom Characterization options, expand the Custom Characterization heading.
   - To the **Categorical variables** role, assign the variables to use to produce the frequency tables.
   - To the **Date variables** role, assign the date variables to analyze.
4. (Optional) To the **Grouping variable** role, assign any variables to specify how the table is sorted. The step also generates a list for each distinct value, or BY group, in the variable or combination of variables.

Step 2: Set the Options

On the **Options** tab, you must select at least one option for each type of column that you selected on the **Data** tab. If no option is selected for an assigned column type, the step does not run, and you receive an error.

1. Select the options for the categorical variables:
   - **Frequency table** displays a frequency table in the results. This table is included by default.
   - **Frequency chart** displays a frequency chart in the results.

- **Treat missing values as valid level** treats missing values as a valid nonmissing level for all variables in the table.
- **Limit categorical values** specifies the maximum number of variable levels to display in one-way frequency tables.

2 Select the options for the numeric variables:

- **Descriptive statistics** displays the descriptive statistics for any numeric variables that you assigned to the **Variables** role. This option is selected by default.
- **Histogram** displays a histogram for any numeric variables that you assigned to the **Variables** role. This option is selected by default.

3 Select the options for the date variables:

- **Display minimum and maximum date** shows the minimum and maximum dates for each variable that you assigned to the **Date variables** role. This option is selected by default.
- **Frequency plot** displays a frequency plot in the results.

Compare Data

About the Compare Data Step

The Compare Data step compares two data sets or compares two variables within or across data sets.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio Basic, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Compare Data: Connection Requirements for the Node

In order to run the Compare Data step, you must create connections to the input node.

Input Port	Output Port
If you are comparing variables within the same table, you need only one input table. If you are comparing across tables, you need a base data set and a comparison table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. **Note:** By default, the output data is written to temporary tables in the Work library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Compare Data: Two Data Sets

Step 1: Select the Input Data Sources

1 Add the base table and comparison table to your flow. Connect the input ports of the Compare Data node to the data sources. For more information, see "Connecting Nodes" on page 13.

2 Select the Compare Data node in the flow.

3 On the **Select Tables** tab, select **Between 2 data sets** from the **Compare data** drop-down list.

Step 2: Select the Columns to Compare

On the **Select Columns** tab, the options that are available depend on whether you are comparing the data by observations or by ID variables.

To compare the data by observations:

1 From the **Match data by** drop-down list, select **Observations**.

2 Specify whether to compare all the columns in the data sets or to select the columns to compare. Click **Select columns** to select the columns from each table to compare.

By default, the Compare Data step adds a column with the same name for comparison. To change the name of a column, click .

To compare the data by ID variables:

1 From the **Match data by** drop-down list, select **ID variables**.

2 In the navigation pane, click **ID variables**. Click **Select columns** to select the columns from each table that contain the ID variables.

3 In the navigation pane, click **Compare columns**. Specify whether to compare all the columns in the data sets or to select the columns to compare. Click **Select columns** to select the columns from each table to compare.

By default, the Compare Data step adds a column with the same name for comparison. To change the name of a column, click .

Step 3: Select the Comparison Criteria

On the **Comparison Criteria** tab, you can set these options.

1 Select the method for judging equality. Numeric values are determined to be unequal if the magnitude of their difference, as determined by the method that you select, is greater than the value of the equality criterion.

The following methods are available:

- **Absolute** - compares the absolute difference of the values to the value of the equality criterion. If the absolute value of y minus x is greater than the equality criterion, then the values are determined to be unequal.
- **Exact** - tests for exact equality. If the value of y does not equal the value of x, then the values are determined to be unequal.
- **Percent** - compares the absolute percent difference to the value of the equality criterion.
- **Relative** - compares the absolute relative difference to the value of the equality criterion.

Note: For the **Absolute**, **Percent**, and **Relative** methods, the default value is `0.00001`. You can specify the value for the equality criterion.

2 Specify how to treat missing values. You can choose from these options: **Treat a missing value in the BASE data set as equal to any value** or **Treat a missing value in the COMPARISON data set as equal to any value**.

Step 4: Create an Output Data Set

On the **Output Data** tab, you can set these options.

1 Select **Include output data set** to create an output data set that contains a row for each matching observation. This data set contains a column for each variable in the observation, a column for the type of observation (_TYPE_), and

a column for observation number (_OBS_). The values in the _TYPE_ column can be one of these types:

- BASE - The values in this observation are from an observation in the base data set.
- COMPARE - The values in this observation are from an observation in the comparison data set.
- DIF - The values in this observation are the differences between the values in the base and comparison data sets.
- PERCENT - The values in this observation are the percent differences between the values in the base and comparison data sets.

You can choose to include these observations in the output data set:

- **Write an observation for each observation in the base data** writes in the output data set the observations in the base data set. The value in the _TYPE_ column of the output data set is set to BASE.
- **Write an observation for each observation in the comparison data** writes in the output data set the observations in the comparison data set. The value in the _TYPE_ column of the output data set is set to COMP.
- **Include difference value** writes in the output data set the differences between the values in the base and comparison data sets. The value in the _TYPE_ column of the output data set is set to DIF.
- **Include values for the percent differences** writes in the output data set the percent differences between the values in the base and comparison data sets. The value in the _TYPE_ column of the output data set is set to PERCENT.
- **Suppress observations when all values are equal** does not include in the output data set any observations where all of the values of the variables are equal.

2 Select **Include output data set for summary statistics** to create an output data set that contains a row for each summary statistic for each pair of variables. The output data set contains these columns:

- _VAR_ - contains the name of the variable from the base data set.
- _WITH_ - contains the name of the variable from the comparison data set.
- _TYPE_ - contains the name of the statistic in the observation.
- _BASE_ - contains the value of the statistic that is calculated from the values of the variable in the base data set with matching observations in the comparison data set.
- _COMP_ - contains the value of the statistic that is calculated from the values of the variable in the comparison data set with matching observations in the base data set.
- _DIF_ - contains the value of the statistic that is calculated from the differences of the values of the variable in the base data set and the matching variable in the comparison data set.

- _PCTDIF_ - contains the value of the statistic that is calculated from the percent differences of the values of the variable in the base data set and the matching variable in the comparison data set.

3 Specify the maximum number of differences to print.

Compare Data: Comparing Variables within the Same Data Set

Step 1: Select the Input Data Source

1 Add the input table to the flow. Connect the input port of the Compare Data node to the data source. For more information, see "Connecting Nodes" on page 13.

2 Select the Compare Data node in the flow.

3 On the **Select Tables** tab, select **Within a single data set** from the **Compare data** drop-down list.

Step 2: Select the Columns to Compare

On the **Select Columns** tab, select the columns from the input table to compare.

To add a variable pair to the table, click **Select Columns**.

By default, the Compare Data step adds a column with the same name for comparison. To change the name of a column, click .

Step 3: Select the Comparison Criteria

On the **Comparison Criteria** tab, you can set these options.

1 Select the method for judging equality. Numeric values are determined to be unequal if the magnitude of their difference, as determined by the method that you select, is greater than the value of the equality criterion.

The following methods are available:

- **Absolute** - compares the absolute difference of the values to the value of the equality criterion. If the absolute value of y minus x is greater than the equality criterion, then the values are determined to be unequal.

- **Exact** - tests for exact equality. If the value of y does not equal the value of x, then the values are determined to be unequal.
- **Percent** - compares the absolute percent difference to the value of the equality criterion.
- **Relative** - compares the absolute relative difference to the value of the equality criterion.

Note: For the **Absolute**, **Percent**, and **Relative** methods, the default value is `0.00001`. You can specify the value for the equality criterion.

2 Specify how to treat missing values. You can choose from these options: **Treat a missing value in the BASE data set as equal to any value** or **Treat a missing value in the COMPARISON data set as equal to any value**.

Step 4: Create an Output Data Set

On the **Output Data** tab, you can set these options.

1 Select **Include output data set** to create an output data set that contains a row for each matching observation. This data set contains a column for each variable in the observation, a column for the type of observation (_TYPE_), and a column for observation number (_OBS_). The values in the _TYPE_ column can be one of these types:

- BASE - The values in this observation are from an observation in the base data set.
- COMPARE - The values in this observation are from an observation in the comparison data set.
- DIF - The values in this observation are the differences between the values in the base and comparison data sets.
- PERCENT - The values in this observation are the percent differences between the values in the base and comparison data sets.

You can choose to include these observations in the output data set:

- **Write an observation for each observation in the base data** writes in the output data set the observations in the base data set. The value in the _TYPE_ column of the output data set is set to BASE.
- **Write an observation for each observation in the comparison data** writes in the output data set the observations in the comparison data set. The value in the _TYPE_ column of the output data set is set to COMP.
- **Include difference value** writes in the output data set the differences between the values in the base and comparison data sets. The value in the _TYPE_ column of the output data set is set to DIF.
- **Include values for the percent differences** writes in the output data set the percent differences between the values in the base and comparison data

sets. The value in the _TYPE_ column of the output data set is set to PERCENT.

- **Suppress observations when all values are equal** does not include in the output data set any observations where all of the values of the variables are equal.

2 Select **Include output data set for summary statistics** to create an output data set that contains a row for each summary statistic for each pair of variables. The output data set contains these columns:

- _VAR_ - contains the name of the variable from the base data set.
- _WITH_ - contains the name of the variable from the comparison data set.
- _TYPE_ - contains the name of the statistic in the observation.
- _BASE_ - contains the value of the statistic that is calculated from the values of the variable in the base data set with matching observations in the comparison data set.
- _COMP_ - contains the value of the statistic that is calculated from the values of the variable in the comparison data set with matching observations in the base data set.
- _DIF_ - contains the value of the statistic that is calculated from the differences of the values of the variable in the base data set and the matching variable in the comparison data set.
- _PCTDIF_ - contains the value of the statistic that is calculated from the percent differences of the values of the variable in the base data set and the matching variable in the comparison data set.

3 Specify the maximum number of differences to print.

Describe Missing Data

About the Missing Data Step

The Describe Missing Data step displays the frequencies and percentages of missing values for each selected variable. If two or more variables are assigned to this step, the step displays the pattern of missing data across variables.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Describe Missing Data: Connection Requirements for the Node

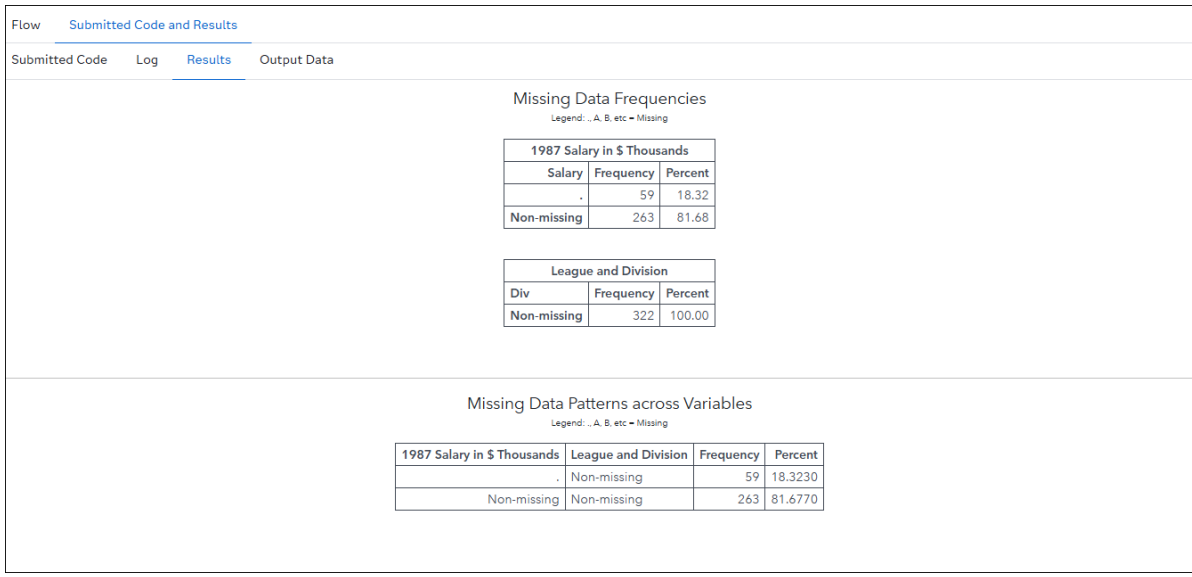
In order to run the Describe Missing Data step, you must create connections to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Describing Missing Data for Sashelp.Baseball

1. In the **Steps** section of the navigation pane, expand the **Examine Data** folder and double-click **Describe Missing Data**.
2. Add the Sashelp.Baseball table to your flow. Connect the input port of the Describe Missing Data node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Describe Missing Data step, click the Describe Missing Data node.
4. To the **Analysis variables** role, assign **Salary** and **Div**.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here are the results:


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Missing Data Frequencies

Legend: ., A, B, etc = Missing

1987 Salary in $ Thousands		
Salary	Frequency	Percent
.	59	18.32
Non-missing	263	81.68

League and Division		
Div	Frequency	Percent
Non-missing	322	100.00

Missing Data Patterns across Variables

Legend: ., A, B, etc = Missing

1987 Salary in $ Thousands	League and Division	Frequency	Percent
.	Non-missing	59	18.3230
Non-missing	Non-missing	263	81.6770

Describe Missing Data: Step-by-Step Instructions

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. To the **Analysis variables** role, assign the numeric and character variables to use in the analysis.
3. (Optional) To the **Frequncy count** role, assign a variable to specify that each observation in the table is assumed to represent *n* observations, where *n* is the frequency count for that row.
4. (Optional) To the **Group analysis role** role, assign the variables to compute separate statistics for each distinct value or combination of values of the Group analysis by variables.

Explore Data

About the Explore Data Step

The Explore Data step provides graphs that can be used to explore the relationships among selected variables.

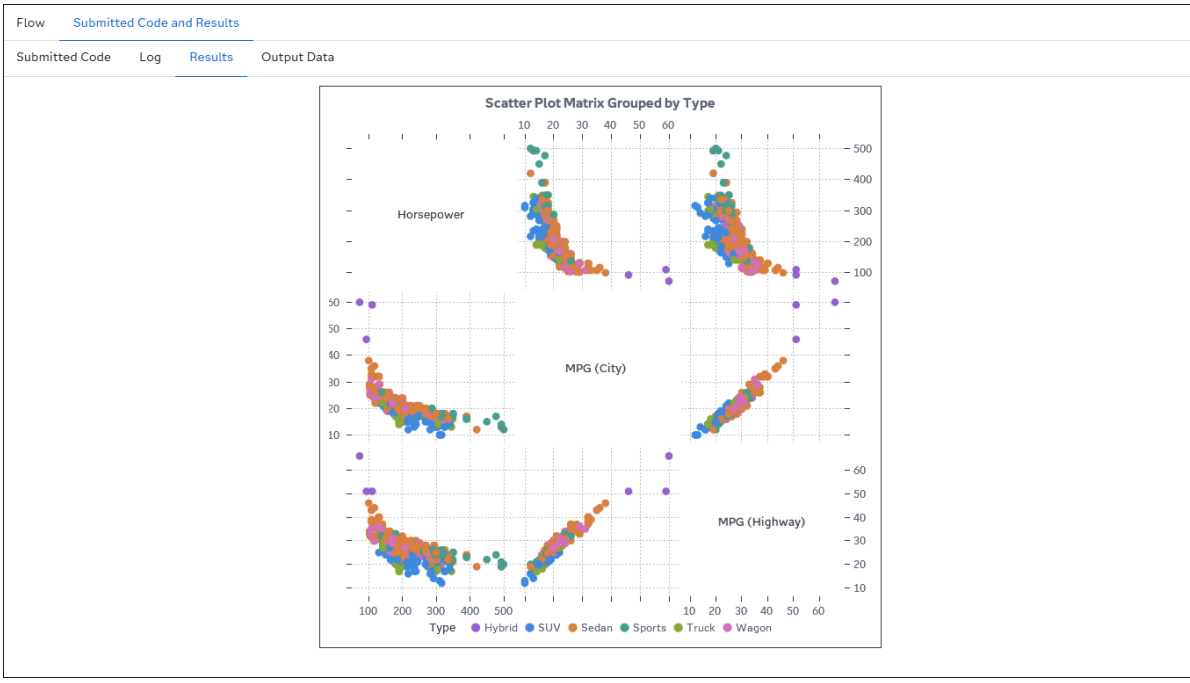
Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio Basic, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Example: Exploring the Sashelp.Cars Data

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Examine Data** folder and double-click **Explore Data** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the Explore Data node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Explore Data step, click the Explore Data node.
4. On the **Data** tab, set these options:
   - To the **Continuous variables** role, assign **Horsepower**, **MPG_City**, and **MPG_Highway**.
   - To the **Classification variables** role, assign **Type** and **DriveTrain**.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Explore Data: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Explore Data step, you must assign either one column to the **Continuous variables** role or two columns to the **Classification variables** role.

1 To the **Continuous variables** role, assign the continuous variables in the analysis.

2 To the **Classification variables** role, assign the classification variables to use to explore the data.

3 (Optional) To the **Group analysis by** role, assign the variable to create separate analyses based on the number of BY variables.

Step 2: Set the Plot Options

On the **Options** tab, the plot options that are available depend on the columns that you assigned on the **Data** tab.

1 Create a scatter plot matrix.

Note: The scatter plot matrix options are available when at least two columns are assigned to the **Continuous variables** role.

- Select **Add histograms** to add histograms to the diagonal cells of the matrix. You can add a normal density curve and the kernel density estimate to these histograms.
- Select **Add prediction ellipses** to add a prediction ellipse to each cell that contains a scatter plot. You can specify the confidence level for the ellipses. Valid values are between 0 and 1.

2 Create pairwise scatter plots. The step plots the values of two or more variables and produces a separate cell for each combination of Y and X variables. That is, each Y*X pair is plotted on a separate set of axes.

Select **Add prediction ellipses** to add a prediction ellipse to each cell that contains a scatter plot. You can specify the confidence level for the ellipses. Valid values are between 0 and 1.

Note: The pairwise scatter plot options are available when at least two columns are assigned to the **Continuous variables** role.

3 Create regression scatter plots.

Specify the variables to use when fitting the regression line. You can then choose from these options:

- Add a regression fit to the scatter plot.
- Add a loess fit to the scatter plot.
- Add a fitted, penalized B-spline curve to the scatter plot.

Note: The regression scatter plot options are available when at least two columns are assigned to the **Continuous variables** role.

4 Create a combined histogram and box plot.

Note: These options are available when a column is assigned to the **Continuous variables** role, but no column is assigned to the **Classification variables** role.

5 Create a mosaic plot, which displays tiles that correspond to the crosstabulation table cells. The areas of the tiles are proportional to the frequencies of the table cells. The column variable is displayed on the X axis, and the tile widths are proportional to the relative frequencies of the column variable levels. The row variable is displayed on the Y axis, and the tile heights are proportional to the relative frequencies of the row levels within column levels.

You can also choose from these options:

- Produce a square mosaic plot, where the height of the Y axis equals the width of the X axis. In a square mosaic plot, the scale of the relative frequencies is the same on both axes.
- Specify the colors for the mosaic plot tiles according to the values of residuals. You can also specify to color the tiles according to the Pearson or standardized residuals of the corresponding table cells.

Note: The mosaic plot is available when two variables are assigned to the **Classification variables** role.

6 Create a comparative histogram by using any numeric variables in the input table. You can also choose from these options:

- Add a normal density curve to the histogram.
- Add a kernel density estimate to the histogram.
- Add a box or table of summary statistics directly in the histogram.

Note: This histogram is available when at least one column is assigned to the **Continuous variables** role and at least one column is assigned to the **Classification variables** role.

7 Create a comparative box plot for each classification variable. This plot shows all continuous variables by the classification variable.

Note: The box plot is available when at least one column is assigned to the **Classification variables** role.

List Data

About the List Data Step

The List Data step displays the contents of a table as a report. For example, you can use the List Data step to create a report that sums the expenses and revenues for each sales region.

For more information, see "SORT Procedure" in *Base SAS Procedures Guide*.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio Basic, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

List Data: Connection Requirements for the Node

In order to run the List Data step, you must create connections to the input node.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created.

Example: Reports of Drive Train, Engine Size, and MSRP by Car Type

In this example, you want to create reports for each car type. Each report lists the drive train, MSRP, and engine size.

1 In the **Steps** section of the navigation pane, expand the **Examine Data** folder and double-click **List Data**.

2 Add the Sashelp.Cars table to your flow. Connect the input port of the List Data node to the data source. For more information, see “Connecting Nodes” on page 13.

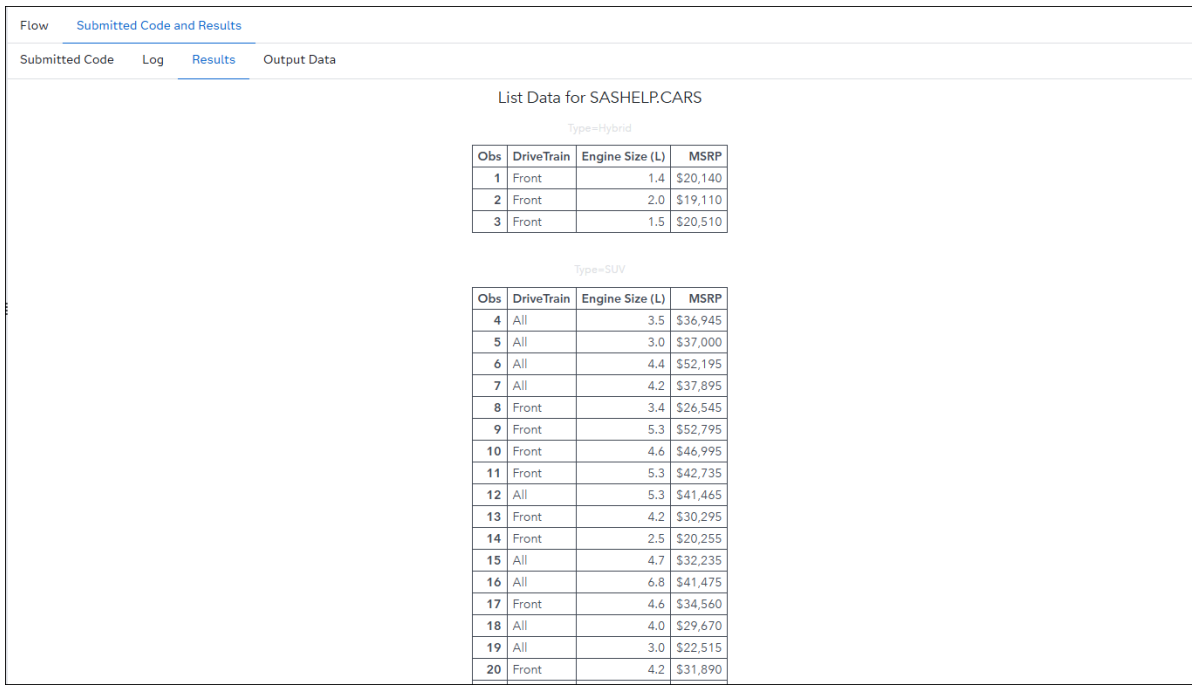
3 To set the options for the List Data step, click the List Data node.

4 On the **Data** tab, assign columns to these roles:

- To the **List variables** role, assign **DriveTrain**, **EngineSize**, and **MSRP**.
- To the **Group analysis by** role, assign **Type**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a sample of the results:


Flow Submitted Code and Results

Submitted Code Log Results Output Data

List Data for SASHELP.CARS

Type=Hybrid

Obs	DriveTrain	Engine Size (L)	MSRP
1	Front	1.4	$20,140
2	Front	2.0	$19,110
3	Front	1.5	$20,510

Type=SUV

Obs	DriveTrain	Engine Size (L)	MSRP
4	All	3.5	$36,945
5	All	3.0	$37,000
6	All	4.4	$52,195
7	All	4.2	$37,895
8	Front	3.4	$26,545
9	Front	5.3	$52,795
10	Front	4.6	$46,995
11	Front	5.3	$42,735
12	All	5.3	$41,465
13	Front	4.2	$30,295
14	Front	2.5	$20,255
15	All	4.7	$32,235
16	All	6.8	$41,475
17	Front	4.6	$34,560
18	All	4.0	$29,670
19	All	3.0	$22,515
20	Front	4.2	$31,890

List Data: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter** field.

2 To the **List variables** role, assign the variables that you want to print. You can specify the order of the variables.

3 (Optional) To obtain separate analyses of observations for each unique group, assign a variable to the **Group analysis by** role.

4 (Optional) To print the sum of a selected variable at the bottom of the listing report, assign the variable to the **Total of** role.

5 (Optional) To use the formatted values of specific variables to identify the rows (rather than the observation numbers), assign one or more variables to the **Identifying label** role.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 To include in the output a column that lists the row number for each observation, select **Display row numbers**. The row numbers are included by default.

You can specify a label for this column in the **Column label** text box.

2 Specify whether to use the column labels as column headings. The column labels are used by default.

3 To show the number of rows in the table at the end of the output or the number of rows in each BY group at the end of each BY group's output, select **Display number of rows**.

4 To round each numeric value to the number of decimal places in its format or to two decimal places if no format is specified, select **Round values before summing the variable**. If this option is selected, the List Data step performs the rounding before summing the variable.

5 Specify the direction of the column heading. Column headings can be printed horizontally or vertically, or you can select **Default** and let SAS determine the optimal arrangement for each column.

6 Specify the column widths for the output. You can choose from these options:

- **Default** determines the column widths on a per-page basis.
- **Full** uses a format width (or default width if no format is specified) for all pages.
- **Minimum** uses the smallest possible column width on a per-page basis.
- **Uniform** reads the entire table to determine the appropriate column widths before generating output. When this option is not selected, different pages could have different widths for the same column.
- **Uniform by** formats all columns uniformly within a BY group by using each variable's formatted width as its column width. If the variable does not have a format that explicitly specifies a field width, the step uses the widest data value as the column width.

7 Specify whether to split the column labels.

If the column labels contain one of the split characters (*, !, @, #, $, %, ^, &, or +), the labels split at the specified character or characters. For example, for a column label that reads "This is*a label" and the * character is selected as the split character, the column heading reads

```
This is
a label
```

You do not need to select both the **Use column label as column headings** and **Split labels** options. The **Split labels** option implies that you want to use column labels.

8 To specify the number of rows to list in the output, use the **Rows to list** option. By default, all rows are listed.

9 (Optional) Specify a custom title and footnote for the output. You can also specify the font size for this text.

List Table Attributes

About the List Table Attributes Step

The List Table Attributes step enables you to quickly see the date on which the table was created and last modified, the number of rows, the encoding, any engine-dependent or host-dependent information, and an alphabetical list of the variables and their attributes. You can also view any directory and host or engine information by using this step.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or

SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

List Table Attributes: Connection Requirements for the Node

In order to run the List Table Attributes step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node	No connection is required.

Example: Table Attributes for Sashelp.PriceData

1 In the **Steps** section of the navigation pane, expand the **Examine Data** folder and double-click **List Table Attributes**.

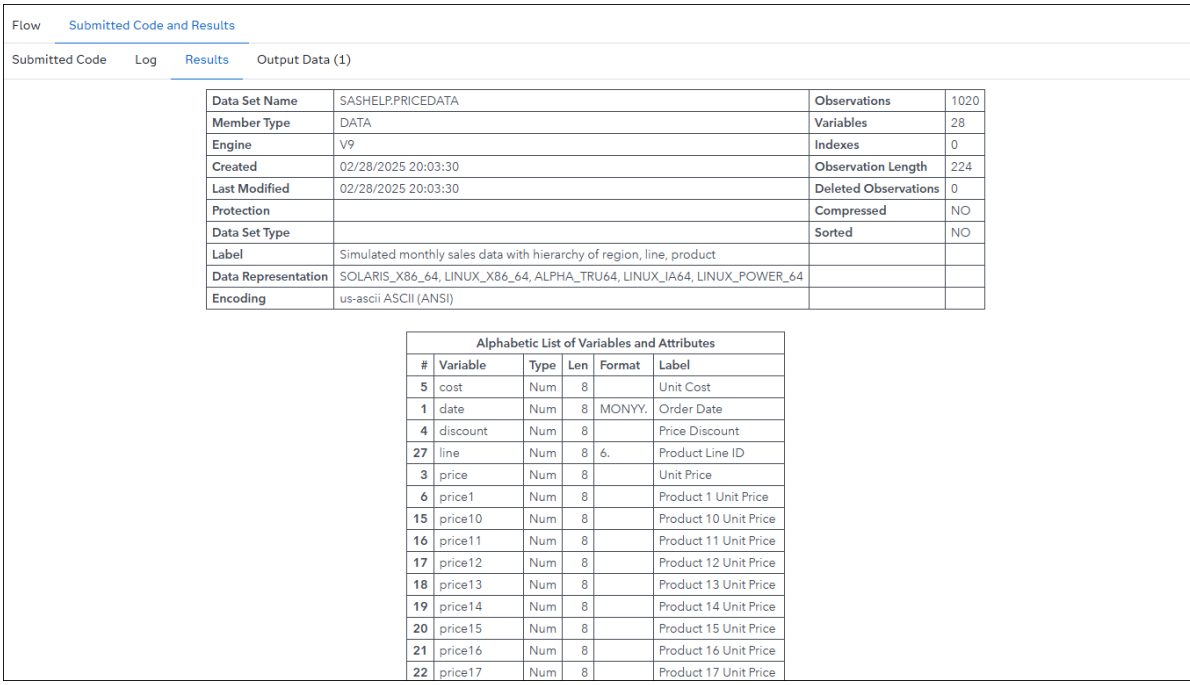
2 Add the Sashelp.PriceData table to your flow. Connect the input port of the List Table Attributes node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the List Table Attributes step, click the List Table Attributes node.

4 On the **Output** tab, select **Create output data**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a sample of the results:



Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

Data Set Name	SASHELP.PRICEDATA	Observations	1020
Member Type	DATA	Variables	28
Engine	V9	Indexes	0
Created	02/28/2025 20:03:30	Observation Length	224
Last Modified	02/28/2025 20:03:30	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label	Simulated monthly sales data with hierarchy of region, line, product		
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64, LINUX_POWER_64		
Encoding	us-ascii ASCII (ANSI)		

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
5	cost	Num	8		Unit Cost
1	date	Num	8	MONYY.	Order Date
4	discount	Num	8		Price Discount
27	line	Num	8	6.	Product Line ID
3	price	Num	8		Unit Price
6	price1	Num	8		Product 1 Unit Price
15	price10	Num	8		Product 10 Unit Price
16	price11	Num	8		Product 11 Unit Price
17	price12	Num	8		Product 12 Unit Price
18	price13	Num	8		Product 13 Unit Price
19	price14	Num	8		Product 14 Unit Price
20	price15	Num	8		Product 15 Unit Price
21	price16	Num	8		Product 16 Unit Price
22	price17	Num	8		Product 17 Unit Price

List Table Attributes: Step-by-Step Instructions

Step 1: Select the Information to Display

On the **Options** tab, you can set these options:

1. (Optional) To view attributes of the table (such as the table name, member type, when the table was created, when the table was last modified, encoding, and so on), select **Data set attributes**. The table attributes are included by default.
2. (Optional) To view the list of all the variables and their attributes (such as variable name, type, length, and so on), select **Variables list**. The variables are listed in the results by default.
3. Specify the order of the variables in the output. You can choose to display the variables in alphabetical order or in the order in which they appear in the table.
4. (Optional) To view the name of the directory where this table is located, select **Directory information**.
5. (Optional) To display the SAS engine, physical name, and file name for each level in the directory, select **Host/Engine information**.

Step 2: Set the Output Options

On the **Output** tab, you can set these options:

1. (Optional) To save the table attributes in an output table, select **Create output data**. You can specify whether to replace an existing table.
2. (Optional) Specify whether to show output table in the results.

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Managing Models

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Assess Model

About the Assess Model Step

The Assess Model step evaluates the performance of a predictive model by comparing the predicted and actual target values in a scored data set. Based on the type of target, performance measures such as ROC, lift, and fit statistics are available.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Assess Model: Connection Requirements for the Node

In order to run the Assess Model step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No output data is created. No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Assess Models: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter scored data** field.

2 Select the target type.

- Select **Nominal** to specify that you want to use a nominal target in the analysis. You must also select the event level for the target and the posterior probability of the target event.
- Select **Interval** to specify that you want to use an interval target in the analysis. You must also assign a variable to the **Predicted target** role.

3 (Optional) To the **Frequency count**, assign a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Set the Options

On the **Options** tab, specify the options for your nominal or interval target. The available options depend on whether you are using a nominal target or an interval target.

To set the options for a nominal target:

1 Select the options for the lift analysis.
   - Specify the curve type for the lift. Valid values are **Decile** and **Semi-decile**.
   - Specify the maximum number of iterations in the percentile analysis.

2 For the ROC analysis, use the **Increase cutoff probability from 0 to 1 by** option to specify the cutoff size. The default value is `0.1`.

3 Specify the fit statistics.
   - Select **Produce fit statistics** to include fit statistics in the results.
   - Specify whether the step should detect the posterior probabilities for non-event target levels automatically or whether a user-specified value should be used.

4 Specify whether to include plots in the results. Available plots include a ROC curve, a lift chart, a cumulative lift chart, and a captured response chart.

To set the options for an interval target:

1 Select the options for the lift analysis.
   - Specify the curve type for the lift. Valid values are **Decile** and **Semi-decile**.
   - Specify the maximum number of iterations in the percentile analysis.

2 Specify whether to include a lift chart.

Step 3: Create the Output Data

On the **Output** tab, specify whether to create these output tables.

- a data set with the ROC information

  Note: The ROC information is available only if you are using a nominal target.

- a data set that contains the lift information
- a data set that contains the fit statistics

When naming these tables, you must use a SAS libref.

Register Python Model

About the Register Python Model Step

This step is used with SAS Model Manager and requires python-sasctl versions 1.10.7 and later.

Using this step, you can register into SAS Model Manager your Python models that have been trained in SAS Data and AI Studio. Then you can use the functionality in SAS Model Manager to manage and govern your trained models.This step is available only for classification models with a binary target. For more information, see *SAS Model Manager: User's Guide*.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Python Model: Requirements for the Node

To run the Register Python Model step, these conditions must be met:

- You must have these input tables: a table of trained data and a table of scored data. These input tables must be connected to the corresponding input ports on the Register Python Model node.
- The Python training file can be specified in the same flow. If this file is not in the flow, the file must have been run in the current SAS Data and AI Studio session.

Step-by-Step: Register Python Model

Step 1: Register a Model

1 In the **Steps** section of the navigation pane, expand the **Manage Models** folder and double-click **Register Python Model**.

2 Add the training data and the scored data. If you are running the step in a flow, you must connect the input data to the corresponding input port on the Register Python Model node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

3 Click the Register Python Model node.

4 Enter a name and an optional description for the model.

5 Select the file that contains the Python training code.

Note: This file must be specified in either a previous node or run within the current SAS Data and AI Studio session.

6 Specify the name of the trained model. This name must be the same as the model name in the training code.

7 Specify the name of the project.

Note: This project must already exist in SAS Model Manager.

8 (Optional) Specify whether to register the model in a new project version.

Step 2: Select the Variables

On the **Variables** tab, specify these options:

Note: If you are working in a flow, you must connect the scored data to the input port of the Register Python Model node. The values from the scored data are used to populate the option values on the **Variables** tab.

1 Specify the model function.

Note: Only models with a classification function and a binary target are supported. The binary target level is automatically detected for a model.

2 Select the target variable that was used to train the model.

3 Select the target values. This is the set of possible outcome classes for the target variable. For example, the values for binary classification targets could be `0` or `1`.

4 Select the value for the target event. This is the value of the target variable that defines the desired event. This value must be one of the two classifications that were specified in the target values.

5 Select the input variables that were used to train the model.

6 Select the output variable that contains the predicted classification values for the model.

7 Select the output variable that contains the event probability. This output variable contains the predicted probabilities for the desired target variable.

Step 3: Run the Flow

To run the flow, click ▷ Run.

Open SAS Model Manager and navigate to your specified project. Refresh your display to view the model in your project.

Register SAS Model

About the Register SAS Model Step

This step is used with SAS Model Manager.

The Register SAS Model step imports a scoring model from SAS Data and AI Studio into SAS Model Manager. This step accepts both scoring models that are analytical objects in a CAS table (ASTORE) as well as score code, which is a file containing DATA step code.

For more information, see these examples:

- "Import an Analytic Store File into a Project" in *SAS Model Manager: Macro Reference*
- "Import a Model Using a DATA Step Score Code File" in *SAS Model Manager: Macro Reference*

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Register a Model

Note: A prerequisite for this is step is an existing SAS Model Manager project. If no project exists, you must create one in SAS Model Manager.

1 In the **Steps** section of the navigation pane, expand the **Manage Models** folder and double-click **Register SAS Model**.

2 (Optional) Add an analytic store, scoring table, or train table to the flow.

If you are running the step in a flow, you must connect the input data to the corresponding input port on the Register SAS Model node. To add an input port, right-click the node and select **Add input port**. Then select **Analytic Store**, **Scored Table**, or **Train Table**. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

3 Click the **Register SAS Model** node.

4 Enter a name and description for the model.

5 Select the model type: **Analytic store** or **DATA step**.

6 Under the **Model Manager** heading, enter the name of the project that you created in SAS Model Manager.

7 Specify the location of the project in SAS Model Manager. The default model repositories are **`Public`** and **`DMRepository`**. For more information, see "About Model Repositories" in *SAS Model Manager: User's Guide*.

Note: White space and special characters are not allowed in the model name.

8 (Optional) To create a new project with an incremental number, select **New project version**.

9 To run the flow, click ▷ Run.

10 Open SAS Model Manager. Refresh your display to view the model in your project.

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Enhancing Data Quality

Clean Data **1025**
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Clean Data

About the Clean Data Step

The Clean Data step performs Standardization, Casing, Identification Analysis, Gender Analysis, and Pattern Analysis by using the Quality Knowledge Base (QKB) locale. Many of the examples in the following sections use the English, United States locale. For more information about all available locales, see SAS Quality Knowledge Base for Contact Information 33.

Note: This step is available to use in a flow or as a standalone step in SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Standardization

Standardization transforms text strings by rendering them in a preferred format. A Standardization operation can rearrange words, change individual words or symbols, and apply casing rules.

The particular transformations that are applied to a text string are determined by the semantic type of the data. You provide the semantic type of the data as a context when you invoke a Standardization operation. For example, if you specify that the string "Virginia" is a US state, then the transformed value is "VA". In contrast, if you specify that the string "SMITH, VIRGINIA" is the name of an individual, then the transformed value is "Virginia Smith".

Here are some example inputs and outputs of a Standardization operation:

Table 16.1 *Examples of Standardization*

Input	Output
north carolina	NC
JONES, DOCTOR JAMES	Dr James Jones
9195425602	(919) 542-5602
apartment 3 100 main street	100 Main St, Apt 3

Use Standardization to increase the readability or consistency of your relational text strings. Standardizations can increase the accuracy of subsequent frequency counts.

Standardization uses pattern-based rules to perform transformations. It does not perform lookups in reference databases. In this way, Standardization differs from data enrichment operations such as address verification. Data enrichment operations search reference databases to return records that match an input text string. Data enrichment can also retrieve additional information about the input string. Therefore, data enrichment provides a richer feature set than Standardization. However, reference database searches can be computationally intensive, and the licensing fees for the reference databases can be expensive.

Casing

Casing applies context-sensitive case rules to text. It operates on character content such as names, organizations, and addresses.

Table 16.2 *Examples of Case Stored Procedure Inputs and Outputs*

Input	Procedure	Output
SAS INSTITUTE	DQ_LOWERCASE()	sas institute
	DQ_UPPERCASE()	SAS INSTITUTE
	DQ_PROPERCASE()	SAS Institute

Gender Analysis

Gender analysis evaluates the name or other information about an individual to determine the gender of that individual. If the evaluation finds substantial clues that indicate gender, the function returns a value that indicates that the gender is female or male. If the evaluation is inconclusive, the stored procedure returns a value that indicates that the gender is unknown. The exact return value is determined by the specified gender analysis definition and locale.

Table 16.3 *Examples of Gender Analysis*

Input	Output
Jane Smith	F
Sam Adams	M
P. Jones	U

Identification Analysis

Identification analysis returns a value that indicates the category of the content in an input character string. The available categories and return values depend on your choice of identification definition and locale.

Table 16.4 *Examples of Identification Analysis*

Input	Output
John Smith	NAME
SAS Institute	ORGANIZATION

Pattern Analysis

Pattern analysis returns a simple representation of a text string's character pattern, which can be used for pattern frequency analysis in profiling jobs. Pattern analysis identifies words or characters in the input data column as numeric, alphabetic, non-alphanumeric, or mixed. The choice of pattern analysis definition determines the nature of the analysis.

Table 16.5 *Examples of Pattern Analysis*

Input	Output
919-677-8000	999-999-9999
NC	AA

Clean Data: Connection Requirements for the Node

In order to run the Clean Data step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. **Note:** By default, the output data is written to temporary tables in the Work library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Clean Data: Step-by-Step Instructions for Clean Data

Step 1: Add the Clean Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Data Quality** folder and double-click **Clean Data** to add the step to your flow.

2 Connect the input port of the Clean Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Clean Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table.

Next, connect the output port of the Clean Data node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Select the QKB Locale

Select the QKB locale for the step. The available definitions and outputs depend on the selected locale. In this documentation, the examples are from English (United States).

For more information about all available locales, seeSAS Quality Knowledge Base for Contact Information 33.

Step 3: Enable Standardization

On the **Standardization** tab, you can set these options:

1 Select **Enable standardization**.

2 (Optional) To include a column in the output that indicates whether the data was standardized, select **Generate column to indicate status**.

3 (Optional) To preserve missing values in the data, select **Preserve missing values**.

4 Create up to 10 standardization operations.

a Select a column from the input data source.

b Select the standardization definitions. You can choose from these options:

- **ASCII Non-Printable Character Removal** removes control characters and other non-printable characters. For example, Mr. John Smith[DELETE] becomes Mr. John Smith.
- **Anonymize E-mail Domain** replaces the email (sub-level and top-level) domain with "nodomain.com". A display name or any other text that is not part of the email address is removed. For example, john.smith@sas.com becomes john.smith@nodomain.com.
- **Brand to Manufacturer** converts well-known brand names to the manufacturer name. All trademark symbols are removed. Manufacturer names are standardized. Different industries require different lists of brands and manufacturers. For example, VOLKSWAGEN OF AMERICA becomes VOLKSWAGEN.
- **Business Title** standardizes business titles by using a parse definition as an initial step. For example, cfo and Chief Financial Officer both become CFO.
- **Business Title (No Parse)** standardizes business titles without using a parse definition as an initial step. For example, bus mgr and BUSINESS MGR both become Business Manager.
- **Color Reduction** reduces the color names to the set of base colors: RED, YELLOW, BLUE, GREEN, PURPLE, ORANGE, WHITE, BLACK, BROWN, BEIGE, GRAY, MULTI, CLEAR. For example, ONYX becomes BLACK.
- **Country** standardizes country names and identifiers to a country name based on the ISO 3166 "QKB locale short name". For example, if your locale is English, FRANCA becomes France, and COMMONWEALTH OF NORTHERN MARIANA ISLANDS becomes Northern Mariana Islands.
- **Country (ISO 2 Char)** standardizes country names and country identifiers to the two-character numeric code that is defined by ISO 3166. If the input is not recognized, the output is converted to uppercase without diacritics or punctuation. For example, USA becomes US, and "unknown" becomes UNKNOWN.
- **Country (ISO 3 Char)** standardizes country names and country identifiers to the three-character numeric code that is defined by ISO 3166. If the input is not recognized, the output is converted to uppercase without diacritics or punctuation. For example, US becomes USA, and "unknown" becomes UNKNOWN.
- **Country (ISO Number)** standardizes country names and country identifiers to the three-digit numeric code that is defined by ISO 3166. If the input is not recognized, the output is converted to uppercase without diacritics or punctuation. For example, USA becomes 840, and "unknown" becomes UNKNOWN.

- **Country (Region)** standardizes country names and country identifiers to the United Nations region designation. If the input is not recognized, the output is converted to uppercase without diacritics or punctuation. For example, USA and 840 both become Americas, and "unknown" becomes UNKNOWN.
- **Country (Sub-region)** standardizes country names and country identifiers to the United Nations sub-region designation. If the input is not recognized, the output is converted to uppercase without diacritics or punctuation. For example, USA and 840 both become North America, and "unknown" becomes UNKNOWN.
- **Date (DMY)** standardizes dates that have the format DMY. The output is a zero-padded two-digit day, followed by a zero-padded two-digit month, followed by a four-digit year. The day, month, and year are separated by slashes, equal to the SAS Date format "DDMMYYS10.". For example, 04 JUL 23 and 04. juillet 2023 both become 04/07/2023.
- **Date (MDY)** standardizes dates that have the format MDY. The output is a zero-padded two-digit month, followed by a zero-padded two-digit day, followed by a four-digit year. The month, day, and year are separated by slashes, equal to the SAS Date format "MMDDYYS10.". For example, 04 JUL 23 and 04. juillet 2023 both become 07/04/2023.
- **Date (YMD)** standardizes dates that have the format YMD. The output is a four-digit year, followed by a zero-padded two-digit month, followed by a zero-padded two-digit day. The year, month, and day are separated by slashes, equal to the SAS Date format "YYMMDDS10.". For example, 04 JUL 23 and 04. juillet 2023 both become 2023/07/04.
- **Date/Time (DMY) Basic** standardizes dates that have the format DMY HH:MM:SS. The output is a four-digit year followed by a zero-padded two-digit month, followed by a zero-padded two-digit day, followed by a zero-padded two-digit hour, followed by zero-padded two-digit minutes, followed by zero-padded two-digit seconds. The day, month, and year are separated by spaces, and the time elements are separated by spaces. The date and the time are separated by a "T". For example, 04/07/02 becomes 2002 07 04, and 11 May 2000 10:12:45 becomes 2000 05 11T10 12 45.
- **Date/Time (DMY) Extended** standardizes dates that have the format DMY HH:MM:SS. The output is a four-digit year followed by a zero-padded two-digit month, followed by a zero-padded two-digit day, followed by a zero-padded two-digit hour, followed by zero-padded two-digit minutes, followed by zero-padded two-digit seconds. The day, month, and year are separated by hyphens, and the time elements are separated by colons. The date and the time are separated by a "T". For example, 04/07/02 becomes 2002-07-04, and 11 May 2000 10:12:45 becomes 2000-05-11T10:12:45.
- **Date/Time (MDY) Basic** standardizes dates that have the format DMY HH:MM:SS. The output is a four-digit year followed by a zero-padded two-digit month, followed by a zero-padded two-digit day, followed by a zero-padded two-digit hour, followed by zero-padded two-digit minutes, followed by zero-padded two-digit seconds. The day, month, and year are separated by spaces, and the time elements are separated by spaces. The

date and the time are separated by a "T". For example, 04/07/02 becomes 2002 04 07, and 11 May 2000 10:12:45 becomes 2000 05 11T10 12 45.

- **Date/Time (MDY) Extended** standardizes dates that have the format DMY HH:MM:SS. The output is a four-digit year followed by a zero-padded two-digit month, followed by a zero-padded two-digit day, followed by a zero-padded two-digit hour, followed by zero-padded two-digit minutes, followed by zero-padded two-digit seconds. The day, month, and year are separated by hyphens, and the time elements are separated by colons. The date and the time are separated by a "T". For example, 04/07/02 becomes 2002-04-07, and 11 May 2000 10:12:45 becomes 2000-05-11T10:12:45.
- **Date/Time (YMD) Basic** standardizes dates that have the format DMY HH:MM:SS. The output is a four-digit year followed by a zero-padded two-digit month, followed by a zero-padded two-digit day, followed by a zero-padded two-digit hour, followed by zero-padded two-digit minutes, followed by zero-padded two-digit seconds. The day, month, and year are separated by spaces, and the time elements are separated by spaces. The date and the time are separated by a "T". For example, 04/07/02 becomes 2004 07 02, and 11 May 2000 10:12:45 becomes 2000 05 11T10 12 45.
- **Date/Time (YMD) Extended** standardizes dates that have the format DMY HH:MM:SS. The output is a four-digit year followed by a zero-padded two-digit month, followed by a zero-padded two-digit day, followed by a zero-padded two-digit hour, followed by zero-padded two-digit minutes, followed by zero-padded two-digit seconds. The day, month, and year are separated by hyphens, and the time elements are separated by colons. The date and the time are separated by a "T". For example, 04/07/02 becomes 2004-07-02, and 11 May 2000 10:12:45 becomes 2000-05-11T10:12:45.
- **Dimensions** standardizes dimensions data to well-known abbreviations. For example, 5 feet becomes 5 FT, and 0.7 oz becomes 0.7 OZ.
- **E-mail** standardizes the email addresses.
- **HTML Character Reference Conversion** transforms all HTML named character references, as well as the equivalent Unicode and Numeric HTML codes, into the characters they represent. For example, São Paulo becomes Sao Paulo.
- **Hyphen/Dash Removal** removes hyphen-looking characters. For example, 919-541-2777 becomes 9195417777, and Mary-Ann becomes MaryAnn.
- **Hyphen/Dash Space Replacement** replaces hyphen-looking characters with a space character. Any white space at the beginning or end of an output string is removed. For example, ATTN-Mary-Ann becomes ATTN Mary Ann.
- **IBAN (Electronic)** standardizes International Bank Account Numbers for electronic storage. For example, MT84 MALT 0110 0001 2345 MTLC AST0 01S becomes MT84MALT011000012345MTLCAST001S, and IBAN:

IT18U676465399313492877422 4 becomes IT18U6764653993134928774224.

- **IBAN (Printed)** standardizes International Bank Account Numbers for printout. For example, NL91ABNA0417164300 becomes IBAN NL91 ABNA 0417 1643 00.
- **Mask All Characters** replaces every alphanumeric, punctuation, and symbol character with the * character. For example, John Smith 123 becomes **** ***** ***.
- **Mask All Characters Except First and Last** replaces every alphanumeric, punctuation, and symbol character with the * character, except for the first and last characters. For example, Juan becomes J**n.
- **Mask Digits** replaces every digit with the * character. For example, AAA111 111 becomes AAA*** ***.
- **Mask E-mail Domain** replaces every non-space character in the complete email domain with the * character. For example, john.smith@sas.com becomes john.smith@*******.
- **Mask E-mail Mailbox** replaces every non-space character in the mailbox portion of the email address with the * character. For example, john.smith@sas.com becomes **********@sas.com.
- **Mask E-mail Mailbox Except First and Last Characters** replaces all of the characters except the first and last in the mailbox portion of the email address with three * characters. For example, john.smith@sas.com becomes j***n@sas.com.
- **Mask E-mail Sub-Domain** replaces every non-space character in the email sub-domain with the * character. For example, john.smith@sas.com becomes john.smith@***.com.
- **Mask Letters** replaces every letter with the * character. For example, AAA111 111 becomes ***111 111.
- **Mask Partial String** replaces every alphanumeric character except the last four with the * character. For example, 221-161-355 becomes *****1355.
- **Material** standardizes material data, expanding well-known abbreviations. Different industries require different lists of materials.
- **Multiple Space Collapse** converts multiple space characters to one space character.
- **Name** standardizes names of individuals. For example, john donovan becomes John Donovan, and KEVIN I MC ALLISTER becomes Kevin I McAllister.
- **Non-Alphanumeric Removal** removes all non-alphanumeric characters, including spaces. For example, Cary.NC.27513 becomes CaryNC27513, and #AA-456-A12 becomes AA45612.
- **Non-Number Removal** removes all non-number characters. For example, John Smith 123 becomes 123, and AAA111 becomes 111111.
- **Number Removal** removes all number characters. For example, John Smith 123 becomes John Smith, and AAA111 111 becomes AAA.

- **Organization** standardizes organization names. For example, Moffat Limited Australia becomes Moffat Ltd, Australia, and A.T.W.Products Sp. z o. o. becomes ATW Products SP ZOO.
- **Package/UOM** standardizes package and unit of measurement (UOM) data to standard terms in the format QUANTITY PACKAGE - UNITS UOM. For example, 55 Gal Drum becomes DRUM - 55 GAL, and 4 10lb cotton bags becomes 4 BAG - 10 LB.
- **Part Number** standardizes part number data. This definition removes words that are commonly used to indicate a part number, such as Item, Part, Serial, Manufacturer, Number, and their abbreviations. The definition converts characters other than alphanumeric, hyphen, forward slash, and period to a dash. For example, 6000105-0010 becomes 6000105-0010, and P/N 15-2HD becomes 15-2HD.
- **Phone Country Code to Country Name** transforms a phone country code into its corresponding country code. For example, +1 becomes United States/Canada, and 0034 becomes Spain.
- **Punctuation Removal** removes punctuation characters. For example, 100 Main St. Apt #100 becomes 100 Main St Apt 100, and (919) 541-2777 ext. 500 becomes 919 541-2777 ext 500.
- **Punctuation Space Replacement** replaces punctuation characters with a space character. White space at the beginning or end of the output string is removed. For example, 100 Main St. Apt#100 becomes 100 Main St Apt 100, and 919-541-2777/ext.500 becomes 919-541-2777 ext 500.
- **Size** standardizes sizes such as small, medium, and large to the shortest well-known abbreviation. For example, Small becomes S, and LARGE/ TALL becomes L/T.
- **Space Removal** removes all space characters. For example, 10 : 10 becomes 10:10, and N A becomes NA.
- **Surrounding Quote Removal** removes quotation mark characters that surround an entire string. For example, "John O'Malley" becomes John O'Malley, and "1" Steel Tube" becomes 1" Steel Tube.
- **Symbol Removal** removes all symbol characters. For example, $125.99 becomes 125.99.
- **Truncate Word to Initial** removes all characters except the first letter or digit of each alphanumeric sub-string. Sub-strings are delimited by punctuation, symbols, and white space with the exception of periods and commas in decimal numbers. For example, John Smith 123 becomes J S 1, and $123,000.45 becomes 1.
- **URL** standardizes URLs. For example, http://www.sas.com/News-and-Events becomes http://www.sas.com/news-and-events, and ftp:/file.text becomes ftp://file.txt.
- **Website** standardizes websites. For example, WWW.SAS.COM becomes www.sas.com, and http://www.sas.com/News-and-Events/ becomes www.sas.com/news-and-events.

5 Specify whether the standardized data replaces the existing column in the input data source or whether a new column is created in the output. By default, a new column is created, and the name of the column is *InputColumnName*_STND.

Step 4: Enable Casing

On the **Casing** tab, you can set these options:

1 Select **Enable casing**.

2 (Optional) To include a column in the output that indicates whether the data was standardized, select **Generate column to indicate status**.

3 (Optional) To preserve missing values in the data, select **Preserve missing values**.

4 Create up to 10 casing operations.

   a Select a column from the input data source.

   b Select the casing definitions. You can choose from these options:

   - **Lower** converts to lowercase general text. For example, Lowercase General Text becomes lowercase general text.
   - **Proper** performs generic proper casing. For example, propercase general text becomes Propercase General Text.
   - **Proper (Address Number)** uses proper case for address numbers. For example, box 123a becomes Box 123A, and 4201a becomes 4201A.
   - **Proper (Business Title)** uses proper case for business titles. For example, ceo becomes CEO, and SALES MANAGER becomes Sales Manager.
   - **Proper (City - State/Province - Postal Code)** uses proper case for the last line of address information. For example, in English, cary, nc 27513 becomes Cary, NC 27513.
   - **Proper (Given Name)** uses proper case for given names of individuals. For example, aj becomes AJ, and mckensie becomes McKensie.
   - **Proper (Name)**uses proper case for names of individuals. For example, GWENDOL GUTTERMOTH becomes Gwendol Guttermoth, and ronald chung-hui mcdonald becomes Ronald Chung-Hui McDonald.
   - **Proper (Organization)** uses proper case for organization names. For example, sas institute becomes SAS Institute.
   - **Proper (Site)** uses proper case for organization sites. For example, of new zealand becomes New Zealand, and uk becomes UK.
   - **Upper** converts to uppercase general text. For example, uppercase general text becomes UPPERCASE GENERAL TEXT.
   - **Upper (Legal Form)** converts to uppercase organization legal forms. For example, inc becomes Inc, and sp zoo becomes SP ZOO.

5 Specify whether the casing data replaces the existing column in the input data source or whether a new column is created in the output. By default, a new column is created, and the name of the column is *InputColumnName*_CASE.

Step 5: Enable Gender Analysis

On the **Gender Analysis** tab, you can set these options:

1 Select **Enable gender analysis**.

2 (Optional) To preserve missing values in the data, select **Preserve missing values**.

3 Create up to 10 gender analysis operations.

   a Select a column from the input data source.

   b Select **Name** as the definition. This definition determines the probable gender of a full name. Possible outputs are `M`, `F`, and `U`. For example, Sandi Baker becomes F, and T. Millhouse becomes U.

4 (Optional) Specify the name of the new column that is created. By default, the name of the column is *InputColumnName*_GNDR.

Step 6: Enable Identification Analysis

On the **Identification Analysis** tab, you can set these options:

1 Select **Enable identification analysis**.

2 (Optional) To preserve missing values in the data, select **Preserve missing values**.

3 Create up to 10 identification analysis operations.

   a Select a column from the input data source.

   b Select the identification analysis definitions. You can choose from these options:

   - **Date (DMY Validation - Numeric Only)** identifies date strings as valid or invalid. Possible outputs are `VALID` and `INVALID`. For example, 10/18/2007 outputs as INVALID, and 10/5/07 outputs as VALID.
   - **Date (MDY Validation - Numeric Only)** identifies date strings as valid or invalid. Possible outputs are `VALID` and `INVALID`. For example, 10/18/2007 outputs as VALID, and October 5, 2007 outputs as INVALID.
   - **Date (YMD Validation - Numeric Only)** identifies date strings as valid or invalid. Possible outputs are `VALID` and `INVALID`. For example, 10/18/2007 outputs as INVALID, and 07/18/10 outputs as VALID.

- **E-mail (Country Identification)** identifies the country of an email address. For example, john.smith@example.co.jp outputs as JAPAN, and john.smith@example.com outputs as UNKNOWN.
- **E-mail (Validation)** identifies whether an email address is syntactically correct. Possible outputs are `VALID` and `INVALID`. For example, VIRGINIE.MAZOUINGMAIL.COM outputs as INVALID, and ai@sas.com outputs as VALID.
- **Field Content** identifies the type of data that is represented by a string. Here are the possible outputs:
  - `CITY`
  - `CITY-STATE/PROVINCE-POSTAL CODE`
  - `COUNTRY`
  - `CURRENCY`
  - `DATE`
  - `DATE/TIME`
  - `DELIVERY ADDRESS`
  - `E-MAIL`
  - `EMPTY`
  - `FAMILY NAME`
  - `FULL ADDRESS`
  - `GEOGRAPHICAL POINT`
  - `GIVEN NAME`
  - `IBAN`
  - `INDIVIDUAL`
  - `MONTH`
  - `NETWORK ADDRESS`
  - `ORGANIZATION`
  - `PAYMENT CARD NUMBER`
  - `PHONE`
  - `POSTAL CODE`
  - `SOCIAL SECURITY NUMBER`
  - `STATE/PROVINCE`
  - `UNKNOWN`
  - `URL`
- **Field Content (Global)** identifies the type of data that is represented by a string. Here are the possible outputs:
  - `COUNTRY`
  - `CURRENCY`

- DATE
- DATE/TIME
- E-MAIL
- EMPTY
- GEOGRAPHICAL POINT
- IBAN
- MONTH
- NETWORK ADDRESS
- PAYMENT CARD NUMBER
- UNKNOWN
- URL

- **Field Name** identifies the type of data that is indicated by database field names. Here are the possible outputs:
  - AGE
  - ADDRESS
  - BIRTH DATE
  - CITY
  - COUNTRY
  - COUNTY
  - DATE
  - DATE/TIME
  - DAY
  - DELIVERY ADDRESS
  - E-MAIL
  - FAMILY NAME
  - GENDER
  - GENERIC_ID
  - GIVEN NAME
  - INDIVIDUAL
  - LATITUDE
  - LONGITUDE
  - MARTIAL_STATUS
  - MATCHCODE
  - MIDDLE NAME
  - MONTH
  - ORGANIZATION

- ORGANIZATION_ID
- PERSONAL_ID
- PHONE
- POSTAL CODE
- STATE/PROVINCE
- UNKNOWN
- URL
- WEEK
- YEAR

- **Offensive** identifies potentially offensive words and phrases. Here are the possible outputs:
  - OFF_ENUSA_1
  - OFF_ENUSA_2
  - OFF_ENGBR_1
  - OFF_ENGBR_2
  - OFF_FRFRA_1
  - OFF_FRFRA_2
  - INVALID, PASS
- **Phone (Validation)** determines whether a string represents a valid phone number. Possible outputs are `VALID` and `INVALID`. For example, (514) 444-4444 outputs as VALID, and 055-5555 outputs as INVALID.

4 (Optional) Specify the name of the new column. By default, the column name is *InputColumnName*_ID.

Step 7: Enable Pattern Analysis

On the **Pattern Analysis** tab, you can set these options:

1 Select **Enable pattern analysis**.

2 (Optional) To preserve missing values in the data, select **Preserve missing values**.

3 Create up to 10 pattern analysis operations.

a Select a column from the input data source.

b Select the pattern analysis definitions. You can choose from these options:

- **Character** determines the pattern of characters in the input string. White space in the input string is identified as white space in the output.

Table 16.6 *Output Symbols*

Symbol	Meaning
A	Uppercase letter
a	Lowercase letter
9	Numeric digit
*	Other (punctuation, symbols, and so on)

For example, 1 800-846-Flux becomes 9 999*999*Aaaa, and JND 5134 becomes AAA 9999.

- **Character (Script Identification)** determines the Unicode script of each character in the input, and outputs a character representing that script.

Table 16.7 *Output Symbols*

Symbol	Meaning
L	Latin character
漢	Kanji/Han
ア	Katakana
あ	Hiragana
가	Hangul
Я	Cyrillic
Θ	Greek
ก	Thai
ا	Arabic
א	Hebrew
9	Numeric digit
*	Other (punctuation, symbols, and so on)

For example, JOHN DOE outputs as LLLL LLL, which means uppercase Latin character.

- **Word** determines the pattern of words in the input string. White space in the input string is identified as white space in the output.

Table 16.8 *Output Symbols*

Symbol	Meaning
A	Alphabetic
9	Numeric digit
M	Mixed alphabetic/numeric
*	Other (punctuation, symbols, and so on)

For example, 1 800-846-Flux becomes 9 9*9*A, and JND 5134 becomes A 9.

- **Word (Script Identification)** determines the Unicode script of each word in the input, and outputs a character representing that script.

Table 16.9 *Output Symbols*

Symbol	Meaning
L	Latin character
漢	Kanji/Han
ア	Katakana
あ	Hiragana
가	Hangul
Я	Cyrillic
Θ	Greek
ก	Thai
ا	Arabic
א	Hebrew
9	Numeric digit

Symbol	Meaning
*	Other (punctuation, symbols, and so on)

For example, JOHN DOE outputs as L L, which means Latin character.

4 (Optional) Specify the name of the new column. By default, the column name is *InputColumnName*_PATTERN.

Step 8: Setting Options

On the **Options** tab, you can select the **Show detailed log information** option to include detailed information in the SAS log.

Step 9: Specify the Output Data

On the **Output** tab, you can select these options:

1 **Output** (Optional) Select **Replace existing output table with the same name** to replace an existing table with the new table. Any output tables are replaced by default.

2 To create a CAS table from the output data, select these options:

- **Promote to a global in-memory table**
- **Save to persist the table on disk**
- **File format**

Step 10: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

Match Codes

About the Match Codes Step

Use the Match Codes step to create match codes that can be used as a basis for standardization or other transformations. Using the Match Codes step, you can create a match code for a column based on a locale and rule definition. (SAS provides these locale and rule definitions in the SASDqRef.DM_Madef data table.)

Note: This step is available to use in a flow or as a standalone step in SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

The amount of information that is contained in match codes is determined by a specified sensitivity level. Changing the sensitivity level enables you to change what is considered a match. Match codes that are created at lower levels of sensitivity capture little information about the input values. The result is more matches, fewer clusters, and more values in each cluster.

Higher sensitivity levels require that input values be more similar to receive the same match code. Clusters are more numerous, and each cluster contains fewer entries. For example, when collecting customer data that is based on account numbers, cluster on account numbers with a high sensitivity value.

For example, your input data source contains these three values in a Name column: James Briggs, Jim Briggs, and Mr. James E. Briggs. The generated match code is based on the English (US) locale and the Name definition. The Match Codes step saves the generated match code in a new column in the output data table. In this example, the Match Codes step generates an identical match code for the three name values. You can now use the match code to help you identify duplicate rows in your input data source.

You can generate up to 10 match codes for an input table.

Many of the examples in the following sections use the English, United States locale. For more information about all available locales, see SAS Quality Knowledge Base for Contact Information 33.

Note: The Match Codes step is available in SAS Data and AI Studio Enterprise.

Match Codes: Connection Requirements for the Node

In order to run the Match Codes step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. **Note:** By default, the output data is written to temporary tables in the Work library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Match Codes: Step-by-Step Instructions for Matching Code

Step 1: Add the Match Codes Step and Connect a Source Table

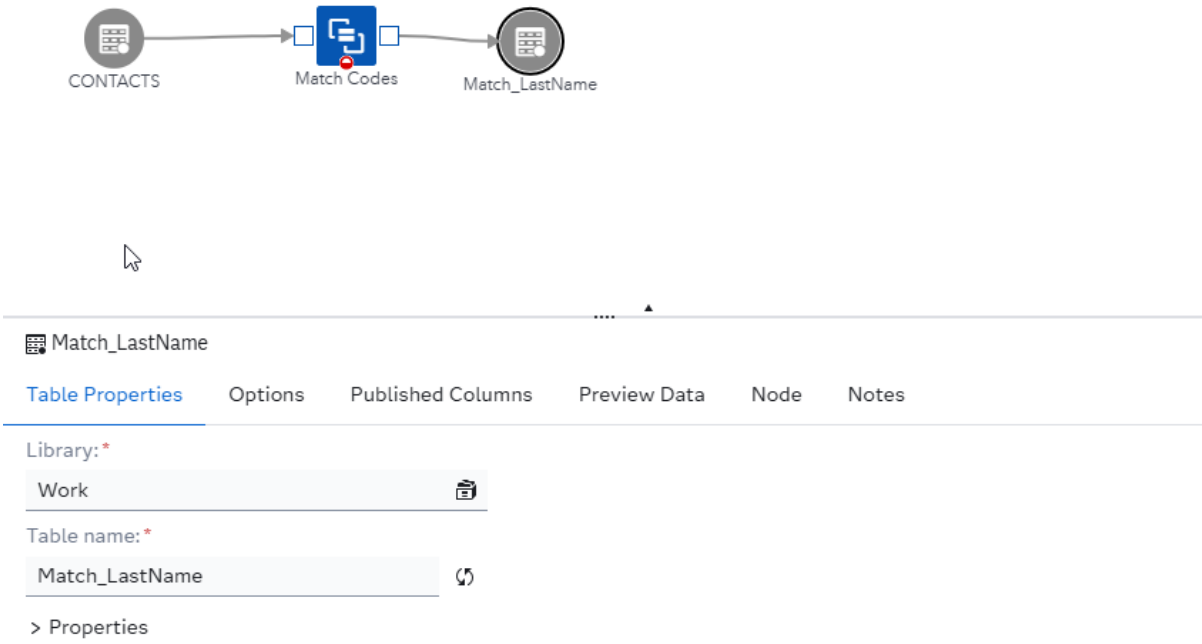
1 In the **Steps** section of the navigation pane, expand the **Data Quality** folder and double-click **Match Codes** to add the step to your flow.

2 Connect the input port of the Match Codes node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Match Codes step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table. (In this example, the output table is named Work.Match_Name.)

Next, connect the output port of the Match Codes node to the table node.

Note: The output table does not have any columns until you run the flow.



Step 2: Generating Match Codes

1 Select the QKB locale.

   For more information about all available locales, see SAS Quality Knowledge Base for Contact Information 33.

2 Select a column from the input data source.

3 (Optional) Specify a name for the column that contains the match code. Sensitivities are available only in increments of five with a range between 50 and 95. The default value is 85.

   By default, this column is the *InputColumnName*_MC*Sensitivity-suffix*. An example of a column name is ColumnName_MC85.

4 Select the definition to use for the match code. These definitions are in the SASDqRef.DM_Madef data table. Here are some of the possible definitions for the English, United States locale:

   - **Account Number** generates match codes that can be used to cluster records that contain account numbers. Data values are rendered right-to-left in the match codes, so matches are found based on the least-significant positions in the input data. For example, with an 85 match sensitivity, 111-AB-3333-48-26656 results in a cluster ID of 0.
   - **Address** generates match codes that can be used to cluster records that contain addresses. The maximum length of the match code is 82 characters. For example, with an 85 match sensitivity, 52 Commerce Street, Apt 3 results in a cluster ID of 2.

Address (PO Box only) generates match codes that can be used to cluster records that contain the PO Box portion of an address. The maximum length of the match code is 15 characters. For example, with an 85 match sensitivity, P.O. Box 12345 results in a cluster ID of 1.

- **Address (Street Only)** generates match codes that can be used to cluster records that contain the street portion of an address. The maximum length of the match code is 54 characters. For example, with an 85 match sensitivity, John Doe, 1200 Main St results in a cluster ID of 0. An input of 52 Commerce Road results in a cluster ID of 2.
- **Business Title** generates match codes that can be used to cluster records that contain business title information. The maximum length of match codes is 15 characters. For example, with an 85 match sensitivity, Chief Executive Officer results in a cluster ID of 0.
- **City** generates match codes that can be used to cluster records that contain city names. The maximum length of match codes is 15 characters. For example, with an 85 match sensitivity, Cary results in a cluster ID of 0, and Durham results in a cluster ID of 1.
- **City - State/Province - Postal Code** generates match codes that can be used to cluster records that contain last line address information. The maximum length of match codes is 15 characters. For example, with an 85 match sensitivity, Cary, NC 27653 results in a cluster ID of 0, and Durham, North Carolina 27713 results in a cluster ID of 1.
- **Country** generates match codes that can be used to cluster records that contain country names and identifiers. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, UNITED STATES OF AMERICA results in a cluster ID of 0, and POLAND results in a cluster ID of 1.
- **Date (DMY)** generates match codes that can be used to cluster records that contain dates in DMY format. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, 04/07/05 results in a cluster ID of 1, and 02 March 2005 results in a cluster ID of 2.

Note:

- At sensitivities 85 and lower, centuries are not regarded as part of the match criteria.
- At sensitivity 90 only: If the input year is a two-digit value, it is assumed to be within the hundred-year span with 2049 as the end of the span. A year of 49 matches 2049, but not 1949. A year of 50 matches 1950, but not 2050.
- At sensitivities 95 and higher, four-digit years are included in the match code. A two-digit year will not match a four-digit year.

- **Date (DMY) (with Combinations)** generates match codes that can be used to cluster records that contain dates in DMY format. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, 01/02/2013 results in a cluster ID of 0 and a score of 40.

- **Date (MDY)** generates match codes that can be used to cluster records that contain dates in MDY format. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, 07/04/05 results in a cluster ID of 1, and March 05 2005 results in a cluster ID of 2.

  Note:

  - At sensitivities 85 and lower, centuries are not regarded as part of the match criteria.
  - At sensitivity 90 only: If the input year is a two-digit value, it is assumed to be within the hundred-year span with 2049 as the end of the span. A year of 49 matches 2049, but not 1949. A year of 50 matches 1950, but not 2050.
  - At sensitivities 95 and higher, four-digit years are included in the match code. A two-digit year will not match a four-digit year.

- **Date (MDY) (with Combinations)** generates match codes that can be used to cluster records that contain dates in MDY format. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, 01/02/2013 results in a cluster ID of 0 and a score of 40.
- **Date (YMD)** generates match codes that can be used to cluster records that contain dates in YMD format. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, 05/07/04 results in a cluster ID of 1, and 2005 March 05 results in a cluster ID of 2.
- **Date/Time (DMY)** generates match codes that can be used to cluster records that contain date/time information. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, 20 Jul 1969 02:20:32 results in a cluster ID of 0.

  Note: If the input year is a two-digit value, it is assumed to be within the hundred-year span with 2049 as the end of the span. For example, a year of 49 is 2049, but a year of 50 is 1950.

- **Date/Time (MDY)** generates match codes that can be used to cluster records that contain date/time information. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, Nov-06-2001 2:32 PM results in a cluster ID of 1.

  Note: If the input year is a two-digit value, it is assumed to be within the hundred-year span with 2049 as the end of the span. For example, a year of 49 is 2049, but a year of 50 is 1950.

- **Date/Time (YMD)** generates match codes that can be used to cluster records that contain date/time information. The maximum length of match code is 15 characters. For example, with an 85 match sensitivity, 1999.10.11 22:40:00+04:00 results in a cluster ID of 0.

Note: If the input year is a two-digit value, it is assumed to be within the hundred-year span with 2049 as the end of the span. For example, a year of 49 is 2049, but a year of 50 is 1950.

- **E-mail** generates match codes that can be used to cluster records that contain email addresses.The maximum length of the match code is 38 characters. For example, with an 85 match sensitivity, jane.smith@gmail.com results in a cluster ID of 0.
- **E-mail (with Combinations)** generates match codes that can be used to cluster records that contain email addresses.The maximum length of the match code is 54 characters. For example, with an 85 match sensitivity, info@acme1.com results in a cluster ID of 0 and a score of 85. info2@acme1.com results in a cluster ID of 1 and a score of 21.25.
- **Field Name** generates match codes that can be used to cluster records that contain database field names. The maximum length of the match code is 15 characters. For example, with an 85 match sensitivity, Company Name results in a cluster ID of 0, and Address results in a cluster ID of 1.
- **Name** generates match codes that can be used to cluster records that contain names of individuals. The maximum length of the match code is 27 characters. For example, with an 85 match sensitivity, Mary Shafer results in a cluster ID of 0, and Martine Dubois results in a cluster ID of 2.
- **Name (with Combinations)** generates match codes that can be used to cluster records that contain names of individuals. The maximum length of the match code is 27 characters. For example, with an 85 match sensitivity, Mary Shafer results in a cluster ID of 0 and a score of 100. John Elton results in a cluster ID of 1, and a score of 50.
- **Name (with Suggestions)** generates match codes that can be used to cluster records that contain names of individuals. The maximum length of the match code is 21 characters. For example, with an 85 match sensitivity, Prais Hilton results in a cluster ID of 0 and a score of 75.14.
- **Organization** generates match codes that can be used to cluster records that contain organization names. The maximum length of the match code is 35 characters. For example, with an 85 match sensitivity, SAS Institute results in a cluster ID of 0.
- **Phone** generates match codes that can be used to cluster records that contain phone numbers. The maximum length of the match code is 22 characters. For example, with an 85 match sensitivity, 345-6789 results in a cluster ID of 1, and 447-300 ext 1234 results in a cluster ID of 3.
- **Postal Code** generates match codes that can be used to cluster records that contain postal codes. The maximum length of the match code is 15 characters. For example, with an 85 match sensitivity, 27653 results in a cluster ID of 0, and 27713 results in a cluster ID of 1.
- **Size** standardizes sizes such as small, medium, and large to the shortest well-known abbreviation. For example, Small becomes S, and LARGE/TALL becomes L/T.
- **State/Province** generates match codes that can be used to cluster records that contain states, territories, and federal districts. The maximum length for

the match code is 15 characters. For example, with an 85 match sensitivity, Florida results in a cluster ID of 0, and North Carolina results in a cluster ID of 1.

- **Text** generates match codes that can be used to cluster records that contain general text strings. The maximum length of the match code is 15 characters. For example, with an 85 match sensitivity, "they want" results in a cluster ID of 0, and "you are" results in a cluster ID of 1.
- **Text (Long)** generates match codes that can be used to cluster records that contain longer general text strings. The maximum length of the match code is 30 characters. For example, with an 85 match sensitivity, they want results in a cluster ID of 0, and you are results in a cluster ID of 1.

5 (Optional) Create additional match codes. You can generate up to 10 match codes for an input table.

Step 3: Set the Options

On the **Options** tab, select **Show detailed log information** to include debugging information in the log.

Step 4: Specify the Output Data

On the **Output** tab, you can select these options:

1 (Optional) Select **Replace existing output table** to replace an existing table with the new table. Any output tables are replaced by default.

2 (Optional) Select **Preserve missing values** to show missing values in the results.

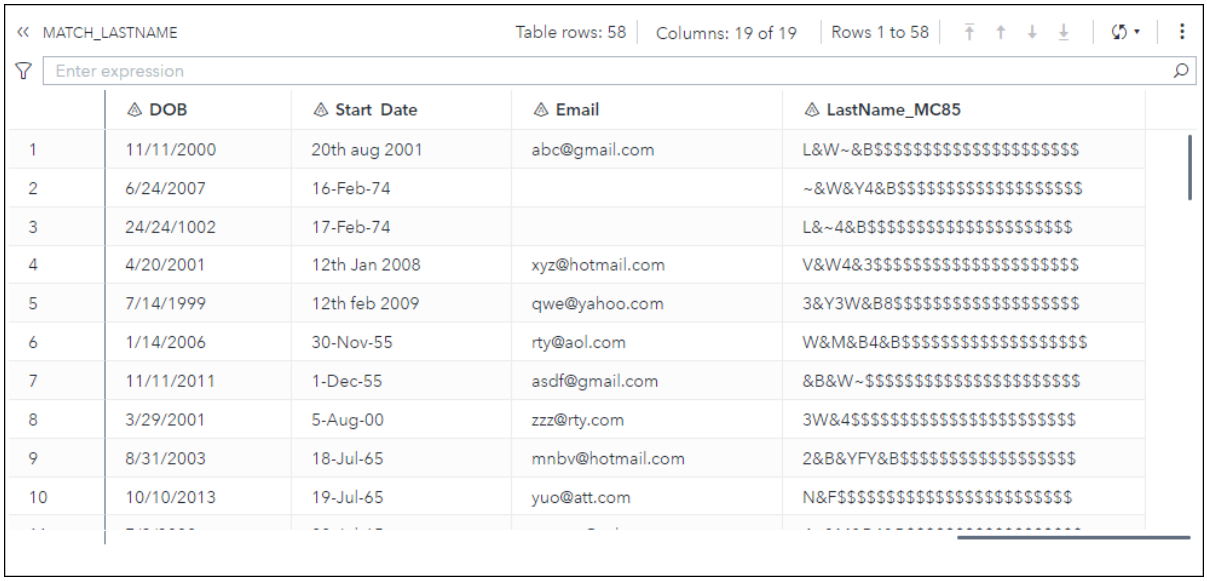
3 To create a CAS table from the output data, select these options:

- **Promote to a global in-memory table**
- **Save to persist the table on disk**
- **File format**

Step 5: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab. In this example, the LastName_MC85 column contains the generated match code for the values in the Last Name column.



MATCH_LASTNAME | Table rows: 58 | Columns: 19 of 19 | Rows 1 to 58

Enter expression

	DOB	Start Date	Email	LastName_MC85
1	11/11/2000	20th aug 2001	abc@gmail.com	L&W~&B$$$$$$$$$$$$$$$$$$$$
2	6/24/2007	16-Feb-74		~&W&Y4&B$$$$$$$$$$$$$$$$$$
3	24/24/1002	17-Feb-74		L&~4&B$$$$$$$$$$$$$$$$$$$
4	4/20/2001	12th Jan 2008	xyz@hotmail.com	V&W4&3$$$$$$$$$$$$$$$$$$$
5	7/14/1999	12th feb 2009	qwe@yahoo.com	3&Y3W&B8$$$$$$$$$$$$$$$$$$
6	1/14/2006	30-Nov-55	rty@aol.com	W&M&B4&B$$$$$$$$$$$$$$$$$$
7	11/11/2011	1-Dec-55	asdf@gmail.com	&B&W~$$$$$$$$$$$$$$$$$$$$
8	3/29/2001	5-Aug-00	zzz@rty.com	3W&4$$$$$$$$$$$$$$$$$$$$
9	8/31/2003	18-Jul-65	mnbv@hotmail.com	2&B&YFY&B$$$$$$$$$$$$$$$$
10	10/10/2013	19-Jul-65	yuo@att.com	N&F$$$$$$$$$$$$$$$$$$$$

Parse Data

About the Parse Data Step

The Parse Data step performs Parsing and Extraction by using the QKB locale. Many of the examples in the following sections use the English, United States locale. For more information about all available locales, see SAS Quality Knowledge Base for Contact Information 33.

Note: This step is available to use in a flow or as a standalone step in SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Parsing

Parsing segments a string into semantically atomic tokens.

Table 16.10 *Example of Parsing*

Input	Output
Mr. Roy G. Biv Jr	Prefix: Mr.

Input	Output
	Given Name: Roy
	Middle Name: G.
	Family Name: Biv
	Suffix: Jr.

Extraction

Extraction returns one or more extracted text values, or tokens, as output.

Table 16.11 *Example of Extraction*

Input	Output
Blue men's long-sleeved button-down collar denim shirt	Color: Blue
	Material: Denim
	Item: Shirt

Parse Data: Connection Requirements for the Node

In order to run the Parse Data step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. **Note:** By default, the output data is written to temporary tables in the Work library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Parse Data: Step-by-Step Instructions for Parse Data

Step 1: Add the Parse Data Step and Connect a Source Table

1 In the **Steps** section of the navigation pane, expand the **Data Quality** folder and double-click **Parse Data** to add the step to your flow.

2 Connect the input port of the Parse Data node to a data source by using a Table node or another node that creates an output table, such as a Query node, a SAS Program node, or an Import node. For more information, see "Connecting Nodes" on page 13.

3 To save the results from the Parse Data step to a permanent output table, select **Add** ⇨ **Table**. A table node is added to the flow. Specify the library and name for the output table.

Next, connect the output port of the Parse Data node to the table node.

Note: The output table does not have any columns until you run the flow.

Step 2: Select the QKB Locale

Select the QKB locale for the step.

For more information about all available locales, see SAS Quality Knowledge Base for Contact Information 33.

Step 3: Enable Parsing

On the **Standardization** tab, you can set these options:

1 Select **Enable parsing**.

2 (Optional) To include a column in the output that indicates whether the data was standardized, select **Generate column to indicate status**.

3 (Optional) To preserve missing values in the data, select **Preserve missing values**.

4 Create the parsing operation.

a Select a column from the input data source.

b Select the parsing definition. You can choose from these options:

- **Address** parses addresses into a set of tokens. Here are some examples of output tokens:
  - Recipient
  - Building/Site
  - Street
  - Extension
  - PO Box
  - Additional Info

Table 16.12 *Example of Address Parse Definition*

Input	Output Token	Output
Mr John Smith, Building T, Unit 102, 100 SAS Campus Dr, PO Box 12345	Recipient	Mr. John Smith
	Building/Site	Building T
	Street	100 SAS Campus Dr
	Extension	Unit 102
	PO Box	PO Box 12345
	Additional Info	

- **Address (Detailed)** parses addresses into a set of tokens with detailed street information. Here are some examples of output tokens:
  - Recipient
  - Building/Site
  - Street Number
  - Predirectional
  - Street Name
  - Street Type
  - Postdirectional
  - Extension
  - PO Box
  - Additional Info

Table 16.13 Example of Address (Detailed) Parse Definition

Input	Output Token	Output
Mr John Smith, Building T, Unit 102, 100 SAS Campus Dr, PO Box 12345	Recipient	Mr. John Smith
	Building/Site	Building T
	Street Number	100
	Predirectional	
	Street Name	SAS Campus
	Street Type	Dr
	Postdirectional	
	Extension	Unit 102
	PO Box	PO Box 12345
	Additional Info	

- **Address (Full)** parses addresses that contain complete two-line addresses into a set of tokens. Here are some examples of output tokens:
  - Recipient
  - Building/Site
  - Street
  - Extension
  - PO Box
  - City
  - State/Province
  - Postal Code
  - Country
  - Additional Info

Table 16.14 Example of Address (Full) Parse Definition

Input	Output Token	Output
Mr John Smith, Building T, Unit 102, 100 SAS Campus Dr, PO Box	Recipient	Mr. John Smith
	Building/Site	Building T

Input	Output Token	Output
12345, Cary, NC 27513 USA	Street	100 SAS Campus Dr
	Extension	Unit 102
	PO Box	PO Box 12345
	City	Cary
	State/Province	NC
	Postal Code	27513
	Country	USA
	Additional Info	

Table 16.15 Example of Address (Global) Parse Definition

Input	Output Token	Output
Mr John Smith, Building T, Unit 102, 100 SAS Campus Dr, PO Box 12345,	Recipient	Mr. John Smith
	Building/Site	Building T
	Street	100 SAS Campus Dr
	Extension	Unit 102
	PO Box	PO Box 12345
	Additional Info	

- **Business Title** parses business title information into a set of tokens. Here are some examples of output tokens:
  - Position
  - Level
  - Location
  - Department
  - Grade

Table 16.16 Example of Business Title Parse Definition

Input	Output Token	Output
Marketing Director	Position	Director
	Level	
	Location	
	Department	Marketing
	Grade	

- **City - State/Province - Postal Code** parses last line address information into a set of tokens
  - City
  - State
  - ZIP

Table 16.17 Example of City - State/Province - Postal Code Parse Definition

Input	Output Token	Output
Cary, NC 27513	City	Cary
	State	NC
	ZIP	27513

- **City - State/Province - Postal Code (Global)** parses last line-address information into a globally recognized set of tokens. Here are examples of output tokens:
  - City
  - State/Province
  - Postal Code
  - Additional Info

Note: Parse definitions that are named with the Global keyword use a set of output tokens that is consistent across every locale. Results that are obtained from these definitions can be stored in the same database fields as the results that are obtained from definitions of the same name in other locales.

Table 16.18 Example of City - State/Province - Postal Code (Global) Parse Definition

Input	Output Token	Output
Cary, NC 27513	City	Cary
	State/Province	NC
	ZIP	27513
	Additional Info	

- **Date (DMY)** parses dates with format DMY into a set of tokens. Here are examples of output tokens:
  - Day
  - Month
  - Year

Table 16.19 Example Date (DMY) Parse Definition

Input	Output Token	Output
05March1969	Day	05
	Month	March
	Year	1969

- **Date (MDY)** parses dates with format MDY into a set of tokens. Here are examples of output tokens:
  - Day
  - Month
  - Year

Table 16.20 Example Date (MDY) Parse Definition

Input	Output Token	Output
03-05-1969	Day	05
	Month	03
	Year	1969

- **Date (YMD)** parses dates with format YMD into a set of tokens. Here are examples of output tokens:
  - Day
  - Month
  - Year

Table 16.21 Example Date (YMD) Parse Definition

Input	Output Token	Output
1969.3.5	Day	5
	Month	3
	Year	1969

- **Date/Time (DMY)** parses dates with format DMY HH:MM:SS into a set of tokens. Here are examples of output tokens:
  - Year
  - Month
  - Day
  - Weekday
  - Hours
  - Minutes
  - Seconds
  - Time Extension

Table 16.22 Example Date/Time (DMY) Parse Definition

Input	Output Token	Output
20 July 1969 02:20:32	Year	1969
	Month	Jul
	Day	20
	Weekday	
	Hours	02
	Minutes	20
	Seconds	32

Input	Output Token	Output
	Time Extension	

- **Date/Time (MDY)** parses dates with format MDY HH:MM:SS into a set of tokens. Here are examples of output tokens:
  - Year
  - Month
  - Day
  - Weekday
  - Hours
  - Minutes
  - Seconds
  - Time Extension

Table 16.23 *Example Date/Time (MDY) Parse Definition*

Input	Output Token	Output
Nov-06-2001 2:32 PM	Year	2001
	Month	Nov
	Day	06
	Weekday	
	Hours	2
	Minutes	32
	Seconds	
	Time Extension	PM

- **Date/Time (YMD)** parses dates with format YMD HH:MM:SS into a set of tokens. Here are examples of output tokens:
  - Year
  - Month
  - Day
  - Weekday
  - Hours

- Minutes
- Seconds
- Time Extension

Table 16.24 Example Date/Time (YMD) Parse Definition

Input	Output Token	Output
1999.10.11 22:40:00+04:00	Year	1999
	Month	10
	Day	11
	Weekday	
	Hours	22
	Minutes	40
	Seconds	00
	Time Extension	+04:00

- **Dimensions** parses a dimension into output tokens. Here are examples of output tokens:
  - Length
  - Width
  - Height
  - Inside Diameter
  - Outside Diameter
  - Size
  - Other

Table 16.25 Example Dimensions Parse Definition

Input	Output Token	Output
11 1/16 X 19 7/16	Length	11 11/16
	Width	19 7/16
	Height	
	Inside Diameter	

Input	Output Token	Output
	Outside Diameter	
	Size	
	Other	00

- **Email** parses email addresses into a set of tokens. Here are examples of output tokens:
  - Mailbox
  - Subdomain
  - Top-Level Domain
  - Additional Info

Table 16.26 Example Email Parse Definition

Input	Output Token	Output
info@sas.com	Mailbox	info
	Subdomain	sas
	Top-level Domain	com
	Additional Info	

- **IBAN** parses International Bank Account Numbers into a general set of tokens. Here are examples of output tokens:
  - Country Code
  - Basic Bank Account Number
  - Key

Table 16.27 Example IBAN Parse Definition

Input	Output Token	Output
NL91ABNA0417164300	Country Code	NL
	Basic Bank Account Number	ABNA0417164300
	Key	91

- **IBAN (Detailed)** parses International Bank Account Numbers into a set of tokens. Here are examples of output tokens:
  - Country Code
  - Control Key
  - Basic Bank Account Number
  - Bank Code
  - Sort Code
  - Account Number
  - Key

Table 16.28 Example IBAN (Detailed) Parse Definition

Input	Output Token	Output
NL91ABNA0417164300	Country Code	NL
	Control Key	91
	Basic Bank Account Number	ABNA0417164300
	Bank Code	ABNA
	Sort Code	
	Account Number	0417164300
	Key	

- **Name** parses names of individuals into a set of tokens. Here are examples of output tokens:
  - Prefix
  - Given Name
  - Middle Name
  - Family Name
  - Suffix
  - Title/Additional Info

Table 16.29 Example Name Parse Definition

Input	Output Token	Output
Dr. James Johnson, CEO	Prefix	Dr.

Input	Output Token	Output
	Given Name	James
	Middle Name	
	Family Name	Johnson
	Suffix	
	Title/Additional Info	CEO

- **Name (Address Update)** parses names of individuals into a set of tokens. Here are examples of output tokens:
  - Prefix
  - Given Name
  - Middle Name
  - Family Name
  - Suffix
  - Title/Additional Info

Table 16.30 *Example Name (Address Update) Parse Definition*

Input	Output Token	Output
ANDY JEFFERSON	Prefix	
	Given Name	ANDY
	Middle Name	
	Family Name	JEFFERSON
	Suffix	
	Title/Additional Info	

- **Name (Global)** parses names of individuals into a globally recognized set of tokens. Here are examples of output tokens:
  - Prefix
  - Given Name
  - Middle Name
  - Family Name

- Suffix
- Title/Additional Info

Table 16.31 Example Name (Global) Parse Definition

Input	Output Token	Output
Dr. James Johnson, CEO	Prefix	Dr.
	Given Name	James
	Middle Name	
	Family Name	Johnson
	Suffix	
	Title/Additional Info	CEO

Note: Parse definitions that are named with the Global keyword use a set of output tokens that is consistent across every locale. Results that are obtained from these definitions can be stored in the same database fields as the results that are obtained from definitions of the same name in other locales.

- **Name (Multiple Name)** parses strings that contain the name of two individuals into a set of tokens. Here are examples of output tokens:
  - Name 1
  - Name 2

Table 16.32 Example Name (Multiple Name) Parse Definition

Input	Output Token	Output
Mr Jon and Mrs Sally Smith	Name 1	Mr Jon Smith
	Name 2	Mrs Sally Smith

- **Name/Organization** parses names and organizations into a set of tokens. Here are examples of output tokens:
  - Name
  - Organization

Table 16.33 Example Name/Organization Parse Definition

Input	Output Token	Output
Scott Brauer, SAS Institute	Name	Scott Brauer
	Organization	SAS Institute

- **Organization** parses organization names into a set of tokens. Here are examples of output tokens:
  - Name
  - Legal Form
  - Site
  - Additional Info

Table 16.34 Example Organization Parse Definition

Input	Output Token	Output
3Com Europe Limited	Name	3Com Europe
	Legal Form	Limited
	Site	
	Additional Info	

- **Organization (Global)** parses organization names into a globally recognized set of tokens. Here are examples of output tokens:
  - Name
  - Legal Form
  - Site
  - Additional Info

Table 16.35 Example Organization (Global) Parse Definition

Input	Output Token	Output
3Com Europe Limited	Name	3Com Europe
	Legal Form	Limited
	Site	
	Additional Info	

Note: Parse definitions that are named with the Global keyword use a set of output tokens that is consistent across every locale. Results that are obtained from these definitions can be stored in the same database fields as the results that are obtained from definitions of the same name in other locales.

- **Organization (Multiple)** parses strings that contain names of one or two organizations into a set of tokens. Here are examples of output tokens:
  - Organization 1
  - Organization 2

Table 16.36 *Example Organization (Multiple) Parse Definition*

Input	Output Token	Output
THE GINGER CAT T/A EMBROIDERY PLACE LLc	Organization	THE GINGER CAT
	Organization 2	EMBROIDERY PLACE LLc

- **Package/UOM** parses package and unit of measurement (UOM) data into output tokens. Here are examples of output tokens:
  - Quantity
  - Package
  - Units
  - UOM
  - Additional Info

Table 16.37 *Example Package/UOM Parse Definition*

Input	Output Token	Output
4 10lb cotton bags	Quantity	4
	Package	bags
	Units	10
	UOM	lb
	Additional Info	cotton

- **Phone** parses phone numbers into a set of tokens. Here are examples of output tokens:

- Country Code
- Area Code
- Base Number
- Extension
- Line Type
- Additional Info

Table 16.38 *Example Phone Parse Definition*

Input	Output Token	Output
Work: +1 (919) 447-3000 Ext 3118 (ask for John)	Country Code	+1
	Area Code	919
	Base Number	447-3000
	Extension	3118
	Line Type	Work:
	Additional Info	(ask for John)

- **Phone** parses phone numbers into a globally recognized set of tokens. Here are examples of output tokens:
  - Country Code
  - Area Code
  - Base Number
  - Extension
  - Line Type
  - Additional Info

Table 16.39 *Example Phone Parse Definition*

Input	Output Token	Output
Work: +1 (919) 447-3000 Ext 3118 (ask for John)	Country Code	+1
	Area Code	919
	Base Number	447-3000
	Extension	3118
	Line Type	Work:

Input	Output Token	Output
	Additional Info	(ask for John)

Note: Parse definitions that are named with the Global keyword use a set of output tokens that is consistent across every locale. Results that are obtained from these definitions can be stored in the same database fields as the results that are obtained from definitions of the same name in other locales.

- **Postal Code** parses postal codes into a set of tokens. Here are examples of output tokens:
  - ZIP
  - ZIP Add-on

Table 16.40 *Example Postal Code Parse Definition*

Input	Output Token	Output
27513-0001	ZIP	27513
	ZIP Add-on	0001

- **Website** parses websites into a set of tokens. Here are examples of output tokens:
  - Scheme
  - Hostname
  - Project

Table 16.41 *Example Website Parse Definition*

Input	Output Token	Output
http://www.sas.com/News-and-Events	Scheme	http://
	Hostname	www.sas.com
	Project	News-and-Events

5 Select the tokens for that definition. By default, a column is created for each token, and the name of the column is *InputColumnName_Token*.

Step 4: Enable Extraction

On the **Extraction** tab, you can set these options:

1 Select **Enable extraction**.

2 (Optional) To include a column in the output that indicates whether the data was standardized, select **Generate column to indicate status**.

3 (Optional) To preserve missing values in the data, select **Preserve missing values**.

4 Create the extraction operation.

a Select a column from the input data source.

b Select the extraction definitions. You can choose from these options:

- **Brand/Manufacturer** extracts brand and manufacturer names from a string. The remainder of the string is returned in the Additional Info token. Here are examples of output tokens:
  - Brand/Manufacturer
  - Additional Info

Table 16.42 *Example Brand/Manufacturer Extraction Definition*

Input	Output Token	Output
225703 SIMPLE 256MB IBM NETFINITY	Brand/Manufacturer	IBM NETFINITY
	Additional Info	225703 SIMPLE 256MB

- **Contact Info** extracts the Name, Organization, Address, Email, and Phone from a string. Here are examples of output tokens:
  - Name
  - Organization
  - Address
  - E-mail
  - Phone
  - Additional Info

Table 16.43 *Example Contact Info Extraction Definition*

Input	Output Token	Output
Mr John Smith, 100 SAS Campus Dr, PO Box	Name	Mr John Smith

Input	Output Token	Output
12345, Cary, NC 27513, 919-531-0000	Organization	
	Address	100 SAS Campus Dr, PO Box 12345, Cary, NC 27513
	E-mail	
	Phone	919-531-000
	Additional Info	

- **Product Attributes** extracts the product description data from a string. The remainder of the string is returned in the Additional Info token. Here are examples of output tokens:
  - Colors
  - Dimensions
  - Materials
  - Package/UOM
  - Part Numbers
  - Additional Info

Table 16.44 *Example Product Attributes Extraction Definition*

Input	Output Token	Output
BALLPT PEN MED. BLK PREMIUM TUNGSTEN CARBIDE 6/PK P/N: 456789	Colors	MED. BLK
	Dimensions	
	Materials	PREMIUM TUNGSTEN CARBIDE
	Package/UOM	6/PK
	Part Numbers	P/N: 456789
	Additional Info	BALLPT PEN

5 Select the tokens for that definition. By default, a column is created for each token, and the name of the column is *InputColumnName_Token*.

Step 5: Specify the Output Data

On the **Output** tabm you can select these options:

1 (Optional) Select **Replace existing output table with the same name** to replace an existing table with the new table. Any output tables are replaced by default.

2 To create a CAS table from the output data, select these options:

- **Promote to a global in-memory table**
- **Save to persist the table on disk**
- **File format**

Step 6: Setting Options

On the **Options** tab, you can select the **Show detailed log information** option to include detailed information in the SAS log.

Step 7: Run the Flow and View the Output Table

To run the flow, click ▷ Run.

To view the output data, click the table node, and then click the **Preview Data** tab.

17

Preparing Data

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Binning

About the Binning Step

Binning is a common step in the data preparation stage of the model-building process. You can use binning to classify missing variables, reduce the impact of outliers, and generate multiple effects. The generated effects are useful and contain certain nonlinear information about the original interval variables.

The Binning step divides the data values of a continuous variable into intervals. The values for each interval are replaced with a single value that is representative of the interval.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Binning Step: Connection Requirement for the Node

In order to run the Binning step, you must connect a table to the input node.

Input Port	Output Port
For the Binning node, the input data source must be a CAS table.	By default, no output tables are created, and no connection is required.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	However, on the **Output** tab, you can specify whether to save the binned data. This table must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1077. To run this step in a flow, you must add an output port for this optional table. To add an output port, right-click the Binning node and select **Add output port**. For this step to run, the output data must use a CAS engine library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Binning Cars Data

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.cars;
   set sashelp.cars;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Binning** to add the step to your flow.

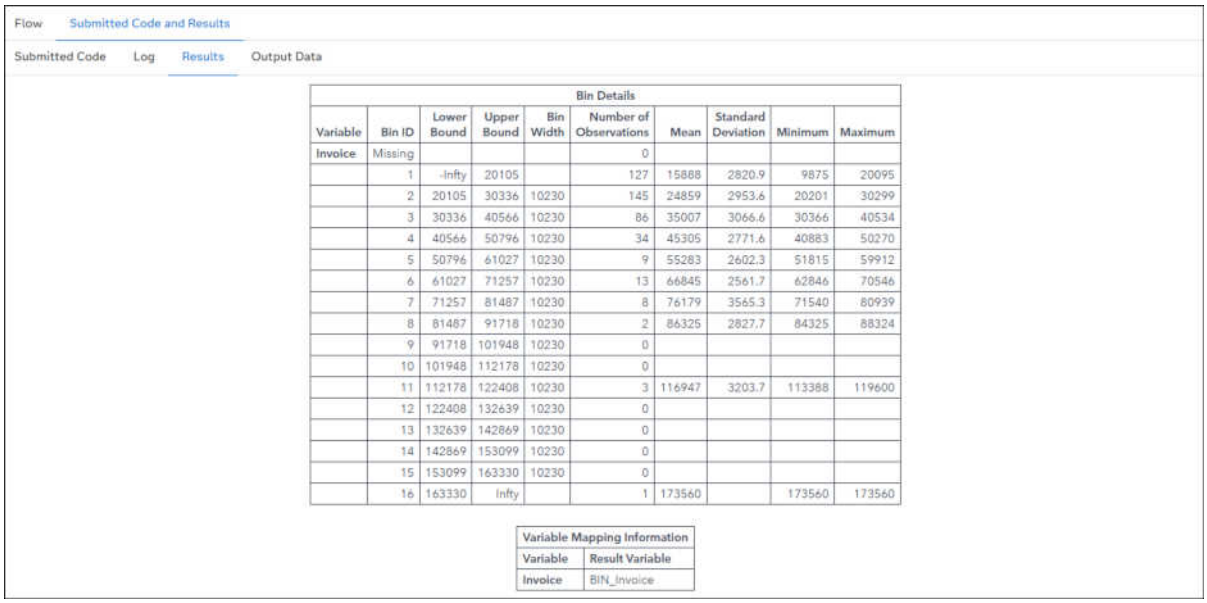
4 Add the MyCas.Cars table to your flow. Connect the input port of the Binning node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Binning step, click the Binning node.

6 On the **Data** tab, assign **Invoice** to the **Interval inputs to bin** role.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data

Bin Details

Variable	Bin ID	Lower Bound	Upper Bound	Bin Width	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Invoice	Missing				0				
	1	-Infty	20105		127	15888	2820.9	9875	20095
	2	20105	30336	10230	145	24859	2953.6	20201	30299
	3	30336	40566	10230	86	35007	3066.6	30366	40534
	4	40566	50796	10230	34	45305	2771.6	40883	50270
	5	50796	61027	10230	9	55283	2602.3	51815	59912
	6	61027	71257	10230	13	66845	2561.7	62846	70546
	7	71257	81487	10230	8	76179	3565.3	71540	80939
	8	81487	91718	10230	2	86325	2827.7	84325	88324
	9	91718	101948	10230	0				
	10	101948	112178	10230	0				
	11	112178	122408	10230	3	116947	3203.7	113388	119600
	12	122408	132639	10230	0				
	13	132639	142869	10230	0				
	14	142869	153099	10230	0				
	15	153099	163330	10230	0				
	16	163330	Infty		1	173560		173560	173560

Variable Mapping Information

Variable	Result Variable
Invoice	BIN_Invoice

Binning: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Interval inputs to bin** role, assign one or more variables as input variables for binning. The specified variables must be interval variables.

3 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Set the Options

On the **Options** tab, you can set these options.

1 Specify the global number of binning levels for all binning variables. This value can be any integer between 2 and 1,000 (inclusive.) The default number of binning levels is `16`.

2 Select the binning method.

- **Bucket binning** creates equal-length bins and assigns the data to one of these bins. You can choose the number of bins during the binning. The default number of bins (the binning level) is `16`.
- **Quantile binning** assigns the same number of observations to each bin, if the number of observations is evenly divisible by the number of bins. As a result, each bin should have the same number of observations, provided that there are no tied values at the boundaries of the bins.
- **Winsorized binning** is similar to bucket binning except that both tails are cut off to obtain a smooth binning result. This technique is often used to remove outliers during the data preparation stage.

  You must specify a value for the **Winsor rate** option. Valid values are from 0.0 to 0.5 (exclusive). The default value is `0.05`.

Step 3: Set the Output Options

On the **Output** tab, you can set these options:

1 (Optional) Specify whether to save the binned data to an output table. When naming this table, you must specify a CAS engine libref.

You can choose to include all the variables from the input data source, all the variables that are used in the analysis, none of the variables, or only selected variables.

Note: If you are running the step in a flow, you must add an output port to the Binning node for this optional table. For more information, see "Binning Step: Connection Requirement for the Node" on page 1074.

2 (Optional) Specify whether to save the generated scoring code.

3 (Optional) If you are saving the binned data, specify whether to show any data in the results.

Imputation

About the Imputation Step

The Imputation step replaces missing values in a data source with an estimate of the missing value.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Imputation: Connection Requirements for the Node

In order to run the Imputation step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, the imputed output data is created. This table must use a CAS engine libref. For more information, see "Step 2: Set the Output Options" on page 1081. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Replacing Missing Values in the Heart Table

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Run this code to load the table into a CAS table:

```
libname mycas cas;
```

```
data mycas.heart;
   set sashelp.heart;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Imputation** to add the step to your flow.

4 Add the MyCas.Heart table to your flow. Connect the input port of the Imputation node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Imputation step, click the Imputation node.

6 On the **Data** tab, assign variables to these roles.

- To the **Replace missing values with the mean** role, assign **Height**.
- To the **Replace missing values with the median** role, assign **Weight**.
- To the **Replace missing values with a random number** role, assign **Smoking**.

7 Select **Random number seed** and enter `1234` as the random seed.

8 On the **Output** tab, select **Save imputed data**.

If you are running the step in a flow, you must add an output table to the flow and an output port to the Imputation node for this optional table.

a To add an output table to the flow, click **Add** and select **Table**.

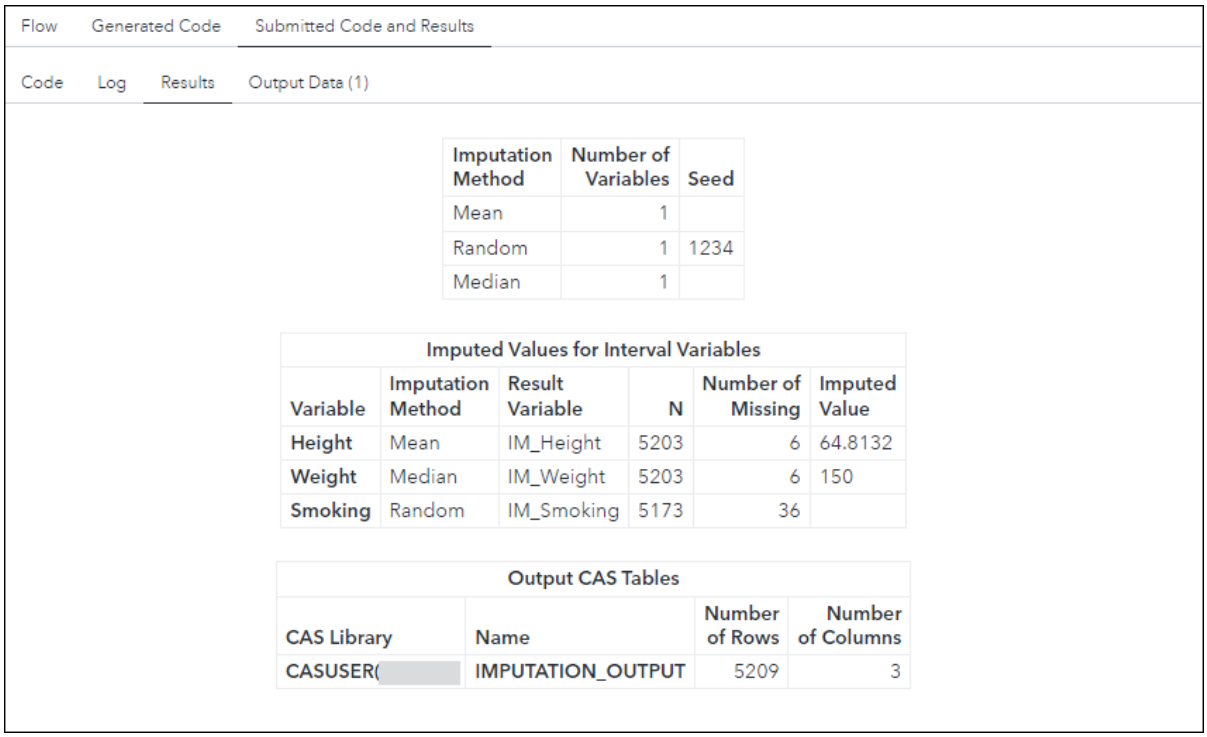
b Select the Table node. In the Table Properties, enter **`MyCas`** as the library and **`Imputation_output`** as the table name.

c Right-click the Imputation node and select **Add output port**.

d Connect the output port to the new table.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results and the output data.



Imputation Method	Number of Variables	Seed
Mean	1	
Random	1	1234
Median	1	

Imputed Values for Interval Variables

Variable	Imputation Method	Result Variable	N	Number of Missing	Imputed Value
Height	Mean	IM_Height	5203	6	64.8132
Weight	Median	IM_Weight	5203	6	150
Smoking	Random	IM_Smoking	5173	36	

Output CAS Tables

CAS Library	Name	Number of Rows	Number of Columns
CASUSER(	IMPUTATION_OUTPUT	5209	3

Imputation: Step-by-Step Instructions

Step 1: Assign Data to Roles

You must select at least one variable to replace its missing values with the mean, median, mode, or random number.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Replace missing values with the mean** role, assign the interval variable that contains the mean to use for replacing missing values.

3 To the **Replace missing values with the median** role, assign the interval variable that contains the median to use for replacing missing values.

4 To the **Replace missing values with a random number** role, assign the interval variable to replace missing values with a random value that is drawn between the minimum and maximum of the variable. If there is no nonmissing value, the random value is `0`.

5 To the **Replace missing values with the mode** role, assign the nominal variable to replace missing values with the mode (most frequent value).

6 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to

this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Set the Output Options

On the **Output** tab, specify whether to create an output table that includes the imputed data. When naming this table, you must specify a CAS engine libref.

This table includes the data, imputation indicator variables (0 for not imputed or 1 for imputed), and imputed variables. You can also include all of the variables from the input data source, only the variables that are used in the analysis, only selected variables, or none of the variables from the input data source.

Note: If you are running the step in a flow, you must add an output port to the Imputation node. For more information, see "Imputation: Connection Requirements for the Node" on page 1078.

Label Encoding

About the Label Encoding Step

The Label Encoding step converts low cardinality categorical variables into a sparse label-encoded representation.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Label Encoding: Connection Requirements for the Node

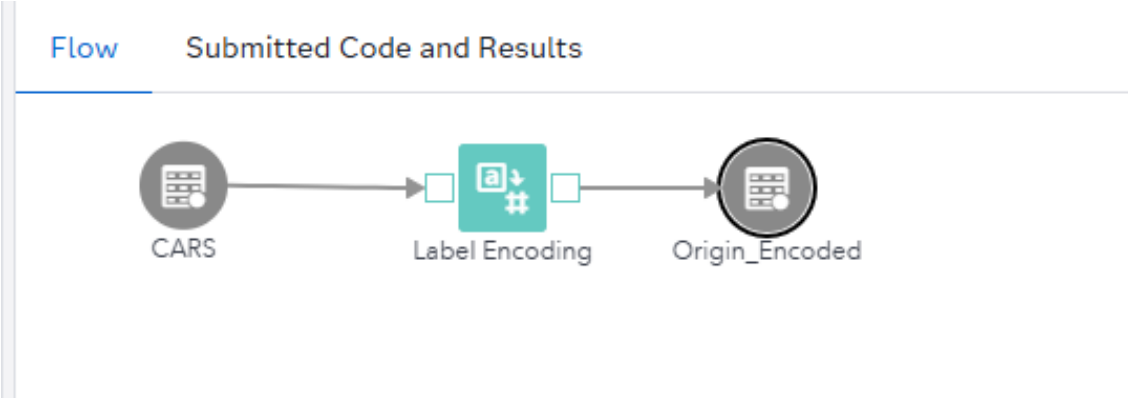
In order to run the Label Encoding step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, output data is created. If the input table is a CAS table, you must use a CAS table for the output. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Label Encoding

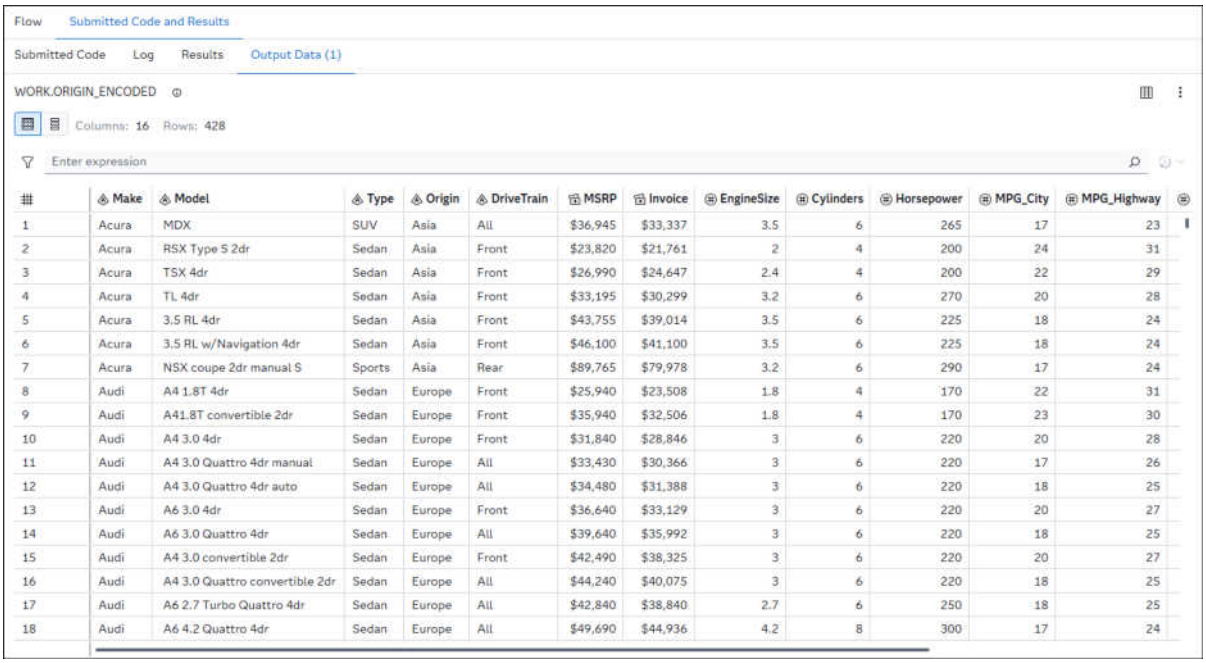
To create this example:

1. In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Label Encoding** to add the step to your flow.
2. Add the Sashelp.Cars table to your flow. Connect the input port of the Label Encoding node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Label Encoding step, click the Label Encoding node.
4. On the **Encoding** tab, select **Origin** as the column.
5. In the **New column** field, enter `Origin_ENC`.
6. Add the output table to the flow and connect it to the Label Encoding step.
   a. Select **Add** ⇨ **Table**.
   b. In the Table Properties, enter `Work` as the library name and `Origin_Encoded` as the table name.
   c. Connect the output port of the Label Encoding node to the Origin_Encoded node.



7 Run the flow.

Click the **Submitted Code and Results** tab to view the output data. By default, the output data is saved in the Work library.



	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize	Cylinders	Horsepower	MPG_City	MPG_Highway
1	Acura	MDX	SUV	Asia	All	$36,945	$33,337	3.5	6	265	17	23
2	Acura	RSX Type S 2dr	Sedan	Asia	Front	$23,820	$21,761	2	4	200	24	31
3	Acura	TSX 4dr	Sedan	Asia	Front	$26,990	$24,647	2.4	4	200	22	29
4	Acura	TL 4dr	Sedan	Asia	Front	$33,195	$30,299	3.2	6	270	20	28
5	Acura	3.5 RL 4dr	Sedan	Asia	Front	$43,755	$39,014	3.5	6	225	18	24
6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front	$46,100	$41,100	3.5	6	225	18	24
7	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear	$89,765	$79,978	3.2	6	290	17	24
8	Audi	A4 1.8T 4dr	Sedan	Europe	Front	$25,940	$23,508	1.8	4	170	22	31
9	Audi	A41.8T convertible 2dr	Sedan	Europe	Front	$35,940	$32,506	1.8	4	170	23	30
10	Audi	A4 3.0 4dr	Sedan	Europe	Front	$31,840	$28,846	3	6	220	20	28
11	Audi	A4 3.0 Quattro 4dr manual	Sedan	Europe	All	$33,430	$30,366	3	6	220	17	26
12	Audi	A4 3.0 Quattro 4dr auto	Sedan	Europe	All	$34,480	$31,388	3	6	220	18	25
13	Audi	A6 3.0 4dr	Sedan	Europe	Front	$36,640	$33,129	3	6	220	20	27
14	Audi	A6 3.0 Quattro 4dr	Sedan	Europe	All	$39,640	$35,992	3	6	220	18	25
15	Audi	A4 3.0 convertible 2dr	Sedan	Europe	Front	$42,490	$38,325	3	6	220	20	27
16	Audi	A4 3.0 Quattro convertible 2dr	Sedan	Europe	All	$44,240	$40,075	3	6	220	18	25
17	Audi	A6 2.7 Turbo Quattro 4dr	Sedan	Europe	All	$42,840	$38,840	2.7	6	250	18	25
18	Audi	A6 4.2 Quattro 4dr	Sedan	Europe	All	$49,690	$44,936	4.2	8	300	17	24

Label Encoding: Step-by-Step Instructions

1 Add the input data to the flow and connect the data to the input port of the Label Encoding node. For more information, see "Connecting Nodes" on page 13.

2 Select the Label Encoding node to set the options for the Label Encoding step.

3 On the **Encoding** tab, set the options for the label encoding.

   a Select the column from the input data that contains the label to encode.

   b Specify whether to replace the existing column or create a column. By default, the name of the new column is *InputColumnName*_ENC.

c On the **Options** tab, specify whether to include detailed information in the SAS log.

d On the **Output** tab, specify whether to replace an existing output table with the same name. For more information about the requirements for the output table, see "Label Encoding: Connection Requirements for the Node" on page 1082.

Partition Data

About the Partition Data Step

A *partition* is all or part of a logical file. The Partition Data step enables you to create up to four partitions that are created by randomly sampling the input data. Partitions can be used to develop a model. In this case, you want to train the model on part of the data and reserve some of the data for testing. Using the Partition Data step, you can save all the partitions to one output data set or save each partition in a separate table.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Partition Data: Connection Requirements for the Node

In order to run the Partition Data step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running the step using the SAS Compute Server, the input data can be a SAS or CAS table. If you are running the step using the SAS CAS Server, the input data must use a CAS engine libref.	An output table is created by default. If you are running the step using the SAS Compute Server, you must specify a SAS libref. By default, the output data is written to a temporary table in the Work library.

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	If you are running the step using the SAS CAS Server, you must specify a CAS engine libref. You must add the output table to the flow. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Partitioning the Sashelp.ClassFit Data Set

To create this example:

1 In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Partition Data** to add the step to your flow.

2 Add the Sashelp.ClassFit table to your flow. Connect the input port of the Partition Data node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the Partition Data step, click the Partition Data node.

4 In the **Number of partitions** box, enter `2`.

5 In the **Sampling percentage for partition 1** box, enter `50`, which specifies that 50% of the values should be in partition 1.

6 In the **Sampling percentage for partition 2** box, enter `30`, which specifies that 30% of the values should be in partition 2.

7 On the **Output** tab, select **All partitions in one data set** from the **Partition data sets** drop-down list.

8 Add the output data table to the flow.

   a Click **Add** and select **Table**.

   b Select the Table node. Enter `Work` as the library and `Partition_Data` as the table name.

   c Right-click the Partition Data node and select **Add output port** ⇨ **Partitioned Table**.

   d Connect the output port to the new table.

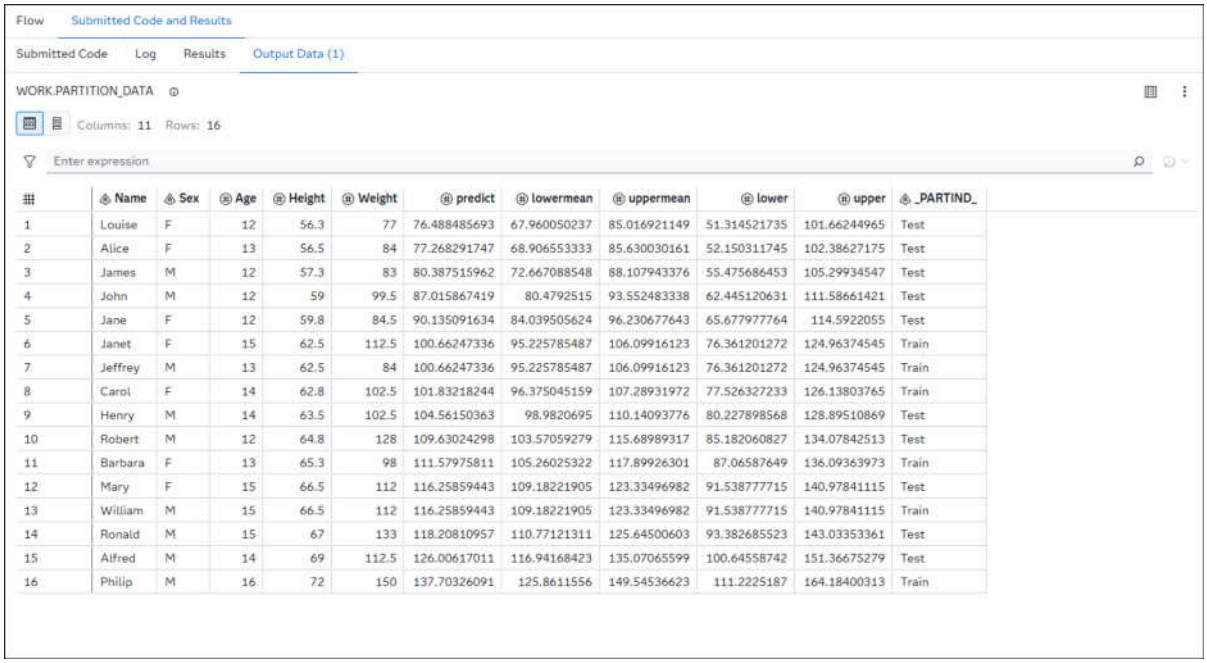
9 In the **ID value for partition 1 data** box, enter `Test`.

10 In the **ID value for partition 2 data** box, enter `Train`.

11 Run the flow.

Click the **Submitted Code and Results** tab to view the output data.

The new PARTIND variable in the output data specifies the partition (either Train or Test) for the observation. For example, the data for Joyce is in the Train partition. The data for Jane is in the Test partition. This example does not specify a random seed. As a result, the task randomly assigns 50% of the observations to the Test partition and 30% of the observations to the Train partition. If you run this example again, you might see slightly different results.


Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK.PARTITION_DATA

Columns: 11 Rows: 16

Enter expression

	Name	Sex	Age	Height	Weight	predict	lowermean	uppermean	lower	upper	_PARTIND_
1	Louise	F	12	56.3	77	76.488485693	67.960050237	85.016921149	51.314521735	101.66244965	Test
2	Alice	F	13	56.5	84	77.268291747	68.906553333	85.630030161	52.150311745	102.38627175	Test
3	James	M	12	57.3	83	80.387515962	72.667088548	88.107943376	55.475686453	105.29934547	Test
4	John	M	12	59	99.5	87.015867419	80.4792515	93.552483338	62.445120631	111.58661421	Test
5	Jane	F	12	59.8	84.5	90.135091634	84.039505624	96.230677643	65.677977764	114.5922055	Test
6	Janet	F	15	62.5	112.5	100.66247336	95.225785487	106.09916123	76.361201272	124.96374545	Train
7	Jeffrey	M	13	62.5	84	100.66247336	95.225785487	106.09916123	76.361201272	124.96374545	Train
8	Carol	F	14	62.8	102.5	101.83218244	96.375045159	107.28931972	77.526327233	126.13803765	Train
9	Henry	M	14	63.5	102.5	104.56150363	98.9820695	110.14093776	80.227898568	128.89510869	Test
10	Robert	M	12	64.8	128	109.63024298	103.57059279	115.68989317	85.182060827	134.07842513	Test
11	Barbara	F	13	65.3	98	111.57975811	105.26025322	117.89926301	87.06587649	136.09363973	Train
12	Mary	F	15	66.5	112	116.25859443	109.18221905	123.33496982	91.538777715	140.97841115	Test
13	William	M	15	66.5	112	116.25859443	109.18221905	123.33496982	91.538777715	140.97841115	Train
14	Ronald	M	15	67	133	118.20810957	110.77121311	125.64500603	93.382685523	143.03353361	Test
15	Alfred	M	14	69	112.5	126.00617011	116.94168423	135.07065599	100.64558742	151.36675279	Test
16	Philip	M	16	72	150	137.70326091	125.8611556	149.54536623	111.2225187	164.18400313	Train

Partition Data: Step-by-Step Instructions

Step 1: Assign the Data

1 Select the server for this step.

You can run this step on the SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use the SAS Compute Server. Using the SAS Compute Server enables you to use any library for the input and output tables.

- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 Specify the sampling method. If you select **Stratified sampling**, you must assign the variables that specify the separate partitions for each combination of levels to the **Stratify by** role.

- If you are running the step using a SAS Compute Server, you can specify a maximum of two variables to the **Stratify by** role.
- If you are running the step using a CAS server, you can specify a maximum of four variables to the **Stratify by** role.

4 Specify the number of partitions.

- If you are running the step using a SAS Compute Server, you can choose to create one, two, three, or four partitions.
- If you are running the step using a CAS server, you can choose to create one or two.

5 Specify the proportion of cases for each partition.

- If you are running the step using a SAS Compute Server, the sum of all the partition proportions must be less than or equal to 100.
- If you are running the step using a CAS server, the sum of all the partitioned proportions must be less than 100.

6 Specify the initial seed for the generation of random numbers. This value must be an integer. If you do not specify a number, then a seed that is based on the system clock is used to produce the sample.

Step 2: Specify the Output Data

1 Specify whether to include all partitions in one table or put each partition in a separate table.

Note: This option applies only if you are running the step using the SAS Compute Server. If you are running the step using a CAS server, an output table is created by default.

2 When running this step in a flow, you must add an output port for these output tables. If you include all partitions in one table, you need to add one output port. If you put each partition in a separate table, you need to add multiple output ports.

a Click **Add** and select **Table**.

b Select the Table node. In the table properties, enter the library name and the table name.

Note: If you are running the step using a SAS Compute Server, you must specify a SAS libref. If you are running the step using a CAS server, you must specify a CAS libref.

c Right-click the Partition Data node and select **Add output port** ⇨ ***name-of-table***.

d Connect the output port to the Table node.

3 Specify whether to include unsampled observations in the output table.

Note: This option applies only if you are saving all the partitions to one output table.

4 Specify the name for the variable that contains the partitioned values.

Note: This option applies only if you are saving all the partitions to one output table.

5 Specify the identifier to use for each value in a partition.

Note: This option applies only if you are saving all the partitions to one output table.

6 Specify whether to display the output table on the Results tab. You can choose to display all of the data or a subset of the output data. The step always creates an output table that appears on the Output Data tab. The output data is also saved in the library that you specified.

Sample Data

About the Sample Data Step

The Sample Data step performs simple or stratified random sampling or oversampling of the input data source.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or

SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Sample Data: Connection Requirements for the Node

In order to run the Sample Data step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running the step using SAS Compute Server, the input data can be a SAS or CAS table. If you are running the step using SAS CAS Server, the input data must use a CAS engine libref. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	An output table is created by default. If you are running the step using SAS Compute Server, you must specify a SAS libref. By default, the output data is written to a temporary table in the Work library. If you are running the step using SAS CAS Server, you must specify a CAS engine libref. You must add the output table to the flow. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

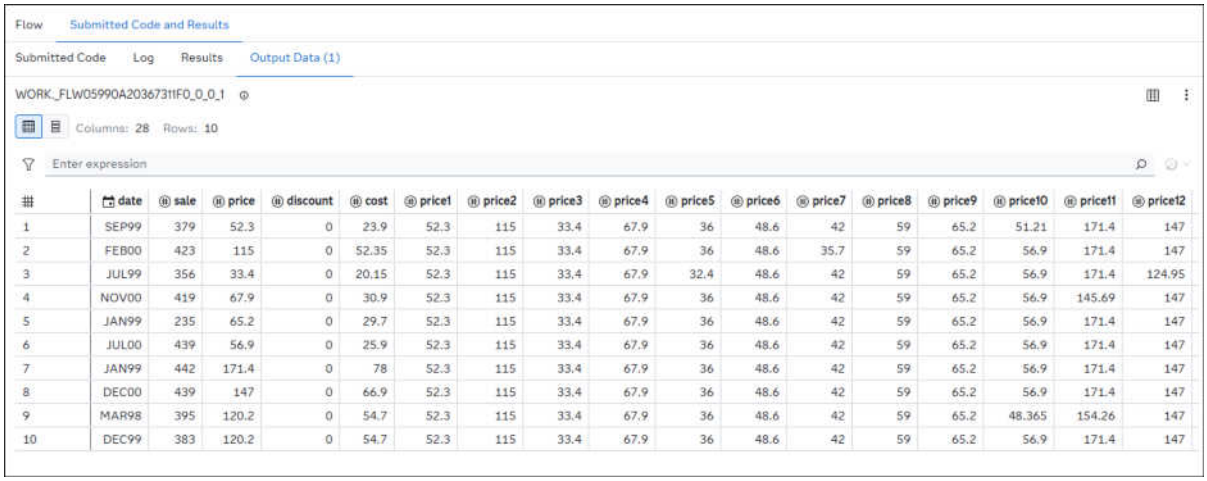
Example: Creating a Random Sample of the Sashelp.Pricedata Data Set

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Sample Data** to add the step to your flow.
2. Add the Sashelp.Pricedata table to your flow. Connect the input port of the Sample Data node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Sample Data step, click the Sample Data node.
4. On the **Data** tab, select **Simple random sampling**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the output data. Because you are running this step on SAS Compute Server, the output table is saved to the Work library by default.


Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK._FLW05990A2036731IF0_0_0_1

Columns: 28 Rows: 10

Enter expression

#	date	sale	price	discount	cost	price1	price2	price3	price4	price5	price6	price7	price8	price9	price10	price11	price12
1	SEP99	379	52.3	0	23.9	52.3	115	33.4	67.9	36	48.6	42	59	65.2	51.21	171.4	147
2	FEB00	423	115	0	52.35	52.3	115	33.4	67.9	36	48.6	35.7	59	65.2	56.9	171.4	147
3	JUL99	356	33.4	0	20.15	52.3	115	33.4	67.9	32.4	48.6	42	59	65.2	56.9	171.4	124.95
4	NOV00	419	67.9	0	30.9	52.3	115	33.4	67.9	36	48.6	42	59	65.2	56.9	145.69	147
5	JAN99	235	65.2	0	29.7	52.3	115	33.4	67.9	36	48.6	42	59	65.2	56.9	171.4	147
6	JUL00	439	56.9	0	25.9	52.3	115	33.4	67.9	36	48.6	42	59	65.2	56.9	171.4	147
7	JAN99	442	171.4	0	78	52.3	115	33.4	67.9	36	48.6	42	59	65.2	56.9	171.4	147
8	DEC00	439	147	0	66.9	52.3	115	33.4	67.9	36	48.6	42	59	65.2	56.9	171.4	147
9	MAR98	395	120.2	0	54.7	52.3	115	33.4	67.9	36	48.6	42	59	65.2	48.365	154.26	147
10	DEC99	383	120.2	0	54.7	52.3	115	33.4	67.9	36	48.6	42	59	65.2	56.9	171.4	147

Sample Data: Step-by-Step Instructions

Step 1: Assign the Data

1 Select the server for this step.

You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 Specify the sampling method. You can choose from these options:

- **Simple random sampling**
- **Stratified sampling** - You must assign the variables that specify the separate partitions for each combination of levels to the **Stratify by** role.
- **Oversampling** - You must assign one variable to the **Stratify by** role. This variable identifies the oversampled event. You must also select the oversample event level.

Step 2: Set the Options

On the **Options** tab, the available options depend on the sampling method that you selected on the **Data** tab.

These options are available for simple random sampling and stratified sampling if you are running the step on SAS Compute Server.

1 Select the method to use when sampling the data. Here are the valid values:

- **With replacement** specifies that when a row is selected, it is removed from eligibility for subsequent selections. This removal makes it impossible to select the same row more than once.
- **Without replacement** specifies that when a row is selected, it remains eligible for subsequent selections. This eligibility makes it possible to select the same row more than once. You can specify how multiple selections of the same row are recorded in the output table.

2 Use the **Sample size** and **Sample size type** options to specify the sample size in the desired number of rows or in the desired percentage of input rows. For example, if you specify 3% of rows and there are 400 input rows, then the resulting sample has 12 rows.

Note: If you assign variables to the **Stratify by** role, then the sample size specification that you make here applies to each stratum rather than to the entire input table.

3 (Optional) Specify the initial seed for the generation of random numbers. This value must be an integer. If you do not specify a number, then a seed that is based on the system clock is used to produce the sample.

4 (Optional) Specify whether to generate a summary table that includes the seed that was used to produce the sample. By specifying this same seed later with the same input table, you can reproduce the sample.

These options are available if you selected oversampling and you are running the step on SAS Compute Server.

1 Specify the percentage of the oversampled event to sample. The default value is `50`.

2 Specify the proportion of the oversampled event to sample. The default value is `0.3`.

3 (Optional) Specify the initial seed for the generation of random numbers. This value must be an integer. If you do not specify a number, then a seed that is based on the system clock is used to produce the sample.

4 (Optional) Specify whether to generate a summary table that includes the seed that was used to produce the sample. By specifying this same seed later with the same input table, you can reproduce the sample.

These options are available if you selected simple random sampling or stratified sampling and you are running the step on SAS CAS Server.

1 Specify the percentage of the input table to use to create the sample.

2 (Optional) Specify the initial seed for the generation of random numbers. This value must be an integer. If you do not specify a number, then a seed that is based on the system clock is used to produce the sample.

These options are available if you selected oversampling and you are running the step on SAS CAS Server.

1 Specify the percentage of the oversampled event to sample. The default value is `50`.

2 Specify the proportion of the oversampled event to sample. The default value is `0.3`.

3 (Optional) Specify the initial seed for the generation of random numbers. This value must be an integer. If you do not specify a number, then a seed that is based on the system clock is used to produce the sample.

Step 3: Specify the Output Data

On the **Output** tab, you can specify these options. An output table is created by default.

1 Specify whether to replace the existing output table.

2 When running this step in a flow, you must add an output table to the flow and connect the new table with the output port on the Sample Data node.

   a Click **Add** and select **Table**.

   b Select the Table node. In the table properties, enter the library name and the table name.

   Note: If you are running the step using SAS Compute Server, you must specify a SAS libref. If you are running the step using a CAS server, you must specify a CAS libref.

   c Connect the output port to the Table node.

3 Specify whether to include all input observations and a sampling indicator variable in the output table.

4 Specify whether to include all variables in the output data.

5 Specify whether to display the output table on the Results tab. You can choose to display all of the data or a subset of the output data. The step always creates an output table that appears on the Output Data tab. The output data is also saved in the library that you specified.

Note: If you are creating a CAS output table, the resulting table could be potentially large and take a long time to display.

Standardize Data

About the Standardize Data Step

The Standardize Data step enables you to center or standardize one or more numeric variables by using a variety of methods. The standardized variables are saved in an output table.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Standardize Data: Connection Requirements for the Node

In order to run the Standardize Data step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running the step using the SAS Compute Server, the input data can be a SAS or CAS table. If you are running the step using the SAS CAS Server, the input data must use a CAS engine libref. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program	An output table is created by default. If you are running the step using the SAS Compute Server, you must specify a SAS libref. By default, the output data is written to a temporary table in the Work library. If you are running the step using the SAS CAS Server, you must specify a CAS engine libref. You must add the output table to the flow. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more

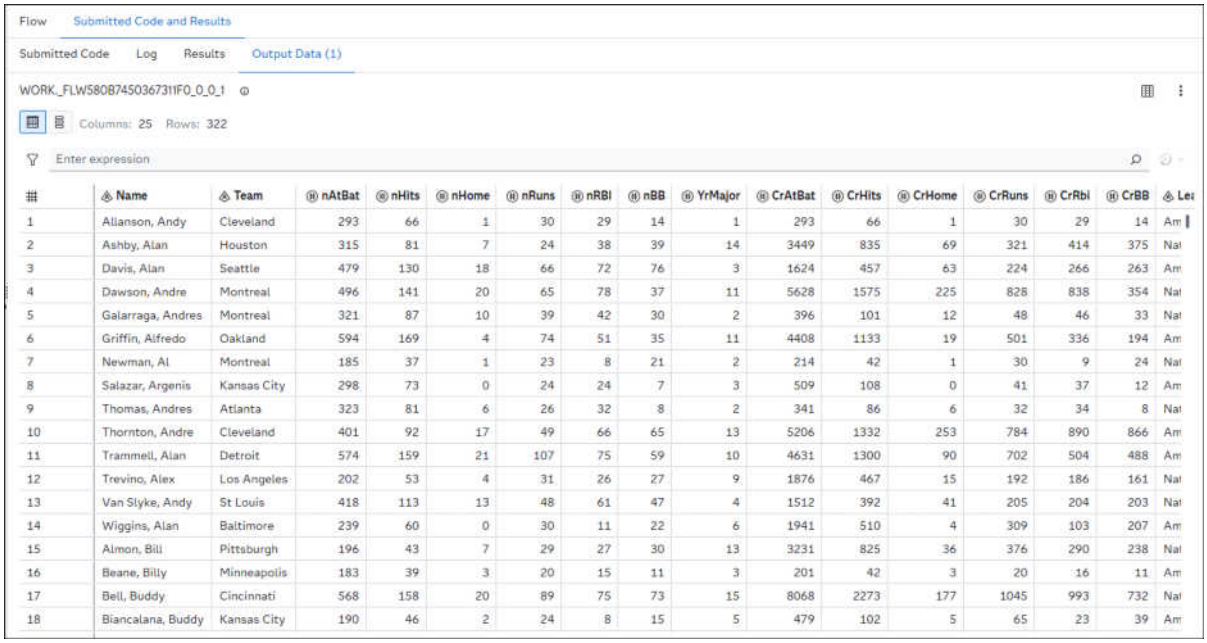
Input Port	Output Port
node, or an Import node) that creates an output table	information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Standardizing Variables in the Sashelp.Baseball Data Set

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Standardize Data** to add the step to your flow.
2. Add the Sashelp.Baseball table to your flow. Connect the input port of the Standardize Data node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Standardize Data step, click the Standardize Data node.
4. On the **Data** tab, assign **nHits** to the **Variables to standardize** role.
5. Run the flow.

Click the **Submitted Code and Results** tab to view the output data. By default, the output data is saved in the Work library.


Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK_FLW580B745036731 1F0_0_0_1

Columns: 25 Rows: 322

Enter expression

#	Name	Team	nAtBat	nHits	nHome	nRuns	nRBI	nBB	YrMajor	CrAtBat	CrHits	CrHome	CrRuns	CrRbi	CrBB	Lea
1	Allanson, Andy	Cleveland	293	66	1	30	29	14	1	293	66	1	30	29	14	Am
2	Ashby, Alan	Houston	315	81	7	24	38	39	14	3449	835	69	321	414	375	Nat
3	Davis, Alan	Seattle	479	130	18	66	72	76	3	1624	457	63	224	266	263	Am
4	Dawson, Andre	Montreal	496	141	20	65	78	37	11	5628	1575	225	828	838	354	Nat
5	Galarraga, Andres	Montreal	321	87	10	39	42	30	2	396	101	12	48	46	33	Nat
6	Griffin, Alfredo	Oakland	594	169	4	74	51	35	11	4408	1133	19	501	336	194	Am
7	Newman, Al	Montreal	185	37	1	23	8	21	2	214	42	1	30	9	24	Nat
8	Salazar, Argenis	Kansas City	298	73	0	24	24	7	3	509	108	0	41	37	12	Am
9	Thomas, Andres	Atlanta	323	81	6	26	32	8	2	341	86	6	32	34	8	Nat
10	Thornton, Andre	Cleveland	401	92	17	49	66	65	13	5206	1332	253	784	890	866	Am
11	Trammell, Alan	Detroit	574	159	21	107	75	59	10	4631	1300	90	702	504	488	Am
12	Trevino, Alex	Los Angeles	202	53	4	31	26	27	9	1876	467	15	192	186	161	Nat
13	Van Slyke, Andy	St Louis	418	113	13	48	61	47	4	1512	392	41	205	204	203	Nat
14	Wiggins, Alan	Baltimore	239	60	0	30	11	22	6	1941	510	4	309	103	207	Am
15	Almon, Bill	Pittsburgh	196	43	7	29	27	30	13	3231	825	36	376	290	238	Nat
16	Beane, Billy	Minneapolis	183	39	3	20	15	11	3	201	42	3	20	16	11	Am
17	Bell, Buddy	Cincinnati	568	158	20	89	75	73	15	8068	2273	177	1045	993	732	Nat
18	Biancalana, Buddy	Kansas City	190	46	2	24	8	15	5	479	102	5	65	23	39	Am

Standardize Data: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

   You can run this step on SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

   - Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
   - If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 Assign columns to roles.

   - If you are running the step using the SAS Compute server, these roles are available:

     1 To the **Variables to standardize** role, assign the numeric variables to be standardized.

     2 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

     3 (Optional) To the **Weight** role, assign the numeric variable that contains the values to use to weigh each observation. These values can be nonintegers. An observation is used in the analysis only if the value of the Weight variable is greater than zero.

     4 (Optional) To the **Group analysis by** role, assign the variables that enable you to obtain separate analyses of observations for each unique group.

   - If you are running the step using the SAS CAS Server, you can center and scales values so that different features are equally weighted. By default, a new column is created and named Standardized_*InputColumnName*.

Step 2: Set the Options

On the **Options** tab, you can set these options if you are running this step using the SAS Compute Server:

1 (Optional) Use the **Center data only** option to specify that you want to use either the mean or median standardization method.

2 Select the standardization method. Here are the available methods:

- **Standard deviation** (which is the default and the method most often associated with standardization).
- **Andrew's wave estimate**. The tuning constant for this method must be greater than 0. The default value is 4.7.
- **Euclidean length**.
- **Huber's estimate**. The tuning constant for this method must be greater than 0. The default value is 1.
- **Interquartile range**.
- **Maximum absolute value**.
- **Median absolute deviation**.
- **Minkowski**.
- **Range**.
- **Sum**.
- **Tukey's biweight estimate**. The tuning constant for this method must be greater than 0. The default value is 6. (Goodall 1983)
- **Art, Gnanadesikan, and Kettenring estimate** .
- **Minimum spacing**.

3 Specify how to deal with missing values. You can choose to omit observations with missing values or to replace the missing value. You can replace the missing values with one of these options:

- **Default location measure**, which is the location measure that is used by the selected centering or standardization method.
- **Mean**.
- **Median**.
- **Minimum**.
- **Specify custom value**, which enables you to specify the value for all variables that are being standardized.

4 (Optional) Specify whether to display the location and scale measures in the results. These measures show you what the standardization process accomplished.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to replace any existing output tables. This option is selected by default.

If you are running this step using the SAS Compute Server, these options are also available:

1. Select the variables to include in the results. You can choose from these options:
   - **Include original and standardized variables**
   - **Include standardized variables only**
2. (Optional) Specify whether to add a prefix to the variable names to differentiate between the original and standardized variables. By default, the step adds the Standardized_ prefix to the standardized variable.
3. (Optional) Specify whether to show the output data in the Results tab.

If you are running the step using the SAS Compute Server, you must specify a SAS libref. By default, the output table is saved in the Work library. To save the data to a permanent location, you must add an output table to the flow and connect it to the Standardize Data node.

If you are running the step using the SAS CAS Server, you must specify a CAS engine libref and add an output table to the flow. For more information, see "Standardize Data: Connection Requirements for the Node" on page 1093.

Transform Columns

About the Transform Columns Step

The Transform Columns step enables you to transform one or more variables in the input data set. These transformed variables are saved to an output data set.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Transform Columns: Connection Requirements for the Node

In order to run the Transform Columns step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running the step using the SAS Compute Server, the input data source can be a SAS or CAS table. If you are running the step using SAS CAS Server, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, an output table is created. This table must use a CAS engine libref. For more information, see "Step 2: Create the Output Data" on page 1100. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Transforming the Data in the Baseball Data Set

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Transform Columns** to add the step to your flow.
2. Add the Sashelp.Baseball table to your flow. Connect the input port of the Transform Columns node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Transform Columns step, click the Transform Columns node.
4. To transform the data in the nRuns column, complete these steps under the **Transform 1** heading:
   a. To the **Variable 1** role, assign the **nRuns** column.
   b. From the **Transform 1** drop-down list, select **Natural log**.

5 To convert the values in the Salary column to dollars, complete these steps under the **Transform 2** heading:

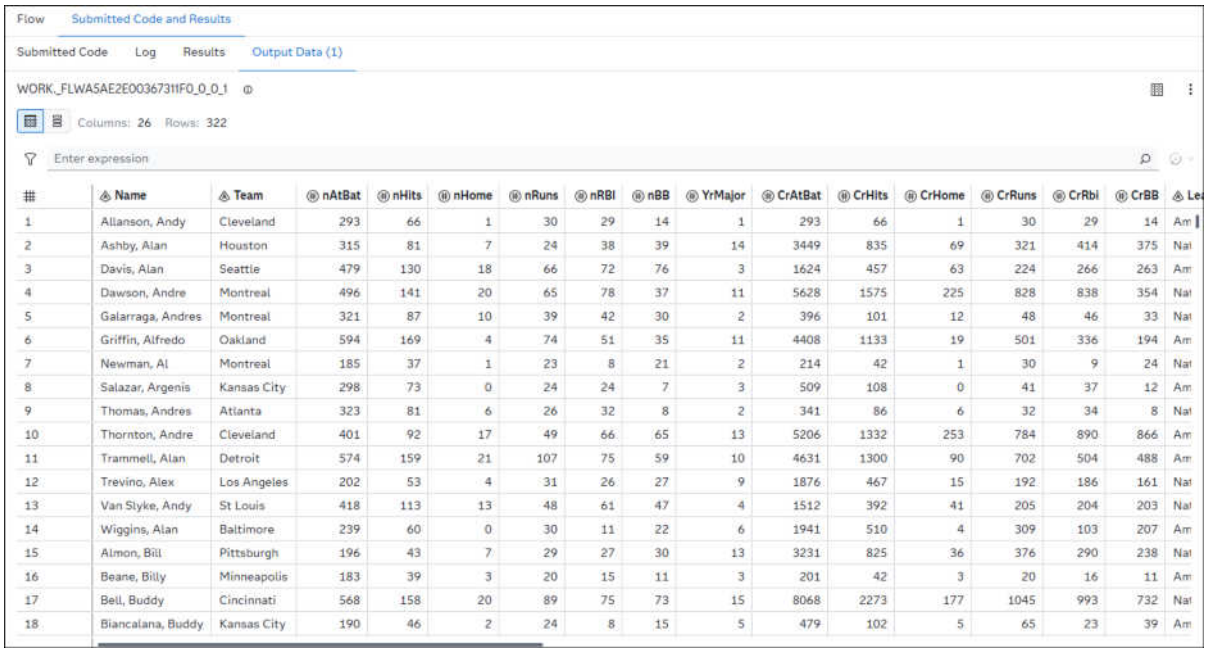
   a To the **Variable 2** role, assign the **Salary** column.

   b From the **Transform** drop-down list, select **Specify custom transformation**.

   c In the **Custom transform**, enter `Salary*1000`.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

WORK._FLWASAE2E0036731IF0_0_0_1

Columns: 26 Rows: 322

Enter expression

#	Name	Team	nAtBat	nHits	nHome	nRuns	nRBI	nBB	YrMajor	CrAtBat	CrHits	CrHome	CrRuns	CrRbi	CrBB	Le
1	Allanson, Andy	Cleveland	293	66	1	30	29	14	1	293	66	1	30	29	14	Am
2	Ashby, Alan	Houston	315	81	7	24	38	39	14	3449	835	69	321	414	375	Nat
3	Davis, Alan	Seattle	479	130	18	66	72	76	3	1624	457	63	224	266	263	Am
4	Dawson, Andre	Montreal	496	141	20	65	78	37	11	5628	1575	225	828	838	354	Nat
5	Galarraga, Andres	Montreal	321	87	10	39	42	30	2	396	101	12	48	46	33	Nat
6	Griffin, Alfredo	Oakland	594	169	4	74	51	35	11	4408	1133	19	501	336	194	Am
7	Newman, Al	Montreal	185	37	1	23	8	21	2	214	42	1	30	9	24	Nat
8	Salazar, Argenis	Kansas City	298	73	0	24	24	7	3	509	108	0	41	37	12	Am
9	Thomas, Andres	Atlanta	323	81	6	26	32	8	2	341	86	6	32	34	8	Nat
10	Thornton, Andre	Cleveland	401	92	17	49	66	65	13	5206	1332	253	784	890	866	Am
11	Trammell, Alan	Detroit	574	159	21	107	75	59	10	4631	1300	90	702	504	488	Am
12	Trevino, Alex	Los Angeles	202	53	4	31	26	27	9	1876	467	15	192	186	161	Nat
13	Van Slyke, Andy	St Louis	418	113	13	48	61	47	4	1512	392	41	205	204	203	Nat
14	Wiggins, Alan	Baltimore	239	60	0	30	11	22	6	1941	510	4	309	103	207	Am
15	Almon, Bill	Pittsburgh	196	43	7	29	27	30	13	3231	825	36	376	290	238	Nat
16	Beane, Billy	Minneapolis	183	39	3	20	15	11	3	201	42	3	20	16	11	Am
17	Bell, Buddy	Cincinnati	568	158	20	89	75	73	15	8068	2273	177	1045	993	732	Nat
18	Biancalana, Buddy	Kansas City	190	46	2	24	8	15	5	479	102	5	65	23	39	Am

The output data set contains two additional columns. The log_nRuns column lists the values of the natural log of the values in the nRuns column. The tr2_Salary column contains the values from the Salary column multiplied by 1,000.

Transform Columns: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

   You can run this step on the SAS Compute Server or on a CAS server. The features that are available in the step might be different depending on where you run the step.

   - Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.

- If you are using SAS Cloud Analytic Services (CAS), run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 To the **Variable *n*** role, assign the variable that you want to transform.

4 Select the transform to use. Here are the available transforms:

- **Inverse square**
- **Inverse**
- **Inverse square root**
- **Natural log**
- **Square root**
- **Square**

To create your own transformation, select **Specify custom transformation**. An example of a custom transformation is Salary*1000.

Step 2: Create the Output Data

On the **Output** tab, specify whether to replace any existing output tables. You can also specify whether to show the output data in the Results tab.

Unique Identifier

About the Unique Identifier Step

The Unique Identifier step returns a Universally Unique Identifier (UUID) as a string of 36 hexadecimal characters and hyphens or a binary value of 16 bytes.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Examples: Unique Identifier Step

Example 1: Generating a Hexadecimal UUID

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Unique Identifier** to add the step to your flow.
2. Add the Sashelp.Class table to your flow. Connect the input port of the Unique Identifier node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Unique Identifier step, click the Unique Identifier node.
4. Select the **Generate identifier as UUID** check box.
5. Add an output table to the flow.
   a. Click **Add** and select **Table**.
   b. Select the Table node. In the table properties, enter `Work` as the library name and `Example` as the table name.

      Note: If your input data is a SAS table, you must specify a SAS libref for the output table. If your input data is a CAS table, you must specify a CAS libref for the output table.

   c. Connect the output port to the Table node.
   d. Run the flow.

Click the **Submitted Code and Results** tab to view the output data.

Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

WORK.EXAMPLE

Columns: 6 Rows: 19

Enter expression

	Unique_ID	Name	Sex	Age	Height	Weight
1	f409e892-a5d3-984c-97eb-15583de2773b	Alfred	M	14	69	112.5
2	30668c32-c848-8746-ad53-6fd5275ccd14	Alice	F	13	56.5	84
3	20593a0f-9fbb-f441-b769-5ce9180f189a	Barbara	F	13	65.3	98
4	a00b094c-5a80-b044-b7f9-813a787f0baa	Carol	F	14	62.8	102.5
5	4ee122c2-6d6c-bd4d-9385-a39cceef44a8	Henry	M	14	63.5	102.5
6	2000c2eb-285c-ff46-b8dd-ceb2489a8e5b	James	M	12	57.3	83
7	2dba779d-b352-304f-8b71-94d2cd331af1	Jane	F	12	59.8	84.5
8	094c6463-ba38-564c-9dae-cd1719b6e0cc	Janet	F	15	62.5	112.5
9	b69e9ee0-2fc9-8843-81e9-acf7f086a12b	Jeffrey	M	13	62.5	84
10	6acbde11-e8c5-8841-9aa8-fb24966c7280	John	M	12	59	99.5
11	f67c806f-1bc9-b048-8201-aaf87b6b8dce	Joyce	F	11	51.3	50.5
12	2b1626fb-46f7-5e43-8da4-e2767771ef80	Judy	F	14	64.3	90
13	3823aad8-5eb3-bf46-9c5d-25d50c17a299	Louise	F	12	56.3	77
14	cf7651dc-d846-7846-813a-7bad8a2bcedd	Mary	F	15	66.5	112
15	5cd35951-7348-4945-acef-7e616a078d97	Philip	M	16	72	150
16	1b8e64e3-1389-a64d-9cc3-2008f321af85	Robert	M	12	64.8	128
17	7e47abe6-f31b-0e4e-b3c2-62ca3be46ee5	Ronald	M	15	67	133
18	6d15a382-afa7-8446-bc9a-7d353225c74c	Thomas	M	11	57.5	85

Example 2: Generating a Binary UUID

To create this example:

1. In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Unique Identifier** to add the step to your flow.
2. Add the Sashelp.Class table to your flow. Connect the input port of the Unique Identifier node to the data source. For more information, see "Connecting Nodes" on page 13.
3. To set the options for the Unique Identifier step, click the Unique Identifier node.
4. Select the **Generate identifier as UUID** check box.
5. Select the **Generate as binary** check box.
6. Add an output table to the flow.

a Click **Add** and select **Table**.

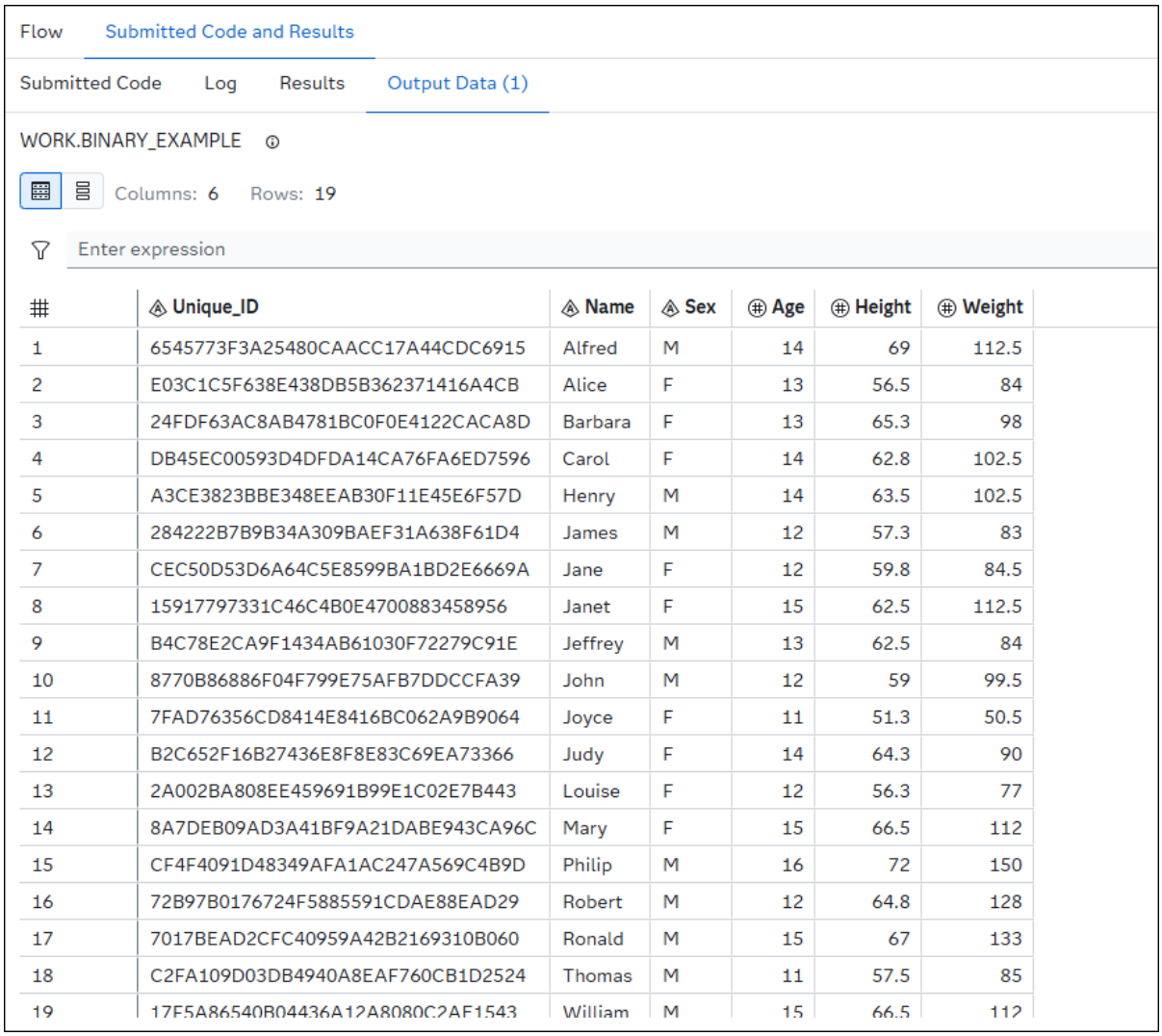
b Select the Table node. In the table properties, enter `Work` as the library name and `Binary_Example` as the table name.

Note: If your input data is a SAS table, you must specify a SAS libref for the output table. If your input data is a CAS table, you must specify a CAS libref for the output table.

c Connect the output port to the Table node.

d Run the flow.

Click the **Submitted Code and Results** tab to view the output data.



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

WORK.BINARY_EXAMPLE

Columns: 6 Rows: 19

Enter expression

#	Unique_ID	Name	Sex	Age	Height	Weight
1	6545773F3A25480CAACC17A44CDC6915	Alfred	M	14	69	112.5
2	E03C1C5F638E438DB5B362371416A4CB	Alice	F	13	56.5	84
3	24FDF63AC8AB4781BC0F0E4122CACA8D	Barbara	F	13	65.3	98
4	DB45EC00593D4DFDA14CA76FA6ED7596	Carol	F	14	62.8	102.5
5	A3CE3823BBE348EEAB30F11E45E6F57D	Henry	M	14	63.5	102.5
6	284222B7B9B34A309BAEF31A638F61D4	James	M	12	57.3	83
7	CEC50D53D6A64C5E8599BA1BD2E6669A	Jane	F	12	59.8	84.5
8	15917797331C46C4B0E4700883458956	Janet	F	15	62.5	112.5
9	B4C78E2CA9F1434AB61030F72279C91E	Jeffrey	M	13	62.5	84
10	8770B86886F04F799E75AFB7DDCCFA39	John	M	12	59	99.5
11	7FAD76356CD8414E8416BC062A9B9064	Joyce	F	11	51.3	50.5
12	B2C652F16B27436E8F8E83C69EA73366	Judy	F	14	64.3	90
13	2A002BA808EE459691B99E1C02E7B443	Louise	F	12	56.3	77
14	8A7DEB09AD3A41BF9A21DABE943CA96C	Mary	F	15	66.5	112
15	CF4F4091D48349AFA1AC247A569C4B9D	Philip	M	16	72	150
16	72B97B0176724F5885591CDAE88EAD29	Robert	M	12	64.8	128
17	7017BEAD2CFC40959A42B2169310B060	Ronald	M	15	67	133
18	C2FA109D03DB4940A8EAF760CB1D2524	Thomas	M	11	57.5	85
19	17F5A86540B04436A12A8080C2AF1543	William	M	15	66.5	112

Unique Identifier: Connection Requirements for the Node

In order to run the Unique Identifier step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
You can use a SAS table or a CAS table as the input data. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	An output table is created by default. A connection to an output table is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Unique Identifier: Step-by-Step Instructions

1 Select whether to generate the identifier as a UUID, a string of 36 hexadecimal characters and hyphens.

2 (Optional) Specify whether to generate the UUID as a binary value of 16 bytes.

3 Enter the name of the new column in the output table. If no name is entered, the new column name is Unique_ID.

4 On the **Output** table, specify whether to replace an existing output table. By default, the existing table is replaced.

5 If you are running the step in a flow, add an output table to the flow.

   a Click **Add** and select **Table**.

   b Select the Table node. In the table properties, enter the library name and the table name.

   Note: If your input data is a SAS table, you must specify a SAS libref for the output table. If your input data is a CAS table, you must specify a CAS libref for the output table.

   c Connect the output port to the Table node.

6 Run the step.

Variable Selection

About the Variable Selection Step

The Variable Selection step enables you to perform unsupervised and supervised variable selection. The step identifies a set of variables that explain the maximum amount of data variance that is contained in the target variable or the data source.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Variable Selection: Connection Requirements for the Node

In order to run the Variable Selection step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
Your input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output table. For more information, see "Step 4: Create the Output Data" on page 1111. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Variable Selection of Baseball Data

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Run this code to load the data into a CAS table:

```
libname mycas cas;
data mycas.baseball;
   set sashelp.baseball;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Prepare Data** folder and double-click **Variable Selection** to add the step to your flow.

4 Add the MyCas.Baseball table to your flow. Connect the input port of the Variable Selection node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Variable Selection step, click the Variable Selection node.

6 On the **Data** tab, assign these variables to the **Continuous variables** role:

- **nAtBat**
- **nHits**
- **nHome**
- **nRuns**
- **nRBI**
- **nBB**
- **YrMajor**
- **CrAtBat**
- **CrHits**
- **CrHome**
- **CrRuns**
- **CrRBI**
- **CrBB**

- **nOuts**
- **nAssts**
- **nError**
- **Salary**
- **logSalary**

7 To the **Classification variables** role, assign these variables:

- **League**
- **Division**
- **Position**

8 On the **Options** tab, select **Iteration plot**.

9 On the **Output** tab, select **Save selection summary**. Next, add an output table to the flow.

a Select **Add** ⇨ **Table**.

b Select the Table node. In the table properties, enter `Work` as the library name and enter `Selection_Summary` as the table name.

c Right-click the Variable Selection node and select **Add output port** ⇨ **Selection Summary Table**.

d Connect the new output port to the Selection_Summary node.

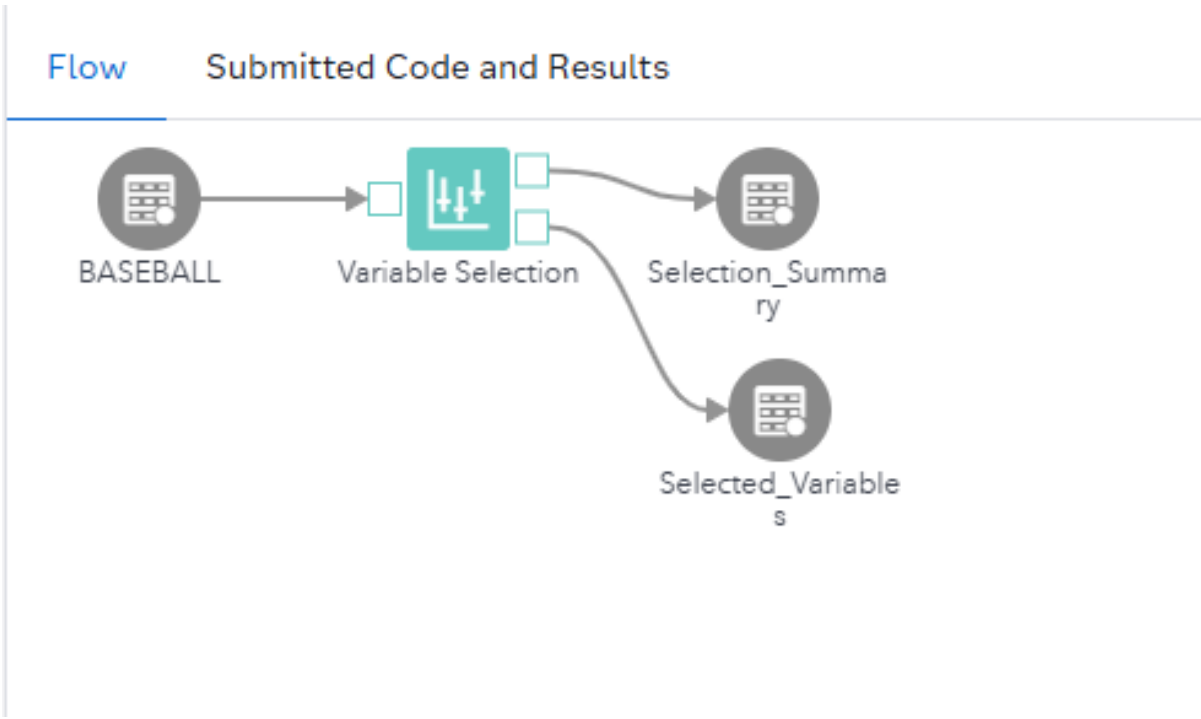
10 On the **Output** tab, select **Save selected variables**. Next, add an output table to the flow.

a Select **Add** ⇨ **Table**.

b Select the Table node. In the table properties, enter `Work` as the library name and enter `Selected_Variables` as the table name.

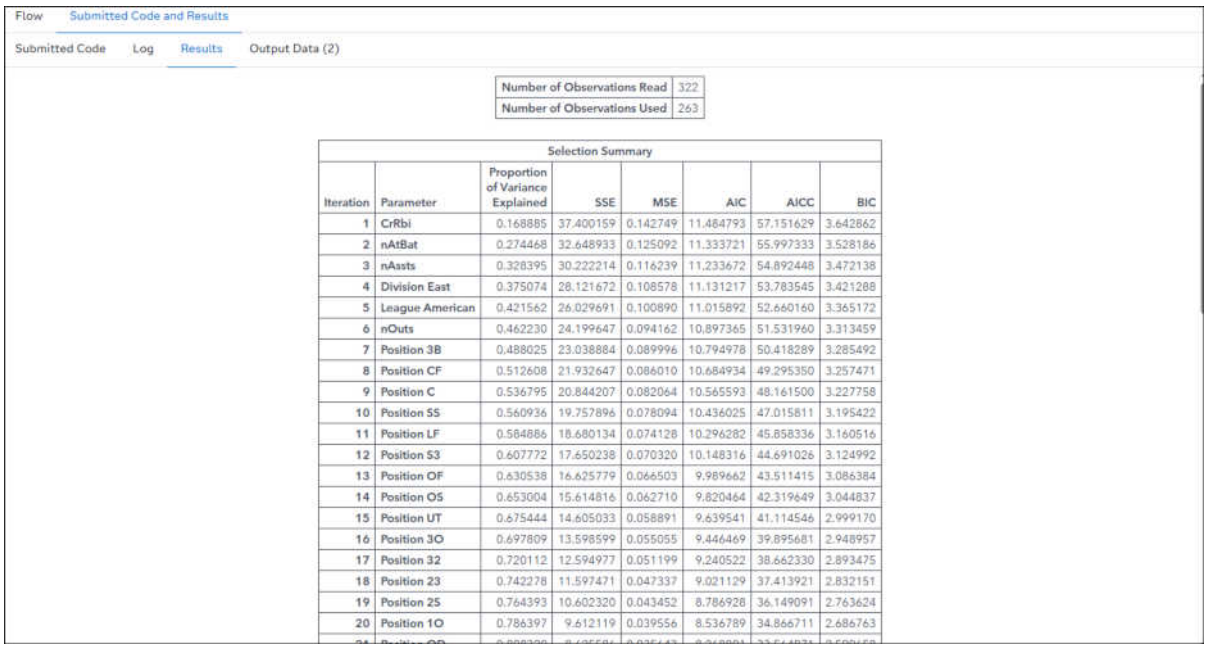
c Right-click the Variable Selection node and select **Add output port** ⇨ **Selected Variables Table**.

d Connect the new output port to the Selected_Variables node.



11 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (2)

Number of Observations Read	322
Number of Observations Used	263

Selection Summary

Iteration	Parameter	Proportion of Variance Explained	SSE	MSE	AIC	AICC	BIC
1	CrRbi	0.168885	37.400159	0.142749	11.484793	57.151629	3.642862
2	nAtBat	0.274468	32.648933	0.125092	11.333721	55.997333	3.528186
3	nAssts	0.328395	30.222214	0.116239	11.233672	54.892448	3.472138
4	Division East	0.375074	28.121672	0.108578	11.131217	53.783545	3.421288
5	League American	0.421562	26.029691	0.100890	11.015892	52.660160	3.365172
6	nOuts	0.462230	24.199647	0.094162	10.897365	51.531960	3.313459
7	Position 3B	0.488025	23.038884	0.089996	10.794978	50.418289	3.285492
8	Position CF	0.512608	21.932647	0.086010	10.684934	49.295350	3.257471
9	Position C	0.536795	20.844207	0.082064	10.565593	48.161500	3.227758
10	Position SS	0.560936	19.757896	0.078094	10.436025	47.015811	3.195422
11	Position LF	0.584886	18.680134	0.074128	10.296282	45.858336	3.160516
12	Position 53	0.607772	17.650238	0.070320	10.148316	44.691026	3.124992
13	Position OF	0.630538	16.625779	0.066503	9.989662	43.511415	3.086384
14	Position OS	0.653004	15.614816	0.062710	9.820464	42.319649	3.044837
15	Position UT	0.675444	14.605033	0.058891	9.639541	41.114546	2.999170
16	Position 3O	0.697809	13.598599	0.055055	9.446469	39.895681	2.948957
17	Position 32	0.720112	12.594977	0.051199	9.240522	38.662330	2.893475
18	Position 23	0.742278	11.597471	0.047337	9.021129	37.413921	2.832151
19	Position 25	0.764393	10.602320	0.043452	8.786928	36.149091	2.763624
20	Position 1O	0.786397	9.612119	0.039556	8.536789	34.866711	2.686763

Variable Selection: Step-by-Step Instructions

Step 1: Assign Data to Roles

Unsupervised Variable Selection

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 For the **Variable selection type** option, select **Unsupervised variable selection**. You must assign at least one continuous or classification variable.

3 To the **Continuous variables** role, assign the numeric variables to use as the interval inputs.

4 To the **Classification variables** role, assign the variables to use as the nominal inputs.

5 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Supervised Variable Selection

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 For the **Variable selection type** option, select **Supervised variable selection**.

3 Select the type for the dependent variable.

4 Select whether to use a continuous or classification target.

5 To the **Continuous variables** role, assign the numeric variables to use as the interval inputs.

6 To the **Classification variables** role, assign the variables to use as the nominal inputs.

7 (Optional) To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the step assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS

truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Build a Model

On the **Model** tab, specify the model type.

You can choose from these options:

- **Main effects model**.
- **Custom model** - You must specify the model effects.
- **Main effects and all n-way interactions** - You must specify the value of N.

Step 3: Setting the Options

On the **Options** tab, you can set these options:

1 Specify how to select the variables. You can choose from these options:
   - correlations
   - covariances
   - sum of squares and cross-products

2 Specify the technique to use when selecting the variables.

   Note: This option is available for supervised variable selection and when the target variable is nominal input. If this option is not available, the step performs a variance analysis.

3 (Supervised variable selection only) Select the model selection criteria:
   - **Akaike's information criterion**
   - **Corrected Akaike's information criterion**
   - **Schwarz Bayesian information criterion**

   Note: The model selection criteria are available only when the target model is supervised.

4 For the **Proportion of total variance to be explained** option, specify a number greater than 0 and less than 1. The default value is `0.9`.

5 For the **Maximum number of selected effects** option, specify an integer greater than or equal to 1 and less than or equal to 9999. The default value is `200`.

6 For the **Specify minimum increment of explained variance** option, specify a number greater than 0 and less than 1. The default value is `0.001`.

7 For the **Specify the maximum number of iterations** option, specify an integer greater than or equal to 1 and less than or equal to 9999. The default value is `200`.

8 Specify whether to include an iteration plot in the results.

Step 4: Create the Output Data

On the **Output** tab, specify whether to create these output tables:

- a table of the selection summary and a table of the selected variables. To save these tables, you must specify a SAS libref.
- a table of a correlation or covariance matrix. To save this table, you must specify a CAS libref.

You can also create a CAS table that contains the matrix data. When naming this table, you must use a CAS libref.

Note: If you are running the step in a flow, you must add an output port to the Variable Selection node. For more information, see "Step 4: Create the Output Data" on page 1111.

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Integrating with SAP

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Extract BW Metadata

About the Extract BW Metadata Step

The Extract BW Metadata step enables you to select SAP BW metadata objects that you want to use as data sources in SAS Data and AI Studio. Examples include InfoCubes, DataStore Objects (DSOs), Advanced DataStore Objects (ADSOs), and Composite Providers.

Note: This step is available to use in a flow or as a standalone step only if your site licenses SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Extract BW Metadata: Prerequisites

Before you can use this step, you must complete these tasks:

1 In the Libraries pane, use the C3 component to make the connection to SAP.

2 Run this code snippet:

```
data work.infoProvTable;
```

```
    length INFOPROVIDER $100;
    stop;
run;
```

Extract BW Metadata: Connection Requirements for the Node

In order to run the Extract BW Metadata step, you must create a connection to the input port of the node as indicated here:

Input Port	Output Port
■ Table node	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to save the output to a file.

Extract BW Metadata: Step-by-Step Instructions

Step 1: Select the Data

1 Select the SAP library connection.

Specify the information provider. You can use an existing provider or enter the name of an information provider.

- SAS Data and AI Studio provides a list of information providers.

  If this is the first time you are running the step or if the information provider that you need does not appear in this list, you first need to retrieve the list of information providers.

  1 Select **Retrieve a list of information providers** and run the Extract BW Metadata step. An output table that contains the list of information providers is created. The location for this table is listed in the log.

  2 Open the Extract BW Metadata step again, and this time select **Use an existing list of information providers**. Select the information provider from the drop-down list.

- You can also add an information provider by selecting **Type in the name of an information provider**.

2 Specify any additional input data sources.

If you select an existing provider or enter the name of an information provider, you must create these tables: **Characteristics that are to be returned data** and **Key figures that are to be returned data**.

For every table that you create, you must add an input port to the Extract BW Metadata step. To add an input port, right-click the Extract BW Metadata node, and then select **Add input port** ⇨ ***type-of-input-table***.

- **Characteristics that are to be returned data**
- **Key figures that are to be returned data**
- **Use selection conditions connected with AND**
- **Use list of table selections**
- **Use table of ranges for non-cumulative InfoCubes**
- **Use table for ranges for REQUID**

Step 2: Select the Options

On the **Options** tab, you can set these options.

1 (Optional) Select a reference date.

2 Select the authority check. You can choose from these options:
   - **No authority check**
   - **Read authorization** (default)
   - **Write authorization**

3 Specify the currency conversion. You can choose from these options:
   - **Default for the information provider**
   - **External format**(default)
   - **Internal format**

4 (Optional) Select **Use database aggregation**.

5 (Optional) Select **Use aggregations**.

6 (Optional) Select **Cubes: roll-up only**.

7 (Optional) Select **Read data from the ODS change log**.

8 (Optional) Select **Read near-line storage or archive**.

9 (Optional) Select **Use debug mode**.

Step 3: Create the Output Data

On the **Output** tab, specify whether to create any output.

If you are running this step in a flow, you must add output ports for any optional output tables. To add an output port, right-click the Extract BW Metadata node and select **Add output port** ⇨ ***type-of-output-table***.

1 Select the result type. You can choose from these options:

- **Return in E_T_RFCDATA**
- **Return in E_T_RFCDATAV** (default)

2 (Optional) Specify any output tables. The output tables that are available depend on the selected result type.

- If your result type is RFCDATA, you can save an internal table with the query result and save the RFC table description.
- If your result type is RFCDATAV, you can save a view with the query result and save the RFC table description.

3 Specify whether to save the output in a file on the SAP application server. By default, the output is not saved to a file.

4 (Optional) Specify whether to create these output tables. All data values are saved by SAP in a tabular format.

- **Save last data package**
- **Save last aggregate used**
- **Save result may not be completely aggregated**
- **Save UUID of the step in the query statistics**

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Working with Machine Learning

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Automated Feature Engineering

About the Automated Feature Engineering Step

The Automated Feature Engineering step explores the variables in the input data and automatically performs feature engineering in a parallel, scalable way.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Automated Feature Engineering: Connection Requirements for the Node

In order to run the Automated Feature Engineering step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1124. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Finding Automated Feature Engineering

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio .

2 Enter this code on a **SAS Program** tab:

```
libname mycas cas;

data mycas.dmagecr;
   set sampsio.dmagecr;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Automated Feature Engineering** to add the step to your flow.

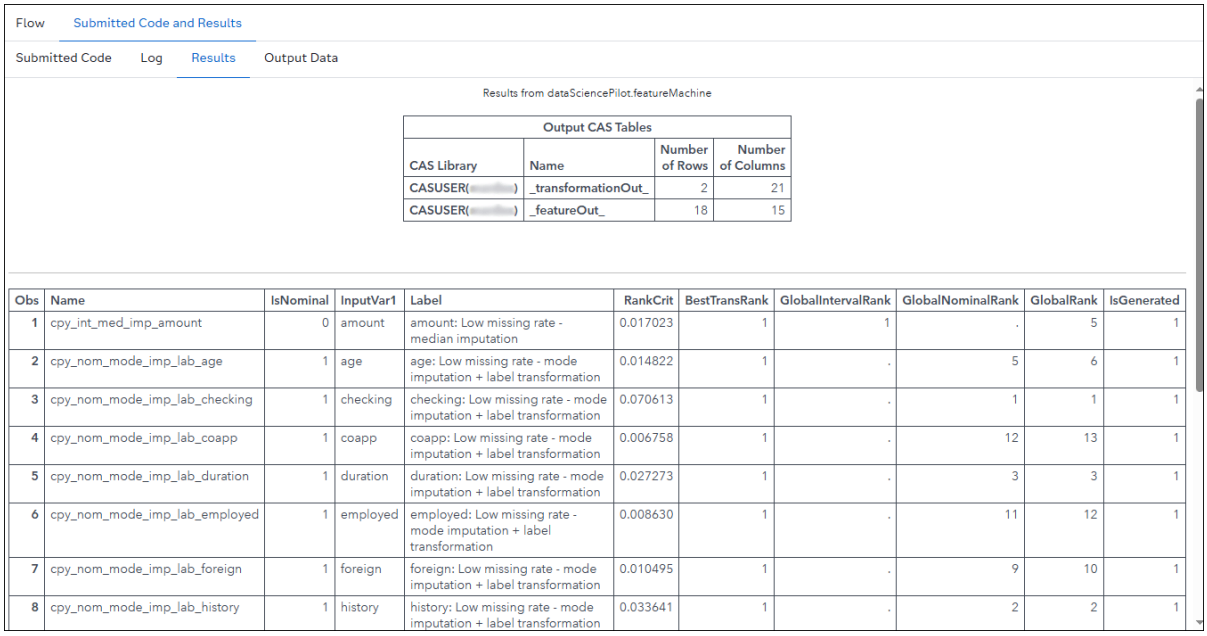
4 Add the MyCas.Dmagecr table to your flow. Connect the input port of the Automated Feature Engineering node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Automated Feature Engineering step, click the Automated Feature Engineering node.

6 On the **Data** tab, select **good_bad** for the nominal target.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data

Results from dataSciencePilot.featureMachine

Output CAS Tables

CAS Library	Name	Number of Rows	Number of Columns
CASUSER( )	_transformationOut_	2	21
CASUSER( )	_featureOut_	18	15

Obs	Name	IsNominal	InputVar1	Label	RankCrit	BestTransRank	GlobalIntervalRank	GlobalNominalRank	GlobalRank	IsGenerated
1	cpy_int_med_imp_amount	0	amount	amount: Low missing rate - median imputation	0.017023	1	1	.	5	1
2	cpy_nom_mode_imp_lab_age	1	age	age: Low missing rate - mode imputation + label transformation	0.014822	1	.	5	6	1
3	cpy_nom_mode_imp_lab_checking	1	checking	checking: Low missing rate - mode imputation + label transformation	0.070613	1	.	1	1	1
4	cpy_nom_mode_imp_lab_coapp	1	coapp	coapp: Low missing rate - mode imputation + label transformation	0.006758	1	.	12	13	1
5	cpy_nom_mode_imp_lab_duration	1	duration	duration: Low missing rate - mode imputation + label transformation	0.027273	1	.	3	3	1
6	cpy_nom_mode_imp_lab_employed	1	employed	employed: Low missing rate - mode imputation + label transformation	0.008630	1	.	11	12	1
7	cpy_nom_mode_imp_lab_foreign	1	foreign	foreign: Low missing rate - mode imputation + label transformation	0.010495	1	.	9	10	1
8	cpy_nom_mode_imp_lab_history	1	history	history: Low missing rate - mode imputation + label transformation	0.033641	1	.	2	2	1

Automated Feature Engineering: Partitioning Data

When you have sufficient data, you can partition your data into three parts: training data, validation data, and test data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds. Finally, after a model is selected, the test data can be used to assess how the selected model generalizes on data that played no role in selecting the model.

The Automated Feature Engineering step does not produce a predictive model but instead generates features that can be used as inputs to a predictive model. Automatic feature engineering is performed on the training set, and then that feature engineering process is applied to the validation or test sets. Creating these partitions before the feature engineering phase helps maintain independence between the partitions.

You can partition your data in either of these ways:

- You can specify a proportion of the validation or test data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is a validation or test case, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for validation or test cases. The input data set is divided into partitions by using these values.

Automated Feature Engineering: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. Specify whether to use a nominal or interval target. If you use a nominal target, you can also specify the event of interest.
3. Select the input variables. You can choose to use all columns from the input data except for the variable that is assigned as the target variable, or you can select the input variables to use.
4. Specify the types for the input variables.
   - **Specify variable types for selected inputs** - identifies any date, time, or datetime input variables. You can also identify interval and nominal variables. Unspecified variables are automatically classified as interval or nominal.
   - **Specify criteria for automatically detecting nominal inputs**
     - **Maximum number of unique values**, which must be an integer between 32 and 10,000 (inclusive). The default value is `1024`.
     - **Cardinality ratio threshold** is the number of unique values divided by the number of observations. This value must be a number between 0 and 1. The default value is `0.25`.

- **Include numeric variables** enables you to specify whether to include negative and non-integer values.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1. Use the **Constant values** option to identify interval and nominal variables with constant values as noise variables. This option is selected by default.
2. Use the moment coefficient of variation percentage threshold and the robust correlation of variation percentage threshold to identify interval variables with low coefficients of variation as noise variables.
3. In the **High missing values percentage threshold**, specify the threshold to identify variables with missing rates above the specified threshold as noise variables. By default, this value is `90`.

   Note: This value must be greater than the **Medium-low cutoff** for the **Specify missing values percentage grouping thresholds** option.

4. In the **Low target mutual information threshold**, specify the threshold to identify variables that have a low level of information about the target as noise variables. The default value is `0.05`.
5. Select **High redundancy threshold** to use symmetric uncertainty to identify redundant (highly correlated) variables. If the symmetric uncertainty for two variables exceeds the threshold, the variable that has less information about the target is removed.
6. Select **High target leakage threshold** to use the percentage reduction in target entropy to identify potential target leakage variables. These are variables that have a very high level of information about the target. The default value is `90`.
7. Specify whether to detect and generate interactions.
8. Specify whether to generate polynomial transformations up to the order of three.
9. Specify whether to include transformations for data quality issues. Based on the thresholds that are specified in these options, variables with similar statistical profiles are grouped together and appropriate features are generated for each group. Transformations for missing values, high cardinality, and high skewness are included by default.
   - For missing values, the default for the low-medium cutoff is `5`, and the default for the medium-high cutoff is `25`. The medium-high cutoff must be less than the **High missing values percentage threshold**.
   - For high cardinality values, the default for the low-medium cutoff is `32`, and the default for the medium-high cutoff is `64`.

- For high skewness, there are two options.
  - For **Specify moment skewness grouping thresholds**, the default for the low-medium cutoff is `2`, and the default for the medium-high cutoff is `10`.

    For **Specify robust skewness grouping thresholds**, the default for the low-medium cutoff is `0.75`, and the default for the medium-high cutoff is `2`.
- Specify any additional transformations for the treatment for these options.
  - Select **Rare event levels** to specify a threshold for identifying rare events. The default value is `10`.
  - Select **Low entropy**. There are two options:
    - For **Specify Gini entropy grouping thresholds**, the default for the low-medium cutoff is `0.25`, and the default for the medium-high cutoff is `0.75`.
    - For **Specify Shannon entropy grouping thresholds**, the default for the low-medium cutoff is `0.25`, and the default for the medium-high cutoff is `0.75`.
  - Select **Low index of qualitative variation (IQV)** to specify the criteria to use to identify a low index of qualitative variation. There are two options.
    - For **Specify IQV frequency ratio grouping thresholds**, the default for the two most frequent levels ratio cutoff is `10`, and the default for the **Most and least frequent levels ratio cutoff** is `100`.
    - For **Specify IQV variation ratio grouping thresholds**, the default for the **Low-high cutoff** is `0.5`.
  - Select **Outliers** to specify the criteria for identifying outliers. There are two options.
    - For **Specify z-score percentage grouping thresholds**, the default for the low-medium cutoff is `1`, and the default for the medium-high cutoff is `2.5`.
    - For **Specify interquartile range percentage grouping thresholds**, the default for the low-medium cutoff is `1`, and the default for the medium-high cutoff is `2.5`.
  - Select **High kurtosis** to specify the criteria for high kurtosis. There are two options.
    - For **Specify moment kurtosis grouping thresholds**, the default for the low-medium cutoff is `5`, and the default for the medium-high cutoff is `10`.
    - For **Specify robust kurtosis grouping thresholds**, the default for the low-medium cutoff is `2`, and the default for the medium-high cutoff is `3`.

10 Specify whether the features should be ranked.

11 Rank the interval and nominal features separately.

- Select the interval feature ranking criterion.

- Select the nominal feature ranking criterion.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains the generated features.

   - If you selected the **Rank generated features** option on the **Options** tab, you can specify which top-ranked features to include in the output. By default, one feature is included for each input variable.
   - If you selected the **Detect and generate interactions** option on the **Options** tab, you can also specify the number of interaction features. The default value is `10`.

     Note: If you created any partitions on the **Data** tab, the output table includes a partition indicator variable, _PartInd_, that indicates the partition for each observation. If all three partitions are created, then 0=training, 1=validation, and 2=test. If only the validation or test partition is created, then 0=training and 1 corresponds to the other set.

2 (Optional) Specify whether to create an output table that contains the metadata on each generated feature.

3 (Optional) Specify whether to create a CAS table that contains the metadata on each feature transformation and generation pipeline. Each pipeline corresponds to a set of related transformations that address certain data quality issues.

4 (Optional) Specify whether to create an analytic store scoring object for the feature transformation and generation scoring model. This model can be used to perform the same feature engineering on new variables.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Automated Feature Engineering node. For more information, see "Automated Feature Engineering: Connection Requirements for the Node" on page 1119.

Bayesian Network

About the Bayesian Network Step

The Bayesian Network step trains a predictive model of a nominal target using different types of Bayesian network structures, including parent-child Bayesian network (default), Markov blanket, naive Bayesian network, or tree-augmented naive Bayesian network. Automatic selection of the best parameters using a validation data subset is available.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Bayesian Network: Connection Requirements for the Node

In order to run the Bayesian Network step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. For more information, see "Step 3: Set the Output Options" on page 1131. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Bayesian Network

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in Data and AI Studio .

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.Neuralgia;
input Treatment $ Sex $ Age Duration Pain $ @@;
datalines;
P F 68 1 No B M 74 16 No P F 67 30 No
P M 66 26 Yes B F 67 28 No B F 77 16 No
A F 71 12 No B F 72 50 No B F 76 9 Yes
A M 71 17 Yes A F 63 27 No A F 69 18 Yes
B F 66 12 No A M 62 42 No P F 64 1 Yes
A F 64 17 No P M 74 4 No A F 72 25 No
P M 70 1 Yes B M 66 19 No B M 59 29 No
A F 64 30 No A M 70 28 No A M 69 1 No
B F 78 1 No P M 83 1 Yes B F 69 42 No
B M 75 30 Yes P M 77 29 Yes P F 79 20 Yes
A M 70 12 No A F 69 12 No B F 65 14 No
B M 70 1 No B M 67 23 No A M 76 25 Yes
P M 78 12 Yes B M 77 1 Yes B F 69 24 No
P M 66 4 Yes P F 65 29 No P M 60 26 Yes
A M 78 15 Yes B M 75 21 Yes A F 67 11 No
P F 72 27 No P F 70 13 Yes A M 75 6 Yes
B F 65 7 No P F 68 27 Yes P M 68 11 Yes
P M 67 17 Yes B M 70 22 No A M 65 15 No
P F 67 1 Yes A M 67 10 No P F 72 11 Yes
A F 74 1 No B M 80 21 Yes A F 69 3 No
;
```

Run the code to create the MyCas.Neuralgia table.

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Bayesian Network** to add the step to your flow.

4 Add the MyCas.Neuralgia table to your flow. Connect the input port of the Bayesian Network node to the data source. For more information, see “Connecting Nodes” on page 13.

5 To set the options for the Bayesian Network step, click the Bayesian Network node.

6 On the **Data** tab, set these options:

- To the **Nominal target** role, assign **Pain**.
- To the **Interval inputs** role, assign **Age** and **Duration**.
- To the **Nominal inputs** role, assign **Treatment** and **Sex**.

7 On the **Output** tab, select **Save network structure**.

Add an output table to the flow for the network structure data.

a Select **Add** ⇨ **Table**.

b In the **Table Properties** tab, enter `Work` as the name of the library, and enter `network_structure` as the table name.

c Right-click the Bayesian Network node and select **Add output port** ⇨ **Network Structure Table**.

d Connect the outport port for the network structure table to the network_structure Table node.

8 On the **Output** tab, expand the **Variable information** heading. Select **Save variable information**.

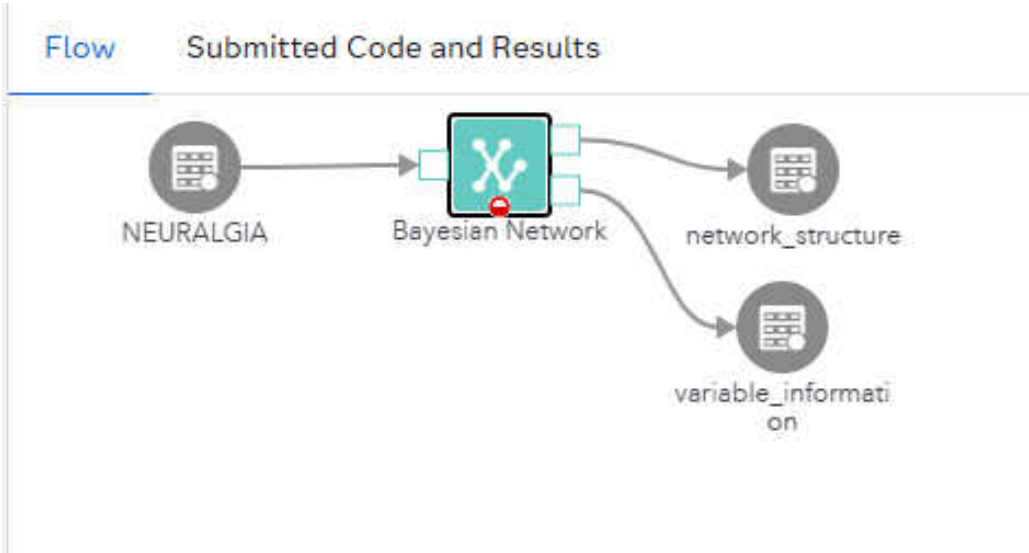
Add an output table to the flow for the variable information.

a Select **Add** ⇨ **Table**.

b In the **Table Properties** tab, enter `Work` as the name of the library, and enter `variable_information` as the table name.

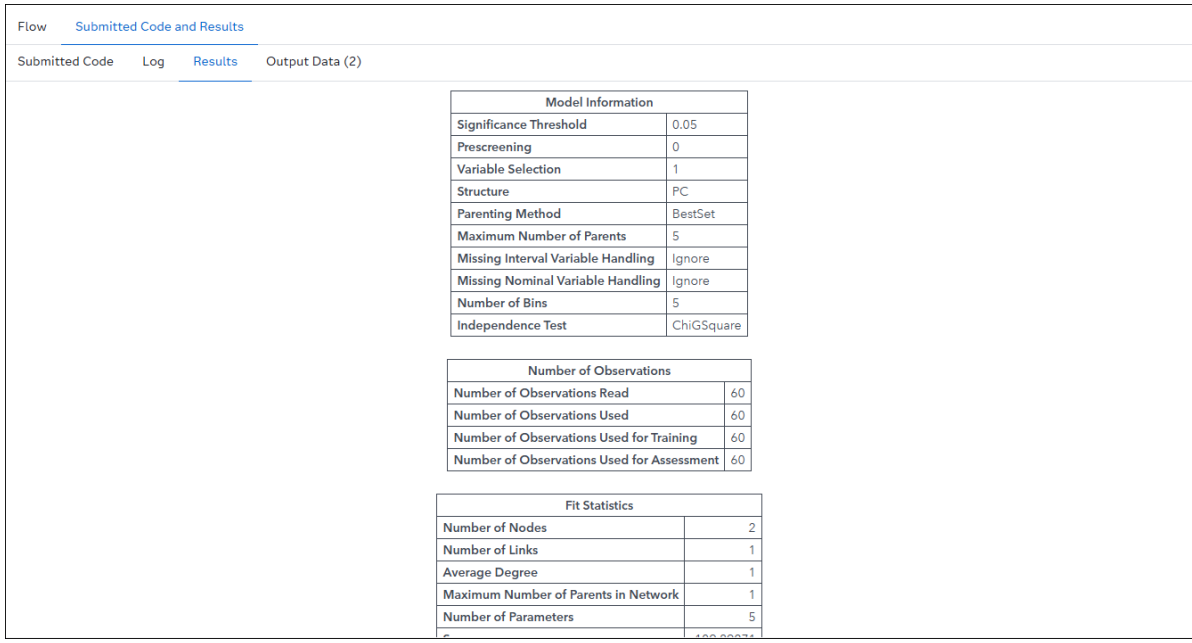
c Right-click the Bayesian Network node and select **Add output port** ⇨ **Variable Information Table**.

d Connect the outport port for the network structure table to the variable_information Table node.



9 Run the flow.

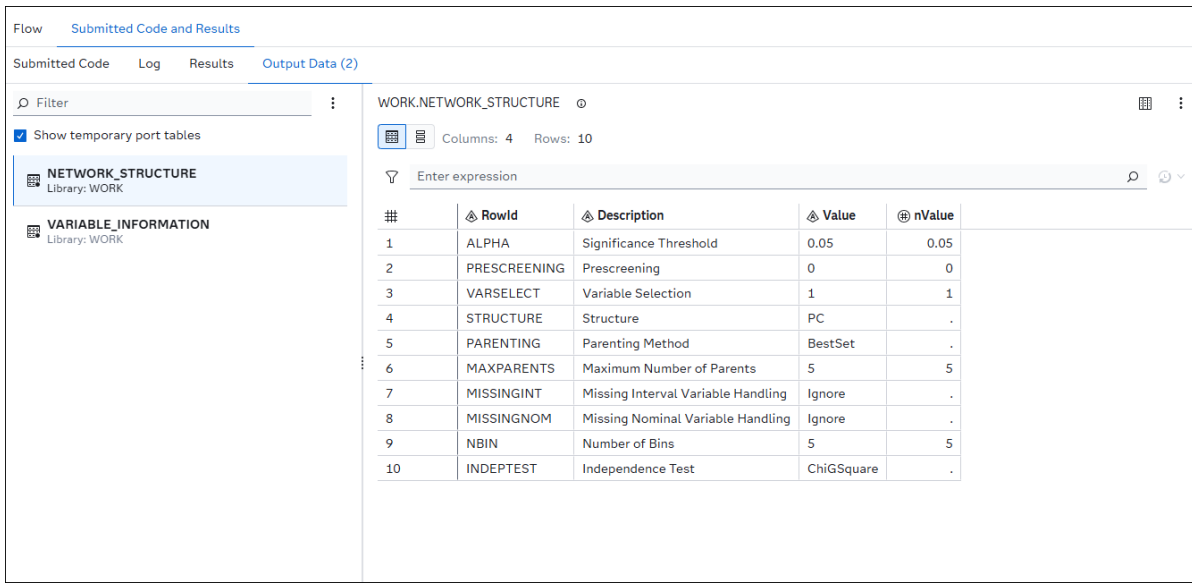
Click the **Submitted Code and Results** tab to view the results and the output data.



Model Information	
Significance Threshold	0.05
Prescreening	0
Variable Selection	1
Structure	PC
Parenting Method	BestSet
Maximum Number of Parents	5
Missing Interval Variable Handling	Ignore
Missing Nominal Variable Handling	Ignore
Number of Bins	5
Independence Test	ChiGSquare

Number of Observations	
Number of Observations Read	60
Number of Observations Used	60
Number of Observations Used for Training	60
Number of Observations Used for Assessment	60

Fit Statistics	
Number of Nodes	2
Number of Links	1
Average Degree	1
Maximum Number of Parents in Network	1
Number of Parameters	5



	RowId	Description	Value	nValue
1	ALPHA	Significance Threshold	0.05	0.05
2	PRESCREENING	Prescreening	0	0
3	VARSELECT	Variable Selection	1	1
4	STRUCTURE	Structure	PC	.
5	PARENTING	Parenting Method	BestSet	.
6	MAXPARENTS	Maximum Number of Parents	5	5
7	MISSINGINT	Missing Interval Variable Handling	Ignore	.
8	MISSINGNOM	Missing Nominal Variable Handling	Ignore	.
9	NBIN	Number of Bins	5	5
10	INDEPTEST	Independence Test	ChiGSquare	.

Bayesian Network: Partitioning Data

When you have sufficient data, you can partition your data into training data and validation data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds.

You can partition your data in either of these ways:

- You can specify a proportion of the validation data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is for validation, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for validation. The input data set is divided into partitions by using these values.

Bayesian Network: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. To the **Nominal target** role, assign the nominal target in the analysis.
3. To the **Interval inputs** role, assign the numeric variable to use as interval inputs.
4. To the **Nominal inputs** role, assign the numeric or character variables to use as nominal inputs.
5. To the **Frequency count** role, assign the numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the task assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the observation is excluded from the analysis. The sum of the frequency variable represents the total number of observations.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1. Specify the number of bins for interval inputs. The default value is `5`.
2. Specify how to interpret missing values for interval inputs. You can ignore observations with missing values or replace missing values with the mean of the input.
3. Specify how to interpret missing values for nominal inputs. You can ignore those observations, replace the missing values with the mode of the input, or treat the missing value as a level.

4 Specify whether to select the best model using the validation data.

Note: This option is available only if you selected **Include validation data** on the **Data** tab.

5 Specify whether to use all inputs or use the inputs that are dependent on the target, which is the default.

Note: If you select the **Include validation data** option on the **Data** tab and the **Select the best model** option, you can select multiple values for this option.

6 Specify one of these networks: Parent-child Bayesian network (default), Markov blanket, Naive Bayesian network, or Tree-augmented naive Bayesian network.

Note: If you select the **Include validation data** option on the **Data** tab and the **Select the best model** option, you can select multiple values for this option.

7 Specify a value between 1 and 16 (inclusive) that is the maximum number of parents per node. The default value is 5.

8 Specify whether to use the best variable or the best set of variables to determine the parents of the nodes (which is the default).

9 Specify the variable selection method. Here are the available options:

- **Use all inputs after initial screening**
- **Use inputs that are dependent on the target given any other input**
- **Use inputs that are dependent on the target given any subset of inputs** (default)
- **Use inputs in the Markov blanket of the target**

10 Specify the independence test to use. Here are the available options:

- **Chi-square**
- **G-square**
- **Chi-square and G-square** (default)
- **Mutual information**
- **All**

11 Specify the significance level for the independence test.

12 Specify the plots to include in the results.

If two or more input variables are specified, you can include these plots:

- partial dependence plot
- individual conditional expectation plot

If either plot is selected, you must set these options: specify an analysis variable. If the target variable is nominal, you must specify a nominal value of interest.

- the value for the nominal target variable.
- the type of analysis variable, the interval or nominal column, and the number of bins

Step 3: Set the Output Options

On the **Output** tab, specify whether to create these CAS tables:

- predicted probabilities
- scoring model

You can also create these SAS data sets. When naming these tables, you must specify a SAS engine libref.

- network structure
- fit statistics
- variable information
- variable levels
- variable order
- variable selection information

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Bayesian Network node. For more information, see "Bayesian Network: Connection Requirements for the Node" on page 1125.

You can also save the scoring code.

Factorization Machine

About the Factorization Machine Step

The Factorization Machine step combines the advantages of smart machine vision (SMV) with factorization models.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as

a standalone step in SAS Data Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Factorization Machine: Connection Requirements for the Node

In order to run the Factorization Machine step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1136. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Factorization Machine

To create this example:

1 On a **SAS program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in S Data and AI Studio .

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

proc casutil;
```

```
   load data=sashelp.baseball casout="baseball";
run;
```

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Factorization Machine** to add the step to your flow.

4 Add the MyCas.Baseball table to your flow. Connect the input port of the Factorization Machine node to the data source. For more information, see "Connecting Nodes" on page 13.

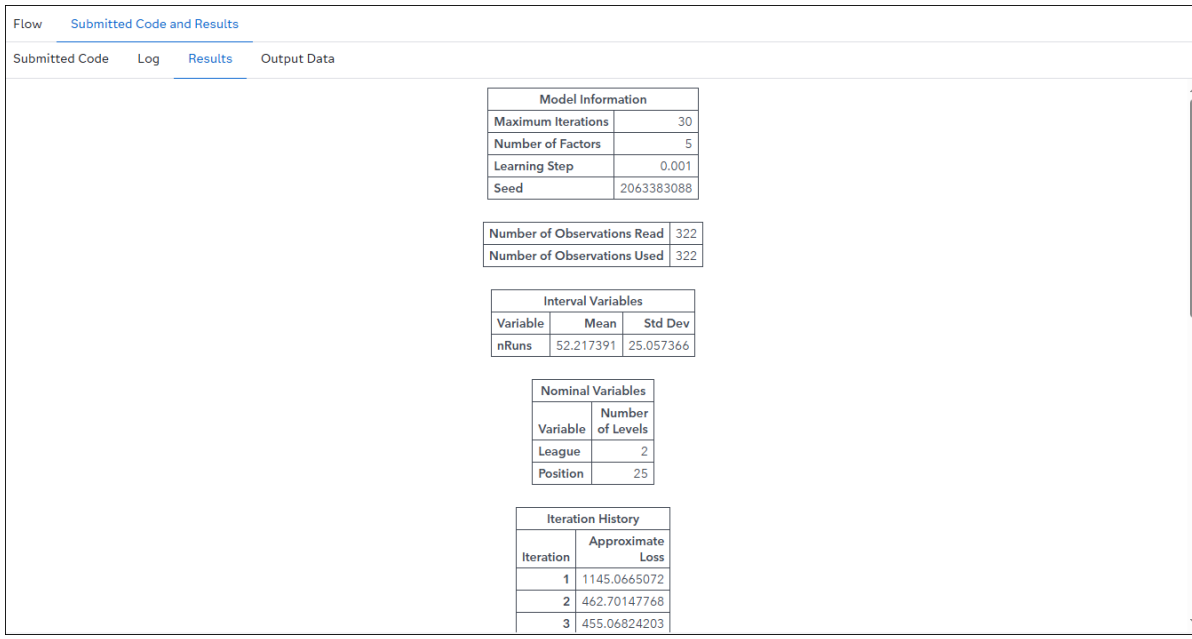
5 To set the options for the Factorization Machine step, click the Factorization Machine node.

6 On the **Data** tab, assign variables to these roles:

- To the **Interval target** role, assign **nRuns**.
- To the **Nominal inputs** role, assign **League** and **Position**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Factorization Machine: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Interval target** role, assign the numeric variable to use as the target.

3 To the **Nominal inputs** role, assign the numeric or character variables to use as the nominal target.

4 (Optional) To the **Interval inputs** role, assign the numeric variable to use as an input.

Step 2: Set the Options

On the **Options** tab, the options available depend on whether you specify to autotune the step.

If you do not select the **Automatically tune selected options** check box, these options are available.

1 Specify the number of factors. The default value is `5`.

2 Specify the maximum number of iterations. The default value is `30`.

3 Specify the size of the learning step. The default value is `0.001`.

4 Select the plots to include in the analysis. You must specify two or more input variables.

- partial dependence plot
- individual conditional expectation plot

If either plot is selected, you must specify an analysis variable. If the target variable is nominal, you must specify a nominal value of interest.

If you select the **Automatically tune selected options** check box, the step uses an optimization search process to select the best value for any specified autotune options. In the user interface, autotuning is identified by the **Autotune *option-name*** check box. For each autotune option, you can specify an initial value, a lower bound, and an upper bound for the search process.

Note: The autotune capability can take considerable processing time.

1 Specify the number of factors. The initial value is `5`. You can also specify the upper and lower bound.

2 Specify the maximum number of iterations. The initial value is `30`. You can also specify the upper and lower bound.

3 Specify the size of the learning step. The initial value is `0.001`. You can also specify the upper and lower bound.

4 Specify the search method to use for tuning. Here are the valid values:

- **Genetic algorithm** uses an initial Latin hypercube sample that seeds a genetic algorithm to generate a new population of alternative configurations at each iteration. You can also specify these settings: the maximum iterations, the maximum evaluations, and the evaluations per iteration.

- **Latin hypercube sample** uses a Latin hypercube to generate a single sample of configurations that is uniform in each tuning parameter, but random in combinations. You must specify the sample size.
- **Random sample** generates a single sample of purely random configurations. You must specify the sample size.
- **Bayesian sample** builds a kriging surrogate model to approximate the objective value and uses this surrogate model to generate new alternative configurations at each iteration. The kriging model is continuously updated during the search process.

5 From the **Objective** drop-down list, select the measure of model performance the tuner uses as the objective function.

6 Specify the maximum time allowed for the tuner, where number must be greater than or equal to 1. When this value is reached, the tuner terminates the search and returns results.

7 Specifies whether to use a partition or *k*-fold cross validation as the validation method.

- **Partition** specifies the fraction of all data to be used for validation, where number must be between 0.01 and 0.99, inclusive. If you specify this option, the tuner uses a single partition validation for finding the objective value (validation error estimate). This option might not be advisable for small or unbalanced data tables where the random assignment of the validation subset might not provide a good estimate of error. For large, balanced data tables, a single validation partition is usually sufficient for estimating error; a single partition is more efficient than cross validation in terms of the total execution time.
- **K-fold cross-validation** specifies the number of partition folds in the cross validation process, where number must be between 2 and 20, inclusive. If you specify this option, the tuner uses cross validation to find the objective value. In cross validation, each model evaluation requires number of training executions (on number−1 data folds) and number of scoring executions (on one holdout fold). Thus, the evaluation time is increased by approximately a factor of number. For small to medium data tables or for unbalanced data tables, cross validation provides on average a better representation of error across the entire data table (a better generalization error).

8 Specify the number of evaluations to be performed in parallel, where the number must be greater than or equal to 0, and less than or equal to 32.

9 Specify whether to create and display the result table and log from the evaluation history report.

10 Specify whether to include these autotune plots in the results: objective history, best objective history, and option values versus objective.

11 Select the plots to include in the analysis. You must specify two or more input variables.

- partial dependence plot
- individual conditional expectation plot

If either plot is selected, you must specify an analysis variable.

Step 3: Set the Output Options

On the **Output** tab, specify whether to create these CAS tables:

- a table of the scored data
- a table of the computed factor parameters
- a table of the scoring model

For the scored data and the table of the scoring model, you can specify whether to include any variables from the input data set. When naming these tables, you must specify a CAS engine libref.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Factorization Machine node. For more information, see "Factorization Machine: Connection Requirements for the Node" on page 1132.

Fast k-Nearest Neighbors

About the Fast k-Nearest Neighbors Step

The Fast k-Nearest Neighbors step searches for the *k*-nearest neighbors (KNN) of the specified data.

Note: This step is available to use in a flow only if your site licenses or . You can use this step as a standalone step in SAS Data and AI Studio, , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Fast k-Nearest Neighbors: Connection Requirements for the Node

In order to run the Fast k-Nearest Neighbors step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The Fast k-Nearest Neighbors node has two input ports—one for the query data table and one for the reference data table. These tables must be CAS tables. ■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	By default, no output tables are created, and no connection is required. However, on the **Output** tab, you can specify whether to create an output data table and an output distance data table. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1140. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Fast k-Nearest Neighbor node, select **Add output port**, and then select **Output Table** or **Output Distance Table**. For this step to run, the output data must use a CAS engine library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Fast k-Nearest Neighbors

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in Data and AI Studio .

1 Enter this code on a **SAS Program** tab:

```
libname mycas cas caslib="CASUSER";

data mycas.asia;
  set maps.asia;
run;

data mycas.query;
    set mycas.asia(firstobs=1 obs=10);
    id=_n_;
run;
```

2 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Fast k-Nearest Neighbors** to add the step to your flow.

3 Add the input data tables to the flow. Connect the Query Data input port of the Fast k-Nearest Neighbor node to the data source.

   - Add the MyCas.Query table to the flow. Connect the input port for the Query Data to this data source.
   - Add the MyCas.Asia table to the flow. Connect the input port for the Reference Data to this data source.

   For more information, see “Connecting Nodes” on page 13.

4 To set the options for the Fast k-Nearest Neighbors step, click the Fast k-Nearest Neighbor node.

5 On the **Data** tab, assign variables to these roles:

   - To the **ID variable** role, assign **ID**.
   - To the **Input variables** role, assign **X** and **Y**.

6 On the **Output** tab, select **Create output data**.

   a Select **Add** ⇨ **Table**.

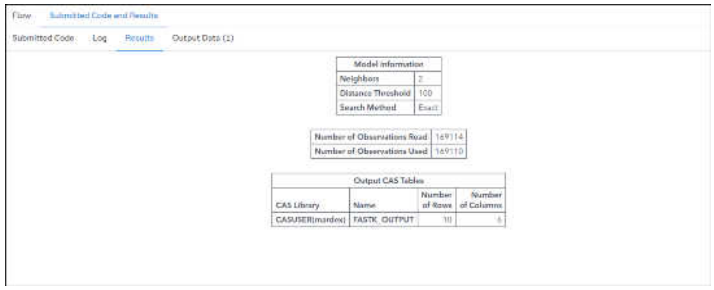
   b In the table properties, enter **`MyCas`** as the library name and **`FastK_output`**as the table name.

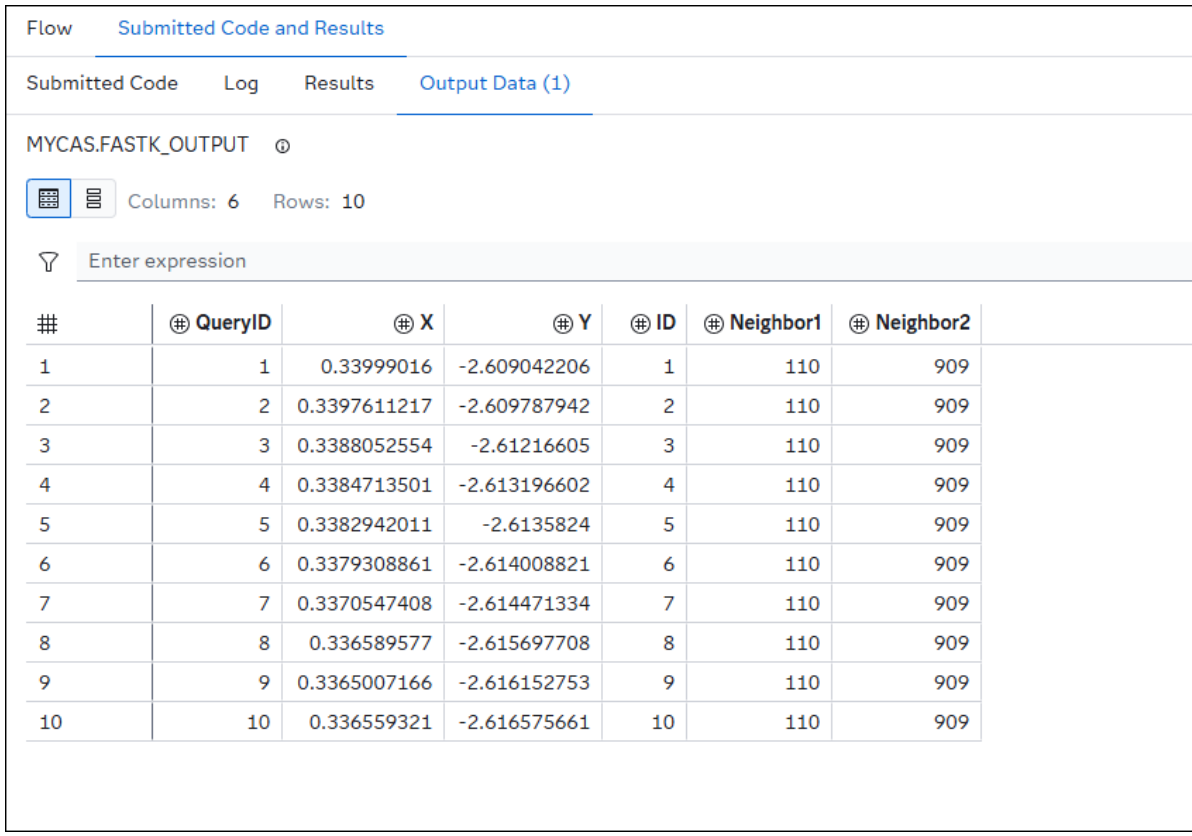
   c Right-click the Fast k-Nearest Neighbor node.and select **Add output port** ⇨ **Output Table**.

   d Connect the MyCas.FastK_output table to the Output Table port.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.




Flow Submitted Code and Results

Submitted Code Log Results Output Data (1)

MYCAS.FASTK_OUTPUT

Columns: 6 Rows: 10

Enter expression

#	QueryID	X	Y	ID	Neighbor1	Neighbor2
1	1	0.33999016	-2.609042206	1	110	909
2	2	0.3397611217	-2.609787942	2	110	909
3	3	0.3388052554	-2.61216605	3	110	909
4	4	0.3384713501	-2.613196602	4	110	909
5	5	0.3382942011	-2.6135824	5	110	909
6	6	0.3379308861	-2.614008821	6	110	909
7	7	0.3370547408	-2.614471334	7	110	909
8	8	0.336589577	-2.615697708	8	110	909
9	9	0.3365007166	-2.616152753	9	110	909
10	10	0.336559321	-2.616575661	10	110	909

Fast k-Nearest Neighbors: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Fast k-Nearest Neighbors step, the input data sources must be CAS tables.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **ID variable** role, assign the ID variable for the analysis.

3 To the **Input variables** role, assign the interval variables to use for distance calculation.

4 (Optional) For the reference data, specify a filter for the data table within the nearest neighbors that are to be searched.

Note: If you are running this step in a flow, you must connect this data table to the Reference Data input port for the Fast k-Nearest Neighbors node.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Select **Number of neighbors (K)** to specify the number of neighbors to return.

2 Select **Distance threshold** to specify the distance threshold for the model.

3 (Optional) Select **Use approximate search** to compute a subset of the distances that are less than or equal to the distance threshold. Specify a random seed to start the pseudo-random number generator.

By default, all pairwise distances less than or equal to the distance threshold are computed.

4 (Optional) Select **Distribute data among worker nodes** to specify whether to distribute the query data or the reference data among worker nodes.

5 (Optional) Select which code to use to run the step. You can use the FASTKNN procedure or the CAS procedure. For more information, see FASTKNN Procedure in *SAS Viya: Machine Learning Procedures* and "CAS Procedure" in *SAS Cloud Analytic Services: CASL Reference*.

Step 3: Set the Output Options

On the **Output** tab, you can set these options:

1 (Optional) Specify whether to create a table that contains the results of the analysis. You can include all the variables from the results and in the input data source, only the variables that were used in the analysis, or selected variables.

Note: If you are running the step in a flow, you must add an output port for this optional table to the Fast k-Nearest Neighbors node. For more information, see "Fast k-Nearest Neighbors: Connection Requirements for the Node" on page 1136.

2 (Optional) Specify whether to create a table that contains the output distances. These columns are in the output table: QueryID, ReferenceID, and Distance.

Note: If you are running the step in a flow, you must add an output port for this optional table to the Fast k-Nearest Neighbors node. For more information, see "Fast k-Nearest Neighbors: Connection Requirements for the Node" on page 1136.

Forest

About the Forest Step

The Forest step produces an ensemble of tree-based statistical models called decision trees for interval or nominal targets. It uses the Random Forest approach.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Forest: Connection Requirements for the Node

In order to run the Forest step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input table must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output table, use the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 1151. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Examples: Forest Step

Example 1: Interval Target

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

proc casutil;
   load data=sashelp.baseball casout="baseball";
run;
```

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Forest** to add the step to your flow.

4 Add the MyCas.Baseball table to your flow. Connect the input port of the Forest node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Forest step, click the Forest node.

6 On the **Data** tab, select **Use an interval target**.

7 Assign variables to these roles:

- To the **Interval target** role, assign **logsalary**.
- To the **Interval inputs** role, assign these variables:
  - **nAtBat**
  - **nHits**
  - **nHome**
  - **nRuns**
  - **nRBI**
  - **nBB**
  - **YrMajor**
  - **CrAtBat**

- **CrHits**
- **CrHome**
- **CrRuns**
- **CrRbi**
- **CrBB**
- **nOuts**
- **nAssts**
- **nError**

- To the **Nominal inputs** role, assign **League** and **Division**.

8 On the **Options** tab, expand the **Plots** heading and select **Average square error by number of trees** and **Variable importance chart**.

9 On the **Output** tab, select **Save scored data**.

10 For the **Include variables from the input CAS table** option, select **Variables used in the analysis**.

11 Add the output table to the flow and connect it to the Forest node.

a Select **Add** ⇨ **Table**.

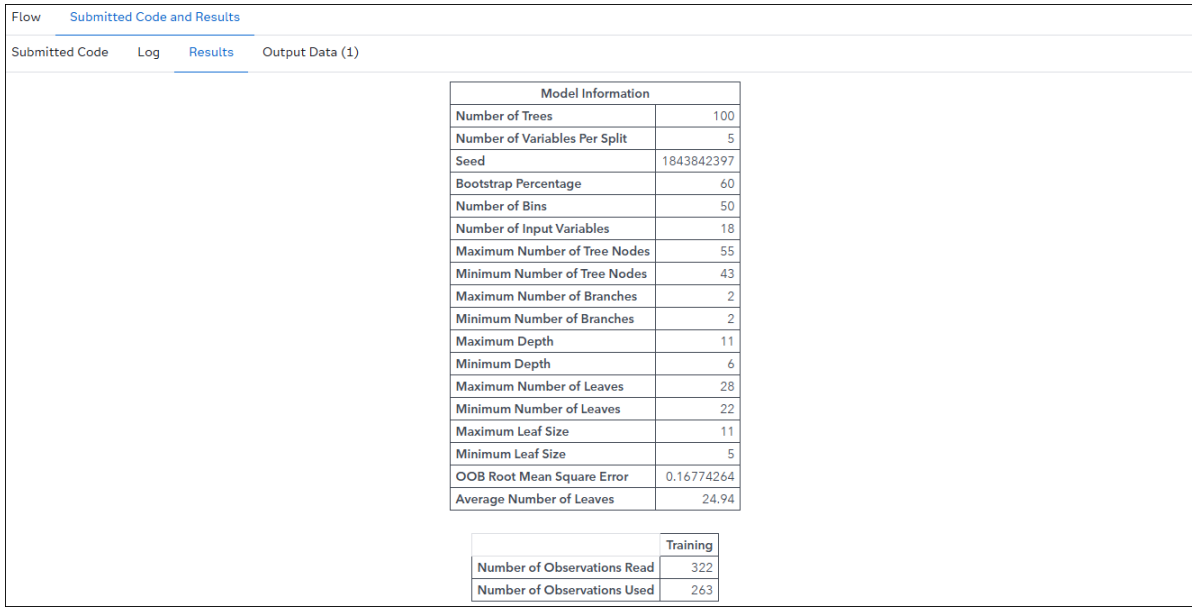
b In the table properties, enter `MyCas` as the library name and `Forest_scores` as the table name.

c Right-click Forest node and select **Add output port** ⇨ **Scored Data Table**.

d Connect the MyCas.Forest_scores table to the Scored Data port.

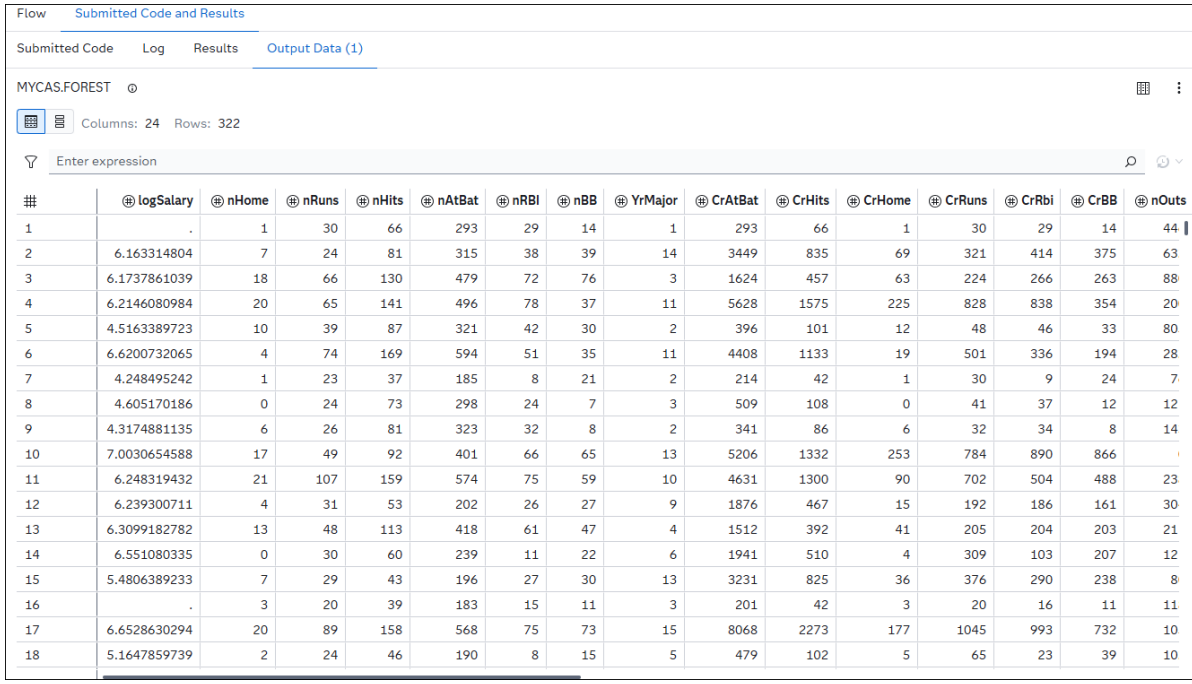
12 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Model Information	
Number of Trees	100
Number of Variables Per Split	5
Seed	1843842397
Bootstrap Percentage	60
Number of Bins	50
Number of Input Variables	18
Maximum Number of Tree Nodes	55
Minimum Number of Tree Nodes	43
Maximum Number of Branches	2
Minimum Number of Branches	2
Maximum Depth	11
Minimum Depth	6
Maximum Number of Leaves	28
Minimum Number of Leaves	22
Maximum Leaf Size	11
Minimum Leaf Size	5
OOB Root Mean Square Error	0.16774264
Average Number of Leaves	24.94

	Training
Number of Observations Read	322
Number of Observations Used	263



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

MYCAS.FOREST

Columns: 24 Rows: 322

Enter expression

#	logSalary	nHome	nRuns	nHits	nAtBat	nRBI	nBB	YrMajor	CrAtBat	CrHits	CrHome	CrRuns	CrRbi	CrBB	nOuts
1	.	1	30	66	293	29	14	1	293	66	1	30	29	14	44
2	6.163314804	7	24	81	315	38	39	14	3449	835	69	321	414	375	63
3	6.1737861039	18	66	130	479	72	76	3	1624	457	63	224	266	263	88
4	6.2146080984	20	65	141	496	78	37	11	5628	1575	225	828	838	354	20
5	4.5163389723	10	39	87	321	42	30	2	396	101	12	48	46	33	80
6	6.6200732065	4	74	169	594	51	35	11	4408	1133	19	501	336	194	28
7	4.248495242	1	23	37	185	8	21	2	214	42	1	30	9	24	7
8	4.605170186	0	24	73	298	24	7	3	509	108	0	41	37	12	12
9	4.3174881135	6	26	81	323	32	8	2	341	86	6	32	34	8	14
10	7.0030654588	17	49	92	401	66	65	13	5206	1332	253	784	890	866	
11	6.248319432	21	107	159	574	75	59	10	4631	1300	90	702	504	488	23
12	6.239300711	4	31	53	202	26	27	9	1876	467	15	192	186	161	30
13	6.3099182782	13	48	113	418	61	47	4	1512	392	41	205	204	203	21
14	6.551080335	0	30	60	239	11	22	6	1941	510	4	309	103	207	12
15	5.4806389233	7	29	43	196	27	30	13	3231	825	36	376	290	238	8
16	.	3	20	39	183	15	11	3	201	42	3	20	16	11	11
17	6.6528630294	20	89	158	568	75	73	15	8068	2273	177	1045	993	732	10
18	5.1647859739	2	24	46	190	8	15	5	479	102	5	65	23	39	10

Example 2: Nominal Target

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

proc casutil;
   load data=sashelp.iris casout="iris";
run;
```

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Forest** to add the step to your flow.

4 Add the MyCas.Iris table to your flow. Connect the input port of the Forest node to the data source. For more information, see “Connecting Nodes” on page 13.

5 To set the options for the Forest step, click the Forest node.

6 On the **Data** tab, select **Use a nominal target**.

7 Assign variables to these roles:

- To the **Nominal target** role, assign **Species**.
- To the **Interval inputs** role, assign these variables:
  - **SepalLength**
  - **SepalWidth**
  - **PetalLength**
  - **PetalWidth**

8 On the **Options** tab, expand the **Plots** heading, select **Misclassifications by number of trees** and **Variable importance chart**.

9 On the **Output** tab, select **Save scored data**.

10 For the **Include variables from the input CAS table** option, select **Variables used in the analysis**.

11 Add the output table to the flow and connect it to the Forest node.

a Select **Add** ⇨ **Table**.

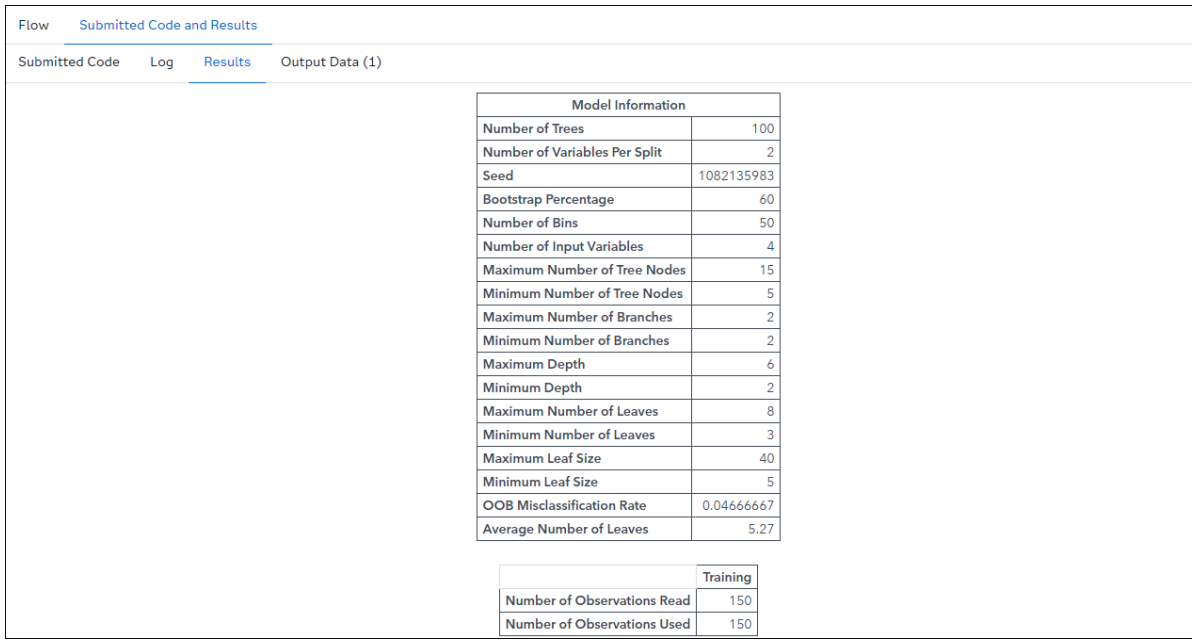
b In the table properties, enter **`MyCas`** as the library name and **`Forest_scores2`**as the table name.

c Right-click Forest node and select **Add output port** ⇨ **Scored Data Table**.

d Connect the MyCas.Forest_Scores2 table to the Scored Data port.

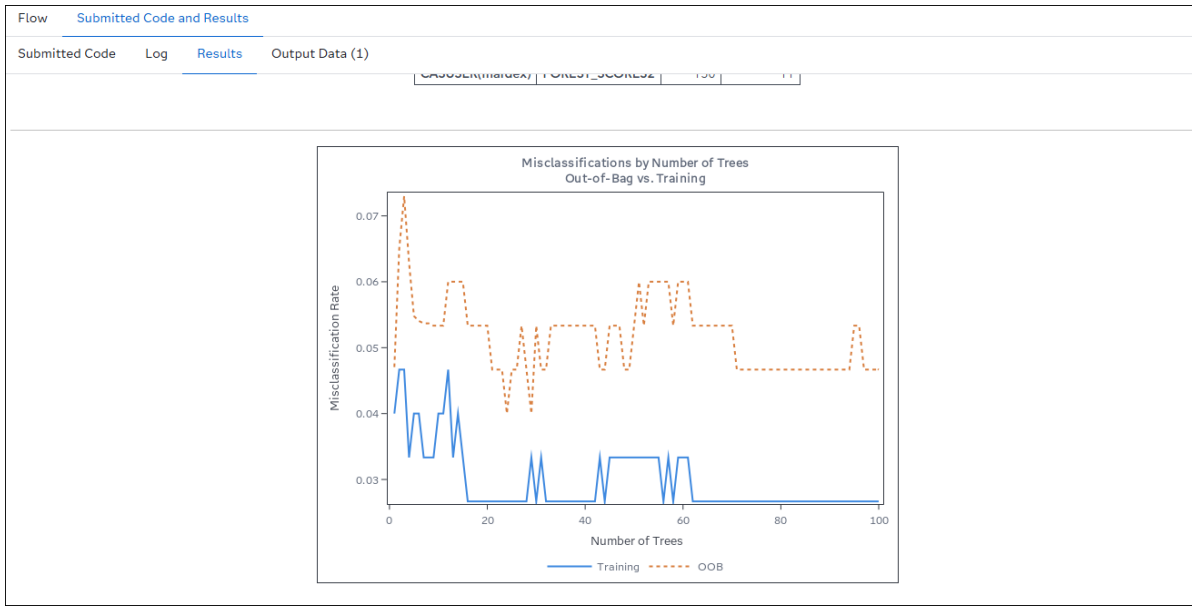
12 Run the flow.

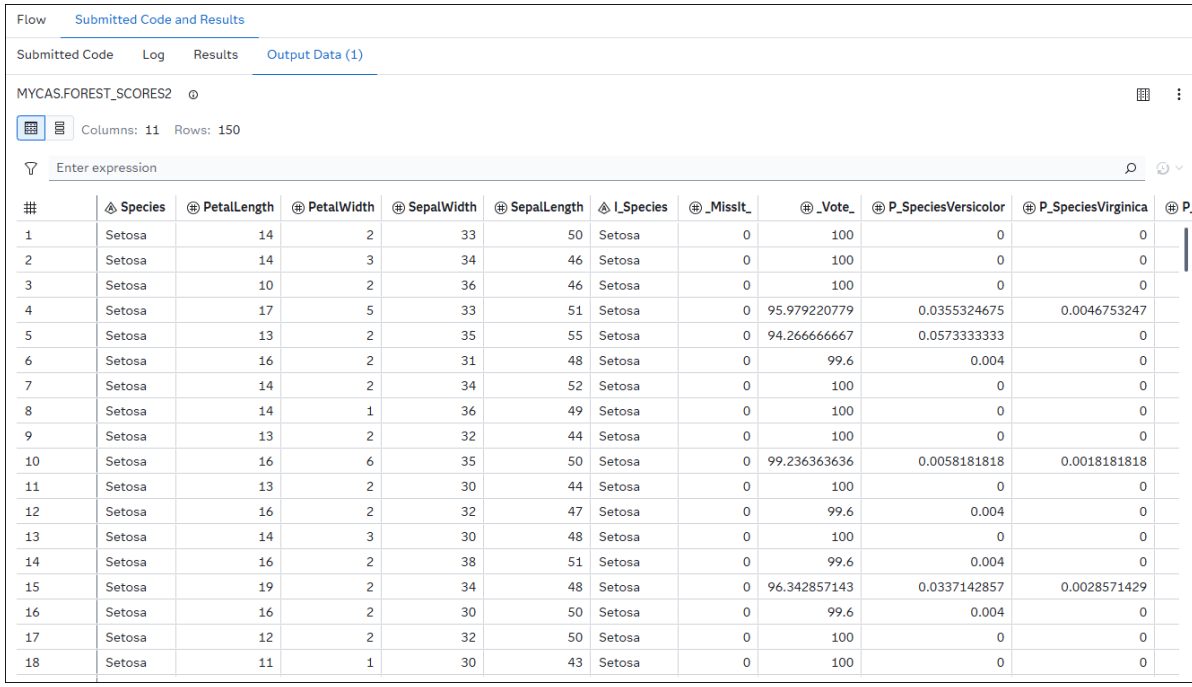
Click the **Submitted Code and Results** tab to view the results.



Model Information	
Number of Trees	100
Number of Variables Per Split	2
Seed	1082135983
Bootstrap Percentage	60
Number of Bins	50
Number of Input Variables	4
Maximum Number of Tree Nodes	15
Minimum Number of Tree Nodes	5
Maximum Number of Branches	2
Minimum Number of Branches	2
Maximum Depth	6
Minimum Depth	2
Maximum Number of Leaves	8
Minimum Number of Leaves	3
Maximum Leaf Size	40
Minimum Leaf Size	5
OOB Misclassification Rate	0.04666667
Average Number of Leaves	5.27

	Training
Number of Observations Read	150
Number of Observations Used	150





	Species	PetalLength	PetalWidth	SepalWidth	SepalLength	I_Species	_MissIt_	_Vote_	P_SpeciesVersicolor	P_SpeciesVirginica	P
1	Setosa	14	2	33	50	Setosa	0	100	0	0	
2	Setosa	14	3	34	46	Setosa	0	100	0	0	
3	Setosa	10	2	36	46	Setosa	0	100	0	0	
4	Setosa	17	5	33	51	Setosa	0	95.979220779	0.0355324675	0.0046753247	
5	Setosa	13	2	35	55	Setosa	0	94.266666667	0.0573333333	0	
6	Setosa	16	2	31	48	Setosa	0	99.6	0.004	0	
7	Setosa	14	2	34	52	Setosa	0	100	0	0	
8	Setosa	14	1	36	49	Setosa	0	100	0	0	
9	Setosa	13	2	32	44	Setosa	0	100	0	0	
10	Setosa	16	6	35	50	Setosa	0	99.236363636	0.0058181818	0.0018181818	
11	Setosa	13	2	30	44	Setosa	0	100	0	0	
12	Setosa	16	2	32	47	Setosa	0	99.6	0.004	0	
13	Setosa	14	3	30	48	Setosa	0	100	0	0	
14	Setosa	16	2	38	51	Setosa	0	99.6	0.004	0	
15	Setosa	19	2	34	48	Setosa	0	96.342857143	0.0337142857	0.0028571429	
16	Setosa	16	2	30	50	Setosa	0	99.6	0.004	0	
17	Setosa	12	2	32	50	Setosa	0	100	0	0	
18	Setosa	11	1	30	43	Setosa	0	100	0	0	

Forest: Partitioning Data

When you have sufficient data, you can partition your data into three parts: training data, validation data, and test data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds. Finally, after a model is selected, the test data can be used to assess how the selected model generalizes on data that played no role in selecting the model.

You can partition your data in either of these ways:

- You can specify a proportion of the validation or test data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is a validation or a test case, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for validation or test cases. The input data set is divided into partitions by using these values.

Forest: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) Specify how to partition the data.

2 Select the target type.

   - To use a nominal target in the analysis, select **Use a nominal target**. Assign a numeric or character variable to the **Nominal target** role.
   - To use an interval target in the analysis, select **Use an interval target**. Assign a numeric variable to the **Interval target** role.

3 To the **Interval inputs** role, assign the numeric variables to use as interval inputs.

   You can also specify the number of bins for interval inputs. The default number is `20`.

4 To the **Nominal inputs** role, assign the numeric or character variables to use as nominal inputs.

Step 2: Set the Options

On the **Options** tab, the options that are available depend on whether you specify to autotune the step.

If you do not select the **Automatically tune selected options** check box, complete these steps:

1 Specify the number of trees that are generated in the forest. The default value is `100`.

2 Specify the maximum depth of a tree. The default value is `20`.

3 From the **Number of inputs considered for splitting a node** drop-down list, select **Square root of the number of inputs** or specify a custom value.

4 Specify the criterion to use to split a node.

Note: The options that are available depend on the type of target.

5 Specify the minimum number of observations for a leaf. The default value is 5.

6 Specify the maximum number of branches of a node. The default value is 2.

7 Specify the method to use to determine variable importance. The available methods depend on whether you have nominal targets or interval targets.

8 For nominal targets, use the **Method to calculate predicted nominal target levels** drop-down list to calculate the predicted probability of the target levels for the nominal target. The predicted level is the level that has the highest predicted probability.

Here are the valid values:

- **Probability** specifies that the predicted probability of each target level is equal to the probability of that level averaged over each tree in the forest. This value is the default.
- **Majority** specifies that the predicted probability of each target level is equal to the number of trees in the forest that predicted that level as the target, divided by the total number of trees in the forest.

9 If you want to sample the data, select **Specify random number seed** and specify a value for the bootstrap sampling rate.

10 (Optional) Select the plots to include in the results.

- misclassifications by number of trees (for a nominal target) or average square error by number of trees (for an interval target)
- variable importance chart

11 (Optional) If two or more input variables are specified, select the interpretability plots to include in the results.

- partial dependence plot
- individual conditional expectation plot

If either plot is selected, you must specify an analysis variable. If the target variable is nominal, you must specify a nominal value of interest.

If you select the **Automatically tune selected options** check box, the step uses an optimization search process to select the best value for any specified autotune options. In the user interface, autotuning is identified by the **Autotune *option-name*** check box. For each autotune option, you can specify an initial value, a lower bound, and an upper bound for the search process.

Note: The autotune capability can take considerable processing time.

1 Specify whether to autotune the number of trees. The initial value is `20`.

2 Specify whether to autotune the depth of a tree. The initial value is `20`.

3 Specify whether to autotune the number of inputs considered for splitting a node. The specified value must be less than or equal to the total number of selected inputs.

4 Specify whether to autotune the bootstrap sampling rate. The initial value is `0.6`.

5 Specify the criterion to use to split a node.

Note: The options that are available depend on the type of target.

6 Specify the minimum number of observations for a leaf. The default value is `5`.

7 Specify the maximum number of branches of a node. The default value is `2`.

8 Specify the method to use to determine variable importance. The available methods depend on whether you have nominal targets or interval targets.

9 For nominal targets, use the **Method to calculate predicted nominal target levels** drop-down list to calculate the predicted probability of the target levels for the nominal target. The predicted level is the level that has the highest predicted probability.

Here are the valid values:

- **Probability** specifies that the predicted probability of each target level is equal to the probability of that level averaged over each tree in the forest. This value is the default.
- **Majority** specifies that the predicted probability of each target level is equal to the number of trees in the forest that predicted that level as the target, divided by the total number of trees in the forest.

10 To sample the data, select **Specify random number seed**, and then specify a value for the bootstrap sampling rate.

11 Specify the search method to use for tuning.

Here are the valid values:

- **Genetic algorithm** uses an initial Latin hypercube sample that seeds a genetic algorithm to generate a new population of alternative configurations at each iteration. You can also specify these settings: the maximum iterations, the maximum evaluations, and the evaluations per iteration.
- **Latin hypercube sample** uses a Latin hypercube to generate a single sample of configurations that is uniform in each tuning parameter but random in combinations. You must specify the sample size.
- **Random sample** generates a single sample of purely random configurations. You must specify the sample size.
- **Bayesian sample** builds a kriging surrogate model to approximate the objective value and uses this surrogate model to generate new alternative

configurations at each iteration. The kriging model is continuously updated during the search process.

12 From the **Objective** drop-down list, select the measure of model performance for the tuner to use as the objective function.

13 From the **Event of interest** drop-down list, select the target event to use for calculating the objective function.

Note: This option is available only for nominal targets.

14 Specify the maximum time allowed for the tuner, where the number must be greater than or equal to 1. When this value is reached, the tuner terminates the search and returns results.

15 Select the validation method.

- **Partition** specifies the fraction of all data to be used for validation, where number must be between 0.01 and 0.99, inclusive. If you specify this option, the tuner uses a single partition validation for finding the objective value (validation error estimate). This option might not be advisable for small or unbalanced data tables where the random assignment of the validation subset might not provide a good estimate of error. For large, balanced data tables, a single validation partition is usually sufficient for estimating error; a single partition is more efficient than cross validation in terms of the total execution time.
- **K-fold cross-validation** specifies the number of partition folds in the cross validation process, where the number must be between 2 and 20, inclusive. If you specify this option, the tuner uses cross validation to find the objective value. In cross validation, each model evaluation requires a number of training executions (on number−1 data folds) and a number of scoring executions (on one holdout fold). Thus, the evaluation time is increased by approximately a factor of number. For small to medium data tables or for unbalanced data tables, cross validation provides on average a better representation of error across the entire data table (a better generalization error).

Note: This option is not available if you select the **Validation data** check box on the **Data** tab.

16 (Optional) Select the plots to include in the results.

- misclassifications by number of trees (for a nominal target) or average square error by number of trees (for an interval target)
- variable importance chart

17 Select the **Set number of parallel evaluations** check box to specify the number of evaluations to be performed in parallel, where the number must be greater than or equal to 0, and less than or equal to 32.

18 From the **Evaluation history report** drop-down list, select whether to create and display the result table and log.

19 (Optional) Select the plots to include in the results.

- misclassifications by number of trees (for a nominal target) or average square error by number of trees (for an interval target)
- variable importance chart

You can also specify whether to include these autotune plots in the results: objective history, best objective history, and option values versus objective.

20 (Optional) If two or more input variables are specified, select the interpretability plots to include in the results.

- partial dependence plot
- individual conditional expectation plot

If either plot is selected, you must specify an analysis variable. If the target variable is nominal, you must specify a nominal value of interest.

Step 3: Set the Output Options

On the **Output** tab, you can create these output tables:

- a table of the scored data
- a table of the model data
- a table of the scoring model

For the scored data and the table of the scoring model, you can specify whether to include any variables from the input data set. When naming these tables, you must specify a CAS engine libref.

You can also create these SAS tables:

- a data set of the fit statistics
- a data set of the variable importance

When naming these tables, you must specify a SAS libref.

Note: If you are running the step in a flow, you must add an output port for any optional tables to the Forest node. For more information, see "Forest: Connection Requirements for the Node" on page 1141.

Gradient Boosting

About the Gradient Boosting Step

The Gradient Boosting step produces an ensemble of tree-based statistical models called decision trees for interval or nominal targets. It uses the gradient boosting approach.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Gradient Boosting: Connection Requirements for the Node

In order to run the Gradient Boosting step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input table must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output table is created. No connection is required. You can specify the output tables from the **Output** tab. For more information, see "Step 3: Specify the Output Options" on page 1161. **Note:** You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Examples: Gradient Boosting

Example 1: Interval Target

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS server:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio .

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

proc casutil;
   load data=sashelp.baseball casout="baseball";
run;
```

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Gradient Boosting** to add the step to your flow.

4 Add the MyCas.Baseball table to your flow. Connect the input port of the Gradient Boosting node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Gradient Boosting step, click the Gradient Boosting node.

6 On the **Data** tab, select **Use an interval target**.

7 Assign columns to these roles:

- To the **Interval target** role, assign **logsalary**.
- To the **Interval inputs** role, assign these columns:
  - **nAtBat**
  - **nHits**
  - **nHome**
  - **nRuns**
  - **nRBI**
  - **nBB**
  - **YrMajor**
  - **CrAtBat**

- **CrHits**
- **CrHome**
- **CrRuns**
- **CrRbi**
- **CrBB**
- **nOuts**
- **nAssts**
- **nError**

- To the **Nominal inputs** role, assign the **League** and **Division**.

8 On the **Options** tab, expand the **Plots** section and select the **Misclassifications by number of trees** and **Variable importance chart** check boxes.

9 On the **Output** tab, select **Save scored data**.

10 For the **Include variables from the input CAS table** option, select **Variables used in the analysis**.

11 Add the output table for scored data to the flow.

a Select **Add** ⇨ **Table**.

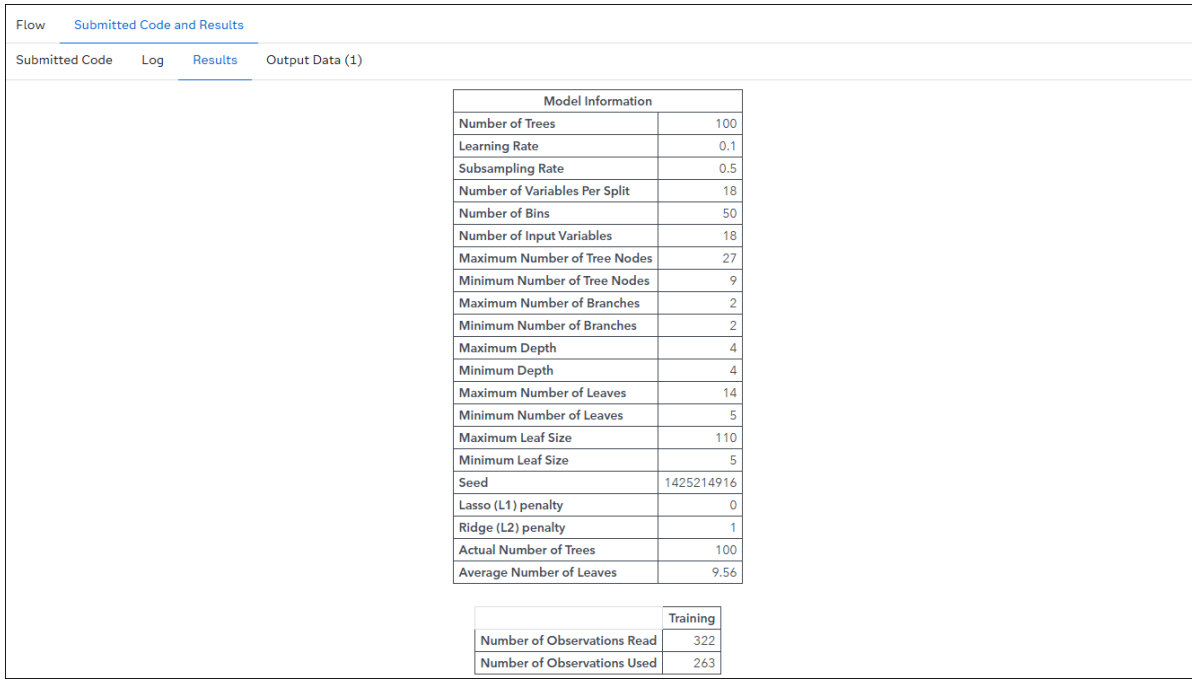
b Select the Table node to enter these table properties. In the **Library** field, enter `MyCas`. In the **Table name** field, enter `Scored_Data`.

c To add an output port to the Gradient Boosting node, right-click the Gradient Boosting node and select **Add output port** ⇨ **Scored Data Table**.

d Connect the new output port to the MyCas.Scored_Data table.

12 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a sample of the results:

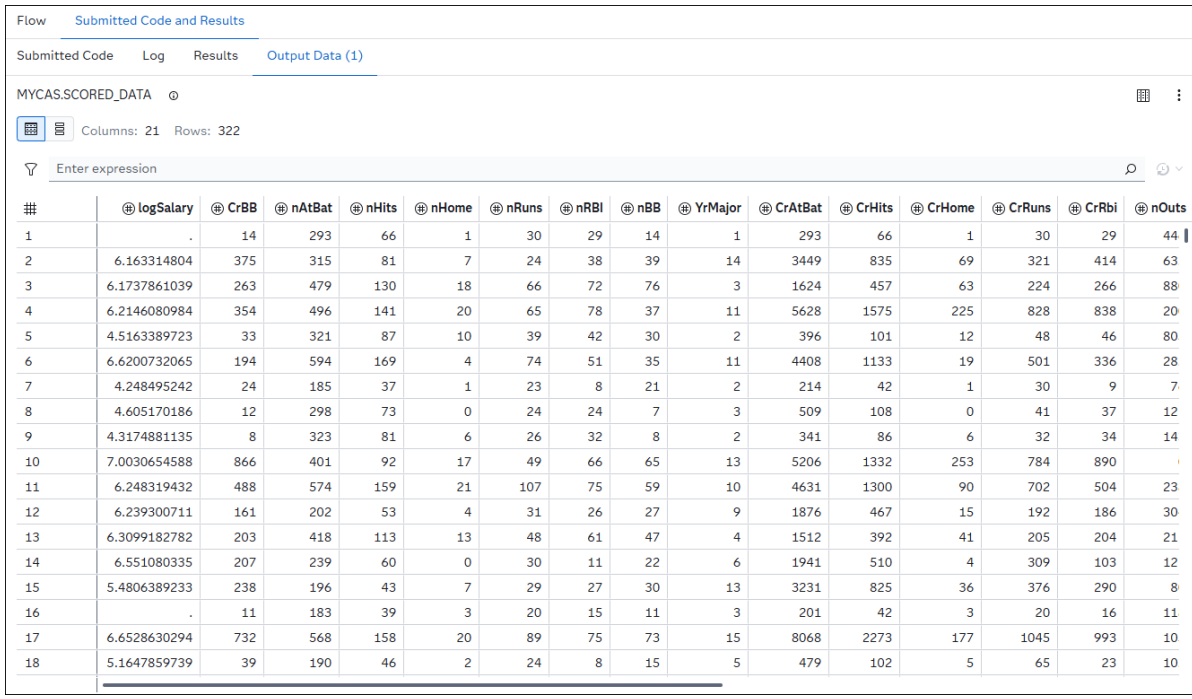


Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

Model Information	
Number of Trees	100
Learning Rate	0.1
Subsampling Rate	0.5
Number of Variables Per Split	18
Number of Bins	50
Number of Input Variables	18
Maximum Number of Tree Nodes	27
Minimum Number of Tree Nodes	9
Maximum Number of Branches	2
Minimum Number of Branches	2
Maximum Depth	4
Minimum Depth	4
Maximum Number of Leaves	14
Minimum Number of Leaves	5
Maximum Leaf Size	110
Minimum Leaf Size	5
Seed	1425214916
Lasso (L1) penalty	0
Ridge (L2) penalty	1
Actual Number of Trees	100
Average Number of Leaves	9.56

	Training
Number of Observations Read	322
Number of Observations Used	263



Flow | Submitted Code and Results

Submitted Code | Log | Results | Output Data (1)

MYCAS.SCORED_DATA

Columns: 21 Rows: 322

Enter expression

	logSalary	CrBB	nAtBat	nHits	nHome	nRuns	nRBI	nBB	YrMajor	CrAtBat	CrHits	CrHome	CrRuns	CrRbi	nOuts
1	.	14	293	66	1	30	29	14	1	293	66	1	30	29	44
2	6.163314804	375	315	81	7	24	38	39	14	3449	835	69	321	414	63
3	6.1737861039	263	479	130	18	66	72	76	3	1624	457	63	224	266	88
4	6.2146080984	354	496	141	20	65	78	37	11	5628	1575	225	828	838	20
5	4.5163389723	33	321	87	10	39	42	30	2	396	101	12	48	46	80
6	6.6200732065	194	594	169	4	74	51	35	11	4408	1133	19	501	336	28
7	4.248495242	24	185	37	1	23	8	21	2	214	42	1	30	9	7
8	4.605170186	12	298	73	0	24	24	7	3	509	108	0	41	37	12
9	4.3174881135	8	323	81	6	26	32	8	2	341	86	6	32	34	14
10	7.0030654588	866	401	92	17	49	66	65	13	5206	1332	253	784	890	
11	6.248319432	488	574	159	21	107	75	59	10	4631	1300	90	702	504	23
12	6.239300711	161	202	53	4	31	26	27	9	1876	467	15	192	186	30
13	6.3099182782	203	418	113	13	48	61	47	4	1512	392	41	205	204	21
14	6.551080335	207	239	60	0	30	11	22	6	1941	510	4	309	103	12
15	5.4806389233	238	196	43	7	29	27	30	13	3231	825	36	376	290	8
16	.	11	183	39	3	20	15	11	3	201	42	3	20	16	11
17	6.6528630294	732	568	158	20	89	75	73	15	8068	2273	177	1045	993	10
18	5.1647859739	39	190	46	2	24	8	15	5	479	102	5	65	23	10

Example 2: Nominal Target

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS server:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio .

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

proc casutil;
   load data=sashelp.iris casout="iris";
run;
```

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Gradient Boosting** to add the step to your flow.

4 Add the MyCas.Iris table to your flow. Connect the input port of the Gradient Boosting node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Gradient Boosting step, click the Gradient Boosting node.

6 On the **Data** tab, select **Use a nominal target**.

7 Assign columns to these roles:

- To the **Nominal target** role, assign **Species**.
- To the **Interval inputs** role, assign these columns:
  - **SepalLength**
  - **SepalWidth**
  - **PetalLength**
  - **PetalWidth**

8 On the **Options** tab, expand the **Plots** section and select the **Misclassifications by number of iterations** and **Variable importance chart** check boxes.

9 On the **Output** tab, select **Save scored data**.

10 For the **Include variables from the input CAS table** option, select **Variables used in the analysis**.

11 Add the output table for scored data to the flow.

a Select **Add** ⇨ **Table**.

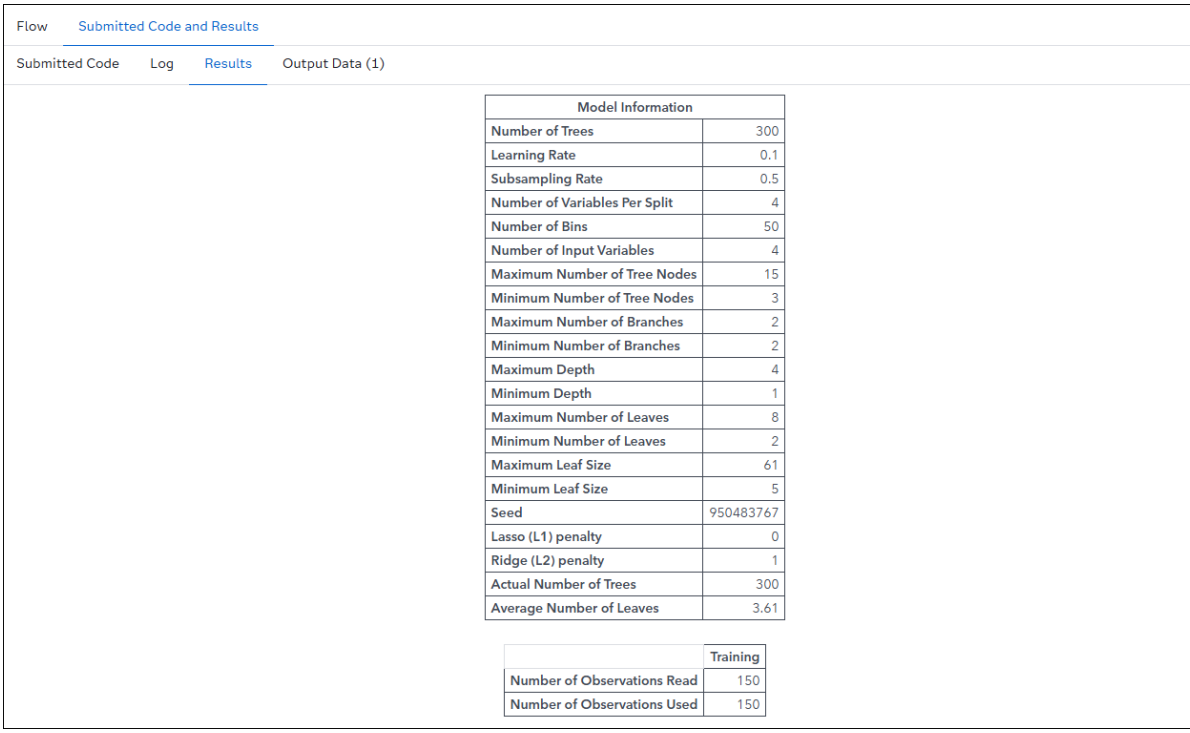
b Select the Table node to enter these table properties. In the **Library** field, enter **`MyCas`**. In the **Table name** field, enter `Scored_Data_Nominal`.

c To add an output port to the Gradient Boosting node, right-click the Gradient Boosting node and select **Add output port** ⇨ **Scored Data Table**.

d Connect the new output port to the MyCas.Scored_Data_Nominal table.

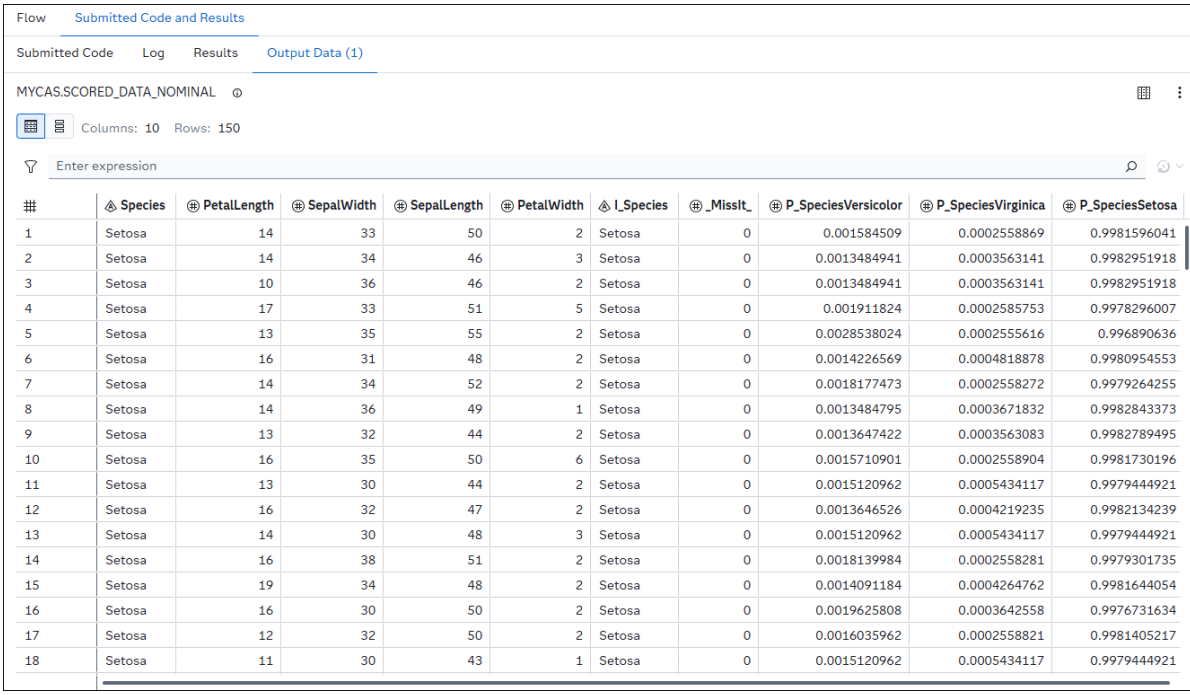
12 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here is a sample of the results:



Model Information	
Number of Trees	300
Learning Rate	0.1
Subsampling Rate	0.5
Number of Variables Per Split	4
Number of Bins	50
Number of Input Variables	4
Maximum Number of Tree Nodes	15
Minimum Number of Tree Nodes	3
Maximum Number of Branches	2
Minimum Number of Branches	2
Maximum Depth	4
Minimum Depth	1
Maximum Number of Leaves	8
Minimum Number of Leaves	2
Maximum Leaf Size	61
Minimum Leaf Size	5
Seed	950483767
Lasso (L1) penalty	0
Ridge (L2) penalty	1
Actual Number of Trees	300
Average Number of Leaves	3.61

	Training
Number of Observations Read	150
Number of Observations Used	150



##	Species	PetalLength	SepalWidth	SepalLength	PetalWidth	I_Species	_MissIt_	P_SpeciesVersicolor	P_SpeciesVirginica	P_SpeciesSetosa
1	Setosa	14	33	50	2	Setosa	0	0.001584509	0.0002558869	0.9981596041
2	Setosa	14	34	46	3	Setosa	0	0.0013484941	0.0003563141	0.9982951918
3	Setosa	10	36	46	2	Setosa	0	0.0013484941	0.0003563141	0.9982951918
4	Setosa	17	33	51	5	Setosa	0	0.001911824	0.0002585753	0.9978296007
5	Setosa	13	35	55	2	Setosa	0	0.0028538024	0.0002555616	0.996890636
6	Setosa	16	31	48	2	Setosa	0	0.0014226569	0.0004818878	0.9980954553
7	Setosa	14	34	52	2	Setosa	0	0.0018177473	0.0002558272	0.9979264255
8	Setosa	14	36	49	1	Setosa	0	0.0013484795	0.0003671832	0.9982843373
9	Setosa	13	32	44	2	Setosa	0	0.0013647422	0.0003563083	0.9982789495
10	Setosa	16	35	50	6	Setosa	0	0.0015710901	0.0002558904	0.9981730196
11	Setosa	13	30	44	2	Setosa	0	0.0015120962	0.0005434117	0.9979444921
12	Setosa	16	32	47	2	Setosa	0	0.0013646526	0.0004219235	0.9982134239
13	Setosa	14	30	48	3	Setosa	0	0.0015120962	0.0005434117	0.9979444921
14	Setosa	16	38	51	2	Setosa	0	0.0018139984	0.0002558281	0.9979301735
15	Setosa	19	34	48	2	Setosa	0	0.0014091184	0.0004264762	0.9981644054
16	Setosa	16	30	50	2	Setosa	0	0.0019625808	0.0003642558	0.9976731634
17	Setosa	12	32	50	2	Setosa	0	0.0016035962	0.0002558821	0.9981405217
18	Setosa	11	30	43	1	Setosa	0	0.0015120962	0.0005434117	0.9979444921

Gradient Boosting: Partitioning Data

When you have sufficient data, you can partition your data into three parts: training data, validation data, and test data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds. Finally, after a model is selected, the test data can be used to assess how the selected model generalizes on data that played no role in selecting the model.

You can partition your data in either of these ways:

- You can specify a proportion of the validation or test data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is a validation or test case, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for validation or test cases. The input data set is divided into partitions by using these values.

Gradient Boosting: Step-by-Step Instructions

Step 1: Assign Data to Roles

1. (Optional) Specify whether you want to partition data.
2. Specify whether to use a nominal target or an interval target in the analysis. Next, assign a variable to the **Nominal target** or **Interval target**.
3. Specify the numeric variables to use as interval inputs. Select the **Number of bins for interval inputs** check box to specify the number of bins. By default, the number of bins for interval inputs is `50`.
4. Specify the numeric or character variables to use as nominal inputs.

Step 2: Select the Options

On the **Options** tab, you can specify whether the step uses an optimization search process to select the best value for any specified autotune options.

These options are available if you are not using autotuning:

1. For the **Lasso regularization** option, specify the L1 norm regularization parameter. The default value is `0`.
2. For the **Ridge regularization** option, specify the L2 norm regularization parameter. The default value is `1`.
3. For the **Sampling proportion of training observations for each iteration** option, specify the proportion of sampling without replacement for each iteration. The default value is `0.5`.
4. Specify the learning rate for creating a tree. The default value is `0.1`.
5. Specify the number of trees. The default value is `100`.
6. From the **Number of inputs considered for splitting a node** drop-down list, select whether to consider all of the inputs or specified number of inputs for splitting a node.
7. Specify the maximum depth of a tree. The default value is `4`.
8. Specify the minimum number of observations for a leaf. The default value is `5`.
9. Specify the maximum number of branches for a node. The default value is `2`.
10. (Optional) Expand the **Sampling** heading, and specify a random number seed for sampling.
11. Select the plots to include in the results.
    - misclassification by number of trees (for a nominal target) or average square error by number of trees (for an interval target)
    - variable importance chart

    If two or more input variables are specified, you can include these plots:

    - partial dependence plot
    - individual conditional expectation plot

    If either plot is selected, you must specify an analysis variable. If the target variable is interval, you must specify the maximum number of levels. If the target variable is nominal, you must specify the number of bins.

If you select the **Automatically tune selected options** check box, these options are available:

1. For the **Autotune LASSO regularization** option, specify the L1 norm regularization parameter. The initial value is `0`.
2. For the **Autotune ridge regularization** option, specify the L2 norm regularization parameter. The initial value is `1`.
3. For the **Autotune sampling proportion** option, specify the proportion of the sample for each iteration. The initial value is `0.5`.
4. Specify the autotune learning rate for creating a tree. The default value is `0.1`.
5. Specify the number of trees. The initial value is `100`.

6 Specify the number of inputs. The initial value is `100`. The initial value, the lower bound, and the upper bound cannot be greater than the total number of input variables that you selected.

7 Specify the maximum depth of a tree. The default value is `4`.

8 Specify the minimum number of observations for a leaf. The default value is `5`.

9 Specify the maximum number of branches for a node. The default value is `2`.

10 (Optional) Expand the **Sampling** heading and specify a random number seed for sampling.

11 Under the **Autotune Settings** heading, select the search method to use for tuning. Here are the valid values:

- **Genetic algorithm** uses an initial Latin hypercube sample that seeds a genetic algorithm to generate a population of alternative configurations at each iteration. You can also specify these settings: the maximum iterations, the maximum evaluations, and the evaluations per iteration.
- **Latin hypercube sample** uses a Latin hypercube to generate a single sample of configurations that is uniform in each tuning parameter, but random in combinations. You must specify the sample size.
- **Random sample** generates a single sample of purely random configurations. You must specify the sample size.
- **Bayesian sample** builds a kriging surrogate model to approximate the objective value and uses this surrogate model to generate alternative configurations at each iteration. The kriging model is continuously updated during the search process.

12 For the **Objective** option, specify which measure of model performance the tuner uses as the objective function.

13 Specify the target event to use for calculating the objective function.

Note: This option is available only for nominal targets.

14 Specify the maximum time allowed for the tuner, where the value must be greater than or equal to 1. When this value is reached, the tuner terminates the search and returns results.

15 Specifies whether to use a partition or k-fold cross validation as the validation method.

- **Partition** specifies the fraction of all data to be used for validation, where number must be between 0.01 and 0.99, inclusive. If you specify this option, the tuner uses a single partition validation for finding the objective value (validation error estimate). This option might not be advisable for small or unbalanced data tables where the random assignment of the validation subset might not provide a good estimate of error. For large, balanced data tables, a single validation partition is usually sufficient for estimating error; a single partition is more efficient than cross validation in terms of the total execution time.

- **K-fold cross-validation** specifies the number of partition folds in the cross validation process, where number must be between 2 and 20, inclusive. If you specify this option, the tuner uses cross validation to find the objective value. In cross validation, each model evaluation requires number of training executions (on number–1 data folds) and number of scoring executions (on one holdout fold). Thus, the evaluation time is increased by approximately a factor of number. For small to medium data tables or for unbalanced data tables, cross validation provides on average a better representation of error across the entire data table (a better generalization error).

Note: This option is not available if you select the **Validation data** check box on the **Data** tab.

16 Specify the number of evaluations to be performed in parallel, where the number must be greater than or equal to 0, and less than or equal to 32.

17 Select the contents of the evaluation history report. By default, the result table is included in the report.

18 Select the plots to include in the results.

- misclassification by number of trees (for a nominal target) or average square error by number of trees (for an interval target)
- variable importance chart

You can also specify whether to include these autotune plots in the results: objective history, best objective history, and option values versus objective.

If two or more input variables are specified, you can include these plots:

- partial dependence plot
- individual conditional expectation plot

If either plot is selected, you must specify an analysis variable. If the target variable is nominal, you must specify a nominal value of interest.

Step 3: Specify the Output Options

On the **Output** tab, you can specify whether to create these CAS tables:

- a table of the scored data
- a table of the model data
- a table of the scoring model

For the scored data and the table of the scoring model, you can specify whether to include any variables from the input data set. When naming these tables, you must specify a CAS engine libref.

Note: If you are running the step in a flow, you must add an output port for each output table to the Gradient Boosting node. For more information, see "Gradient Boosting: Connection Requirements for the Node" on page 1152.

You can also specify whether to create these SAS data sets:

- a data set of the fit statistics
- a data set of the variable importance measures

When naming these data sets, you must specify a SAS libref. By default, these data sets are saved in the Work library. If you want to save them permanently, you must add an output port for each output table to the Gradient Boosting node.

Market Basket Analysis

About the Market Basket Analysis Step

The Market Basket Analysis step performs association rule mining on a transaction data set.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Market Basket Analysis: Connection Requirements for the Node

In order to run the Market Basket Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. - Table node or	By default, no output data is created. However, you must create an output table that contains either the frequent item sets data, the unique frequent items data, or the rule data.

Input Port	Output Port
■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	On the **Output** tab, you can select the output tables. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1168. **Note:** To run the step in a flow, you must add an output table and connect this table to the Market Basket Analysis node. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Market Basket Analysis Step

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio .

2 Enter this code on a **SAS Program** tab:

```
libname mycas cas;

data mycas.assocs;
   set sampsio.assocs;
run;

data mycas.firstLevel;
  length Item $20 Category $20;
    Item='apples'; Category='Fruits'; output;
    Item='artichok'; Category='Vegetables'; output;
    Item='avocado'; Category='Fruits'; output;
    Item='baguette'; Category='Bread'; output;
    Item='bordeaux'; Category='Wine'; output;
    Item='bourbon'; Category='Whisky'; output;
    Item='chicken'; Category='Non-Veg'; output;
    Item='coke'; Category='Cold-Drink'; output;
    Item='corned_b'; Category='Non-Veg'; output;
    Item='cracker'; Category='Vegetables'; output;
    Item='ham'; Category='Non-Veg'; output;
    Item='heineken'; Category='Beer'; output;
```

```
    Item='hering'; Category='Non-Veg'; output;
    Item='ice_crea'; Category='Cold-Drink'; output;
    Item='olives'; Category='Vegetables'; output;
    Item='peppers'; Category='Fruits'; output;
    Item='sardines'; Category='Non-Veg'; output;
    Item='soda'; Category='Cold-Drink'; output;
    Item='steak'; Category='Non-Veg'; output;
    Item='turkey'; Category='Non-Veg'; output;
 run;

data mycas.secondLevel;
  length Category $20 Dept $20;
    Category='Fruits'; Dept='Breakfast'; output;
    Category='Vegetables'; Dept='Breakfast'; output;
    Category='Bread'; Dept='Breakfast'; output;
    Category='Wine'; Dept='Drinks'; output;
    Category='Whisky'; Dept='Drinks'; output;
    Category='Non-Veg'; Dept='Breakfast'; output;
    Category='Cold-Drink'; Dept='Drinks'; output;
    Category='Beer'; Dept='Drinks'; output;
 run;
```

Run this code to create the MyCas.Assocs, MyCas.FirstLevel, and MyCas.SecondLevel tables.

Note: Depending on the SAS product licensing at your site, you might not have access to the sampsio library. If you do not have access to this library, you will see an error.

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Market Basket Analysis** to add the step to your flow.

4 Add the MyCas.Assocs table to your flow. Connect the input port of the Market Basket Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Market Basket Analysis step, click the Market Basket Analysis node.

6 On the **Data** tab, assign variables to these roles:

- To the **Item variable** role, assign **Product**.
- To the **Basket ID variable** role, assign **Customer**.

7 Select **Product hierarchy lowest level**. Now you need to specify the input data.

a Add the **MyCas.FirstLevel** table to your flow.

b Right-click the Market Basket Analysis node and select **Add input port** ⇨ **Lowest Level Data**.

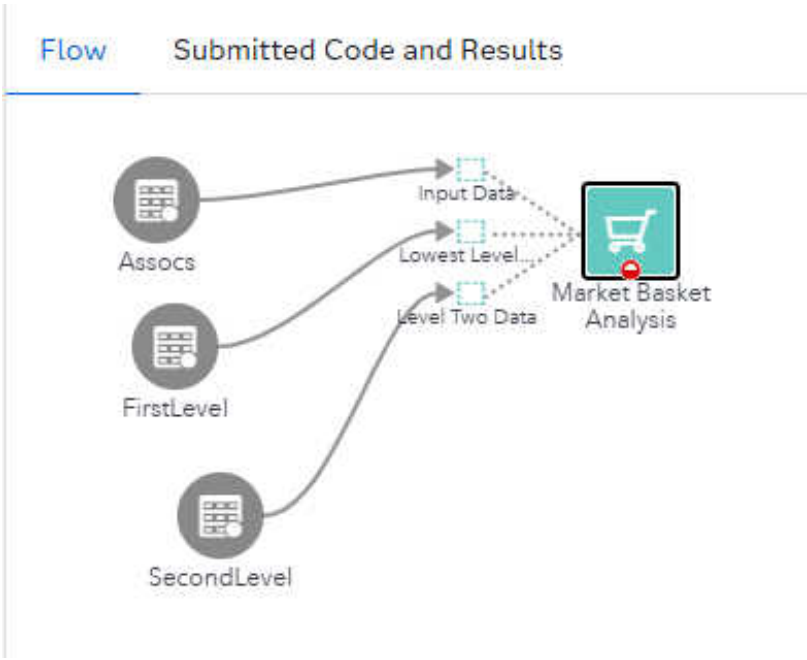
c Connect the input port for Lowest Level Data to the MyCas.FirstLevel table.

8 Select the Market Basket Analysis node again. On the **Data** tab, select **Product hierarchy level two**. Now you need to specify the input data.

a Add the **MyCas.SecondLevel** table to your flow.

b Right-click the Market Basket Analysis node and select **Add input port** ⇨ **Level Two Data**.

c Connect the input port for Level Two Data to the MyCas.SecondLevel table.



9 On the **Output** tab, select **Save rule data**.

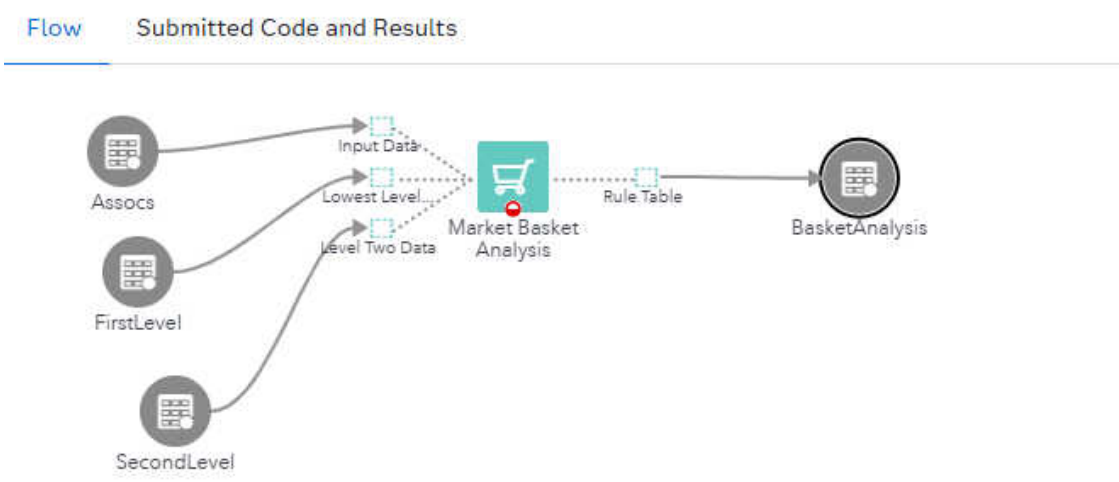
10 Add the output table for rule data to the flow.

a Select **Add** ⇨ **Table**.

b Select the Table node to enter these table properties. In the **Library** field, enter **`MyCas`**. In the **Table name** field, enter `BasketAnalysis`.

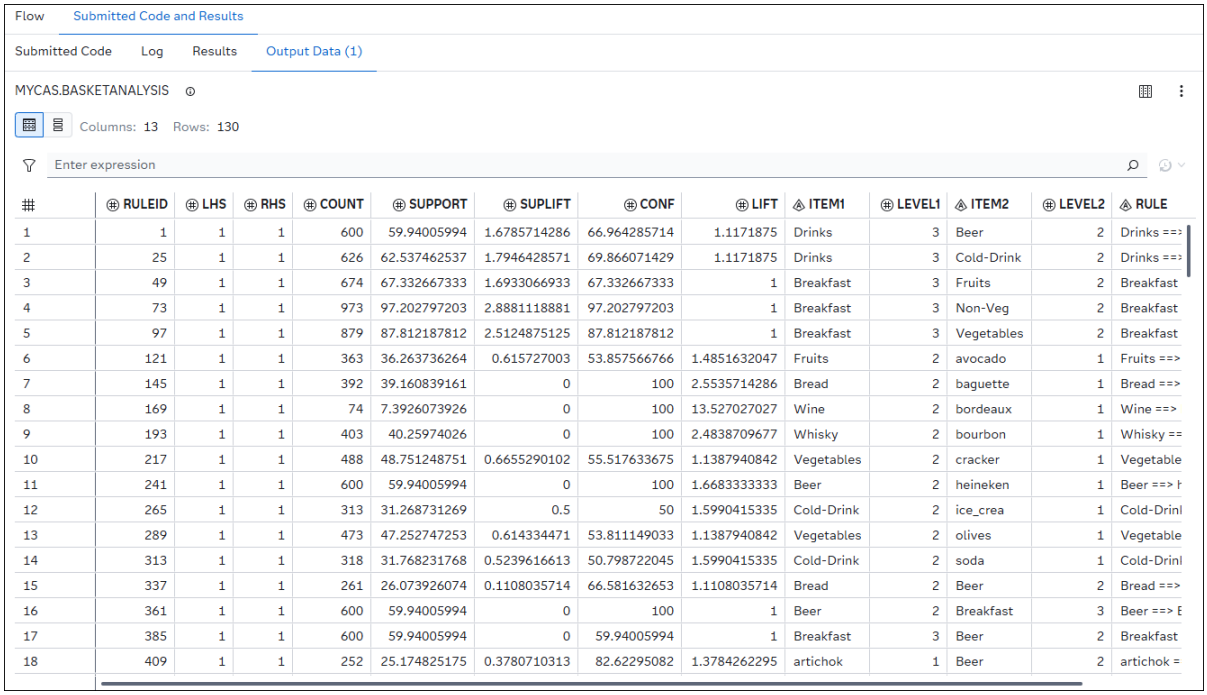
c To add an output port to the Market Basket Analysis node, right-click the Market Basket Analysis node and select **Add output port** ⇨ **Rule Table**.

d Connect the new output port to the MyCas.BasketAnalysis table.



11 Run the flow.

Click the **Submitted Code and Results** tab to view the output data.



#	RULEID	LHS	RHS	COUNT	SUPPORT	SUPLIFT	CONF	LIFT	ITEM1	LEVEL1	ITEM2	LEVEL2	RULE
1	1	1	1	600	59.94005994	1.6785714286	66.964285714	1.1171875	Drinks	3	Beer	2	Drinks ==>
2	25	1	1	626	62.537462537	1.7946428571	69.866071429	1.1171875	Drinks	3	Cold-Drink	2	Drinks ==>
3	49	1	1	674	67.332667333	1.6933066933	67.332667333	1	Breakfast	3	Fruits	2	Breakfast
4	73	1	1	973	97.202797203	2.8881118881	97.202797203	1	Breakfast	3	Non-Veg	2	Breakfast
5	97	1	1	879	87.812187812	2.5124875125	87.812187812	1	Breakfast	3	Vegetables	2	Breakfast
6	121	1	1	363	36.263736264	0.615727003	53.857566766	1.4851632047	Fruits	2	avocado	1	Fruits ==>
7	145	1	1	392	39.160839161	0	100	2.5535714286	Bread	2	baguette	1	Bread ==>
8	169	1	1	74	7.3926073926	0	100	13.527027027	Wine	2	bordeaux	1	Wine ==>
9	193	1	1	403	40.25974026	0	100	2.4838709677	Whisky	2	bourbon	1	Whisky ==
10	217	1	1	488	48.751248751	0.6655290102	55.517633675	1.1387940842	Vegetables	2	cracker	1	Vegetable
11	241	1	1	600	59.94005994	0	100	1.6683333333	Beer	2	heineken	1	Beer ==> H
12	265	1	1	313	31.268731269	0.5	50	1.5990415335	Cold-Drink	2	ice_crea	1	Cold-Drinl
13	289	1	1	473	47.252747253	0.614334471	53.811149033	1.1387940842	Vegetables	2	olives	1	Vegetable
14	313	1	1	318	31.768231768	0.5239616613	50.798722045	1.5990415335	Cold-Drink	2	soda	1	Cold-Drinl
15	337	1	1	261	26.073926074	0.1108035714	66.581632653	1.1108035714	Bread	2	Beer	2	Bread ==>
16	361	1	1	600	59.94005994	0	100	1	Beer	2	Breakfast	3	Beer ==> E
17	385	1	1	600	59.94005994	0	59.94005994	1	Breakfast	3	Beer	2	Breakfast
18	409	1	1	252	25.174825175	0.3780710313	82.62295082	1.3784262295	artichok	1	Beer	2	artichok =

Market Basket Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Item variable** role, assign the variable that contains the items in the basket.

3 To the **Basket ID variable** role, assign the variable to use to uniquely identify a basket.

4 For the Product Hierarchy Level options, specify the CAS tables to use as the first through fifth levels in the hierarchy. After you select the check box for the level, complete these steps:

   a Add the input data table to your flow.

   b Right-click the Market Basket Analysis node and select **Add input port** ⇨ ***name-of-input-port-for-the-selected-level***.

   c Connect the new input port to the input table.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 In the **Minimum level of support (frequency)** option, specify the minimum number of transactions that contain the items in a potential rule.

2 In the **Minimum level of support (percentage)** option, specify the minimum percentage of transactions that contain the items in a potential rule. The default value is `1`.

3 In the **Minimum confidence (percentage)** option, specify the minimum percentage value that shows how frequently the rule occurs among all the transactions containing the left side of the potential rule. The default value is `50`.

4 In the **Minimum lift (correlation)** option, specify the minimum lift of a rule. The default value is `1`.

5 In the **Minimum support lift** option, specify the minimum support lift of a rule. The default value is `0`.

6 Set the options for the rule size:

   - Specify the minimum number of items that are allowed on both sides of a potential rule. The default value is `2`.
   - Specify the range for the number of items that are allowed in the left side and the right side of a potential rule.

7 Set the options for the rule form.

   - Specify the patterns that must appear in the left side and the right side of a potential rule.

Note: Patterns must be specified using the syntax of an ICU regular expression. For more information, see Regular Expressions in the ICU Documentation.

- Specify the ASCII character that is used to separate items in both sides of a potential rule.
- Specify whether to normalize item values in output tables.

8 For the basket size, specify the minimum and maximum number of items in a basket. The default minimum value is `1`. The default maximum value is `1,000`.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 Specify whether to create these output tables. You must select at least one table. All output tables must use a CAS engine libref.
   - a CAS table that contains the frequent items sets information
   - a CAS table that contains unique frequent items
   - a CAS table that contains mined rules

2 (Optional) Specify whether to create an output table that contains the scored model data.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Market Basket Analysis node. For more information, see "Market Basket Analysis: Connection Requirements for the Node" on page 1162.

Moving Window Principal Component Analysis

About the Moving Window Principal Component Analysis Step

The Moving Window Principal Component Analysis step can be used to assess how principal components change over time.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Moving Window Principal Component Analysis: Connection Requirement for the Node

In order to run the Moving Window Principal Component Analysis step, you must connect a table to the input node.

Input Port	Output Port
For the Moving Window Principal Component Analysis node, the input data source must be a CAS table. ■ Table node or ■ Operational node that creates an output table, such as a Query node, a SAS Program node, or an Import node	By default, no output tables are created, and no connection is required. However, on the **Output** tab, you can specify whether to create an output data table. This table must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1172. To run this step in a flow, you must add an output port for this optional table. To add an output port, right-click the Moving Window Principal Component Analysis node, select **Add output port**. For this step to run, the output data must use a CAS engine library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Moving Window Principal Component Analysis

1 Run this code to create the MyCas.Iris table.

```
libname mycas cas;
data mycas.iris;
   set sashelp.iris;
   id = _n_;
run;
```

2 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Moving Window Principal Component Analysis** to add the step to your flow.

3 Add the MyCas.Iris table to your flow. Connect the input port of the Moving Window Principal Component Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Moving Window Principal Component Analysis step, click the Moving Window Principal Component Analysis node.

5 On the **Data** tab, select **Use all numeric variables as inputs**.

6 To the **ID variable** role, assign **id**.

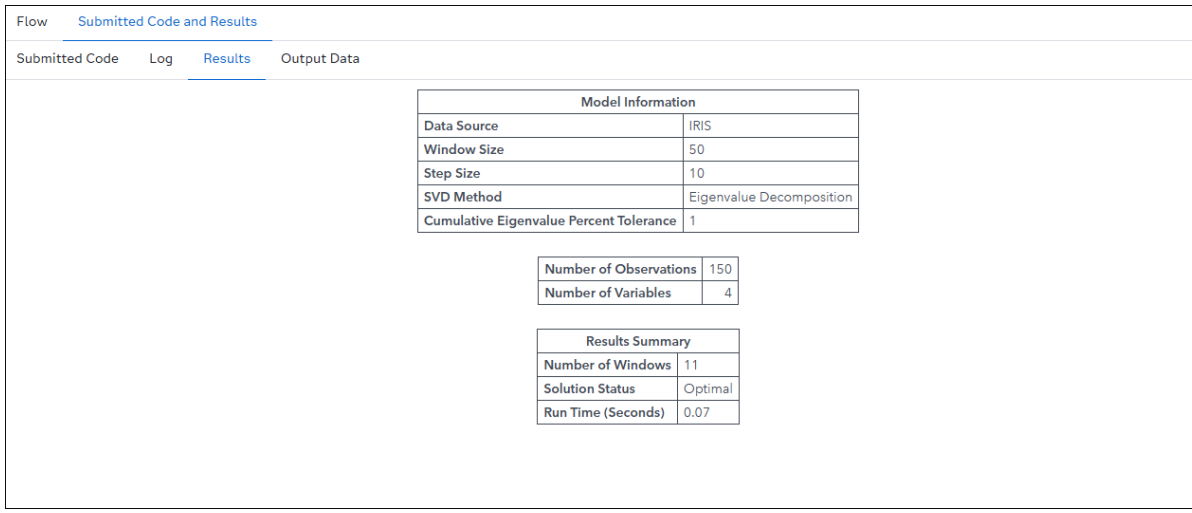
7 On the **Options** tab, complete these steps:

   a Enter `10` as the step size.

   b Enter `50` as the window size.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Moving Window Principal Component Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Moving Window Principal Component Analysis step, the input data source must be a CAS table.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Specify the variables to use in the analysis. You can choose to use all the numeric variables from the input data table as input, or you can select the variables to use as interval inputs.

3 To the **ID variable** role, assign the ID variable for the analysis. The values of the ID variable must be unique with a common difference.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Use the **Step size** option to specify the observation log between two consecutive windows.

2 Use the **Window size** option to specify the number of observations in each window.

3 (Optional) Specify the SVD maximum rank.

4 (Optional) Specify whether to center the observations by the mean of each column.

5 (Optional) Specify whether to use robust PCA. If you select **Use robust PCA**, you can set these options:

- **Method** specifies the algorithm to use to find the low-rank and sparse matrices: Augmented Lagrangian Multiplier or Accelerated Proximal Gradient.
- **Lambda** specifies whether to use the computed value for lambda or a custom value. The default value is computed by $\frac{1}{\sqrt{n}}$, where n is the number of observations in the input data. If the number of variables in the input data is more than the number of observations, n is the number of variables. The bigger the value of lambda, the more sparse the sparse matrix is.
- **Lambda weight** specifies whether to use 1 as the lambda weight or a custom value. You can use this value to control the sparsity of the sparse matrix.
- **Maximum number of iterations** specifies the maximum number of iterations to run in the analysis. The default value is `1000`.
- **Tolerance** specifies the convergence criterion for the algorithms. The default value is `1e-7`.
- If you selected **Accelerated Proximal Gradient** as the method, you can also specify these options:
  - **Mu** specifies the initial value for the μ parameter. The default value is `0.001`.
  - **Use fixed value for Mu** specifies whether to keep the value of μ fixed in each iteration of RPCA. If this option is unchecked, the value of μ is

updated dynamically in each iteration. By default, this option is unchecked.

Step 3: Set the Output Options

On the **Output** tab, you can set these options:

1 (Optional) Specify whether to create a table that contains the results of the analysis. When naming the table, you must specify a CAS engine libref. You can choose to replace an existing output table with the same name.

Note: If you are running the step in a flow, you must add an output port to the Moving Window Principal Component Analysis node. For more information, see "Moving Window Principal Component Analysis: Connection Requirement for the Node" on page 1169.

2 (Optional) Specify whether to standardize the output principal components.

3 Specify the number of principal components to display for each window in the output table. The default is 1.

Neural Network

About the Neural Network Step

The Neural Network step creates a multilayer perceptron neural network. You can create networks with up to 10 hidden layers.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Neural Network: Connection Requirements for the Node

In order to run the Neural Network step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create several output tables. These tables must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1124. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Neural Network of the Iris Data Set

To create this example:

1 On a **SAS program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio .

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.iris;
   set sashelp.iris;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Neural Network** to add the step to your flow.

4 Add the MyCas.Iris table to your flow. Connect the input port of the Neural Network node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Neural Network step, click the Neural Network node.

6 On the **Data** tab, select **Use a nominal target**.

7 To the **Nominal target** role, assign **Species**.

8 To the **Interval inputs** role, assign these columns:

- **SepalLength**
- **SepalWidth**
- **PetalLength**
- **PetalWidth**

9 Click the **Options** tab. In the first row of the **Include hidden layers** table, enter `2` as the number of neurons.

10 On the **Output** tab, select **Save scored data**.

Add an output table to the flow.

a Select **Add** ⇨ **Table**.

b Select the Table node. In the Table Properties, enter **`MyCas`** as the library name and **`Nnet_scores`**.

c Right-click the Neural Network node and select **Add output port** ⇨ **Scored Data Table**.

d Connect the new output port to the MyCas.Nnet_scores table.

11 Select the Neural Network node in the flow. On the **Output** tab, select **Save model parameters**.

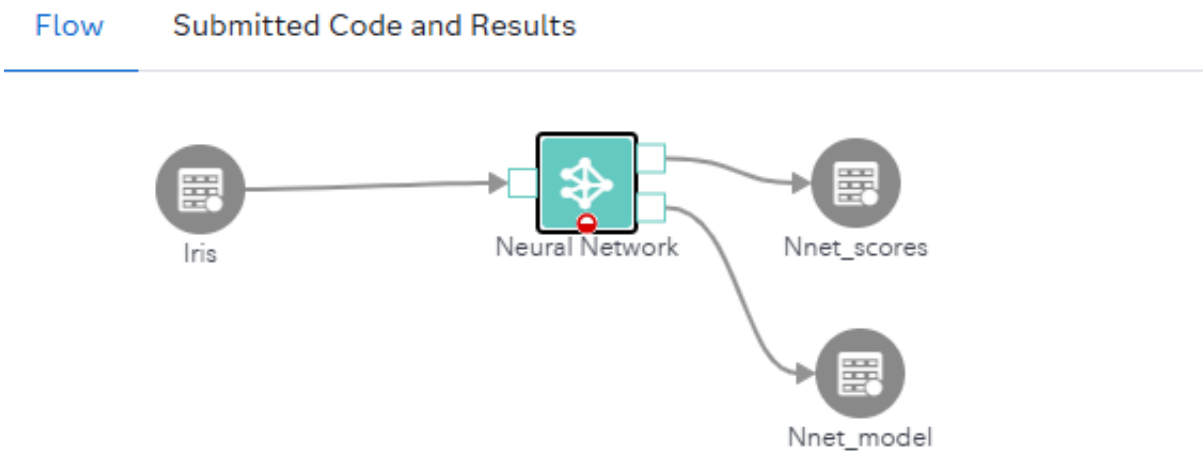
Add an output table to the flow.

a Select **Add** ⇨ **Table**.

b Select the Table node. In the Table Properties, enter **`MyCas`** as the library name and **`Nnet_model`** as the table name.

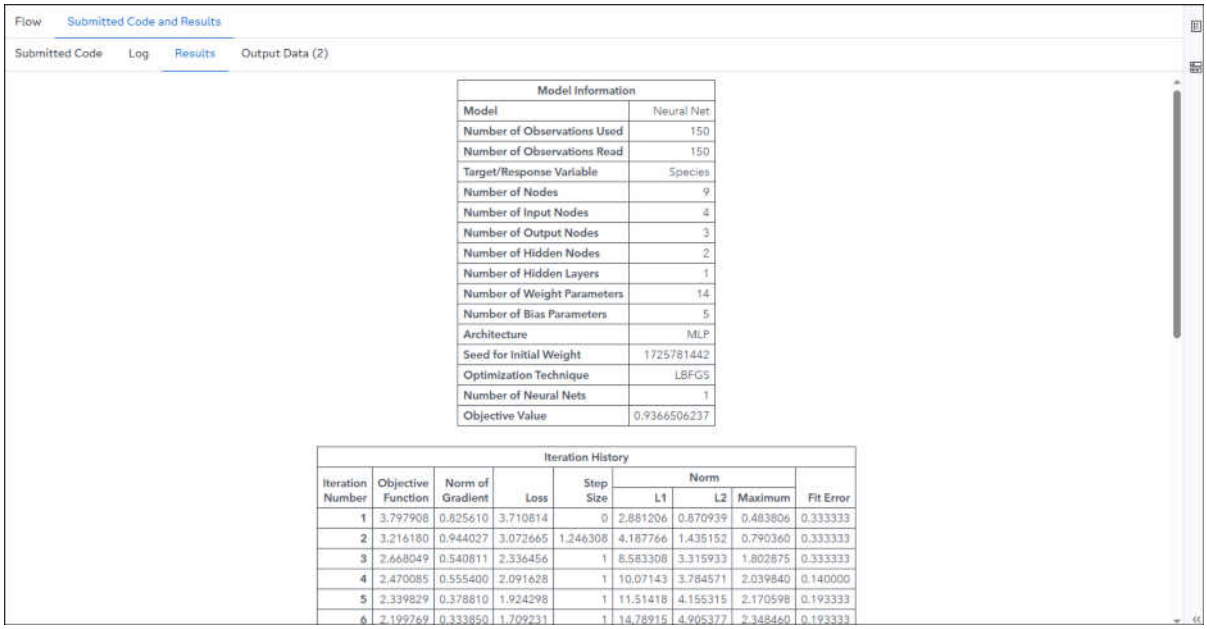
c Right-click the Neural Network node and select **Add output port** ⇨ **Model Parameters Table**.

d Connect the new output port to the MyCas.Nnet_model table.



12 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Model Information

Model	Neural Net
Number of Observations Used	150
Number of Observations Read	150
Target/Response Variable	Species
Number of Nodes	9
Number of Input Nodes	4
Number of Output Nodes	3
Number of Hidden Nodes	2
Number of Hidden Layers	1
Number of Weight Parameters	14
Number of Bias Parameters	5
Architecture	MLP
Seed for Initial Weight	1725781442
Optimization Technique	LBFGS
Number of Neural Nets	1
Objective Value	0.9366506237

Iteration History

Iteration Number	Objective Function	Norm of Gradient	Loss	Step Size	Norm			Fit Error
					L1	L2	Maximum	
1	3.797908	0.825610	3.710614	0	2.881206	0.870939	0.483806	0.333333
2	3.216180	0.944027	3.072665	1.246308	4.187766	1.435152	0.790360	0.333333
3	2.668049	0.540811	2.336456	1	8.583308	3.315933	1.802875	0.333333
4	2.470085	0.555400	2.091628	1	10.07143	3.784571	2.039840	0.140000
5	2.339829	0.378810	1.924298	1	11.51418	4.155315	2.170598	0.193333
6	2.199769	0.333850	1.709231	1	14.78915	4.905377	2.348460	0.193333

Partitioning Data

When you have sufficient data, you can partition your data into three parts: training data, validation data, and test data. During the selection process, models are fit on the training data, and the prediction error for the model is determined using the validation data. This prediction error can be used to decide when to terminate the selection process or which effects to include as the selection process proceeds. Finally, after a model is selected, the test data can be used to assess how the

selected model generalizes on data that played no role in selecting the model. You can partition your data in either of these ways:

- You can specify a proportion of the validation or test data. The proportions are used to divide the input data by sampling. You can also specify whether to use a random seed to determine the start of this proportion.
- If the input data set contains a variable whose values indicate whether an observation is a validation or test case, you can specify the variable to use when partitioning the data. When you specify the variable, you also select the appropriate values for validation or test cases. The input data set is divided into partitions by using these values.

Neural Network: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) Specify whether to partition the data.

2 Specify the type of target. You can choose from these options:

- **Use a nominal target** specifies to use a nominal target in the analysis. Assign a numeric or character variable to the **Nominal target** role.
- **Use an interval target** specifies to use an interval target in the analysis. Assign a numeric variable to the **Interval target** role.

  Select the distribution and activation function for an interval target.

  - If you select the gamma or Poisson distribution, an exponential activation function is used.
  - If you select a normal distribution, the identity activation function is used by default.
- **Train as an autoencoder** specifies a neural network that is used for efficient codings and widely used for feature extraction and nonlinear principal component analysis. Architecturally, an autoencoder is similar to a multilayer perceptron neural network because it has an input layer, hidden layers, and an output layer. However, it differs in that the output layer is duplicated from the input layer. Therefore, autoencoders are unsupervised learning models.

3 To the **Interval inputs** role, assign the numeric variables to use as interval inputs.

4 To the **Nominal inputs** role, assign the numeric or character variables to use as nominal inputs.

Step 2: Set the Options

No Autotuning

On the **Options** tab, these options are available if you do not select the **Automatically tune selected options** check box.

1 Specify whether to include missing values. Missing values of nominal inputs are treated as a level of the variable. Missing values of interval inputs are replaced with the mean.

2 Specify whether to use a standardization method for an interval input. By default, the midrange is the standardization method.

Note: This option is available only if you have an interval input.

3 Specify whether to include hidden layers. If you select this option, one hidden layer is used by default. You can have a maximum of 10 hidden layers. If you have more than five hidden layers, the CAS procedure is used for code generation.

   a Specify the number of neurons in the hidden layer. The default value is `50`.

   b Specify the activation function. The default function is the hyperbolic tangent.

   c (Optional) Allow direct connections between the input and target neurons.

   Note: This option is available only if you specify one to five hidden layers.

4 (Optional) Specify the training details.

   a Specify the number of times to train the network. The default value is `1`.

   Note: This option is available for zero to five hidden layers.

   b Specify the random seed.

   Note: When you specify a random seed, you might not be able to replicate results in a distributed computing environment.

   c To the **Prediction error weights** role, assign the weight variable to use.

5 (Optional) Expand the **Optimization** heading to specify the optimization method. The default method is **LBFGS** (Limited-memory BFGS).

- The LBFGS method is available only when you have zero to two hidden layers.
- If you specify more than three hidden layers, the Stochastic gradient descent (SGD) method becomes the default method.

If you select **LBFGS** as the optimization method, set these options.

a Specify the L1 norm regularization parameter. The default value is `0`.

b Specify the L2 norm regularization parameter. The default value is `0.1`.

c Specify the maximum time in seconds.

d Specify the maximum number of iterations.

If you select **SGD** as the optimization method, set these options:

a Specify the L1 norm regularization parameter. The default value is `0`.

b Specify the L2 norm regularization parameter. The default value is `0.1`.

c For the **Input layer dropout ratio** option, specify a value between 0 and 1 (inclusive). The default value is `0`.

Note: This option is available only for the Stochastic gradient descent (SGD) method.

d For the **Hidden layer dropout ratio** option, specify a value between 0 and 1 (inclusive). The default value is `0`.

Note: This option is available only for the Stochastic gradient descent (SGD) method.

e Specify the learning rate. The initial value is `0.001`.

Note: This option is available only for the Stochastic gradient descent (SGD) method.

f For the **Maximum epochs** option, specify a value greater than or equal to 1. The default value is `10`.

Note: This option is available only for the Stochastic gradient descent (SGD) method and only if you specify 6 to 10 hidden layers.

g Specify the annealing rate. The initial value is `0.000001`.

Note: This option is available only for the Stochastic gradient descent (SGD) method.

h For the **Momentum** option, specify a value between 0 and 1 (inclusive). The default value is `0`.

Note: This option is available only for the Stochastic gradient descent (SGD) method and only for zero to five hidden layers.

i For the **Minibatch size** option, specify a value between 1 and 20,000 (inclusive). The default value is `50`.

Note: This option is available only for the Stochastic gradient descent (SGD) method and only if you specify 0 to 10 hidden layers.

j Specify the maximum time in seconds.

Note: This option is available only if you specify zero to five hidden layers.

k Specify the maximum number of iterations.

Note: This option is available only if you specify zero to five hidden layers.

l (Optional) Set these advanced options if your neural network contains six or more hidden layers.

- From the **SGD Algorithm** option, specify whether to use the SGD, Adam SGD, or Momentum SGD algorithm.
- For the **First exponential decay rate** option, specify a value between 0 and 1 (inclusive). The default value is `0.9`.

  Note: This option is available only for the Adam SGD algorithm.
- For the **Second exponential decay rate** option, specify a value between 0 and 1 (inclusive). The default value is `0.999`.

  Note: This option is available only for the Adam SGD algorithm.
- For the **Momentum** option, specify a value between 0 and 1. The default value is `0.9`.

  Note: This option is available only for the Momentum SGD algorithm.
- For the **Minimum gradient value** option, specify a value less than or equal to 0. The default value is `0`.
- For the **Maximum gradient value** option, specify a value greater than or equal to 0. The default value is `0`.
- Specify the learning rate policy. Here are the available options:
  - **Fixed decay** specifies a fixed learning rate.

    Inverse decay. You can specify a gamma value or a power value. The gamma value must be between 0 and 1 (inclusive), and the default

value is `0.1`. The power value must be between 0 and 100 (inclusive), and the default value is `0.75`.

- **Polynomial decay**. For the power, you can specify a value between 0 and 100 (inclusive), and the default value is `0.75`.
- **Step down**. You can specify a gamma value and a step size. The gamma value must be between 0 and 1 (inclusive), and the default value is `0.1`. The step size must be an integer between 1 and 100 (inclusive). The default value is `10`.

6 Specify whether to generate the code for the step using either the NNET procedure or the CAS procedure.

Autotuning Options

If you select the **Automatically tune selected options** check box, the step uses an optimization search process to select the best value for any specified autotune options. In the user interface, autotuning is identified by the **Autotune** `option-name` check box. For each autotune option, you can specify an initial value, a lower bound, and an upper bound for the search process.

1 Specify whether to include missing values. Missing values of nominal inputs are treated as a level of the variable. Missing values of interval inputs are replaced with the mean.

2 Specify whether to use a standardization method for an interval input. By default, the midrange is the standardization method.

Note: This option is available only if you have an interval input.

3 Specify whether to autotune the hidden layers. No hidden layers are included by default. You can have a maximum of 10 hidden layers. If you have more than five hidden layers, the CAS procedure is used for code generation.

Specify the number of neurons in the hidden layer.

4 (Optional) Specify the training details.

a Specify the number of times to train the network. The default value is `1`.

Note: This option is available for zero to five hidden layers.

b Specify the random seed.

Note: When you specify a random seed, you might not be able to replicate results in a distributed computing environment.

c To the **Prediction error weights** role, assign the weight variable to use.

5 (Optional) Expand the **Optimization** heading to specify the optimization method. The default method is **LBFGS** (Limited-memory BFGS).

- The LBFGS method is available only when you have zero to two hidden layers.
- If you specify more than three hidden layers, SGD becomes the default method.

If you select **LBFGS** as the optimization method, set these options:

a Specify the L1 norm regularization parameter.

b Specify the L2 norm regularization parameter.

c Specify the maximum time in seconds.

d Specify the maximum number of iterations.

If you select **SGD** as the optimization method, set these options:

a Specify the L1 norm regularization parameter.

b Specify the L2 norm regularization parameter.

c For the **Input layer dropout ratio** option, specify a value between 0 and 1 (inclusive). The default value is `0`.

Note: This option is available only for the Stochastic gradient descent (SGD) method.

d For the **Hidden layer dropout ratio** option, specify a value between 0 and 1 (inclusive). The default value is `0`.

e Specify the learning rate. The initial value is `0.001`.

f Specify the annealing rate. The initial value is `0.000001`.

g For the **Momentum** option, specify a value between 0 and 1 (inclusive). The default value is `0`.

h For the **Minibatch size** option, specify a value between 1 and 20,000 (inclusive). The default value is `50`.

i Specify the maximum time in seconds.

Note: This option is available only if you specify zero to five hidden layers.

j Specify the maximum number of iterations.

Note: This option is available only if you specify zero to five hidden layers.

6 Select the search method to use for tuning. Here are the valid values:

- **Genetic algorithm** uses an initial Latin hypercube sample that seeds a genetic algorithm to generate a new population of alternative configurations at each iteration. You can also specify these settings: the maximum iterations, the maximum evaluations, and the evaluations per iteration.

- **Latin hypercube sample** uses a Latin hypercube to generate a single sample of configurations that is uniform in each tuning parameter, but random in combinations. You must specify the sample size.
- **Random sample** generates a single sample of purely random configurations. You must specify the sample size.
- **Bayesian sample** builds a kriging surrogate model to approximate the objective value and uses this surrogate model to generate new alternative configurations at each iteration. The kriging model is continuously updated during the search process.

7 Specify which measure of model performance the tuner uses as the objective function.

8 Specify the target event to use for calculating the objective function.

Note: This option is available only for nominal targets.

9 Specify the maximum time allowed for the tuner, where number must be greater than or equal to 1. When this value is reached, the tuner terminates the search and returns results.

10 Specifies whether to use a partition or k-fold cross validation as the validation method.

- **Partition** specifies the fraction of all data to be used for validation, where number must be between 0.01 and 0.99, inclusive. If you specify this option, the tuner uses a single partition validation for finding the objective value (validation error estimate). This option might not be advisable for small or unbalanced data tables where the random assignment of the validation subset might not provide a good estimate of error. For large, balanced data tables, a single validation partition is usually sufficient for estimating error; a single partition is more efficient than cross validation in terms of the total execution time.
- **K-fold cross-validation** specifies the number of partition folds in the cross validation process, where number must be between 2 and 20, inclusive. If you specify this option, the tuner uses cross validation to find the objective value. In cross validation, each model evaluation requires a number of training executions (on number−1 data folds) and a number of scoring executions (on one hold-out fold). Thus, the evaluation time is increased by approximately a factor of number. For small to medium data tables or for unbalanced data tables, cross validation provides on average a better representation of error across the entire data table (a better generalization error).

Note: This option is not available if you select the **Validation data** check box on the **Data** tab.

11 Specify the number of evaluations to be performed in parallel, where the number must be greater than or equal to 0, and less than or equal to 32.

12 Specify whether to create and display the results table and log from the evaluation history report.

13 Specify whether to include these autotune plots in the results: objective history, best objective history, and option values versus objective.

14 Specify whether to generate the code for the step using either the NNET procedure or the CAS procedure.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create these CAS tables:

- a table that contains the scored data and any variables from the input data source
- a table of the model parameters
- a table of the model weights, if you specified 6 to 10 hidden layers

When naming these tables, you must specify a CAS engine libref.

You can also choose to save the scoring code.

Note: If you are running the step in a flow, you must add an output port for these optional tables to the Neural Network node. For more information, see "Neural Network: Connection Requirements for the Node" on page 1173.

Robust Principal Component Analysis

About the Robust Principal Component Analysis Step

The Robust Principal Component Analysis step can be used to perform matrix decomposition that is useful for feature extraction and anomaly detection.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Robust Principal Component Analysis: Connection Requirements for the Node

In order to run the Robust Principal Component Analysis step, you must create connections to the input port of the node as indicated here:

Input Port	Output Port
For the Robust Principal Component Analysis node, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	No connection is required. You can use the options on the **Output** tab to create an output table. For more information, see "Step 3: Set the Output Options" on page 1186. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Robust Principal Component Analysis

To create this example:

1 On a **SAS program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use Create CAS Connection snippet in SAS Data and AI Studio .

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.iris;
   set sashelp.iris;
run;
```

1 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Robust Principal Component Analysis** to add the step to your flow.

2 Add the MyCas.Iris table to your flow. Connect the input port of the Robust Principal Component Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the Robust Principal Component Analysis step, click the Robust Principal Component Analysis node.

4 On the **Data** tab, select **Use all numeric variables as inputs**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Robust Principal Component Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Specify the inputs. You can choose from these options:

- Select **Use all numeric variables as inputs** to include all the numeric variables from the input data.
- Select **Select inputs** to select the variables to use as interval inputs. You must assign these variables to the **Interval inputs** role.

3 (Optional) To the **ID variable** role, assign the variable from the data source that is not being considered as part of the original matrix (or input data source).

Step 2: Set the Options

On the **Options** tab, set these options:

1 For the **Method** option, select the algorithm to use to find the low-rank and sparse metrics. Augmented Lagrangian Multiplier or Accelerated Proximal Gradient.

2 Use the **Lambda** option to use the computed value for lambda or a custom value. The default value is computed by $\frac{1}{\sqrt{n}}$, where *n* is the number of observations in the input data set. If the number of variables in the data set is more than the number of observations, n is the number of variables. The bigger the value of lambda, the more sparse the sparse matrix is.

3 Use the **Lambda weight** option to whether to use 1 as the lambda weight or a custom value. You can use this value to control the sparsity of the sparse matrix.

4 Specify the maximum number of iterations to run in the analysis.

5 Use the **Tolerance** to specify the convergence criterion for the algorithms. The default value is 1e-7.

6 Specify whether to scale the observation by the standard deviation of each column. If there exists a constant variable (where all observations are the same value), these observations are not scaled.

7 Specify whether to center the observations by the mean of each column.

8 Set these options for singular value decomposition (SVD).

- Specify the singular value decomposition method to use. You can use the Eigenvalue decomposition method or the randomized SVD method.
- Specify the maximum value for rank considered by the SVD method.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create these output tables. You must specify a CAS engine libref.

- a low rank table
- a sparse table
- an error table

Note: If you are running the step in a flow, you must add an output port for each output table to the Robust Principal Component Analysis node. For more information, see "Robust Principal Component Analysis: Connection Requirements for the Node" on page 1184.

You can also save the scoring code.

If you select SVD as the decomposition method, you can also create a left singular vectors table, a singular vectors table, and a right singular vectors table. If you select PCA as the decomposition method, you can create a component loadings table and a PC scores table.

Semi-supervised Learning

About the Semi-supervised Learning Step

The Semi-supervised Learning step iteratively propagates the labels from the labeled data to the unlabeled data by computing the similarity measure between pairs of data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Semi-supervised Learning: Connection Requirements for the Node

In order to run the Semi-supervised Learning step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Semi-supervised Learning node, the input data source must be a CAS table. ■ Table node	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output data table. This table must use a

Input Port	Output Port
or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1192. To run this step in a flow, you must add an output port for this optional table. To add an output port, right-click the Semi-supervised Learning node and select **Add output port**. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Semi-supervised Learning

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio .

2 Enter this code on a **SAS Program** tab:

```
libname mycas cas;

/* Creating data set with 3 balls */
%macro mball (num=);
data ball&num;
  do i = 1 to 500;
    x1 = 1000*&num + 100*ranuni(123);
    x2 = 1000*&num + 100*ranuni(123);
    y=&num||'B';
    output;
  end;
run;
%mend;

%mball(num=1);
%mball(num=2);
%mball(num=3);

data indata;
```

```
   set ball1 ball2 ball3;
run;

/* create id for each observation in input data */
data unlabeled;
   set indata;
   id = _n_;
run;

/* Create labeledData from unlabeled data */
proc surveyselect data=unlabeled out=labeled(drop=SelectionProb
SamplingWeight) method=srs samprate=.1 seed=9876
                  nmin=1 nmax=100;
   strata y notsorted;
run;

data mycas.unlabeled;
  set unlabeled;
run;
data mycas.labeled;
  set labeled;
run;
```

Click **Run** to create the MyCas.Labeled and MyCas.Unlabled tables.

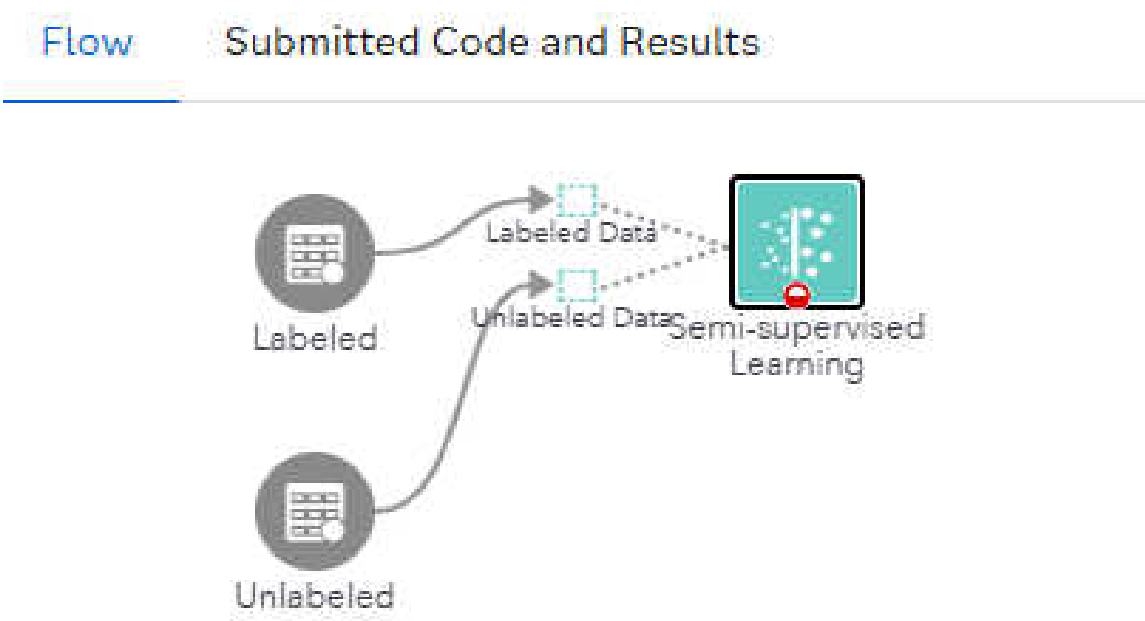
3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Semi-supervised Learning** to add the step to your flow.

4 Add these input tables to your flow.

   a Add the MyCas.Labeled table to your flow. Connect the Labeled Data input port of the Semi-supervised Learning node to the data source.

   b Add the MyCas.Unlabeled table to your flow. Connect the Unlabeled Data input port of the Semi-supervised Learning node to the data source.

For more information, see “Connecting Nodes” on page 13.



5 To set the options for the Semi-supervised Learning step, click the Semi-supervised Learning node.

6 On the **Data** tab, assign columns to these roles:

- To the **Target variable** role, assign **y**.
- To the **Input variables** role, assign **x1** and **x2**.

7 On the **Output** tab, select **Create output data**.

Add an output table to the flow.

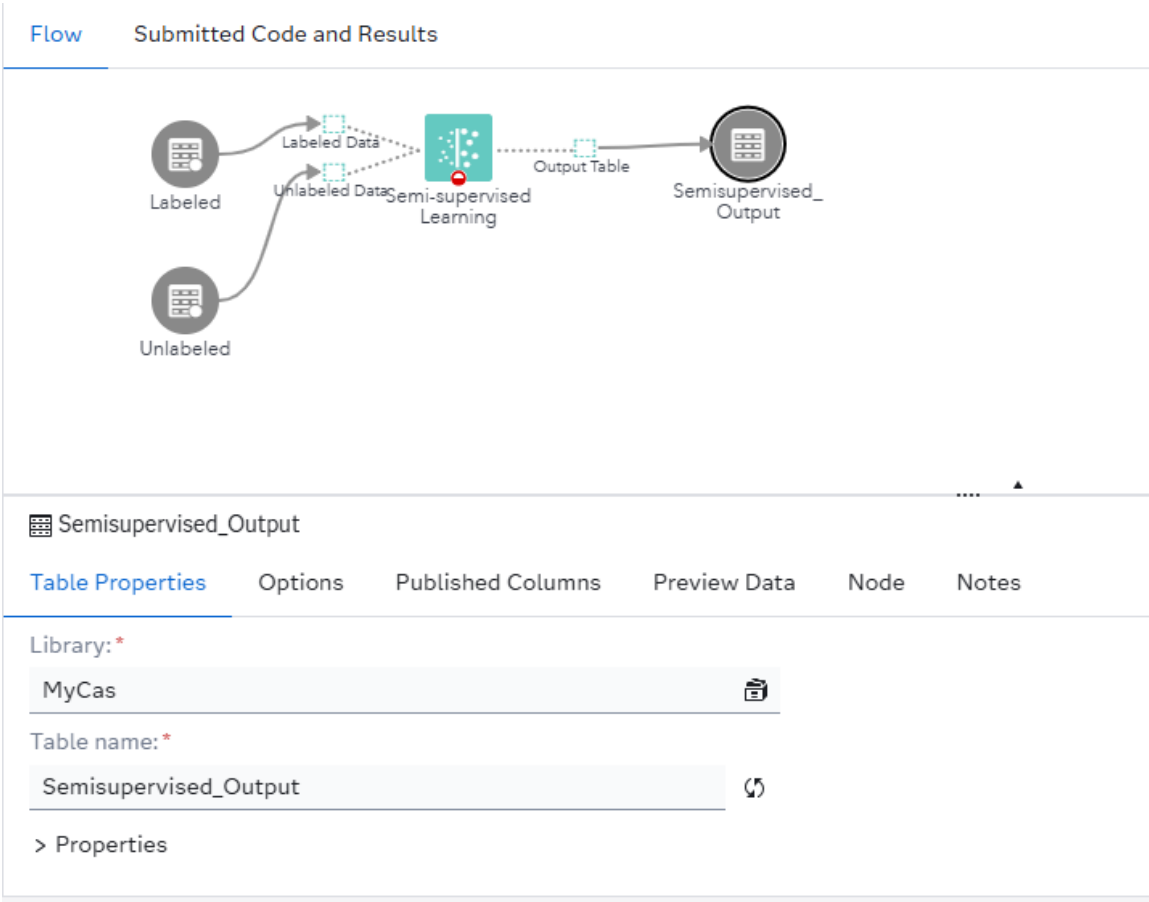
a Select **Add** ⇨ **Table**. A Table node is added to the flow.

b Select the Table node. In the Table Properties, enter `MyCas` as the library name, and enter `Semisupervised_Output` as the table name.

c Right-click the Semi-supervised Learning node and select **Add output port**.

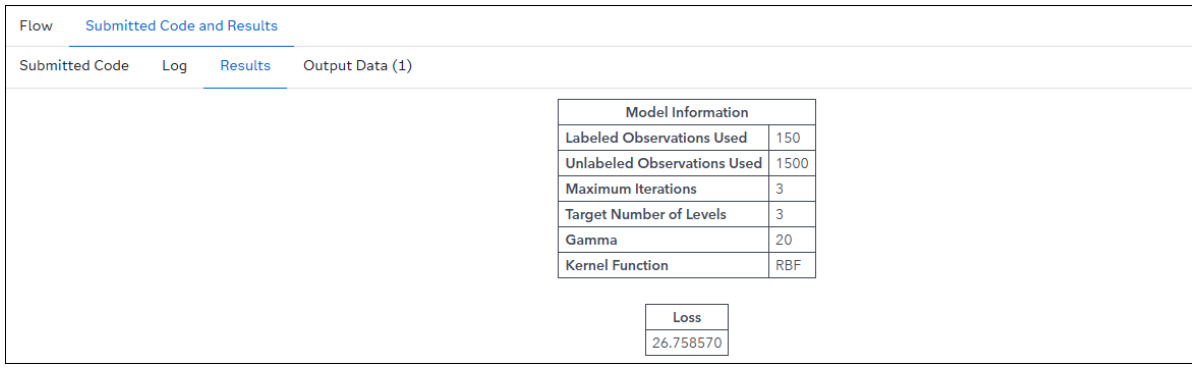
d Connect the new output port to the Semisupervised_Output node.

Note: If you are running the step in a flow, you must add an output port to the Semi-supervised Learning node. For more information, see "Semi-supervised Learning: Connection Requirements for the Node" on page 1187.



8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Semi-supervised Learning: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Target variable** role, assign the variable that contains the label.

3 To the **Input variables** role, assign the input variables to use for distance calculation. Only interval variables are supported.

4 (Optional) To filter the unlabeled data source, enter the filter expression in the **Filter input data** field.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify how to calculate the distance computation. You can choose from these options:

- **Radial basis function** - This is the default and uses the Gaussian kernel.
- **K-nearest neighbor** - After selecting this option, you must specify the number of neighbors.

2 Specify the maximum number of iterations. The default value is `3`.

3 Use the **RBF kernel width** option to specify the width for the Gaussian kernel that the semi-supervised learning algorithm used to calculate the distances between features of data points. The default value is `20`.

4 Specify how the code is generated for the step. You can choose from these options:

- **Use SEMISUPLEARN procedure**
- **Use CAS procedure**

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table. This table must use a CAS engine libref.

Note: If you are running the step in a flow, you must add an output port to the Semi-supervised Learning node. For more information, see "Semi-supervised Learning: Connection Requirements for the Node" on page 1187.

2 (Optional) Specify whether to replace an existing output table and what variables to include from the input CAS table.

Support Vector Data Description

About the Support Vector Data Description Step

The Support Vector Data Description step is a one-class classification machine learning technique.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Support Vector Data Description: Connection Requirements for the Node

In order to run the Support Vector Data Description step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Support Vector Data Description node, the input data source must be a CAS table. ■ Table node or	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output data table. This table must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1196.

Input Port	Output Port
■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	To run this step in a flow, you must add an output port for this optional table. To add an output port, right-click the Support Vector Data Description node and select **Add output port**. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Support Vector Data Description

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio .

2 Enter this code on a **SAS Program** tab:

```
libname mycas cas;

data mycas.class;
   set sashelp.class;
run;
```

Click **Run** to create the MyCas.Class table.

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Support Vector Data Description** to add the step to your flow.

4 Add the MyCas.Class table to your flow. Connect the input port of the Support Vector Data Description node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Support Vector Data Description step, click the Support Vector Data Description node.

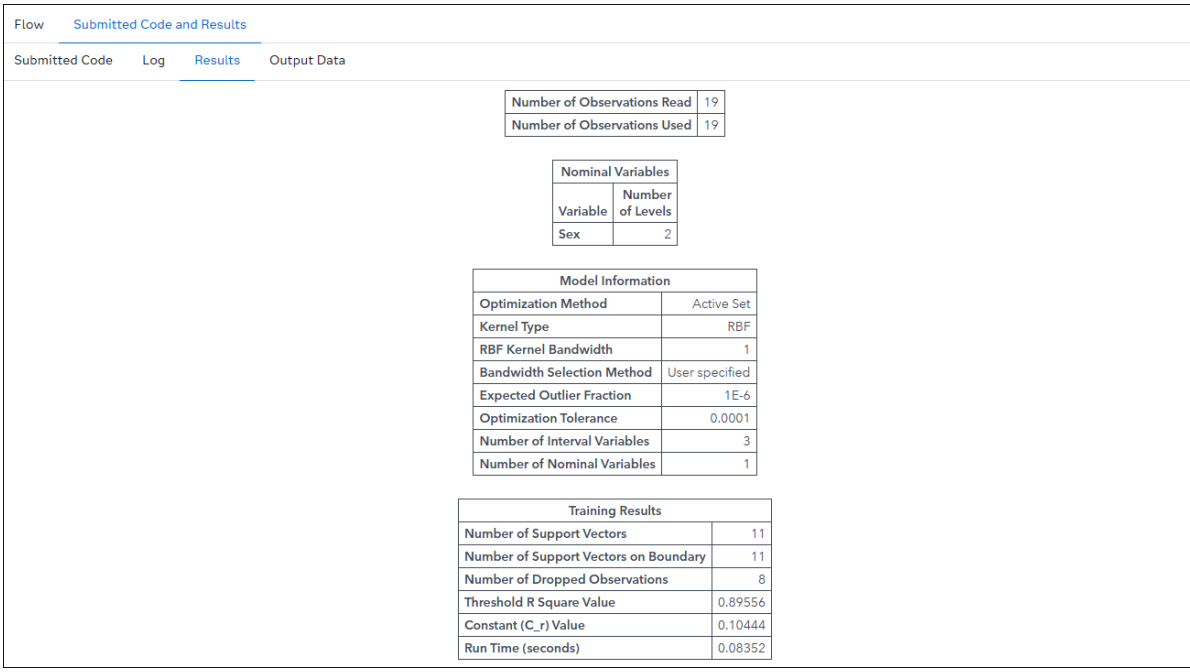
6 On the **Data** tab, assign columns to these roles:

- To the **Interval inputs** role, assign **Age**, **Weight**, and **Height**.
- To the **Nominal inputs** role, assign **Sex**.

7 On the **Options** tab, enter 1 for the RBF bandwidth parameter.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Support Vector Data Description: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Interval inputs** role, assign the variables to treat as continuous inputs.

3 To the **Nominal inputs** role, assign the variables to treat as categorical inputs.

4 (Optional) To the **Weight variable** role, assign the variable in the training data that specifies the weight to be assigned to each observation.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Select **RBF bandwidth parameter** to use a radial basis function (also known as the Gaussian kernel function) during training. The bandwidth must be a positive number.

2 Specify the expected fraction of the training data that consists of outliers. This value must be between `0` and `1`. The default value is `0.000001`.

Note: This option is available only for the **Activeset** optimization solver.

3 Specify the tolerance value for the solver. The default value is `0.0001`.

4 Specify the maximum number of iterations to perform in the analysis.

5 Specify whether the optimization solver is **Activeset** or **Stochastic**. If you select **Stochastic**, you can choose to use the default parameter settings or the custom parameter settings for these options:

- **Maximum support vectors** specifies the maximum number of support vectors.
- **Observations sampled** specifies the number of observations that are sampled in each iteration of the stochastic solver.
- **Threshold tolerance** specifies the tolerance value that is used to detect convergence of the threshold value.
- **Center tolerance** specifies the tolerance value that is used for detecting convergence of the center.
- **Convergence criterion** specifies the convergence criterion for the stochastic solver.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains the support vectors data. You must specify a CAS engine libref.

Note: If you are running the step in a flow, you must add an output port to the Support Vector Data Description node. For more information, see "Support Vector Data Description: Connection Requirements for the Node" on page 1193.

2 (Optional) Specify whether to save the scoring model.

Support Vector Machine

About the Support Vector Machine Step

The Support Vector Machine step performs classification analysis for binary targets by using a support vector machine, which is a supervised machine learning method.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise . You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced , or SAS Data and AI Studio Enterprise . For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Support Vector Machine: Connection Requirements for the Node

In order to run the Support Vector Data Machine step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Support Vector Machine node, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output data table. This table must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1202. To run this step in a flow, you must add an output port for this optional table. To add an output port, right-click the Support Vector Machine node and select **Add output port**. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and name of the output tables by connecting the output ports to Table nodes. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Support Vector Machine

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to SAS Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Connect to CAS step or the Create CAS Connection snippet in SAS Data and AI Studio .

2 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.baseball;
   set sashelp.baseball;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Machine Learning** folder and double-click **Support Vector Machine** to add the step to your flow.

4 Add the MyCas.Baseball table to your flow. Connect the input port of the Support Vector Machine node to the data source. For more information, see "Connecting Nodes" on page 13.

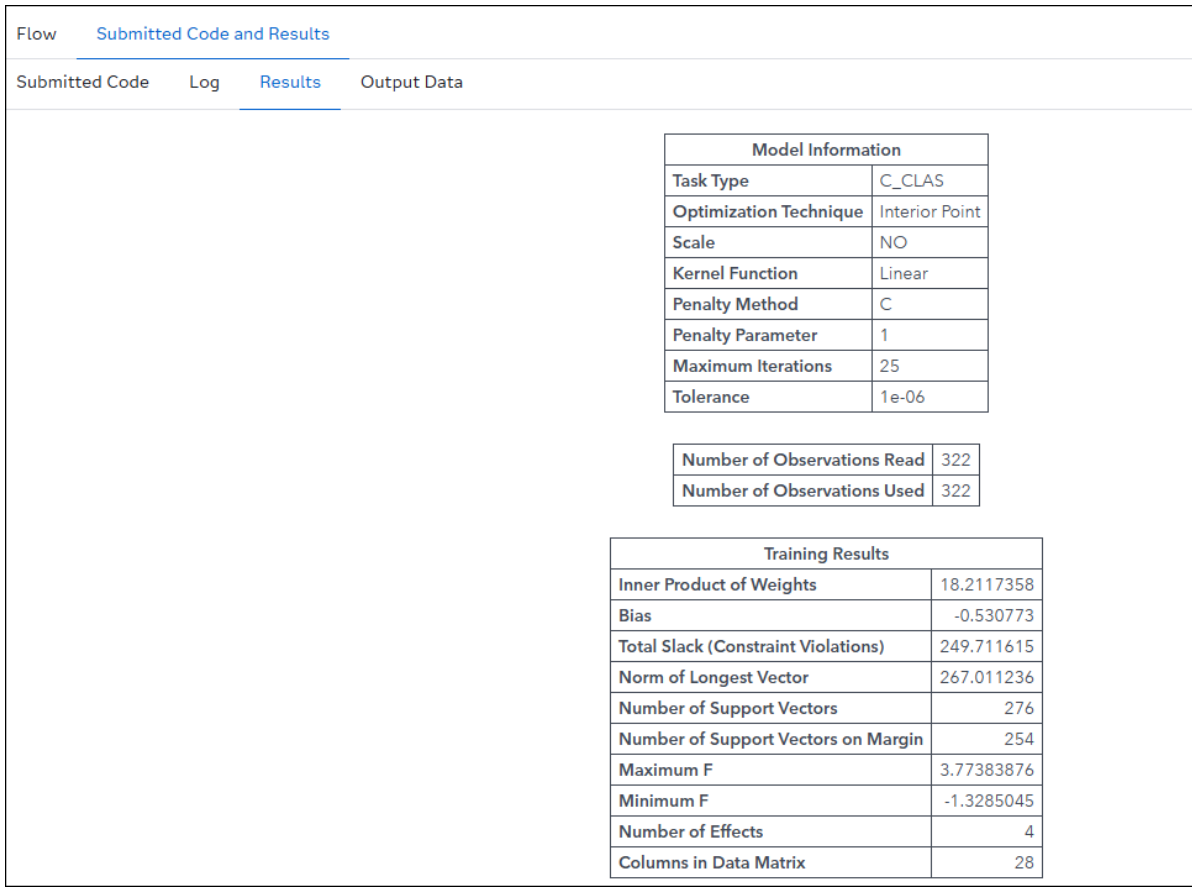
5 To set the options for the Support Vector Machine step, click the Support Vector Machine node.

6 On the **Data** tab, set these options:

- To the **Binary target** role, assign **League**.
- To the **Interval inputs** role, assign **nHits**, **nHome**, and **nRuns**.
- To the **Nominal inputs** role, assign **Position**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Model Information	
Task Type	C_CLAS
Optimization Technique	Interior Point
Scale	NO
Kernel Function	Linear
Penalty Method	C
Penalty Parameter	1
Maximum Iterations	25
Tolerance	1e-06

Number of Observations Read	322
Number of Observations Used	322

Training Results	
Inner Product of Weights	18.2117358
Bias	-0.530773
Total Slack (Constraint Violations)	249.711615
Norm of Longest Vector	267.011236
Number of Support Vectors	276
Number of Support Vectors on Margin	254
Maximum F	3.77383876
Minimum F	-1.3285045
Number of Effects	4
Columns in Data Matrix	28

Support Vector Machine: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Binary target** role, assign the variable to use as the target. This variable must have two levels.

3 To the **Interval inputs** role, assign the numeric variables to use as the interval inputs. The interval inputs can range from 0 to 1.

4 (Optional) To the **Nominal inputs** role, assign the variable to use as the nominal inputs.

Step 2: Set the Options

On the **Options** tab, you can set the options for the step. The options differ slightly if you decide to use the autotune process.

To use the autotune process:

1 Select **Automatically tune selected options**.

Note: The autotune process takes significantly longer than training a single model.

2 Specify the type of kernel. You can select either a linear or polynomial function.

(Optional) Select **Autotune type of kernel**. Select the polynomial function to use.

3 (Optional) Specify whether to include missing values. For interval inputs, missing values are imputed to the mean. For nominal inputs, missing values are treated as a level of the variable.

4 (Optional) Set the training options:

- **Penalty value** enables you to specify the number of penalties. The default value is `1`.

  If you select **Autotune penalty**, you must specify the initial value, the lower bound, and the upper bound.

- **Tolerance** enables you to specify the level of tolerance. The default value is `0.000001`.

- **Maximum number of iterations** enables you to specify the maximum number of iterations. The default value is `25`.

5 Specify the autotune settings:

- Specify the search method to use for tuning.
  - **Genetic algorithm** uses an initial Latin hypercube sample that seeds a genetic algorithm to generate a new population of alternative configurations at each iteration. You can also specify these settings: the maximum iterations, the maximum evaluations, and the evaluations per iteration.
  - **Latin hypercube sample** uses a Latin hypercube to generate a single sample of configurations that is uniform in each tuning parameter but random in combinations. You must specify the sample size.
  - **Random sample** generates a single sample of purely random configurations. You must specify the sample size.
  - **Bayesian sample** builds a kriging surrogate model to approximate the objective value and uses this surrogate model to generate new

alternative configurations at each iteration. The kriging model is continuously updated during the search process.

Specify the maximum iterations, maximum evaluations, and the evaluations per iteration.

- **Objective** specifies which measure of model performance the tuner uses as the objective function.
- **Event of interest** specifies the target event to use for calculating the objective function.

Note: This option is available only for nominal targets.

- **Maximum time (in minutes)** specifies the maximum time allowed for the tuner, where the number must be greater than or equal to 1. When this value is reached, the tuner terminates the search and returns results.
- **Validation method** specifies whether to use a partition or *k*-fold cross validation as the validation method.
  - **Partition** specifies the fraction of all data to be used for validation, where the fraction value must be between 0.01 and 0.99, inclusive. If you specify this option, the tuner uses a single partition validation for finding the objective value (validation error estimate). This option might not be advisable for small or unbalanced data tables where the random assignment of the validation subset might not provide a good estimate of error. For large, balanced data tables, a single validation partition is usually sufficient for estimating error; a single partition is more efficient than cross validation in terms of the total execution time.
  - **K-fold cross-validation** specifies the number of partition folds in the cross validation process, where the fraction value must be between 2 and 20, inclusive. If you specify this option, the tuner uses cross validation to find the objective value. In cross validation, each model evaluation requires a number of training executions (on number-1 data folds) and a number of scoring executions (on one holdout fold). Thus, the evaluation time is increased by approximately a factor of number. For small to medium data tables or for unbalanced data tables, cross validation provides on average a better representation of error (a better generalization error) across the entire data table.
- **Set number of parallel evaluations** specifies the number of evaluations to be performed in parallel. This number must be greater than or equal to 0, and less than or equal to 32.
- **Evaluation history report** specifies whether to create and display the result table and log from the evaluation history report.

6 Specify whether to include these autotune plots in the results: objective history, best objective history, and option values versus objective.

7 Specify whether to include plots in the results. Available plots include a partial dependence plot and an individual conditional expectation plot.

Note: To create a plot, you must have at least two input variables.

8 Specify how the code is generated.

- **Use SVMACHINE procedure** uses PROC SVMACHINE to run the step.
- **Use CAS procedure** uses the `svm` action set to run the step.

If you do not want to use the autotune process, do not select **Automatically tune selected options**. Instead, set these options:

1 Specify the type of kernel. You can select either a linear or polynomial function.

2 (Optional) Specify whether to include missing values. For interval inputs, missing values are imputed to the mean. For nominal inputs, missing values are treated as a level of the variable.

3 (Optional) Set the training options:

- **Penalty value** enables you to specify the number of penalties. The default value is `1`.
- **Tolerance** enables you to specify the level of tolerance. The default value is `0.000001`.
- **Maximum number of iterations** enables you to specify the maximum number of iterations. The default value is `25`.

4 Specify whether to include plots in the results. Available plots include a partial dependence plot and an individual conditional expectation plot.

Note: To create a plot, you must have at least two input variables.

5 Specify how the code is generated.

- **Use SVMACHINE procedure** uses PROC SVMACHINE to run the step.
- **Use CAS procedure** uses the `svm` action set to run the step.

Step 3: Set the Output Options

On the **Output** tab, set these options:

1 (Optional) Specify whether to create a CAS table that contains the scored data.

Note: If you are running the step in a flow, you must add an output port to the Support Vector Machine node. For more information, see "Support Vector Machine: Connection Requirements for the Node" on page 1197.

2 (Optional) Specify whether to save the scoring model.

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Biconnected Components

About the Biconnected Components Step

A biconnected component of an undirected graph is a connected subgraph that cannot be broken into disconnected pieces by deleting any single node (and its incident links). The Biconnected Components step finds all biconnected components of such a graph.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Biconnected Components: Connection Requirements for the Node

In order to run the Biconnected Components step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. However, on the **Output** tab, you can specify whether to create an output data table. If you are using a CAS server, this table must use a CAS engine libref. For more information, see "Step 3: Set the Output Options" on page 1208. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Biconnected Components

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

```
data LinkSetInBiCC_Char;
   input from $ to $ @@;
   datalines;
A B  A F  A G  B C  B D
B E  C D  E F  G I  G H
H I
;
```

Click **Run** to create the Work.LinkSetInBiCC_Char table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Biconnected Components** to add the step to your flow.

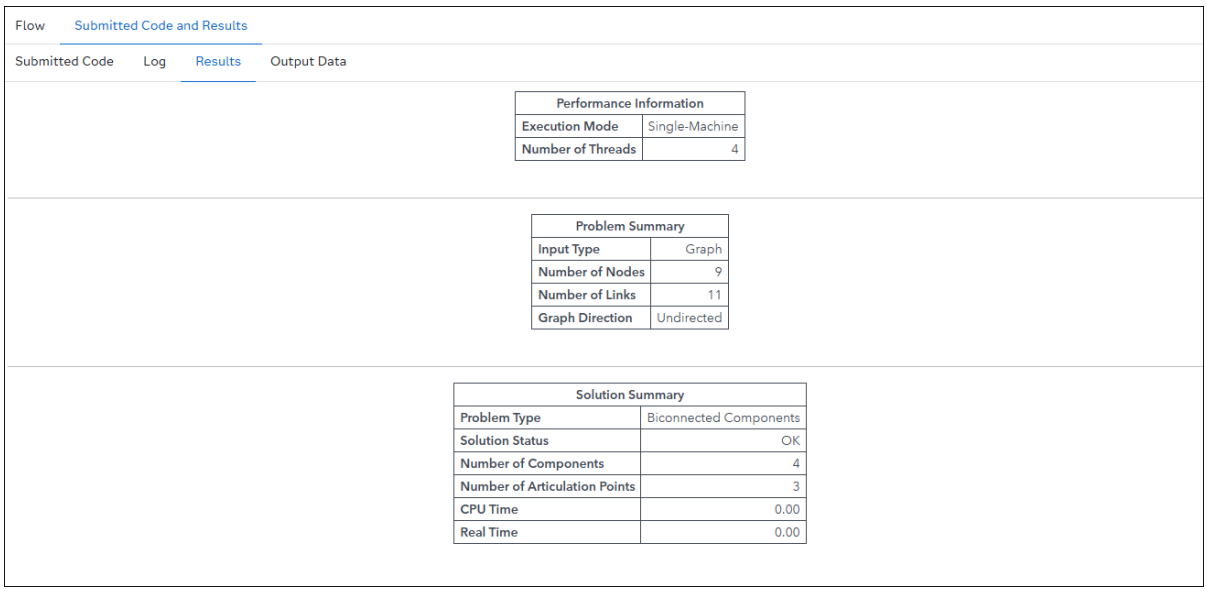
3 Add the Work.LinkSetInBiCC_Char table to your flow. Connect the input port of the Biconnected Components node to the data source. For more information, see “Connecting Nodes” on page 13.

4 To set the options for the Biconnected Components step, click the Biconnected Components node.

5 On the **Data** tab, assign **from** to the **From node** role and assign **to** to the **To node** role.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Biconnected Components: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter links data** field.

3 To the **From node** role, assign the variable in the link data set that corresponds to the From node of a link.

4 To the **To node** role, assign the variable in the link data set that corresponds to the To node of a link.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify how much information to display in the SAS log.

2 Specify how to generate the code.

If you are using the SAS Compute Server, these options are available:

- **Use OPTNET Procedure** - Uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

If you are using a SAS CAS Server, these options are available:

- **Use NETWORK Procedure** - Uses PROC NETWORK to generate the SAS code for the step.
- **Use OPTNETWORK Procedure** - Uses PROC OPTNETWORK to generate the SAS code for the step.
- **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS Procedure** - Uses PROC CAS to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains the biconnected components information.

2 (Optional) Specify whether to create an output table that contains the articulation points information.

Note: If you are running the step in a flow, you must add an output port for any output tables to the Biconnected Components node. For more information, see "Biconnected Components: Connection Requirements for the Node" on page 1205.

Centrality Metrics

About the Centrality Metrics Step

The Centrality Metrics step calculates several types of centrality metrics that indicate the relative importance of a node or link within a graph.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Centrality Metrics: Connection Requirements for the Node

In order to run the Centrality Metrics step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Centrality Metrics

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Enter this code on a **SAS Program** tab:

```
data LinkSetInCM;
   input from $ to $ community weight wt;
   datalines;
A B 1 3 3
A C 1 2 2
A D 1 1 1
B C 1 5 5
C D 1 7 7
C E 1 2 2
D F . 3 3
F G 2 9 9
F H 2 3 3
```

```
F I 2 5 5
G H 2 7 7
G I 2 3 3
I J . 3 3
J K 3 1 2
J L 3 6 6
K L 3 3 3
;

data NodeSetInCM;
   input node $ @@;
   datalines;
A    M   N
;
```

Click **Run** to create the Work.LinkSetInCM and Work.NodeSetINCM tables.

3 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.linksetincm;
   set work.linksetincm;
run;

data mycas.nodesetincm;
   set work.nodesetincm;
run;
```

4 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Centrality Metrics** to add the step to your flow.

5 Add the MyCas.MyCas.LinkSetInCM table to your flow. Connect the input port of the Centrality Metrics node to the data source. For more information, see "Connecting Nodes" on page 13.

6 To set the options for the Centrality Metrics step, click the Centrality Metrics node.

7 On the **Data** tab, assign columns to these roles:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.
- To the **Weight** role, assign **weight**.

8 On the **Options** tab, select the **Degree** and **Influence** check boxes.

9 On the **Output** tab, select **Create nodes data**. The output table must use a CAS engine libref.

If you are running the step in a flow, you must add an output table to the flow and connect it to the Centrality Metrics node.

a Click ⋮ and select **Add** ⇨ **Table**.

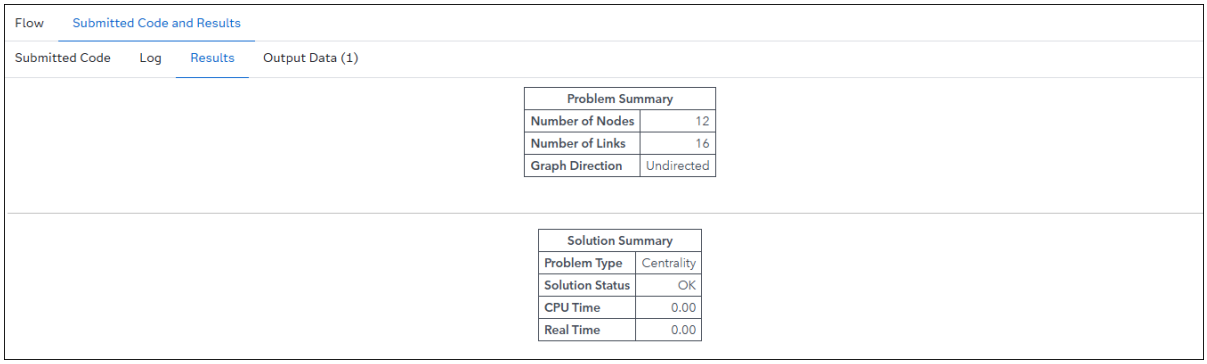
b Enter the library and table name for the new Table node. You must use a CAS library for this step.

c Right-click the Centrality Metrics node and select **Add output port** ⇨ **Nodes Table**.

d Connect the Nodes Table port to the new output table.

10 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Centrality Metrics: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **From node** role, assign the variable in the link data set that corresponds to the From node of a link.

3 To the **To node** role, assign the variable in the link data set that corresponds to the To node of a link.

4 (Optional) To the **Weight variable** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

5 To the **Auxiliary weight** role, assign the numeric variable that defines the auxiliary link weight.

6 (Optional) To the **Group analysis by** role, assign the variable that enables you to obtain separate analyses of observations for each unique group.

7 (Optional) To include nodes data, select **Include nodes data**.

If you are running this step in a flow, you must add an input port to the Centrality Metrics node.

a Right-click the Centrality Metrics node and select **Add input port**.

b Add the nodes data table to the flow. Connect the nodes data table to the Centrality Metrics node.

(Optional) To filter the nodes data source, enter the filter expression in the **Filter nodes data** field.

Assign columns to these roles:

- To the **Node** role, assign the variable to use for the node values.
- (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

Note: This functionality is not available if you assign a variable to the **Group analysis by** role.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Select the centrality metrics. You can choose from these metrics:

- **Degree**
- **Influence**

  If you select this centrality metric, you must also select the metric type.
- **Clustering coefficient**
- **Closeness**

  If you select this centrality metric, you must also specify how to calculate the shortest path distance between disconnected nodes.
- **Betweenness**

  If you select this centrality metric, you must also specify whether to normalize betweenness centrality.
- **Eigenvector**

  If you select this centrality metric, these additional options are available:

  - **Metric type**
  - **Eigenvector calculation method**
  - **Maximum number of iterations for eigenvector calculations**
- **Hub Score**

If you select this centrality metric, these additional options are available:

- **Metric type**
- **Eigenvector calculation method**
- **Maximum number of iterations for eigenvector calculations**

- **Authority Score**

  If you select this centrality metric, these additional options are available:

  - **Metric type**
  - **Eigenvector calculation method**
  - **Maximum number of iterations for eigenvector calculations**

Note: The **Hub Score** and **Authority Score** options are available only if you selected **Directed** as the link direction.

2 Specify how much information to display in the SAS log.

3 Specify how to generate the code for the step. You can choose from these options:

- **Use NETWORK procedure**
- **Use CAS procedure**

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains the nodes information. You must specify a CAS engine libref.

2 (Optional) Specify whether to create an output table that contains the links information.

Note: This option is available if you select **Betweenness** as the centrality metric on the **Options** tab. For more information, see "Step 2: Set the Options" on page 1212.

Community Detection

About the Community Detection Step

The Community Detection step partitions a graph into communities such that the nodes within the community subgraphs are more densely connected than the nodes from different communities.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Community Detection: Connection Requirements for the Node

In order to run the Community Detection step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input data must be a CAS table. ■ Table node	No connection is required. You can specify the output data from the **Output** tab. For more information, see "Step 3: Create the Output Data" on page 1219. **Note:** Output from the Community Detection node can be connected to any flow node that accepts a SAS or CAS table as an input, such as a Table node, a Query node, or a SAS Program node. By default, the output data is written to a session-scoped CAS table in the same CAS library as the source table. You can specify the library and name of the output tables by connecting the output port to a Table node. It is recommended that a CAS output table reside in the same CAS session as the input table. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Community Detection

1 Copy and paste this code on a **SAS program** tab:

```
data LinkSetInCD;
   input from $ to $ community weight wt;
   datalines;
A B 1 3 3
A C 1 2 2
A D 1 1 1
B C 1 5 5
C D 1 7 7
C E 1 2 2
D F . 3 3
F G 2 9 9
F H 2 3 3
F I 2 5 5
G H 2 7 7
G I 2 3 3
I J . 3 3
J K 3 1 2
J L 3 6 6
K L 3 3 3
;

data NodeSetInCD;
   input node $ @@;
   datalines;
A    M   N
;
```

Click **Run** to create the Work.LinkSetInCD and Work.NodeSetInCD data sets.

2 On a **SAS program** tab, run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.linksetincd;
   set work.linksetincd;
run;

data mycas.nodesetincd;
   set work.nodesetincd;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Community Detection** to add the step to your flow.

4 Add the MyCas.LinkSetInCd table to your flow. Connect the input port of the Community Detection node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Community Detection step, click the Community Detection node.

6 On the **Data** tab, assign columns to these roles:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.
- To the **Weight** role, assign **weight**.

7 On the **Output** tab, select **Save links data** and **Save nodes data**. These output tables must use CAS librefs.

If you are running the step in a flow, you must add two output tables to the flow and connect them to the Community Detection node.

8 Add the output table for the links data to the flow.

a Select **Add** ⇨ **Table**.

b Enter the library (**`MyCas`**) and table name (**`LinksData`**) for the new Table node. You must use a CAS library for this step.

c Right-click the Community Detection node and select **Add output port** ⇨ **Links Table**.

d Connect the Links Table port to the MyCas.LinkData table.

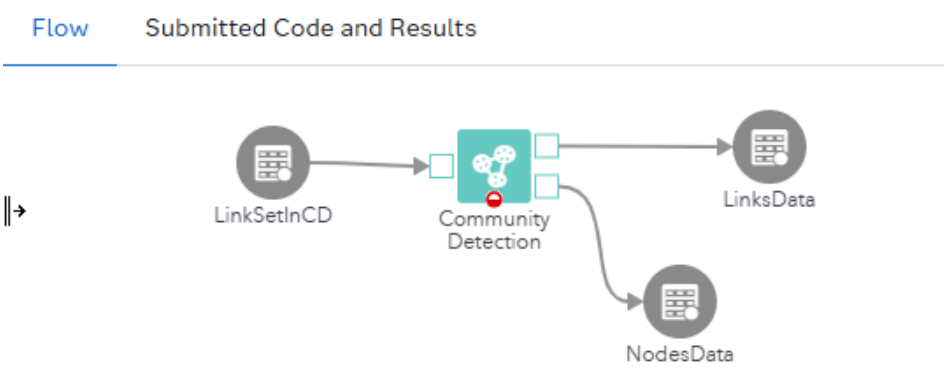
9 Add the output table for the nodes data to the flow.

a Select **Add** ⇨ **Table**.

b Enter the library (**`MyCas`**) and table name (**`NodesData`**) for the new Table node. You must use a CAS library for this step.

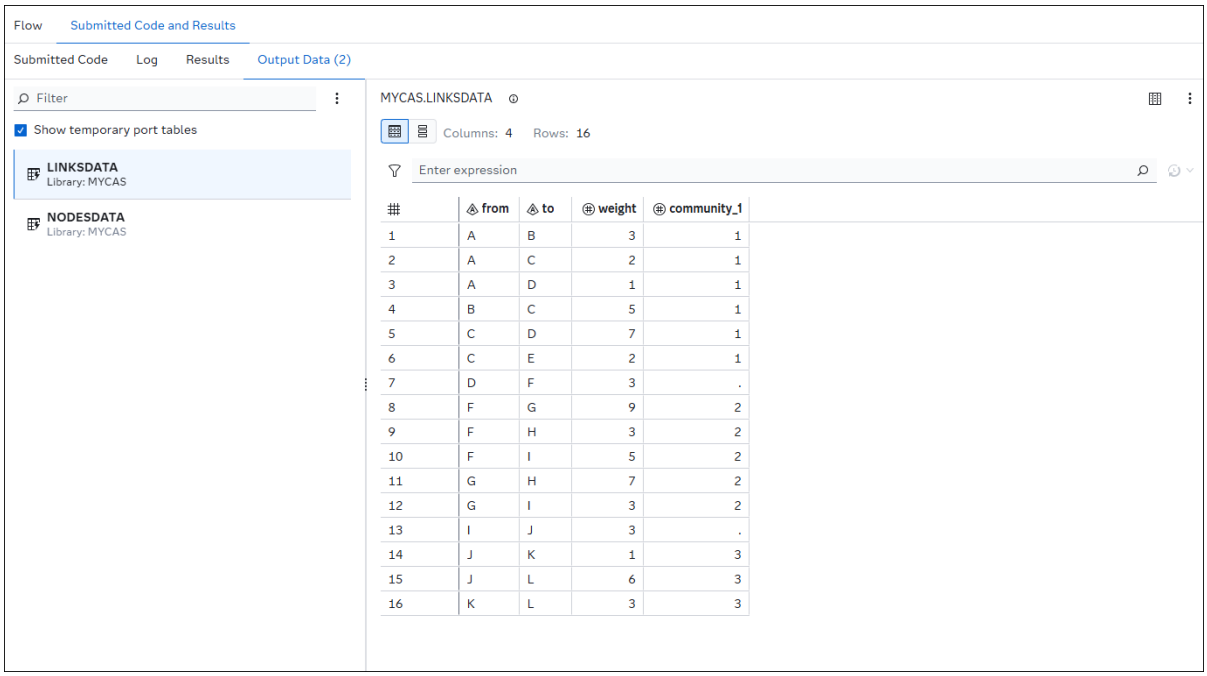
c Right-click the Community Detection node and select **Add output port** ⇨ **Nodes Table**.

d Connect the Nodes Table port to the MyCas.NodesData table.



10 Run the flow.

Click the **Submitted Code and Results** tab to view the output data.



	from	to	weight	community_1
1	A	B	3	1
2	A	C	2	1
3	A	D	1	1
4	B	C	5	1
5	C	D	7	1
6	C	E	2	1
7	D	F	3	.
8	F	G	9	2
9	F	H	3	2
10	F	I	5	2
11	G	H	7	2
12	G	I	3	2
13	I	J	3	.
14	J	K	1	3
15	J	L	6	3
16	K	L	3	3

Community Detection: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter links data** field.

2 Specify the link direction.

3 To the **From node** role, assign the variable in the link table that corresponds to the From node of a link.

4 To the **To node** role, assign the variable in the link table that corresponds to the To node of a link.

5 To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

6 (Optional) To the **Auxiliary weight** role, assign the numeric variable that defines the auxiliary link weight.

7 (Optional) To the **Group analysis by** role, assign the variables to enable you to obtain separate analyses of observations for each unique group.

8 (Optional) Select **Include nodes data** to include the nodes data as an input data source.

a Add the nodes data to the flow. Right-click the Community Detection node and select **Add input port**. Connect the nodes data to the new Nodes Data port.

b (Optional) To filter the input data source, enter the filter expression in the **Filter nodes data** field.

c To the **Node** role, assign a variable from the nodes table.

d (Optional) To the **Weight** role, assign the numeric variable whose value represents the weight for each observation in the input data set. If the value for the weight is less than or equal to 0 or the weight is a missing value, the observation is excluded from the analysis.

Step 2: Set the Options

On the **Options** tab, set these options:

1 Specify the algorithm for the analysis. The available algorithms depend on whether you are creating an undirected or directed graph.
   - For an undirected graph, you can choose between the Louvain algorithm and the label propagation algorithm.
   - For a directed graph, you must use the parallel label propagation algorithm. You can also specify the randomization.

2 Set the stopping criterion.
   - Specify the maximum number of iterations.
   - Specify the tolerance value to use to determine when to stop iterations.

3 Specify a list of resolution values. The order of these values is not important. If you specify more than one resolution value, the recursive option is not available.

   Note: This option is not available if you selected a label propagation algorithm.

4 Select **Recursively break down large communities into smaller ones**. When you select this option, you must also specify the stopping criterion.

5 Set the method options:
   - Specify the percentage of small-weight links to be removed. The default value is `10`.
   - Specify how much information to display in the log.

6 Specify how to generate the code for the step.
   - **Use NETWORK procedure** uses PROC NETWORK to generate the SAS code for the step.

- **Use the CAS procedure** uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Create the Output Data

On the **Output** tab, specify whether to create these CAS output tables:

- a table of the output links
- a table of the output nodes
- a table of the output links between communities
- a table of the output nodes count in each community
- a table of the output community information at different resolution levels
- a table of the output nodes intensity

Note: If you are running the step in a flow, you must add an output port for each output table to the Community Detection node. For more information, see "Community Detection: Connection Requirements for the Node" on page 1214.

Connected Components

About the Connected Components Step

The Connected Components step finds all the connected components in a graph. A connected component in a graph is a set of nodes that have a path between them.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Connected Components: Connection Requirements for the Node

In order to run the Connected Components step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Connected Components node, the input data source must be a CAS table, if you run the step on a CAS server. If you run the step on a SAS Compute Server, the input data source can be a SAS or CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output table is created, and no connection is required. On the **Output** tab, you can select the output tables to create. For more information, see "Step 3: Set the Output Options" on page 1222. **Note:** By default, the output data is written to a temporary table in the Work library. For this step to run on a CAS Server, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Connected Components

To create this example:

1 Copy and paste this code into a **SAS Program** tab.

```
data LinkSetInCharNode;
   input from $ to $ @@;
   datalines;
   A B  A C  B C  C H  D E  D F  D G  F E  G I  K L
;
```

Run the flow to create the Work.LinkSetInCharNode table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Connected Components** to add the step to your flow.

3 Add the Work.LinkSetInCharNode table to your flow. Connect the input port of the Connected Components node to the data source. For more information, see "Connecting Nodes" on page 13.

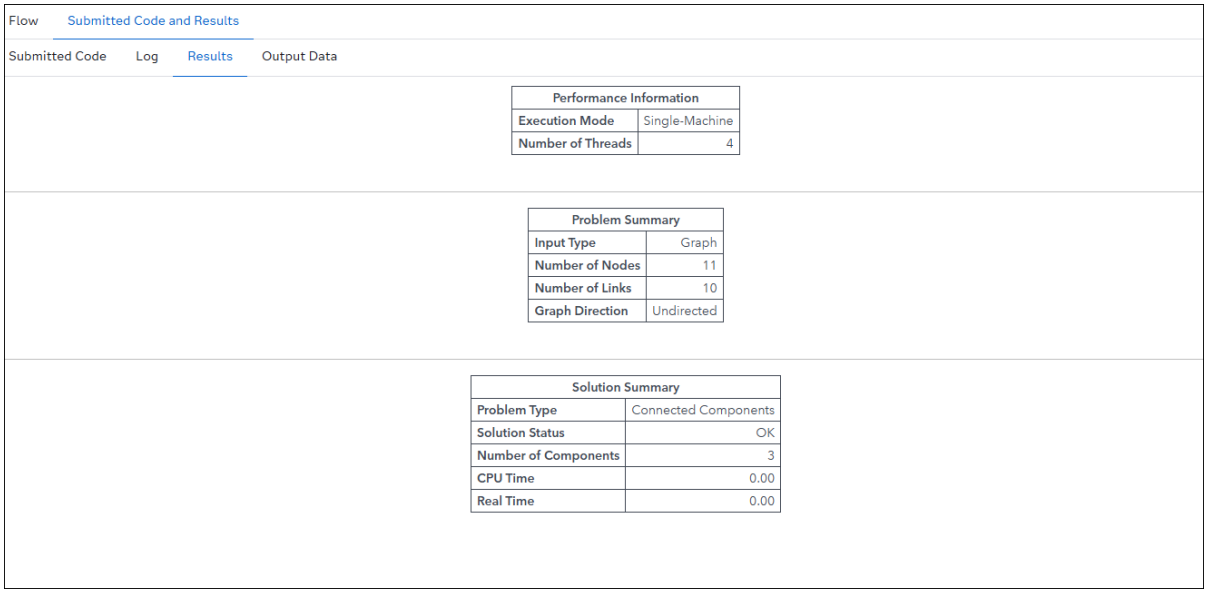
4 To set the options for the Connected Components step, click the Connected Components node.

5 On the **Data** tab, assign columns to these roles:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Connected Components: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 Select the link direction.

4 To the **From node** role, assign the variable in the link table that corresponds to the From node of a link.

5 To the **To node** role, assign the variable in the link table that corresponds to the To node of a link.

6 (Optional) To the **Group analysis by** role, assign the variable that enables you to obtain separate analyses of observations for each unique group.

Note: This option is available only if you are using a CAS server to run the step.

Step 2: Set the Options

On the **Options** tab, set these options:

1 Specify how much information to display in the SAS log.

2 Specify how to generate the code for the step.

These options are available if you use the SAS Compute Server to run the step.

- **Use OPTNET procedure** uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL procedure** uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

These options are available if you use the SAS CAS server to run the step.

- **Use NETWORK procedure** uses PROC NETWORK to generate the SAS code for the step.
- **Use OPTNETWORK procedure** uses PROC OPTNETWORK to generate the SAS code for the step.
- **Use OPTMODEL procedure** uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS procedure** uses PROC CAS to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create these output tables:

- the connected components information data

- the connected components links information data

Note: If you are running the step in a flow, you must add an output port for each output table to the Connected Components node. For more information, see "Connected Components: Connection Requirements for the Node" on page 1220.

Core Decomposition

About the Core Decomposition Step

The Core Decomposition step decomposes a graph into cohesive subgroups. Although this method is generally not as powerful as community detection for extracting a detailed community structure, this method can provide a coarse approximation of cohesive structure at a very low computational cost.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Core Decomposition: Connection Requirements for the Node

In order to run the Core Decomposition step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Core Decomposition node, the input data source must be a CAS table. You could also have input data sources for the nodes. If you need to include a node data source in the step, you must add an additional input port to the Core Decomposition node. To add an input port, right-click the Core Decomposition node and select **Add input port**. Add the nodes	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 1226.

Input Port	Output Port
data table to the flow and connect the data table to the Nodes Input Data port. For more information, see "Step 1: Assign Data to Roles " on page 1225. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	**Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Core Decomposition

To create this example:

1 On a **SAS Program** tab, copy and paste this code.

```
data LinkSetIn;
   input from $ to $ community weight wt;
   datalines;
A B 1 3 3
A C 1 2 2
A D 1 1 1
B C 1 5 5
C D 1 7 7
C E 1 2 2
D F . 3 3
F G 2 9 9
F H 2 3 3
F I 2 5 5
G H 2 7 7
G I 2 3 3
I J . 3 3
J K 3 1 2
J L 3 6 6
K L 3 3 3
;
```

Click **Run**. The Work.LinkSetIn table is created.

2 On a **Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session:

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

3 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.linksetin;
   set work.linksetin;
run;
```

4 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Core Decomposition** to add the step to your flow.

5 Add the MyCas.LinkSetIn table to your flow. Connect the input port of the Core Decomposition node to the data source. For more information, see "Connecting Nodes" on page 13.

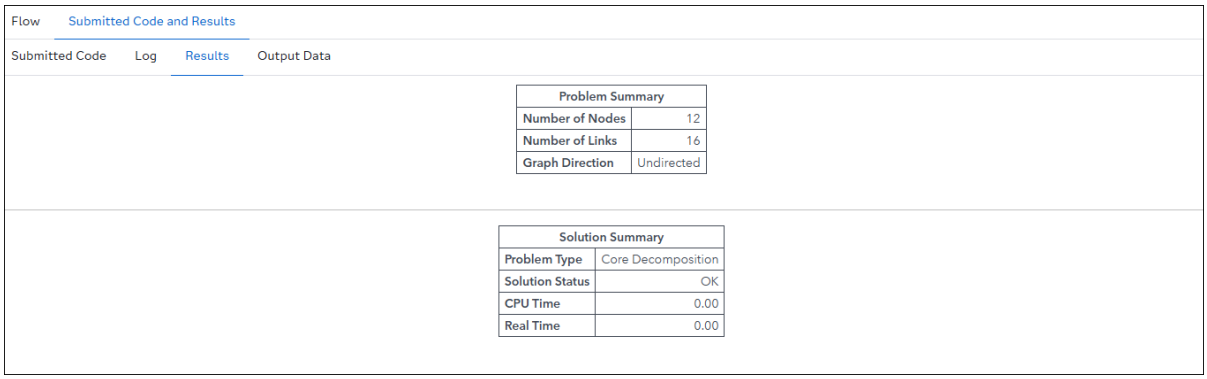
6 To set the options for the Core Decomposition step, click the Core Decomposition node.

7 On the **Data** tab, set these options:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Core Decomposition: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter** field.

2 To the **From node** role, assign the variable in the link table that corresponds to the From node of a link.

3 To the **To node** role, assign the variable in the link table that corresponds to the To node of a link.

4 (Optional) To the **Group analysis by** role, assign the variable that specifies how to group the data. This role enables you to obtain separate analyses of observations by each group.

5 (Optional) To include nodes data, select **Include nodes data**.

- Specify the data source that contains the list of nodes in the graph.
- Specify the variable to use for the node values.

Note: If you are running the step in a flow, you must add an input port for the nodes data to the Core Decomposition node. For more information, see "Core Decomposition: Connection Requirements for the Node" on page 1223.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 (Optional) Specify the maximum amount of time that you want the algorithm to run.

2 Specify how much information to display in the SAS log.

3 (Optional) Specify how to generate the code. You can use either the NETWORK procedure or the CAS procedure.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Select **Create output nodes table** to save the results to an output table.

Note: If you are running the step in a flow, you must add an output port for the output nodes table to the Core Decomposition node. For more information, see "Core Decomposition: Connection Requirements for the Node" on page 1223.

2 (Optional) Specify whether to replace any existing output tables with the same name.

Cycle Detection

About the Cycle Detection Step

The Cycle Detection step finds the elementary cycles of an input graph. An *elementary cycle* is a path in which the start node and the end node are the same, and no node appears more than once in the sequence.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Cycle Detection: Connection Requirements for the Node

In order to run the Cycle Detection step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Cycle Detection node, the input data source must be a CAS table, if you run the step on a CAS server. If you run the step on a SAS Compute Server, the input data source name can be a SAS or CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output table is created. No connection is required. You can create an output table that contains the cycles information by using the option on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 1231. **Note:** By default, the output data is written to a temporary table in the Work library. For this step to run on the CAS Server, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Finding Elementary Cycles

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

```
data LinkSetIn;
   input from $ to $ weight @@;
   datalines;
A B 3  A C 2  A D 6  A E 4  B D 5
B F 5  C E 1  D E 2  D F 1  E F 4
;

data NodeSetIn;
   input node $ nodeweight;
   datalines;
A 3
B 2
C 1
D 4
E 3
F 2
;
```

Click **Run** to create the Work.LinkSetIn table and the Work.NodeSetIn table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Cycle Detection** to add the step to your flow.

3 Add the Work.LinkSetIn table to your flow. Connect the input port of the Cycle Detection node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Cycle Detection step, click the Cycle Detection node.

5 On the **Data** tab, assign columns to these roles:

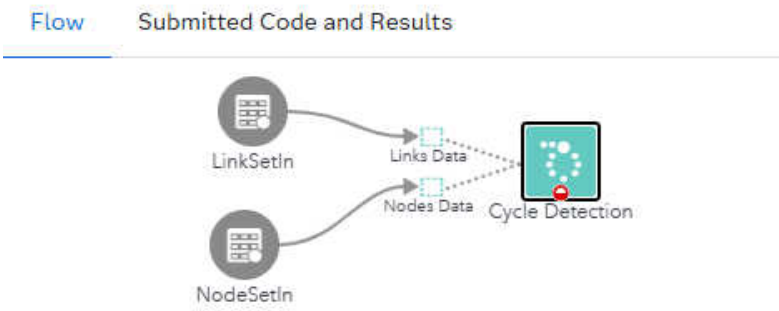
- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.
- To the **Weight** role, assign **weight**.

6 Add a node table to the analysis.

a Add the Work.NodeSetIn table to the flow.

b Right-click the Cycle Detection node and select **Add input port**.

c Connect the Work.NodeSetIn table to the new input node.



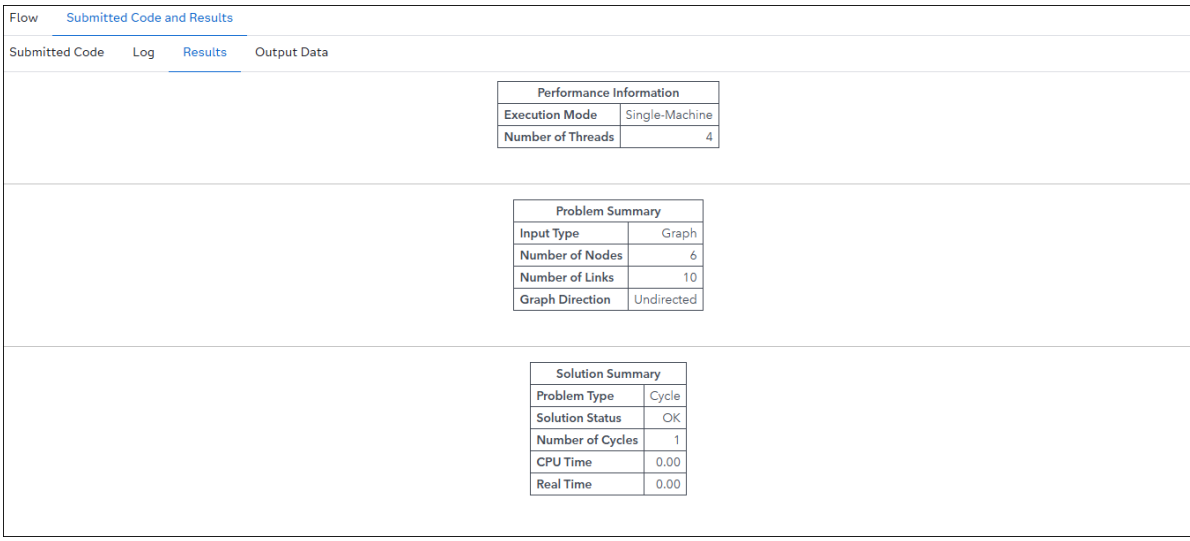
7 On the **Data** tab, select **Include nodes data**.

8 For the nodes table, assign variables to these roles:

- To the **Node** role, assign **node**.
- To the **Weight** role, assign **nodeweight**.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Cycle Detection: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 Select the link direction.

4 To the **From node** role, assign the variable in the link table that corresponds to the From node of a link.

5 To the **To node** role, assign the variable in the link table that corresponds to the To node of a link.

6 (Optional) To the **Weight** role, assign the numeric variable for the link weight.

7 (Optional) To add a node data set to the analysis, select **Include nodes data**.

a Add the nodes table to the flow.

b Right-click the Cycle Detection node and select **Add input port**.

c Connect the nodes table to the new input node.

8 On the **Data** tab, assign variables to these roles for the nodes table:

- To the **Node** role, assign **node**.
- To the **Weight** role, assign **nodeweight**.

Step 2: Set the Options

On the **Options** tab, set these options:

1 Specify the number of cycles to find. By default, the step returns the first cycle found.

You can choose from these options:

- **Find the first cycle**
- **Find all cycles**
- **Find up to the specified number of cycles**

If you select **Find all cycles** or **Find up to the specified number of cycles**, you can specify this additional information:

- the maximum number of cycles

Note: This option is available if you select the **Find up to the specified number of cycles** option.

- the maximum amount of time to spend finding cycles
- the maximum and minimum links per cycle
- the maximum and minimum sum of link weights per cycle

Note: These options are available only when you assign a variable to the **Weight** role.

- the minimum and maximum sum of node weights per cycle

Note: These options are available only when you include a nodes data set and assign a variable to the **Nodes weight** role.

2 Specify how much information to display in the SAS log.

3 Specify how to generate the code for the step.

These options are available if you use SAS Compute Server to run the step.

- **Use OPTNET procedure** uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL procedure** uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

These options are available if you are using the CAS server to run the step.

- **Use NETWORK procedure** uses PROC NETWORK to generate the SAS code for the step.
- **Use OPTNETWORK procedure** uses PROC OPTNETWORK to generate the SAS code for the step. The OPTNETWORK procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL procedure** uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS procedure** uses the CAS procedure to generate the code.

Step 3: Set the Output Options

On the **Output** tab, you can create a table that contains the cycle information. If you are running this step on a CAS server, the output table must use a CAS libref.

Note: If you are running the step in a flow, you must add an output port for each output table to the Cycle Detection node. For more information, see "Cycle Detection: Connection Requirements for the Node" on page 1227.

Linear Assignment

About the Linear Assignment Step

The Linear Assignment step assigns any objects from one group to objects in a second group at minimal costs.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Linear Assignment: Connection Requirements for the Node

In order to run the Linear Assignment step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Linear Assignment node, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data table is created. No connection is required. To create an output table that contains the optimal assignments, select **Save optimal assignments data**.For more information, see "Step 3: Set the Output Options" on page 1237. **Note:** By default, the output data is written to a temporary table in the Work library. For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table

Input Port	Output Port
	node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Examples: Linear Assignment

Example 1: Using the Links Data Format

This example looks at the problem of assigning swimmers to strokes based on their best times. The input data source for this example is a links data set.

To create this example:

1 Copy and paste this code on a **SAS Program** tab:

```
data RelayTimesLinks;
   input name $ stroke $ time;
   datalines;
Sue     back        35.1
Sue     breast      36.7
Sue     fly         28.3
Sue     free        36.1
Karen   back        34.6
Karen   breast      32.6
Karen   fly         26.9
Karen   free        26.2
Jan     back        31.3
Jan     breast      33.9
Jan     fly        27.1
Jan     free       31.2
Andrea  back       28.6
Andrea  breast     34.1
Andrea  fly        29.1
Andrea  free       30.3
Carol   back       32.9
Carol   breast     32.2
Carol   fly        26.6
Carol   free       24.0
Ellen   back       27.8
Ellen   breast     32.5
Ellen   fly        27.8
Ellen   free       27.0
;
```

Run the flow to create the Work.RelayTimesLink table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Linear Assignment** to add the step to your flow.

3 Add the Work.RelayTimesLinks table to your flow. Connect the input port of the Linear Assignment node to the data source. For more information, see "Connecting Nodes" on page 13.

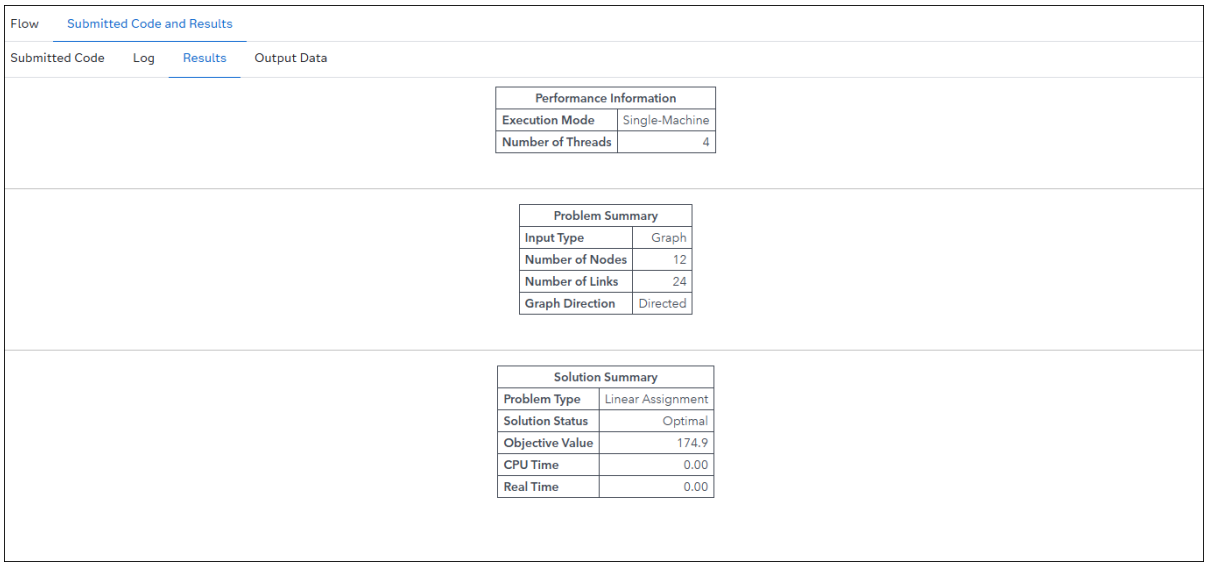
4 To set the options for the Linear Assignment step, click the Linear Assignment node.

5 On the **Data** tab, assign columns to these roles:

- To the **From node** role, assign **name**.
- To the **To node** role, assign **stroke**.
- To the **Weight** role, assign **time**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Example 2: Using the Matrix Data Format

This example looks at the problem of assigning swimmers to strokes based on their best times. The input data source for this example is a matrix data set.

1 Copy and paste this code on a **SAS Program** tab:

```
data RelayTimesMatrix;
   input name $ sex $ back breast fly free;
   datalines;
Sue     F 35.1 36.7 28.3 36.1
Karen   F 34.6 32.6 26.9 26.2
Jan     F 31.3 33.9 27.1 31.2
```

```
Andrea   F 28.6 34.1 29.1 30.3
Carol    F 32.9 32.2 26.6 24.0
Ellen    F 27.8 32.5 27.8 27.0
;
```

Run the flow to create the Work.RelayTimesMatrix table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Linear Assignment** to add the step to your flow.

3 Add the Work.RelayTimesMatrix table to your flow. Connect the input port of the Linear Assignment node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the LInear Assignment step, click the LInear Assignment node.

5 On the **Data** tab, select **Matrix** for the data format.

6 Assign variables to these roles:

- To the **Identifier variables** role, assign **name** and **sex**.
- To the **Weight variables** role, assign **back**, **breast**, **fly**, and **free**.

7 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Linear Assignment: Step-by-Step Instructions

Step 1: Assign Data to Roles

The available roles depend on whether you are using a links data format or a matrix data format.

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

3 Select the data format.

4 Assign variables to the required roles.

Here are the roles for the links data format:

- To the **From node**, assign the variable in the link data set that corresponds to the From node of a link.
- To the **To node**, assign the variable in the link data set that corresponds to the To node of a link.
- To the **Weight** role, assign a numeric variable for the link weight.

Here are the roles for the matrix data format:

- To the **Identifier variables**, assign the variables that identify the matrix rows.
- To the **Weight variables**, assign the variables that define the cost matrix.
- (Optional) To the **Group analysis by** role, specify the variable to use to obtain separate analyses of observations for each unique group.

Note: This role is available only if you are running on a CAS server.

Step 2: Set the Options

On the **Options** tab, set these options:

1 Specify how much information to display in the SAS log.

2 Specify how to generate code for the step.

These options are available if you are running the step on SAS Compute Server.

- **Use OPTNET procedure** uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL procedure** uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

These options are available if you are running the step on a CAS server.

- **Use OPTNETWORK procedure** uses PROC OPTNETWORK to generate the SAS code for the step. The OPTNETWORK procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL procedure** uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

  Note: The Group analysis by role on the Data page is not available if you select the OPTMODEL procedure.

- **Use CAS procedure** uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create an output table that contains the optimal assignments.

Note: If you are running the step in a flow, you must add an output port for each output table to the Linear Assignments node. For more information, see "Linear Assignment: Connection Requirements for the Node" on page 1232.

Maximal Cliques

About the Maximal Cliques Step

The Maximal Cliques step finds the maximal cliques of a graph. A *clique* is an induced subgraph such that every node in that subgraph is connected to every other node. A *maximal clique* is a clique that is not a subset of the nodes of any larger clique.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Maximal Cliques: Connection Requirements for the Node

In order to run the Maximal Cliques step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 1241. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Finding Maximal Cliques

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

```
data LinkSetIn;
   input from to @@;
   datalines;
0 1  0 2  0 3  0 4  0 5
0 6  1 2  1 3  1 4  2 3
2 4  2 5  2 6  2 7  2 8
3 4  5 6  7 8  8 9
;
```

Click **Run** to create the Work.LinkSetIn table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Maximal Cliques** to add the step to your flow.

3 Add the Work.LinkSetIn table to your flow. Connect the input port of the Maximal Cliques node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Maximal Cliques step, click the Maximal Cliques node.

5 On the **Data** tab, assign **from** to the **From node** role and assign **to** to the **To node** role.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.

Maximal Cliques: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter links data** field.

3 To the **From node** role, assign the variable in the link data set that corresponds to the From node of a link.

4 To the **To node** role, assign the variable in the link data set that corresponds to the To node of a link.

Note: The variables that are assigned to the **From node** and **To node** roles must be of the same data type.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 (Optional) Specify the number of cliques to identify. You can also specify the maximum amount of time the step should spend identifying these cliques.

2 Specify how much information to display in the log.

3 Specify how to generate the code.

If you are using a SAS Compute Server, you can choose from these options:

- **Use OPTNET procedure** - Uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful

OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

If you are using a SAS CAS Server, you can choose from these options:

- **Use NETWORK procedure** - Uses PROC NETWORK to generate the SAS code for the step.
- **Use OPTNETWORK procedure** - Uses PROC OPTNETWORK to generate the SAS code for the step.
- **Use OPTMODEL procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS procedure** - Uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create an output table that contains the maximal cliques.

Note: If you are running the step in a flow, you must add an output port to the Maximal Cliques node. For more information, see "Maximal Cliques: Connection Requirements for the Node" on page 1238.

Minimum Cost Network Flow

About the Minimum Cost Network Flow Step

The Minimum Cost Network Flow (MCF) step is a fundamental problem in network analysis that involves sending flow over a network at minimal cost.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Minimum Cost Network Flow: Connection Requirements for the Node

In order to run the Minimum Cost Network Flow step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running this step on a CAS server, the input table must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output table that contains the information for the minimum cost network flow, select **Save network flow information data** on the **Output** tab. If you are running this step on a CAS server, you must use a CAS libref. For more information, see "Step 3: Set the Output Options" on page 1253. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Minimum Cost Network Flow

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

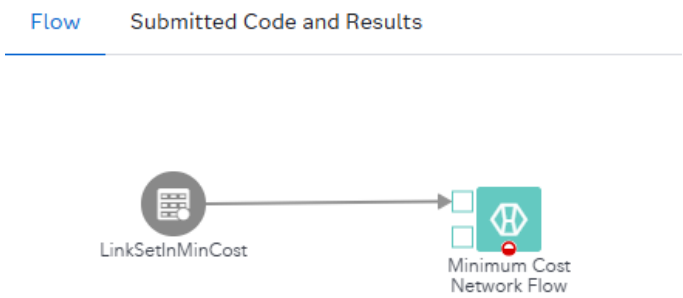
```
data LinkSetInMinCost;
   input from to boundlink upper;
   datalines;
1 4 2 15
2 1 1 10
2 3 0 10
2 6 6 10
3 4 1  5
3 5 4 10
4 7 5 10
5 6 2 20
5 7 7 15
6 8 8 10
7 8 9 15
;
```

```
data NodeSetInMinCost;
   input node boundnode;
   datalines;
1  10
2  20
4  -5
7 -15
8 -10
;
```

Click **Run** to create the Work.LinkSetInMinCost and Work.NodeSetInMinCost tables.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Minimum Cost Network Flow** to add the step to your flow.

3 Add the Work.LinkSetInMinCost table to your flow. On the Minimum Cost Network Flow node, connect the input port for the Links data to the data source. For more information, see "Connecting Nodes" on page 13.



4 To set the options for the Minimum Cost Network Flow step, click the Minimum Cost Network Flow node.

5 On the **Data** tab, assign variables to these roles for the links data:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.

6 Expand the **Additional Roles** heading. Assign **upper** to the **Flow upper bound** role.

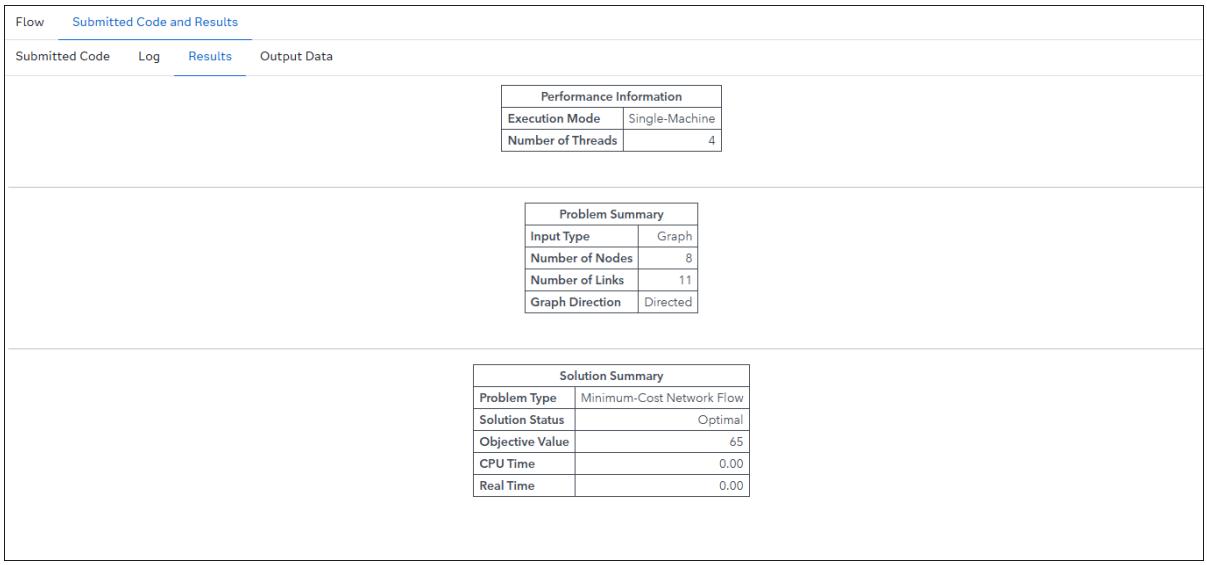
7 Add the Work.NodeSetInMinCost table to your flow. On the Minimum Cost Network Flow node, connect the input port for the Nodes data to the data source. For more information, see "Connecting Nodes" on page 13.

8 Assign variables to these roles:

- To the **Node** role, assign **node**.
- To the **Node supply lower bound** role, assign **boundnode**.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Minimum Cost Network Flow: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the links data source, enter the filter expression in the **Filter links data** field.

3 To the **From node** role, assign the variable in the link data set that corresponds to the From node of a link.

4 To the **To node** role, assign the variable in the link data set that corresponds to the To node of a link.

5 (Optional) To the **Weight** role, specify the numeric variable for the link weight.

6 (Optional) Expand the **Additional Roles** heading to set these roles:

- **Flow lower bound** - specifies the lower bound for the network flow.
- **Flow upper bound** - specifies the upper bound for the network flow.

7 (Optional) To analyze nodes data, add to the flow your input nodes table and connect the data to the input port for the Nodes data.

8 On the **Data** tab, expand the **Nodes** heading to complete these tasks:

- Specify a filter for the nodes data.
- To the **Nodes** role, assign the variable that defines the node label.
- Specify the lower bound for the node supply.
- Specify the upper bound for the node supply.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the maximum amount of time to spend calculating the minimum cost network flow.

2 Specify how much information to display in the log.

3 Specify how to generate the code. The generation options that are available depend on whether you are running the step on SAS Compute Server or a CAS server.

These options are available if you are running on the SAS Compute Server:

- **Use OPTNET Procedure** - Uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

These options are available if you are running on a SAS CAS server:

- **Use OPTNETWORK Procedure** - Uses PROC OPTNETWORK to generate the SAS code for the step. The OPTNETWORK procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS procedure** - Uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create an output table that contains the network flow information.

Note: If you are running the step on a SAS CAS server and in a flow, you must add an output port for the output table to the Minimum Cost Network Flow node. For more information, see "Step 3: Set the Output Options" on page 1246.

Minimum Cut

About the Minimum Cut Step

The Minimum Cut step finds a minimum cut of an undirected graph that has the smallest link metric. A cut is a partition of the nodes of a graph into two disjoint subsets.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Minimum Cut: Connection Requirements for the Node

In order to run the Minimum Cut step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Finding Minimum Cut

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

```
data LinkSetIn;
   input from to weight @@;
   datalines;
1 2 2  1 5 3  2 3 3  2 5 2  2 6 2
3 4 4  3 7 2  4 7 2  4 8 2  5 6 3
6 7 1  7 8 3
;
```

Click **Run** to create the Work.LinkSetIn table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Minimum Cut** to add the step to your flow.

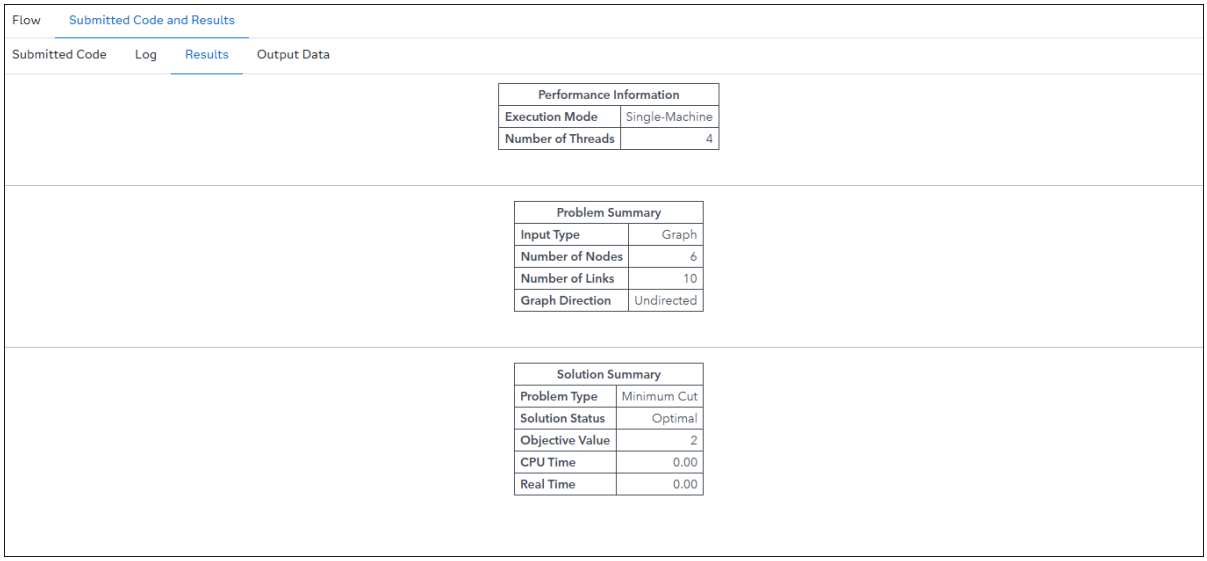
3 Add the Work.LinkSetIn table to your flow. Connect the input port of the Minimum Cut node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Minimum Cut step, click the Minimum Cut node.

5 On the **Data** tab, assign **from** to the **From node** role, and assign **to** to the **To node** role.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Minimum Cut: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the links data source, enter the filter expression in the **Filter links data** field.

3 To the **From node** role, assign the variable in the link data set that corresponds to the From node of a link.

4 To the **To node** role, assign the variable in the link data set that corresponds to the To node of a link.

5 (Optional) To the **Weight** role, specify the numeric variable for the link weight.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 (Optional) Specify the maximum weight to use to identify the cuts.

2 Specify how much information to display in the log.

3 Specify how to generate the code. The generation options that are available depend on whether you are running the step on SAS Compute Server or a CAS server.

These options are available if you are running on the SAS Compute Server:

- **Use OPTNET Procedure** - Uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

These options are available if you are running on a SAS CAS server:

- **Use OPTNETWORK Procedure** - Uses PROC OPTNETWORK to generate the SAS code for the step. The OPTNETWORK procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS procedure** - Uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains the cut information.

2 (Optional) Specify whether to create an output table that contains the nodes partition information.

Minimum Spanning Tree

About the Minimum Spanning Tree Step

A *spanning tree* of a connected undirected graph is a subgraph. This subgraph is a tree that connects all the nodes. The Minimum Spanning Tree (MST) step finds the spanning tree, among all possible spanning trees, that has the minimum link cost.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Minimum Spanning Tree: Connection Requirements for the Node

In order to run the Minimum Spanning Tree step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running this step on a CAS server, the input table must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output table that contains the information for the minimum spanning tree, select **Save minimum spanning tree information data** on the **Output** tab. If you are running this step on a CAS server, you must use a CAS libref. For more information, see "Step 3: Set the Output Options" on page 1253. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: A Simple Undirected Graph

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

```
data LinkSetInCharNode;
   input from $ to $ weight @@;
   datalines;
A B  7  A D  5  B C 8  B D 9  B E 7
C E  5  D E 15  D F 6  E F 8  E G 9
F G 11  H I  1  I J 3  H J 2
;
```

Click **Run** to create the Work.LinkSetInCharNode table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Minimum Spanning Tree** to add the step to your flow.

3 Add the Work.LinkSetInCharNode table to your flow. Connect the input port of the Minimum Spanning Tree node to the data source. For more information, see "Connecting Nodes" on page 13.

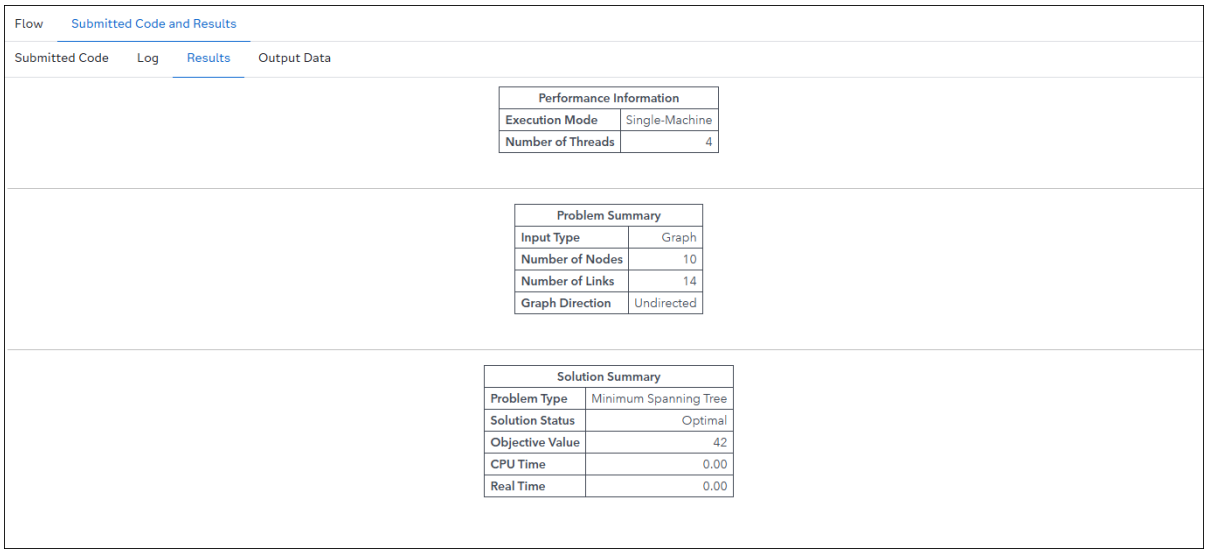
4 To set the options for the Minimum Spanning Tree step, click the Minimum Spanning Tree node.

5 On the **Data** tab, assign variables to these roles:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.
- To the **Weight** role, assign **weight**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Minimum Spanning Tree: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the links data source, enter the filter expression in the **Filter links data** field.

3 To the **From node** role, assign the variable in the link data set that corresponds to the From node of a link.

4 To the **To node** role, assign the variable in the link data set that corresponds to the To node of a link.

5 (Optional) To the **Weight** role, specify the numeric variable for the link weight.

6 (Optional) To the **Group analysis by** role, specify the variable to use to obtain separate analyses of observations for each unique group.

Note: This role is available only if you are running on a CAS server.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify how much information to display in the log.

2 Specify how to generate the code. The generation options that are available depend on whether you are running the step on SAS Compute Server or a CAS server.

These options are available if you are running on the SAS Compute Server:

- **Use OPTNET Procedure** - Uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

These options are available if you are running on a SAS CAS server:

- **Use OPTNETWORK Procedure** - Uses PROC OPTNETWORK to generate the SAS code for the step. The OPTNETWORK procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS procedure** - Uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create an output table that contains the information for the minimum spanning tree.

Note: If you are running the step on a SAS CAS server and in a flow, you must add an output port for the output table to the Minimum Spanning Tree node. For more information, see "Minimum Spanning Tree: Connection Requirements for the Node" on page 1250.

Network Summary

About the Network Summary Step

The Network Summary step calculates various summary statistics for a graph and its nodes.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Network Summary: Connection Requirements for the Node

In order to run the Network Summary step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Network Summary node, the input data source must be a CAS table. You could also have an input data source for the nodes data. If you need to include a node data source in the step, you must add an additional input port to the Network Summary node. To add an input port, right-click the Network Summary node and select **Add input port**. Add the nodes data table to the flow and connect the data table to the Nodes Data port. For more information, see "Step 1: Assign Data to Roles " on page 1257. ■ Table node or	By default, no output data is created, and no connection is required. However, on the **Output** tab, you can specify whether to create an output table, an output nodes table, or an output links tables. These tables must use a CAS engine libref. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Network Summary node and select **Output Table**, **Output Nodes Table**, or **Output Links Table**. For more information, see "Step 3: Set the Output Options" on page 1258.

Input Port	Output Port
■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	**Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Network Summary

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Copy and paste this code on a **SAS Program** tab.

```
libname mycas cas;

data mycas.LinkSetInCD;
   input from $ to $ community weight wt;
   datalines;
A B 1 3 3
A C 1 2 2
A D 1 1 1
B C 1 5 5
C D 1 7 7
C E 1 2 2
D F . 3 3
F G 2 9 9
F H 2 3 3
F I 2 5 5
G H 2 7 7
G I 2 3 3
I J . 3 3
J K 3 1 2
J L 3 6 6
K L 3 3 3
;

data mycas.NodeSetInCD;
   input node $ @@;
```

```
   datalines;
A    M   N
;
```

Click **Run**. The MyCas.LinkSetInCD and MyCas.NodeSetInCD tables are created.

3 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Network Summary** to add the step to your flow.

4 Add the MyCas.LinkSetInCD table to your flow. Connect the input port of the Network Summary node to the data source. For more information, see "Connecting Nodes" on page 13.

1 To set the options for the Network Summary step, click the Network Summary node.

2 On the **Data** tab, complete these tasks:

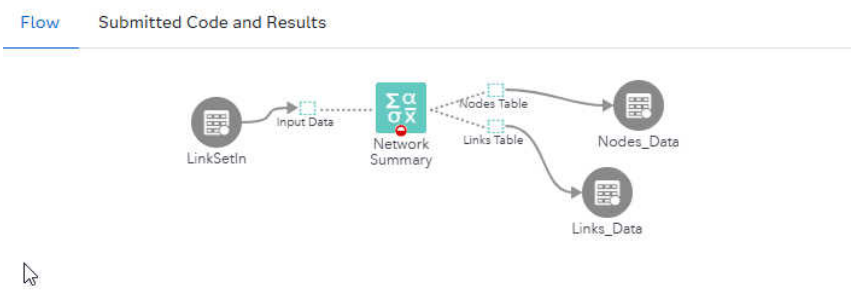
- For the link direction, select **Undirected**.
- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.
- To the **Weight** role, assign **weight**.

3 On the **Options** tab, select **Biconnected components** and **Connected components**.

4 On the **Output** tab, select **Create nodes table** and **Create links table**.

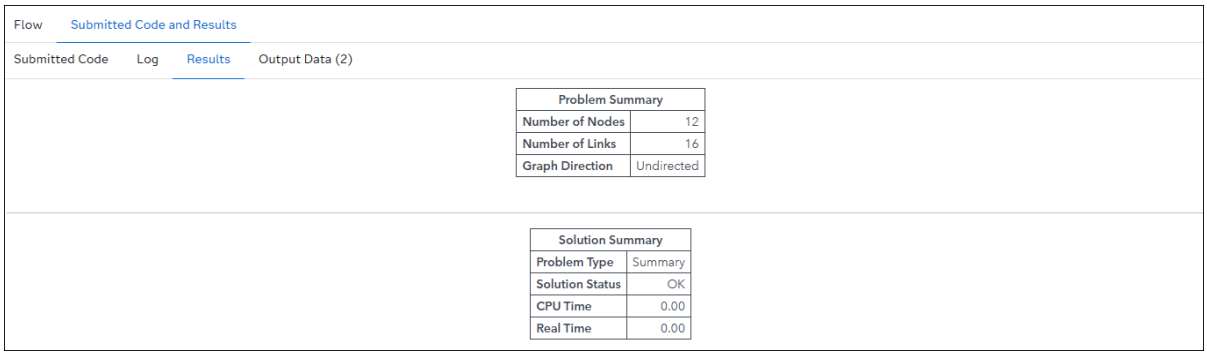
Note: If you are running the step in a flow, you must add an output port for the nodes table and an output port for the links table to the Network Summary node. For more information, see "Network Summary: Connection Requirements for the Node" on page 1254.

After adding the two output ports, your flow should appear similar to the following figure:



5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Network Summary: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **From node** role, assign the variable in the link data set that corresponds to the From node of a link.

3 To the **To node** role, assign the variable in the link data set that corresponds to the To node of a link.

4 (Optional) To the **Group analysis by** role, assign a variable that enables you to obtain separate analyses of observations for each unique group.

5 (Optional) To include nodes data, select **Include nodes data**.

Note: If you are running the step in a flow, you must add an input port for the nodes table to the Network Summary node. For more information, see "Network Summary: Connection Requirements for the Node" on page 1254.

6 (Optional) To the **Node** role, assign the variable in the nodes data set that corresponds to the nodes.

7 (Optional) To the **Weight** role, assign a variable that contains the value of the variable for each observation that is used to calculate weighted means, variances, and sums. You can assign a maximum of one variable to this role.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the statistics to calculate.
   - biconnected components
   - connected components
   - the approximate diameter of the network, using a metric type of weighted, unweighted, or both
   - the statistics for the shortest paths, using a metric type of weighted, unweighted, or both
2 Specify how much information to display in the SAS log.
3 Specify how the code is generated for the step. You can choose from these options:
   - **Use NETWORK procedure**
   - **Use CAS procedure**

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create these CAS tables:
   - an output table
   - an output nodes table
   - an output links table

   Note: If you are running the step in a flow, you must add an output port for any output tables to the Network Summary node. For more information, see "Network Summary: Connection Requirements for the Node" on page 1254.
2 (Optional) Specify whether to replace any existing output tables.

Reach Network

About the Reach Network Step

The Reach Network step calculates the reach (ego) network of a graph. In the context of social networks, reach networks are often referred to as ego networks, because they focus on the neighbors of one particular individual (or more than one).

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Reach Network: Connection Requirements for the Node

In order to run the Reach Network step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
The input table must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output table, use the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 1264. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Reach Network

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also the Create CAS Connection snippet in SAS Data and AI Studio.

2 Enter this code on a **SAS Program** tab:

```
data LinkSetInReach;
   input from $ to $ community weight wt;
```

```
   datalines;
A B 1 3 3
A C 1 2 2
A D 1 1 1
B C 1 5 5
C D 1 7 7
C E 1 2 2
D F . 3 3
F G 2 9 9
F H 2 3 3
F I 2 5 5
G H 2 7 7
G I 2 3 3
I J . 3 3
J K 3 1 2
J L 3 6 6
K L 3 3 3
;

data NodeSetInReach;
   input node $ @@;
   datalines;
A    M   N
;

data NodeSubsetReach;
   input node $ reachId;
   datalines;
A 1
C 2
G 1
J 2
K 2
;
```

Click **Run** to create the Work.LinkSetInReach, Work.NodeSetInReach, and Work.NodeSubsetReach tables.

3 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.linksetinreach;
   set work.linksetinreach;
run;

data mycas.nodesetinreach;
   set work.nodesetinreach;
run;

data mycas.nodesubsetreach;
   set work.nodesubsetreach;
run;
```

4 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Reach Network** to add the step to your flow.

5 Add the MyCas.LinkSetInReach table to your flow. Connect the input port of the Reach Network node to the data source. For more information, see "Connecting Nodes" on page 13.

6 To set the options for the Reach Network step, click the Reach Network node.

7 On the **Data** tab, assign variables to these roles.

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.

8 On the **Options** tab, select **Find reach networks from specified source nodes subset**.

9 Add the input table for the source nodes subset to the flow.

a Add the MyCas.NodeSubsetReach to the flow.

b Right-click the Reach Network node and select **Add input port** ⇨ **Source Nodes Subset Data**.

c Connect the MyCas.NodeSubsetReach table to the input port for source nodes subset data.

10 On the **Options** tab, assign variables to these roles:

- To the **Node** role, assign **node**.
- To the **Reach network identifier** role, assign **reachId**.

11 On the **Output** tab, select **Save reach network nodes data** and **Save reach network links data**.

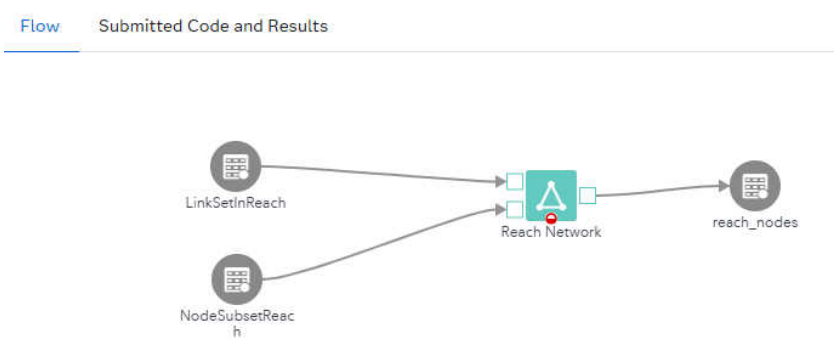
12 Add the output tables to the flow and connect them to the Reach Network node.

a Select **Add** ⇨ **Table**.

b In the table properties, enter `MyCas` as the library name and `reach_nodes` as the table name.

c Right-click the Reach Network node and select **Add output port** ⇨ **Reach Network Nodes Table**.

d Connect the MyCas.reach_nodes table to the Reach Network Nodes Table port.



e Select **Add** ⇨ **Table**.

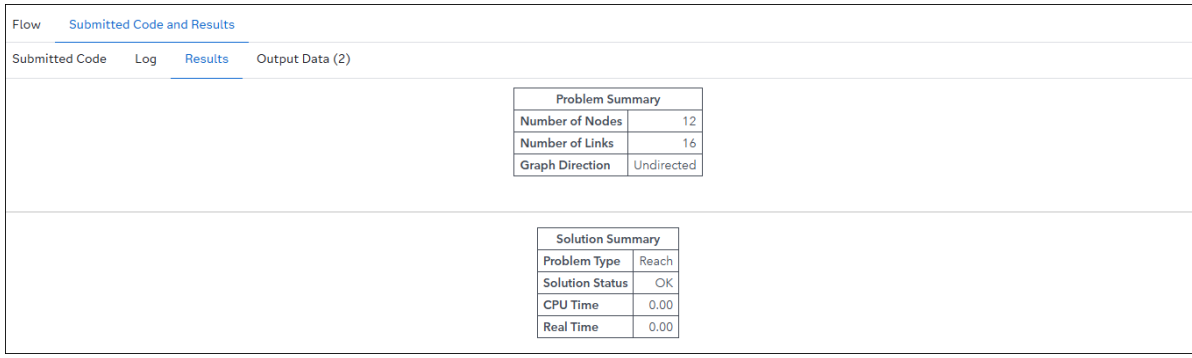
f In the table properties, enter **`MyCas`** as the library name and **`reach_links`** as the table name.

g Right-click the Reach Network node and select **Add output port** ⇨ **Reach Network Links Table**.

h Connect the MyCas.reach_links table to the Reach Network Links Data port.

13 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Reach Network: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter links data** field.

2 Select the link direction.

3 To the **From node**, assign the variable in the link table that corresponds to the From node of a link.

4 To the **To node**, assign the variable in the link table that corresponds to the To node of a link.

5 To the **Group analysis**, assign a variable to obtain separate analyses of observations for each unique group.

6 (Optional) Select **Include nodes data**. Add the nodes data to the flow and connect it to the Reach Network node.

a Add the nodes table to the flow.

b Right-click the Reach Network node and select **Add input port** ⇨ **Nodes data**.

c Connect the node for the nodes table to the Nodes data port.

7 (Optional) To filter the input data source, enter the filter expression in the **Filter nodes data** field.

8 To the **Node** role, assign the variable to use for the node values.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the maximum number of hops that each reach path can have from a source node.

2 Calculate the directed reach counts when computing the reach networks and include the directed counts in the output data.

Note: This option is available only if you select **Directed** as the link direction on the **Data** tab. This option is ignored unless the maximum number of links from each source node is 1.

3 Specify the scope of reach networks. Here are the valid values:

- **Find a reach network from each node separately**.
- **Find reach networks from specified source nodes subset**. You must specify a data source for the nodes subset. This data source must have at least two columns: one column that contains the node data and one column with the reach network identifier. Nodes with the same reach network identifier are treated as the source nodes of the identified reach network.

4 (Optional) Add the input table for the source nodes subset to the flow.

a Add the input table to the flow.

b Right-click the Reach Network node and select **Add input port** ⇨ **Source Nodes Subset Data**.

c Connect the input table to the input port for source nodes subset data.

d On the **Options** tab, assign variables to the **Node** and **Reach network identifier** roles.

5 Specify how much information to display in the SAS log.

6 Specify how to generate the code.

- **Use NETWORK procedure** - Uses PROC NETWORK to generate the SAS code for the step.
- **Use CAS procedure** - Uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can create these CAS output tables:

- a table that contains the nodes in each reach network
- a table that contains the links in each reach network
- a table that contains the node counts in each reach network
- a table that contains the mapping between the node and reach identifier

Note: This option is available only if you request to find a reach network from each node separately.

Note: If you are running the step in a flow, you must add an output port for any output tables to the Reach Network node. For more information, see "Reach Network: Connection Requirements for the Node" on page 1259.

Shortest Paths

About the Shortest Paths Step

The Shortest Paths step calculates paths between sets of nodes in the input graph with the lowest total link weight.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Shortest Paths: Connection Requirements for the Node

In order to run the Shortest Paths step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are using the SAS Compute Server to run the step, the input table can be a SAS or CAS table. If you are using the SAS CAS server to run the step, the input table must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output table, use the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 1269. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Shortest Paths

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Enter this code on a **SAS Program** tab:

```
data LinkSetInSP;
   input from $ to $ weight @@;
   datalines;
A B 3  A C 2  A D 6  A E 4  B D 5
B F 5  C E 1  D E 2  D F 1  E F 4
;
```

```
data NodeSubSetInSP;
   input node $ source sink;
   datalines;
A 1 0
C 1 0
B 0 1
F 0 1
;
```

Run the code to create the Work.LinkSetInSP and Work.NodeSubSetInSP tables.

3 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.linksetinsp;
   set work.linksetinsp;
run;
data mycas.nodesubsetinsp;
   set work.nodesubsetinsp;
run;
```

4 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Shortest Paths** to add the step to your flow.

5 Add the MyCas.LinkSetInSP table to your flow. Connect the input port of the Shortest Paths node to the data source. For more information, see "Connecting Nodes" on page 13.

6 To set the options for the Shortest Paths step, click the Shortest Paths node.

7 On the **Data** tab, select **CAS** as the server for this step.

8 Assign variables to these roles:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.
- To the **Weight** role, assign **weight**.

9 On the **Output** tab, select **Save path details** and **Save path summaries** check boxes.

10 Add the output tables to the flow and connect them to the Shortest Paths node.

a Select **Add** ⇨ **Table**.

b In the table properties, enter **`MyCas`** as the library name and **`Path_Details`**.

c Right-click Shortest Paths node and select **Add output port** ⇨ **Path Details Table**.

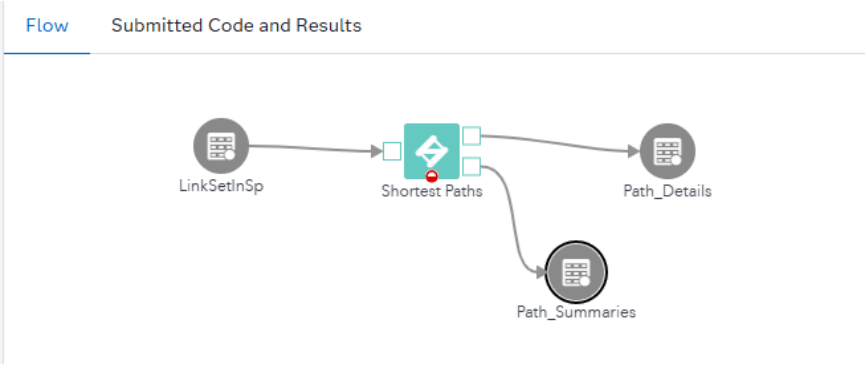
d Connect the Path Details Table port to the MyCas.Path_Details.

e Select **Add** ⇨ **Table**.

f In the table properties, enter **`MyCas`** as the library name and **`Path_Summaries`**.

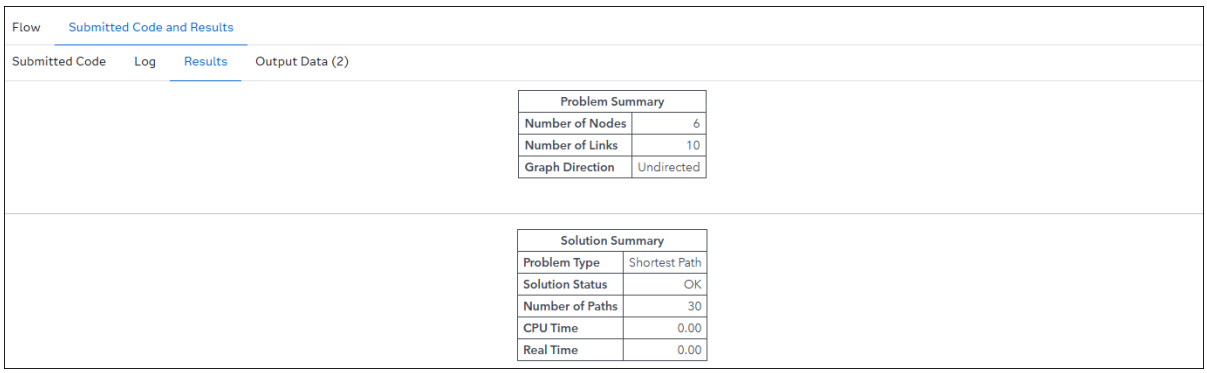
g Right-click Reach Network node and select **Add output port** ⇨ **Path Summaries Table**.

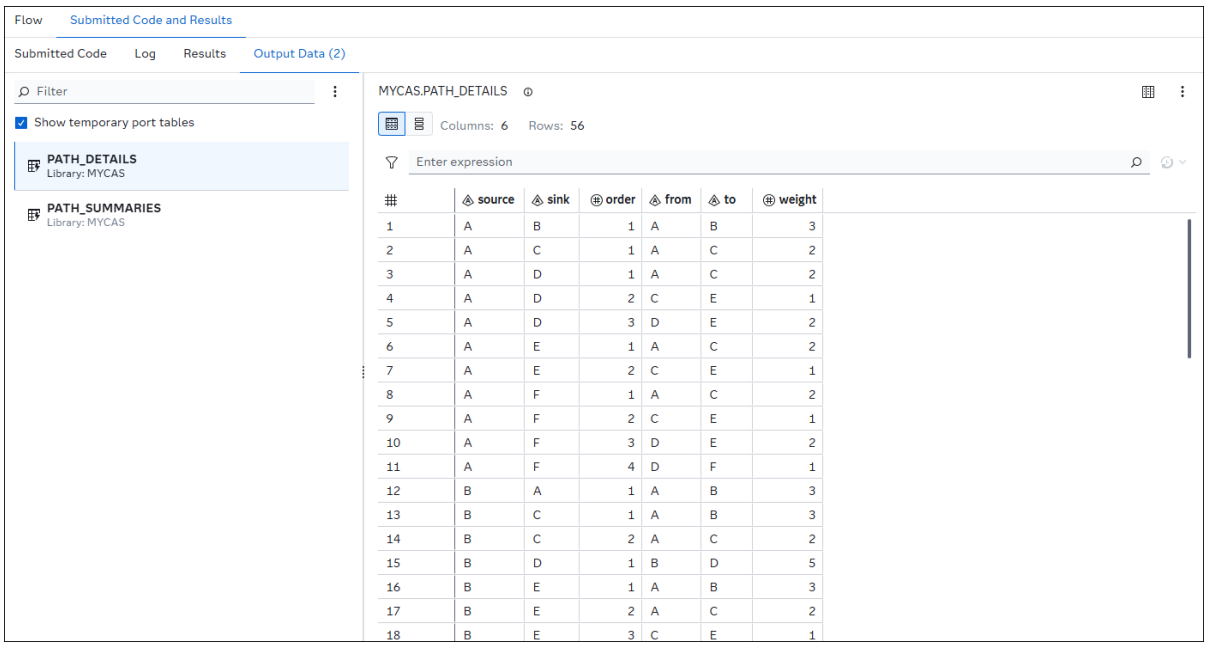
h Connect the Path Summaries Table port to the MyCas.Path_Summaries table.



11 Run the flow.

Click the **Submitted Code and Results** tab to view the results and the output data.





	source	sink	order	from	to	weight
1	A	B	1	A	B	3
2	A	C	1	A	C	2
3	A	D	1	A	C	2
4	A	D	2	C	E	1
5	A	D	3	D	E	2
6	A	E	1	A	C	2
7	A	E	2	C	E	1
8	A	F	1	A	C	2
9	A	F	2	C	E	1
10	A	F	3	D	E	2
11	A	F	4	D	F	1
12	B	A	1	A	B	3
13	B	C	1	A	B	3
14	B	C	2	A	C	2
15	B	D	1	B	D	5
16	B	E	1	A	B	3
17	B	E	2	A	C	2
18	B	E	3	C	E	1

Shortest Paths: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step. Here are the valid values:

- **Compute** - Select this option to run the step using a SAS Compute Server. The input data must be a SAS table.
- **CAS** - Select this option to run the step using a SAS CAS Server. The input data must be a CAS table.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter links data** field.

3 Select the link direction.

4 To the **From node**, assign the variable in the link table that corresponds to the From node of a link.

5 To the **To node**, assign the variable in the link table that corresponds to the To node of a link.

6 To the **Weight**, assign the numeric variable for the link weight.

7 (Optional) To the **Auxiliary weight**, assign the numeric variable for the auxiliary weight.

8 To the **Group analysis by**, assign a variable to obtain separate analyses of observations for each unique group.

Note: This option is available only if you run the step on a CAS server and you do not select the OPTMODEL procedure on the **Options** tab.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the type of problem to solve. Here are the valid options:

- **All source-sink pairs** solves for all the source-sink pairs. This is the default.
- **A subset of source-sink pairs** solves for all the source-sink pairs specified in the data set that you select as the node subset.
- **Specified source-sink pairs** solves for only the source-sink pairs that you specify. You can specify the source node or sink node by selecting it from a

list or entering a value. The values of the source node are from the variable that you assigned to the **From node**. The values of the sink node are from the variable that you assigned to the **To node**.

2 Specify how much information to display in the SAS log.

3 Specify how to generate the code.

If you are running the step on a SAS Compute Server, these options are available:

- **Use OPTNET procedure** - Uses PROC OPTNET to generate the SAS code for the step.
- **Use OPTMODEL procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

If you are running the step on a SAS CAS Server, these options are available:

- **Use NETWORK procedure** - Uses PROC NETWORK to generate the SAS code for the step.
- **Use OPTNETWORK procedure** - Uses PROC OPTNETWORK to generate the SAS code for the step. The OPTNETWORK procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS procedure** - Uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can create these output tables:

- a table that stores the links of the shortest path for each source-sink pair combination
- a table that stores the total weight for the shortest paths for each source-sink pair combination

Note: If you are running the step in a flow, you must add an output port for any output tables to the Shortest Paths node. For more information, see "Shortest Paths: Connection Requirements for the Node" on page 1265.

Transitive Closure

About the Transitive Closure Step

The Transitive Closure step calculates the transitive closure of a graph.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Transitive Closure: Connection Requirements for the Node

In order to run the Transitive Closure step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
If you are running this step on a CAS server, the input table must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output table, use the options on the **Output** tab. If you are running this step on a CAS server, the output table must be a CAS table. For more information, see "Step 3: Set the Output Options" on page 1275. **Note:** You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Transitive Closure

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use Create CAS Connection snippet in SAS Data and AI Studio.

2 Copy and paste this code on a **SAS Program** tab:

```
data LinkSetInTC;
   input from $ to $ @@;
   datalines;
B C  B D  C B  D A  D C
;
```

Run the program to create the Work.LinkSetInTC table.

3 Run this code to load the data into a CAS table:

```
libname mycas cas;

data mycas.linksetintc;
   set work.linksetintc;
run;
```

4 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Transitive Closure** to add the step to your flow.

5 Add the MyCas.LinkSetInTC table to your flow. Connect the input port of the Transitive Closure node to the data source. For more information, see "Connecting Nodes" on page 13.

6 To set the options for the Transitive Closure step, click the Transitive Closure node.

7 On the **Data** tab, select **CAS** as the server for this step.

8 Assign variables to these roles:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.

9 On the **Output** tab, select **Create transitive closure information table**.

10 Add the output table to the flow and connect them to the Transitive Closure node.

a Select **Add** ⇨ **Table**.

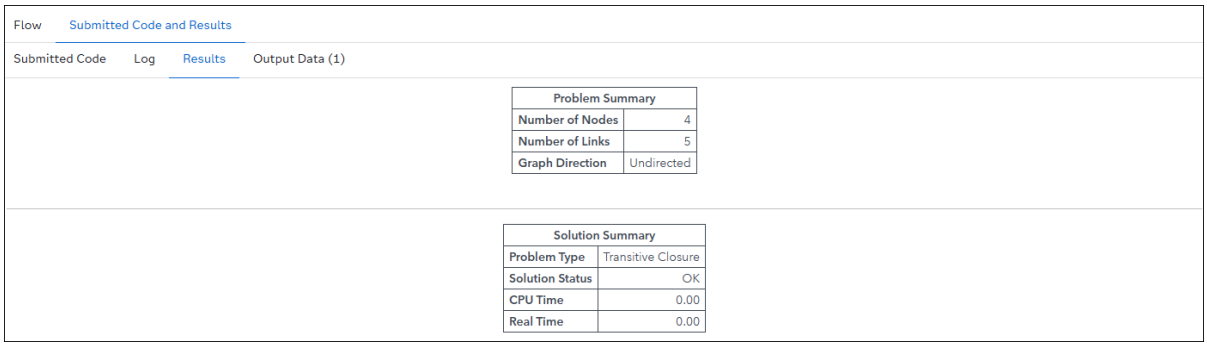
b In the table properties, enter **`MyCas`** as the library name and **`transitive`**.

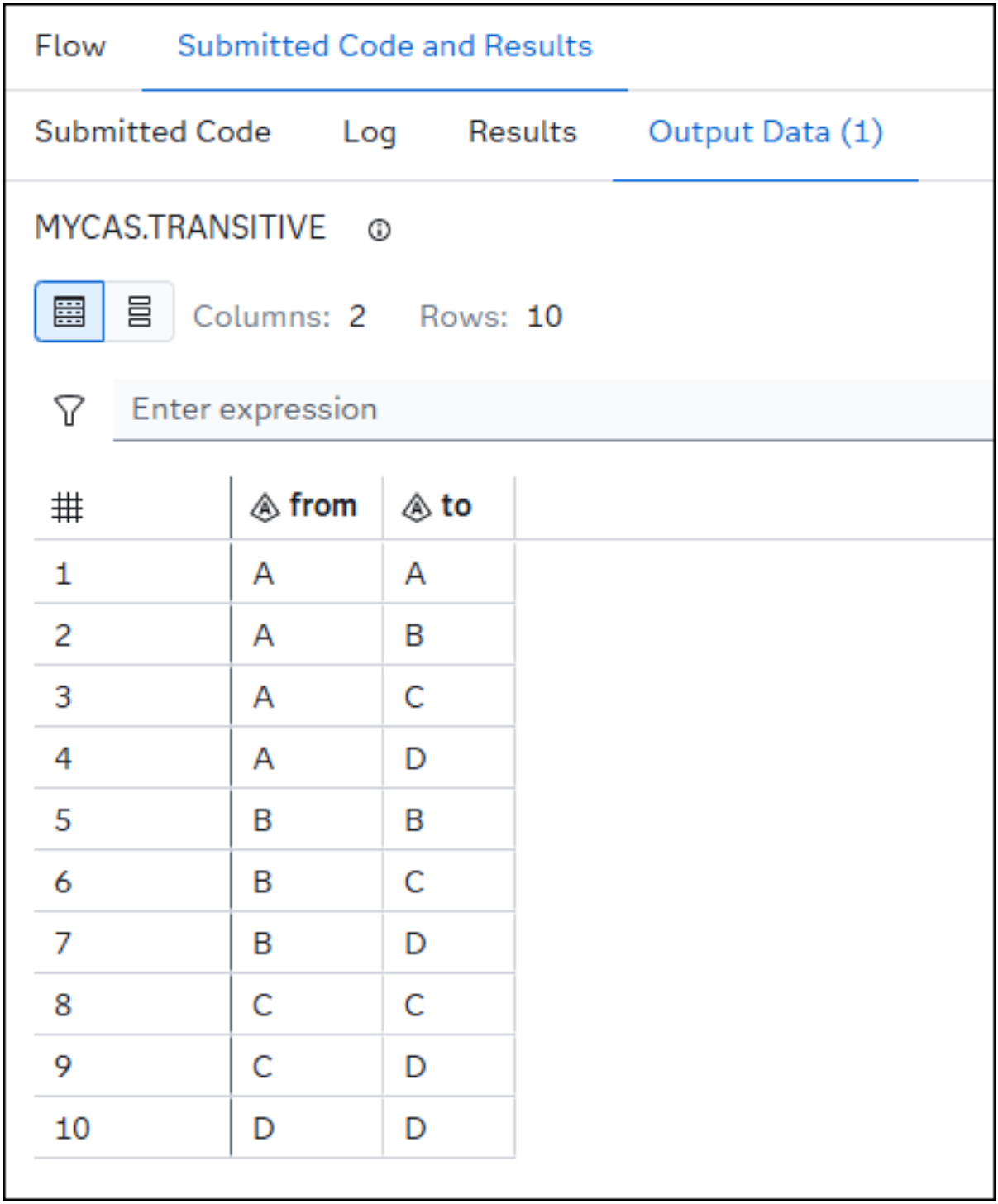
c Right-click Transitive Closure node and select **Add output port**.

d Connect the MyCas.transitive table to the output port.

11 Run the flow.

Click the **Submitted Code and Results** tab to view the results.





#	from	to
1	A	A
2	A	B
3	A	C
4	A	D
5	B	B
6	B	C
7	B	D
8	C	C
9	C	D
10	D	D

Transitive Closure: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server for this step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the links data source, enter the filter expression in the **Filter links data** field.

3 Specify the link direction.

4 To the **From node**, assign the variable in the link table that corresponds to the From node of a link.

5 To the **To node**, assign the variable in the link table that corresponds to the To node of a link.

6 To the **Group analysis by**, assign a variable to obtain separate analyses of observations for each unique group.

Note: This option is available only if you are using a CAS server. Group analysis is not available if you select the OPTMODEL procedure on the **Options** tab.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify how much information to display in the SAS log.

2 Specify how to generate the code.

These options are available if you are using a SAS Compute server.

- **Use OPTNET procedure** - Uses PROC OPTNET to generate the SAS code for the step.
- **Use OPTMODEL procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful

OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

These options are available if you are using a CAS server.

- **Use NETWORK procedure** - Uses PROC NETWORK to generate the SAS code for the step.
- **Use OPTNETWORK procedure** - Uses PROC OPTNETWORK to generate the SAS code for the step. The OPTNETWORK procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
- **Use OPTMODEL procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
- **Use CAS procedure** - Uses the CAS procedure and CAS actions to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can create a table that contains the transitive closure information. If you are using a CAS server to run the step, this table must be a CAS table.

Note: If you are running the step in a flow, you must add an output port to the Transitive Closure node. For more information, see "Transitive Closure: Connection Requirements for the Node" on page 1270.

Traveling Salesman Problem

About the Traveling Salesman Problem Step

The traveling salesman problem (TSP) finds a minimum-cost tour in a graph. A *tour* of a graph is a sequence of nodes where the start node and end node are the same, and every node in the graph is visited exactly once. In solving the TSP, the goal is to find a tour that minimizes the costs of the links.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or

SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Traveling Salesman Problem: Connection Requirements for the Node

In order to run the Traveling Salesman Problem step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. For more information, see "Step 3: Set the Output Options" on page 1279. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Finding Traveling Salesman Problem

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

```
data LinkSetInUndirected;
   input from $ to $ weight @@;
   datalines;
A B 1.0 A C 1.0 A D 1.5 B C 2.0 B D 4.0
B E 3.0 C D 3.0 C F 3.0 C H 4.0 D E 1.5
D F 3.0 D G 4.0 E F 1.0 E G 1.0 F G 2.0
F H 4.0 H I 3.0 I J 1.0 C J 5.0 F J 3.0
F I 1.0 H J 1.0
;
```

Click **Run** to create the Work.LinkSetInUndirected table.

2 In the **Steps** section of the navigation pane, expand the **Optimization and Network Analysis** folder and double-click **Traveling Salesman Problem** to add the step to your flow.

3 Add the Work.LinkSetInUndirected table to your flow. Connect the input port of the Traveling Salesman Problem node to the data source. For more information, see "Connecting Nodes" on page 13.

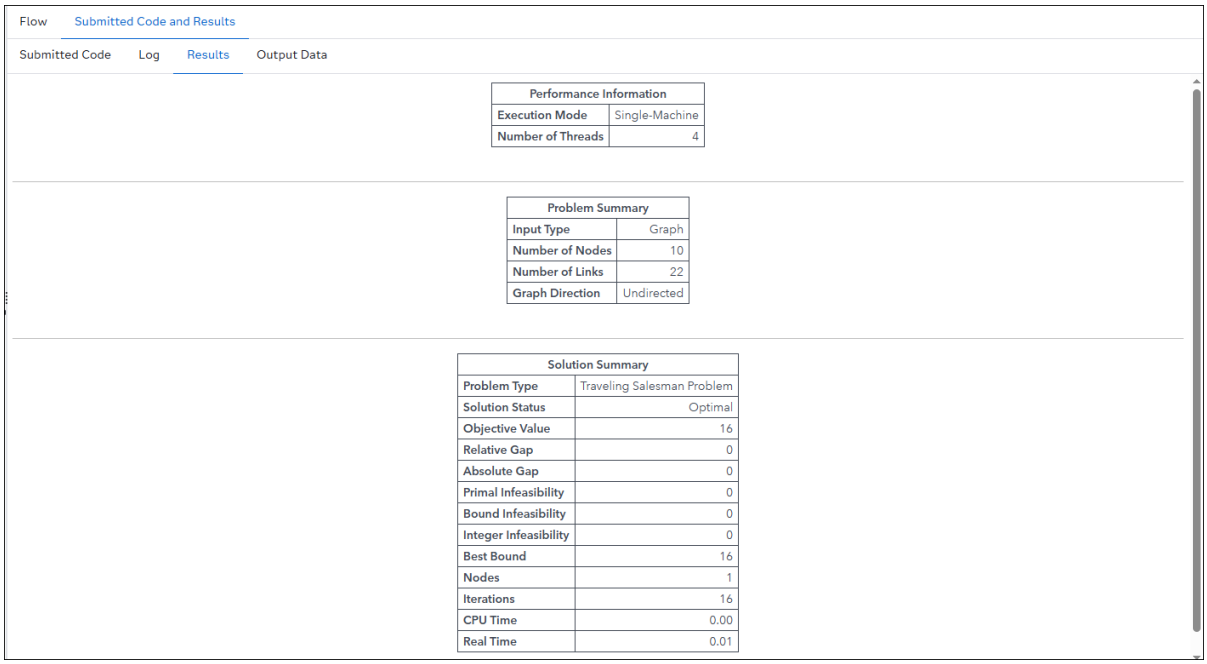
4 To set the options for the Traveling Salesman Problem step, click the Traveling Salesman Problem node.

5 On the **Data** tab, assign variables to these roles:

- To the **From node** role, assign **from**.
- To the **To node** role, assign **to**.
- To the **Weight** role, assign **weight**.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Performance Information	
Execution Mode	Single-Machine
Number of Threads	4

Problem Summary	
Input Type	Graph
Number of Nodes	10
Number of Links	22
Graph Direction	Undirected

Solution Summary	
Problem Type	Traveling Salesman Problem
Solution Status	Optimal
Objective Value	16
Relative Gap	0
Absolute Gap	0
Primal Infeasibility	0
Bound Infeasibility	0
Integer Infeasibility	0
Best Bound	16
Nodes	1
Iterations	16
CPU Time	0.00
Real Time	0.01

Traveling Salesman Problem: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 Select the server to use for the step.

You can run this step on SAS Compute Server or a CAS server. The features that are available in the step might be different depending on where you run the step.

- Most of the time, you can use SAS Compute Server. Using SAS Compute Server enables you to use any library for the input and output tables.
- If you are using SAS Cloud Analytic Services, run this step on a CAS server to get the best performance using in-memory execution. To use a CAS server, the input and output tables must be in a CAS library.

2 (Optional) To filter the input data source, enter the filter expression in the **Filter links data** field.

3 To the **From node** role, assign the variable in the link data set that corresponds to the From node of a link.

4 To the **To node** role, assign the variable in the link data set that corresponds to the To node of a link.

5 (Optional) To the **Weight** role, specify the numeric variable for the link weight.

6

7 (Optional) To the **Group analysis by** role, assign the variable to obtain separate analyses of observations in groups that are defined by the BY variables.

Note: This option is available only if you are running on a CAS server. This option is disabled if you select **Use OPTMODEL procedure** on the **Options** tab.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 (Optional) Specify the maximum amount of time to spend calculating the optimal solution.

2 Specify how much information to display in the log.

3 Specify how to find the solution for the analysis. Here are the available options:

- **Heuristics** specifies that the initial heuristics for the OPTNET procedure are used to a find a feasible tour as quickly as possible. This tour might not be the optimal solution.
- **Mixed integer linear programming (MILP)** uses the MILP solver to find the overall best tour. MILP uses a branch-and-bound-based algorithm, which can be expensive for large-scale problems.

  If you select the MILP solution strategy, you can also set these options:

  - **Target objective value** specifies a stopping criterion for minimization problems. If the best integer objective is better than or equal to the target objective value, the MILP solver stops.
  - **Absolute gap between current and best remaining objective value** specifies a stopping criterion. When the absolute difference between the best integer objective and the objective of the best remaining branch-and-bound node becomes less than the specified value of the gap, the solver stops. The default value is `0.000001`.
  - **Relative gap between current and best remaining objective value** specifies a stopping criterion that is based on the best integer objective and the objective of the best remaining branch-and-bound node. When the relative gap becomes less than the specified value of the gap, the solver stops. The default value is `0.0001`.

4 Specify how to generate the code.

  If you are running on a SAS Compute Server, you have these options:

  - **Use OPTNET Procedure** - Uses PROC OPTNET to generate the SAS code for the step. The OPTNET procedure includes a number of graph theory, combinatorial optimization, and network analysis algorithms.
  - **Use OPTMODEL Procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.

  If you are running on a SAS CAS Server, you have these options:

  - **Use OPTNETWORK procedure** - Uses PROC OPTNETWORK to generate the SAS code for the step.
  - **Use OPTMODEL procedure** - Uses PROC OPTMODEL to generate the SAS code for the step. The OPTMODEL procedure includes the powerful OPTMODEL modeling language and state-of-the-art solvers for several classes of mathematical programming problems.
  - **Use CAS procedure** - Uses PROC CAS to generate the SAS code for the step.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains the tour information.

2 (Optional) Specify whether to create an output table that contains the tour nodes information.

Note: If you are running the step in a flow, you must add an output port to the Traveling Salesman Problem node. For more information, see "Traveling Salesman Problem: Connection Requirements for the Node" on page 1276.

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Controlling the Statistical Process

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Analysis of Means

About the Analysis of Means Step

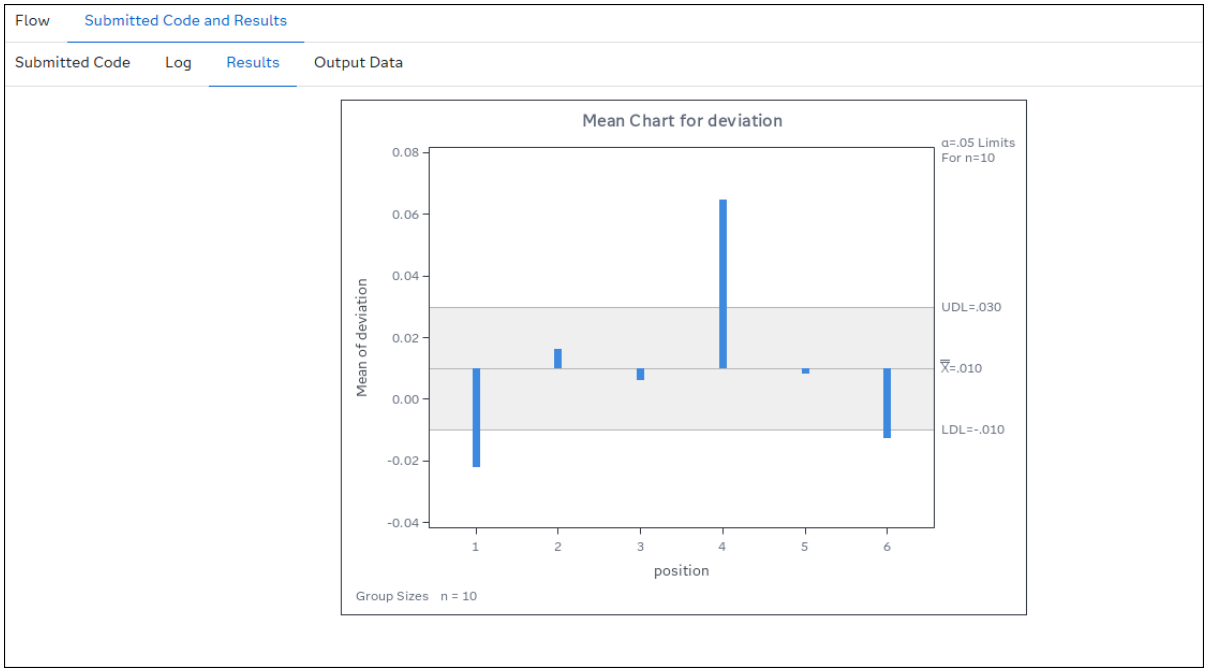
Analysis of means is a method for simultaneously comparing treatment means with their overall mean. The Analysis of Means step is available only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Mean Chart

The Mean chart shows the deviation of the mean for the groups identified by the **Group variable**.

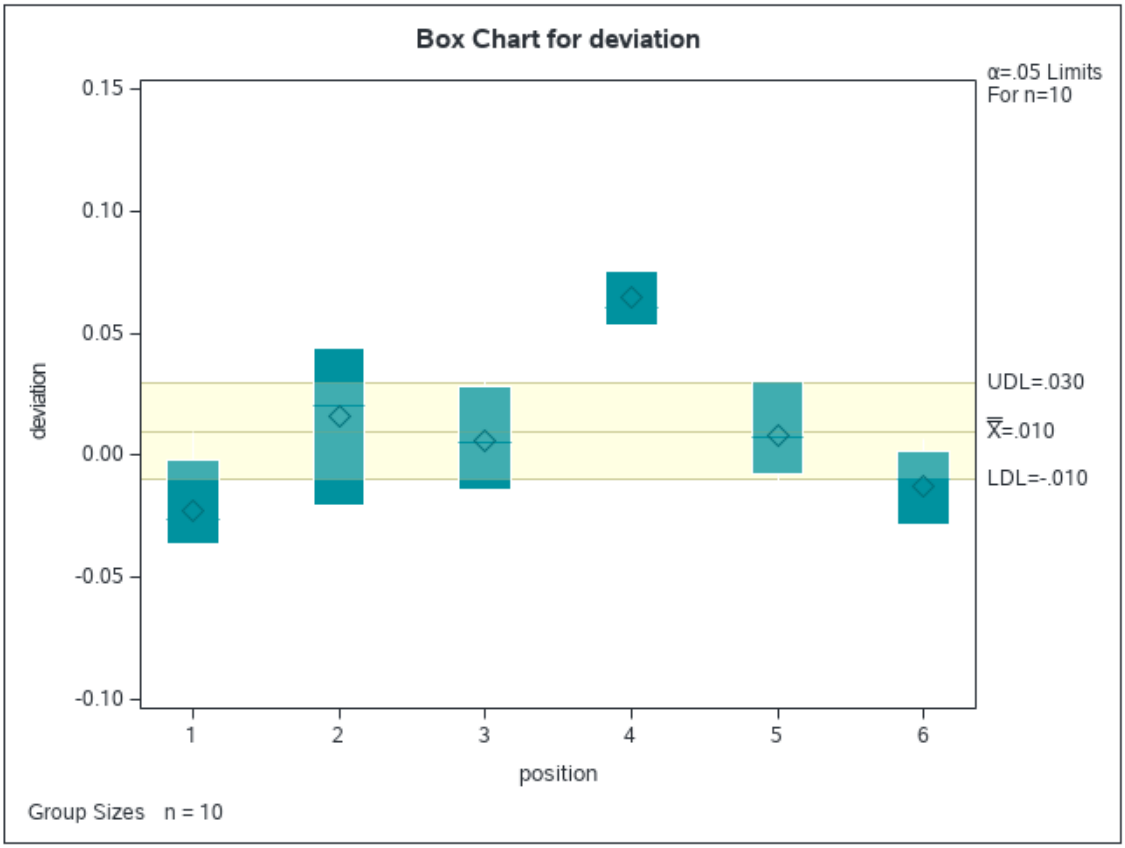
Here is an example of a mean chart. For more information, see "Example: Determine the Deviation of Label Positions" on page 1286.



Mean Chart with Boxes

You can choose to include box plots to show the deviation of the means for each group.

Here is an example of a mean chart with boxes:

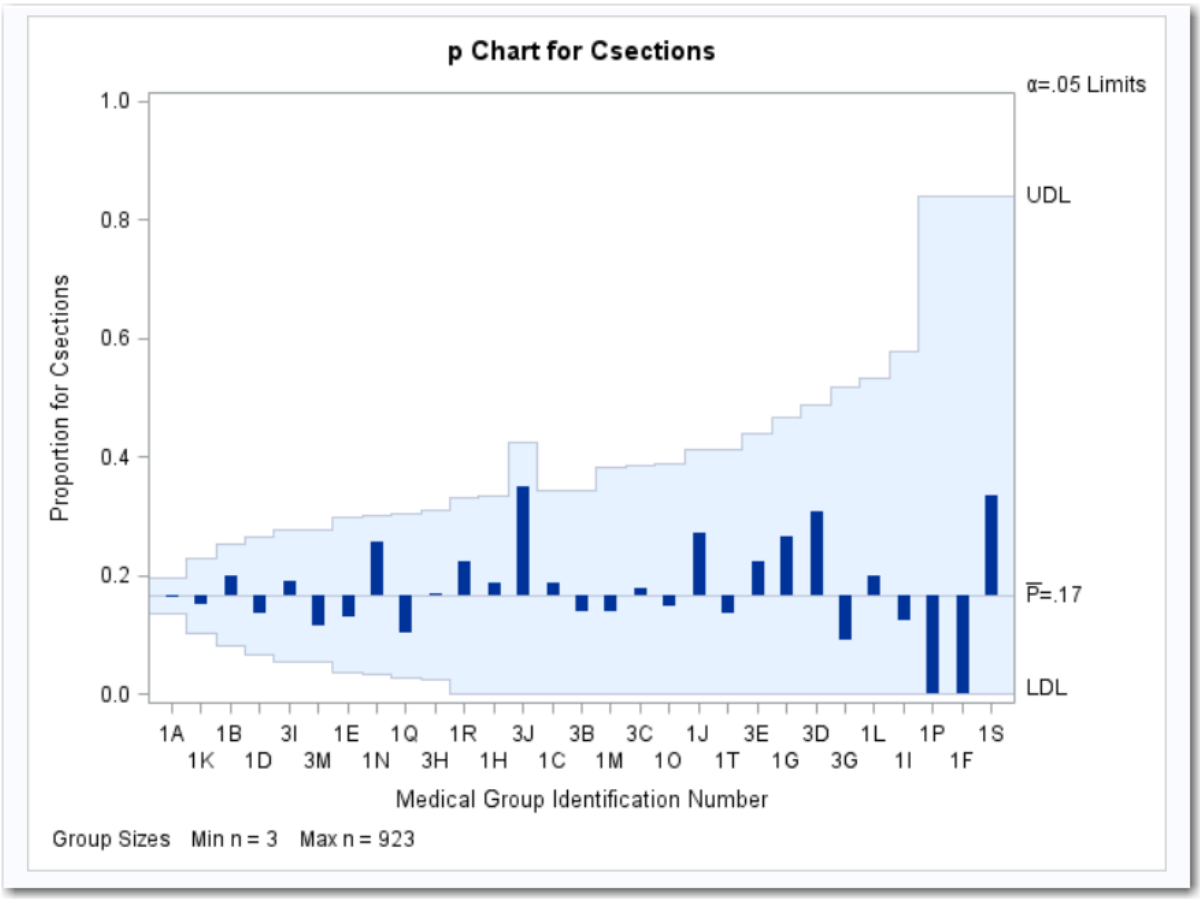


Proportion Chart

Proportion charts (also called *p* charts) are for the group (treatment-level) proportions.

A health care system administrator wants to compare Cesarean section rates for a set of medical groups (Rodriguez 1996).

For the analysis, the administrator creates this *p* chart.

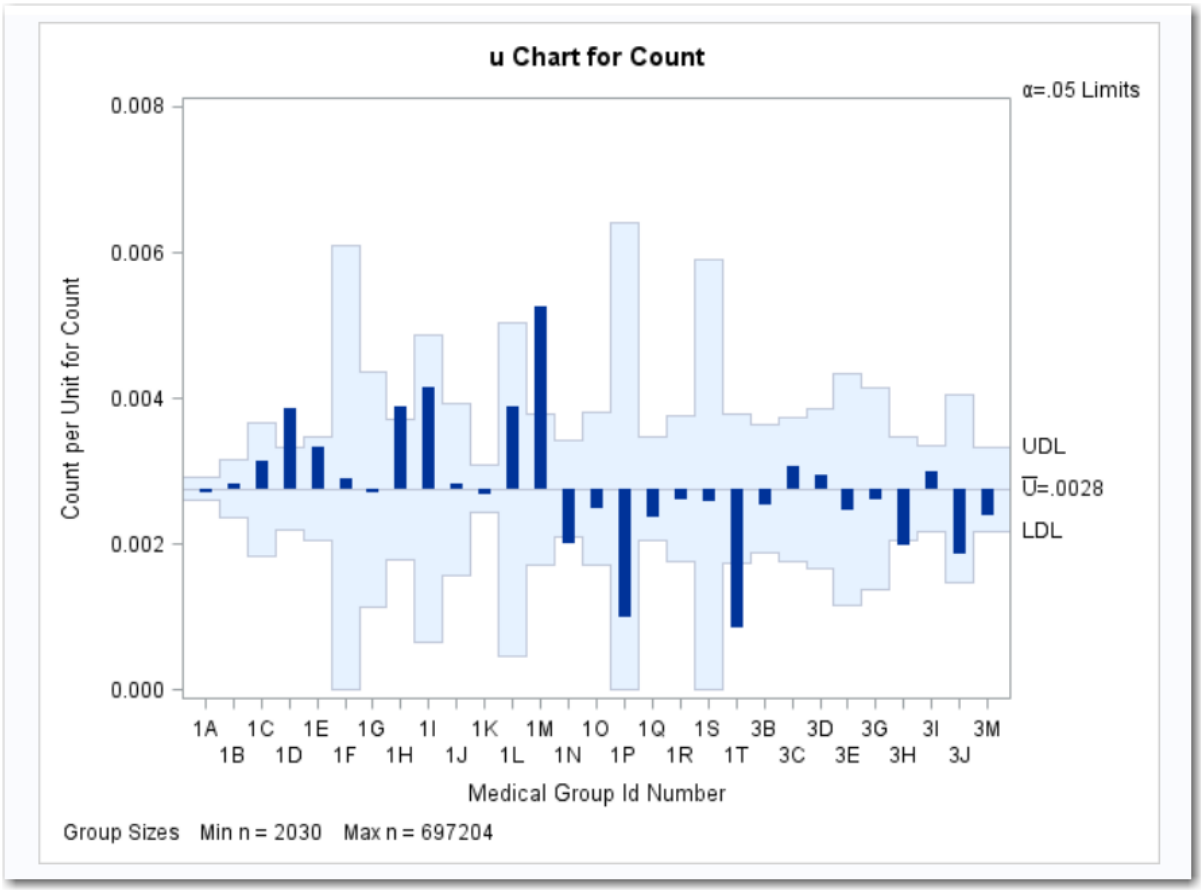


Each point on the *p* chart represents the proportion of C-sections for a particular group. For example, the value plotted for group 1A is 150/923=0.163. Because all the points fall within the decision limits, it can be concluded that the variation in proportions of C-sections across medical groups is strictly due to chance. By default, the decision limits shown correspond to a significance level of alpha equals 0.05. If you assume that all groups have the same proportion of C-sections, there is a 0.05 probability that one or more of the decision limits are exceeded purely by chance. The decision limits vary with the number of deliveries in each group, and the widest limits correspond to the group with the smallest number of deliveries.

Rate Chart

A rate chart (also called a *u* chart) is for group (treatment-level) rates. The rate plotted on a *u* chart is the number or count of events that occur in a group divided by a measure of the opportunity for an event to occur.

A health care administrator wants to compare the admission rates for a set of clinics (Rodriguez 1996).



Each point on the *u* chart represents the rate of occurrence, computed as the count divided by the number of opportunity units. The points are displayed in the sort order for the group variable, ID. The chart shows that Clinics 1D, 1H, and 1M have significantly higher admissions rates, and Clinics 1N, 1T, and 3H have significantly lower admissions rates.

By default, the decision limits correspond to a significance level of alpha equals 0.05. If you assume that all clinics have the same rate of admissions, there is a 0.05 probability that one or more of the decision limits are exceeded purely by chance. The decision limits vary with the number of 1,000 member years for each clinic.

Analysis of Means: Connection Requirements for the Node

In order to run the Analysis of Means step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or	By default, no output data is created. No connection is required.

Input Port	Output Port
■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	To create an output data table, you must select the options on the **Output** tab. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Determine the Deviation of Label Positions

A manufacturing engineer conducts a study to determine the source of excessive variation in the positioning of labels on shampoo bottles (Hansen 1990). A labeling machine removes bottles from the line, attaches the labels, and returns the bottles to the line. There are six positions on the machine, and the engineer suspects that one or more of the position heads might be faulty.

A sample of 60 bottles, 10 per position, is run through the machine. For each bottle, the deviation of the label is measured in millimeters, and the machine position is recorded. In this example, you create a SAS data set named LabelDeviations, which contains the deviation measurements for the 60 bottles.

1 Copy and paste this code on a **SAS Program** tab.

```
data labeldeviations;
   input position @;

   do i=1 to 5;
      input deviation @;
      output;
   end;
   drop i;
   datalines;
1 -0.02386 -0.02853 -0.03001 -0.00428 -0.03623
1 -0.04222 -0.00144 -0.06466 0.00944 -0.00163
2 -0.02014 -0.02725 0.02268 -0.03323 0.03661
2 0.04378 0.05562 0.00977 0.05641 0.01816
3 -0.00728 0.02849 -0.04404 -0.02214 -0.01394
3 0.04855 0.03566 0.02345 0.01339 -0.00203
4 0.06694 0.10729 0.05974 0.06089 0.07551
4 0.03620 0.05614 0.08985 0.04175 0.05298
5 0.03677 0.00361 0.03736 0.01164 -0.00741
5 0.02495 -0.00803 0.03021 -0.00149 -0.04640
6 0.00493 -0.03839 -0.02037 -0.00487 -0.01202
6 0.00710 -0.03075 0.00167 -0.02845 -0.00697
```

Run the flow to create the Work.LabelDeviations table.

2 In the **Steps** section of the navigation pane, expand the **Statistical Process Control** folder and double-click **Analysis of Means** to add the step to your flow.

3 Add the Work.LabelDeviations table to your flow. Connect the input port of the Analysis of Means node to the data source. For more information, see "Connecting Nodes" on page 13.

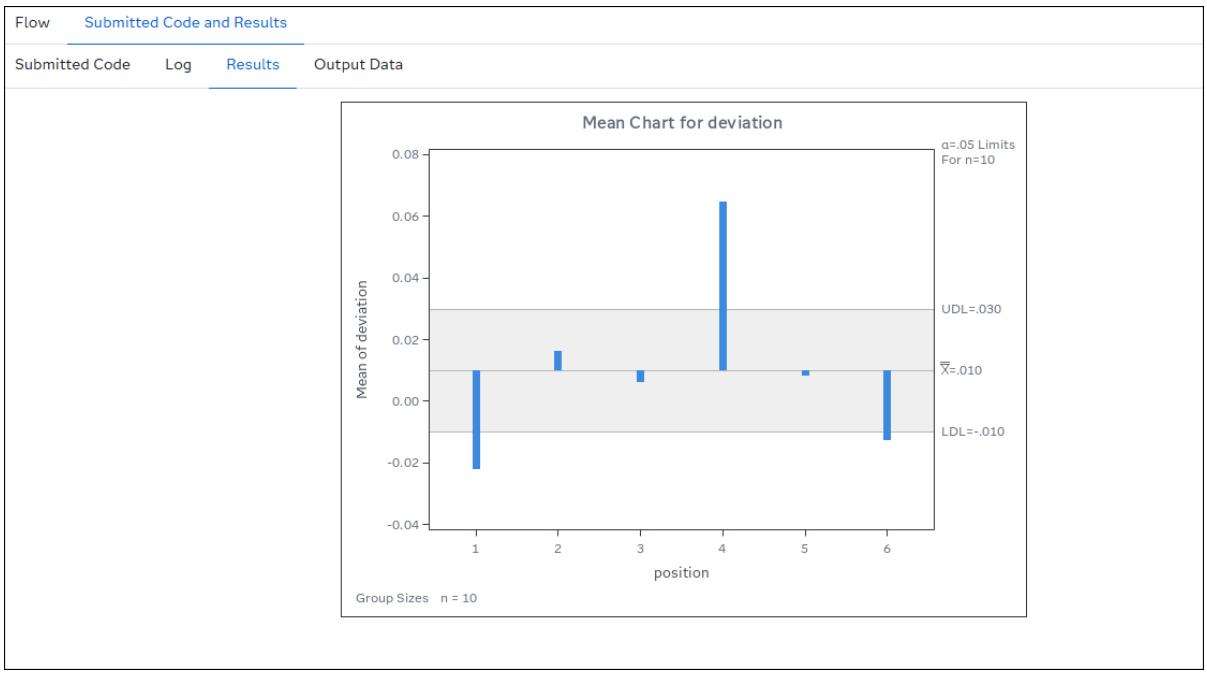
4 To set the options for the Analysis of Means step, click the Analysis of Means node.

On the **Data** tab, assign columns to these roles:

- To the **Response variable** role, assign **deviation**.
- To the **Group variable** role, assign **position**.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here are the results:



Each point on the chart represents the average (mean) of the response measurements for a particular sample. The average for Position 1 is below the lower decision limit (LDL), and the average for Position 6 is slightly below the lower decision limit. The average for Position 4 exceeds the upper decision limit (UDL). The conclusion is that Positions 1, 4, and 6 are operating differently.

Analysis of Means: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Analysis of Means step, you must assign a column to the **Response variable** and **Group variable** roles.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Response variable** role, assign the variable that contains the responses to analyze.

3 To the **Group variable** role, assign the variable that identifies the groups in the data.

4 Select the type of chart. For more information about the chart types, see "About the Analysis of Means Step" on page 1281.

5 (Optional) To obtain separate analyses of observations for each unique group, assign a variable to the **Group analysis by** role.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 For the **Decision limits method** option, specify whether to compute the control limits by using the current input table or by using a different table.

- If you use the input table, you can set the **Compute from data** option.
- If you want to compute the data from a different table, select **Use stored limits**, and then select the table to use. The table that you select must be a LIMITS= table. For more information about the variables that are required in a LIMITS= table, see the procedure documentation for the chart that you are creating.

  In the Analysis of Means step, you can create this table by selecting the **Save control limits** check box on the **Output** tab and then running the step. After the step runs, select **Use stored limits** and select the newly created table.

2 (Optional) Select **Display table of points that exceed limits** to create a basic table for subgroups whose decision limits are exceeded. Each row of the table corresponds to a subgroup. For each subgroup, the table shows the sample size, the group mean, and the upper and lower control limits.

3 (Optional) Specify whether to include an insert table in the output.

You can also choose statistics to include in this table: significance level, degrees of freedom, average of group means, and mean square error.

Step 3: Set the Output Options

(Optional) You can choose to create a decision limits table or a table that contains both the statistics and decision limits. By default, these tables are saved in the Work library.

Capability Analysis

About the Capability Analysis Step

Capability analysis compares the distribution of a process to its specification limits. When you run the Capability Analysis step, the output includes a variety of statistics for summarizing the data distribution of the process variable. Examples of statistics are sample moments, basic statistical measures, and quantiles.

When you add specification limits, the output includes statistics such as percents of measurements within and outside the specification limits and process capability indices.

You can plot the results by using a histogram, a probability plot, and a quantile-quantile plot.

- Histograms are typically used in process capability analysis to compare the distribution of measurements from an in-control process to its specification limits.
- A probability plot compares ordered values of a variable with percentiles of a specified theoretical distribution such as the normal. If the data distribution matches the theoretical distribution, the points on the plot form a linear pattern. Thus, you can use a probability plot to determine how well a theoretical distribution models a set of measurements.
- A quantile-quantile plot (Q-Q plot) compares ordered values of a variable with quantiles of a specified theoretical distribution such as the normal. If the data distribution matches the theoretical distribution, the points on the plot form a linear pattern. Thus, you can use a Q-Q plot to determine how well a theoretical distribution models a set of measurements.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as

a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Capability Analysis: Connection Requirements for the Node

In order to run the Capability Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Analysis of Plating Thickness

To create this example:

1 Copy and paste this code on a **SAS Program** tab.

```
data trans;
   input thick @@;
   label thick='Plating Thickness (mils)';
   datalines;
3.468 3.428 3.509 3.516 3.461 3.492 3.478 3.556 3.482 3.512
3.490 3.467 3.498 3.519 3.504 3.469 3.497 3.495 3.518 3.523
3.458 3.478 3.443 3.500 3.449 3.525 3.461 3.489 3.514 3.470
3.561 3.506 3.444 3.479 3.524 3.531 3.501 3.495 3.443 3.458
3.481 3.497 3.461 3.513 3.528 3.496 3.533 3.450 3.516 3.476
3.512 3.550 3.441 3.541 3.569 3.531 3.468 3.564 3.522 3.520
3.505 3.523 3.475 3.470 3.457 3.536 3.528 3.477 3.536 3.491
3.510 3.461 3.431 3.502 3.491 3.506 3.439 3.513 3.496 3.539
3.469 3.481 3.515 3.535 3.460 3.575 3.488 3.515 3.484 3.482
3.517 3.483 3.467 3.467 3.502 3.471 3.516 3.474 3.500 3.466
run;
```

Run the flow to create the Work.Trans table.

2 In the **Steps** section of the navigation pane, expand the **Statistical Process Control** folder and double-click **Capability Analysis** to add the step to your flow.

3 Add the Work.Trans table to your flow. Connect the input port of the Capability Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Capability Analysis step, click the Capability Analysis node.

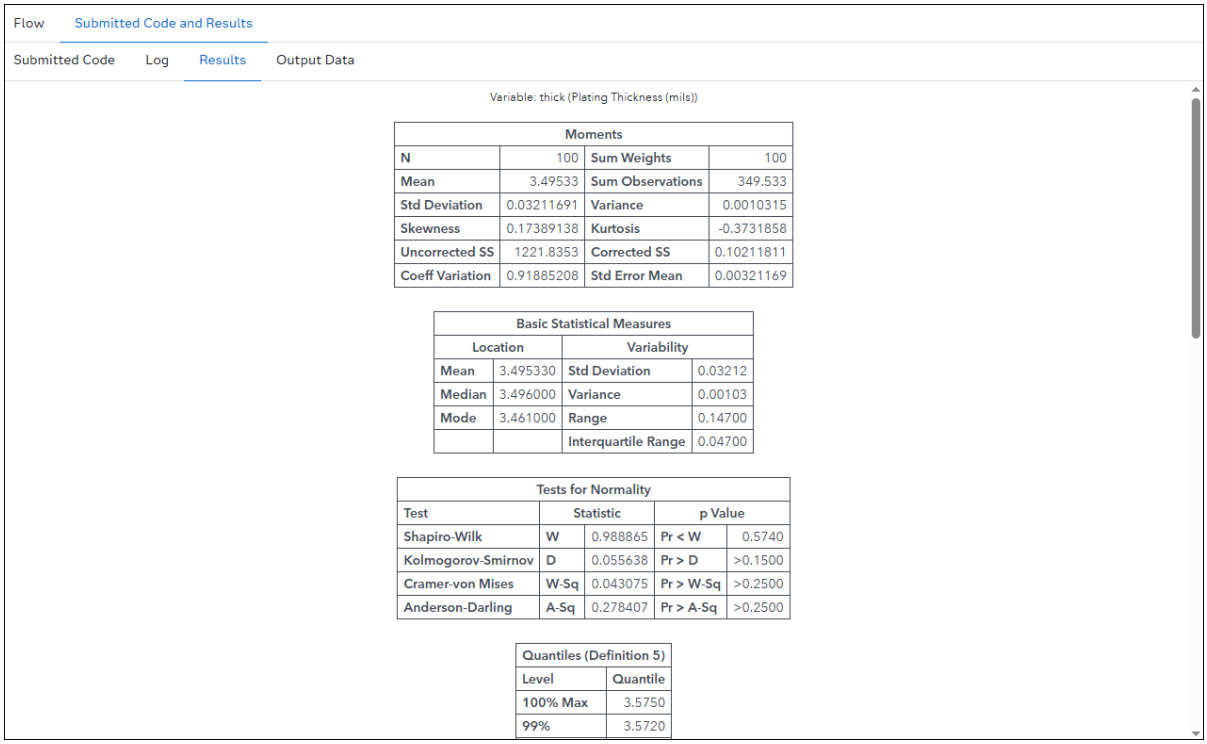
5 On the **Data** tab, assign **thick** to the **Process variable** role.

6 For the lower specification limit, enter `3.45`.

7 For the upper specification limit, enter `3.55`.

8 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Capability Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Process variable** role, assign the variable that you want to analyze.

3 Specify the target value.

4 Specify the value for the lower specification limit.

5 Specify the value for the upper specification limit.

6 (Optional) To the **Classification variable** role, assign one or two variables that are used to group the data into classification levels. These variables can have floating-point values, but they typically have a few discrete values that define levels of the variable.

7 (Optional) To the **Group analysis by** role, assign the variables that enable you to obtain separate analyses of observations for each unique group.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify the plots to include in the results.

2 Specify whether to add an insert table of summary statistics to the graph. The insert can include these statistics:

- sample size
- sample mean
- sample standard deviation
- Capability index C_p
- Capability index C_{pk}
- Capability index C_{pl}
- Capability index C_{pm}
- Capability index C_{pu}

Note: The availability of the capability indices depends on whether you entered specification limits on the **Data** tab.

Step 3: Set the Output Options

On the **Output** tab, you can specify whether to create an output table. By default, the output table is saved in the Work library.

Control Charts

About the Control Charts Step

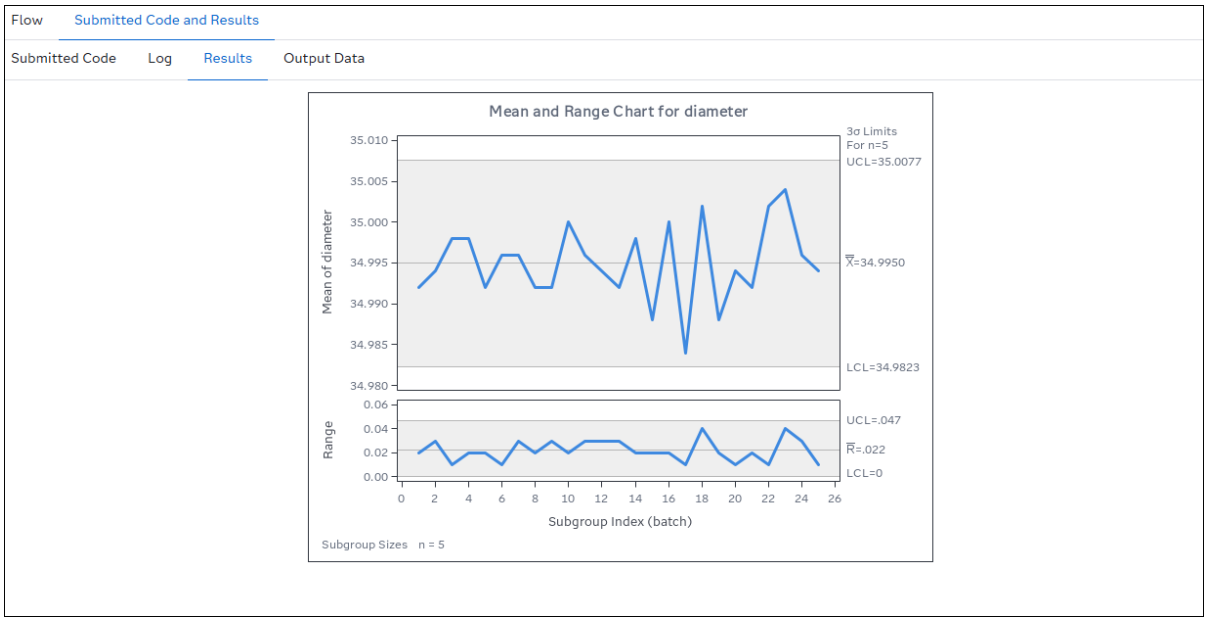
The Control Charts step creates Shewhart control charts for deciding whether a process is in a state of statistical control. Using the Control Charts step, you can create these types of charts. The Control Charts step is available only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Mean and Range Chart

The Mean and Range chart displays the subgroup means and the subgroup ranges. These charts are useful for analyzing the central tendency and the variability of a process.

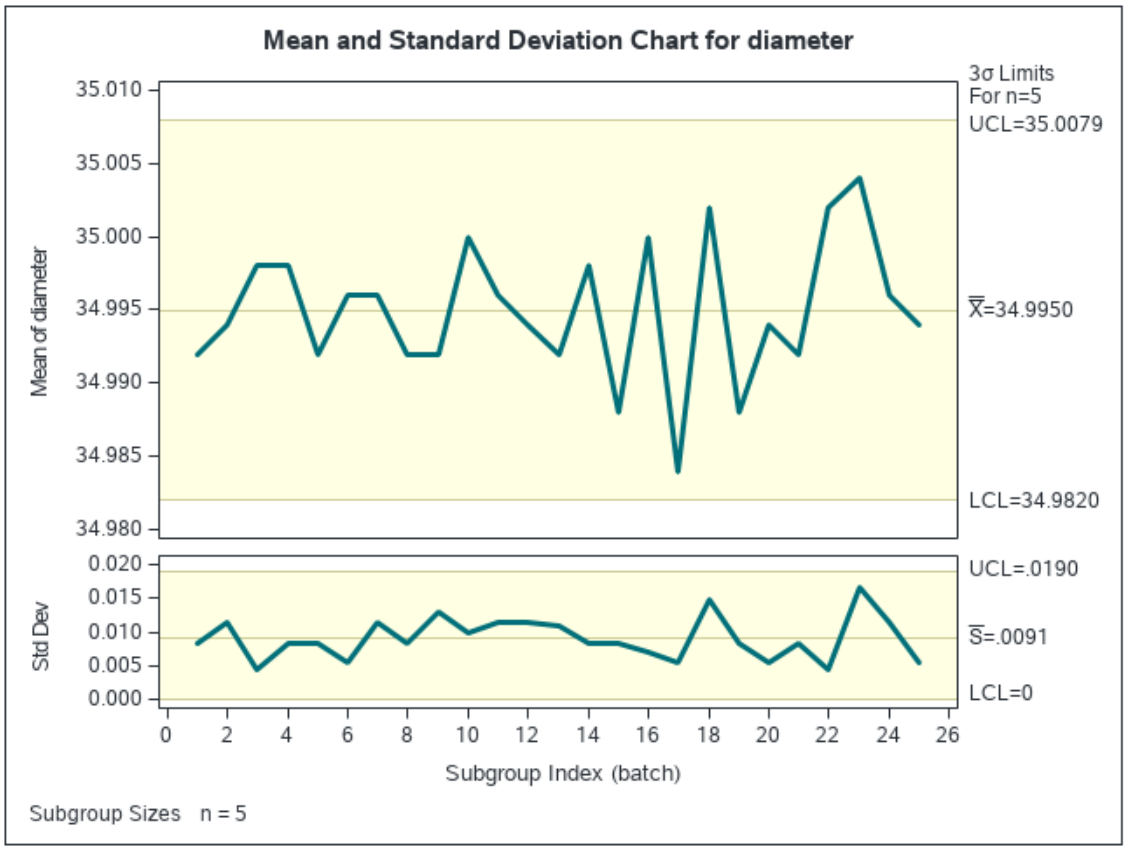
Suppose that in the manufacture of silicon wafers, batches of five wafers are sampled, and their diameters are measured in millimeters. The measurements for 25 batches are stored in a SAS data set, which is used to create the mean and range charts. Each point on the mean chart represents the average (mean) of the measurements for a particular batch. Each point on the range chart represents the range of the measurements for a particular batch. If all the points fall within the control limits, you can conclude that the process is in statistical control.



Mean and Standard Deviation Chart

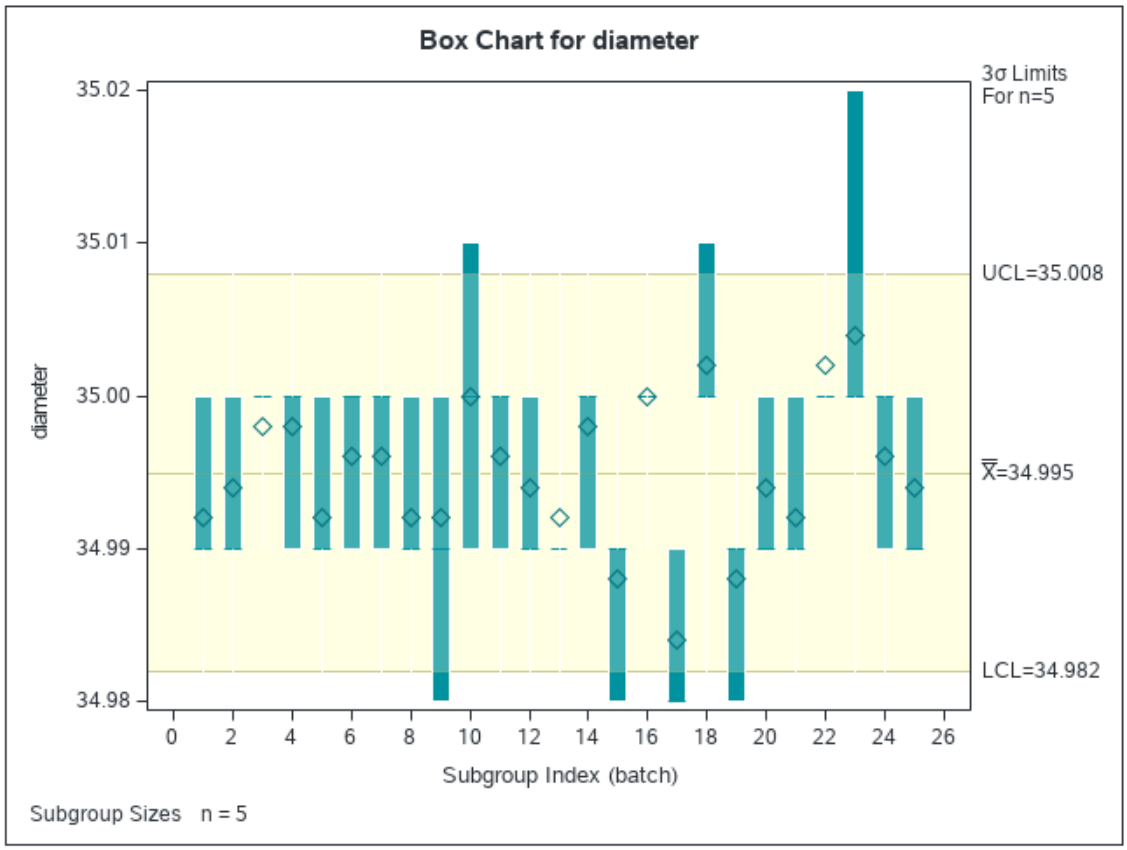
The Mean and Standard Deviation chart displays the subgroup means and the subgroup standard deviations. These charts are useful for analyzing the central tendency and the variability of a process.

You might want to use this chart to find the distribution of the output and to determine whether a process is in statistical control. For example, suppose a petroleum company uses a turbine to heat water into steam that is pumped into the ground to make oil less viscous and easier to extract. This process occurs 20 times daily, and the amount of power (in kilowatts) that is used to heat the water to the desired temperature is recorded. Each point on the mean chart represents the mean of the measurements for a particular day. Each point on the standard deviation chart represents the standard deviation of the measurements for a particular day. If all the points lie within the control limits, it can be concluded that the process is in statistical control.



Mean with Box-And-Whisker Plot

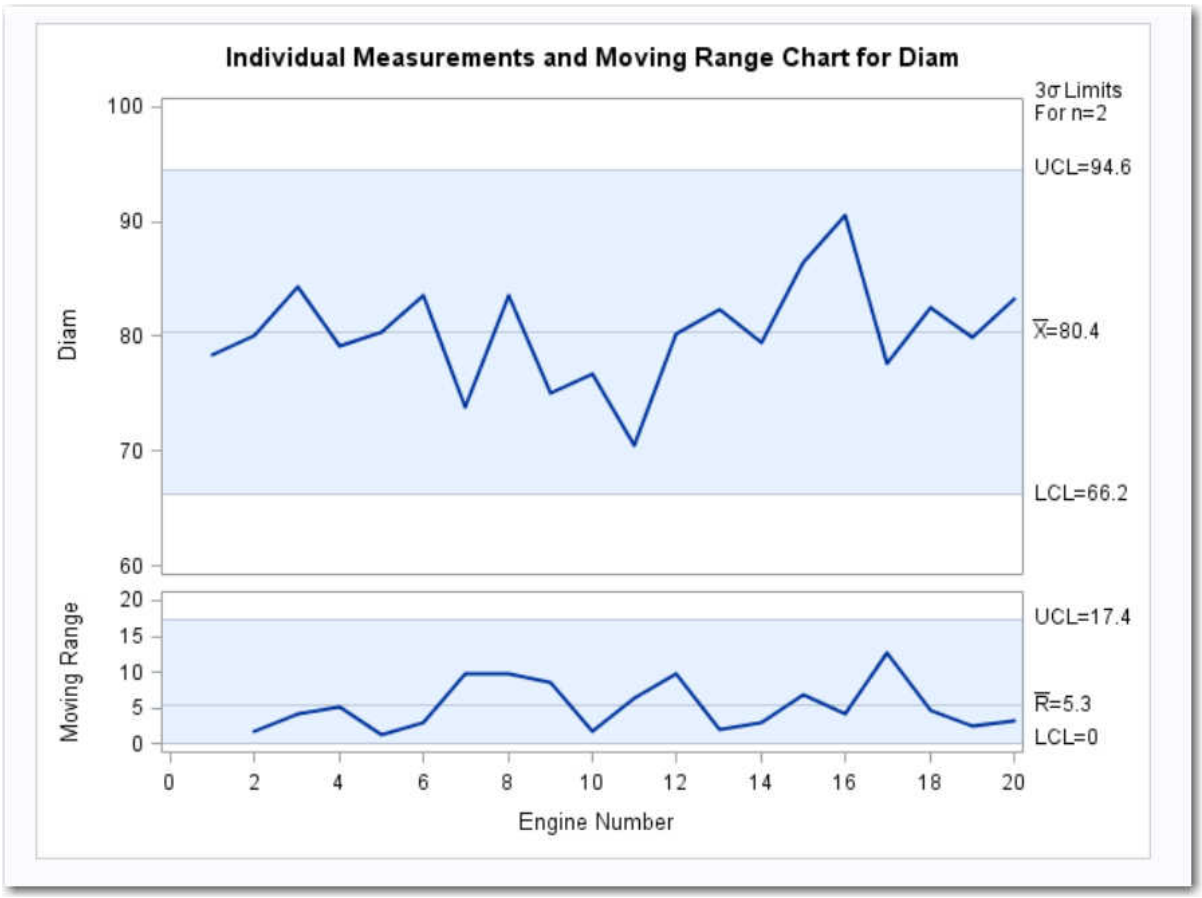
The Mean with Box-and-Whisker plot is a chart of the subgroup means superimposed with box-and-whisker plots for the measurements in each subgroup.



Individual Measurements

The Individual Measurements chart displays the individual measurements and the moving ranges. These charts are appropriate when only one measurement is available for each subgroup sample and when the measurements are independently and normally distributed. You might want to use this step to analyze a manufacturing process.

Suppose that an aeronautics company that manufactures jet engines measures the inner diameter of the forward face of each engine (in centimeters). The diameter measurements of 20 engines are stored in a SAS data set. Each point on the individual measurements chart indicates the inner diameter of a particular engine. Each point on the moving range chart indicates the range of the two most recent measurements. If all the individual measurements and moving ranges fall within the control limits, you can conclude that the process is in statistical control.

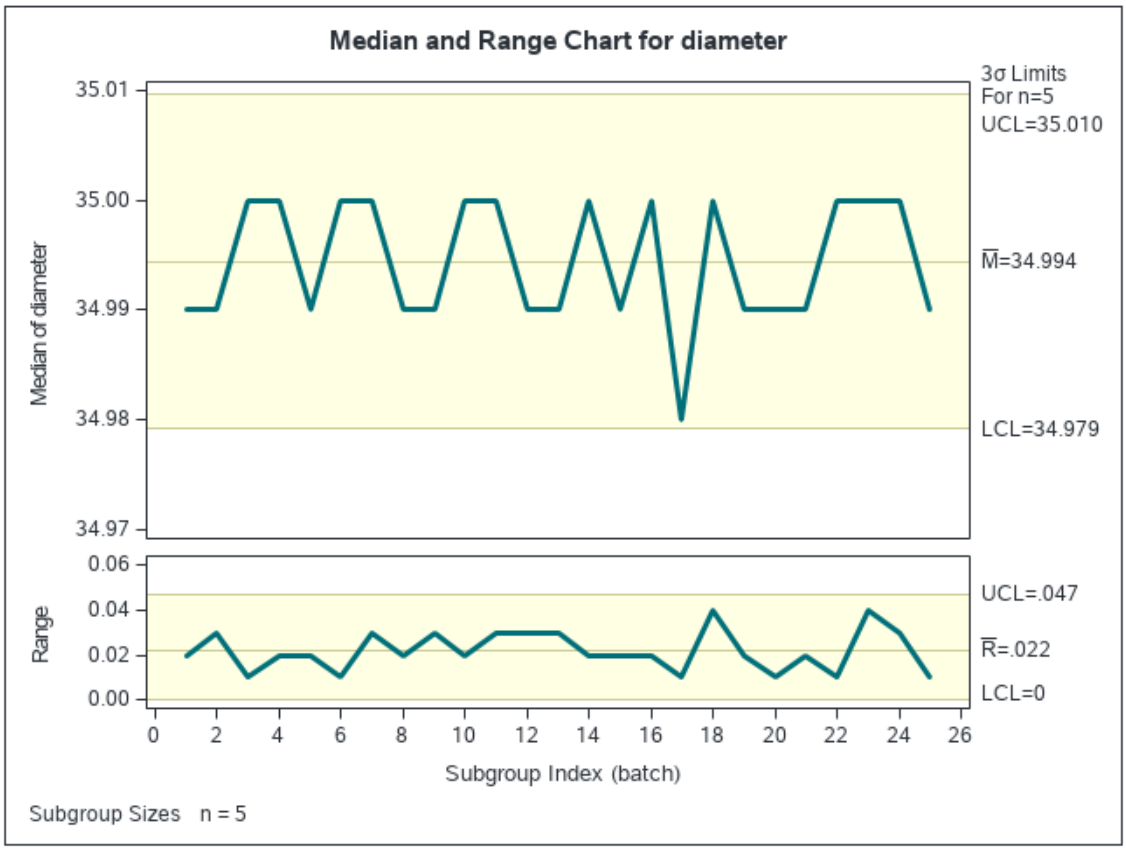


Median and Range Chart

The Median and Range chart displays the subgroup medians and ranges, which are used to analyze the central tendency and variability of a process.

A consumer products company weighs detergent boxes (in pounds) to determine whether the fill process is in control. The Detergent data set contains the weights for five boxes in each of 28 lots. A lot is considered a rational subgroup.

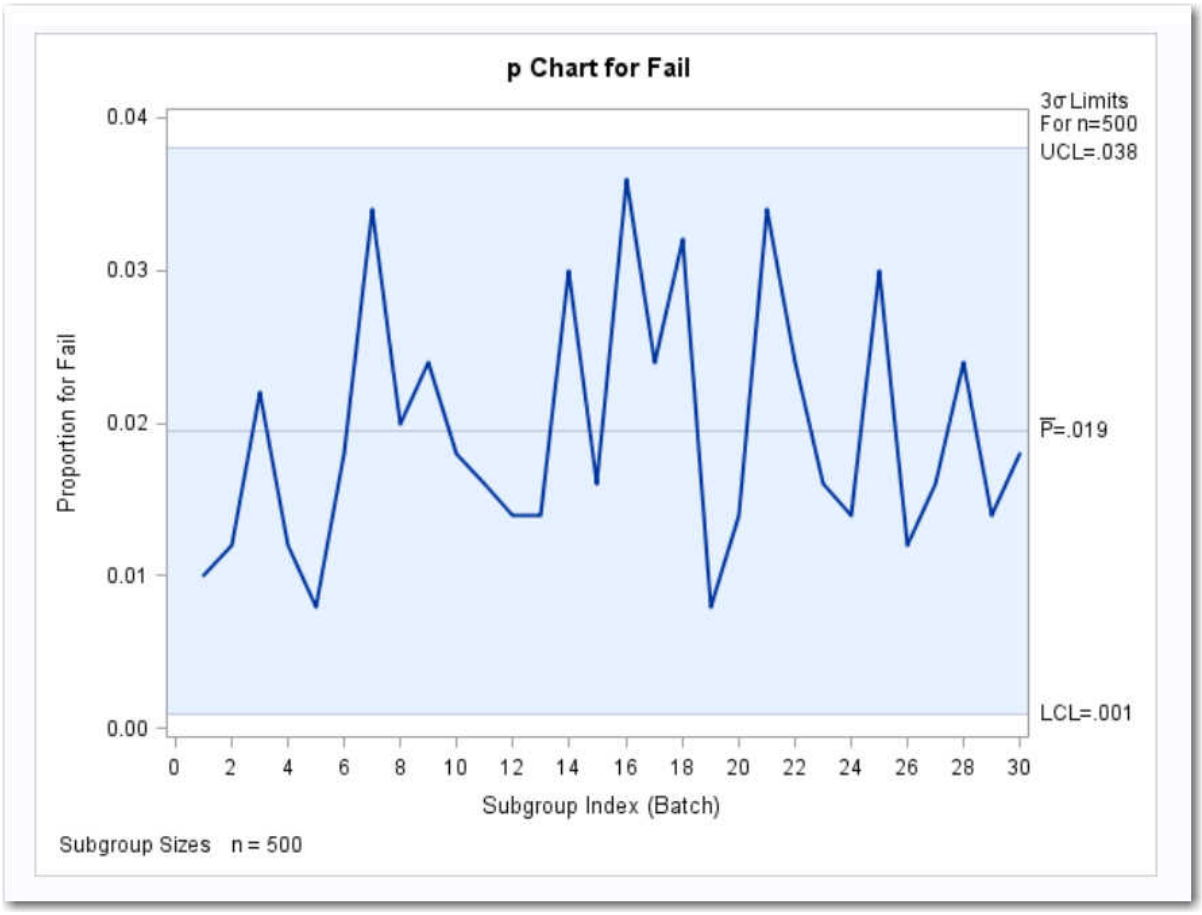
Each point on the median chart represents the median of the measurements for a particular lot. For example, the weights for the first lot are 17.39, 19.34, 22.56, 24.49, and 26.93, and consequently, the median plotted for this lot is 22.56. Each point on the range chart represents the range of the measurements for a particular batch. For example, the range plotted for the first lot is 26.93–17.39=9.54. Because all of the points lie within the control limits, you can conclude that the process is in statistical control.



Proportion of Nonconforming Items (p Charts)

A p chart displays proportions of nonconforming (defective) items in the subgroup samples. You might want to use this step to monitor the proportion of defects in a manufacturing process.

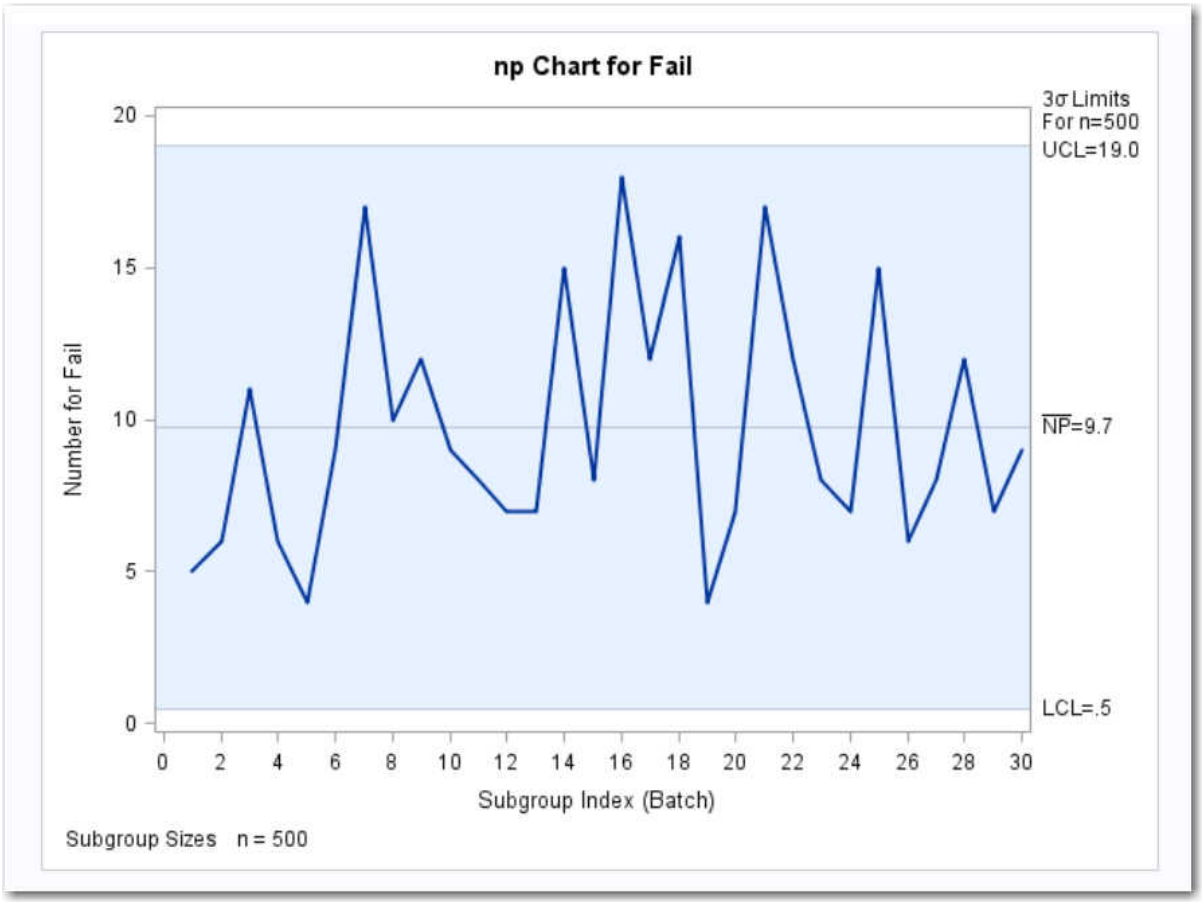
Suppose that an electronics company manufactures circuits in batches of 500 and uses a p chart to monitor the proportion of failing circuits. Thirty batches are examined, and the failures in each batch are counted. The failure counts are stored in a SAS data set, which is used to create the p chart. Each point on the p chart represents the proportion of nonconforming items in a particular subgroup. For example, if the number of failures in the first circuit is 5, then the value that is plotted for the first batch is 5/500=0.01. If all the points fall within the control limits, it can be concluded that the process is in statistical control.



Number of Nonconforming Items (np Charts)

An np chart displays the numbers of nonconformities (defects) in the subgroup samples. You might want to use this step to monitor the number of defects in a manufacturing process.

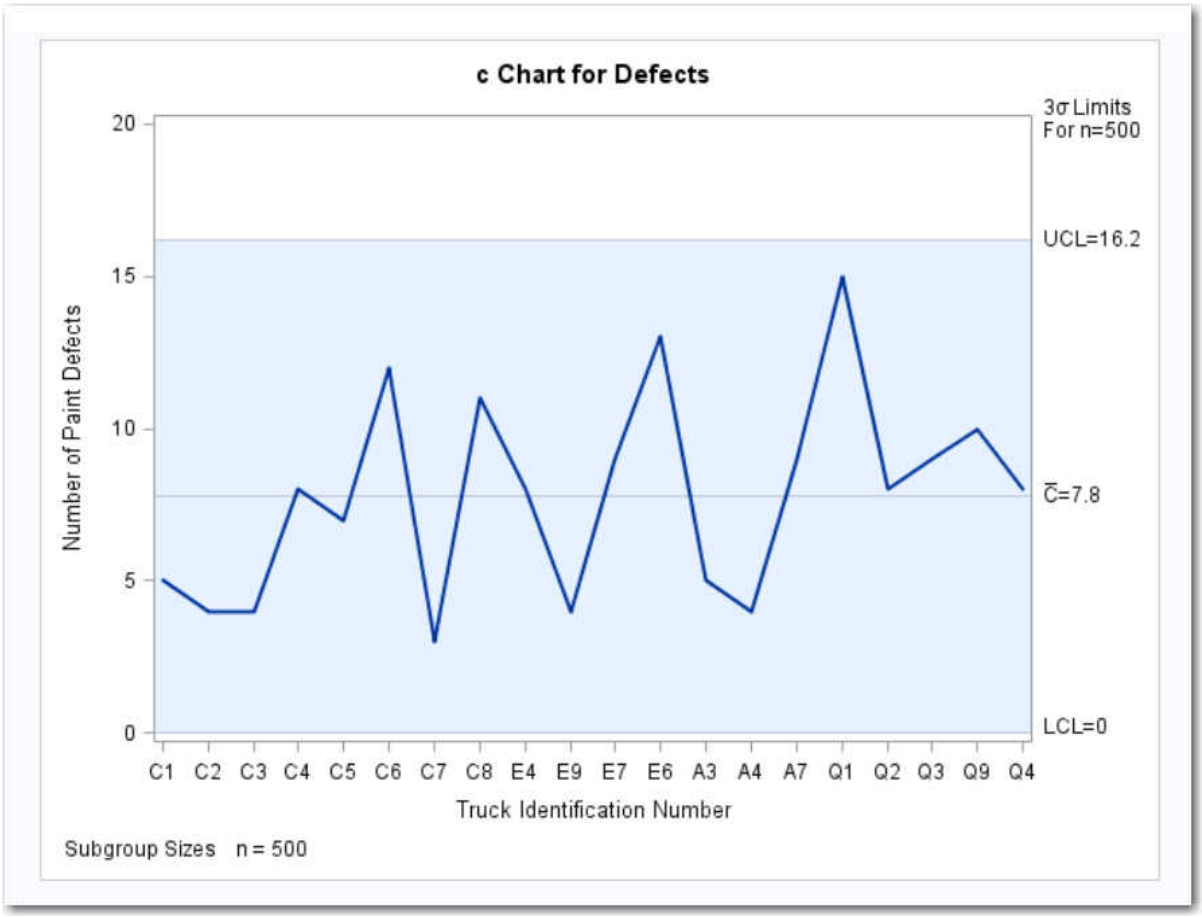
Suppose that an electronics company manufactures circuits in batches of 500 and uses an np chart to monitor the number of failing circuits. Thirty batches are examined, and the failures in each batch are counted. The failure counts are stored in a SAS data set, which is used to create the np chart. Each point on the np chart represents the number of nonconforming items in a particular subgroup. For example, the value that is plotted for the first batch is 5. If all the points fall within the control limits, it can be concluded that the process is in statistical control.



Number of Nonconformities (c Chart)

A c chart displays the numbers of nonconformities (defects) in the subgroup samples. You might want to use a c chart to monitor the number of defects that are found in a new product.

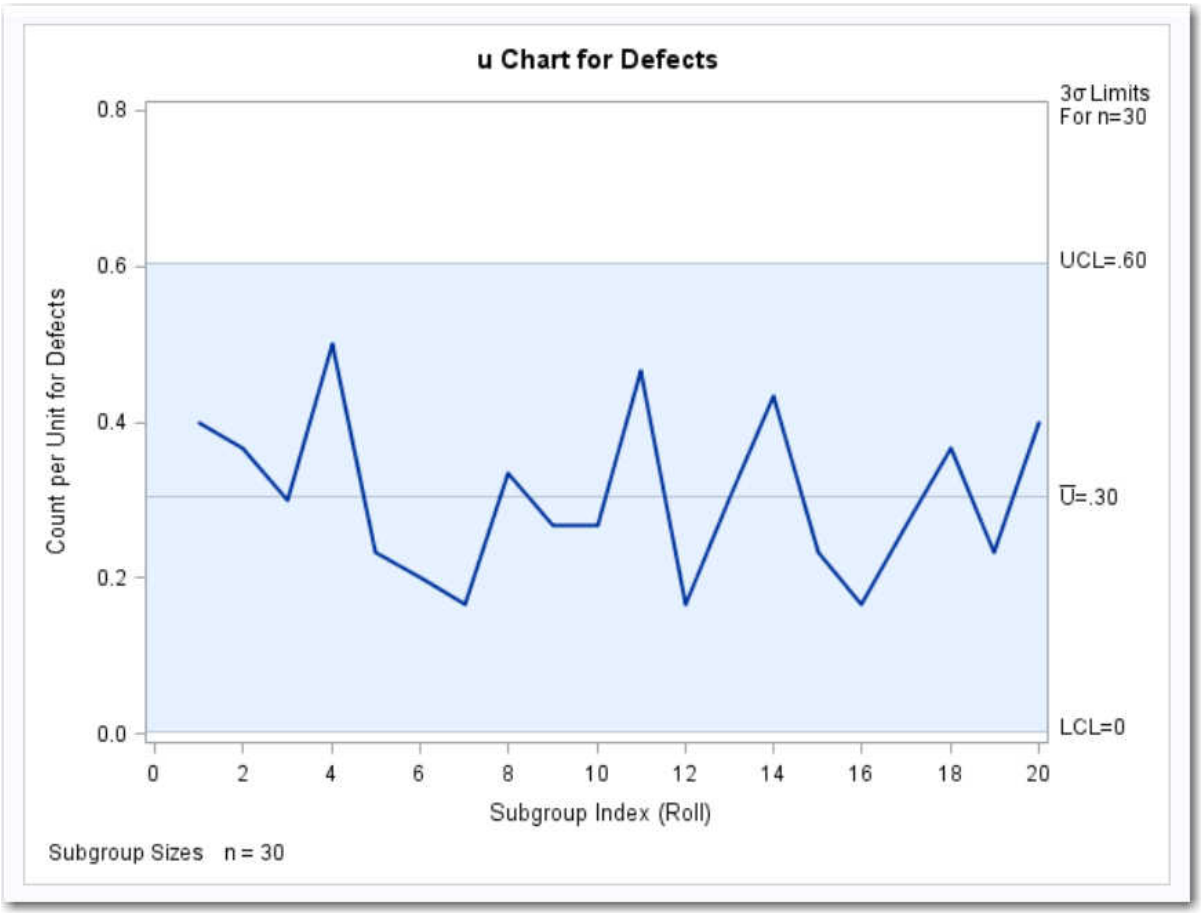
Suppose that an automobile company wants to monitor the number of paint defects on its new trucks. Twenty trucks of the same model are inspected, and the number of paint defects per truck is recorded. Each point on the c chart represents the number of defects for a given truck. If all the points fall within the control limits, it can be concluded that the process is in statistical control.



Number of Nonconformities per Unit (u Chart)

A u chart displays the numbers of nonconformities (defects) per inspection unit in the subgroup samples that contain arbitrary numbers of units. You might want to use this step to determine the number of defects per inspection unit that resulted from a manufacturing process.

Suppose that a textile company uses a u chart to monitor the number of defects per square meter of fabric. The fabric is spooled onto rolls as it is inspected for defects. Each piece of fabric is one meter wide and 30 meters long. The defect counts for 20 rolls are saved in a SAS data set, which is used to create the u chart. Each point on the u chart represents the number of nonconformities per inspection unit for a particular subgroup. For example, the value that is plotted for the first subgroup is 12/30=0.4 (because there are 12 defects on the first roll and the roll contains 30 square meters of fabric). If none of the points exceed the control limit (which is 3 sigma by default), the u chart indicates that the fabric manufacturing process is in statistical control.



Control Charts: Connection Requirements for the Node

In order to run the Control Charts step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Determine the Mean and Range

1 Copy and paste this code on a **SAS Program** tab.

```
data wafers;
   input batch @;
   do i=1 to 5;
      input diameter @;
      output;
   end;
   drop i;
   datalines;
1 35.00 34.99 34.99 34.98 35.00
2 35.01 34.99 34.99 34.98 35.00
3 34.99 35.00 35.00 35.00 35.00
4 35.01 35.00 34.99 34.99 35.00
5 35.00 34.99 34.98 34.99 35.00
6 34.99 34.99 35.00 35.00 35.00
7 35.01 34.98 35.00 35.00 34.99
8 35.00 35.00 34.99 34.98 34.99
9 34.99 34.98 34.98 35.01 35.00
10 34.99 35.00 35.01 34.99 35.01
11 35.01 35.00 35.00 34.98 34.99
12 34.99 34.99 35.00 34.98 35.01
13 35.01 34.99 34.98 34.99 34.99
14 35.00 35.00 34.99 35.01 34.99
15 34.98 34.99 34.99 34.98 35.00
16 34.99 35.00 35.00 35.01 35.00
17 34.98 34.98 34.99 34.99 34.98
18 35.01 35.02 35.00 34.98 35.00
19 34.99 34.98 35.00 34.99 34.98
20 34.99 35.00 35.00 34.99 34.99
21 35.00 34.99 34.99 34.98 35.00
22 35.00 35.00 35.01 35.00 35.00
23 35.02 35.00 34.98 35.02 35.00
24 35.00 35.00 34.99 35.01 34.98
25 34.99 34.99 34.99 35.00 35.00
run;
```

Run the flow to create the Work.Wafers table.

2 In the **Steps** section of the navigation pane, expand the **Statistic Process Control** folder and double-click **Control Charts** to add the step to your flow.

3 To set the options for the Control Charts step, click the Control Charts node.

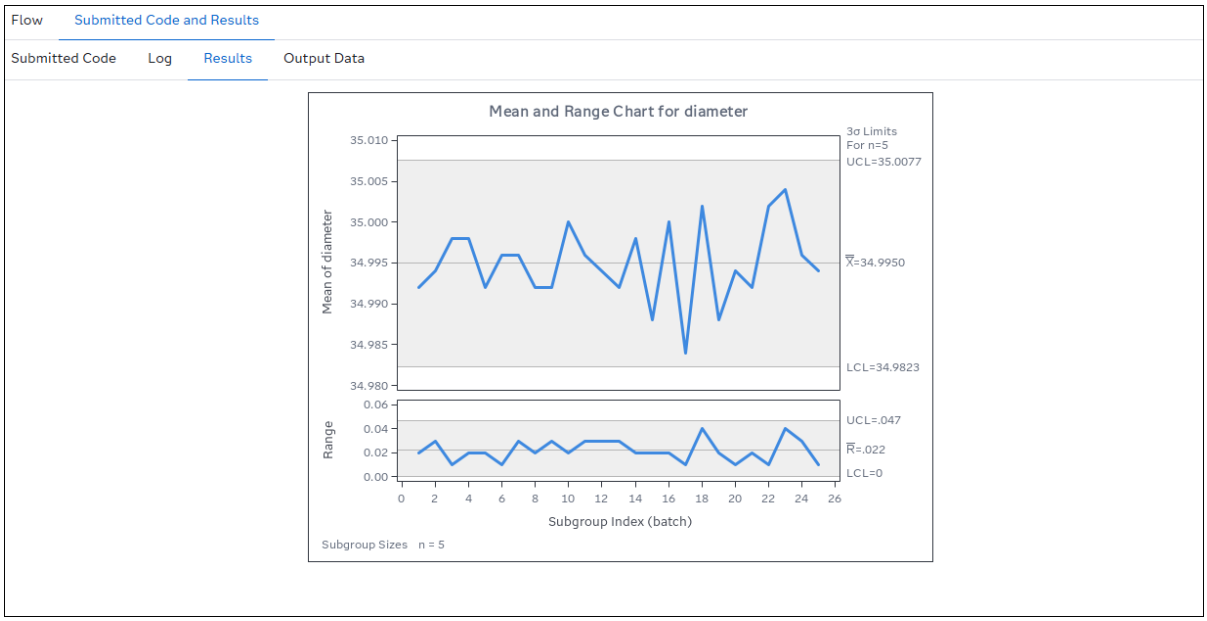
On the **Data** tab, assign columns to these roles:

- To the **Process variable** role, assign **diameter**.
- To the **Subgroup variable** role, assign **batch**.

4 Select **Mean and range** as the chart type.

5 Run the flow.

Click the **Submitted Code and Results** tab to view the results. Here are the results:



Control Charts: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Control Charts step, you must assign a column to the **Process variable** and **Subgroup variable** roles.

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 To the **Process variable** role, assign the variable for the process that you want to test.

3 To the **Subgroup variable** role, assign the variable that identifies the subgroups in the data. The values of this variable indicate how the observations in the input table are arranged into rational subgroups.

Here are some examples of the subgroup values:

- indices that give the order in which the subgroup samples were collected
- the dates or times at which the subgroup samples were collected
- the labels that uniquely identify the subgroup samples

4 Select the type of control chart to create. For more information about the chart types, see “About the Control Charts Step” on page 1293.

5 (Optional) To obtain separate analyses of observations for each unique group, assign a variable to the **Group analysis by** role.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 For the **Control limits method** option, specify whether to compute the control limits by using the current input table or by using a different table.

- If you use the input table, you can set the **Compute from data** option. When computing the control limits from the data, you must specify a value for the **Limits based on** option.
- If you want to compute the data from a different table, select **Use stored limits**, and then select the table to use. The table that you select must be a LIMITS= table. For more information about the variables that are required in a LIMITS= table, see the procedure documentation for the chart that you are creating. In the Control Charts step, you can create this table by selecting the **Save control limits** check box on the **Output** tab.

  Note: If you are running this step in a flow, you must add an input port for the limits table to the Control Charts node.

2 (Optional) If you are computing the control limits from the data, you can specify tests for special causes.

Here are the available tests:

- **One point outside control limits**
- **Nine points in a row on one side of central line**
- **Six points in a row increasing/decreasing**
- **Fourteen points alternating up and down**
- **Two of three points in a row in zone A**
- **Four of five points in zone B or beyond**
- **Fifteen points in a row in zone C**
- **Eight points in a row with no points in zone C**

You can also specify whether to add lines that define zones A, B, and C for the selected tests.

Note: These tests are available only when you are computing the control limits from the current table and when either of these conditions is met:

- **Three sigma** is selected in the **Limits based on** drop-down list.
- **k sigma** is selected in the **Limits based on** drop-down list and the value for the multiple standard error is 3.

3 (Optional) Add markers to indicate the subgroup points.

4 (Optional) Connect plotted points to the central line with vertical line segments.

5 (Optional) Create a table that lists the subgroups for which a test is positive or for which the observations are outside the control limits. Each row of the table corresponds to a subgroup. For each subgroup, the table shows the sample size and the upper and lower control limits.

Step 3: Set the Output Options

On the **Output** tab, you can set these options:

1 (Optional) Save the summary statistics to an output table.

2 (Optional) Save the control limits to an output table.

Note: To use the control limits table to compute the control limits, select **Use stored limits** for the **Control limits method** option on the **Options** tab.

3 (Optional) Save the summary statistics and the control limits to the same output table.

Pareto Analysis

About the Pareto Analysis Step

Pareto charts display the frequencies of quality-related problems in a process. The frequencies are represented by bars that are ordered in decreasing magnitude. Thus, you can use a Pareto chart to decide which subset of problems to solve first or which problem areas deserve the most attention.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio , SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see “Summary of Flow Functionality” in *SAS Data and AI Studio: User’s Guide*.

Pareto Analysis: Connection Requirements for the Node

In order to run the Pareto Analysis step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, no output data is created. No connection is required. To create an output data table, you must select the options on the **Output** tab. **Note:** By default, the output data is written to a temporary table in the Work library. You can specify the library and the name of the output tables by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Causes of Failure

During the manufacture of an MOS capacitor, different cleaning processes were used by two manufacturing systems operating in parallel. Process A used a standard cleaning solution, and Process B used a different cleaning solution that contained less particulate matter. The failure causes that were observed with each process for five consecutive days were recorded. Now you want to compare the causes of the failure for each process.

To create this example:

1 Copy and paste this code on the **SAS Program** tab.

```
data failure;
   length Cause $ 16;
   label Cause='Cause of Failure';
   input Cause & $;
   datalines;
Corrosion
Oxide Defect
Contamination
Oxide Defect
Oxide Defect
Miscellaneous
Oxide Defect
```

```
Contamination
Metallization
Oxide Defect
Contamination
Contamination
Oxide Defect
Contamination
Contamination
Contamination
Corrosion
Silicon Defect
Miscellaneous
Contamination
Contamination
Contamination
Miscellaneous
Contamination
Contamination
Doping
Oxide Defect
Oxide Defect
Metallization
Contamination
Contamination
run;
```

Run the program to create the Work.Failure table.

2 In the **Steps** section of the navigation pane, expand the **Statistical Process Control** folder and double-click **Pareto Analysis** to add the step to your flow.

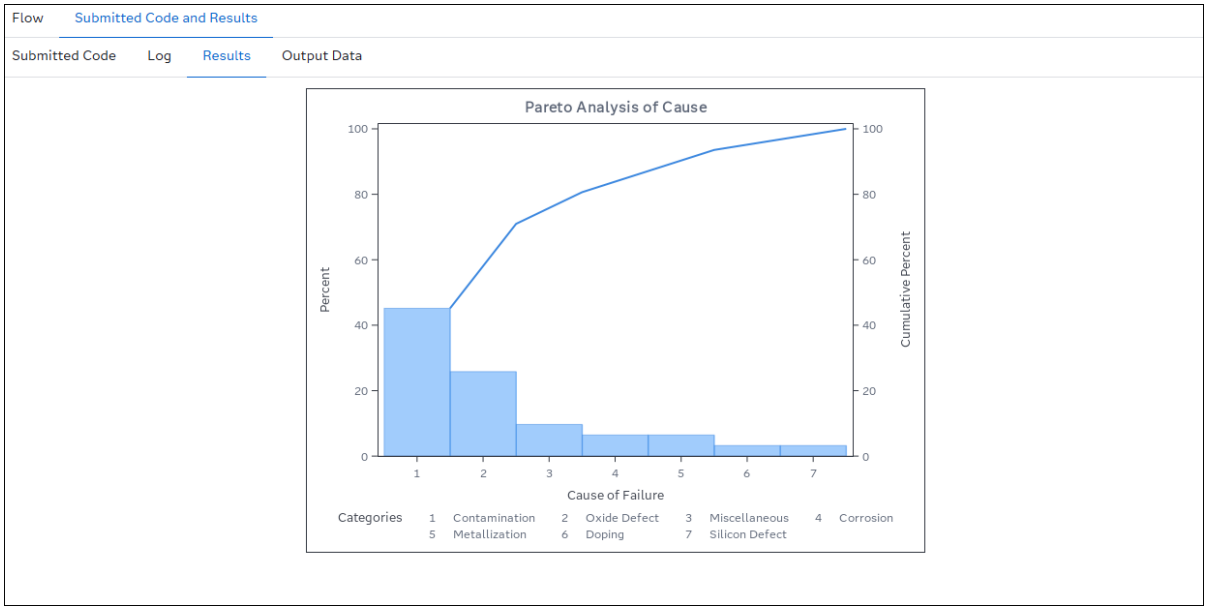
3 Add the Work.Failure table to your flow. Connect the input port of the Pareto Analysis node to the data source. For more information, see "Connecting Nodes" on page 13.

4 To set the options for the Pareto Analysis step, click the Pareto Analysis node.

5 To the **Process variable** role, assign the **Cause** variable.

6 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Pareto Analysis: Step-by-Step Instructions

Step 1: Assign Data to Roles

To run the Pareto Analysis step, you must assign a column to the **Process variable** role.

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. To the **Process variable** role, assign the variable to analyze.
3. (Optional) To the **Frequency variable** role, assign the variable that specifies the counts (numbers of occurrences) of the unique values in the process variable.
4. (Optional) To the **Classification variable** role, assign the variable that specifies how to group the data. Assigning a variable to this role results in a comparative Pareto chart by using the levels of the variable.
5. (Optional) To the **Group analysis by** role, assign the variable that specifies the groups. This role enables you to obtain separate analyses of observations for each unique group.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 (Optional) Specify whether to use vertical or horizontal bars to measure the frequencies in the Pareto chart.

2 (Optional) Specify whether to display the cumulative percentage curve.

3 (Optional) Specify whether to include a legend for the sample size.

4 (Optional) Specify the number of categories with the *n* highest frequencies to display.

5 (Optional) Specify whether to merge smaller categories into one category to display on the Pareto chart.

Step 3: Set the Output Options

(Optional) Specify whether to create an output data table. By default, this table is saved in the Work library.

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Boolean Rules

About the Boolean Rules Step

The Boolean Rules step extracts Boolean rules from text data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Boolean Rules: Connection Requirements for the Node

In order to run the Boolean Rules step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Boolean Rules node, the input data source must be a CAS table. If you are using unparsed text, you can also add these optional input tables: a start or stop list, a synonym list, and a multi-word terms list. For more information, see "Step 2: Set the Options" on page 1318. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, at least one output data table is created. A connection from the step node to the output table is required. On the **Output** tab, you can specify the additional output tables to create. These tables must use a CAS engine libref. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Boolean Rules node and select the name of the output port. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Examples: Boolean Rules

Example 1: Unparsed Text

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Copy and paste this code on a **SAS Program** tab:

```
libname mycas cas;

data mycas.getstart;
    infile datalines delimiter='|' missover;
    length text $150;
    input text$ apple_fruit did$;
    datalines;
Delicious and crunchy apple is one of the popular fruits | 1 |d01
Apple was the king of all fruits. | 1 |d02
Custard apple or Sitaphal is a sweet pulpy fruit | 1 |d03
apples are a common tree throughout the tropics | 1 |d04
apple is round in shape, and tastes sweet | 1 |d05
Tropical apple trees produce sweet apple| 1| d06
Fans of sweet apple adore Fuji because it is the sweetest of| 1 |d07
this apple tree is small | 1 |d08
Apple Store shop iPhone x and iPhone x Plus.| 0 |d09
See a list of Apple phone numbers around the world.| 0 |d10
Find links to user guides and contact Apple Support, | 0 |d11
Apple counters Samsung Galaxy launch with iPhone gallery | 0 |d12
Apple Smartphones - Verizon Wireless.| 0 |d13
Apple mercurial chief executive, was furious.| 0 |d14
Apple has upgraded the phone.| 0 |d15
the great features of the new Apple iPhone x.| 0 |d16
Apple sweet apple iphone.| 0 |d17
Apple apple will make cars | 0 |d18
Apple apple also makes watches| 0 |d19
Apple apple makes computers too| 0 |d20
;
run;
```

Run the flow to create the MyCas.GetStart table.

3 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Boolean Rules** to add the step to your flow.

4 Add the MyCas.GetStart table to your flow. Connect the input port of the Boolean Rules node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Boolean Rules step, click the Boolean Rules node.

6 On the **Data** tab, select **Unparsed text**.

7 Assign columns to these roles:

- To the **Text variable** role, assign **text**.
- From the **Key variable** option, select **Select variable**. Assign **did** to the **Key variable** role.
- For the **Type of target** option, select **One or more binary targets**.
- To the **Primary binary target** role, select **apple_fruit**.
- For the **Level of interest**, select **1**.

8 On the **Options** tab, modify these options.

- Under the **Parse Text** heading, enter `3` for the **Minimum number of occurrences to keep a term** option.
- Under the **Rules Extraction** heading, enter `6` for the **Minimum g-score** option.

9 On the Output tab, select **Save term-by-document matrix** and **Save parsed term information**.

10 To create an output table that contains the term-by-document matrix:

a Select **Add** ⇨ **Table**.

b In the table properties, enter **`MyCas`** as the library and **`tbd`** as the table name.

c Right-click the Boolean Rules node and select **Add output port** ⇨ **Term-by-document Matrix Table**.

d Connect the output port to the MyCas.tbd.

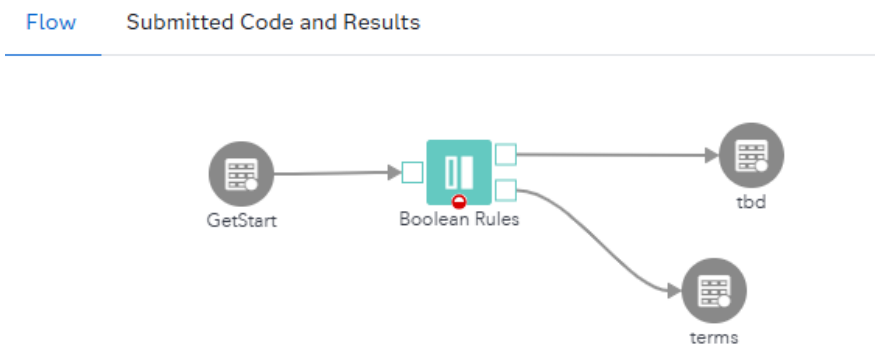
11 To create an output table that contains the parsed term information:

a Select **Add** ⇨ **Table**.

b In the table properties, enter **`MyCas`** as the library and **`terms`** as the table name.

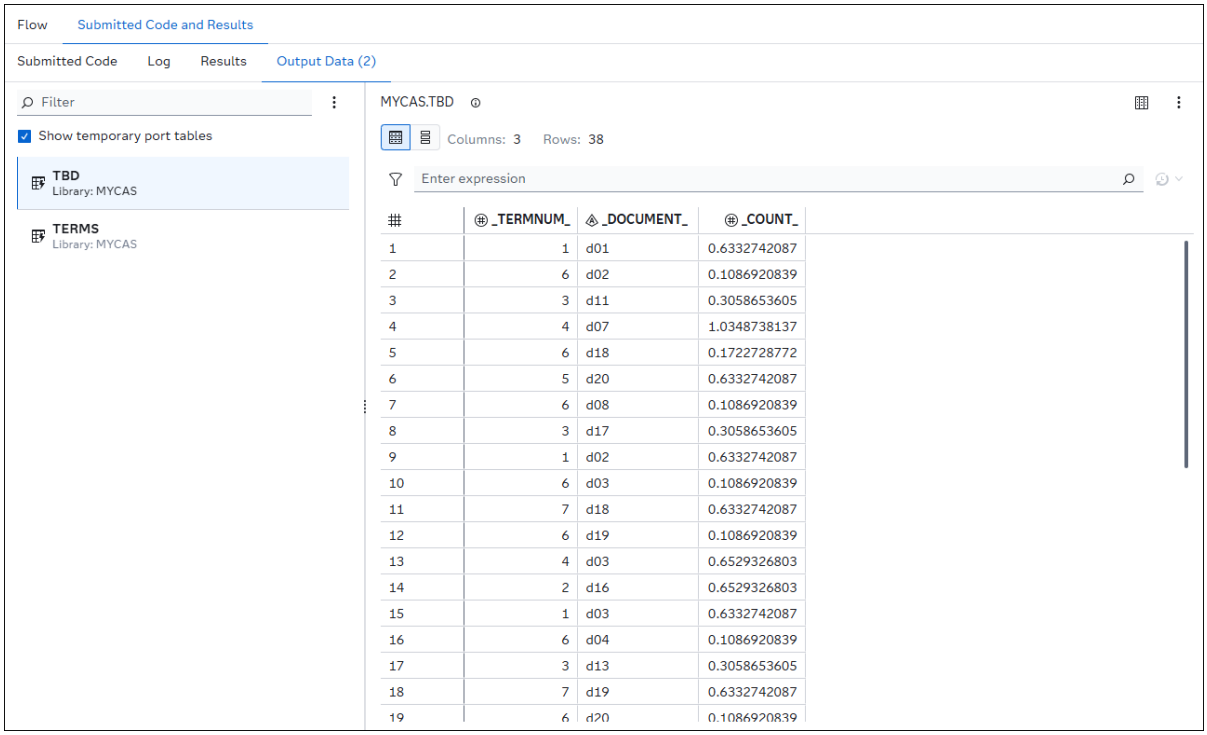
c Right-click the Boolean Rules node and select **Add output port** ⇨ **Parsed Term Information Table**.

d Connect the output port to the MyCas.terms.



12 Run the flow.

Click the **Submitted Code and Results** tab to view the output data.



	TERMNUM	_DOCUMENT_	_COUNT_
1	1	d01	0.6332742087
2	6	d02	0.1086920839
3	3	d11	0.3058653605
4	4	d07	1.0348738137
5	6	d18	0.1722728772
6	5	d20	0.6332742087
7	6	d08	0.1086920839
8	3	d17	0.3058653605
9	1	d02	0.6332742087
10	6	d03	0.1086920839
11	7	d18	0.6332742087
12	6	d19	0.1086920839
13	4	d03	0.6529326803
14	2	d16	0.6529326803
15	1	d03	0.6332742087
16	6	d04	0.1086920839
17	3	d13	0.3058653605
18	7	d19	0.6332742087
19	6	d20	0.1086920839

Example 2: Term-by-Document

To run this example, you must first run the unparsed text example.

To create this example:

1 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Boolean Rules** to add the step to your flow.

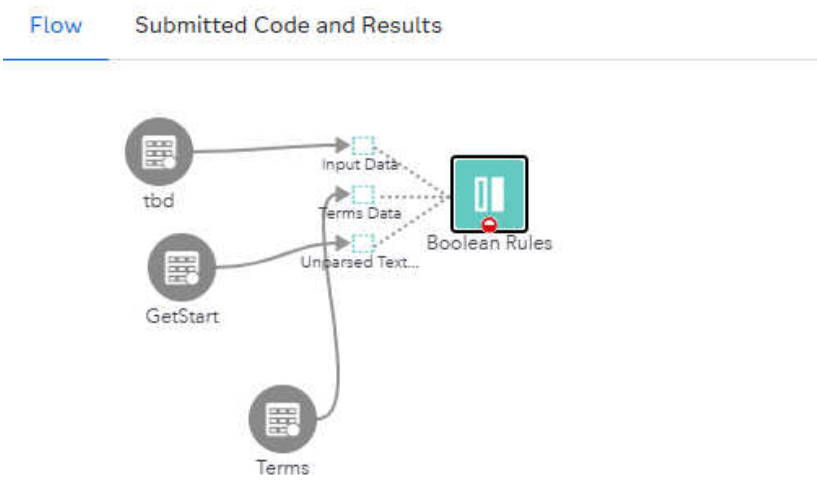
2 Add the MyCas.Tbd table to your flow. Connect the MyCas.Tbd table to the input port of the Boolean Rules node. For more information, see "Connecting Nodes" on page 13.

3 Add the MyCas.GetStart table to your flow. Right-click the Boolean Rules node and select **Add input port** ⇨ **Unparsed Text Data**. Connect the MyCas.GetStart table to the Unparsed Text Data port.

4 To set the options for the Boolean Rules step, click the Boolean Rules node.

5 On the **Data** tab, select **Term-by-document matrix**.

6 Add the MyCas.Terms table to your flow. Right-click the Boolean Rules node and select **Add input port** ⇨ **Terms Data**. Connect the MyCas.Terms table to the Terms Data port.



7 On the **Data** tab, assign columns to these roles:

- To the **Text variable** role, assign **text**.
- From the **Key variable** option, select **Select variable**. Assign **did** to the **Key variable** role.
- For the **Type of target** option, select **One or more binary targets**.
- To the **Primary binary target** role, select **apple_fruit**.
- For the **Level of interest**, select **1**.

8 On the **Options** tab under the **Rules Extraction** heading, enter `6` for the **Minimum g-score** option.

9 On the **Output** tab, select **Save rules**.

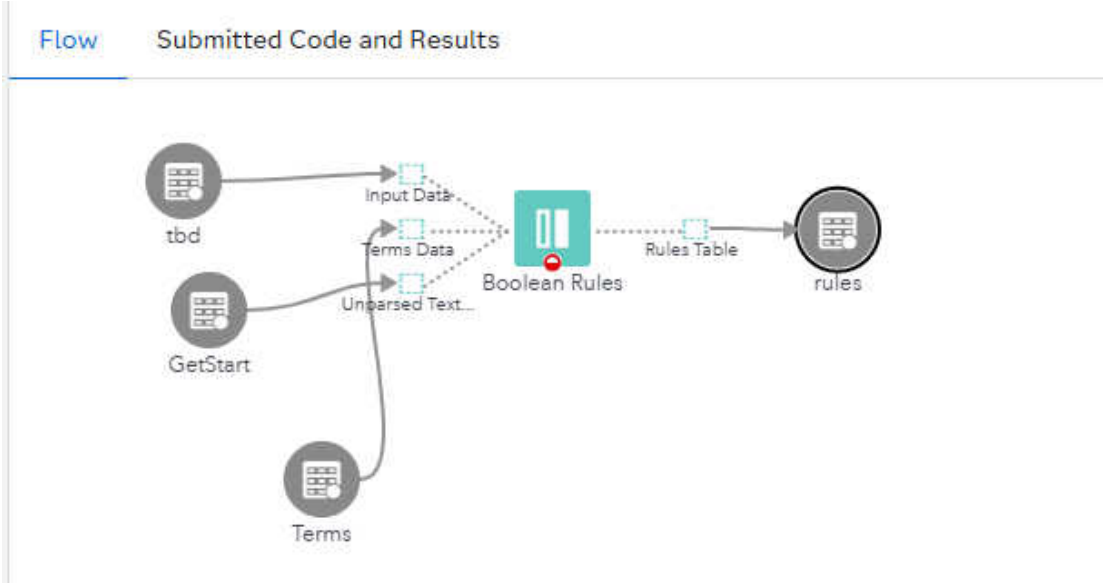
10 To create an output table that contains the save rules data:

a Select **Add** ⇨ **Table**.

b Select the Table node. In the table properties, enter **`MyCas`** as the library and **`rules`** as the table name.

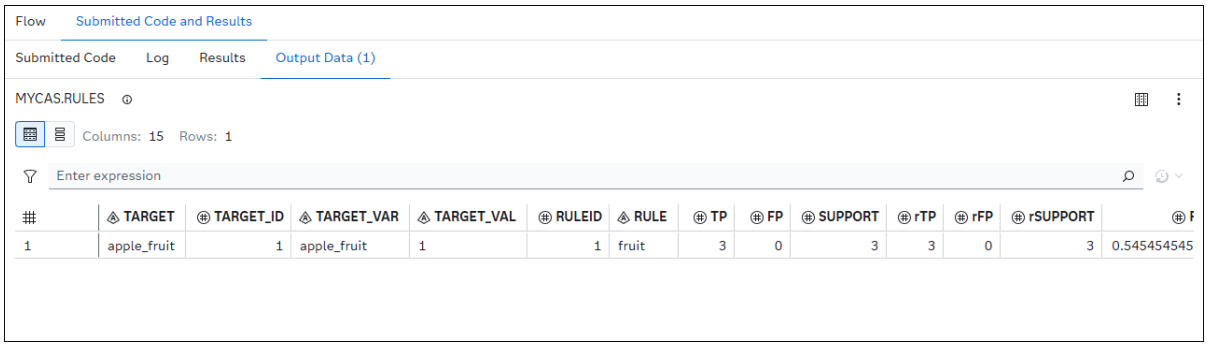
c Right-click the Boolean Rules node and select **Add output port** ⇨ **Rules Table**.

d Connect the output port to the MyCas.Rules.



11 Run the flow.

Click the **Submitted Code and Results** tab to view the output data.



Boolean Rules: Using Unparsed Text

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Select the language of the text in the input data table. The available languages depend on what you license in SAS Visual Text Analytics.

3 Select whether the input table contains unparsed text or a term-by-document matrix.

4 To the **Text variable** role, assign the variable that contains the text to be processed.

5 For the **Key variable**, specify whether the step should automatically create the key variable or whether you want to select a variable from the input table. The key variable contains the ID of each document. In the input table, each row corresponds to one document. The ID of each document must be unique; it can be either a number or a string of characters. By default, this variable is automatically generated.

6 Select the type of target.

- For binary targets, you can specify multiple target variables. Each target variable corresponds to a category.

  From the **Level of interest** drop-down list, specify the values of the target variables that are considered positive events or categories. The selected level is used for all binary targets.

- For nominal targets, you can specify only one target variable. Each level of the target variable corresponds to a category.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Use the **Include parts of speech** to specify whether a term's part of speech should be identified during parsing.

2 Specify whether to extract standard noun groups. When selected, the step extracts noun groups, returns noun phrases without determiners or prepositions, and stems noun group elements (unless the **Stem terms** check box is not selected).

3 Specify whether to extract standard entities during parsing. If this option is selected, the step uses the standard LITI file for entity extraction. You cannot select the specified entities to include or exclude.

A term such as "George W. Bush" is recognized as an entity and given the corresponding entity role and attribute. For this term, the entity role is PERSON and the attribute is Entity. Although the entity is treated as the single term, "george w. bush," the individual tokens "george," "w," and "bush" are also included.

4 Enable the stemming of words. By default, words are stemmed. That is, terms such as "advises" and "advising" are mapped to the parent term "advise." The step uses dictionary-based stemming (also known as lemmatization).

5 Use the **Minimum number of occurrences to keep a term** option to remove terms that are not in at least *n* documents. The default value is `4`.

6 Select the **Use the log to weight the cells of the term-by-document matrix** to specify weighting the cells by using the log formulation. The term weight is a positive number that is assigned to each term based on the distribution of that term in the document collection. This weight can be interpreted as an indication of the importance of that term to the document collection. The cell weight is a function that is applied to every entry in the term-by-document matrix; the cell weight moderates the effect of a term that is repeated within a document.

7 Specify whether the terms are weighted. Terms are weighted by the entropy.

8 Specify a start or stop list to specify the words to keep or exclude during parsing. When the language is English, a default stop list is used.

Note: The input data source must have a column named Term. This column must contain the list of terms to keep or remove from the analysis.

If you are running this step in a flow, you must add an input table for the start list or custom stop list to the flow and connect the input table to the Boolean Rules node.

a Add the input table that contains the start list or stop list to the flow.

b Right-click the Boolean Rules node and select **Add input port**, and then select either **Start List Data** or **Stop List Data**.

c Connect the input data table that contains the start list or stop list to the corresponding input port.

9 Select **Specify a synomyn list** to specify the input data table that contains user-defined synonyms to be used in the analysis. The data table specifies parent-child relationships that enable you to map child terms to a representative parent. The input synonym data table must have either the two variables Term and Parent or the four variables Term, Parent, Termrole, and Parentrole. This data table overrides any relationships that are identified when terms are stemmed.

If you are running this step in a flow, you must add an input table for the synonym list to the flow and connect the table to the Boolean Rules node.

a Add the input table that contains the synonym list to the flow.

b Right-click the Boolean Rules node and select **Add input port** ⇨ **Synonym List Data**.

c Connect the input data table that contains the synonym list to the corresponding input port.

10 Select **Specify a multi-word terms list** to specify that the input data source contains a list of multi-word terms. The multi-word terms are case sensitive and are treated as a single entry. Thus, the terms "Thank You" and "thank you" are processed differently. Consequently, you must convert all text strings to lowercase or add each of the multi-term's case variations to the list before using the step to create consistent multi-word terms.

The multi-term data table must have a variable Multiterm and each of its values must be formatted in the following manner: `multiterm: 3: pos`

Specifically, the first item is the multi-word term itself followed by a colon; the second item is a number that represents the token type followed by a colon; and the third item is the part of speech that the multi-word term represents.

Note: The token type 3 is the most common token type for multi-term lists; it represents compound words.

If you are running this step in a flow, you must add an input table for the multi-word terms list to the flow and connect the table to the Boolean Rules node.

a Add the input table that contains the multi-word term list to the flow.

b Right-click the Boolean Rules node and select **Add input port** ⇨ **Multi-word Terms List Data**.

c Connect the input data table that contains the multi-word list to the corresponding input port.

11 Specify the minimum number of documents in which a term needs to appear in order for the term to be used for creating a rule. The default value is `3`.

12 Specify the minimum *g*-score that is needed in order for a positive term to be considered for rule extraction in the term ensemble. A rule also needs to have a *g*-score that is higher than the *g*-value to be considered in the rule ensemble. The *g*-value is also used in the improvability test. A rule is improvable if the *g*-score that is computed according to the improvability test is larger than the *g*-value. The default value is `8`.

13 Specify the minimum *g*-score that is needed in order for a negative term to be considered for rule extraction in the term ensemble. If you do not select this option, the value of the **Minimum g-score** option is used.

14 Select **Minimum m value for computing estimated precision** to specify the *m* value for computing estimated precision for positive terms. The default value is `8`.

15 Select **Specify separate minimum m value for negative terms** to specify the *m* value for computing estimated precision for negative terms. The default value is `8`. If you do not select this option, the value of the **Minimum m value for computing estimated precision** is used.

Step 3: Set the Output Options

On the **Output** tab, you can create these output CAS tables. When naming these tables, you must use a CAS engine libref.

- a table of the term-by-document matrix
- a table of the parsed term information

- a table of the parsing configuration (for Boolean rules scoring)
- a table of the rules
- a table of the rules term information
- a table of the candidate terms

Note: If you are running the step in a flow, you must add an output port for each output table to the Boolean Rules node. For more information, see "Boolean Rules: Connection Requirements for the Node" on page 1312.

Boolean Rules: Using Term-by-Document Matrix

Step 1: Assign Data to Roles

If you are running the step in a flow, you must first add an input data table to the flow and connect it to the input port on the Boolean Rules node.

To run an analysis of a term-by-document matrix, you must also add an input data source that contains the unparsed text. After you add this input table to the flow, right-click the Boolean Rules node, and then select **Add input port** ⇨ **Unparsed Text Data**. Next, connect the input table for the unparsed text to the Unparsed Text Data port.

1. Select **Term-by-document matrix**.
2. Add the input table that contains the term-by-document matrix to the flow. Right-click Boolean Rules node and select **Add input port** ⇨ **Terms Data**. Connect the input table that contains the term-by-document matrix to the Term Data port.
3. Select the language of the text in the input data table. The available languages depend on what you license in SAS Visual Text Analytics.
4. To the **Text variable** role, assign the variable that contains the text to be processed.
5. For the **Key variable**, specify whether the step should automatically create the key variable or whether you want to select a variable from the input table. The key variable contains the ID of each document. In the input table, each row corresponds to one document. The ID of each document must be unique; it can be either a number or a string of characters. By default, this variable is automatically generated.
6. Select the type of target.
   - For binary targets, you can specify multiple target variables. Each target variable corresponds to a category.

From the **Level of interest** drop-down list, specify the values of the target variables that are considered positive events or categories. The selected level is used for all binary targets.

- For nominal targets, you can specify only one target variable. Each level of the target variable corresponds to a category.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1. Specify the minimum number of documents in which a term needs to appear in order for the term to be used for creating a rule. The default value is `3`.
2. Specify the minimum *g*-score that is needed in order for a positive term to be considered for rule extraction in the term ensemble. A rule also needs to have a *g*-score that is higher than the *g*-value to be considered in the rule ensemble. The *g*-value is also used in the improvability test. A rule is improvable if the *g*-score that is computed according to the improvability test is larger than the *g*-value. The default value is `8`.
3. Specify a separate minimum *g*-score in order for a negative term to be considered for rule extraction in the term ensemble. If you do not select this option, the value of the **Minimum g-score** option is used.
4. Select **Minimum m value for computing estimated precision** to specify the *m* value for computing estimated precision for positive terms. The default value is `8`.
5. Select **Specify separate minimum m value for negative terms** to specify the *m* value for computing estimated precision for negative terms. The default value is `8`. If you do not select this option, the value of the **Minimum m value for computing estimated precision** is used.

Step 3: Set the Output Options

On the **Output** tab, you can create these output CAS tables. When naming these tables, you must use a CAS engine libref.

- a table of the rules
- a table of the rules term information
- a table of the candidate terms

Note: If you are running the step in a flow, you must add an output port for each output table to the Boolean Rules node. For more information, see "Boolean Rules: Connection Requirements for the Node" on page 1312.

Segmentation

About the Segmentation Step

The Segmentation step segments text data by using *k*-means clustering.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Segmentation: Connection Requirements for the Node

In order to run the Segmentation step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Segmentation node, the input data source must be a CAS table. You can also add an input table for the optional start list. For more information, see "Step 2: Set the Options" on page 1326. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, at least one output data table is created. A connection from the step node to the output table is required. On the **Output** tab, you can specify the output tables to create. These tables must use a CAS engine libref. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Segmentation node and select the name of the output port. For more information, see "Step 3: Set the Output Options" on page 1327. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Segmentation

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Enter this code on a **SAS Program** tab:

```
libname mycas cas;

data mycas.reviews;
       infile datalines delimiter='|' missover;
       length text $300 category $20;
       input text$ positive category$ did;
       datalines;
    This is the greatest phone ever! love it!|1|electronics|1
    The phone's battery life is too short.|0|electronics|2
    The screen resolution is low, but I love this tv.|1|electronics|3
    The movie itself is great, although the resolution is low.|1|
movies|4
    The movie's story is boring and the acting is poor.|0|movies|5
    I watched this movie on tv, it's not good on a small screen. |0|
movies|6
    watched the movie first and loved it, the book is even better!|1|
books |7
    I like the story in this book, they should put it on screen.|1|
books|8
    I love the author, but this book is a waste of time, don't buy it.|
0|books|9
;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Segmentation** to add the step to your flow.

4 Add the MyCas.Reviews table to your flow. Connect the input port of the Segmentation node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Segmentation step, click the Segmentation node.

6 On the **Data** tab, assign **text** to the **Text variable** role.

7 On the **Options** tab, enter 3 for the number of segments.

8 To create an output table that contains the segmentation results:

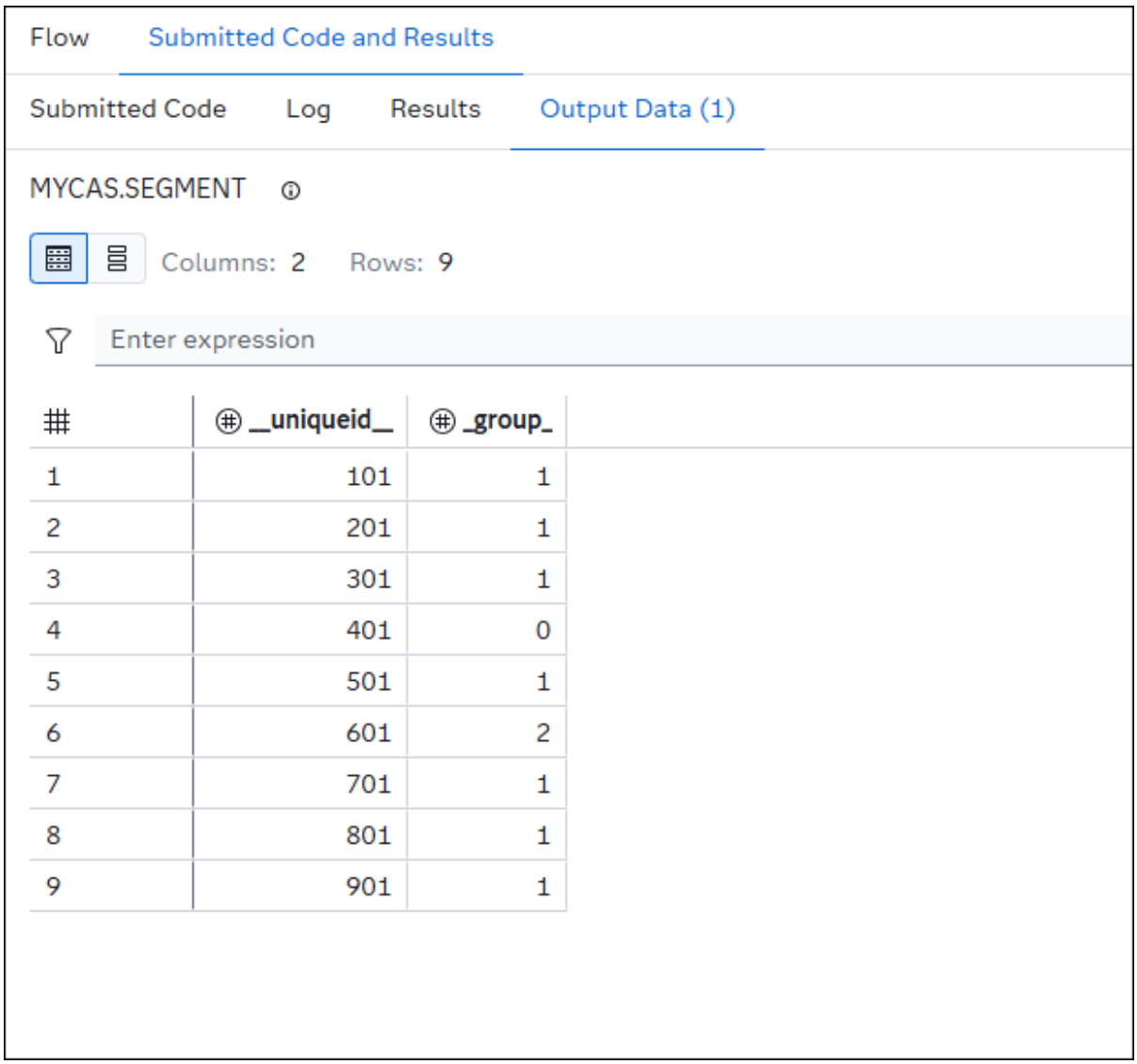
   a Select **Add** ⇨ **Table**.

   b Select the Table node. In the table properties, enter **`MyCas`** as the library and **`segment`** as the table name.

   c Connect the output port for the Segmentation node to the MyCas.segment table.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results and output data.



	uniqueid	_group_
1	101	1
2	201	1
3	301	1
4	401	0
5	501	1
6	601	2
7	701	1
8	801	1
9	901	1

Segmentation: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Select the language of the text in the input data table. The available languages depend on what you license in SAS Visual Text Analytics.

3 To the **Text variable** role, assign the variable that contains the text to be summarized.

4 For the **Key variable**, specify whether the step should automatically create the key variable or whether you want to select a variable from the input table. The key variable contains the ID of each document. In the input table, each row is referred to as one document. The ID of each document must be unique; it can be either a number or a string of characters. By default, this variable is automatically generated.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify whether to extract standard noun groups. By default, the step extracts noun groups, returns noun phrases without determiners or prepositions, and stems noun group elements (unless the **Stem terms** check box is not selected).

2 Specify whether to extract standard entities during parsing. If you choose to keep or ignore any entities, uses the standard LITI file for entity extraction. A term such as "George W. Bush" is recognized as an entity and given the corresponding entity role and attribute. For this term, the entity role is PERSON and the attribute is Entity. Although the entity is treated as the single term, "george w. bush," the individual tokens "george," "w," and "bush" are also included.

3 Enable the stemming of words. By default, words are stemmed. That is, terms such as "advises" and "advising" are mapped to the parent term "advise." The step uses dictionary-based stemming (also known as lemmatization).

4 Specify a data source that contains the start list to use during parsing. If you specify a start list, only the terms that are included in the list appear in the parsing results.

Note: These values must be the VARCHAR data type.

If you are running this step in a flow, you must add an input table for the start list to the flow and connect the table to the Segmentation node.

a Add the input table that contains the start list to the flow.

b Right-click the Boolean Rules node and select **Add input port**.

c Connect the input data table that contains the start list to the new input port.

5 Specify the number of segments to create. This value must be greater than 1 and less than the number of rows in the input data source. The default value is `5`.

6 Specify an integer for the random number seed.

7 Specify the maximum number of iterations for the *k*-means algorithm. The default value is `10`.

Step 3: Set the Output Options

On the **Output** tab, you can create these output CAS tables. When naming these tables, you must use a CAS engine libref.

- a table of the segmentation results. This table contains two columns: one for the original key variable and one for the segment ID.
- a table of the segmentation results with a term-by-document matrix.
- a table of segment statistics, such as the number of observations in each segment and the within-cluster sums of squares.
- a table of document-term segmentation results. For a document, each term is listed with its corresponding term frequency (_tf_) and the segment the document belongs to (_group_).
- a table of term information. This table includes each term identified during parsing and its corresponding term frequency (_tf_).

Note: If you are running the step in a flow, you must add an output port for each output table to the Segmentation node. For more information, see "Segmentation: Connection Requirements for the Node" on page 1323.

Text Parsing and Topic Discovery

About the Text Parsing and Topic Discovery Step

The Text Parsing and Topic Discovery step is used to parse documents into a term-by-document matrix and extract topics from the term-by-document matrix.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Text Parsing and Topic Discovery: Connection Requirements for the Node

In order to run the Text Parsing and Topic Discovery step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Text Parsing and Topic Discovery node, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, at least one output data table is created. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Examples: Text Parsing and Topic Discovery

Example 1: Unparsed Text

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Copy and paste this code on a **SAS Program** tab:

```
libname mycas cas;

data mycas.getstart;
    infile datalines delimiter='|' missover;
    length text $150;
    input text$ apple_fruit did$;
    datalines;
Delicious and crunchy apple is one of the popular fruits | 1 |d01
Apple was the king of all fruits. | 1 |d02
Custard apple or Sitaphal is a sweet pulpy fruit | 1 |d03
apples are a common tree throughout the tropics | 1 |d04
apple is round in shape, and tastes sweet | 1 |d05
Tropical apple trees produce sweet apple| 1| d06
Fans of sweet apple adore Fuji because it is the sweetest of| 1 |d07
this apple tree is small | 1 |d08
Apple Store shop iPhone x and iPhone x Plus.| 0 |d09
See a list of Apple phone numbers around the world.| 0 |d10
Find links to user guides and contact Apple Support, | 0 |d11
Apple counters Samsung Galaxy launch with iPhone gallery | 0 |d12
Apple Smartphones - Verizon Wireless.| 0 |d13
Apple mercurial chief executive, was furious.| 0 |d14
Apple has upgraded the phone.| 0 |d15
the great features of the new Apple iPhone x.| 0 |d16
Apple sweet apple iphone.| 0 |d17
Apple apple will make cars | 0 |d18
Apple apple also makes watches| 0 |d19
Apple apple makes computers too| 0 |d20
;
run;
```

Run the flow to create the MyCas.GetStart table.

3 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Text Parsing and Topic Discovery** to add the step to your flow.

4 Add the MyCas.GetStart table to your flow. Connect the input port of the Text Parsing and Topic Discovery node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Text Parsing and Topic Discovery step, click the Text Parsing and Topic Discovery node.

6 On the **Data** tab, select the **Unparsed text** option.

7 Assign columns to these roles:

- To the **Text variable** role, assign **text**.
- For the **Key variable** option, select **Select variable**. Then assign **did** to the key variable role.

Note: The key variable must contain only unique values.

8 On the **Options** tab, set these options:

- For the topic model, select **Singular value decomposition (SVD)**.
- Select **Scree plot of singular values**.

9 On the **Output** tab, select **Save term-by-document matrix (without child terms)** and **Save term information**.

10 To create an output table for the term-by-document matrix:

a Select **Add** ⇨ **Table**.

b Select the Table node. In the table properties, enter `MyCas` as the library and `tbd` as the table name.

c Right-click the Text Parsing and Topic Discovery node and select **Add output port** ⇨ **Parent Table**.

d Connect the Parent Table port for the Text Parsing and Topic Discovery node to the MyCas.tbd table.

11 To create an output table for the term information:

a Select **Add** ⇨ **Table**.

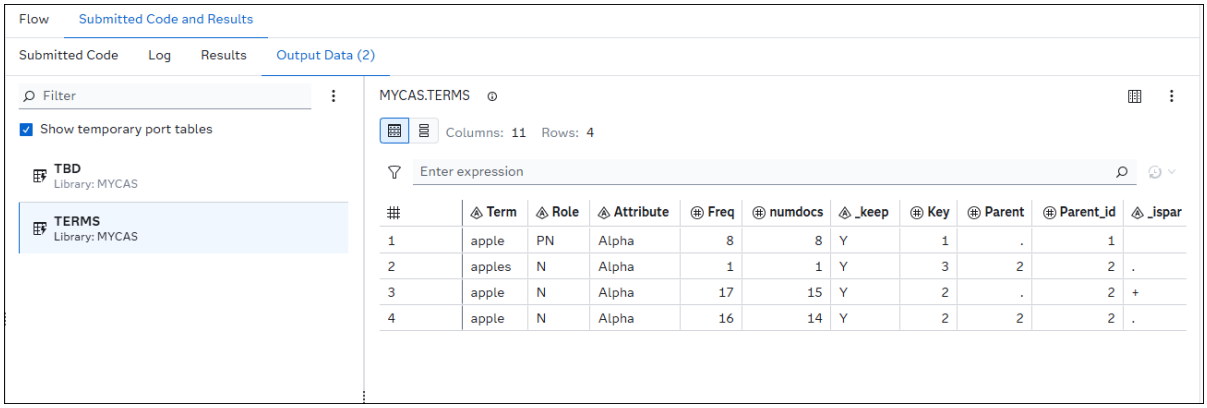
b Select the Table node. In the table properties, enter `MyCas` as the library and `terms` as the table name.

c Right-click the Text Parsing and Topic Discovery node and select **Add output port** ⇨ **Term Information Table**.

d Connect the output port for the Text Parsing and Topic Discovery node to the MyCas.terms table.

12 Run the flow.

Click the **Submitted Code and Results** tab to view the output data.



Example 2: Term-by-Document

1 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Text Parsing and Topic Discovery** to add the step to your flow.

2 Add the MyCas.tbd table to your flow. Connect the input port of the Text Parsing and Topic Discovery node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To set the options for the Text Parsing and Topic Discovery step, click the Text Parsing and Topic Discovery node.

4 On the **Data** tab, select **Term-by-document matrix**.

5 Add the MyCas.Terms table to the flow.

   a Right-click the Text Parsing and Topic Discovery node and select **Add input port ⇨ Terms Data**.

   b Connect the Terms Data port for the Text Parsing and Topic Discovery node to the MyCas.terms table.

6 On the **Options** tab of the Text Parsing and Topic Discovery node, select **Scree plot of singular values**.

7 On the **Output** tab, select **Save topics**.

8 To create an output table for the topics information:

   a Select **Add ⇨ Table**.

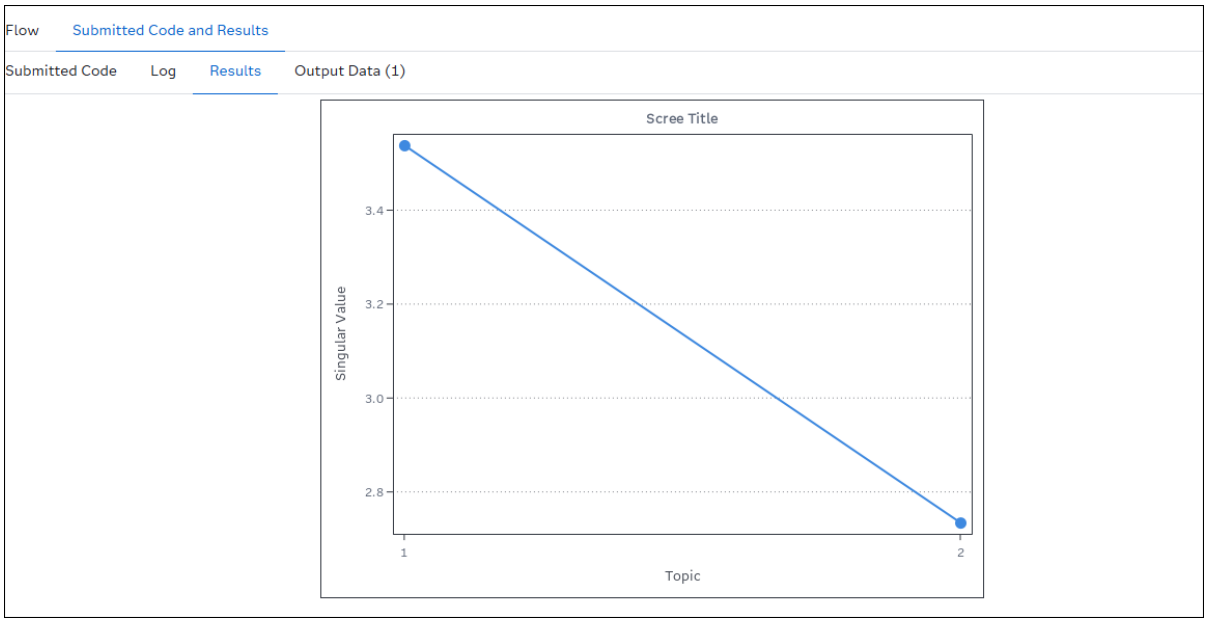
   b Select the Table node. In the table properties, enter `MyCas` as the library and `topics` as the table name.

   c Right-click the Text Parsing and Topic Discovery node and select **Add output port ⇨ Topics Table**.

   d Connect the output port for the Text Parsing and Text Discovery node to the MyCas.topics table.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results and the output data.



Example 3: Latent Dirichlet Allocation (LDA)

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Copy and paste this code on the **SAS Program** tab:

```
libname mycas cas;

data mycas.getstart;
    infile datalines delimiter='|' missover;
    length text $150;
    input text$ apple_fruit did$;
    datalines;
Delicious and crunchy apple is one of the popular fruits | 1 |d01
Apple was the king of all fruits. | 1 |d02
Custard apple or Sitaphal is a sweet pulpy fruit | 1 |d03
apples are a common tree throughout the tropics | 1 |d04
apple is round in shape, and tastes sweet | 1 |d05
Tropical apple trees produce sweet apple| 1| d06
Fans of sweet apple adore Fuji because it is the sweetest of| 1 |d07
this apple tree is small | 1 |d08
Apple Store shop iPhone x and iPhone x Plus.| 0 |d09
See a list of Apple phone numbers around the world.| 0 |d10
```

```
Find links to user guides and contact Apple Support, | 0 |d11
Apple counters Samsung Galaxy launch with iPhone gallery | 0 |d12
Apple Smartphones - Verizon Wireless.| 0 |d13
Apple mercurial chief executive, was furious.| 0 |d14
Apple has upgraded the phone.| 0 |d15
the great features of the new Apple iPhone x.| 0 |d16
Apple sweet apple iphone.| 0 |d17
Apple apple will make cars | 0 |d18
Apple apple also makes watches| 0 |d19
Apple apple makes computers too| 0 |d20
;
run;
```

Run the flow to create the MyCas.GetStart table.

3 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Text Parsing and Topic Discovery** to add the step to your flow.

4 Add the MyCas.GetStart table to your flow. Connect the input port of the Text Parsing and Topic Discovery node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Text Parsing and Topic Discovery step, click the Text Parsing and Topic Discovery node.

6 On the **Data** tab, assign **text** to the **Text variable** role.

7 On the **Options** tab, select **Latent Dirichlet Allocation** for the topic model.

8 Click the **Output** tab. Because you are using **Latent Dirichlet Allocation** for the topic model, you must create an output table for the topic-word distribution data.

   To add the output table to the flow:

   a Select **Add** ⇨ **Table**.

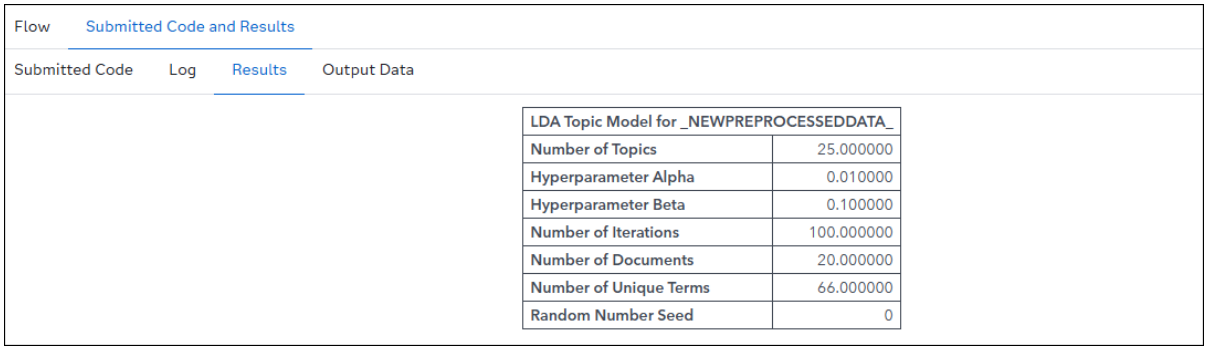
   b Select the Table node. In the table properties, enter **`MyCas`** as the library and **`topicsWord`** as the table name.

   c Right-click the Text Parsing and Topic Discovery node and select **Add output port** ⇨ **Topic-Word Distribution Table**.

   d Connect the Topic-Word Distribution Table port for the Text Parsing and Text Discovery node to the MyCas.topicsWord table.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



LDA Topic Model for _NEWPREPROCESSEDDATA_	
Number of Topics	25.000000
Hyperparameter Alpha	0.010000
Hyperparameter Beta	0.100000
Number of Iterations	100.000000
Number of Documents	20.000000
Number of Unique Terms	66.000000
Random Number Seed	0

Text Parsing and Topic Discovery: Using Unparsed Text

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 For the input table, select **Unparsed text**.

3 Select the language of the text in the input data table. The available languages depend on what you license in SAS Visual Text Analytics.

4 To the **Text variable** role, assign the variable that contains the text to be processed.

5 For the **Key variable**, specify whether the step should automatically create the key variable or whether you want to select a variable from the input table. The key variable contains the ID of each document. In the input table, each row corresponds to one document. The ID of each document must be unique; it can be either a number or a string of characters. By default, this variable is automatically generated.

Step 2: Set the Options

On the **Options** tab, the available options depend on whether you select **Singular value decomposition (SVD)** or **Latent Dirichlet allocation (LDA)** as the topic model.

These options are available for the singular value decomposition (SVD) model.

1 Use the **Include parts of speech** option to specify whether a term's part of speech should be identified during parsing.

2 Extract standard noun groups. By default, the step extracts noun groups, returns noun phrases without determiners or prepositions, and stems noun group elements (unless the **Stem terms** check box is not selected).

3 Specify whether to extract standard entities during parsing. If you choose to keep or ignore any entities, the step uses the standard LITI file for entity extraction.

   A term such as "George W. Bush" is recognized as an entity and given the corresponding entity role and attribute. For this term, the entity role is PERSON and the attribute is Entity. Although the entity is treated as the single term, "george w. bush," the individual tokens "george," "w," and "bush" are also included.

4 Enable the stemming of words. By default, words are stemmed. That is, terms such as "advises" and "advising" are mapped to the parent term "advise." The step uses dictionary-based stemming (also known as lemmatization).

5 Specify the parts of speech to include in the analysis. You can keep all parts of speech, keep selected parts of speech, or ignore selected parts of speech. You can also specify not to tag parts of speech.

6 Use the **Minimum number of occurrences to keep a term** option to remove terms that are not in at least *n* documents. The default value is `4`.

7 Select the **Use the log to weight the cells of the term-by-document matrix** to specify weighting the cells by using the log formulation. The term weight is a positive number that is assigned to each term based on the distribution of that term in the document collection. This weight can be interpreted as an indication of the importance of that term to the document collection. The cell weight is a function that is applied to every entry in the term-by-document matrix; the cell weight moderates the effect of a term that is repeated within a document.

8 Specify whether the terms are weighted. Terms are weighted by the entropy.

9 Specify a start or stop list to specify the words to keep or exclude during parsing. When the language is English, a default stop list is used.

   Note: For the singular value decomposition (SVD) model, the input data source must have a column named Term. This column must contain the list of terms to keep or remove from the analysis.

   If you are running this step in a flow, you must add an input table for the start list or custom stop list to the flow and connect the input table to the Text Parsing and Topic Discovery node.

   a Add the input table that contains the start list or stop list to the flow.

   b Right-click the Text Parsing and Topic Discovery node and select **Add input port**, and then select either **Start List Data** or **Stop List Data**.

   c Connect the input data table that contains the start list or stop list to the corresponding input port.

10 Select **Specify a synomyn list** to specify the input data table that contains user-defined synonyms to be used in the analysis. The data table specifies parent-child relationships that enable you to map child terms to a representative parent. The input synonym data table must have either the two variables Term and Parent or the four variables Term, Parent, Termrole, and Parentrole. This data table overrides any relationships that are identified when terms are stemmed.

   If you are running this step in a flow, you must add an input table for the synonym list to the flow and connect the table to the Text Parsing and Topic Discovery node.

   a Add the input table that contains the synonym list to the flow.

   b Right-click the Text Parsing and Topic Discovery node and select **Add input port ⇨ Synonym List Data**.

   c Connect the input data table that contains the synonym list to the corresponding input port.

11 Select **Specify a multi-word terms list** to specify that the input data source contains a list of multi-word terms. The multi-word terms are case sensitive and are treated as a single entry. Thus, the terms "Thank You" and "thank you" are processed differently. Consequently, you must convert all text strings to lowercase or add each of the multi-term's case variations to the list before using the task to create consistent multi-word terms.

   The multi-term data table must have a variable Multiterm and each of its values must be formatted in the following manner: `multiterm: 3: pos`

   Specifically, the first item is the multi-word term itself followed by a colon; the second item is a number that represents the token type followed by a colon; and the third item is the part of speech that the multi-word term represents.

   Note: The token type 3 is the most common token type for multi-term lists; it represents compound words.

   If you are running this step in a flow, you must add an input table for the multi-word terms list to the flow and connect the table to the Text Parsing and Topic Discovery node.

   a Add the input table that contains the multi-word term list to the flow.

   b Right-click the Text Parsing and Topic Discovery node and select **Add input port ⇨ Multi-word Terms List Data**.

   c Connect the input data table that contains the multi-word list to the corresponding input port.

12 Specify whether to suppress the discovery of topics.

   - If you do not select the **Suppress discovery of topics** option, you can specify the number of topics to be extracted. The default value is **25**.

     You could also choose to have the step automatically recommend the number of topics to be extracted. Specify the upper bound on the number of

topics in the **Maximum number of topics** box. You can also specify the resolution.

You can specify whether to create a scree plot of the number of topics versus singular values.

- If you select the **Suppress discovery of topics** option, you must set these options:
  - the maximum number of topics.
  - the resolution.
  - the type of rotation to use in order to maximize the explanatory power of each topic: Here are the valid values:
    - **Correlated topics (Promax)** performs an oblique rotation on the original left singular vectors and generates topics that might be correlated.
    - **Uncorrelated topics (Varimax)** performs an orthogonal rotation on the original left singular vectors and generates uncorrelated topics. This is the default rotation.
  - the number of terms to use in the descriptive label for each topic. The descriptive label provides a quick synopsis of the discovered topics. The default value is 5.

These options are available for the Latent Dirichlet allocation (LDA) model, which is available if you license and install SAS Visual Text Analytics.

Note: For the LDA topic model, you must add an output table to the flow for the topic-word distribution data. For more information, see "Step 3: Set the Output Options" on page 1338.

1. Extract standard noun groups. By default, the task extracts noun groups, returns noun phrases without determiners or prepositions, and stems noun group elements (unless the **Stem terms** check box is not selected).

2. Specify whether to extract standard entities during parsing. If you choose to keep or ignore any entities, the step uses the standard LITI file for entity extraction.

   A term such as "George W. Bush" is recognized as an entity and given the corresponding entity role and attribute. For this term, the entity role is PERSON and the attribute is Entity. Although the entity is treated as the single term, "george w. bush," the individual tokens "george," "w," and "bush" are also included.

3. Enable the stemming of words. By default, words are stemmed. That is, terms such as "advises" and "advising" are mapped to the parent term "advise." The task uses dictionary-based stemming (also known as lemmatization).

4. Specify a start or stop list to specify the words to keep or exclude during parsing.

   For the LDA model, terms in the start or stop list must be unique. There can be no duplicates in the list. If you select a custom list and it contains duplicate

items, you might see an error. For the LDA model, a default stop list is available only for English.

If you are running this step in a flow, you must add an input table for the start list or custom stop list to the flow and connect the input table to the Text Parsing and Topic Discovery node.

a Add the input table that contains the start list or stop list to the flow.

b Right-click the Text Parsing and Topic Discovery node and select **Add input port**, and then select either **Start List Data** or **Stop List Data**.

c Connect the input data table that contains the start list or stop list to the corresponding input port.

5 Specify the number of topics to be extracted. The default value is `25`.

6 Use the **Alpha (document-topic distribution hyperparameter)** to specify the number of topics used to characterize each document. A higher alpha value corresponds to a larger number of topics per document. The default value is `0.01`.

7 Use the **Beta (topic-word distribution hyperparameter)** to specify the number of words used to characterize each topic. A higher beta value corresponds to a larger number of words per topic. The default value is `0.1`.

8 Specify an integer for the random number seed.

Note: If you specify a random number seed, you might not be able to replicate the results in a distributed computing environment.

9 Specify the maximum number of iterations. The default value is `100`.

Step 3: Set the Output Options

On the **Output** tab, you can create these output CAS tables. When naming these tables, you must use a CAS engine libref.

For the singular value decomposition (SVD) model, you can create these output tables:

- parse text tables: term-by-document matrix (without child terms), raw term-by-document matrix (with child terms), term information, and configuration information (for scoring)
- tables for discover topics: topics, document projections, scoring model
- singular value decomposition: singular values, left singular values, right singular values

For the Latent Dirichlet allocation (LDA) model, you can create these output tables:

- a topic-word distribution table. For each topic, this table contains the estimated probability that each word belongs to that topic.
- a document-topic distribution table. For each document, this table contains the estimated probability that the document contains each topic.

Note: If you are running the step in a flow, you must add an output port for each output table to the Text Parsing and Topic Discovery node. For more information, see "Text Parsing and Topic Discovery: Connection Requirements for the Node" on page 1328.

Text Parsing and Topic Discovery: Term-by-Document Matrix

Step 1: Assign Data to Roles

These options are available if you specify that the input data set contains a term-by-document matrix. You can create this matrix by running the Text Parsing and Topic Discovery step with unparsed text or the Boolean Rules step.

1. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
2. For the input table, select **Term-by-document matrix**.
3. Specify terms in the input table. Each row of the data source must contain one variable for the term ID.
   a. Add the input table that contains the terms data to the flow.
   b. Right-click the Text Parsing and Topic Discovery node and select **Add input port** ⇨ **Terms Data**.
   c. Connect the input data table that contains the terms data to the corresponding input port.

Step 2: Set the Options

On the **Options** tab, the options are available only for the singular value decomposition (SVD) model.

These options are available for the singular value decomposition (SVD) model.

1. Specify the number of topics to be extracted.

- You can specify the number of topics. The default value is **25**.
- You can choose to have the step recommend the number of topics to be extracted. Specify the upper bound on the number of topics in the **Maximum number of topics** box. You can also specify the resolution.

2 Specify the type of rotation to use in order to maximize the explanatory power of each topic: Here are the valid values:

- **Correlated topics (Promax)** performs an oblique rotation on the original left singular vectors and generates topics that might be correlated.
- **Uncorrelated topics (Varimax)** performs an orthogonal rotation on the original left singular vectors and generates uncorrelated topics. This is the default rotation.

3 Specifies the number of terms to use in the descriptive label for each topic. The descriptive label provides a quick synopsis of the discovered topics. The default value is **5**.

4 Creates a scree plot of the number of topics versus singular values.

Step 3: Set the Output Options

On the **Output** tab, you can create these output CAS tables. When naming these tables, you must use a CAS engine libref.

For the singular value decomposition (SVD) model, you can create these output tables:

- tables for discover topics: topics and document projections
- singular value decomposition: singular values, left singular values, and right singular values

Note: If you are running the step in a flow, you must add an output port for each output table to the Text Parsing and Topic Discovery node. For more information, see "Text Parsing and Topic Discovery: Connection Requirements for the Node" on page 1328.

Text Scoring

About the Text Scoring Step

The Text Scoring step scores a data table by using tables that are generated by another Text Analytics step.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Text Scoring: Connection Requirements for the Node

In order to run the Text Scoring step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Text Scoring node, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, at least one output data table is created. A connection from the step node to the output table is required. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Topics (SVD) Model

First, create the CAS table with your training data:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 To create the Review table, Copy and paste this code on a **SAS Program** tab:

```
libname mycas cas;

/* Original training data */
data mycas.reviews;
       infile datalines delimiter='|' missover;
       length text $300 category $20;
       input text$ positive category$ did;
       datalines;
    This is the greatest phone ever! love it!|1|electronics|1
    The phone's battery life is too short and screen resolution is low.
       |0|electronics|2
    The screen resolution is low, but I love this tv.|1|electronics|3
    The movie itself is great and I like it, although the resolution
is low.|1|
       movies|4
    The movie's story is boring and the acting is poor.|0|movies|5
    I watched this movie on tv, it's not good on a small screen. |0|
movies|6
    watched the movie first and loved it, the book is even better!|1|
books |7
    I like the story in this book, they should put it on screen.|1|
books|8
    I love the author, but this book is a waste of time, don't buy it.|
0|books|9
;
run;

/* Test data to score */
data mycas.reviewsTest;
   infile datalines delimiter='|' missover;
   length text $300;
   input text$ did;
   datalines;
Loved the movie! Even better than advertised.|1
I like the book. Better than the movie.|2
;
run;
```

```
/* Test data to score */
data mycas.reviewsTest;
   infile datalines delimiter='|' missover;
   length text $300;
   input text$ did;
   datalines;
Loved the movie! Even better than advertised.|1
I like the book. Better than the movie.|2
;
run;
```

3 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Text Parsing and Topic Discovery** to add the step to the flow.

4 Add the MyCas.Reviews table to your flow. Connect the input port of the Text Parsing and Topic Discovery node to the data source. For more information, see "Connecting Nodes" on page 13.

5 To set the options for the Text Parsing and Topic Discovery step, select the TextParsing and Topic Discovery node.

6 On the **Data** tab, assign **text** to the **Text variable** role.

7 Click the **Options** tab and set these options:

- Under the **Parse Text** heading, enter `1` for **Minimum number of occurrences to keep a term**.
- Under the **Discover Topics** heading, enter `3` for **Number of topics**.

8 Click the **Output** tab. Under the **Discover Topics** heading, select **Save scoring model**. Enter as the name.

Add the output table to the flow.

a Select **Add** ⇨ **Table**.

b Select the Table node. In the table properties, enter **`MyCas`** as the library name and **`svdModel`** as the table name.

c Right-click the Text Parsing and Topic Discovery node and select **Add output port** ⇨ **Scored Model Table**.

d Connect the new output port to the MyCas.svdModel node.

9 Run the flow.

Now use the mycas.svdModel topics model to score the mycas.reviewsTest data table in the Text Scoring step.

1 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Text Scoring** to add the step to your flow.

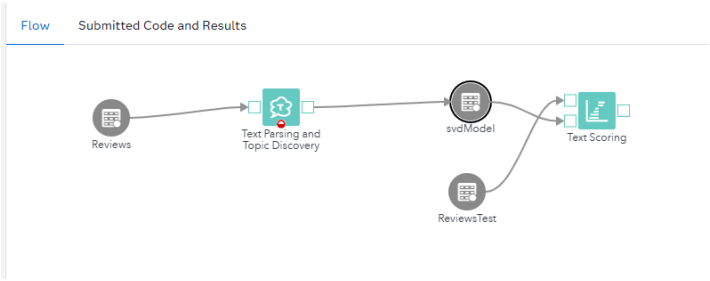
2 Add the MyCas.ReviewsTest table to your flow. Connect the input port of the Text Scoring node to the data source. For more information, see "Connecting Nodes" on page 13.

3 To add the scoring model:

a Add the MyCas.SVDModel table to the flow.

b Right-click the Text Scoring node and select **Add input port** ⇨ **Saved Scoring Model Data**.

c Connect the MyCas.SVDModel table to the input port for saved scoring model data.

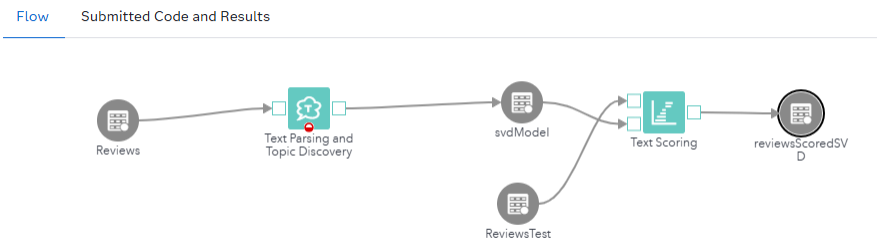


4 To create an output table:

a Select **Add** ⇨ **Table**.

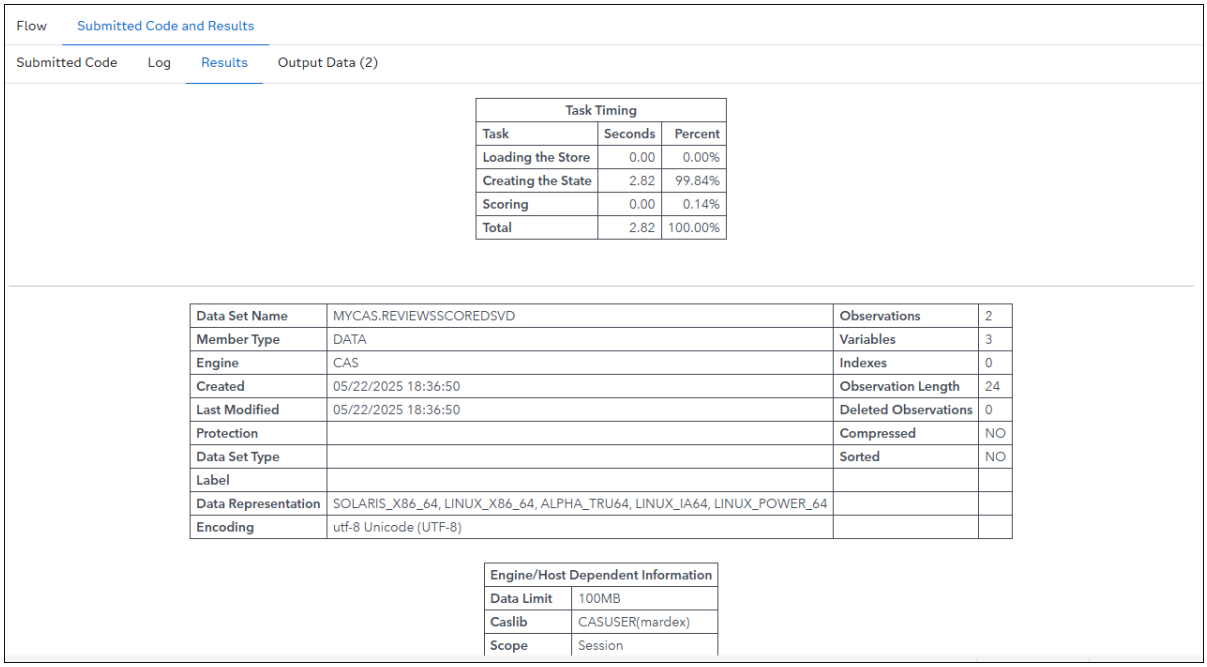
b Select the Table node. In the table properties, enter **`MyCas`** as the library and **`reviewsScoredSVD`** as the table name.

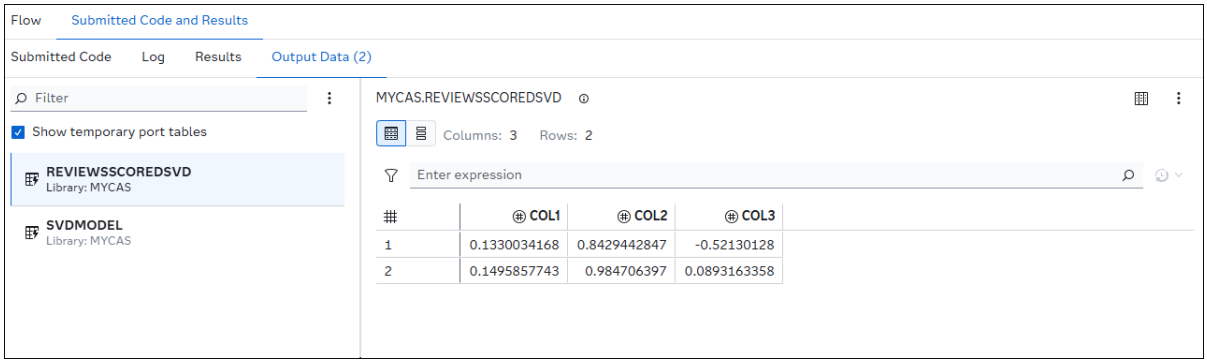
c Connect the output port for the Text Scoring node to the MyCas.reviewsScoredSVD table.



5 Run the flow.

Click the **Submitted Code and Results** tab to view the results.





Text Scoring: Topics (SVD) Model

To run the Text Scoring step by using the Topics (SVD) model:

1. From the **Model type** drop-down list, select **Topics (SVD)**.
2. Add to the flow the data that you want to score. This data source should be similar in structure to the data source that was used to create the score code.

   Connect the input table to the input port for the Text Scoring node.
3. (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.
4. To the flow, add any additional input data that contains the model information. Connect these input tables to the Text Scoring node.
5. Create the output table.

a Click **Add** and select **Table**.

b In the table properties, enter the table name. You must use a CAS engine libref.

c Connect the output port for the Text Scoring node to the output table.

6 Run the flow.

Text Scoring: Topics (LDA) Model

To run the Text Scoring step by using the Topics (LDA) model:

1 From the **Model type** drop-down list, select **Topics (LDA)**.

2 Add to the flow the data that you want to score. This data source should be similar in structure to the data source that was used to create the score code.

Connect the input table to the input port for the Text Scoring node.

3 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

4 In the **Text variable** role, select the character variable that contains the text to be analyzed.

5 Specify how to create the key variables. You can choose from these options:

- **Automatically create**.
- **Select variable** - The key variable must contain only unique values.

6 To the flow, add any additional input data that contains the model information. Connect these input tables to the Text Scoring node.

7 Create the output table.

a Click **Add** and select **Table**.

b In the table properties, enter the table name. You must use a CAS engine libref.

c Connect the output port for the Text Scoring node to the output table.

8 Run the flow.

Text Scoring: Boolean Rules Model

To run the Text Scoring step by using the Boolean Rules model:

1 From the **Model type** drop-down list, select **Boolean Rules**.

2 Add to the flow the data that you want to score. This data source should be similar in structure to the data source that was used to create the score code.

   Connect the input table to the input port for the Text Scoring node.

3 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

4 In the **Text variable** role, select the character variable that contains the text to be analyzed.

5 Specify how to create the key variables. You can choose from these options:

   - **Automatically create**.
   - **Select variable** - The key variable must contain only unique values.

6 To the flow, add CAS tables that contain the following data:

   - parsed term information
   - parsing configuration
   - Boolean rule term information

   Connect these input tables to the Text Scoring node.

7 Create the output table.

   a Click **Add** and select **Table**.

   b In the table properties, enter the table name. You must use a CAS engine libref.

   c Connect the output port for the Text Scoring node to the output table.

8 Run the flow.

Text Summarization

About the Text Summarization Step

The Text Summarization step generates textual summaries of text data.

Note: This step is available to use in a flow only if your site licenses SAS Data and AI Studio Advanced or SAS Data and AI Studio Enterprise. You can use this step as a standalone step in SAS Data and AI Studio, SAS Data and AI Studio Advanced, or SAS Data and AI Studio Enterprise. For more information, see "Summary of Flow Functionality" in *SAS Data and AI Studio: User's Guide*.

Text Summarization: Connection Requirements for the Node

In order to run the Text Summarization step, you must create connections to the input and output ports of the node as indicated here:

Input Port	Output Port
For the Text Summarization node, the input data source must be a CAS table. ■ Table node or ■ Operational node (for example, a Query node, a SAS Program node, or an Import node) that creates an output table	By default, at least one output data table is created. A connection from the step node to the output table is required. On the **Output** tab, you can specify the summarization level for the step. You can create a summary of each document, a summary of the entire corpus, or both. These summaries are saved in output tables. These tables must use a CAS engine libref. To run this step in a flow, you must add output ports for these optional tables. To add an output port, right-click the Text Summarization node and select **Output Document Summaries Data** or **Output Corpus Summary Data**. For more information, see "Step 2: Set the Options" on page 1351. **Note:** For this step to run, the output data must use a CAS engine library. You can specify the library and the name of the output table by connecting the output port to a Table node. For more information, see "Adding a Table from a SAS Library to a Flow" on page 34.

Example: Text Summarization

To create this example:

1 On a **SAS Program** tab, run this code to create a connection to Cloud Analytic Services (CAS) and to start a CAS session.

```
options cashost="<cas-server-name>" casport=<port-number>;
cas;
```

Note: You can also use the Create CAS Connection snippet in SAS Data and AI Studio.

2 Enter this code on a **SAS Program** tab:

```
libname mycas cas;

data mycas.textsummary;
   infile datalines delimiter='|' missover;
   length text $150;
   input text$ key;
   datalines;
Reduces the cost of maintenance. Improves revenue forecast.          | 1
Analytics holds the key to unlocking big data.                       | 2
The cost of updates between different environments is eliminated.    | 3
Ensures easy deployment in the cloud or on-site.                     | 4
Organizations are turning to SAS for business analytics.             | 5
This removes concerns about maintenance and hidden costs.            | 6
Service-oriented and cloud-ready for many cloud infrastructures.     | 7
Easily apply machine learning and data mining techniques to data.    | 8
SAS Viya will address data analysis, modeling and learning.          | 9
Helps customers reduce cost and make better decisions faster.        | 10
Simple, powerful architecture ensures easy deployment in the cloud.  | 11
SAS is helping industries glean insights from data.                  | 12
Solve complex business problems faster than ever.                    | 13
Shatter the barriers associated with data volume with the SAS        | 14
Viya platform.  Casual business users, data scientists and           | 15
application developers. Serves as the basis for innovation causing   | 16
revenue growth.                                                      | 17
;
```

3 In the **Steps** section of the navigation pane, expand the **Text Analytics** folder and double-click **Text Summarization** to add the step to your flow.

4 Add the MyCas.TextSummary table to your flow. Connect the input port of the Text Summarization node to the data source. For more information, see "Connecting Nodes" on page 13.

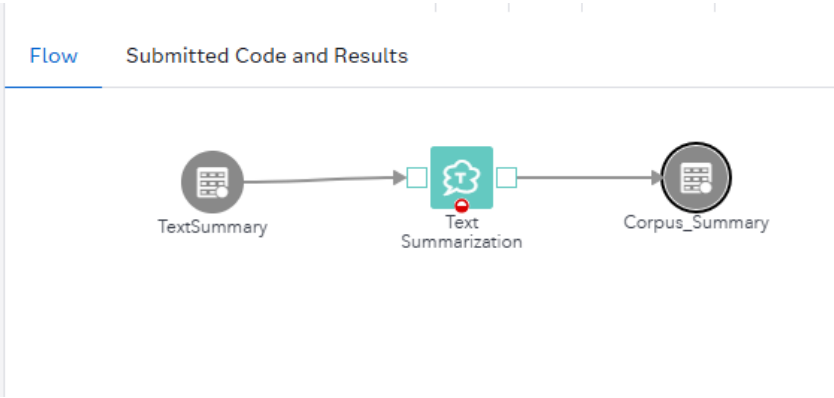
5 To set the options for the Text Summarization step, click the Text Summarization node.

6 On the **Data** tab, assign **text** to the **Text variable** role.

7 On the **Options** tab, clear the **Each document** check box. Select **Entire corpus** for the **Summarization level**.

Note: If you are running the step in a flow, you must add an output port for the output corpus summary data to the Text Summarization node. For more information, see "Text Summarization: Connection Requirements for the Node" on page 1348.

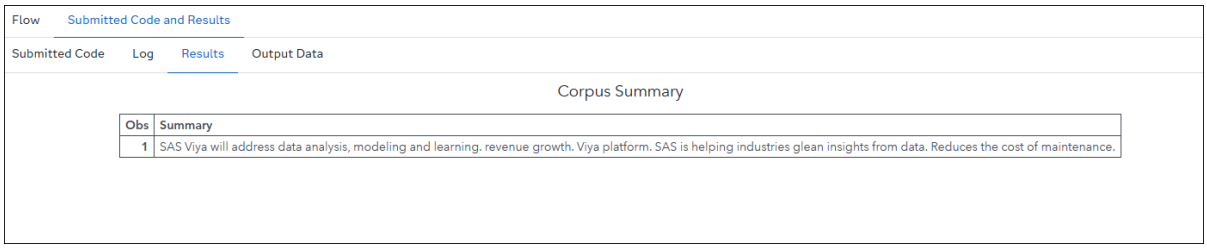
After you add the output table, your flow should appear similar to the following figure:



8 On the **Output** tab, select **Show output data in the Results tab**.

9 Run the flow.

Click the **Submitted Code and Results** tab to view the results.



Text Summarization: Step-by-Step Instructions

Step 1: Assign Data to Roles

1 (Optional) To filter the input data source, enter the filter expression in the **Filter input data** field.

2 Select the language of the text in the input data table. The available languages depend on what you license in SAS Visual Text Analytics.

3 To the **Text variable** role, assign the variable that contains the text to be summarized.

4 For the **Key variable**, specify whether the step should automatically create the key variable or whether you want to select a variable from the input table. The key variable contains the ID of each document. In the input table, each row corresponds to one document. The ID of each document must be unique; it can be either a number or a string of characters. By default, this variable is automatically generated.

Step 2: Set the Options

On the **Options** tab, you can set these options:

1 Specify whether to create a summary for each document, an overall summary for all the documents, or both. By default, a summary for each document is created.

2 Specify the maximum number of sentences in the output summary. Valid values are `1` to `32`. The default value is `5`.

3 Specify whether to use terms or entities and noun groups (or both) when parsing the input text. Terms are used by default.

Step 3: Set the Output Options

On the **Output** tab, you can specify these options:

1 (Optional) Specify whether to create an output table that contains the document summary. You can choose whether to include variables from the input data source and whether to show a subset or all of the output data in the Results tab. You must specify a CAS engine libref.

2 (Optional) Specify whether to create an output table that contains the corpus summary. You can show all of the output data. You must specify a CAS engine libref.

Note: If you are running the step in a flow, you must add an output port for the document summaries table and an output port for the corpus summary table to the Text Summarization node. For more information, see "Text Summarization: Connection Requirements for the Node" on page 1348.

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Optimizing and Running a Flow

Optimizing Steps in a Flow 1353
Adding Status Handling to a Flow 1354
Controlling the Submission Order of a Flow 1355
Excluding a Node from Running 1357
Running a Flow 1357

Optimizing Steps in a Flow

When you use the output of an operational node as the input to another node, it might not be necessary to create and store the output table from the first node. You can optimize the performance of your flow by combining the code generation of adjacent nodes so that the table that is associated with the output port of the first node is not created.

The following step combinations can be optimized:

- Query node connected to an Insert Rows node
- Filter Rows node connected to a Sort node

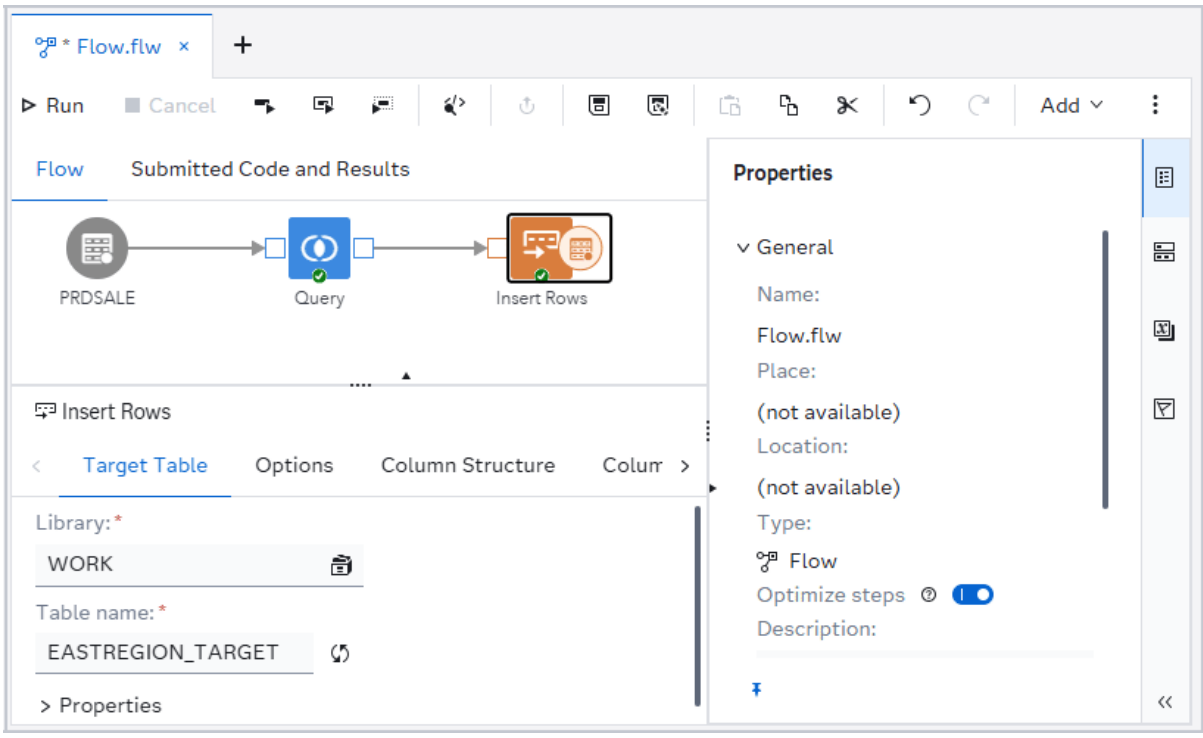
Note: The optimization option works only when the nodes that can be optimized are run at the same time.

For example, you could use the Query step to calculate local sales data that you want to append regularly to a regional sales table by using the Insert Rows step. You can optimize the performance of your flow by combining the code that is generated by the Query and Insert Rows nodes. When the code for the Query and Insert Rows nodes is combined, the output table for the Query node is not explicitly created.

To optimize the performance of your flow:

1 On the flow canvas, expand the Properties pane by clicking .

2 Click to turn on the **Optimize steps** option.



Adding Status Handling to a Flow

You can use the status handling feature to send the flow status to a specified table after the flow is finished running.

Note: Status handling is available only if your site licenses SAS Data and AI Studio Enterprise.

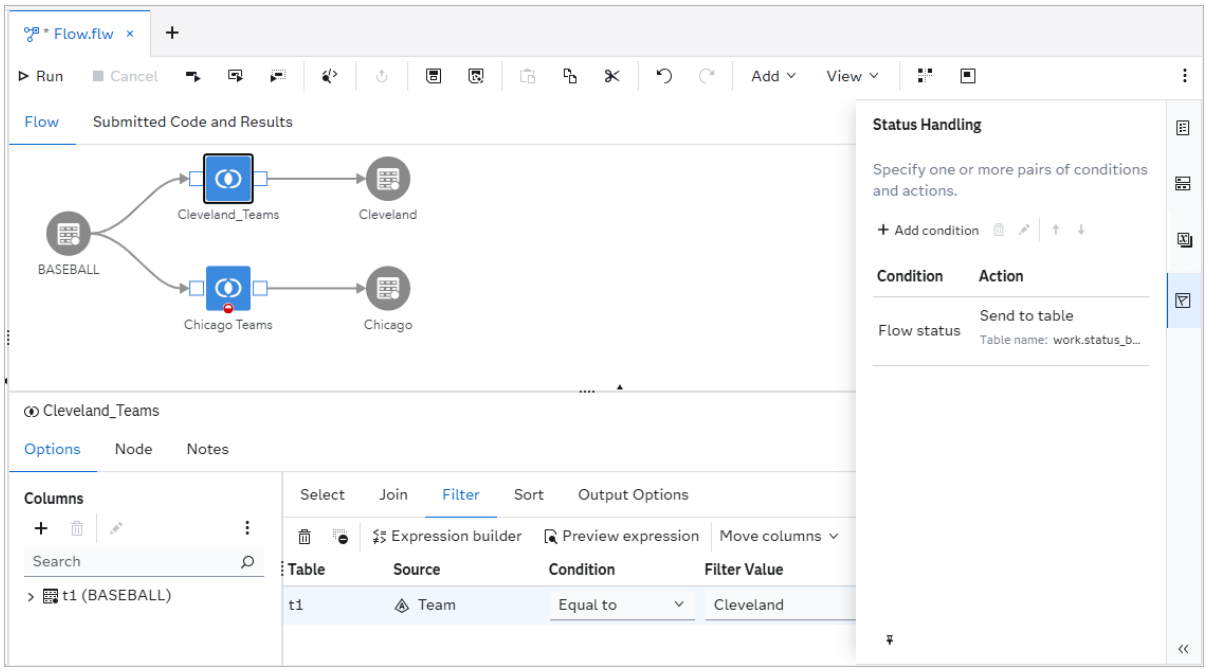
To send the flow status to a table:

1 On the flow canvas, expand the Status Handling pane by clicking on the right side of the canvas.

2 To add a condition, click **Add condition**.

3 In the Condition and Action Details window, specify the library and table name. Click **OK**.

Note: You can add more than one condition to a flow.



Note: The SYSCC automatic macro variable is evaluated at the end of the flow execution to determine the overall run status of the flow. A value of 0 indicates a successful execution. SYSCC is global in scope and reflects the highest severity of any issue that is encountered during the flow execution. In rare cases, the value of SYSCC can be 0 even when other diagnostic automatic variables, such as SYSERR, SYSFILRC, or SYSRC, are set to nonzero values for warnings or errors in a step or program statement.

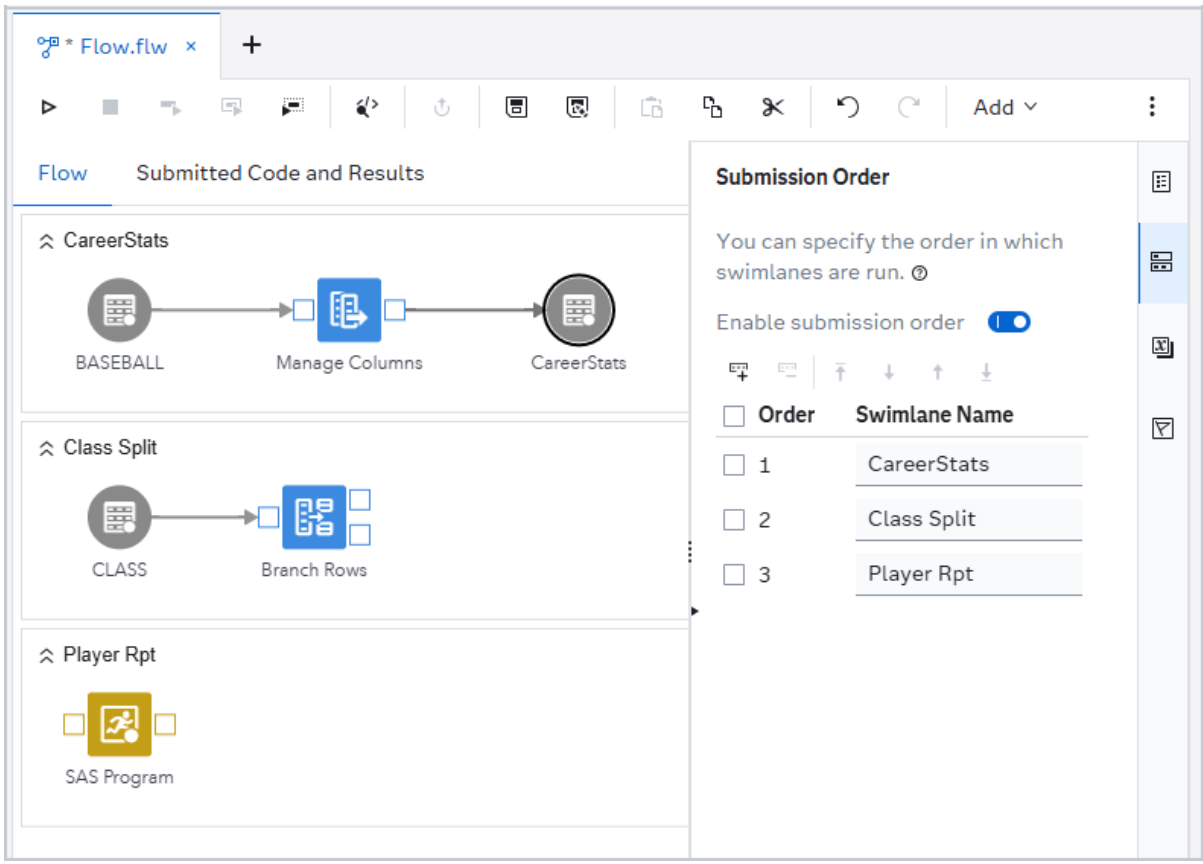
Controlling the Submission Order of a Flow

By default, the order of the nodes on the flow canvas determines the order in which the nodes run. You can control the submission order by grouping connected nodes into swimlanes, and then specifying the order of the swimlanes.

To specify the submission order:

1 On the flow canvas, expand the Submission Order pane by clicking on the right side of the canvas.

2 Click to turn on the **Enable submission order** option. Each group of connected nodes is organized into a separate swimlane.



3 You can perform the following actions in the Submission Order pane:

- To change the order in which the swimlanes are run, use the buttons on the toolbar to move the swimlanes up and down the list.

  Note: To select a swimlane on the flow canvas, click the swimlane name. You can then change the order in which the swimlanes are run by dragging the swimlane to a new position.

- To move one or more nodes from one swimlane to another, select the nodes and drag them to the appropriate swimlane. You can also cut, copy, and paste nodes between swimlanes.
- To add a new swimlane to the flow, click on the Submission Order toolbar.
- To delete a swimlane and the associated nodes, select one or more swimlanes from the list of swimlanes and click on the Submission Order toolbar.
- To rename a swimlane, enter the new name in the Swimlane name column. The name is updated on the flow canvas.
- To refresh the arrangement of the nodes within swimlanes and remove empty swimlanes, click on the toolbar.

Note: When you disable the submission order feature, any changes that you have made to swimlane names and order are not saved.

Excluding a Node from Running

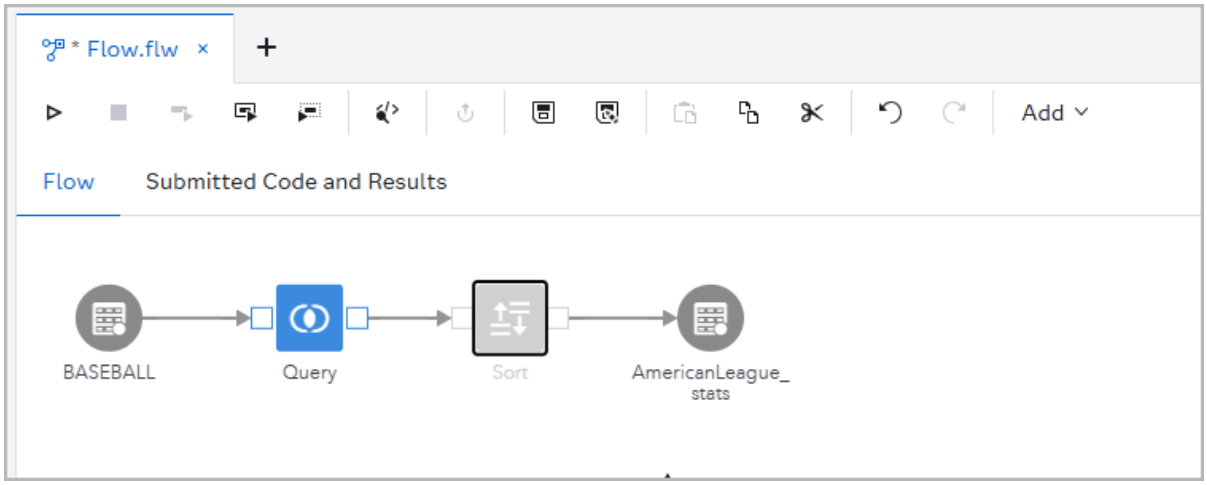
You can exclude one or more nodes from running in a flow. This option enables you to test portions of a flow without running or redesigning the entire flow. You can also add a step to a test run of a flow, and then exclude it from the production run.

Note: You cannot exclude a table node.

To exclude a node from running:

- On the flow canvas, right-click the node that you want to exclude and select **Exclude from run**. The node is disabled in the flow.

  In the following example, the Sort node is excluded from running. The AmericanLeague_stats table is created from the output of the Query node.



Note: Make sure that you do not exclude a node that is required for the flow to run successfully.

Running a Flow

To run all the nodes in a flow, click ▷ Run.

You can also run a subset of the flow by using the following buttons on the flow toolbar:

- - runs only the currently selected node in the flow.

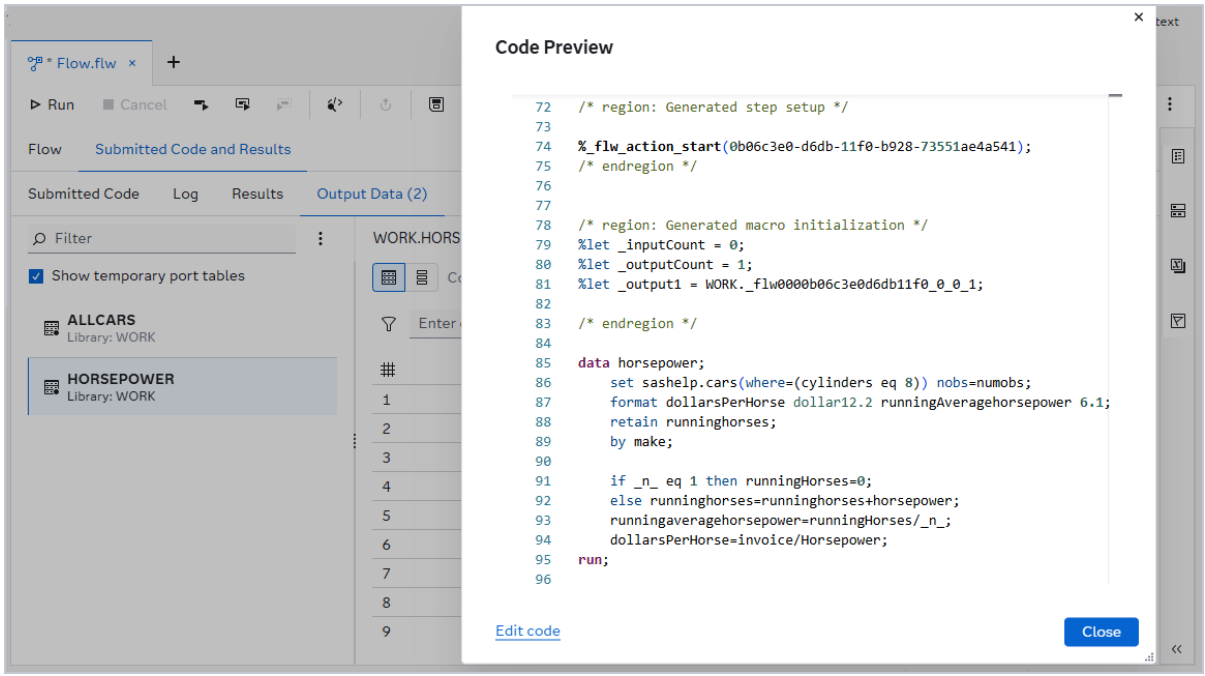
- - runs the currently selected node and all nodes that occur downstream from the currently selected node.
- - runs all nodes that occur upstream from the currently selected node. The currently selected node is not run.

Note: To cancel your flow, click **Cancel** on the toolbar. Currently processing nodes might take a few minutes to be canceled.

You can view the automatically generated code for a flow by clicking on the flow toolbar. The code opens in the Code Preview window. To open the generated code in a new tab in the work area, click **Edit code**. The code is a copy of the code that is generated by SAS Data and AI Studio and is not associated with the flow. Editing this code does not affect the flow.

To view the submitted code and log for a flow, click the **Submitted Code and Results** tab on the flow canvas. The **Submitted Code and Results** tab also displays any results and output data that are generated when you run a node. If more than one output table is generated, you can use the output list to select which table to display.

> **TIP** You can interact with a flow while it is running by scrolling the flow canvas and by clicking nodes and tabs on the flow canvas. You cannot modify the flow or any node details until the flow is finished running.



To view the code or log that is associated with a particular node, right-click the node and select **Go to last submitted code** or **Go to last submitted log**.

To run a saved flow as a background job, open the flow and click on the toolbar. For more information, see "Using the Background Submit Feature" in *SAS Data and AI Studio: User's Guide*.

or right-click the flow in the **Explorer** section of the navigation pane and select **Background submit**.

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Creating a Job from a Flow

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Creating a Job from a Flow

To create a job from a saved flow, open the SAS Server or SAS Content section of the navigation pane. Navigate to the location of the saved FLW file. Right-click the name and select **Create a job definition**. The new job opens as a job definition in the workspace. For more information, see "Create a Job Definition" in *SAS Data and AI Studio Developer's Guide: Working with Jobs*.

To deploy a flow as a job, open the SAS Server or SAS Content section of the navigation pane. Navigate to the location of the saved FLW file. Right-click the name and select **Deploy as a job**. For more information, see "Managing Deployed and Scheduled Jobs" in *SAS Data and AI Studio Developer's Guide: Working with Jobs*.

You can also schedule a job from the SAS Server or SAS Content section of the navigation pane. Right-click the file name of the flow and select **Schedule a job**. For more information, see "Schedule a Job" in *SAS Data and AI Studio Developer's Guide: Working with Jobs*.

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SAS Data Governance and SAS Lineage Viewer Integration

SAS Data Governance and SAS Lineage Viewer Integration 1363

SAS Data Governance and SAS Lineage Viewer Integration

SAS Data and AI Studio flows are automatically indexed in SAS Data Governance and SAS Lineage Viewer. SAS Data Governance enables you to capture and enrich metadata for files, tables, and other information assets. This metadata is stored in a catalog. You can search the catalog to find SAS Data and AI Studio flows and other assets that you need to meet your business goals.

To access SAS Data Governance, select **Discover Information Assets** from the Applications menu in the top left of the application window. For more information, see SAS Data Governance: User's Guide.

SAS Lineage Viewer enables you to better understand the relationships between objects in your applications on the SAS Viya platform. These objects include SAS Data and AI Studio flows, data, transformation processes, reports, and visualizations.

To access SAS Lineage Viewer, select **Explore Lineage** from the Applications menu in the top left of the application window. For more information, see SAS Lineage: User's Guide.