SAS® Studio 3.5

Task Reference

SAS® Documentation

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Using This Book

Audience

This book is a reference guide for anyone who uses SAS Studio tasks. In this document, you can find descriptions of each task and all of the options that are available for each task. When appropriate, the task documentation includes an example that you can walkthrough. This document should be used in conjunction with the *SAS Studio: User's Guide*.

For information about how to develop custom tasks for your site, see *SAS Studio: Developer's Guide*.

Requirements

To run these tasks, you must have access to SAS Studio 3.5. Some tasks require additional SAS software. For example, some tasks require that you license and install SAS/STAT. If you have this additional products licensed and installed at your site, these tasks are available from the user interface. If you do not have the required software, these tasks do no appear in the user interface. The About topic for each task lists any software that is required to run the task.

Part 1

Data Tasks

1

List Table Attributes

About the List Table Attributes Task

The List Table Attributes task enables you to quickly see the date on which the data set was created and last modified, the number of rows, the encoding, any engine-dependent or host-dependent information, and an alphabetic list of the variables and their attributes. You can also view any directory and host/engine information by using this task.

Example: Table Attributes for the Sashelp.Pricedata Data Set

In this example, you want to view the table attributes for the Sashelp.Pricedata data set.

To create this example:

1 In the **Tasks** section, expand the **Data** folder, and then double-click **List Table Attributes**. The user interface for the List Table Attributes task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 On the **Options** tab, select **Create output data set**.

4 To run the task, click .

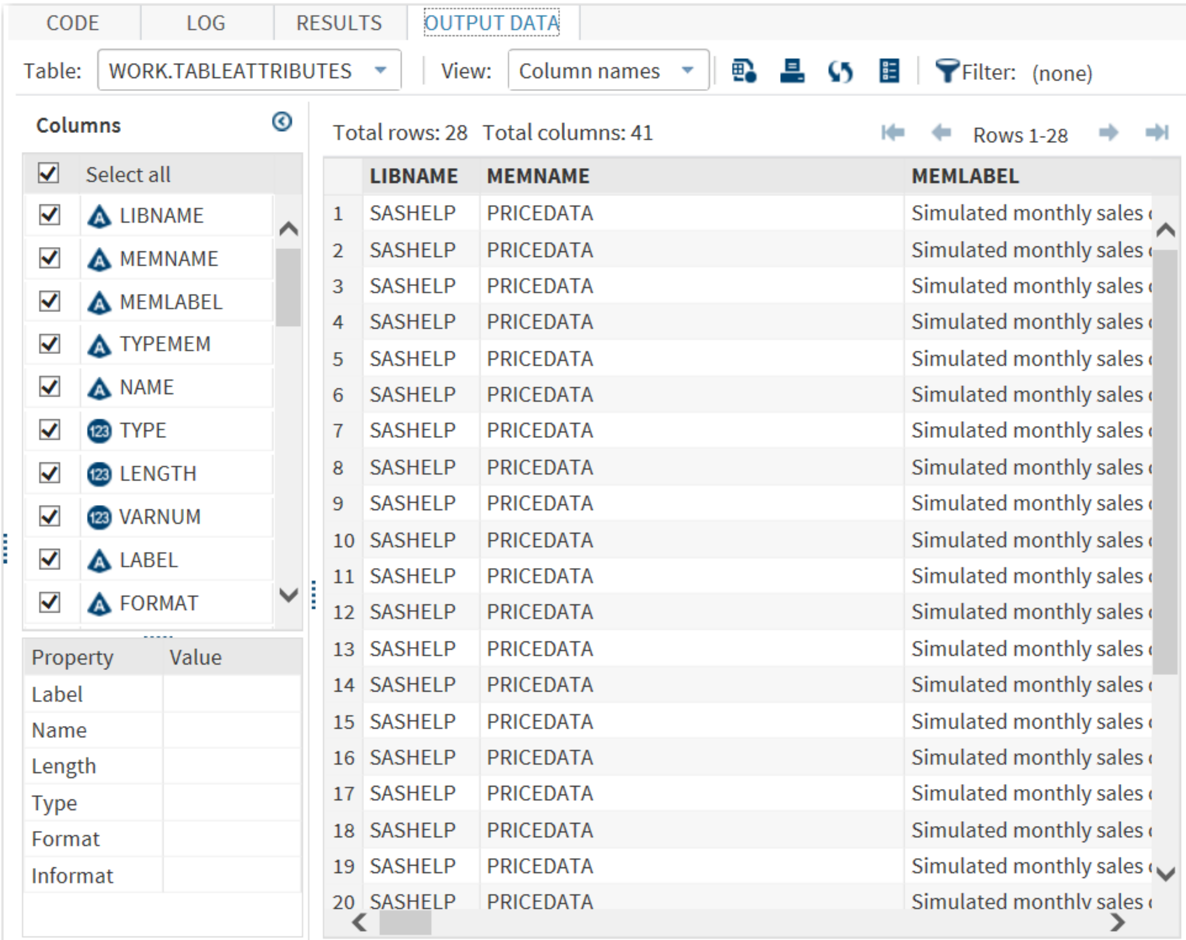
Here is a subset of the results for the List Table Attributes task. These results are the enhanced report for the Sashelp.Pricedata data set.

Data Set Name	SASHELP.PRICEDATA	**Observations**	1020
Member Type	DATA	**Variables**	28
Engine	V9	**Indexes**	0
Created	06/25/2015 00:07:08	**Observation Length**	224
Last Modified	06/25/2015 00:07:08	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label	Simulated monthly sales data with hierarchy of region, line, product		
Data Representation	WINDOWS_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

You can view the output data set from the **Output Data** tab.



Selecting an Input Data Source

To run the List Table Attributes task, you must select an input data source on the **Data** tab.

Setting Options

Option Name	Description
Data set attributes	displays the attributes of the data set. Attributes include the data set name, member type, when the data set was created, when the data set was last modified, encoding, and so on.

Option Name	Description
Variables list	creates a list of all variables and their attributes. Attributes include variable name, type, length, and so on. You can choose to display the variables in alphabetical order or in the order in which they appear in the data set.
Directory information	displays the name of the directory where this data set is located.
Host/Engine information	displays the SAS engine, physical name, and filename for each level in the directory.
Create output data set	specifies to save the table attributes in an output data set.
Print output data set	includes the output data set in the results.

2

Characterize Data Task

About the Characterize Data Task

The Characterize Data task creates a summary report of tables and graphs that describe the variables in the input data set. This task can also create frequency and univariate SAS data sets that describe the main characteristics of the data. The Characterize Data task is useful when you are working with a new data set. This task enables you to better understand the scope and range of the variables in the data.

Example: Characterize Data Task

In this example, you want a better understanding of the contents in the Sashelp.Pricedata data set.

To create this example:

1. In the **Tasks** section, expand the **Data** folder, and then double-click **Characterize Data**. The user interface for the Characterize Data task opens.
2. On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. Assign columns to these roles:

Role	Column Name
Automatic Characterization	
Variables	**sale**
Custom Characterization	
Categorical variables	**regionName**
Date variables	**date**

4 To run the task, click .

Here is a subset of the results:

Frequencies for Categorical Variables

Sales Region				
regionName	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Region1	180	17.65	180	17.65
Region2	480	47.06	660	64.71
Region3	360	35.29	1020	100.00

Descriptive Statistics for Numeric Variables

Analysis Variable : sale Unit Sale						
N	N Miss	Minimum	Mean	Median	Maximum	Std Dev
1020	0	203.0000000	408.5558824	408.5000000	747.0000000	73.0840041

Minimum and Maximum Dates

Date variable	Minimum date	Maximum date
date	JAN98	DEC02

Assigning Data to Roles

To run the Characterize Data task, you must select an input data source. To filter the input data source, click .

You must also select at least one variable to characterize. This task 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 data set, 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 task treats each value of Age as a group.

Role	Description
Automatic Characterization	
Variables	specifies the variables that you want to analyze.
Custom Characterization	
Categorical variables	specifies the frequency tables to produce.
Date variables	specifies the date variables to analyze.
Roles	
Grouping variable	specifies that the table is sorted by the selected variable or variables. Also, the task generates a listing for each distinct value, or BY group, in the variable or combination of variables.

Setting Options

Option Name	Description
Categorical Variables	
Frequency table	displays a frequency table in the results.
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.

Option Name	Description
Limit categorical values	specifies the maximum number of variable levels to display in one-way frequency tables.
Numeric variables	
Descriptive statistics	displays the descriptive statistics for any numeric variables that you assigned to the **Variables** role.
Histogram	displays a histogram for any numeric variables that you assigned to the **Variables** role.
Date Variables	
Display minimum and maximum date	shows the minimum and maximum date for each variable that you assigned to the **Date variables** role.
Frequency plot	displays a frequency plot in the results.

3

Describe Missing Data

About the Describe Missing Data Task

The Describe Missing Data task displays the frequencies and percentages of missing values for each selected variable. If two or more variables are assigned to this task, the task displays the pattern of missing data across variables.

Example: Describing Missing Data for SASHELP.BASEBALL

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Describe Missing Data**. The user interface for the Describe Missing Data task opens.

2 On the **Data** tab, select **SASHELP.BASEBALL** as the input data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 To the **Analysis variables** role, assign **Salary** and **Div**.

4 To run the task, click .

Here are the results:

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

Here is how to interpret the results.

- Under the Missing Data Frequencies heading, the first table shows 59 observations in the input data set have a missing value for the Salary variable. The second table shows that there are no missing values for the League and Division variable.
- Under the Missing Data Patterns across Variables heading, the table shows the pattern of missing values across the variables. In this case, 59 observations have a missing value for the Salary variable. The League and Division variable contains no missing values. Therefore, the remaining 263 observations in the input data set do not have any missing values for the two variables.

  The legend for this table identifies special missing values in the input data. SAS enables you to differentiate among classes of missing values in numeric data. For numeric variables, you can designate up to 27 special missing values by using the letters A through Z, in either uppercase or lowercase, and the underscore character (_).

  For more information about special missing values, see *SAS Language Reference: Concepts*.

Setting the Data Options

To run the Describe Missing Data task, you must select an input data source. To filter the input data source, click .

You must assign at least one variable to the **Analysis variables** role.

Role	Description
Roles	
Analysis variables	specifies the numeric and character variables to use in the analysis.
Additional Roles	
Frequency count	specifies that each observation in the table is assumed to represent *n* observations, where *n* is the value of the frequency count for that row.
Group analysis by	computes separate statistics for each distinct value or combination of values of the Group analysis by variables.

4

List Data

About the List Data Task

The List Data task displays the contents of a table as a report. For example, you can use the List Data task to create a report that sums the expenses and revenues for each sales region.

Example: Reports of Drive Train, MSRP, and Engine Size 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.

To create this example:

1 In the **Tasks** section, expand the **Data** folder, and then double-click **List Data**. The user interface for the List Data task opens.

2 On the **Data** tab, select the **SASHELP.CARS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
List variables	**DriveTrain** **MSRP** **EngineSize**
Group analysis by	**Type**

4 To run the task, click .

Here is a subset of the results:

List Data for SASHELP.CARS

Type=Hybrid

Obs	DriveTrain	MSRP	Engine Size (L)
1	Front	$20,140	1.4
2	Front	$19,110	2.0
3	Front	$20,510	1.5

Type=SUV

Obs	DriveTrain	MSRP	Engine Size (L)
4	All	$36,945	3.5
5	All	$37,000	3.0
6	All	$52,195	4.4
7	All	$37,895	4.2
8	Front	$26,545	3.4
9	Front	$52,795	5.3
10	Front	$46,995	4.6
11	Front	$42,735	5.3
12	All	$41,465	5.3
13	Front	$30,295	4.2
14	Front	$20,255	2.5
15	All	$32,235	4.7
16	All	$41,475	6.8
17	Front	$34,560	4.6
18	All	$29,670	4.0
19	All	$22,515	3.0

Assigning Data to Roles

To run the List Data task, you must assign an input data source. To filter the input data source, click .

Role	Description
List variables	Prints the variables in the order in which they are listed.
Group analysis by	When you assign one or more variables to this role, the table is sorted by the selected variable or variables, and a listing is generated for each distinct value, or BY group, in the variable or combination of variables.
Total of	Prints the sum of the selected variable at the bottom of the listing report.
Identifying label	When you specify one or more variables in this role, the List Data task uses the formatted values of these variables to identify the rows, rather than observation numbers (designated in the results by the column heading "Obs").

Setting Options

Option Name	Description
Basic Options	
Display row numbers	Includes in the output a column that lists the row number for each observation. You can specify a label for this column in the **Column label** text box. By default, the name of this column is **Row number**.
Use column labels as column headings	Uses the column label instead of the column name as the column heading.
Display number of rows	Reports 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.

<table>
<tr><th>Option Name</th><th>Description</th></tr>
<tr><td>Round values before summing the variable</td><td>Rounds each numeric value to the number of decimal places in its format, or to two decimal places if no format is specified. If this option is specified, the List Data task performs the rounding before summing the variable.</td></tr>
<tr><td>Heading direction</td><td>Column headings can be printed horizontally or vertically, or you can select Default and let SAS determine the optimal arrangement for each column.</td></tr>
<tr><td>Column width</td><td>Specifies how the List Data task determines column widths:
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, 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 task uses the widest data value as the column width.</td></tr>
<tr><td>Split labels</td><td>If the variable labels contain one of the split characters (*, !, @, #, $, %, ^, &, or +), the labels will be split at the split character or characters. For example, for a variable label that reads "This is*a label" and the * character is selected as the split character, the column heading will read
<code>This is</code>
<code>a label</code>
You do not need to select both the Use variable label as column headings and Split labels options. The Split labels option implies that you want to use variable labels.</td></tr>
<tr><td>Rows to list</td><td>specifies the number of rows to list in the output. By default, all rows are listed.</td></tr>
</table>

5

Transpose Data

About the Transpose Data Task

The Transpose Data task 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.

Example: Transposing the Data in the CLASS Data Set

1. In the **Tasks** section, expand the **Data** folder, and then double-click **Transpose Data**. The user interface for the Transpose Data task opens.
2. On the **Data** tab, select **SASHELP.CLASS** as the input data set.
3. To the **Variables to transpose** role, assign the **Age**, **Height**, and **Weight** variables.
4. Under the **Output Data Set** heading, select the **Show output data** check box.
5. On the **Options** tab, complete these steps:
   a. Clear the **Use prefix** check box.
   b. Select the **Select a variable that contains the names of the new variables** check box.
   c. To the **New column names** role, assign the **Name** variable.
6. To run the task, click .

The output data set contains a column for each student in the Sashelp.Class data set. The rows of the table are Age, Height, and Weight.

Subset of WORK.Transpose

Obs	_NAME_	Alfred	Alice	Barbara	Carol	Henry	James	Jane	Janet	Jeffrey	John	Joyce	Judy	Louise	Mary	Philip	Robert	Ronald	Thomas	William
1	Age	14.0	13.0	13.0	14.0	14.0	12.0	12.0	15.0	13.0	12.0	11.0	14.0	12.0	15.0	16	12.0	15	11.0	15.0
2	Height	69.0	56.5	65.3	62.8	63.5	57.3	59.8	62.5	62.5	59.0	51.3	64.3	56.3	66.5	72	64.8	67	57.5	66.5
3	Weight	112.5	84.0	98.0	102.5	102.5	83.0	84.5	112.5	84.0	99.5	50.5	90.0	77.0	112.0	150	128.0	133	85.0	112.0

Assigning Data to Roles

To run the Transpose Data task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Variables to transpose** role.

Roles	Description
Roles	
Variables to transpose	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. You must assign at least one column to the **Transpose variables** role. To select a grouping variable, assign a column to the **Group analysis by** role.
Additional Roles	
Group analysis by	Each variable that you assign to this role is used to segment the about-to-be-transposed columns into subcolumns that will be transposed separately. Each subcolumn, defined by a set of values of the grouping variables, becomes a row of the output table.
Output Data Set	

Roles	Description
Copy to output data set	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.
Show output data	specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

Setting Options

Option Name	Description
Names and Labels of Transposed Variables	
Construct New Variable Names	
Use prefix	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 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.
Construct New Variable Labels	

Option Name	Description
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.
Names and Labels of Original Variables	
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 variable 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_.

6

Stack/Split Columns

About the Stack/Split Columns Task

The Stack/Split Columns task enables you to either stack or split columns.

- When stacking columns, the output data set is created by restructuring the selected columns in the input data set so that these columns are transposed into observations. You can use the output data set to analyze values across multiple columns of the input data set. 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 data set.

  This functionality is useful when you have a data set 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 data set would contain the monthly temperature readings by location in a single column.

- When splitting columns, the output data set is created by splitting the unique combination of values of the selected columns. You can use the output data set to individually analyze the columns that contain multiple rows of the input data set.

  This functionality is useful when you have a data set 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 data set would contain the monthly temperature readings for each location in a column for each month.

Stacking Columns

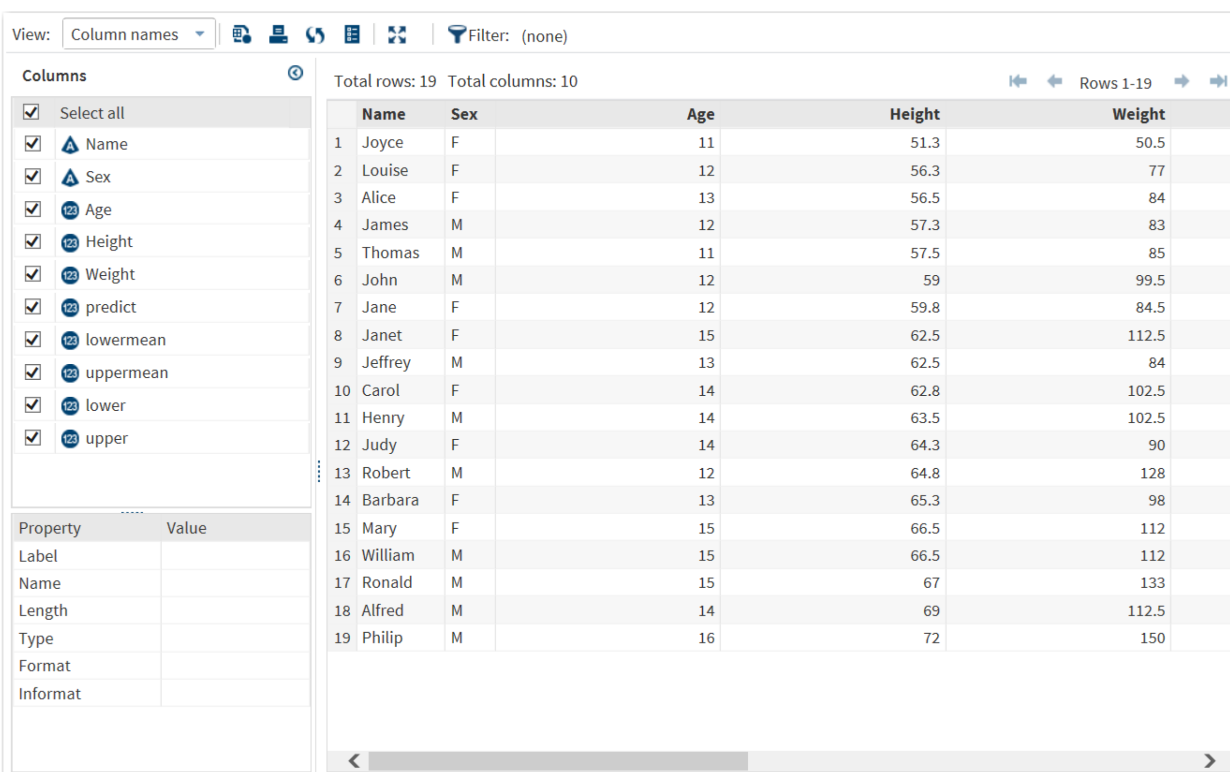
Example 1: Stacking Columns in the CLASSFIT Data Set

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Stack/ Split Columns**. The user interface for the Stack/Split Columns task opens.

2 On the **Data** tab, select **SASHELP.CLASSFIT** as the input data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

Here are the Name, Sex, Age, Height, and Weight variables in the Sashelp.Classfit data set:



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

3 From the **Method** drop-down list, select **Stack columns**.

4 In the **Columns to stack** role, assign the **lowermean** and **uppermean** variables.

5 On the **Output** tab, enter `CLM` as the name of the new column.

6 Assign these variables to the **Include other variables in output data set** role.

- **Name**
- **Sex**
- **Age**
- **Height**
- **Weight**
- **predict**

7 To run the task, click .

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.

Total rows: 38 Total columns: 9 Rows 1-38

	Name	Sex	Age	Height	Weight	predi
1	Joyce	F	11	51.3	50.5	56.9933343
2	Joyce	F	11	51.3	50.5	56.9933343
3	Louise	F	12	56.3	77	76.4884856
4	Louise	F	12	56.3	77	76.4884856
5	Alice	F	13	56.5	84	77.2682917
6	Alice	F	13	56.5	84	77.2682917
7	James	M	12	57.3	83	80.3875159
8	James	M	12	57.3	83	80.3875159
9	Thomas	M	11	57.5	85	81.1673220
10	Thomas	M	11	57.5	85	81.1673220
11	John	M	12	59	99.5	87.0158674
12	John	M	12	59	99.5	87.0158674
13	Jane	F	12	59.8	84.5	90.1350916
14	Jane	F	12	59.8	84.5	90.1350916
15	Janet	F	15	62.5	112.5	100.662473
16	Janet	F	15	62.5	112.5	100.662473
17	Jeffrey	M	13	62.5	84	100.662473
18	Jeffrey	M	13	62.5	84	100.662473
19	Carol	F	14	62.8	102.5	101.832182
20	Carol	F	14	62.8	102.5	101.832182

Example 2: Creating Multiple Stacked Columns

Using the Stack/Split Columns task, you can create multiple stacked variables.

1 In SAS Studio, click and select **New SAS Program**.

2 To create the multistack data set, copy and paste this code onto the **Program** tab.

```
data multistack;
input case L1 L2 L3 K1 K2 K3;
cards;
1 1 2 3 11 22 33
2 4 5 6 44 55 66
;
```

To create the Work.Multistack data set, click .

3 In the **Tasks** section, expand the **Data** folder, and then double-click **Stack/ Split Columns**. The user interface for the Stack/Split Columns task opens.

4 On the **Data** tab, select **WORK.MULTISTACK** as the input data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

5 From the **Method** drop-down list, select **Stack columns**.

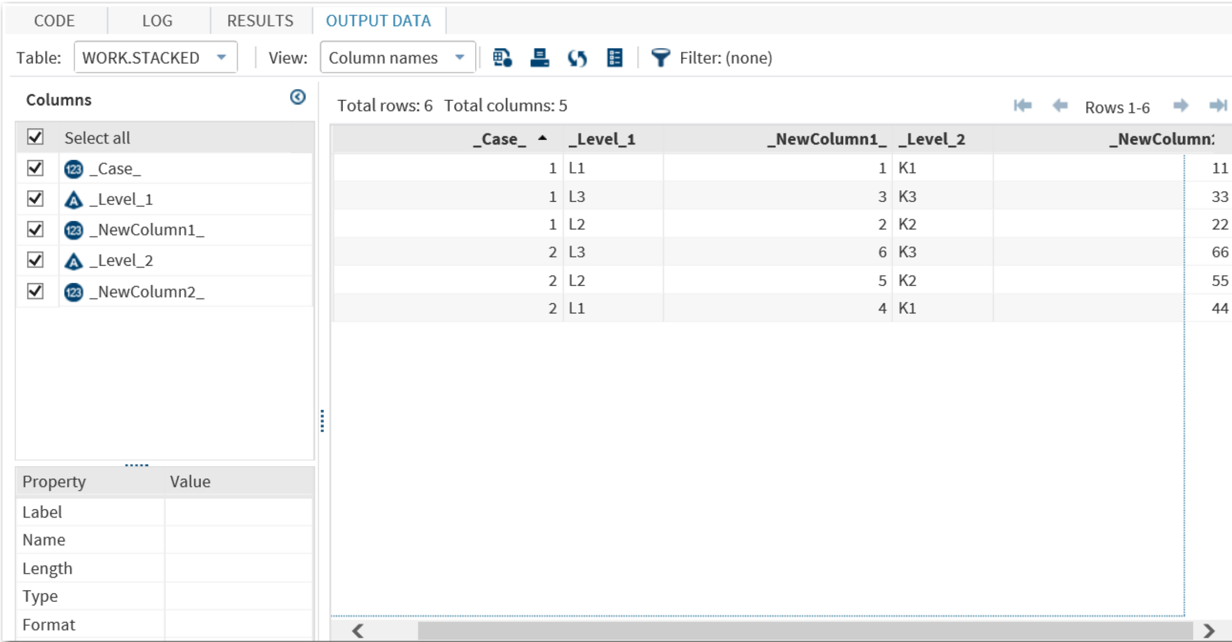
6 In the **Columns to stack** role, assign these variables in this order:

- **L1**
- **L2**
- **L3**
- **K1**
- **K2**
- **K3**

7 In the **Number of stacked variables to create** box, enter `2`.

8 To run the task, click .

Here is the output data set:



Create a Stacked Column

To create a stacked column:

1. Select the input data source. To filter the input data source, click .
2. Select **Stack columns** from the **Method** drop-down list.
3. Assign variables to these roles:

Roles and Options	Description
Roles	
Column to stack	specifies columns that contain the values that you want to stack.
Number of stacked variables to create	specifies the number of stacked variables to include in the output data set. **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.
Additional Roles	
Group analysis by	specifies the variable to use to form BY groups.

4. On the **Output** tab, set these options:

Option Name	Description
Output Data Set	
Name of new column	specifies the name of the new column that contains all the stacked values.
Case Identifier	
Case identifier	specifies the name of the new column that contains the values that identify a particular case. You can select whether the task creates a case variable, or you can select identifier variables from the input data set.
New column name of case identifier	specifies the name of the new column that contains the values of the case identifier.
Level Identifier	
Name of column containing levels of stacked columns	specifies the name of the new column that contains the levels.
Include other variables in output data set	enables you to select other variables from the input data set that you want to include in the output data set.
Show Output Data Set	
Show output data	specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

Splitting Columns

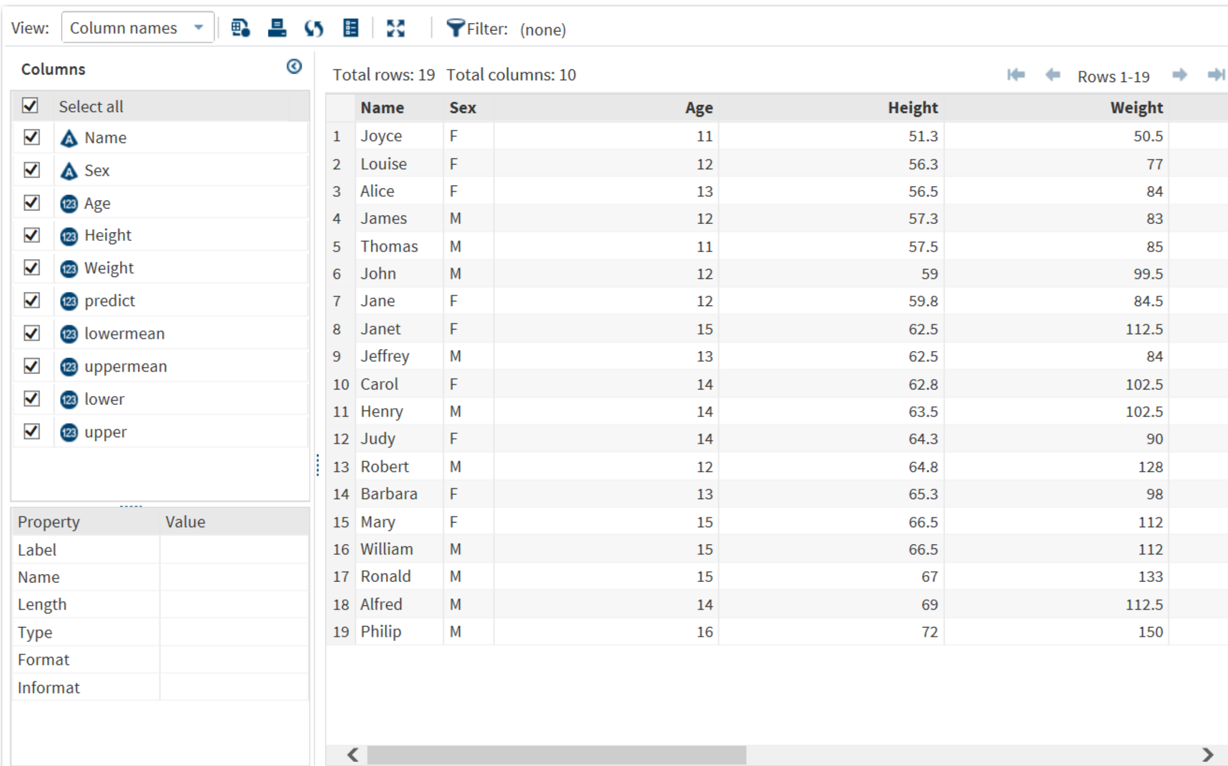
Example 1: Splitting the Height Column in the CLASSFIT Data Set

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Stack/ Split Columns**. The user interface for the Stack/Split Columns task opens.

2 On the **Data** tab, select **SASHELP.CLASSFIT** as the input data set.

TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

Here are the Name, Sex, Age, Height, and Weight columns in the Sashelp.Classfit data set:



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

3 From the **Method** drop-down list, select **Split a column**.

4 Assign columns to these roles:

Role	Column Name
Column to split	**Age**
Case Identifier	**Height**
Level Identifier	**Sex**

5 Click the **Output** tab.

- Clear the **Use prefix** check box.
- Select the **Select a variable that contains the names for the new variables** check box, and assign **Sex** to the **New column names** role.

6 To run the task, click .

The resulting output data set contains three columns: Height, F, and M. From this output, you can see that one 11-year-old female has a height of 51.3 inches. No males are 51.3 inches. A 15-year-old female and a 15-year-old male are both 66.5 inches.

Total rows: 17 Total columns: 3 Rows 1-17

	Height	F	M
1	51.3	11	.
2	56.3	12	.
3	56.5	13	.
4	57.3	.	12
5	57.5	.	11
6	59	.	12
7	59.8	12	.
8	62.5	15	13
9	62.8	14	.
10	63.5	.	14
11	64.3	14	.
12	64.8	.	12
13	65.3	13	.
14	66.5	15	15
15	67	.	15
16	69	.	14
17	72	.	16

Example 2: Creating Multiple Split Columns

Using the Stack/Split Columns task, you can create multiple split columns.

1 In SAS Studio, click  and select **New SAS Program**.

2 To create the multisplit data set, copy and paste this code onto the **Program** tab.

```
data multisplit;
input case level value1 name1 $ value2 name2 $;
cards;
1 1 1 L1 11 K1
1 2 2 L2 22 K2
1 3 3 L3 33 K3
2 1 4 L1 44 K1
2 2 5 L2 55 K2
```

```
2 3 6 L3 66 K3
;
```

To create the Work.Multisplit data set, click .

3 In the **Tasks** section, expand the **Data** folder, and then double-click **Stack/ Split Columns**. The user interface for the Stack/Split Columns task opens.

4 On the **Data** tab, select **WORK.MULTISTACK** as the input data set.

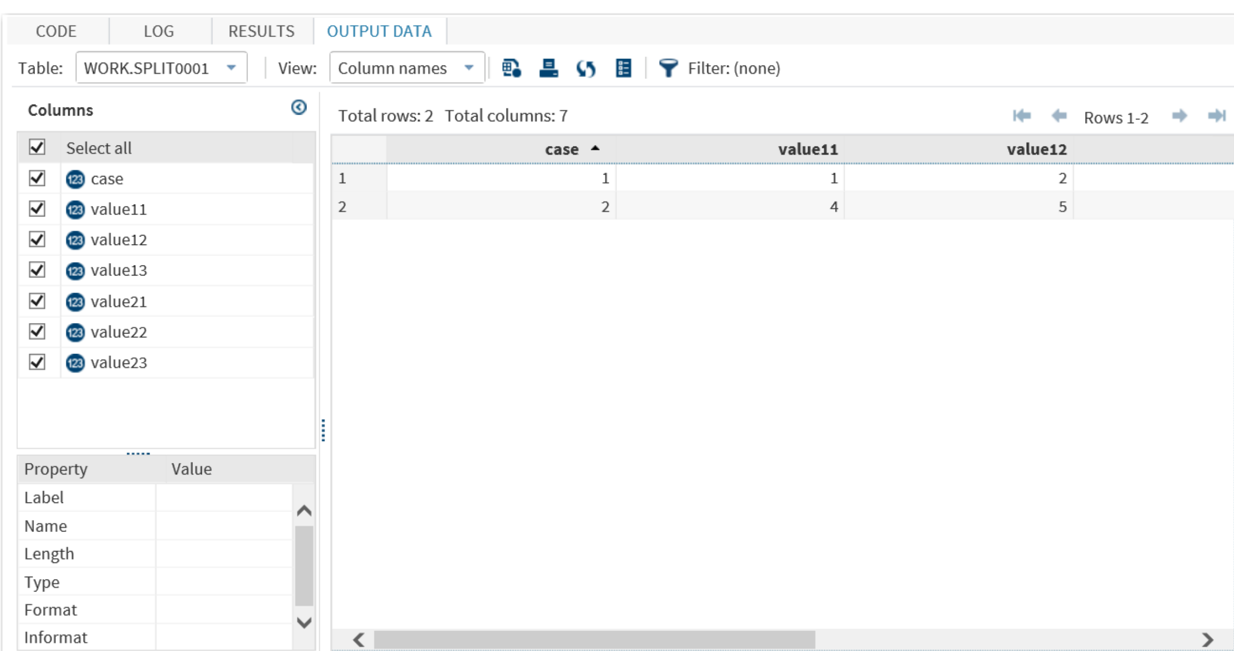
> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

5 Assign columns to these roles:

Role	Column Name
Columns to split	**value1** **value2**
Case identifier	**case**
Level identifier	**level**

6 To run the task, click .

Here is a subset of the output data set:



Split a Column

To split a column:

1 Select the input data source. To filter the input data source, click .

2 Select **Split a column** from the **Method** drop-down list.

3 Assign variables to these roles:

Roles	Description
Roles	
Columns to split	specifies the variable that contains the values that you want to split into multiple columns.
Case identifier	identifies the values that belong to a particular case.
Level identifier	identifies the levels of the column to split. Each new variable contains the values of one level of the level identifier.
Additional Roles	
Group analysis by	specifies the variable to use to form BY groups.

4 On the **Output** tab, set these options:

Option Name	Description
Construct New Variable Names	
Use prefix	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. To create a variable name with the prefix and the value of the selected variable, select **Select a variable that contains the names for the new variables**.
Select a variable that contains the names for the new variables	The variable that you assign to the **New column names** role is used to name the new columns in the output data set. If you assigned two or more variables to the **Columns to split** role on the **Data** tab, you can select the column to use for each split variable.

Option Name	Description
Show Output Data	
Show output data	specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

7

Filter Data

About the Filter Data Task

The Filter Data task enables you to quickly create a basic filter to subset your input data source. You can use just one variable in a filter, or you can use multiple variables to create several comparison expressions. If you create more than one comparison expression in your filter, you specify whether the relationship between the filter elements is AND or OR. The filter elements are evaluated in the order in which they appear in the user interface. To change this order, you can add parentheses to the code generated by the task.

Example 1: Creating a Simple Filter

This example creates an output data set that contains salaries less than $750,000.

1. In the **Tasks** section, expand the **Data** folder, and then double-click **Filter Data**. The user interface for the Filter Data task opens.
2. For the input data source, select **SASHELP.BASEBALL**.
3. To the **Variable 1** role, assign **Salary**.
4. From the **Comparison** drop-down list, select **Less than**.
5. From the **Value type** drop-down list, select **Enter a value**.
6. In the **Value** box, enter `750`.
7. Under the **Output Data Set** heading, select **Show output data** to view the output data set in the results. From the **Show** drop-down list, select **Show all output data**.

8 To run the task, click .

Here is a subset of the results, which lists the players who have a salary less than $750,000.

Filtered data set - WORK.filter

Obs	Name	Team	nAtBat	nHits	nHome	nRuns	nRBI	nBB	YrMajor	CrAtBat	CrHits	CrHome	CrRuns	CrRbi	CrBB	League	Division	Position	nO
1	Allanson, Andy	Cleveland	293	66	1	30	29	14	1	293	66	1	30	29	14	American	East	C	[illegible]
2	Ashby, Alan	Houston	315	81	7	24	38	39	14	3449	835	69	321	414	375	National	West	C	[illegible]
3	Davis, Alan	Seattle	479	130	18	66	72	76	3	1624	457	63	224	266	263	American	West	1B	[illegible]
4	Dawson, Andre	Montreal	496	141	20	65	78	37	11	5628	1575	225	828	838	354	National	East	RF	[illegible]
5	Galarraga, Andres	Montreal	321	87	10	39	42	30	2	396	101	12	48	46	33	National	East	1B	[illegible]
6	Newman, Al	Montreal	185	37	1	23	8	21	2	214	42	1	30	9	24	National	East	2B	
7	Salazar, Argenis	Kansas City	298	73	0	24	24	7	3	509	108	0	41	37	12	American	West	SS	[illegible]
8	Thomas, Andres	Atlanta	323	81	6	26	32	8	2	341	86	6	32	34	8	National	West	SS	[illegible]
9	Trammell, Alan	Detroit	574	159	21	107	75	59	10	4631	1300	90	702	504	488	American	East	SS	[illegible]
10	Trevino, Alex	Los Angeles	202	53	4	31	26	27	9	1876	467	15	192	186	161	National	West	C	[illegible]
11	Van Slyke, Andy	St Louis	418	113	13	48	61	47	4	1512	392	41	205	204	203	National	East	RF	[illegible]
12	Wiggins, Alan	Baltimore	239	60	0	30	11	22	6	1941	510	4	309	103	207	American	East	2B	[illegible]
13	Almon, Bill	Pittsburgh	196	43	7	29	27	30	13	3231	825	36	376	290	238	National	East	UT	
14	Beane, Billy	Minneapolis	183	39	3	20	15	11	3	201	42	3	20	16	11	American	West	OF	[illegible]
15	Biancalana, Buddy	Kansas City	190	46	2	24	8	15	5	479	102	5	65	23	39	American	West	SS	[illegible]

Example 2: Creating a Compound Filter

This example creates an output data set of all the players who earn less than $750,000 and who are in the American League.

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Filter Data**. The user interface for the Filter Data task opens.

2 For the input data source, select **SASHELP.BASEBALL**.

3 To create the filter for salaries less than $750,000:

  a Under the **Filter 1** heading, assign **Salary** to the **Variable 1** role.

  b From the **Comparison** drop-down list, select **Less than**.

  c From the **Value type** drop-down list, select **Enter a value**.

  d In the **Value** box, enter `750`.

  e From the **Logical** drop-down list, select **AND**.

  f To create the filter for players in the American League:

    i Under the **Filter 2** heading, assign **League** to the **Variable 2** role.

    ii From the **Comparison** drop-down list, select **Equal**.

    iii From the **Value type** drop-down list, select **Select distinct value**.

iv From the **Value** drop-down list, select **American**.

4 Under the **Output Data Set** heading, select **Show output data** to view the output data set in the results. From the **Show** drop-down list, select **Show all output data**.

5 To run the task, click .

Here is a subset of the results, which shows all the players in the American League who have a salary less than $750,000.

Filtered data set - WORK.filter

Obs	Name	Team	nAtBat	nHits	nHome	nRuns	nRBI	nBB	YrMajor	CrAtBat	CrHits	CrHome	CrRuns	CrRbi	CrBB	Leagu
1	Allanson, Andy	Cleveland	293	66	1	30	29	14	1	293	66	1	30	29	14	Ameri
2	Davis, Alan	Seattle	479	130	18	66	72	76	3	1624	457	63	224	266	263	Ameri
3	Salazar, Argenis	Kansas City	298	73	0	24	24	7	3	509	108	0	41	37	12	Ameri
4	Trammell, Alan	Detroit	574	159	21	107	75	59	10	4631	1300	90	702	504	488	Ameri
5	Wiggins, Alan	Baltimore	239	60	0	30	11	22	6	1941	510	4	309	103	207	Ameri
6	Beane, Billy	Minneapolis	183	39	3	20	15	11	3	201	42	3	20	16	11	Ameri
7	Biancalana, Buddy	Kansas City	190	46	2	24	8	15	5	479	102	5	65	23	39	Ameri
8	Bochte, Bruce	Oakland	407	104	6	57	43	65	12	5233	1478	100	643	658	653	Ameri
9	Bonilla, Bobby	Chicago	426	109	3	55	43	62	1	426	109	3	55	43	62	Ameri
10	Boone, Bob	California	442	98	7	48	49	43	15	5982	1501	96	555	702	533	Ameri
11	Grich, Bobby	California	313	84	9	42	30	39	17	6890	1833	224	1033	864	1087	Ameri
12	Jacoby, Brook	Cleveland	583	168	17	83	80	56	5	1646	452	44	219	208	136	Ameri
13	Kearney, Bob	Seattle	204	49	6	23	25	12	7	1309	308	27	126	132	66	Ameri
14	Meacham, Bobby	New York	161	36	0	19	10	17	4	1053	244	3	156	86	107	Ameri
15	Oglivie, Ben	Milwaukee	346	98	5	31	53	30	16	5913	1615	235	784	901	560	Ameri

Creating Your Filter

To create a filter for the input data source:

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Filter Data**. The user interface for the Filter Data task opens.

2 Select an input data source.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 In the **Variable 1** box, select the variable that you want to use in the filter.

4 From the **Comparison** drop-down list, select the comparison operator. The default value is **Less than**.

5 From the **Value type** drop-down list, choose one of these options:

- **Enter value** specifies that you want to enter a value in the **Value** box.
- **Select distinct value** specifies that you want to select a value from the input data source. The **Value** drop-down list shows the first 100 unique values for that column.
- **Enter a percentile** specifies that you want to enter a percentage in the **Value** box.

6 To create a compound filter, select a value from the **Logical** drop-down list. Then specify the values for Filter 2.

7 To specify a name for the output data set, expand **Output Data Set** and enter the name for the output data set in the **Data** box. You can select the variables to include in the output data set.

To view the output data in the results, select **Show output data**. You can choose to view a subset or all of the data.

8

Select Random Sample

About the Select Random Sample Task

The Select Random Sample task creates an output table that contains a random sample of the rows in the input table.

You might use this task when you need a subset of the data. For example, suppose you want to audit employee travel expenses in an effort to improve the expense reporting procedure and possibly reduce expenses. Because you do not have the resources to examine all expense reports, you can use statistical sampling to objectively select expense reports for audit.

Example: Creating a Random Sample of the Sashelp.Pricedata Data Set

In this example, you want to create a subset of the data in the Sashelp.Pricedata data set.

To create this example:

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Select Random Sample**. The user interface for the Select Random Sample task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 On the **Options** tab, enter `10` as the sample size.

4 To run the task, click .

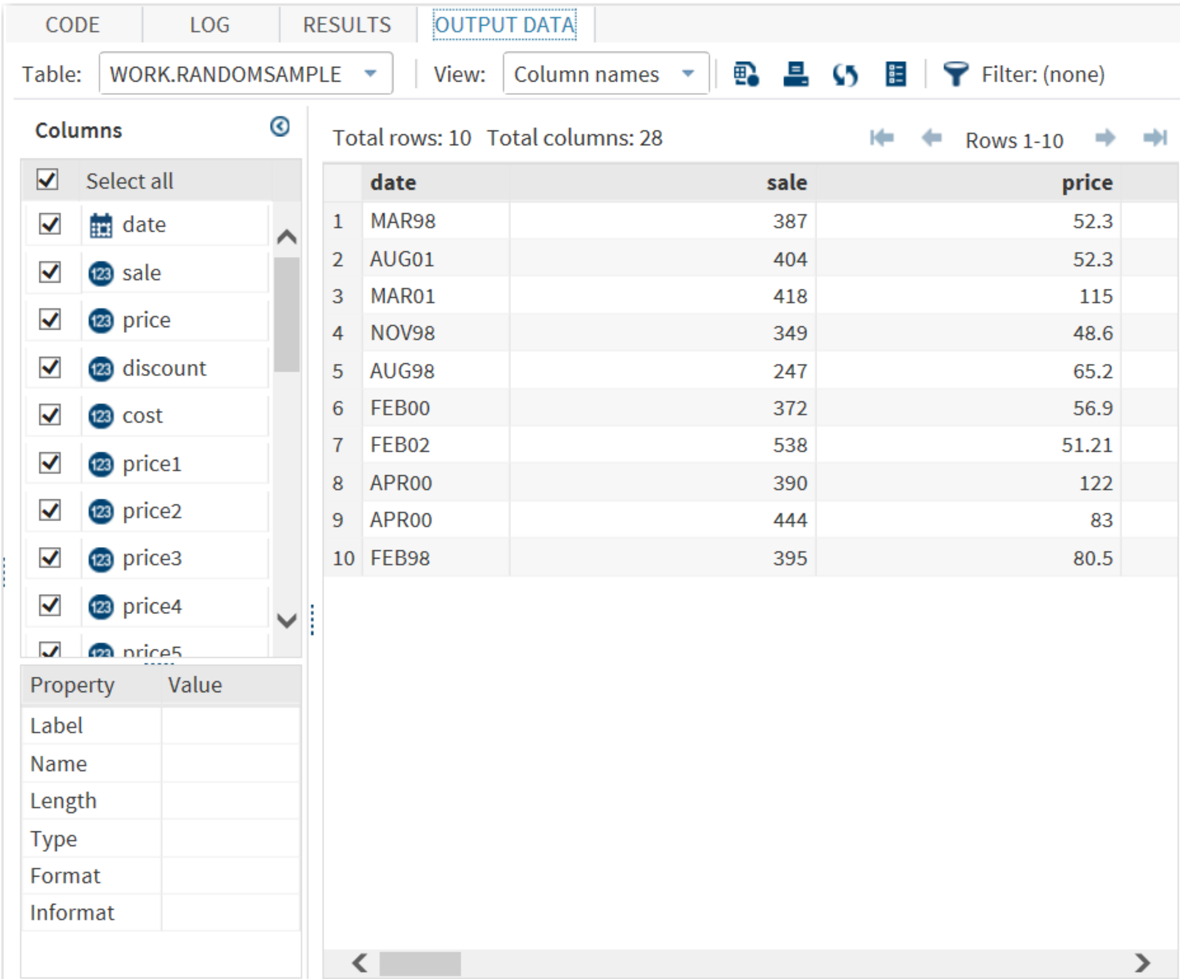
Here are the results:

The SURVEYSELECT Procedure

Selection Method	Simple Random Sampling

Input Data Set	PRICEDATA
Random Number Seed	653674001
Sample Size	10
Selection Probability	0.009804
Sampling Weight	102
Output Data Set	RANDOMSAMPLE

The task also creates a sample data set in the Work library. In SAS Studio, this data set opens on the **Output Data** tab.



Assigning Data to Roles

For the Select Random Sample task, you must select an input data source. To filter the input data source, click .

To run the task, you must specify a sample size for the output table. No roles are required to run the task.

Role	Description
Roles	

Role	Description
Stratify by	specifies the variables to use to partition the input table into mutually exclusive, non-overlapping subsets that are known as strata. Each stratum is defined by a set of values of the strata variables, and each stratum is sampled separately. The complete sample is the union of the samples that are taken from all the strata. **Note:** If you do not assign any variables to this role, then the entire input table is treated as a single stratum. This example shows how the total sample size among the strata is in proportion to the size of the stratum. For this example, the variable GENDER has possible values of M and F, and the variable VOTED has possible values of Y and N. If you assign both GENDER and VOTED to the **Strata columns** role, then the input table is partitioned into four strata: males who voted, males who did not vote, females who voted, and females who did not vote. The input table contains 20,000 rows, and the values are distributed as follows: ■ 7,000 males who voted ■ 4,000 males who did not vote ■ 5,000 females who voted ■ 4,000 females who did not vote Therefore, the proportion of males who voted is 7,000/20,000=0.35 or 35%. The proportions in the sample should reflect the proportions of the strata in the input table. For example, if your sample table contains 100 observations, then 35% of the values in the sample must be selected from the males who voted stratum to reflect the proportions in the input table.
Output Data Set	
Data set name	specifies the name of the output data set.
Include all variables in the output data set	specifies the variables to include in the output table. By default, all variables are included in the output table. However, you can select the variables to include in the output.
Show Output Data	
Show	specifies whether to include all of the data in the output data set or only a portion of the data.

Setting Options

Option Name	Description
Sampling method	specifies 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.
Sample size and **Sample percent**	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.
Specify the random seed	specifies the initial seed for the generation of random numbers. This value must be an integer. If you do not specify a random seed number, then a seed that is based on the system clock is used to produce the sample.
Generate a sample selection summary	generates 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 same sample.

9

Partition Data

About the Partition Data Task

A partition is all or part of a logical file. The Partition Data task enables you to create up to four partitions 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 task, you can save all the partitions to one output data set or save each partition in a separate data set.

Example: Partitioning the SASHELP.CLASSFIT Data Set

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Partition Data**. The user interface for the Partition Data task opens.

2 On the **Data** tab, select **SASHELP.CLASSFIT** as the input data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 In the **Number of partitions** box, enter `2`.

4 In the **Proportion of cases for partition 1** box, enter `.5`, which specifies 50% of the values should be in partition 1.

5 In the **Proportion of cases for partition 2** box, enter `.3`, which specifies 30% of the values should be in partition 2.

6 From the **Partition data sets** drop-down list, select **All partitions in one data set**.

7 In the **ID value for partition 1 data** role, enter `Test`.

8 In the **ID value for partition 2 data** role, enter `Train`.

9 Under the **Output Data Set** heading, select **Show output data** to view the output data set in the results.

10 To run the task, click .

Here is a subset of the results:

Subset of WORK.Partition

Obs	Name	Sex	Age	Height	Weight	predict	lowermean	uppermean	lower	upper	_Partition_
1	Joyce	F	11	51.3	50.5	56.993	43.804	70.182	29.8835	84.103	Test
2	Louise	F	12	56.3	77.0	76.488	67.960	85.017	51.3145	101.662	Test
3	James	M	12	57.3	83.0	80.388	72.667	88.108	55.4757	105.299	Test
4	Thomas	M	11	57.5	85.0	81.167	73.600	88.735	56.3025	106.032	Test
5	Janet	F	15	62.5	112.5	100.662	95.226	106.099	76.3612	124.964	Train
6	Jeffrey	M	13	62.5	84.0	100.662	95.226	106.099	76.3612	124.964	Train
7	Carol	F	14	62.8	102.5	101.832	96.375	107.289	77.5263	126.138	Test
8	Henry	M	14	63.5	102.5	104.562	98.982	110.141	80.2279	128.895	Test
9	Judy	F	14	64.3	90.0	107.681	101.842	113.520	83.2863	132.075	Test
10	Robert	M	12	64.8	128.0	109.630	103.571	115.690	85.1821	134.078	Test

The new _Partition_ variable in the output data set specifies the partition (either Train or Test) for the observation. For example, the data for Joyce is in the Test partition. The data for Janet 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.

Creating a Partitioned Data Set

To run the Partition Data task, you must select an input data source. To filter the input data source, click .

You must assign values to the **Proportion of cases** option for each partition.

Role	Description
Roles	
Stratify by	specifies separate partitions for each combination of levels. You can specify a maximum of two variables to this role.

Role	Description
Partition Data	
Number of partitions	specifies the number of partitions. You can choose to create one, two, three, or four partitions.
Proportion of cases for partition *n*	specifies the proportion of cases for each partition. The sum of all the partition proportions must be less than or equal to 1.
Random seed	specifies 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 will be used to produce the sample.
Output Data Set	
Partition data sets	specifies whether to include all partitions in one data set or put each partition in a separate data set. You can specify a unique name for each output data set.
Include non-sampled observations	specifies whether to include non-sampled observations in the output data set. **Note:** This option applies only if you are saving all the partitions to one data set.
Variable name for partitioned values	specifies the name for the variable that contains the partitioned values. **Note:** This option applies only if you are saving all the partitions to one data set.
ID value for partition *n* data	specifies the identifier to use for each value in a partition. **Note:** This option applies only if you are saving all the partitions to one data set.
Show Output Data	
Show output data	specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

10

Sort Data

About the Sort Data Task

The Sort Data task enables you to sort the table by any of its columns. The result from this task is a sorted table in the Work library.

Example: Sort the SASHELP.CLASS Data Set by Sex and Age

To create this example:

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Sort Data**. The user interface for the Sort Data task opens.

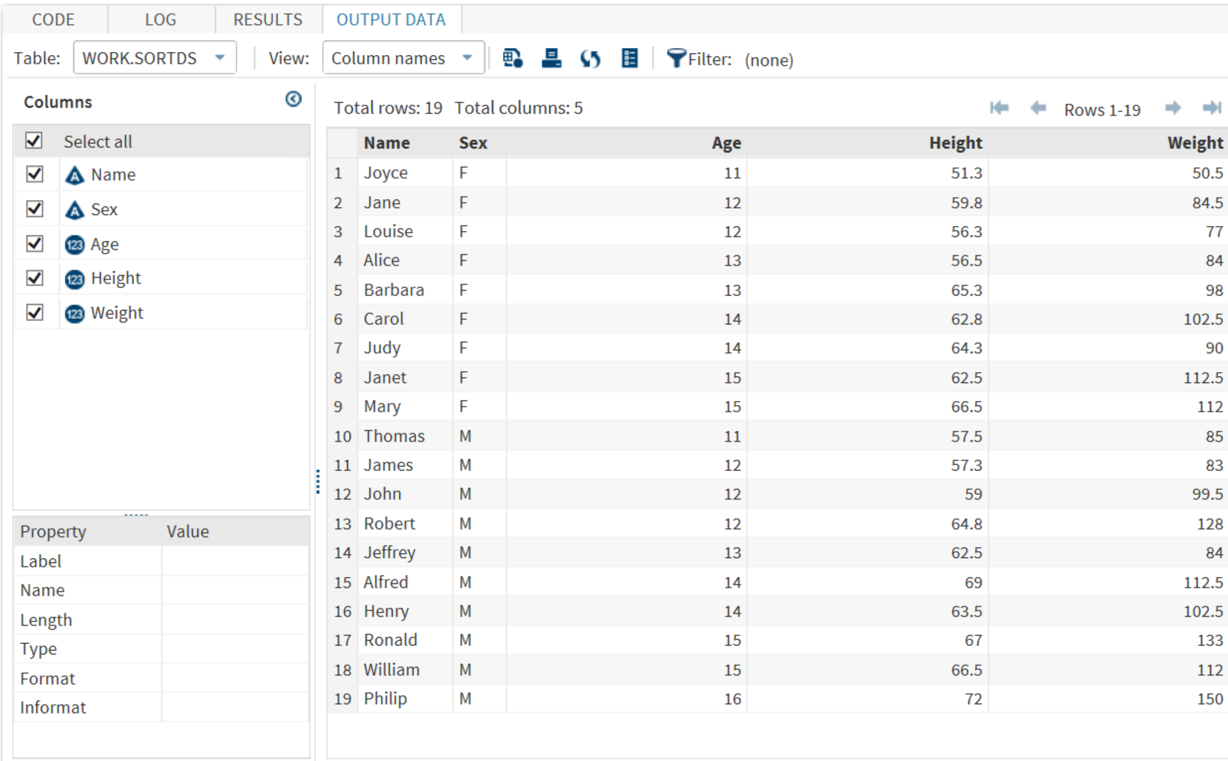
2 On the **Data** tab, select the **SASHELP.CLASS** data set.

TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 To the **Sort by** role, assign the **Sex** and **Age** columns.

4 To run the task, click .

The newly created WORK.SortDS data set is available from the **Output Data** tab. In the output data, the observations are first sorted by Sex (whether Female or Male). Within each group, the observations are sorted in ascending order by age.



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

Assigning Data to Roles

To run the Sort Data task, you must assign an input data source. To filter the input data source, click .

You must assign a column to the **Sort by** role.

Role	Description
Sort by	When you assign one or more variables to this role, the table is grouped by the selected variable or variables. The order in which the variables appear within this role 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 that is listed within the Sort by role.
Columns to drop	When you assign one or more variables to this role, the output that is generated does not contain the specified variables. You can assign a maximum of (n – 1) variables to this role, where n is the total number of variables in the table.

Setting Options

Option Name	Description
Output Order	
Sort order	specifies whether to display the output data in ascending or descending order.
Maintain original order within groups	maintains the order of the observations relative to each other within a BY group.
Duplicate Records	
Keep all records	keeps all of the records that are in the output table, including all duplicate records.
Keep only the first record for each 'Sort by' group	eliminates any duplicate observations that have the same values for the **Sort by** group.
Results	
Sort in place	specifies to sort the existing data set in place. If you select this option, the Sort task keeps any variables that you assigned to the **Columns to drop** role and keeps all duplicate records.
Output data set	specifies the name of the output data set.

11 Rank Data

About the Rank Data Task

The Rank Data task 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 task 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.

Example: Ranking Students by Height within Age

In this example, you want to rank the students in your class by age and height.

To create this example:

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Rank Data**. The user interface for the Rank Data task opens.

2 On the **Data** tab, select the **SASHELP.CLASS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

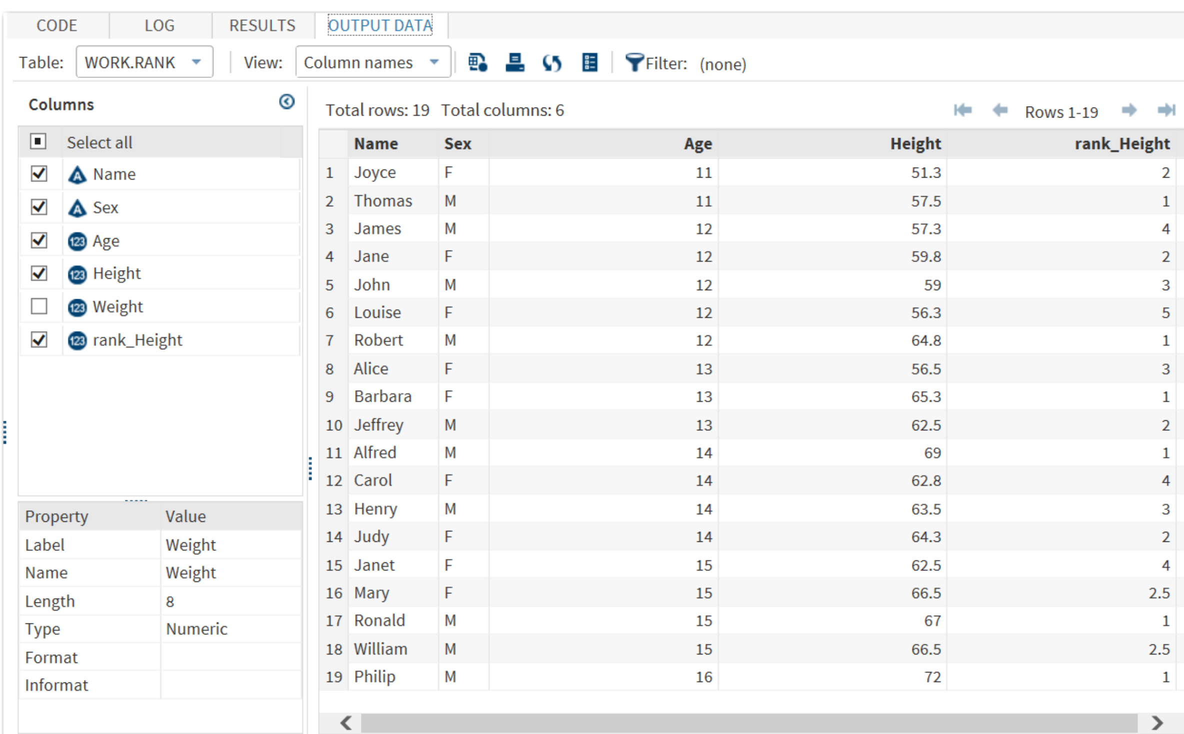
3 Assign columns to these roles:

Role	Column Name
Roles	
Columns to rank	**Height**
Additional Roles	
Rank by	**Age**

4 Open the **Options** tab. From the **Rank order** drop-down list, select **Largest to smallest**.

5 To run the task, click .

The Rank Data task creates an output data set. In SAS Studio, this data set opens on the **Output Data** tab. This data set 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	rank_Height
1	Joyce	F	11	51.3	2
2	Thomas	M	11	57.5	1
3	James	M	12	57.3	4
4	Jane	F	12	59.8	2
5	John	M	12	59	3
6	Louise	F	12	56.3	5
7	Robert	M	12	64.8	1
8	Alice	F	13	56.5	3
9	Barbara	F	13	65.3	1
10	Jeffrey	M	13	62.5	2
11	Alfred	M	14	69	1
12	Carol	F	14	62.8	4
13	Henry	M	14	63.5	3
14	Judy	F	14	64.3	2
15	Janet	F	15	62.5	4
16	Mary	F	15	66.5	2.5
17	Ronald	M	15	67	1
18	William	M	15	66.5	2.5
19	Philip	M	16	72	1

Assigning Data to Roles

To run the Rank Data task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Columns to rank** role.

Role	Description
Roles	
Columns to rank	Each column that is assigned to this role is ranked. You must assign at least one variable to this role. By default, the rankings column is given the name **`rank_`***column-name*, where *column-name* is the name of the original column.
Additional Roles	
Rank by	When you assign one or more columns to this role, the input table is sorted by the selected column or columns and rankings are calculated within each group.
Output Data Set	
Create new variables for the ranked variables	specifies that the output table contains the original columns as well as the ranked columns. If you want to replace the original column with the ranked columns, clear the **Create new variables for the ranked variables** check box. By default, the ranked column is given the name **`rank_`***column-name*, where *column-name* is the name of the original column.
Show output data	specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

Setting Options

You must select at least one output option.

Option Name	Description
Options	

Option Name	Description
Ranking method	specifies the method to use when ranking the data. 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.
Ranking method (continued)	**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.

Option Name	Description
Ranking method (continued)	**Normal scores of ranks** computes normal scores from the ranks. The resulting variables appear normally distributed. Here are the formulas: Blom formula $y_i = \Phi^{-1}\left(\frac{\left(r_i - \frac{3}{8}\right)}{\left(n + \frac{1}{4}\right)}\right)$ Tukey formula $y_i = \Phi^{-1}\left(\frac{\left(r_i - \frac{1}{3}\right)}{\left(n + \frac{1}{3}\right)}\right)$ van der Waerden $y_i = \Phi^{-1}\left(\frac{r_i}{(n+1)}\right)$ In these formulas, Φ^{-1} is the inverse cumulative normal (PROBIT) function, r_i is the rank of the *i*th observation, and *n* is the number of nonmissing observations for the ranking variable. **Note:** If you set the **If values are tied, use** option, the Rank Data task 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 task computes the Savage score from the ranks based on non-tied

Option Name	Description
If values are tied, use	specifies how to compute normal scores or ranks for tied data 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.
Rank order	specifies whether to list the values from smallest to largest or from largest to smallest.

12

Transform Data

About the Transform Data Task

The Transform Data task enables you to transform one or more variables in the input data set. These transformed variables are saved to an output data set.

Example: Transforming the Data in the BASEBALL Data Set

1 In the **Tasks** section, expand the **Data** folder, and then double-click **Transform Data**. The user interface for the Transform Data task opens.

2 On the **Data** tab, select **SASHELP.BASEBALL** as the input data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

This figure shows a subset of the data for the Name, nRuns, and Salary columns.

Total rows: 322 Total columns: 24 Rows 1-100

	Name	nRuns	Salary
1	Allanson, Andy	30	.
2	Ashby, Alan	24	475
3	Davis, Alan	66	480
4	Dawson, Andre	65	500
5	Galarraga, Andres	39	91.5
6	Griffin, Alfredo	74	750
7	Newman, Al	23	70
8	Salazar, Argenis	24	100
9	Thomas, Andres	26	75
10	Thornton, Andre	49	1100
11	Trammell, Alan	107	517.143
12	Trevino, Alex	31	512.5
13	Van Slyke, Andy	48	550
14	Wiggins, Alan	30	700
15	Almon, Bill	29	240
16	Beane, Billy	20	.
17	Bell, Buddy	89	775
18	Biancalana, Buddy	24	175
19	Bochte, Bruce	57	.
20	Bochy, Bruce	16	135
21	Bonds, Barry	72	100
22	Bonilla, Bobby	55	115
23	Boone, Bob	48	.

3 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** drop-down list, select **Natural log**.

4 To convert the values in the Salary column to dollars, complete these steps under the **Transform 2** heading:

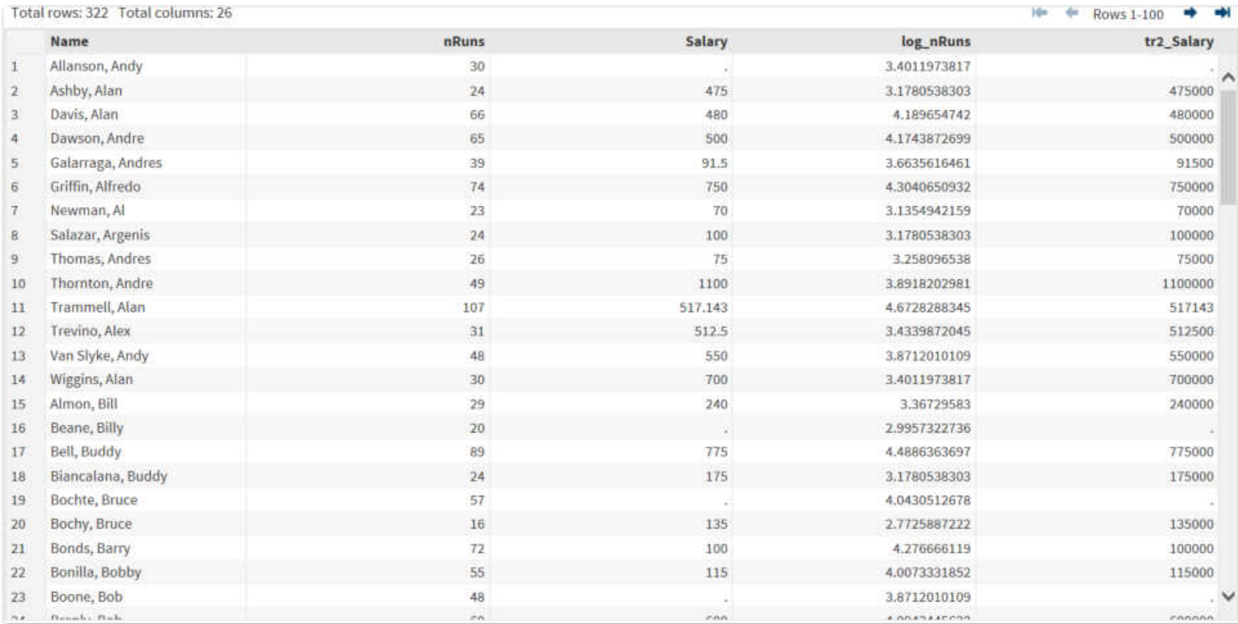
   a To the **Variable 2** role, assign the **Salary** column.

   b From the **Transform** drop-down list, select **Specify custom transformation**.

   c In the **Custom transform** box, enter `Salary*1000`.

5 To run the task, click .

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 columns contains the values from the Salary column multiplied by 1,000.



Total rows: 322 Total columns: 26 Rows 1-100

	Name	nRuns	Salary	log_nRuns	tr2_Salary
1	Allanson, Andy	30	.	3.4011973817	.
2	Ashby, Alan	24	475	3.1780538303	475000
3	Davis, Alan	66	480	4.189654742	480000
4	Dawson, Andre	65	500	4.1743872699	500000
5	Galarraga, Andres	39	91.5	3.6635616461	91500
6	Griffin, Alfredo	74	750	4.3040650932	750000
7	Newman, Al	23	70	3.1354942159	70000
8	Salazar, Argenis	24	100	3.1780538303	100000
9	Thomas, Andres	26	75	3.258096538	75000
10	Thornton, Andre	49	1100	3.8918202981	1100000
11	Trammell, Alan	107	517.143	4.6728288345	517143
12	Trevino, Alex	31	512.5	3.4339872045	512500
13	Van Slyke, Andy	48	550	3.8712010109	550000
14	Wiggins, Alan	30	700	3.4011973817	700000
15	Almon, Bill	29	240	3.36729583	240000
16	Beane, Billy	20	.	2.9957322736	.
17	Bell, Buddy	89	775	4.4886363697	775000
18	Biancalana, Buddy	24	175	3.1780538303	175000
19	Bochte, Bruce	57	.	4.0430512678	.
20	Bochy, Bruce	16	135	2.7725887222	135000
21	Bonds, Barry	72	100	4.276666119	100000
22	Bonilla, Bobby	55	115	4.0073331852	115000
23	Boone, Bob	48	.	3.8712010109	.

Transforming Columns from the Input Data Set

To run the Transform Data task, you must select an input data source. To filter the input data source, click .

Using the Transform Data task, you can transform up to three columns from your input data set. You must assign a column to the **Variable 1** role.

Role	Description
Transform *n*	
Variable *n*	specifies the variable to transform.

<table>
<tr><th>Role</th><th>Description</th></tr>
<tr><td>Transform</td><td>specifies 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.</td></tr>
<tr><td colspan="2">Output Data Set</td></tr>
<tr><td>Show output data</td><td>specifies whether to display the output data set on the Results tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the Output Data tab. The output data is also saved as a SAS data set.</td></tr>
</table>

13

Standardize Data

About the Standardize Data Task

The Standardize Data task enables you to center or standardize one or more numeric variables using a variety of methods. The standardized variables are saved in an output data set.

Example: Standardizing Variables in the SASHELP.BASEBALL Data Set

To create this example:

1. In the **Tasks** section, expand the **Data** folder, and then double-click **Standardize Data**. The user interface for the Standardize Data task opens.

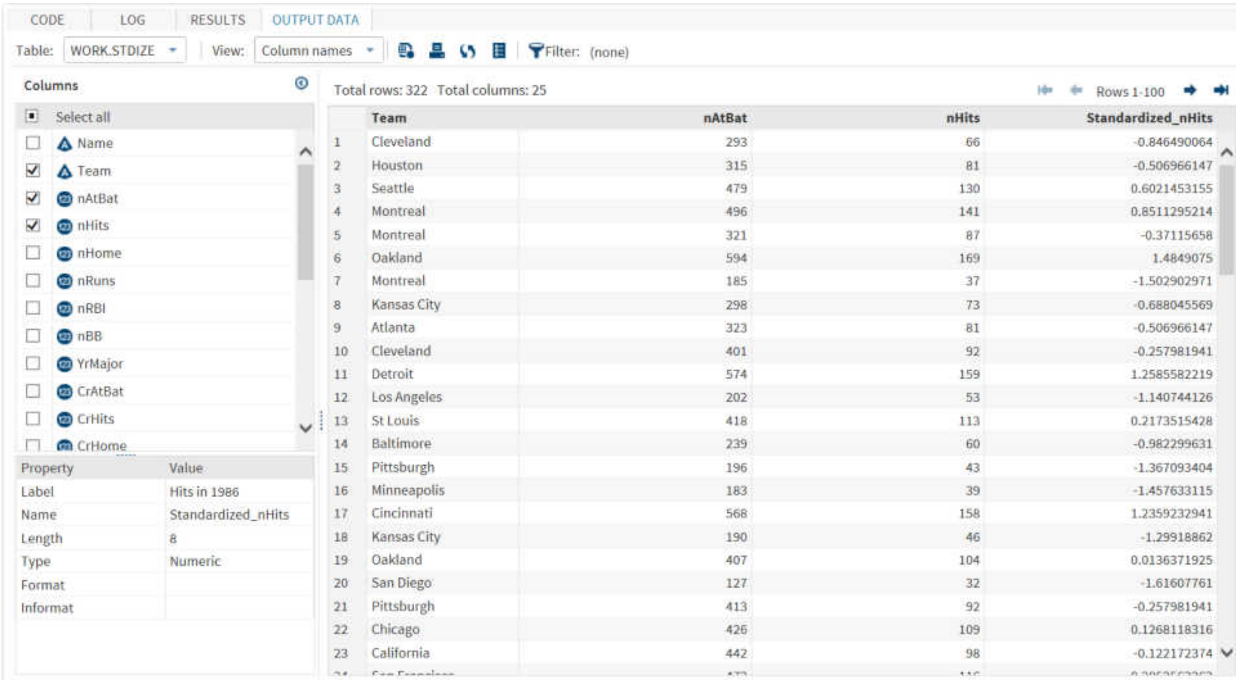
2. On the **Data** tab, select the **SASHELP.BASEBALL** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. To the **Variables to standardize** role, assign the **nHits** column.

4. To run the task, click .

Here is a subset of the output data:



	Team	nAtBat	nHits	Standardized_nHits
1	Cleveland	293	66	-0.846490064
2	Houston	315	81	-0.506966147
3	Seattle	479	130	0.6021453155
4	Montreal	496	141	0.8511295214
5	Montreal	321	87	-0.37115658
6	Oakland	594	169	1.4849075
7	Montreal	185	37	-1.502902971
8	Kansas City	298	73	-0.688045569
9	Atlanta	323	81	-0.506966147
10	Cleveland	401	92	-0.257981941
11	Detroit	574	159	1.2585582219
12	Los Angeles	202	53	-1.140744126
13	St Louis	418	113	0.2173515428
14	Baltimore	239	60	-0.982299631
15	Pittsburgh	196	43	-1.367093404
16	Minneapolis	183	39	-1.457633115
17	Cincinnati	568	158	1.2359232941
18	Kansas City	190	46	-1.29918862
19	Oakland	407	104	0.0136371925
20	San Diego	127	32	-1.61607761
21	Pittsburgh	413	92	-0.257981941
22	Chicago	426	109	0.1268118316
23	California	442	98	-0.122172374

Assigning Data to Roles

To run the Standardize Data task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Variables to standardize** role.

Roles	Description
Roles	
Variables to standardize	lists the numeric variables to be standardized.
Additional Roles	
Frequency count	lists 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.

Roles	Description
Weight	specifies a numeric variable in the input data set with values that are used to weight 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.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Options

Option Name	Description
Methods	
Center data only	specifies that you want to use either the mean or median standardization method.
Standardization method	specifies that you want to use one of these standardization 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**
Treatment of Missing Values	

Option Name	Description
Missing values method	specifies whether to omit observations with missing value 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 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
Statistics	
Display location and scale measures	displays the location and scale measures in the results. These measures give you an idea of what the standardization process accomplished.

Setting the Output Options

By default, the Standardize Data task creates an output data set that includes both the original and standardized variables. You can add a prefix to the variable names to differentiate between the original and standardized variables. By default, the task adds the `Standardize_` prefix to the standardized variable.

The **Show output data** option specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

Part 2

Graph Tasks

14

Bar Chart

About the Bar Chart Task

The Bar Chart task 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.

Example: Bar Chart of Mean Sales for Each Product Line

For example, you can create a bar chart that compares the total amount of sales for each product line in the Sashelp.Pricedata data set. By default, the task calculates the mean of the response variable for each product line. This bar chart shows that Line 2 has the highest mean product sales.

To create this example:

1 In the **Tasks** section, expand the **Graph** folder, and then double-click **Bar Chart**. The user interface for the Bar Chart task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

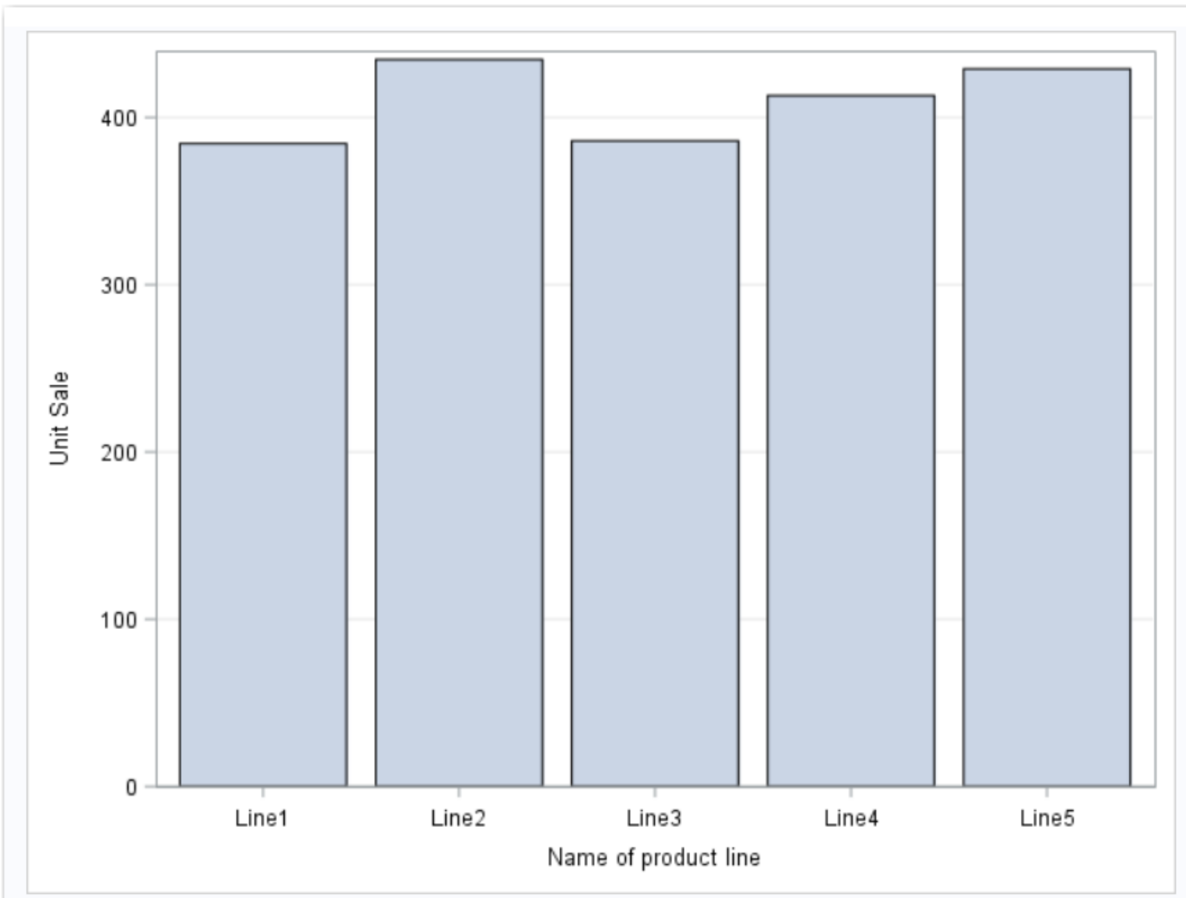
> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
Category variable	**productLine**
Response variable	**sale**

4 To run the task, click .

Here are the results:



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Bar Chart task, you must assign a column to the **Category variable** role.

Option Name	Description
Roles	
Category variable	specifies the variable that classifies the observations into distinct subsets.
Response variable	specifies a numeric response variable for the plot.
Group variable	specifies a variable that is used to group the data.
URL variable	specifies a character variable that contains URLs for web pages to be displayed when parts of the plot are selected within an HTML page.
BY variable	creates a separate graph for each BY group.
Direction	
You can create either a vertical or horizontal bar chart.	
Group Layout	
Cluster	displays group values as separate adjacent bars that replace the single category bar. Each set of group values is centered at the midpoint tick mark for the category.
Stack	overlays group values without any clustering. Each group is represented by unique visual attributes derived from the GraphData1... GraphData*n* style elements in the current style.
Statistics **Note:** The **Statistics** options are not available in these cases: ■ You did not assign a column to the **Response variable** role. If you do not assign a response variable, the default statistic is frequency. ■ You selected **Stack** for the group layout. In this case, the default statistic is sum.	
Mean	calculates the mean of the response variable.
Sum	calculates the sum of the response variable.
Limits	

Option Name	Description
Limits	specifies which limit lines to display. Limits are displayed as heavier line segments with a serif at the end that extends from each bar. Limit lines are displayed only if you select the **Mean** statistic.
Limit statistic	specifies the statistic for the limit lines.
Limit multiplier	specifies the number of standard units for the limit lines. By default, this value is 1.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	
Bar Details	
Apply bar color	specifies the color for the bars when a column is not assigned to the **Group variable** role.
Transparency	specifies the degree of transparency for the plot. The range is 0 (completely opaque) to 1 (completely transparent).
Apply bar gradient	applies a gradient to each bar. **Note:** This option is available only if you are running the second maintenance release of SAS 9.4 or later.
Data skin	specifies a special effect to be used on all filled bars.
Bar Labels	
Show bar labels or statistics	displays the values of the calculated response as data labels.
Category Axis	
Reverse	specifies that the values for the tick marks are displayed in reverse (descending) order.

Option Name	Description
Show values in data order	places the discrete values for the tick marks in the order in which they appear in the data.
Show label	enables you to display a label for the axis. Enter this label in the **Custom label** box.
Response Axis	
Show grid	creates grid lines at each tick on the axis.
Drop statistics suffix	removes the name of the calculated statistic in the axis label. For example, if you are calculating the mean, the axis label could be Weight (Mean).
Show label	specifies whether to display the label for the response axis. By default, the axis label is the name of the variable. However, you can create a custom label.
Legend Details	
Legend location	specifies whether the legend is placed outside or inside the axis area.
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Bar-Line Chart

About the Bar-Line Chart Task

The Bar-Line Chart task creates a vertical bar chart with a line chart overlay.

You can use this task to perform the following tasks:

- display and compare exact and relative magnitudes
- examine the contribution of each part to the whole
- determine trends and patterns in the data

Example: City and Highway Mileage by Origin

For example, 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 task calculates the mean of the number of miles per gallon in the city and in 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.

To create this example:

1. In the **Tasks** section, expand the **Graph** folder, and then double-click **Bar-Line Chart**. The user interface for the Bar-Line Chart task opens.

2. On the **Data** tab, select the **SASHELP.CARS** data set.

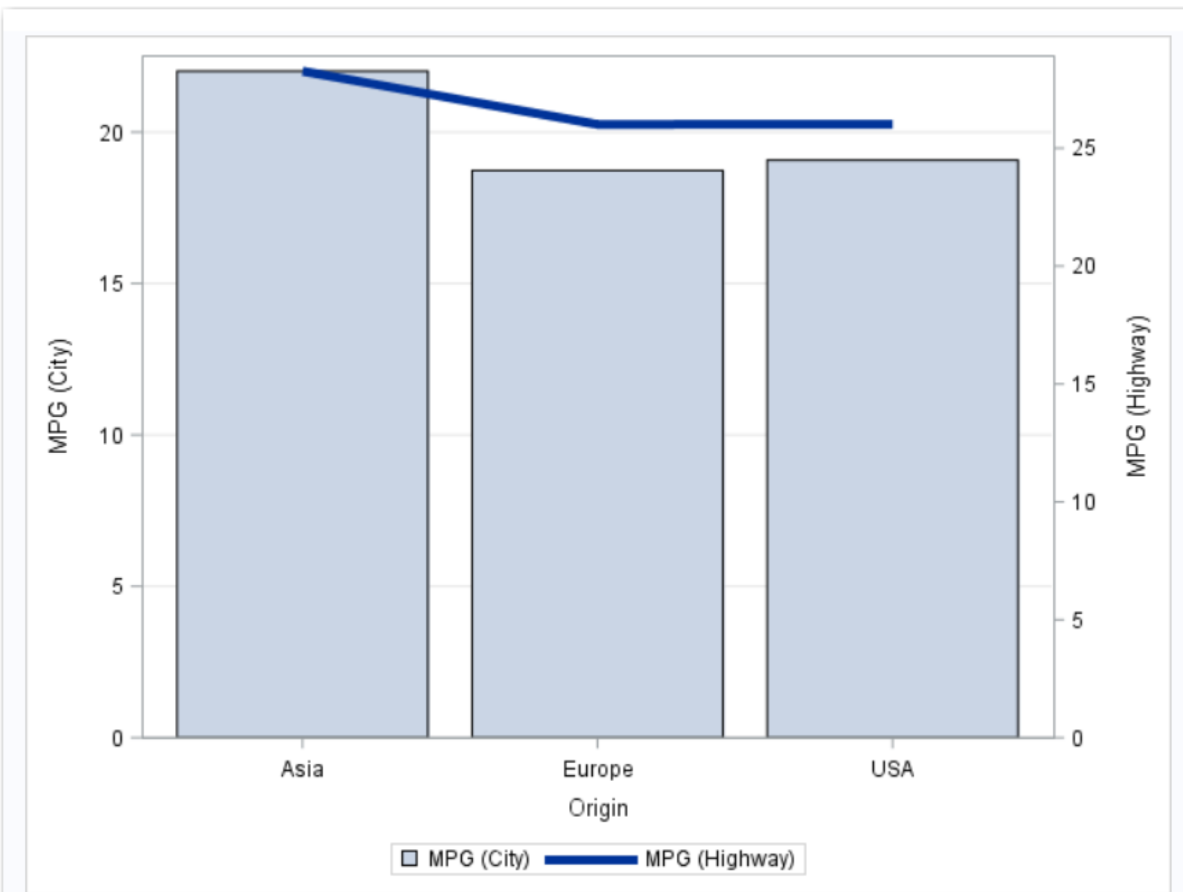
   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set

that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
Category variable	**Origin**
Bar response variable	**MPG_City**
Line response variable	**MPG_Highway**

4 To run the task, click .



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Bar-Line Chart task, you must assign a column to the **Category variable**, **Bar response variable**, and **Line response variable** roles.

Option Name	Description
Roles	
Category variable	specifies the variable that classifies the observations into distinct subsets.
Bar response variable	specifies a numeric response variable for the bar chart.
Line response variable	specifies a numeric response variable for the line plot.
Group variable	specifies a variable that is used to group the data.
URL variable	specifies a character variable that contains URLs for web pages to be displayed when parts of the plot are selected within an HTML page.
Statistics	
Mean	calculates the mean of the response variables.
Sum	calculates the sum of the response variables.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	
Bar Details	
Apply bar color	specifies the color for the bars.
Transparency	specifies the degree of transparency for the plot. The range is 0 (completely opaque) to 1 (completely transparent).

Option Name	Description
Apply bar gradient	applies a gradient to each bar. **Note:** This option is available only if you are running the second maintenance release for SAS 9.4 or later.
Data skin	specifies a special effect to be used on all filled bars.
Line Details	
Apply line color	specifies the color for the line.
Line thickness	specifies the thickness (in pixels) of the line.
Transparency	specifies the degree of transparency for the plot. The range is 0 (completely opaque) to 1 (completely transparent).
Use solid line pattern	specifies a solid pattern for the line.
Category Axis	
Reverse	specifies that the values of the tick marks are displayed in reverse (descending) order.
Show values in data order	places the discrete values for the tick marks in the order in which they appear in the data.
Show label	enables you to display a label for the axis. Enter this label in the **Custom label** box.
Response Axes	
Use zero baseline	specifies whether to offset all lines from the discrete category values and all bars from category midpoints. By default, there is no offset.
Use uniform scale	uses the same scale for both response axes.
Show grid on left (bar) axis	creates grid lines at each tick on the axis for the bar chart.
Drop statistics suffix	removes the name of the calculated statistic in the axis label. For example, if you are calculating the mean, the axis label could be Weight (Mean).
Custom label for left (bar) axis	enables you to specify a custom label for the response axis in the bar chart. The default label is the name of the bar response variable.

Option Name	Description
Custom label for right (line) axis	enables you to specify a custom label for the response axis in the line chart. The default label is the name of the line response variable.
Legend Details	
Legend location	specifies whether the legend is placed outside or inside of the axis area.
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Box Plot

About the Box Plot Task

The Box Plot task creates a single box plot, which represents numeric values measured as intervals. If you choose to categorize the values of the analysis variable, then multiple box plots are created.

Example: Box Plots Comparing MPG (City) for Cars

This example creates three box plots that compares how many miles per gallon (city) cars consume depending on their area of origin (Asia, Europe, and United States).

To create this example:

1. In the **Tasks** section, expand the **Graph** folder, and then double-click **Box Plot**. The user interface for the Box Plot task opens.

2. On the **Data** tab, select the **SASHELP.CARS** data set.

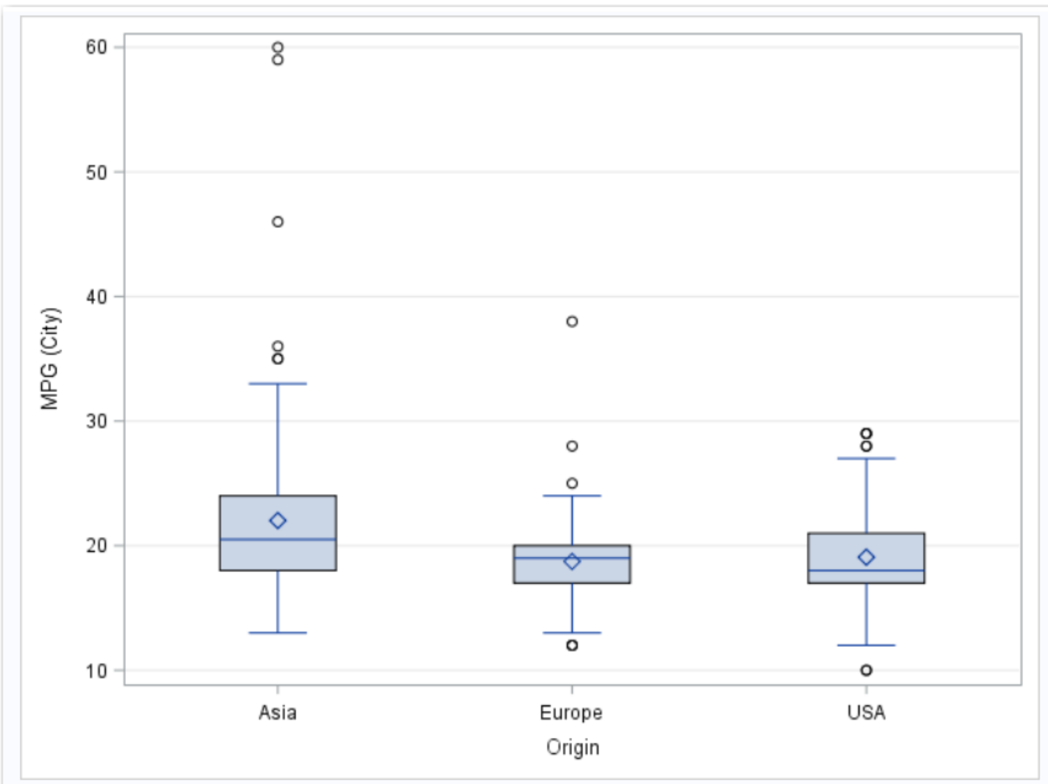
   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. Assign columns to these roles:

Role	Column Name
Analysis variable	**MPG_City**
Category variable	**Origin**

4 To run the task, click .

Here is the resulting box plot:



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Box Plot task, you must assign a column to the **Analysis variable** role. You can create either a vertical box plot or a horizontal box plot.

Role	Description
Analysis variable	specifies the analysis variable for the plot.

Role	Description
Category variable	creates a box plot for each distinct value of the category variable.
Group variable	specifies a variable that is used to group the data.
BY variable	creates a separate graph for each BY group.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	
Box Detail	
Box width	specifies the width of each box. Specify a value between 0.0 (0% of the available width) and 1.0 (100% of the available width).
Fill	specifies whether the boxes are filled with color. The default color is white.
Data skin	specifies a special effect to be used on the plot. The data skin affects all filled boxes. 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.
Transparency	specifies the degree of transparency for the plot. The default value is 0. However, valid values range from 0 (completely opaque) to 1 (completely transparent).
Set cap shape	specifies 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.

Option Name	Description
Notches	specifies that the boxes be notched. The endpoints of the notches are at the following computed locations: $median \pm 1.58\left(\frac{IQR}{\sqrt{N}}\right)$
Group Layout	
Group Order	specifies the order of boxes within a group. The groups can be displayed in ascending order, in descending order, or in the order in which they appear in the data.
Category Axis	
Reverse	specifies that the values for the tick marks are displayed in reverse (descending) order.
Show values in data order	places the discrete values for the tick marks in the order in which they appear in the data.
Show label	enables you to display a label for the axis. Enter this label in the **Custom label** box.
Analysis Axis	
Show grid	creates grid lines at each tick on the axis.
Show label	specifies whether to display the label for the analysis axis. By default, the axis label is the name of the variable. However, you can create a custom label.
Legend Details	
Legend location	specifies whether the legend is placed outside or inside the axis area.
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Bubble Plot

About the Bubble Plot Task

The Bubble Plot task 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.

Example: Bubble Plot

To create this example:

1 In the **Tasks** section, expand the **Graph** folder, and then double-click **Bubble Plot**. The user interface for the Bubble Plot task opens.

2 On the **Data** tab, select the **SASHELP.CLASS** data set.

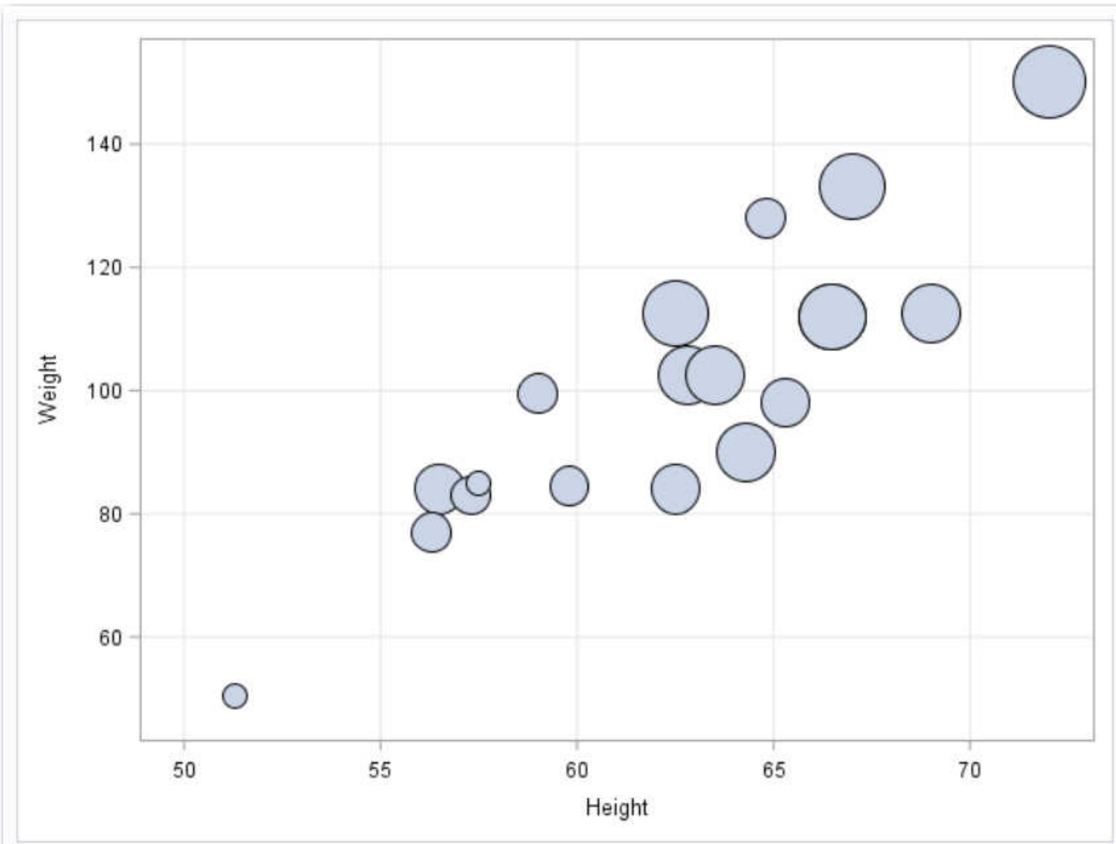
> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
X variable	**Height**
Y variable	**Weight**

Role	Column Name
Size variable	**Age**

4 To run the task, click .



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Bubble Plot task, you must assign a column to the **X variable**, **Y variable**, and **Size variable** roles.

Option Name	Description
Roles	
X variable	specifies the variable for the X axis.

Option Name	Description
Y variable	specifies the variable for the Y axis.
Size variable	specifies 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.
Color response variable	specifies the numeric variable that is used to map colors to a gradient legend.
Group variable	specifies the variable that is used to group the data. The bubbles for each group are automatically distinguished by different colors. **Note:** If you also assign a variable to the **Color response variable** role, the group variable is ignored.
Label variable	specifies the values to use as labels for each data point. If you assign a variable to this role, the values of that variable are used for the data labels. If you do not assign a variable to this role, the values of the Y variable are used for the data labels.
URL variable	specifies a character variable that contains URLs for web pages to be displayed when parts of the plot are selected within an HTML page.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	
Bubble Details	
Apply color	specifies the color for the bars when a column is not assigned to the **Group variable** role.
Minimum radius	specifies the radius of the smallest bubble.

Option Name	Description
Maximum radius	specifies the radius of the largest bubble.
Transparency	specifies the degree of transparency for the bubbles. The range is 0 (completely opaque) to 1 (completely transparent).
Data skin	specifies a special effect to be used on all filled bubbles.
Color Model	
If you assign a variable to the **Color response variable** role, you can specify three colors to use in the color map.	
Bubble Labels	
If you assign a variable to the **Label variable** role, you can determine the label color, the font size for the label text, and the label position.	
X Axis and Y Axis	
Show grid lines	creates grid lines at each tick on the axis.
Show label	specifies whether to display the label for the response axis. By default, the axis label is the name of the variable. However, you can create a custom label.
Legend Details	
Group legend location	specifies whether the group legend is located inside or outside the plot. This option is available when you assign a variable to the **Group variable** role.
Color legend position	specifies whether the color legend appears to the right or below the plot.
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Histogram

About the Histogram Task

The Histograms task creates a chart that displays the frequency distribution of a numeric variable.

Example: Histogram of Stock Volume

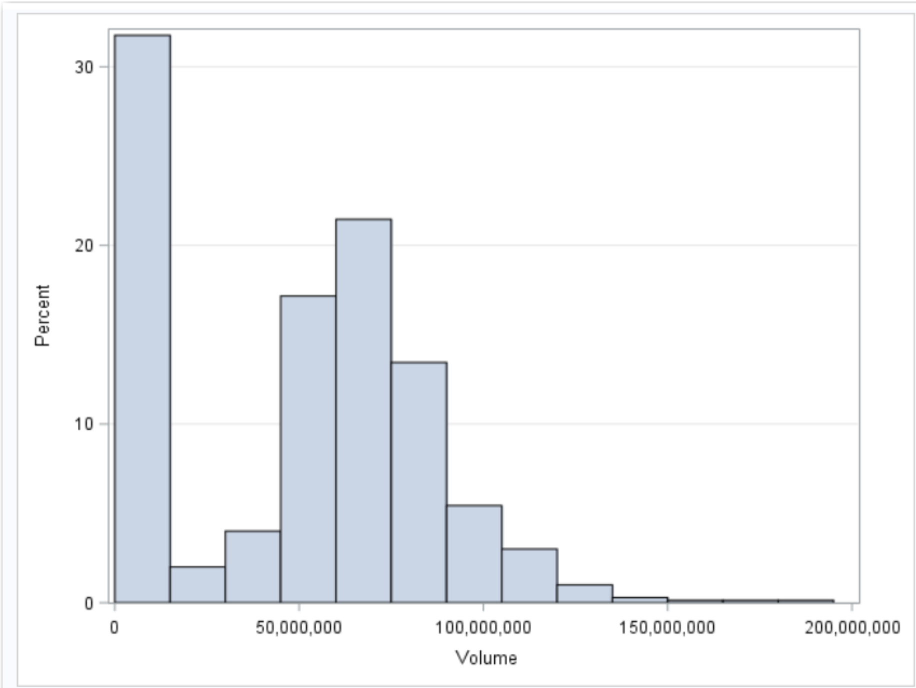
To create this example:

1. In the **Tasks** section, expand the **Graph** folder, and then double-click **Histogram**. The user interface for the Histogram task opens.
2. In the **Data** tab, select the **SASHELP.STOCKS** data set.

   > **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. To the **Analysis variable** role, assign the **Volume** column.
4. To run the task, click .

Here are the results:



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Histogram task, you must assign a column to the **Analysis variable** role.

You can 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.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	

Option Name	Description
Bin Details	
For the bins in the histogram, you can specify the color and the transparency. If you are running the second maintenance release for SAS 9.4 or later, you can also specify whether to apply a gradient to each bin.	
Horizontal Axis	
Interval axis	creates tick marks at regular intervals on the horizontal axis based on the minimum and maximum values of the analysis variable.
Bin axis	creates tick marks at the midpoints of the value bins on the horizontal axis.
Specify number of bins	enables you to specify the number of bins in the histogram. Valid values range from 2 to 20. The bins always span the range of data. The task 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 task automatically determines the number of bins.
Show label	displays the label for the analysis variable along the horizontal axis. You can also enter a custom label.
Vertical Axis	
Specify axis scaling	specifies the scaling that is applied to the vertical axis. You can choose from these options: **COUNT** the axis displays the frequency count **PERCENT** the axis displays values as a percentage of the total. **PROPORTION** the axis displays values as proportions (0.0 to 1.0) of the total.
Show grid	specifies whether to show the grid lines for the vertical axis.
Show label	specifies whether to show the label for the type of axis scaling.
Legend Details	

Option Name	Description
Show legend	specifies whether to display a legend in the output.
Legend location	specifies whether the legend is placed outside or inside of the axis area.
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Line Chart

About the Line Chart Task

The Line Chart task assumes that the values in the category variable are discrete. The task groups these values into distinct categories. If you assign a column from the input data source to the **Response variable** role, you can select the statistic (either mean or sum) for the response values. By default, the task calculates the mean of the values for the response variable. If no response variable is assigned, a frequency chart by category is created.

Example: Displaying the Mean Horsepower for Each Car Type

In this example, you want to display the mean horsepower for each car type in a line plot. The result shows that sports cars have the highest average horsepower and hybrid cars have the lowest average horsepower.

To create this example:

1. In the **Tasks** section, expand the **Graph** folder, and then double-click **Line Chart**. The user interface for the Line Chart task opens.

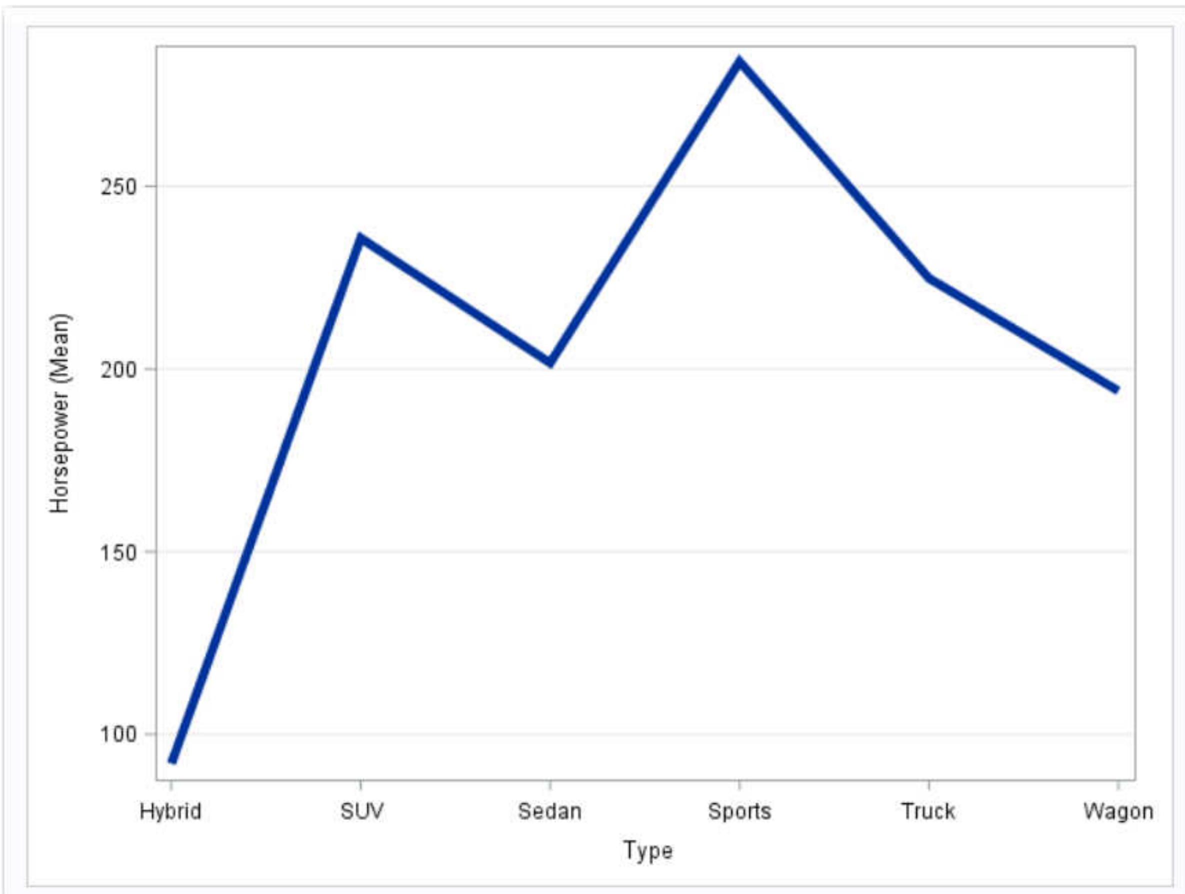
2. On the **Data** tab, select the **SASHELP.CARS** data set.

   > **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. Assign columns to these roles:

Role	Column Name
Category variable	Type
Response variable	Horsepower

4 To run the task, click .



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Line Chart task, you must assign a column to the **Category variable** role.

Option Name	Description
Role	
Category variable	specifies the variable that classifies the observations into distinct subsets.
Response variable	specifies a numeric response variable for the plot.
Group variable	specifies a variable that is used to group the data.
URL variable	specifies a character variable that contains URLs for web pages to be displayed when parts of the plot are selected within an HTML page.
Statistics	
Mean	calculates the mean of the response variable.
Sum	calculates the sum of the response variable.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	
Line Details	
Apply line color	specifies the color for the line when you do not assign a column to the **Group variable** role.
Line thickness	specifies the thickness (in pixels) of the line.
Transparency	specifies the degree of transparency for the plot. The range is 0 (completely opaque) to 1 (completely transparent).
Use solid line	specifies a solid pattern for the line.

Option Name	Description
Line Labels	
Show line labels	displays the label from the response variable. If you assign a column to the **Group variable** role, each line is labeled with the group value.
Category Axis	
Reverse	specifies that the values of the tick marks are displayed in reverse (descending) order.
Show values in data order	places the discrete tick values in the order in which they appear in the data.
Show label	enables you to display a label for the axis. By default, the label is the variable name. To customize this label, enter this label in the **Custom label** box.
Response Axis	
Show grid	creates grid lines at each tick on the axis.
Drop statistics suffix	removes the name of the calculated statistic in the axis label. For example, if you are calculating the mean, the axis label could be Weight (Mean).
Show label	enables you to display a label for the axis. By default, the label is the variable name. To customize this label, enter this label in the **Custom label** box.
Legend Details	
Legend location	specifies whether the legend is placed outside or inside of the axis area.
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Mosaic Plot

About the Mosaic Plot Task

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. For more information, see Friendly (2000).

Example: Mosaic Plot

To create this example:

1. In the **Tasks** section, expand the **Graph** folder, and then double-click **Mosaic**. The user interface for the Mosaic Plot task opens.
2. On the **Data** tab, select the **SASHELP.CARS** data set.

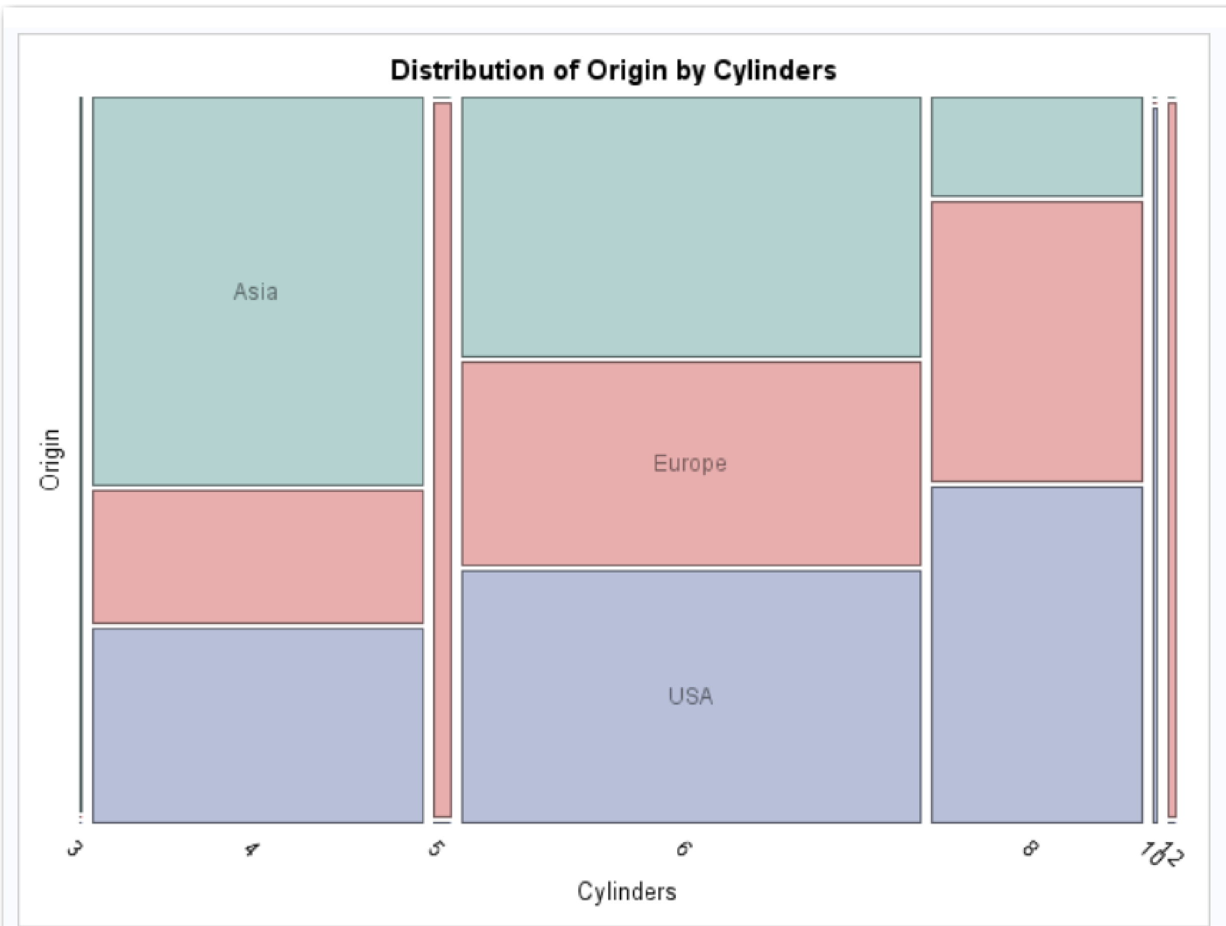
   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. Assign columns to these roles:

Role	Column Name
Vertical axis	**Origin**
Horizontal axis	**Cylinders**

4 To run the task, click .

Here is the result:



Assigning Data to Roles

To run the Mosaic Plot task, you must select an input data source and assign columns to the **Vertical axis** and **Horizontal axis** roles. To filter the input data source, click .

Option Name	Description
Roles	

Option Name	Description
Vertical axis	specifies the variable for the X axis in a two-way crosstabulation table.
Horizontal axis	specifies the variable for the Y axis in a two-way crosstabulation table.
Stratify by	specifies the variables to use to create a multiway table.
Additional Roles	
Frequency count	names a numeric variable that provides a weight for each observation in the input data set. This option is most commonly used to input cell count data.

Setting Options

Option Name	Description
Square plot	produces 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 task creates a rectangular mosaic plot.
Color tiles by	colors 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.

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Pie Chart

About the Pie Chart Task

The Pie Chart task 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.

Example: Pie Chart That Shows Total MSRP for Each Car Type by Region

In this example, you want to compare the manufacturer’s suggested retail price (MSRP) for each car type grouped 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 **Tasks** section, expand the **Graph** folder, and then double-click **Pie Chart**. The user interface for the Pie Chart task opens.

2 On the **Data** tab, select the **SASHELP.CARS** data set.

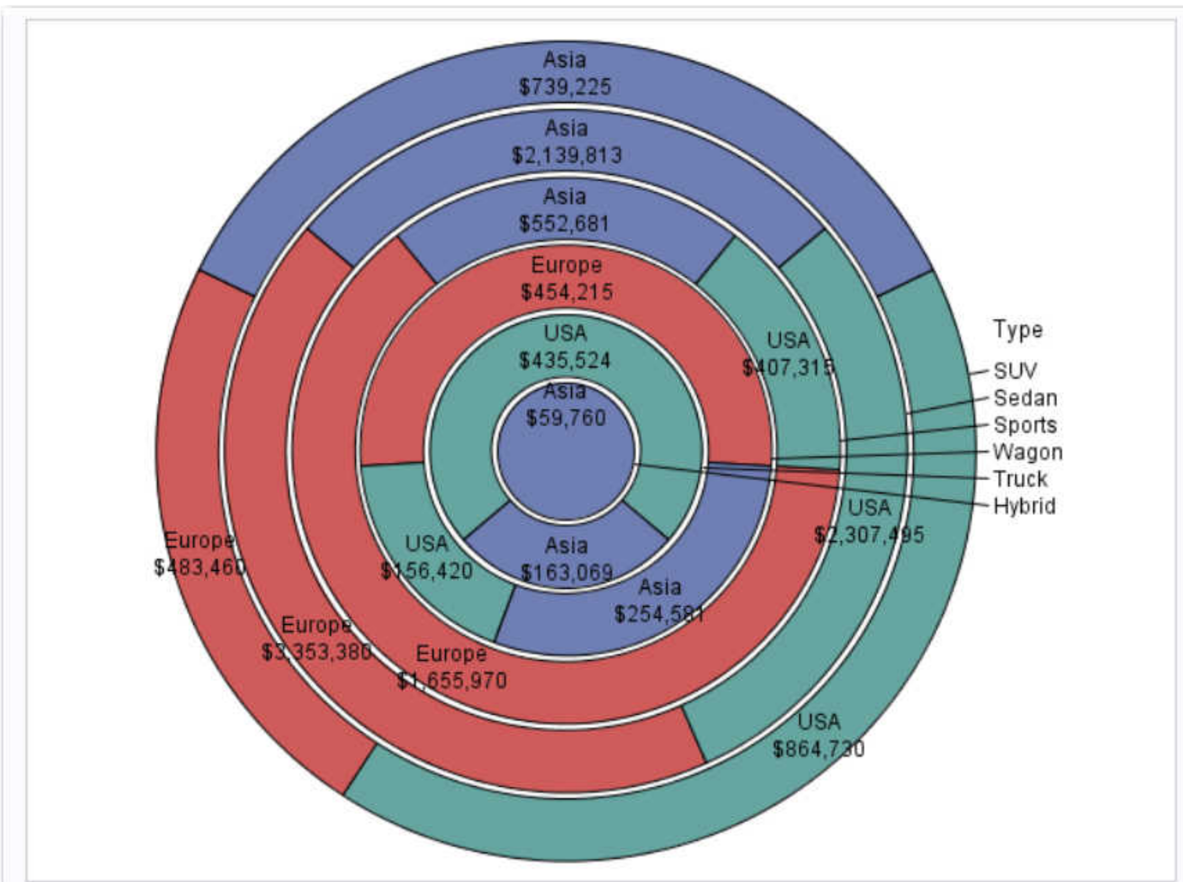
> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
Category variable	**Origin**
Response variable	**MSRP**
Group variable	**Type**

4 To run the task, click .

Here is the result:



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Pie Chart task, you must assign a column to the **Category variable** role.

Option Name	Description
Role	
Category variable	specifies the variable that classifies the observations into distinct subsets.
Response variable	specifies a numeric response variable for the plot.
Group variable	specifies a variable that is used to group the data.
URL variable	specifies a character variable that contains URLs for web pages to be displayed when parts of the plot are selected within an HTML page. **Note:** If the task generates an “Other” slice in the pie chart, there is not a URL associated with this slice. Therefore, this slice does not contain a link.
Orientation	
Starting point	specifies where to create the first slice in the pie chart. The remaining slices appear counterclockwise.
Center the first slice	specifies whether to offset the first slice.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	
Pie Details	
Fill transparency	specifies the degree of transparency for the plot. The range is 0 (completely opaque) to 1 (completely transparent).
Data skin	specifies a special effect to be used on all filled slices.
Pie Labels	

Option Name	Description
Location	specifies whether to display the label inside or outside the slice in the pie chart. By default, the Pie Chart task determines the best location for the slice.
Set label font size	enables you to specify the font size of the label for each slice.
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Scatter Plot

About the Scatter Plot Task

The Scatter Plot task 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.

Example: Scatter Plot of Height versus Weight

In this example, you want to create a scatter plot of height versus weight.

To create this example:

1 In the **Tasks** section, expand the **Graph** folder, and then double-click **Scatter Plot**. The user interface for the Scatter Plot task opens.

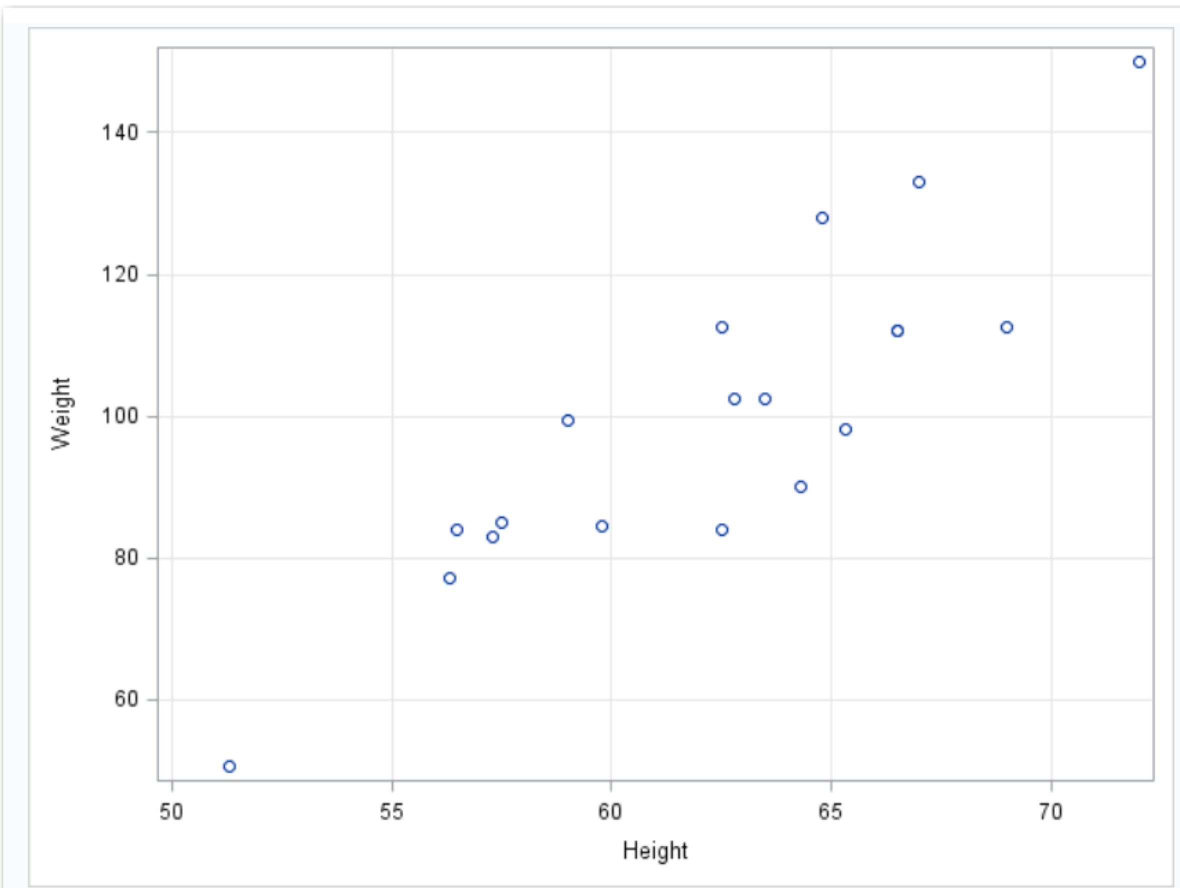
2 On the **Data** tab, select the **SASHELP.CLASS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
X variable	**Height**
Y variable	**Weight**

4 To run the task, click .



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Scatter Plot task, you must assign columns to the **X variable** and **Y variable** role.

Option Name	Description
Roles	
X variable	specifies the variable for the x axis.
Y variable	specifies the variable for the y axis.
Group variable	specifies a variable that is used to group the data. The plot elements for each group value are automatically distinguished by different visual attributes.
Marker label variable	displays a label for each data point. If you specify a variable, the values of that variable are used for the data labels. If you do not specify a variable, then the values of the Y variable are used for the data labels.
URL variable	specifies a character variable that contains URLs for web pages to be displayed when parts of the plot are selected within an HTML page.
Fit Plots **Note:** This is available only if you assign numeric variables.	
Regression	creates a plot with the fitted regression line. You can specify whether to include the confidence limits for means and the prediction limits for the individual predicted values. The **Alpha** option specifies the confidence level for the confidence limits. The **Degree** option specifies the degree of the polynomial fit.
Loess	creates a fitted loess curve. You can specify whether to include the confidence limits. The **Alpha** option specifies the confidence level for the confidence limits.
PBSpline	creates a fitted penalized B-spline curve. You can specify whether to include the confidence limits for means and the prediction limits for the individual predicted values. The **Alpha** option specifies the confidence level for the confidence limits.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	
Marker Details	
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 0 (completely opaque) to 1 (completely transparent).	
Marker Labels	
Font size	specifies the appearance of the labels in the plot when you assign a variable to the **Marker label variable** role.
X Axis, Y Axis	
Show grid lines	creates grid lines at each tick on the axis.
Show label	displays the label for the axis. By default, the label is the variable name. To customize, enter this label in the **Custom label** box.
Legend Details	
Legend location	specifies whether the legend is placed outside or inside the axis area.
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Series Plot

About the Series Plot Task

The Series Plot task creates a line plot. Series plots display a series of line segments that connect observations of input data.

Example: Series Plot of Stock Trends

In this example, you want to create a series plot that shows stock trends.

To create this example:

1 In the **Tasks** section, expand the **Graph** folder, and then double-click **Series Plot**. The user interface for the Series Plot task opens.

2 On the **Data** tab, select the **SASHELP.STOCKS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

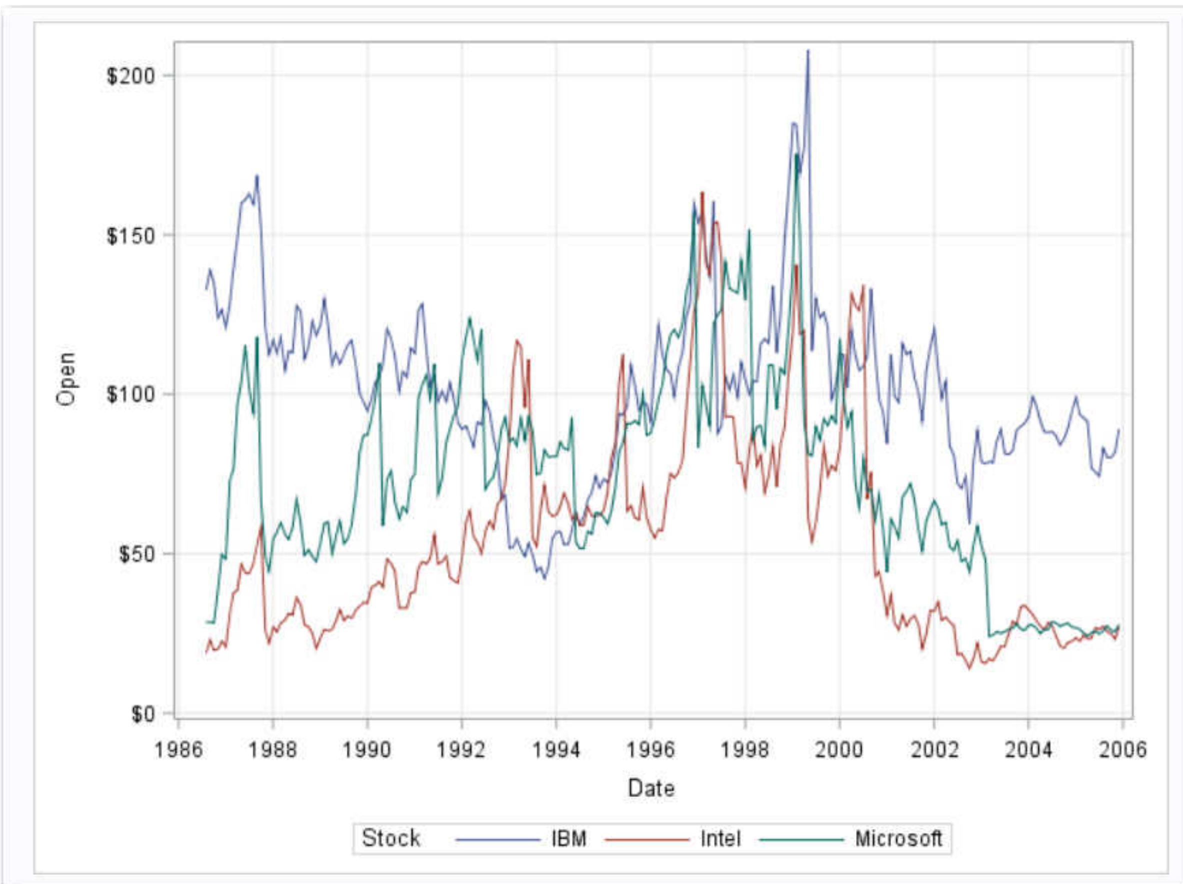
3 Assign columns to these roles:

Role	Column Name
X variable	**Date**
Y variable	**Open**

Role	Column Name
Group variable	Stock

4 To run the task, click .

The resulting series plot shows the stock values for three companies.



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Series Plot task, you must assign columns to the **X variable** and **Y variable** roles.

Role	Description
X variable	specifies the variable for the x axis.
Y variable	specifies the variable for the y axis.
Group variable	specifies a variable that is used to group the data.
URL variable	specifies a character variable that contains URLs for web pages to be displayed when parts of the plot are selected within an HTML page.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	
Plot Details	
You can specify the symbol type, color, and size of the markers in the scatter plot. You can also specify the degree of transparency for the plot. The range is 0 (completely opaque) to 1 (completely transparent).	
Plot Labels	
Show plot labels	adds a label for the curve. You can also specify the size of this text.
X Axis, Y Axis	
Show grid lines	creates grid lines at each tick on the axis.
Show label	displays the label for the axis. By default, the label is the variable name. To customize, enter this label in the **Custom label** box.
Legend Details	
Legend location	specifies whether the legend is placed outside or inside of the axis area.

Option Name	Description
Graph Size	
You can specify the width and height of the graph in inches, centimeters, or pixels.	

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Simple HBar

About the Simple HBar Task

The Simple HBar task creates a simple horizontal bar chart. You can customize the title, footnotes, axes, and legends for the horizontal bar chart.

Example: Horizontal Bar Chart of Mileage by Origin and Type

To create this horizontal bar chart:

1 In the **Tasks** section, expand the **Graphs** folder, and then double-click **Simple HBar**. The user interface for the Simple HBar task opens.

2 On the **Data** tab, select the **SASHELP.CARS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

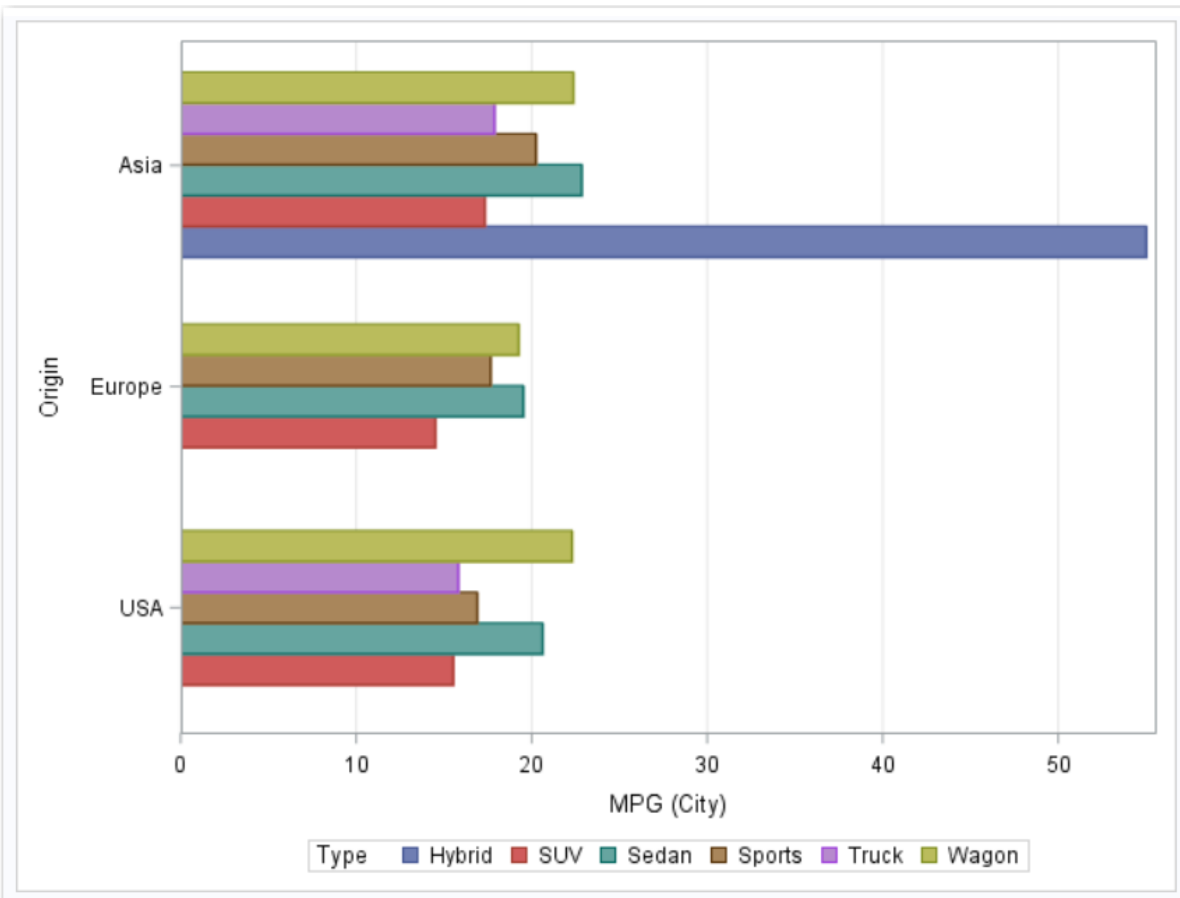
3 Assign columns to these roles:

Role	Column Name
Category variable	**Origin**
Response variable	**MPG_City**

Role	Column Name
Group variable	**Type**

4 To run the task, click .

Here are the results:



Assigning Data to Roles

You can subset the data in the input data set by applying an SQL WHERE clause. In the **Where string** box, enter your valid SQL syntax. Operands that are character strings must be enclosed in single or double quotation marks. To view this WHERE clause with the resulting graph, select the **Include as footnote** check box.

To run the Simple HBar task, you must assign a column to the **Category variable** role.

Option Name	Description
Role	
Category variable	specifies the variable that classifies the observations into distinct subsets.
Response variable	specifies a numeric response variable for the plot.
Group variable	specifies a variable that is used to group the data.
URL variable	specifies a character variable that contains URLs for web pages to be displayed when parts of the plot are selected within an HTML page.
Group Layout	
Cluster	displays group values as separate adjacent bars that replace the single category bar. Each set of group values is centered at the midpoint tick mark for the category.
Stack	overlays group values without any clustering. Each group is represented by unique visual attributes that are derived from the GraphData1... GraphData*n* style elements in the current style.
Statistics	
Mean	calculates the mean of the response variable.
Sum	calculates the sum of the response variable.

Setting Options

Option Name	Description
Title and Footnote	
You can specify a custom title and footnote for the output. You can also specify the font size for this text.	

Option Name	Description
Bar Details	
Apply bar color	specifies the color for the bars when a column is not assigned to the **Group variable** role.
Transparency	specifies the degree of transparency for the plot. The range is 0 (completely opaque) to 1 (completely transparent).
Apply bar gradient	applies a gradient to each bar. **Note:** This option is available only if you are running the second maintenance release for SAS 9.4 or later.
Data skin	specifies a special effect to be used on all filled bars.
Bar Labels	
Show bar labels	displays the values of the calculated response as data labels.
Category Axis	
Reverse	specifies that the values of the tick marks are displayed in reverse (descending) order.
Show values in data order	places the discrete tick values in the order in which they appear in the data.
Show label	enables you to display a label for the axis. Enter this label in the **Custom label** box.
Response Axis	
Show grid	creates grid lines at each tick on the axis.
Drop statistics suffix	removes the name of the calculated statistic in the axis label. For example, if you are calculating the mean, the axis label could be Weight (Mean).
Custom Label	enables you to customize the label for the response axis. By default, the axis label is the name of the variable.
Legend Details	
Legend location	specifies whether the legend is placed outside or inside of the axis area.
Graph Size	

Option Name	Description
You can specify the width and height of the graph in inches, centimeters, or pixels.	

Part 3

Combinatorics and Probability Tasks

25

Permutations

About the Permutations Task

The Permutations task computes the possible permutations of a given number of objects.

Example: Calculating the Permutations of Six Objects

To create this example:

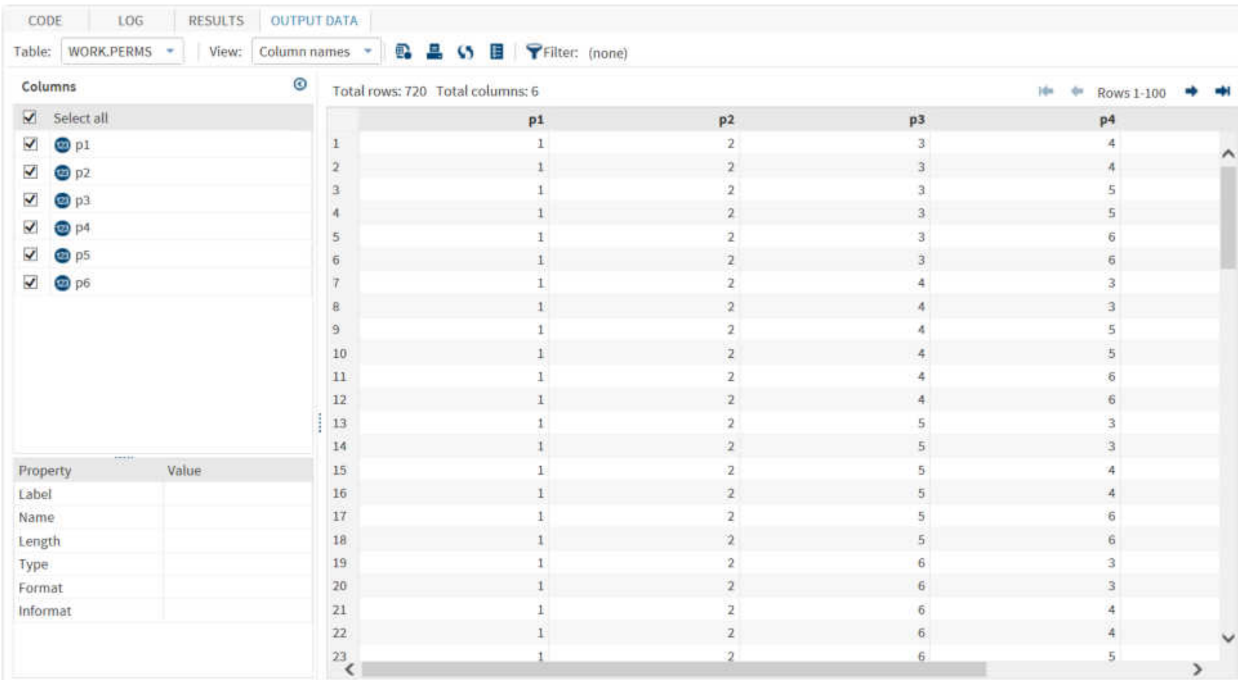
1. In the **Tasks** section, expand the **Combinatorics and Probability** folder, and then double-click **Permutations**. The user interface for the Permutations task opens.
2. On the **Options** tab, specify these options.

   Assign columns to these roles:

Option Name	Value to Specify
Number of objects	`6`
Data set name	`Perms`

3. To run the task, click .

The Permutations task creates an output data set. In SAS Studio, this data set opens on the **Output Data** tab.



Setting Options

All of these options are required to run the Permutations task.

Option Name	Description
Observations	
Number of objects	specifies the number of objects for which you want to compute permutations. This value can range from 1 to 10.
Output Data Set	
Data set name	specifies the name of the output data set.

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Combinations

About the Combinations Task

The Combinations task computes the possible combinations of the total number of objects into sets with a specified number in each set.

Example: Calculating the Combinations of 52 Objects in 5 Sets

To create this example:

1 In the **Tasks** section, expand the **Combinatorics and Probability** folder, and then double-click **Combinations**. The user interface for the Combinations task opens.

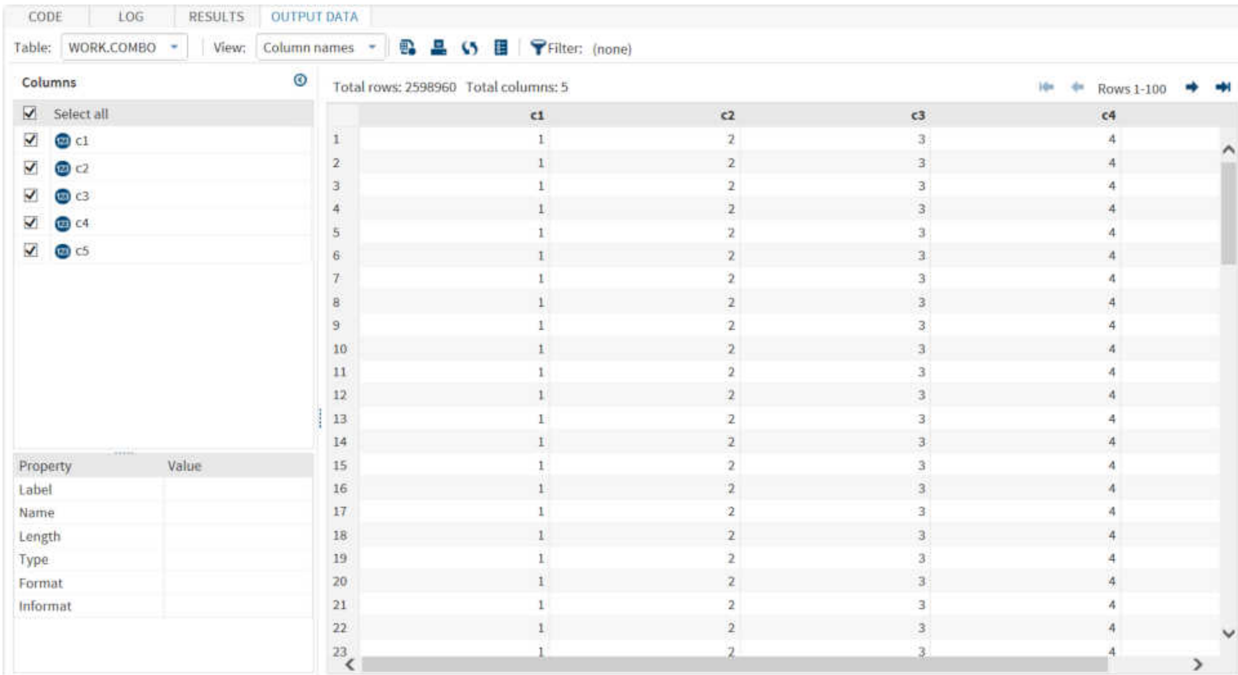
2 On the **Options** tab, specify these options.

Assign columns to these roles:

Option Name	Value to Specify
Total number of objects	`52`
Number of objects in a set	`5`
Data set name	`Combo`

3 To run the task, click .

The Combinations task creates an output data set. In SAS Studio, this data set opens on the **Output Data** tab.



Setting Options

All of these options are required to run the Combinations task.

Option Name	Description
Observations	
Total number of objects	specifies the number of objects.
Number of objects in a set	specifies the number of objects in a set.
Output Data Set	
Data set name	specifies the name of the output data set.

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Same Birthday Probability

About the Same Birthday Probability Task

The Same Birthday Probability task computes the probability that two or more people in a room have the same birthday.

Example: Probability of Two or More People Sharing a Birthday in a Room of 145 People

To create this example:

1. In the **Tasks** section, expand the **Combinatorics and Probability** folder, and then double-click **Same Birthday Probability**. The user interface for the Same Birthday Probability task opens.
2. On the **Options** tab, specify these options.

Option Name	Value to Specify
Number in a room	`145`
Data set name	`Birthdays`

3. To run the task, click .

Here is a subset of the results:

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
26	0.59824082013594
27	0.62685928226324

Setting Options

All of these options are required to run the Same Birthday Probability task.

Option Name	Description
Observations	
Number in a room	specifies the number of people in the room.
Output Data Set	
Data set name	specifies the name of the output data set.

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Dice Roll Simulation

About the Dice Roll Simulation Task

The Dice Roll Simulation task simulates rolling a specified number of dice. The results show the frequency and percentage of each possible roll given a specified number of throws.

Example: Probability of Outcomes for 100,000,000 Dice Rolls

To create this example:

1 In the **Tasks** section, expand the **Combinatorics and Probability** folder, and then double-click **Dice Roll Simulation**. The user interface for the Dice Roll Simulation task opens.

2 On the **Options** tab, specify these options.

Option Name	Value to Specify
Number of dice	`2`
Number of rolls	`100,000,000`
Data set name	`Dice`

3 To run the task, click .

Here are the results:

Rolling 2 dice 100000000 times

Value Rolled	Frequency	Probability
2	2,777,202	0.027772
3	5,555,323	0.055553
4	8,332,115	0.083321
5	11,112,769	0.111128
6	13,889,343	0.138893
7	16,671,035	0.166710
8	13,890,198	0.138902
9	11,108,948	0.111089
10	8,332,523	0.083325
11	5,552,208	0.055522
12	2,778,336	0.027783
.	100,000,000	1.000000

Setting Options

All of these options are required to run the Dice Roll Simulation task.

Option Name	Description
Observations	
Number of dice	specifies the number of dice to roll.
Number of rolls	specifies the number of times to roll the dice.
Output Data Set	
Data set name	specifies the name of the output data set.

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Coin Toss Simulation

About the Coin Toss Simulation Task

The Coin Toss Simulation task 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.

Example: Probability of Outcomes for 10,000,000 Coin Tosses

To create this example:

1 In the **Tasks** section, expand the **Combinatorics and Probability** folder, and then double-click **Coin Toss Simulation**. The user interface for the Coin Toss Simulations task opens.

2 On the **Options** tab, specify these options.

Option Name	Value to Specify
Number of coins	`10`
Number of tosses	`10,000,000`
Data set name	`Coins`

3 To run the task, click .

Here are the results for this example:

Tossing 10 coins 1000000 times

Number of Heads	Frequency	Probability
0	958	0.000958
1	9,740	0.009740
2	43,911	0.043911
3	117,955	0.117955
4	204,979	0.204979
5	245,767	0.245767
6	205,128	0.205128
7	117,009	0.117009
8	43,733	0.043733
9	9,829	0.009829
10	991	0.000991
.	1,000,000	1.000000

Setting Options

Option Name	Description
Observations	
Number of coins	specifies the number of coins to toss.
Number of tosses	specifies the number of times to toss the coins.
Output Data Set	
Data set name	specifies the name of the output data set.
Show graph table	displays 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 less.

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Poker Hand Probability

About the Poker Hand Probability Task

The Poker Hand Probability task calculates the frequency and probability of poker hands. The input data set for the Poker Hand Probability task must be the output data set generated by the Computations task.

Example: Results from the Poker Hand Probability Task

To create this example:

1. In the **Tasks** section, expand the **Combinatorics and Probability** folder and double-click **Poker Hand Probability**. The user interface for the Poker Hand Probability task opens.
2. On the **Options** tab, select the **WORK.COMBO** data set.

   Note: You must run the Combinations task to generate this data set.
3. To run the task, click . The Work.Combo data set is created.
4. In the **Tasks** section, expand the **Combinatorics and Probability** folder, and then double-click **Poker Hand Probability**. The user interface for the Poker Hand Probability task opens.
5. For the input data set, select `WORK.COMBO`.
6. To run the task, click .

Here are the results:

Poker Hand Probability

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

Part 4

Statistics Tasks

31

Data Exploration

About the Data Exploration Task

The Data Exploration task provides graphs that can be used to explore the relationships among selected variables.

Note: You must have SAS/STAT to use this task.

Example: Exploring the SASHELP.CARS Data

To create this example:

1 In the **Tasks** section, expand the **Statistics** folder, and then double-click **Data Exploration**. The user interface for the Data Exploration task opens.

2 On the **Data** tab, select the **SASHELP.CARS** data set.

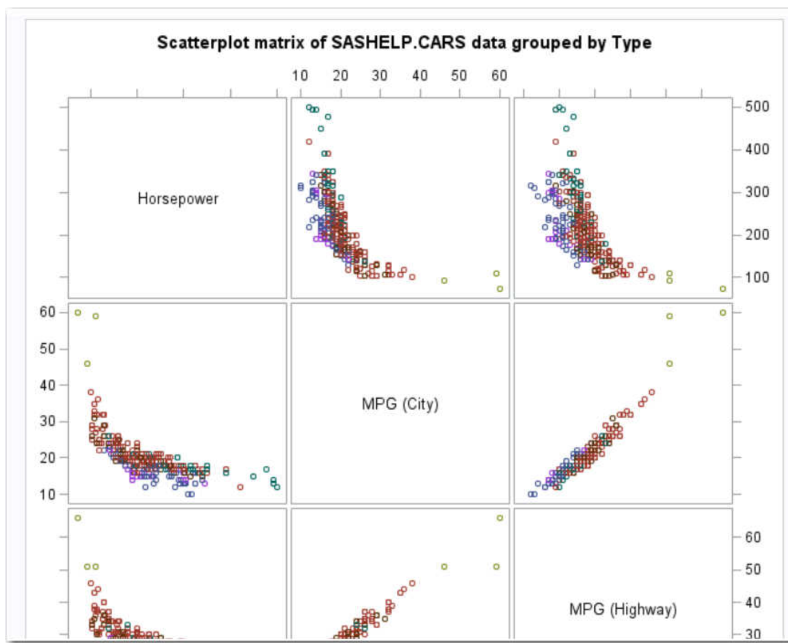
> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

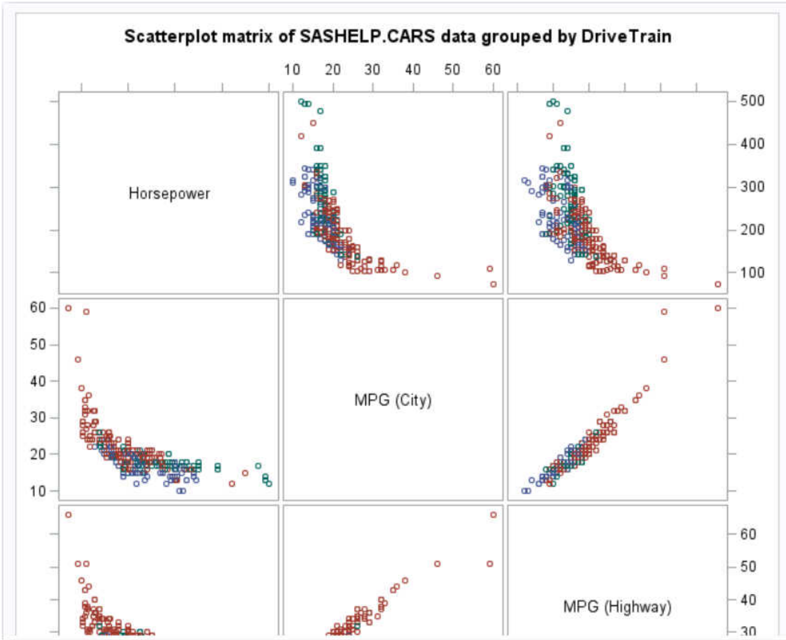
3 Assign columns to these roles:

Role	Column Name
Continuous variables	**Horsepower** **MPG_City** **MPG_Highway**
Classification variables	**Type** **DriveTrain**

4 To run the task, click .

Here is a subset of the results:





Assigning Data to Roles

To run the Data Exploration task, you must assign either two columns to the **Classification variables** role or one column to the **Continuous variables** role.

Role	Description
Roles	
Continuous variables	specifies the continuous variables in the analysis.
Classification variables	specifies the classification variables to use to explore the data.
Additional Roles	
Group analysis by	creates separate analyses based on the number of BY variables.

Setting the Plot Options

The plot options that are available depend on the columns that you assigned on the **Data** tab.

Option Name	Description
Histogram and Box Plot	
The combined histogram and box plot options are available when a column is assigned to the **Continuous variables** role, but no column is assigned to the **Classification variables** role.	
Scatter Plot Matrix	
The scatter plot matrix options are available when at least two columns are assigned to the **Continuous variables** role.	
Add histograms	adds histograms to the diagonal cells of the matrix. You can add a normal density curve and the kernel density estimate to these histograms.
Add prediction ellipses	adds 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.
Pairwise Scatter Plots	
The pairwise scatter plot options are available when at least two columns are assigned to the **Continuous variables** role.	
Pairwise scatter plots	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.
Add a prediction ellipse	adds 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.
Regression Scatter Plots	
The regression scatter plot options are available when at least two columns are assigned to the **Continuous variables** role.	
Regression scatter plots	adds a regression fit to the scatter plot.
Select response variables	specifies the variables to use when fitting the regression line.
Add a fitted line	adds a regression fit to the scatter plot.
Add a loess fit	adds a loess fit to the scatter plot.
Add a fitted, penalized B-spline curve	adds a fitted, penalized B-spline curve to the scatter plot.
Mosaic Plot	

Option Name	Description
Mosaic plot	creates 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.
Square mosaic plot	produces 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 colors of mosaic plot tiles	colors 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.
Histogram	
Histogram	creates a histogram by using any numeric variables in the input data set.
Add normal density curve	adds a normal density curve to the histogram.
Add kernel density estimate	adds a kernel density estimate to the histogram.
Add inset statistics	adds a box or table of summary statistics directly in the histogram.
Box Plot	
The box plot options are available when at least one column is assigned to the **Classification variables** role.	
Comparative box plot	creates a one-way box plot for each classification variable. This plot shows all continuous variables by the classification variable.

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Summary Statistics

About the Summary Statistics Task

The Summary Statistics task 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 task to create a report on the number of new sales, arranged by product type and country.

Note: You must license and install SAS/STAT to use this task.

Example: Summary Statistics of Unit Sales

In this example, you want to analyze unit sales. In addition to the tabular results, you choose to display a histogram of the distribution.

To create this example:

1 In the **Tasks** section, expand the **Statistics** folder, and then double-click **Summary Statistics**. The user interface for the Summary Statistics task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

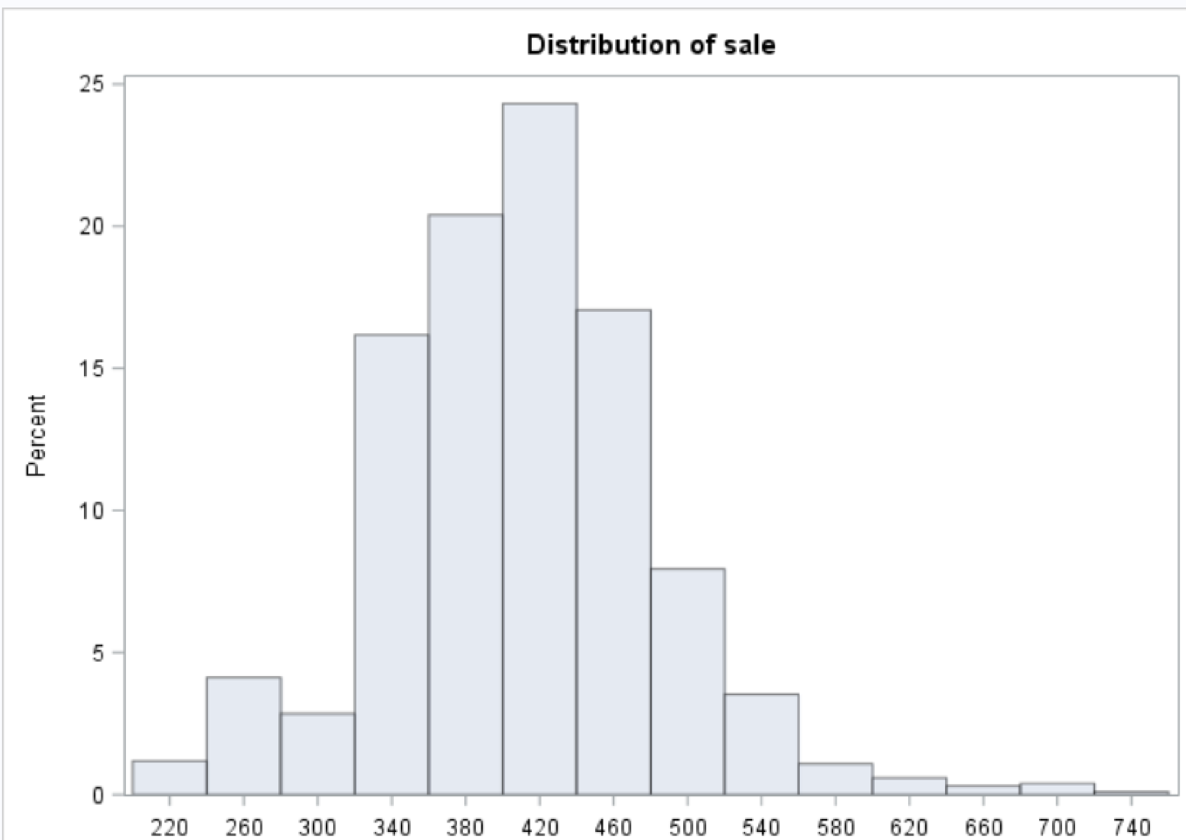
3 To the **Analysis variables** role, assign the **sale** column.

4 On the **Options** tab, expand the **Plots** section and select the **Histogram** check box.

5 To run the task, click .

Here is a subset of the results:

Analysis Variable : sale Unit Sale				
Mean	Std Dev	Minimum	Maximum	N
408.5558824	73.0840041	203.0000000	747.0000000	1020



Assigning Data to Roles

To run the Summary Statistics task, you must select an input data source and assign a column to the **Analysis variables** role.

Role	Description
Roles	

Role	Description
Analysis variables	specifies the numeric variables for which you want statistics. You must assign at least one variable to this role.
Classification variables	specifies the character or discrete numeric variables that 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.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.
Frequency count	lists 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.
Weight variable	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.

Setting Options

Option Name	Description
Statistics	
Basic Statistics	
Mean	is the arithmetic average, calculated by adding the values of an analysis variable and dividing this sum by the number of nonmissing observations.

Option Name	Description
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.
Median	is the middle 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.
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. **Note:** This option is available only if **Degrees of freedom** is selected in the **Divisor for standard deviation and variance** drop-down list.
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.
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. **Note:** You cannot compute the sum of the weights unless you assign a variable to the **Weight variable** role.

Option Name	Description
Confidence limits for the mean	is the two-sided confidence limits for the mean. A two-sided $100(1-\alpha)\%$ confidence interval for the mean has the following upper and lower limits: $\bar{x} \pm t_{\left(1-\frac{\alpha}{2};n-1\right)} \frac{s}{\sqrt{n}}$, where *s* is $\sqrt{\frac{1}{n-1}\Sigma\left(x_i-\bar{x}\right)^2}$ and $t_{\left(1-\frac{\alpha}{2};n-1\right)}$ is the $1-\frac{\alpha}{2}$ of the Student's *t* statistics with $n-1$ degrees of freedom.
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.
Skewness	is skewness, which measures the tendency of the deviations to be larger in one direction than in the other.
Kurtosis	is the kurtosis, which measures the heaviness of tails.
Percentiles	
1st, 5th, 10th, Lower quartile, Median, Upper quartile, 90th, 95th, 99th, Interquartile range	choose the percentiles and quantiles to compute.
Quantile method	specifies the method that is used to compute the quantiles, median, and percentiles. **Order statistics** reads all of the data into memory and sorts it by the unique values. **Piecewise-parabolic algorithm** approximates the quantile and is a less memory-intensive method. **Note:** If you assigned a variable to the **Weight variable** role, only the **Order statistics** method is available.
Plots	

Option Name	Description
Histogram	creates a graph that is used to determine the distribution of the data. If you add a normal density curve, the task uses the sample mean and sample standard deviation for μ and σ. If you add a kernel density curve, the task uses the AMISE method to compute the kernel density estimates. To include the statistics in the graph, select the **Add inset statistics** check box.
Comparative box plot	creates a graph 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. **Note:** The **Comparative box plot** option is available only when no column is assigned to the **Classification variable** role. You can choose to add the overall inset statistics to the graph or only the inset statistics for each group.
Histogram and box plot	displays the histogram and box plots together in a single panel, sharing common X axes. You can choose to add the overall inset statistics to the graph. **Note:** The **Histogram and box plot** option is available only when no column is assigned to the **Classification variable** role.
Details	

Option Name	Description
Divisor for standard deviation and variance	specifies the divisor to use in the calculation of the variance and standard deviation. Here are the valid options: **Degrees of freedom** $n - 1$ By default, the divisor for the variance is the degrees of freedom. **Number of observations** *n* **Sum of weights minus one** $\left(\Sigma_i w_i\right) - 1$ **Sum of weights** $\Sigma_i w_i$ **Note:** The **Sum of weights minus one** and the **Sum of weights** options are available only if you assigned a variable to the **Weight variable** role.

Setting the Output Options

You can specify whether to save the statistics in an output data set.

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Distribution Analysis

About the Distribution Analysis Task

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: You must have SAS/STAT licensed and installed to use this task.

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.

To create this example:

1 In the **Tasks** section, expand the **Statistics** folder, and then double-click **Distribution Analysis**. The user interface for the Distribution Analysis task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 To the **Analysis variables** role, assign the **sale** variable.

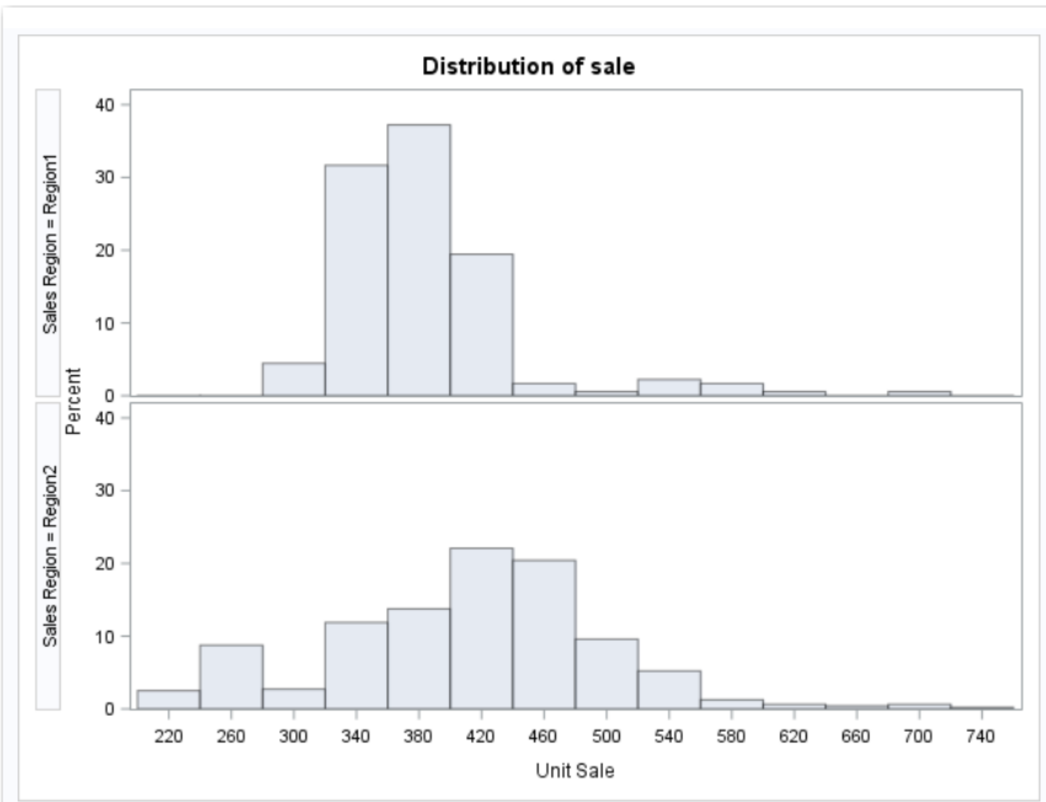
4 On the **Options** tab, set these options:

   a In the **Exploring Data** group, assign the **regionName** variable to the **Classification variables** role.

   b In the **Checking for Normality** group, select the **Histogram and goodness-of-fit tests** and **Normal quantile-quantile plot** options.

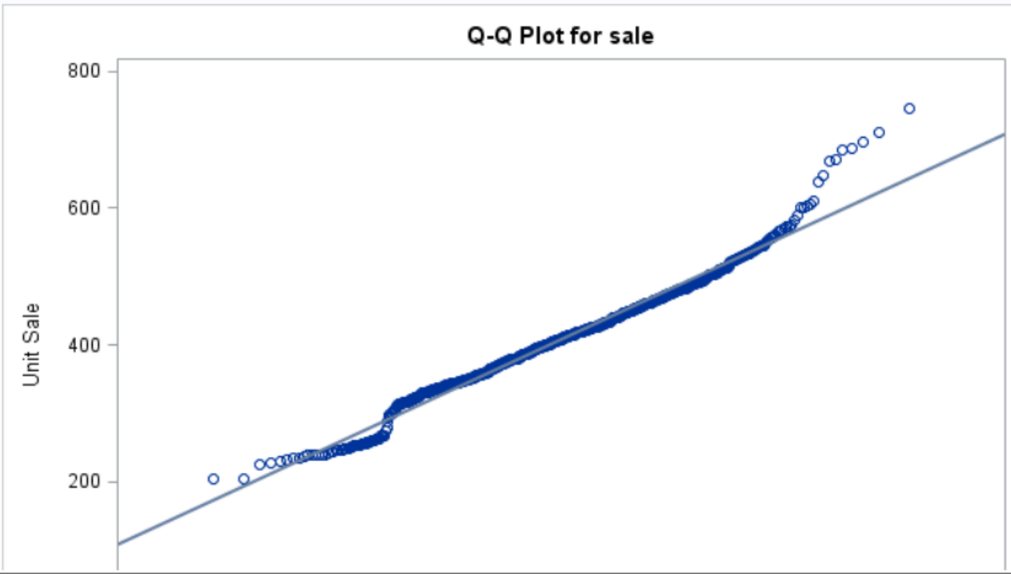
5 To run the task, click .

Here is a subset of the results:



Fitted Normal Distribution for sale (Unit Sale)

Goodness-of-Fit Tests for Normal Distribution				
Test	**Statistic**		**p Value**	
Kolmogorov-Smirnov	D	0.04121623	Pr > D	<0.010
Cramer-von Mises	W-Sq	0.44027199	Pr > W-Sq	<0.005
Anderson-Darling	A-Sq	3.46017068	Pr > A-Sq	<0.005



Assigning Data to Roles

To run the Distribution Analysis task, you must select an input data set. To filter the input data source, click .

You must assign a column to the **Analysis variables** role and select a plot or test on the **Options** tab.

Role	Description
Roles	
Analysis variables	specifies the analysis variables and their order in the results.
Additional Roles	

Role	Description
Frequency count	lists 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.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Exploring Data	
By default, the task creates a histogram of the data. In the **Classification 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. You can also specify whether to superimpose a kernel density estimate and the normal density curve on the histogram. Finally, you can specify whether to include an inset box of selected statistics in the graph.	
Checking for Normality **Note:** If you select any of these options, you can also specify whether to include these inset statistics: number of observations, goodness-of-fit test, mean, median, standard deviation, variance, skewness, and kurtosis.	
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.

Option Name	Description
Normal probability plot	creates a probability plot, which 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. You can also specify whether to include an inset box of selected statistics in the graph.
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.
Fitting Distributions **Note:** If you select a plot option for any of these distributions, you can also specify whether to include these inset statistics: number of observations, mean, median, standard deviation, and variance.	
Beta	
Histogram and goodness-of-fit tests	fits beta distribution with threshold parameter θ, scale parameter σ, and shape parameters α and β.
Probability plot	specifies a beta probability plot for shape parameters α and β.
Quantile-quantile plot	specifies a beta Q-Q plot for shape parameters α and β.
Exponential	
Histogram and goodness-of-fit tests	fits exponential distribution with threshold parameter θ and scale parameter σ.
Probability plot	specifies an exponential probability plot.
Quantile-quantile plot	specifies an exponential Q-Q plot.

Option Name	Description
Gamma	
Histogram and goodness-of-fit tests	fits gamma distribution with threshold parameter θ, scale parameter σ, and shape parameter α.
Probability plot	specifies a gamma probability plot for shape parameter α.
Quantile-quantile plot	specifies a gamma Q-Q plot for shape parameter α.
Lognormal	
Histogram and goodness-of-fit tests	fits lognormal distribution with threshold parameter θ, scale parameter ζ, and shape parameter σ.
Probability plot	specifies a lognormal probability plot for shape parameter σ.
Quantile-quantile plot	specifies a lognormal Q-Q plot for shape parameter σ.
Weibull	
Histogram and goodness-of-fit tests	fits Weibull distribution with threshold parameter θ, scale parameter ζ, and shape parameter c.
Probability plot	specifies a two-parameter Weibull probability plot.
Quantile-quantile plot	specifies a two-parameter Weibull Q-Q plot.

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One-Way Frequencies

About the One-Way Frequencies Task

The One-Way Frequencies task generates frequency tables from your data. You can also use this task to perform binomial and chi-square tests.

You might want to use this task 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 task can be used to evaluate the agreement of the diagnoses.

Note: You must license and install SAS/STAT to use this task.

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 **Tasks** section, expand the **Statistics** folder, and then double-click **One-Way Frequencies**. The user interface for the One-Way Frequencies task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set

that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
Roles	
Analysis variables	**sale**
Additional Roles	
Group analysis by	**regionName**

4 To run the task, click .

Here is a subset of the results:

Sales Region=Region1

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
342	1	0.56	35	19.44
343	1	0.56	36	20.00

Assigning Data to Roles

To run the One-Way Frequencies task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Analysis variables** role.

Role	Description
Roles	
Analysis variables	specifies the variables to be analyzed. For each variable that you assign to this role, the task creates a one-way frequency table. You must assign at least one variable to this role.
Additional Roles	
Frequency count	lists 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.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Plots	
By default, plots are included in the results. Select the **Show frequencies table** check box to create the frequency and cumulative frequency plots. Select the **Asymptotic test** check box for the chi-square goodness-of-fit to create the deviation plot. To suppress the plots from the results, select the **Suppress plots** check box.	
Frequencies and Percentages	
Frequencies table	specifies whether to create the frequencies table.
Include percentages	creates a table that contains the frequencies and percentages of total frequencies for each value of the analysis variable.

Option Name	Description
Include cumulative frequencies and percentages	creates a table that contains the frequencies and cumulative frequencies for each value of the analysis variable.
Row value order	specifies the order of the data in the results. You can choose from these options: ■ **Unformatted value**—orders values in ascending order by their unformatted values. This is the default. ■ **Descending frequency**—orders values by descending frequency count. ■ **Formatted value**—orders values in ascending order by their formatted values. ■ **Order of appearance in data set**—orders values according to their order in the input data set.
Statistics	
Binomial Proportion	
Specify whether to perform an asymptotic test. For binomial proportions, specify a null hypothesis proportion and a confidence level.	
Chi-square goodness-of-fit	
Specify whether to perform an asymptotic test. 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 be insufficient.	
Exact Computations Methods **Note:** This section appears if you select the **Exact test** check box for the binomial proportion or chi-square goodness-of-fit statistics.	
Limit computation time	specifies the time limit (in seconds) for the computation of each *p*-value for each crosstabulation table. The default is 300 seconds (or 5 minutes).
Missing Values	
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.

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Correlation Analysis

About the Correlation Analysis Task

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 task provides graphs and statistics for investigating associations among variables.

Note: You must license and install SAS/STAT to use this task.

Example: Correlations in the Sashelp.Cars Data Set

To create this example:

1 In the **Tasks** section, expand the **Statistics** folder, and then double-click **Correlation Analysis**. The user interface for the Correlation Analysis task opens.

2 On the **Data** tab, select the **SASHELP.CARS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column
Analysis variables	**EngineSize** **Horsepower**
Correlate with	**Cylinders** **MPG_Highway**

4 To run the task, click .

Here are the results:

2 With Variables:	Cylinders MPG_Highway
2 Variables:	EngineSize Horsepower

Pearson Correlation Coefficients Number of Observations		
	EngineSize	**Horsepower**
Cylinders	0.90800 426	0.81034 426
MPG_Highway MPG (Highway)	-0.71730 428	-0.64720 428

Assigning Data to Roles

To run the Correlation Analysis task, you must select an input data set. To filter the input data source, click .

You must also assign at least two columns to the **Analysis variables** role, or you must assign at least one column to the **Analysis variables** role and one column to the **Correlate with** role.

Roles	Description
Roles	
Analysis variables	lists the variables for which to compute correlation coefficients.
Correlate with	lists the variables with which the correlations of the analysis variables are to be computed.
Partial variables	removes the correlation of these variables from the analysis and correlates with variables before calculating the correlation.

Roles	Description
Additional Roles	
Frequency count	lists 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.
Weight	lists the weights to use in the calculation of Pearson weighted product-moment correlation.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Methods	
Missing values	specifies how to treat observations with missing values. If you select the **Use nonmissing values for all selected variables** option, all observations with missing values are excluded from the analysis. If you select the **Use nonmissing values for pairs of variables** option, the correlation statistics are computed using the nonmissing pairs of variables.
Statistics	

Option Name	Description
By default, the results contain a table with the correlations and *p*-values. You can also include these statistics: **Correlations** Selecting this option 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. **Covariances** Selecting this option 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 task computes a partial covariance matrix. **Sum of squares and cross-products** Selecting this option displays a table of the sums of squares and cross products in the results. The Pearson correlations are also included in the results. If you assign a column to the **Partial variables** role, the unpartial sums of squares and cross-products matrix is displayed. **Corrected sum of squares and cross-products** Selecting this option 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 task computes both an unpartial and a partial corrected sum of squares and cross-products matrix. **Descriptive statistics** Selecting this option includes the simple descriptive statistics for each variable. Even if you do not select this option and you choose to create an output data set, the data set contains the descriptive statistics for the variables.	
Fisher's z transformation 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. You can choose from these types of confidence limits: ■ **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: $\rho \le \rho_0$. ■ **Upper confidence limit** requests an upper confidence limit for the test of the one-sided null hypothesis, H_0: $\rho \ge \rho_0$. By default, the level of the confidence limits for the correlation is 95%.	
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.

Option Name	Description
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.
Plots	
You can include either of these plots in your results: ▪ a scatter plot matrix for variables. You can also choose to include a histogram of the analysis variables in the symmetric matrix plot. ▪ 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.	

Setting the Output Options

You can specify whether to create an output data set that contains the Pearson correlation statistics. This data set also includes means, standard deviations, and the number of observations.

You can also choose to include these statistics in the output data set:

- **Correlations** – By default, the output data set contains the correlation coefficients with the corresponding _TYPE_ variable value of ‘CORR’.
- **Covariances** – When you select this option, the output data set 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 data set 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 data set contains a partial corrected sum of squares and cross-products matrix.

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Table Analysis

About the Table Analysis Task

The Table Analysis task provides one-way to n-way frequency and contingency (crosstabulation) tables. This task also generates statistics about the association between rows and columns.

Note: You must license and install SAS/STAT to use this task.

Example: Distribution of Type by DriveTrain

To create this example:

1. In the **Tasks** section, expand the **Statistics** folder, and then double-click **Table Analysis**. The user interface for the Table Analysis task opens.

2. On the **Data** tab, select the **SASHELP.CARS** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. Assign columns to these roles:

Role	Column
Row variables	**Type**

Role	Column
Column variables	DriveTrain

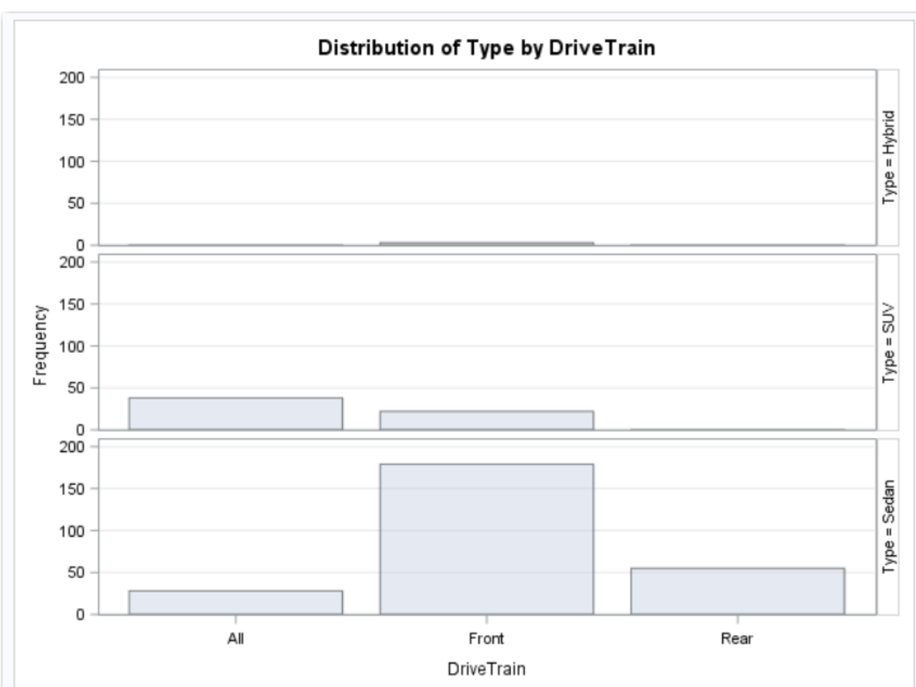
4 To run the task, click .

Here is a subset of the results:

Frequency

Table of Type by DriveTrain

	DriveTrain			
Type	All	Front	Rear	Total
Hybrid	0	3	0	3
SUV	38	22	0	60
Sedan	28	179	55	262
Sports	5	8	36	49
Truck	12	0	12	24
Wagon	9	14	7	30
Total	92	226	110	428



Assigning Data to Roles

To run the Table Analysis task, you must select an input data source. To filter the input data source, click .

You must assign at least one column to the **Row variables** or **Column variables** roles.

Roles	Description
Roles	
Row variables	specifies the row for one-way table analysis. If multiple variables are assigned to this role, the task performs multiple one-way table analyses.
Column variables	creates the columns for one-way table analysis. If only column variables are assigned, the task performs multiple one-way table analyses.
Strata variables	creates the separate tables for n-way frequency and crosstabulation tables. **Note:** You must assign columns to both the **Row variables** or **Column variables** roles to use a strata variable.
Additional Roles	
Frequency count	lists 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.

Setting Options

Option Name	Description
Plots	

Option Name	Description
By default, plots are included in the results. To suppress these plots, select the **Suppress plots** check box.	
Frequency Table	
Frequencies	
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.
Percentages	
Cell	display of overall percentages in crosstabulation tables.
Row	display of row percentages in crosstabulation table cells.
Column	display of column percentages in crosstabulation table cells.
Cumulative	
Column percentages	displays the cumulative column percentage in each cell.
Frequencies and percentages	displays the cumulative frequencies and percentages in one-way frequency tables.
Cell contributions to the chi-square statistics	displays each table cell's contribution to the Pearson chi-square statistic in the crosstabulation table.
Statistics	
Chi-square statistics	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.

Option Name	Description
Measures of association	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).
Cochran-Mantel-Haenszel statistics	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.
Measures of agreement (for square tables)	computes tests and measures of classification agreement for square tables. 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.
Odds ratio and relative risk (for 2x2 tables)	requests relative risk measures and their asymptotic Walk confidence limits for 2x2 tables.
Binomial proportions and risk differences (for 2x2 tables)	requests risks (binomial proportions) and risk differences for 2x2 tables.
Exact Test	
Fisher’s exact test	requests Fisher’s exact test for tables that are larger than 2x2.
Details	

Option Name	Description
Missing value treatment	specifies 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** treats the missing values as valid for all variables.

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t Tests

About the t Tests Task

Using the t Tests task, you can perform a one-sample test, a paired test, or a two-sample test.

For more information, see these topics:

- “One-Sample t Test” on page 176
- “Paired Test” on page 180
- “Two-Sample t Test” on page 184

Note: You must license and install SAS/STAT to use this task.

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 $t = \frac{\bar{x} - m}{\frac{s}{\sqrt{n}}}$ where $\bar{x}$ 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 task. From the **t test** drop-down list, select **One-sample test**.

Example: One-Sample t Test for Horsepower

To create this example:

1 In the **Tasks** section, expand the **Statistics** folder, and then double-click **t Tests**. The user interface for the t Tests task opens.

2 On the **Data** tab, select the **SASHELP.CARS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 From the **t test** drop-down list, select **One-sample test**.

4 To the **Analysis variable** role, assign the **Horsepower** column.

5 On the **Options** tab, enter `300` in the **Alternative hypothesis** field.

6 To run the task, click .

Here is a subset of the results:

Variable: Horsepower

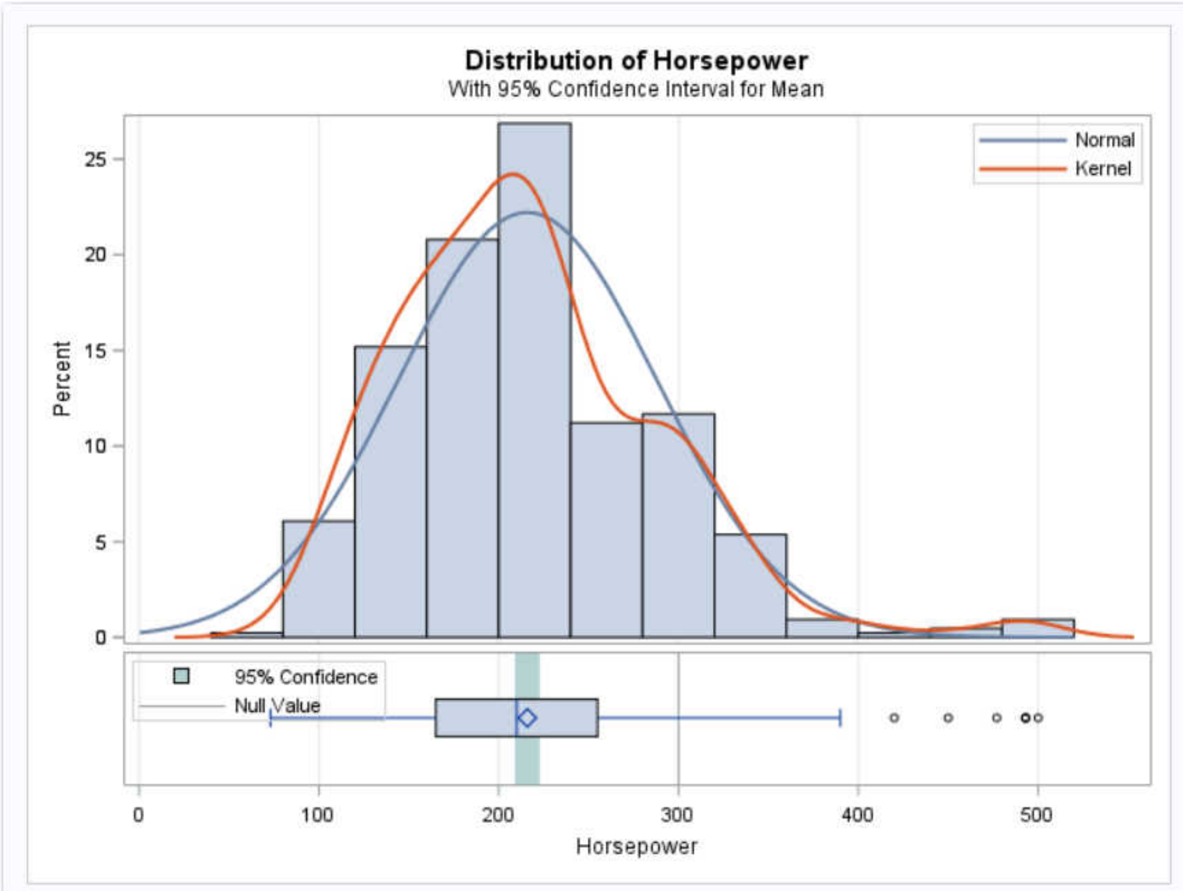
Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	W	0.949922	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.090516	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.589806	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	3.685805	Pr > A-Sq	<0.0050

Variable: Horsepower

N	Mean	Std Dev	Std Err	Minimum	Maximum
428	215.9	71.8360	3.4723	73.0000	500.0

Mean	95% CL Mean		Std Dev	95% CL Std Dev	
215.9	209.1	222.7	71.8360	67.3244	77.0007

DF	t Value	Pr > |t|
427	-24.22	<.0001



Assigning Data to Roles

To run a one-sample *t* test, you must select an input data source. To filter the input data source, click .

Next, select **One-sample test** from the **t test** drop-down list. Assign a numeric column to the **Analysis variable** role.

Setting Options

Option Name	Description
Tests	

Option Name	Description
Tails	specifies 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 test** 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.
Alternative hypothesis	specifies the value of the null hypothesis. By default, the null hypothesis has a value of 0.
Normality Assumption	
Tests for normality	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.
Nonparametric Tests **Note:** This option is available only for a two-tailed test.	
Sign test and Wilcoxon signed rank test	generates the results from these tests: ■ The sign test statistic is $M = \left(n^{+} - n^{-}\right)/2$, where 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 $S = \sum_{i:\left\|x_i - \mu_0\right\| > 0} r_i^{+} - \frac{n_t\left(n_t + 1\right)}{4}$, where 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.

Option Name	Description
Plots	
Histogram and box plot	creates a histogram and box plot together in a single panel, sharing common X axes.
Normality plot	creates a normal quantile-quantile (Q-Q) plot.
Confidence interval plot	creates a plot of the confidence interval for the means.

Paired Test

About the Paired t Test

A paired *t* test 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 $t = \frac{\bar{d} - m}{\frac{s_d}{\sqrt{n}}}$, where $\bar{d}$ 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 task. 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.

To create this example:

1 In the **Tasks** section, expand the **Statistics** folder, and then double-click **t Tests**. The user interface for the t Tests task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 From the **t test** drop-down list, select **Paired test**.

4 Assign columns to these roles:

Role	Column Name
Group 1 variable	**price**
Group 2 variable	**cost**

5 On the **Options** tab, enter `30` in the **Alternative hypothesis** field.

6 To run the task, click .

Here is a subset of the results:

Variable: _Difference_ (Difference: price - cost)

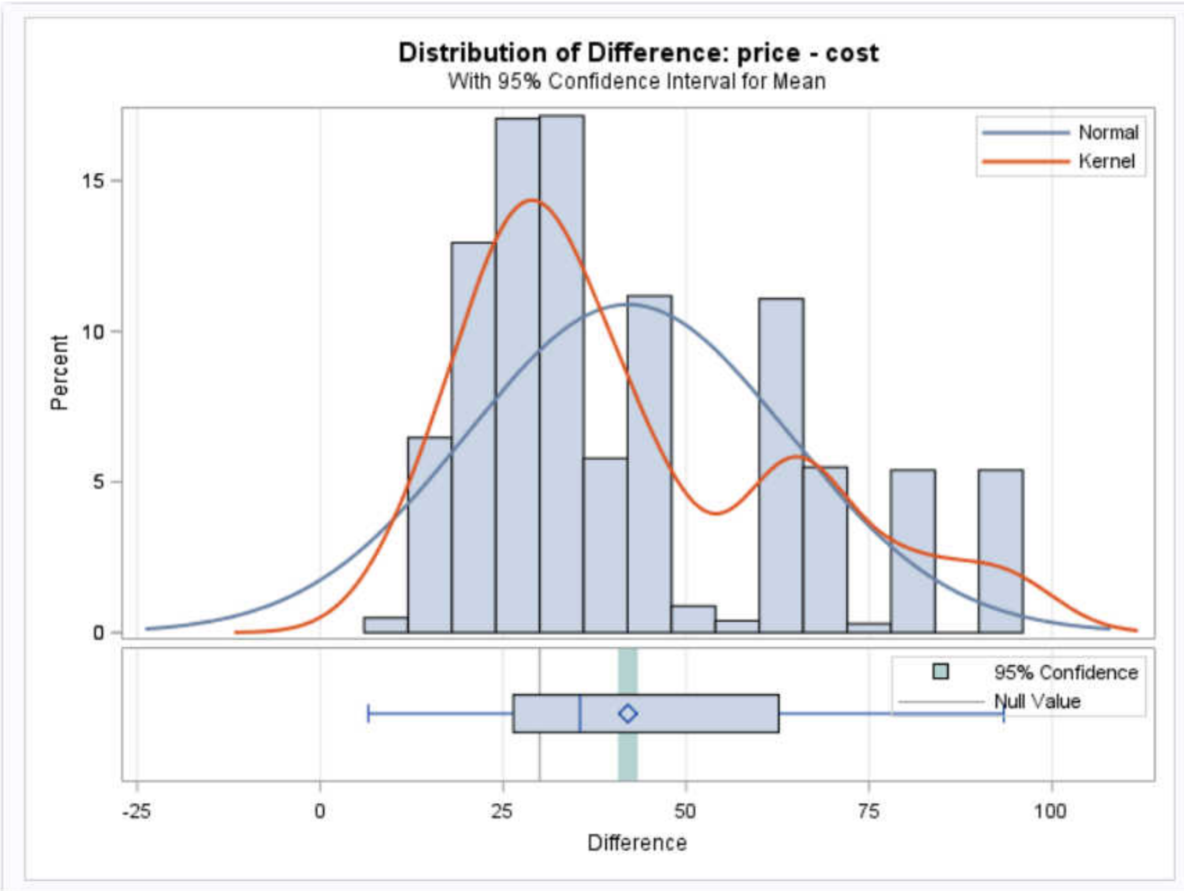
Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	W	0.896986	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.1888	Pr > D	<0.0100
Cramer-von Mises	W-Sq	7.159388	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	39.28743	Pr > A-Sq	<0.0050

Difference: price - cost

N	Mean	Std Dev	Std Err	Minimum	Maximum
1020	42.0448	21.9813	0.6883	6.5700	93.4000

Mean	95% CL Mean		Std Dev	95% CL Std Dev	
42.0448	40.6942	43.3954	21.9813	21.0671	22.9791

DF	t Value	Pr > |t|
1019	17.50	<.0001



Assigning Data to Roles

To run a paired *t* test, you must select an input data source. To filter the input data source, click .

Next, select **Paired test** from the **t test** drop-down list. Assign a numeric column to the **Group 1 variable** and **Group 2 variable** roles.

Setting Options

Option Name	Description
Tests	

Option Name	Description
Tails	specifies 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 test** 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. The upper one-sided confidence intervals range 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. The lower one-sided confidence intervals range between minus infinity and the upper confidence limit.
Alternative hypothesis	specifies the value of the null hypothesis.
Normality Assumption	
Tests for normality	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.
Nonparametric Tests **Note:** This option is available only for a two-tailed test.	
Sign test and Wilcoxon signed rank test	generates the results from these tests: ■ The sign test statistic is $M = \left(n^{+} - n^{-}\right)/2$, where 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 $S = \sum_{i:\left\|x_i - \mu_0\right\| > 0} r_i^{+} - \frac{n_t\left(n_t + 1\right)}{4}$, where 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.

Option Name	Description
Plots	
Histogram and box plot	creates a histogram and box plot together in a single panel, sharing common X axes.
Normality plot	creates a normal quantile-quantile (Q-Q) plot.
Agreement plot	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.
Response profile plot	creates 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.
Confidence interval plot	creates a plot of the confidence interval for the means.

Two-Sample t Test

About the Two-Sample t Test Task

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 $t = \frac{(\bar{x}_1 - \bar{x}_2) - m}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$. In this example, s^2 is the pooled variance

$s^2 = \frac{(n_1 - 1)s_1^2 + (n_1 - 1)s_2^2}{n_1 + n_2 - 2}$, 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 task. From the **t test** drop-down list, select **Two-sample test**.

Example: Two-Sample t Test

In this example, you want to analyze the height values for males and females in your class.

To create this example:

1. In the **Tasks** section, expand the **Statistics** folder, and then double-click **t Tests**. The user interface for the t Tests task opens.

2. On the **Data** tab, select the **SASHELP.CLASS** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. From the **t test** drop-down list, select **Two-sample test**.

4. Assign columns to these roles:

Role	Column Name
Analysis variable	**Height**
Groups variable	**Sex**

5. To run the task, click .

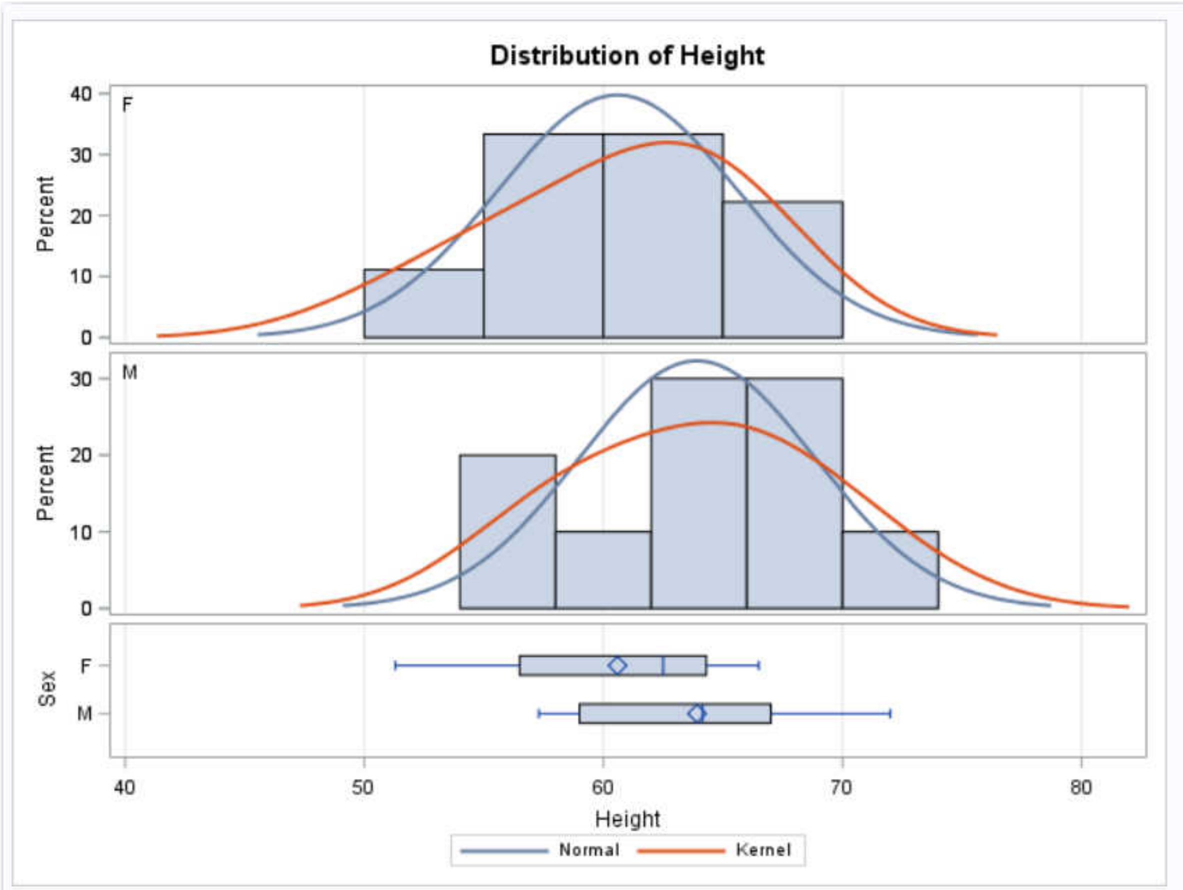
Here is a subset of the results:

Variable: Height
Sex = F

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.931231	Pr < W	0.4932
Kolmogorov-Smirnov	D	0.203889	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.049919	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.308707	Pr > A-Sq	>0.2500

Variable: Height
Sex = M

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.954758	Pr < W	0.7249
Kolmogorov-Smirnov	D	0.139972	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.025769	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.202753	Pr > A-Sq	>0.2500



Assigning Data to Roles

To run a two-sample *t* test, you must select an input data source. To filter the input data source, click .

Next, select **Two-sample test** from the **t test** drop-down list. Assign a column to the **Analysis variable** and **Groups variable** roles.

Setting Options

Option Name	Description
Tests	

Option Name	Description
Tails	specifies 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 test** 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.
Alternative hypothesis	specifies the value of the null hypothesis.
Cox and Cochran probability approximation for unequal variances	calculates the Cochran and Cox approximation. This approximation of the *p*-value of the t_u is the value of *p* such that $t_u = \frac{\left(\frac{s_1^2}{\sum_{i=1}^{n_1^*} f_{1i}w_{1i}}\right)t_1 + \left(\frac{s_2^2}{\sum_{i=1}^{n_2^*} f_{2i}w_{2i}}\right)t_2}{\left(\frac{s_1^2}{\sum_{i=1}^{n_1^*} f_{1i}w_{1i}}\right) + \left(\frac{s_2^2}{\sum_{i=1}^{n_2^*} f_{2i}w_{2i}}\right)}$. In this example, t_1 and t_2 are the critical values of the *t* distribution corresponding to a significance level of *p* and sample sizes n_1 and n_2, respectively. The degrees of freedom is undefined when $n_1 \neq n_2$. (Cochran and Cox 1950).
Normality Assumption	
Tests for normality	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.

Option Name	Description
Nonparametric Tests **Note:** This option is available only for a two-tailed test when the alternative hypothesis equals 0.	
Wilcoxon rank-sum test	generates an analysis of Wilcoxon scores. When there are two classification levels (samples), this option produces the Wilcoxon rank-sum test.
Plots	
Histogram and box plot	creates a histogram and box plot together in a single panel, sharing common X axes.
Normality plot	creates a normal quantile-quantile (Q-Q) plot.
Confidence interval plot	creates plots of the confidence interval for means. This plot is not created by default.
Wilcoxon box plot	creates a box plot of Wilcoxon scores. This plot is associated with the Wilcoxon analysis. This plot is not created by default. **Note:** This plot is available only for a two-tailed test when the alternative hypothesis equals 0.

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One-Way ANOVA

About the One-Way ANOVA Task

The one-way analysis of variance (ANOVA) task 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 task to do the following:

- 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.

Note: You must license and install SAS/STAT to use this task.

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 **Tasks** section, expand the **Statistics** folder, and then double-click **One-Way ANOVA**. The user interface for the One-Way ANOVA task opens.
2. On the **Data** tab, select the **SASHELP.CARS** data set.

TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
Dependent variable	**MPG_Highway**
Categorical variable	**Type**

4 To run the task, click .

Here is a subset of the results:

Class Level Information		
Class	Levels	Values
Type	6	Hybrid SUV Sedan Sports Truck Wagon

Number of Observations Read	428
Number of Observations Used	428

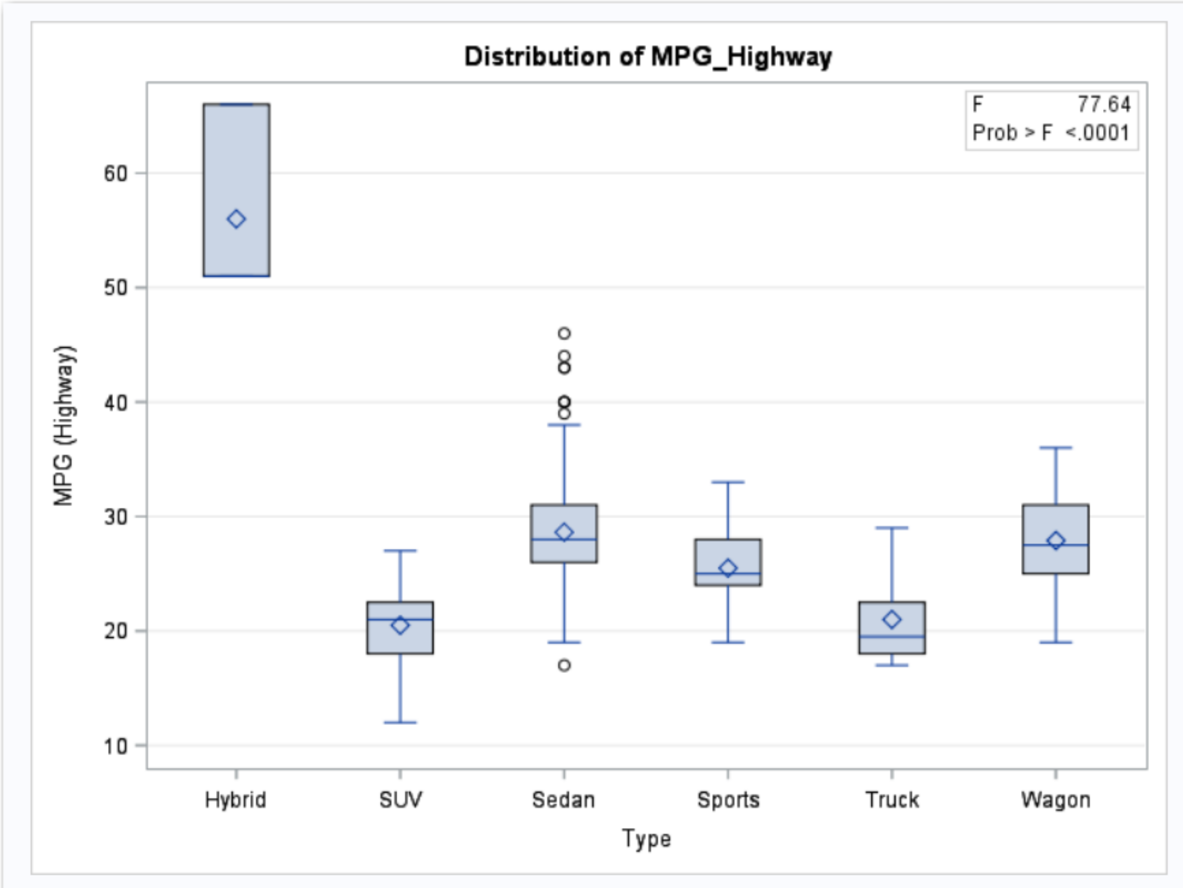
Dependent Variable: MPG_Highway MPG (Highway)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	6743.47900	1348.69580	77.64	<.0001
Error	422	7331.03268	17.37212		
Corrected Total	427	14074.51168			

R-Square	Coeff Var	Root MSE	MPG_Highway Mean
0.479127	15.52701	4.167987	26.84346

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Type	5	6743.478998	1348.695800	77.64	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Type	5	6743.478998	1348.695800	77.64	<.0001



Assigning Data to Roles

To run the One-Way ANOVA task, you must select an input data source. To filter the input data source, click .

You must assign columns to the **Dependent variable** and **Categorical variable** roles.

Role Name	Description
Dependent variable	specifies a continuous numeric column.
Categorical variable	specifies 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.

Setting Options

Option Name	Description
Homogeneity of Variance	
Test	specifies 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.
Test (continued)	**Brown & Forsythe** is a variation of Levene's test. Equal variances are determined by 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 test. This is the default. **O’Brien** specifies O’Brien’s test, which is a modification of Levene’s test that uses squared residuals.
Welch’s variance-weighted ANOVA	tests the group means by using a weighted variance. You can use this test if the assumption of equal variances is rejected.
Comparisons	

Option Name	Description
	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-Welsch 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. You can also specify the level of significance for the selected test.
Plots	
	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.

Setting the Output Options

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.

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Nonparametric One-Way ANOVA

About the Nonparametric One-Way ANOVA Task

The Nonparametric One-Way ANOVA task consists of nonparametric tests for location and scale differences across a one-way classification. The task also provides a standard analysis of variance on the raw data and statistics based on the empirical distribution function.

Note: You must license and install SAS/STAT to use this task.

Example: Wilcoxon Scores for MPG_Highway Classified by Origin

To create this example:

1. In the **Tasks** section, expand the **Statistics** folder, and then double-click **Nonparametric One-Way ANOVA**. The user interface for the Nonparametric One-Way ANOVA task opens.

2. On the **Data** tab, select the **SASHELP.CARS** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

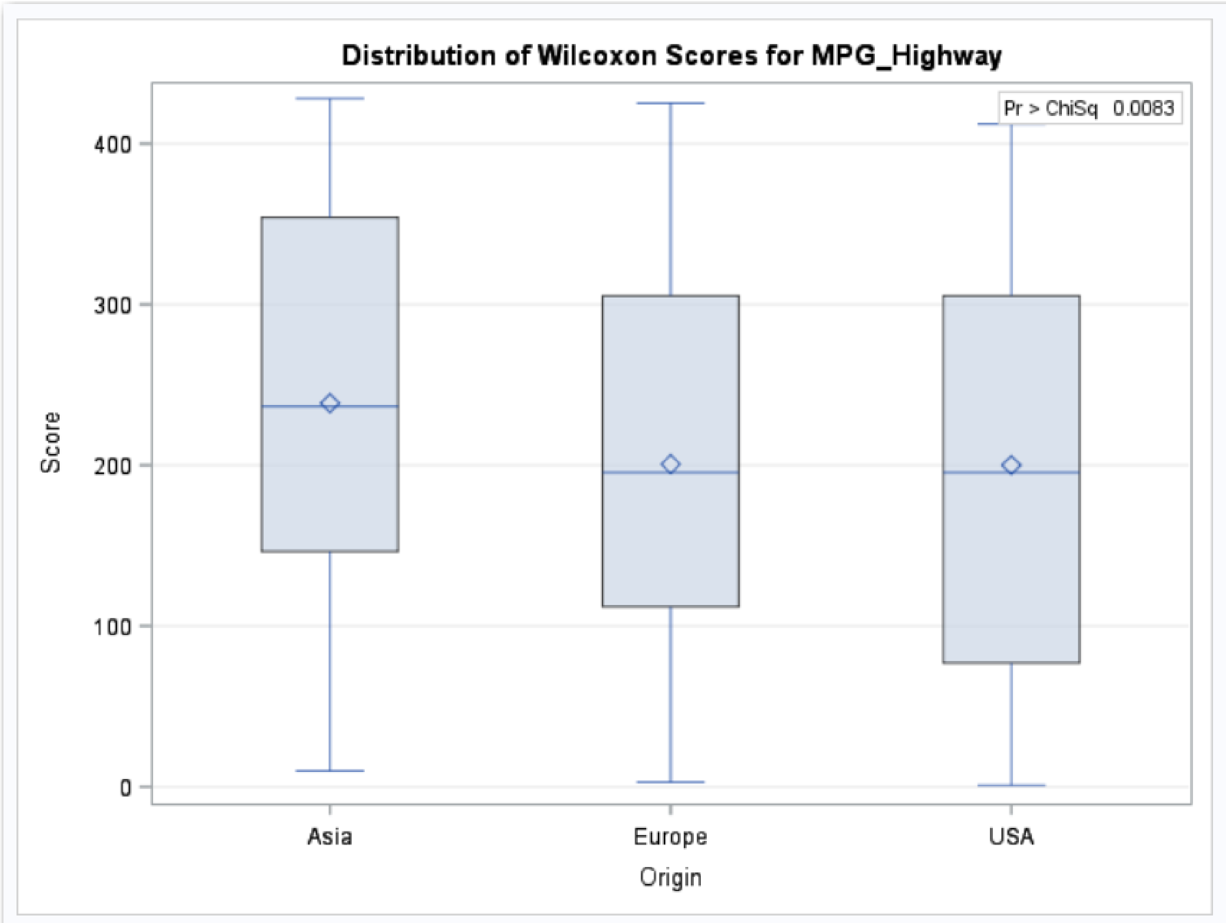
Role	Column Name
Dependent variable	**MPG_Highway**
Classification variable	**Origin**

4 To run the task, click .

Here are the results:

Wilcoxon Scores (Rank Sums) for Variable MPG_Highway Classified by Variable Origin					
Origin	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Asia	158	37704.0	33891.00	1231.66801	238.632911
Europe	123	24687.0	26383.50	1155.00991	200.707317
USA	147	29415.0	31531.50	1211.97891	200.102041
Average scores were used for ties.					

Kruskal-Wallis Test	
Chi-Square	9.5856
DF	2
Pr > Chi-Square	0.0083



Assigning Data to Roles

To run the Nonparametric One-Way ANOVA task, you must select an input data source. To filter the input data source, click .

You must assign columns to the **Dependent variable** and **Classification variable** roles.

Role Name	Description
Roles	
Dependent variable	specifies the column to use as the dependent variable.
Classification variable	defines the subgroups. Separate analyses are performed for each subgroup. You can specify whether to treat missing values as a valid level.
Additional Roles	

Role Name	Description
Frequency count	lists 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.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Plots	
By default, plots are included 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 Kolmogorov-Smirnov and Cramer-von Mises tests** option, you can create a plot of the empirical distribution test. You can specify whether to display the *p*-values in the plot. To suppress the plots from the results, select the **Suppress plots** check box.	
Tests	
Tests	specifies whether to calculate only the asymptotic tests or both the asymptotic tests and exact tests for the various analyses.
Location Differences	
Wilcoxon scores	ranks of the observations.
Median scores	equals 1 for observations greater than the median and 0 otherwise.

Option Name	Description
Van der Waerden scores	the quantiles of a standard normal distribution. These scores are also known as quantile normal scores.
Savage scores	the expected values of order statistics from the exponential distribution with 1 subtracted to center the scores around 0.
Scale Differences	
Ansari-Bradley scores	similar to the Siegel-Tukey scores, but assigns the same scores to corresponding extreme ranks.
Klotz scores	the squares of the Van der Waerden (or quantile normal) scores.
Mood scores	the square of the difference between each rank and the average rank.
Siegel-Tukey scores	scores are computed 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.
Location and Scale Differences	
Conover scores	based on the squared ranks of the absolution deviations from the sample means.
Additional Tests	
Empirical distribution function tests, including Kolmogorov-Smirnov and Cramer-von Mises tests	the empirical distribution function (EDF) statistics.
Pairwise multiple comparison analysis (asymptotic only)	computes the Dwass, Steel, Critchlow-Fligner (DSCF) multiple comparison analyses.
Details	
Continuity Correction	
Continuity correction for two sample Wilcoxon and Siegel-Tukey tests	uses a continuity correction for the asymptotic two-sample Wilcoxon and Siegel-Tukey tests by default. The task 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 task adds 0.5.

Option Name	Description
Exact Statistics Computation	
Use Monte Carlo estimation	requests 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.
Limit computation time	specifies the time limit for calculating each exact *p*-value. Calculating exact *p*-values can consume a large amount of time and memory.

Creating an Output Data Set

You can specify whether to save the statistics to an output data set.

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N-Way ANOVA

About the N-Way ANOVA Task

The N-Way ANOVA task tests and provides graphs for effects of one or more factors on the means of a single, continuous dependent variable.

Note: You must license and install SAS/STAT to use this task.

Example: Analyzing the Sashelp.RevHub2 Data Set

To create this example:

1. In the **Tasks** section, expand the **Statistics** folder, and then double-click **N-Way ANOVA**. The user interface for the N-Way ANOVA task opens.

2. On the **Data** tab, select the **SASHELP.REVHUB2** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set

that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign variables to these roles:

Role	Column Name
Dependent variable	**REVENUE**
Factors	**SOURCE** **TYPE**

4 On the **Model** tab, click . The Model Effects Builder opens.

5 In the **Variables** pane, select **SOURCE** and **TYPE**.

6 Click **Full Factorial**. Click **OK** to close the Model Effects Builder.

7 To run the task, click .

Here is a subset of the results:

Class Level Information		
Class	Levels	Values
SOURCE	4	Freight Other Passenger Service
TYPE	3	Direct Indirect Other

Number of Observations Read	72
Number of Observations Used	72

Dependent Variable: REVENUE REVENUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	9.7259489E13	8.8417717E12	30.35	<.0001
Error	60	1.7480696E13	291344930348		
Corrected Total	71	1.1474018E14			

R-Square	Coeff Var	Root MSE	REVENUE Mean
0.847650	81.22575	539763.8	664523.0

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SOURCE	3	3.2657409E13	1.0885803E13	37.36	<.0001
TYPE	2	3.1959368E13	1.5979684E13	54.85	<.0001
SOURCE*TYPE	6	3.2642711E13	5.4404519E12	18.67	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SOURCE	3	3.2657409E13	1.0885803E13	37.36	<.0001
TYPE	2	3.1959368E13	1.5979684E13	54.85	<.0001
SOURCE*TYPE	6	3.2642711E13	5.4404519E12	18.67	<.0001

Assigning Data to Roles

To run the N-Way ANOVA task, you must select an input data source. To filter the input data source, click .

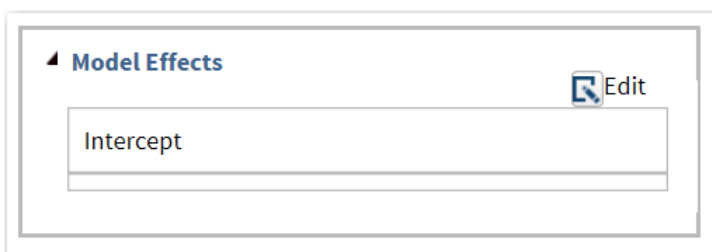
To run the N-Way ANOVA task, you must assign columns to the **Dependent variable** and **Factors** roles.

Role	Description
Dependent variable	specifies the dependent variable.
Factors	specifies the classification variables.

Building a Model

Requirements for Building a Model

By default, no effects are specified, which results in the task fitting an intercept-only model, so here is what you see on the **Models** tab.



To specify a model effect, you must assign at least one variable to the **Factors** role. On the **Models** tab, click **Edit** to open the model builder.

When you close the model builder any effects that you created appear on the **Models** tab.

Create a Main Effect

1. Select the variable name in the **Variables** box.
2. Click **Add** to add the variable to the list of model effects.

Create Crossed Effects (Interactions)

1. Select two or more variables in the **Variables** box. To select more than one variable, press Ctrl.
2. Click **Cross**.

Create a Nested Effect

Nested effects are specified by following a main effect or crossed effect with a classification variable or list of classification variables enclosed in parentheses. Here are examples of nested effects: B(A), C(B*A), D*E(C*B*A). In this example, B(A) is read "B within A."

1. Select the classification variable in the Model Effects Builder.
2. Click **Nest**. The Nested window appears.
3. Select the variable to use in the nested effect. Click **Outer** or **Nested within Outer** to specify how to create the nested effect.

   Note: The **Nested within Outer** button is available only when a classification variable is selected.
4. Select the effect that you want to nest.
5. Click **Add**.

Create a Full Factorial Model

1. Select two or more variables in the **Variables** box.
2. Click **Full Factorial**.

For example, if you select the Height, Weight, and Age variables and then click **Full Factorial**, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, Height*Weight, and Age*Height*Weight.

Create an N-Way Factorial

1. Select two or more variables in the **Variables** box.
2. Click **N-way Factorial** and specify the value of N.

For example, if you select the Height, Weight, and Age variables, click **N-way Factorial**, and then specify the value of N as 2, these model effects are created:

Age, Height, Weight, Age*Height, Age*Weight, and Height*Weight. If N is set to a value greater than the number of variables in the model, N is effectively set to the number of variables.

Setting Options

Option	Description
Statistics	
You can choose to display only the default statistics, the default statistics and additional statistics, or no statistics in the output. Here are the options for the additional statistics: ■ **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.	
Plots	
You can choose to display only the default plots, only selected plots, or no plots in your output. You can specify the maximum number of points to display in the plots. Here are some plots that you can include in your 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	

Setting the Output Options

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.

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Analysis of Covariance

About the Analysis of Covariance Task

The Analysis of Covariance task fits a linear model that combines the continuous and categorical predictors of a continuous dependent variable. This task also produces graphical output to interpret the results.

Note: You must license and install SAS/STAT to use this task.

Example: Analyzing the Sashelp.Class Data Set

To create this example:

1 In the **Tasks** section, expand the **Statistics** folder, and then double-click **Analysis of Covariance**. The user interface for the Analysis of Covariance task opens.

2 On the **Data** tab, select the **SASHELP.CLASS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign variables to these roles:

Role	Column Name
Dependent variable	**Height**
Categorical variable	**Sex**
Continuous covariate	**Weight**

4 To run the task, click .

Here is a subset of the results:

Class Level Information		
Class	Levels	Values
Sex	2	F M

Number of Observations Read	19
Number of Observations Used	19

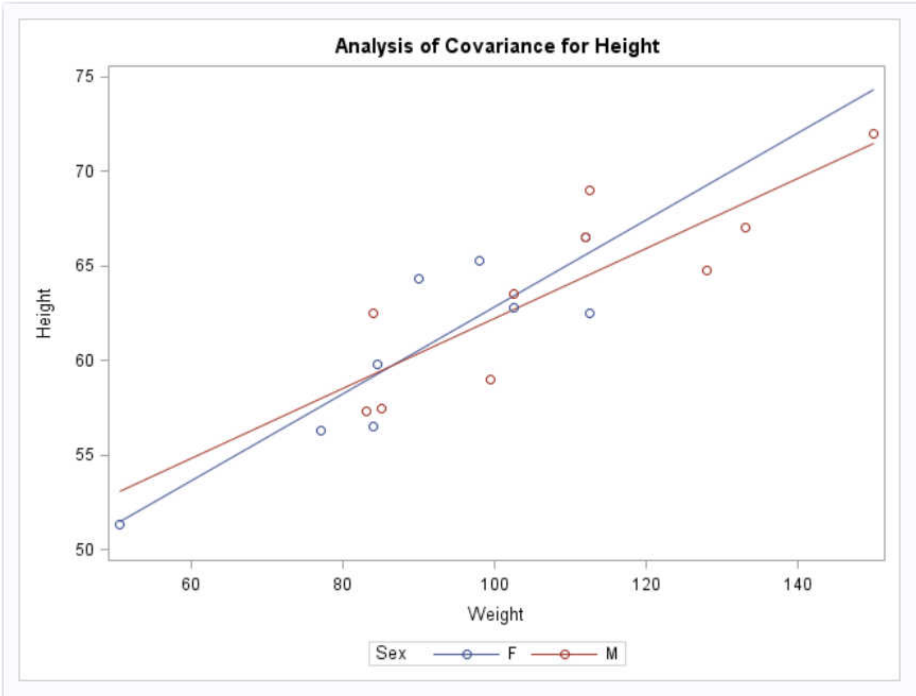
Dependent Variable: Height

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	369.1762676	123.0587559	17.75	<.0001
Error	15	103.9879429	6.9325295		
Corrected Total	18	473.1642105			

R-Square	Coeff Var	Root MSE	Height Mean
0.780229	4.223778	2.632970	62.33684

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Sex	1	52.2463216	52.2463216	7.54	0.0150
Weight	1	313.2623253	313.2623253	45.19	<.0001
Weight*Sex	1	3.6676206	3.6676206	0.53	0.4782

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	2.7552010	2.7552010	0.40	0.5379
Weight	1	313.2122368	313.2122368	45.18	<.0001
Weight*Sex	1	3.6676206	3.6676206	0.53	0.4782



Assigning Data to Roles

To run the Analysis of Covariance task, you must select an input data source. To filter the input data source, click .

You must assign columns to the **Dependent variable**, **Categorical variable**, and **Continuous covariate** roles.

Role	Description
Dependent variable	specifies a continuous numeric variable.
Categorical variable	specifies a character or numeric variable that specifies the levels of the groups.
Continuous covariate	specifies a continuous numeric variable that is related to the dependent variable. You can specify whether to center the covariate variable.

Setting Options

Option	Description
Model	
Intercepts	specifies whether to use the equal or unequal intercepts for each level of the categorical variable.
Slopes	specifies whether to use the equal or unequal slopes for each level of the categorical variable.
Show parameter estimates	produces a solution to the normal equations (parameter estimates). By default, the task 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.
Multiple Comparisons	
Perform multiple comparisons	performs the least squares means for the categorical variable.
Covariate value	specifies the value to use in multiple comparisons. The covariate value can be either the mean value or a specified value.
Method	requests 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 ■ Scheffe ■ Sidak ■ Tukey
Significance level	specifies the significance level for the comparisons. The default is 0.05.
Plots	
You can choose to display only the default plots in your output, select the plots to display in the output, or display no plots in the output. The list of available plots depends on the method that you selected for multiple comparisons.	

Setting the Output Options

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.

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Linear Regression

About the Linear Regression Task

The Linear regression task fits a linear model to predict a single continuous dependent variable from one or more continuous or categorical predictor variables. This task produces statistics and graphs for interpreting the results.

Note: You must license and install SAS/STAT to use this task.

Example: Predicting Weight Based on a Student's Height

In this example, you want to use regression analysis to find out how well you can predict a child's weight if you know the child's height.

To create this example:

1. In the **Tasks** section, expand the **Statistics** folder, and then double-click **Linear Regression**. The user interface for the Linear Regression task opens.
2. On the **Data** tab, select the **SASHELP.CLASS** data set.

TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

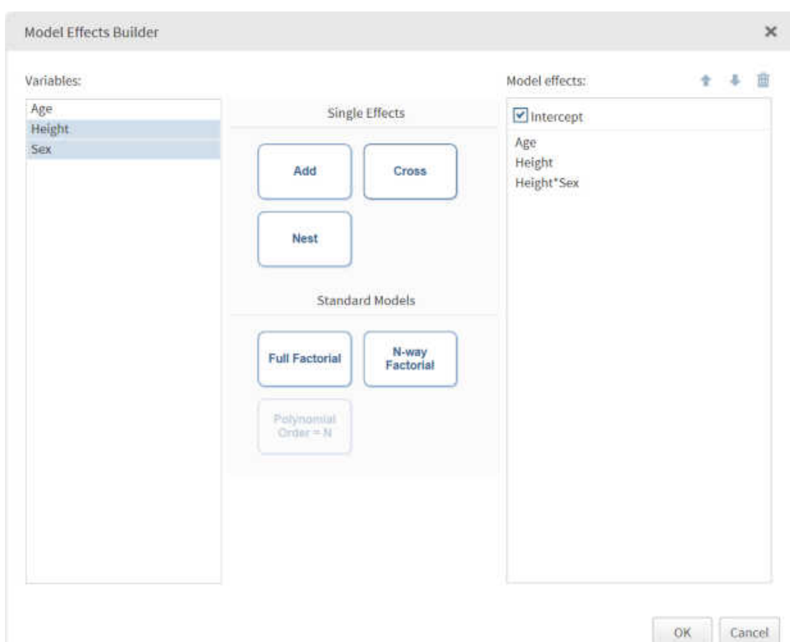
3 Assign columns to these roles:

Role	Column Name
Dependent variable	**Weight**
Classification variables	**Sex**
Continuous variables	**Age** **Height**

4 On the **Model** tab, click and create these models:

a Select the **Height** variable, and then press Ctrl and select the **Age** variable. Click **Add**.

b Select the **Height** variable, and then press Ctrl and select the **Sex** variable. Click **Cross**.



Click **OK**.

5 To run the task, click .

Here is a subset of the results:

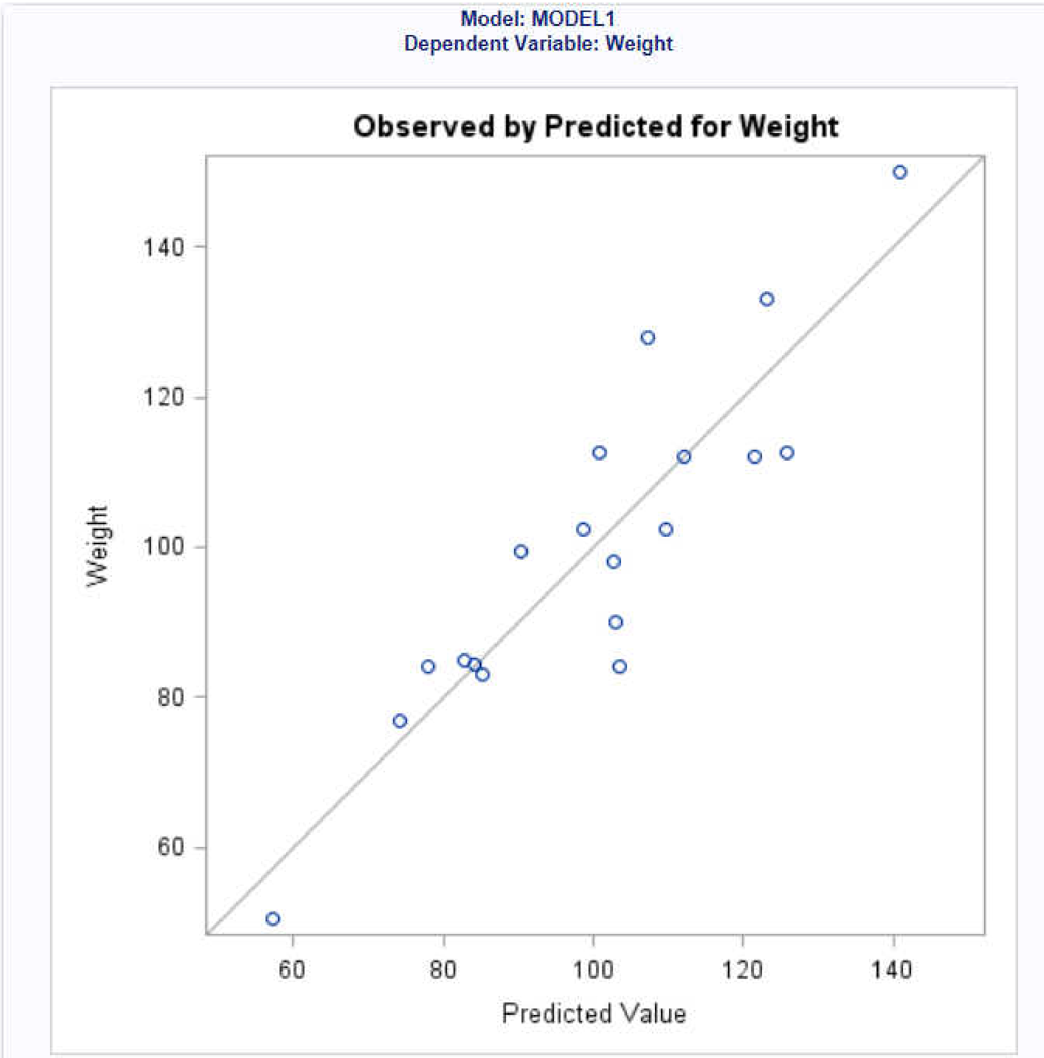
Data Set	SASHELP.CLASS
Dependent Variable	Weight
Selection Method	None

Number of Observations Read	19
Number of Observations Used	19

Class Level Information		
Class	Levels	Values
Sex	2	F M

Dimensions	
Number of Effects	4
Number of Parameters	5

Least Squares Summary				
Step	Effect Entered	Number Effects In	Number Parms In	SBC
0	Intercept	1	1	120.6906
1	Age	2	2	108.5093
2	Height	3	3	98.4141*
3	Height*Sex	4	4	98.6423
* Optimal Value of Criterion				



Assigning Data to Roles

To run the Linear Regression task, you must select an input data source. To filter the input data source, click .

You must also assign a column to the **Dependent variable** role and a column to the **Classification variables** role or the **Continuous variables** role.

Role	Description
Roles	
Dependent variable	specifies the numeric variable to use as the dependent variable for the regression analysis. You must assign a numeric variable to this role.

Role	Description
Classification variables	specifies categorical variables that enter the regression model through the design matrix coding.
Parameterization of Effects	
Coding	specifies 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.
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)	
Continuous variables	specifies the numeric covariates (regressors) for the regression model.
Additional Roles	
Frequency count	lists 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.
Weight	specifies the variable to use as a weight to perform a weighted analysis of the data.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Building a Model

Requirements for Building a Model

By default, no effects are specified, which results in the task fitting an intercept-only model. Here is what you see on the **Model** tab.

To specify a model effect, you must assign at least one variable to the **Classification variables** role or the **Continuous variables** role. On the **Model** tab, click to open the Model Effects Builder.

When you close the Model Effects Builder, any effects that you created appear on the **Model** tab.

Single Effects

Create a Main Effect

1. Select the variable name in the **Variables** box.
2. Click **Add** to add the variable to the list of model effects.

Create Crossed Effects (Interactions)

1. Select two or more variables in the **Variables** box. To select more than one variable, press Ctrl.
2. Click **Cross**.

Create a Polynomial Degree Effect

1 Select one or more continuous variables in the **Variables** box.

2 In the list of single effects, click **Polynomial Degree=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select Age, click **Polynomial Degree=N**, and specify 3 as the value of N, the Age*Age*Age effect is created.

Create a Nested Effect

Nested effects are specified by following a main effect or crossed effect with a classification variable or list of classification variables enclosed in parentheses. Here are examples of nested effects: B(A), C(B*A), D*E(C*B*A). In this example, B(A) is read "B within A."

1 Select the classification variable in the Model Effects Builder.

2 Click **Nest**. The Nested window appears.

3 Select the variable to use in the nested effect. Click **Outer** or **Nested within Outer** to specify how to create the nested effect.

   Note: The **Nested within Outer** button is available only when a classification variable is selected.

4 Select the effect that you want to nest.

5 Click **Add**.

Standard Models

Create a Two-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Two-Way Factorial**.

For example, if you select the Age and Height variables and then click **Two-Way Factorial**, the Age*Height effect is created.

Create a Full Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Full Factorial**.

For example, if you select the Height, Weight, and Age variables and then click **Full Factorial**, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, Height*Weight, and Age*Height*Weight.

Create an N-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **N-way Factorial** and specify the value of N.

For example, if you select the Height, Weight, and Age variables, click **N-way Factorial**, and then specify the value of N as 2, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, and Height*Weight. If N is set to a value greater than the number of variables in the model, N is effectively set to the number of variables.

Create Polynomial Effects of the Nth Order

1 Select one or more continuous variables in the **Variables** box.

2 In the list of standard models, click **Polynomial Order=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select the Age and Height variables, click **Polynomial Order=N**, and specify 3 as the value of N, these model effects are created: Age, Age*Age, Age*Age*Age, Height, Height*Height, and Height*Height*Height.

Setting the Model Options

Option Name	Description
Methods	
Confidence level	specifies the significance level to use for the construction of confidence intervals.
Statistics	
You can choose to include the default statistics in the results or choose to include additional statistics.	
Parameter Estimates	
Standardized regression coefficients	displays 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.
Confidence limits for estimates	displays the $100(1-\alpha)\%$ upper and lower confidence limits for the parameter estimates.
Sums of Squares	
Sequential sum of squares (Type I)	displays the sequential sums of squares (Type I SS) along with the parameter estimates for each term in the model.
Partial sum of squares (Type II)	displays the partial sums of squares (Type II SS) along with the parameter estimates for each term in the model.

Option Name	Description
Partial and Semipartial Correlations	
Squared partial correlations	displays the squared partial correlation coefficients computed by using Type I and Type II sums of squares.
Squared semipartial correlations	displays the squared semipartial correlation coefficients computed by using Type I and Type II sums of squares. This value is calculated as sum of squares divided by the corrected total sum of squares.
Diagnostics	
Analysis of influence	requests a detailed analysis of the influence of each observation on the estimates and the predicted values.
Analysis of residuals	requests an analysis of the residuals. The results include the predicted values from the input data and the estimated model, the standard errors of the mean predicted and residual values, the studentized residual, and Cook's *D* statistic to measure the influence of each observation on the parameter estimates.
Predicted values	calculates predicted values from the input data and the estimated model.
Multiple Comparisons	
Perform multiple comparisons	specifies whether to compute and compare the least squares means of fixed effects.
Select the effects to test	specifies the effects that you want to compare. You specified these effects on the **Model** tab.
Method	requests a multiple comparison adjustment for the *p*-values and confidence limits for the differences of the least squares means. Here are the valid methods: **Bonferroni**, **Nelson**, **Scheffé**, **Sidak**, and **Tukey**.
Significance level	requests that a *t* type confidence interval be constructed for each of the least squares means with a confidence level of 1 – number. The value of number must be between 0 and 1. The default value is 0.05.
Collinearity	

Option Name	Description
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.
Heteroscedasticity	
Heteroscedasticity analysis	performs a test to confirm that the first and second moments of the model are correctly specified.
Asymptotic covariance matrix	displays the estimated asymptotic covariance matrix of the estimates under the hypothesis of heteroscedasticity and heteroscedasticity-consistent standard errors of parameter estimates.
Plots	
Diagnostic and Residual Plots	
By default, several diagnostic plots are included in the results. You can also specify whether to include plots of the residuals for each explanatory variable.	
More 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 observations	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*.

Option Name	Description
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*.
Label extreme points	identifies the extreme values on each different type of plot.
Scatter Plots	
Fit plot for a single continuous variable	produces a scatter plot of the data overlaid with the regression line, confidence band, and prediction band for models with a single continuous variable. The intercept is excluded. When the number of points exceeds the value for the **Maximum number of plot points** option, a heat map is displayed instead of a scatter plot.
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.
Maximum number of plot points	specifies the maximum number of points to include in each plot.

Setting the Model Selection Options

Option	Description
Model Selection	

Option	Description
Selection method	specifies the model selection method for the model. The task 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 values of the specified criteria.
Add/remove effects with	specifies the criterion to use to add or remove effects from the model.
Stop adding/removing effects with	specifies the criterion to use to stop adding or removing effects from the model.
Select best model by	specifies the criterion to use to identify the best fitting model.
Selection Statistics	

Option	Description
Model fit statistics	specifies 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 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 ■ Bayesian information criterion ■ Mallows' C*p* ■ Press statistic, which specifies the predicted residual sum of squares statistic ■ R-square ■ Schwarz's Bayesian information criterion
Selection Plots	
Criteria plots	displays plots for these criteria: adjusted R-square, Akaike's information criterion, Akaike's information criterion corrected for small-sample bias, and the criterion used to select the best fitting model.
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 used to select the best fitting model
Details	
Selection process details	specifies 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.

Creating Output Data Sets

You can specify whether to create an observationwise statistics data set. This data set contains the sum of squares and cross-products.

You can also choose to include these statistics in the output data set:

- predicted values
- press statistic, which is the *i*th residual divided by $(1 - h)$, where *h* is the leverage, and where the model has been refit without the *i*th observation
- residual
- studentized residuals, which are the residuals divided by their standard errors
- studentized residual with current observation removed
- Cook's *D* influence
- the standard influence of observation on covariance of betas
- the standard influence of an observation on predicted value (called DFFITS)
- leverage

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Binary Logistic Regression

About the Binary Logistic Regression Task

The Binary Logistic Regression task is used to fit a logistic regression model to investigate the relationship between discrete responses with binary levels and a set of explanatory variables.

Note: You must license and install SAS/STAT to use this task.

Example: Classifying Email as Junk

To create this example:

1. In the **Tasks** section, expand the **Statistics** folder, and then double-click **Binary Logistic Regression**. The user interface for the Binary Logistic Regression task opens.
2. On the **Data** tab, select the **SASHELP.JUNKMAIL** data set.
3. Assign columns to these roles and specify these options:

Role	Column Name
Response	**Class**
Event of interest	**1**
Continuous variables	**Exclamation** **CapAvg**

4 On the **Model** tab, click . The Model Effects Builder opens.

5 In the **Variables** pane, select **Exclamation** and **CapAvg** .

6 Click **Add** to add these as main effects. Click **OK** to close the Model Effects Builder.

7 To run the task, click .

Model Information		
Data Set	SASHELP.JUNKMAIL	Classifying Email as Junk or Not
Response Variable	Class	0 - Not Junk, 1 - Junk
Number of Response Levels	2	
Model	binary logit	
Optimization Technique	Fisher's scoring	

Number of Observations Read	4601
Number of Observations Used	4601

Response Profile		
Ordered Value	Class	Total Frequency
1	0	2788
2	1	1813

Probability modeled is Class=1.

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	6172.153	5035.224
SC	6178.587	5054.526
-2 Log L	6170.153	5029.224

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	1140.9288	2	<.0001
Score	312.5004	2	<.0001
Wald	630.4776	2	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-1.8144	0.0652	773.5908	<.0001
Exclamation	1	1.8816	0.1165	261.0441	<.0001
CapAvg	1	0.3077	0.0189	264.8582	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Exclamation	6.564	5.224	8.247

Assigning Data to Roles

To run the Binary Logistic Regression task, you must select an input data source. To filter the input data source, click . You must also assign columns to the **Response variable** and a column to either the **Classification variables** role or the **Continuous variables** role.

Role	Description
Roles	

Role	Description
Response	
Response data consists of numbers of events and trials	specifies whether the response data consists of events and trials.
Number of events	specifies the variable that contains the number of events for each observation.
Number of trials	specifies the variable that contains the number of trials for each observation.
Response	specifies the variable that contains the response data. To perform a binary logistic regression, the response variable should have only two levels. Use the **Event of interest** drop-down list to select the event category for the binary response model.
Link function	specifies the link function that links the response probabilities to the linear predictors. Here are the valid values: ■ **Complementary log-log** is the complementary log-log function. ■ **Probit** is the inverse standard normal distribution function. ■ **Logit** is the log odds function.
Explanatory Variables	
Classification variables	specifies the classification variables to use in the analysis. A classification variable is a variable that enters the statistical analysis or model not through its values, but through its levels. The process of associating values of a variable with levels is termed levelization.
Parameterization of Effects	
Coding	specifies 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.

Role	Description
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)	
Continuous variables	specifies the continuous variables to use as the explanatory variables in the analysis.
Additional Roles	
Stratify by	specifies the variables that define the strata or matched sets to use in stratified logistic regression of binary response data.
Frequency count	specifies the variables that contain the frequency of occurrence for each observation. The task treats each observation as if it appears *n* times, where *n* is the value of the variable for that observation.
Weight variable	specifies the how much to weight each observation in the input data set.
Group analysis by	creates separate analyses based on the number of BY variables.

Building a Model

Create a Main Effect

1. Select the variable name in the **Variables** box.
2. Click **Add** to add the variable to the list of model effects.

Create Crossed Effects (Interactions)

1. Select two or more variables in the **Variables** box. To select more than one variable, press Ctrl.
2. Click **Cross**.

Create a Nested Effect

Nested effects are specified by following a main effect or crossed effect with a classification variable or list of classification variables enclosed in parentheses. Here are examples of nested effects: B(A), C(B*A), D*E(C*B*A). In this example, B(A) is read "B within A."

1. Select the classification variable in the Model Effects Builder.
2. Click **Nest**. The Nested window appears.
3. Select the variable to use in the nested effect. Click **Outer** or **Nested within Outer** to specify how to create the nested effect.

   Note: The **Nested within Outer** button is available only when a classification variable is selected.
4. Select the effect that you want to nest.
5. Click **Add**.

Create a Full Factorial Model

1. Select two or more variables in the **Variables** box.
2. Click **Full Factorial**.

For example, if you select the Height, Weight, and Age variables and then click **Full Factorial**, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, Height*Weight, and Age*Height*Weight.

Create an N-Way Factorial

1. Select two or more variables in the **Variables** box.
2. Click **N-way Factorial** and specify the value of N.

For example, if you select the Height, Weight, and Age variables, click **N-way Factorial**, and then specify the value of N as 2, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, and Height*Weight. If N is set to a value greater than the number of variables in the model, N is effectively set to the number of variables.

Create Polynomial Effects of the Nth Order

1. Select one or more continuous variables in the **Variables** box.
2. In the list of standard models, click **Polynomial Order=N**.
3. Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select the Age and Height variables, click **Polynomial Order=N**, and specify 3 as the value of N, these model effects are created: Age, Age*Age, Age*Age*Age, Height, Height*Height, and Height*Height*Height.

Setting the Model Options

Option	Description
Model	
Include an intercept in the model	specifies whether to include the intercept in the model.
Offset variable	specifies 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.

Specifying the Model Selection Options

Option	Description
Model Selection	
Selection method	specifies the model selection method for the model. The task 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.

Option	Description
Selection method (continued)	■ **Fast backward elimination** uses a computational algorithm of Lawless and Singhal (1978). This algorithm computes a first-order approximation to the remaining slope estimates for each subsequent elimination of a variable from the model. Variables are removed from the model based on these approximate estimates. This selection method is extremely efficient because the model is not refitted for every variable removed. ■ **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. ■ **Stepwise selection with fast backward elimination** uses a computational algorithm of Lawless and Singhal. This algorithm computes a first-order approximation to the remaining slope estimates for each subsequent elimination of a variable from the model. Variables are removed from the model based on these approximate estimates. This selection method is extremely efficient because the model is not refitted for every variable removed.
Details	
Display selection process details	specifies how much information about the selection process to include in the results. You can choose to display a summary, details for each step of the selection process, or all of the information about the selection process.

Option	Description
Maintain hierarchy of effects	specifies 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 first be removed. Model hierarchy refers to the requirement that, for any term to be in the model, all effects 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.

Setting Options

Option Name	Description
Statistics **Note:** In addition to the default statistics that are included in the results, you can select the additional statistics to include.	
Classification table	classifies the input binary response observations according to whether the predicted event probabilities are above or below the cut-point value *z* in the range. An observation is predicted as an event if the predicted event probability equals or exceeds *z*.
Partial correlation	computes the partial correlation statistic $\left(\beta_i\right)\sqrt{\frac{\chi_i^2 - 2}{-2\log L_0}}$ for each parameter *i*, where X^2_i is the Wald chi-square statistic for the parameter and $\log L_0$ is the log-likelihood of the intercept-only model (Hilbe 2009). If $X^2_i < 2$, the partial correlation is set to 0.
Generalized R square	requests a generalized R square measure for the fitted model.

Option Name	Description
Goodness-of-fit and Overdispersion	
Deviance and Pearson goodness-of-fit	specifies whether to calculate the deviance and Pearson goodness-of-fit.
Aggregate by	specifies the subpopulations on which the Pearson chi-square test statistic and the likelihood ratio chi-square test statistic (deviance) are calculated. Observations with common values in the given list of variables are regarded as coming from the same subpopulation. Variables in the list can be any variables in the input data set.
Correct for overdispersion	specifies whether to correct for overdispersion by using the Deviance or Pearson estimate.
Hosmer & Lemeshow goodness-of-fit	performs the Hosmer and Lemeshow goodness-of-fit test (Hosmer and Lemeshow 2000) for the case of a binary response model. The subjects are divided into approximately 10 groups of approximately the same size based on the percentiles of the estimated probabilities. The discrepancies between the observed and expected number of observations in these groups are summarized by the Pearson chi-square statistic. This statistic is then compared to a chi-square distribution with t degrees of freedom, where t is the number of groups minus n. By default, $n = 2$. A small p-value suggests that the fitted model is not an adequate model.
Multiple Comparisons	
Perform multiple comparisons	specifies whether to compute and compare the least squares means of fixed effects.
Select the effects to test	specifies the effects that you want to compare. You specified these effects on the **Model** tab.
Method	requests a multiple comparison adjustment for the p-values and confidence limits for the differences of the least squares means. Here are the valid methods: **Bonferroni**, **Nelson**, **Scheffé**, **Sidak**, and **Tukey**.

Option Name	Description
Significance level	requests that a *t* type confidence interval be constructed for each of the least squares means with a confidence level of 1 – *number*. The value of *number* must be between 0 and 1. The default value is 0.05.
Exact Tests	
Exact test of intercept	calculates the exact test for the intercept.
Select effects to test	calculates exact tests of the parameters for the selected effects.
Significance level	specifies the level of significance α for $100(1-\alpha)\%$ confidence limits for the parameters or odds ratios.
Parameter Estimates	

You can calculate these parameter estimates:

- standardized estimates
- exponentiated estimates
- correlations of parameter estimates
- covariances of parameter estimates

You can specify the confidence intervals for parameters, confidence intervals for odds ratios, and the confidence level for these estimates.

Option Name	Description
Diagnostics	
Influence diagnostics	displays the diagnostic measures for identifying influential observations. For each observation, the results include the sequence number of the observation, the values of the explanatory variables included in the final model, and the regression diagnostic measures developed by Pregibon (1981). You can specify whether to include the standardized and likelihood residuals in the results.
Plots	

Option Name	Description
You can select whether to include plots in the results. Here are the additional plots that you can include in the results: ■ standardized DFBETA by observation number ■ influence statistics by observation number ■ influence on model fit and parameter estimates ■ predicted probability plots ■ effect plot ■ odds ratio plot ■ ROC plot You can specify whether to display these plots in a panel or individually. You can also specify whether to label the points on influence and ROC plots. You can label these points with the observation number or the variable values. By default, these points are not labeled.	
Label influence and ROC plots	specifies the variable from the input data that contains the labels for the influence and ROC plots.
Maximum number of plot points	specifies the maximum number of points to include in the plots. By default, 5,000 points are shown.
Methods	
Optimization	
Method	specifies the optimization technique for estimating the regression parameters. The Fisher scoring and Newton-Raphson algorithms yield the same estimates, but the estimated covariance matrices are slightly different except when the Logit link function is specified for binary response data.
Maximum number of iterations	specifies the maximum number of iterations to perform. If convergence is not attained in a specified number of iterations, the displayed output and all output data sets created by the task contain results that are based on the last maximum likelihood iteration.

Creating Output Data Sets

Option Name	Description
Output Data Sets	

<table>
<tr><th>Option Name</th><th>Description</th></tr>
<tr><td colspan="2">You can create two types of output data sets. Select the check box for each data set that you want to create.
Create output data set
outputs a data set that contains the specified statistics.
Here are the statistics that you can include in the output data set:
■ linear predictor
■ predicted values
■ confidence limits for predicted values
■ Pearson residuals
■ Deviance residuals
■ Likelihood residuals
■ standardized Pearson residuals
■ standardized deviance residuals
■ change in the chi-square goodness-of-fit from deleting the individual observation
■ change in the deviance from deleting the individual observation
■ leverage
■ standardized DFBETA
■ standard error of the linear predictor
■ predicted probabilities for each response level
Create scored data set
outputs a data set that contains all the statistics in the output data set plus posterior probabilities.</td></tr>
<tr><td>Add SAS scoring code to the log</td><td>writes SAS DATA step code for computing predicted values of the fitted model either to a file or to a catalog entry. This code can then be included in a DATA step to score new data.</td></tr>
</table>

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Predictive Regression Models

About the Predictive Regression Models Task

The task is predictive in that it selects the most influential effects based on observed data. This task enables you to logically partition your data into disjoint subsets for model training, validation, and testing. The Predictive Regression Models task 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 task can also create a scored data set. The results for this task make it easy to explore the selected model in more detail with other tasks, such as the Linear Regression task.

Note: You must license and install SAS/STAT to use this task.

Example: Predicting a Baseball Player's Salary

To create this example:

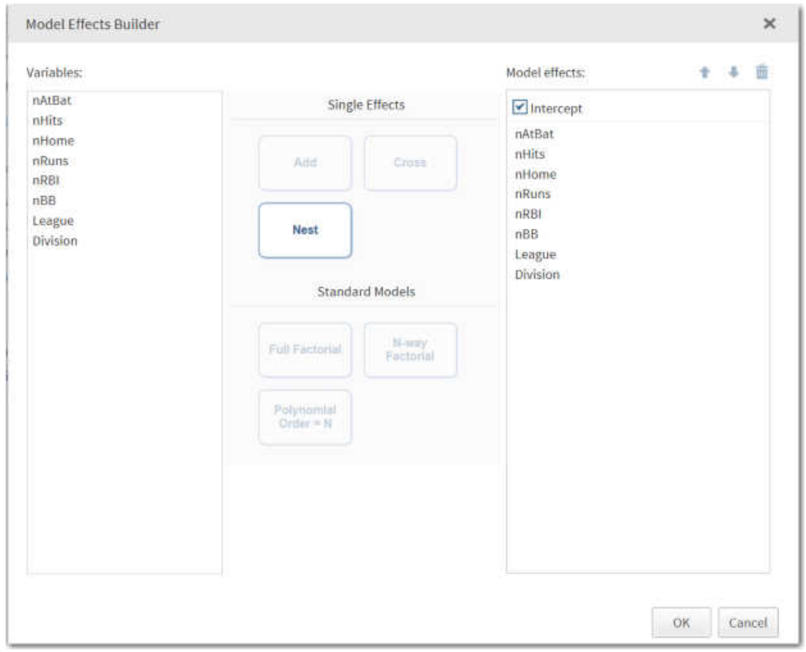
1. In the **Tasks** section, expand the **Statistics** folder, and then double-click **Predictive Regression Models**. The user interface for the Predictive Regression Models task opens.
2. On the **Data** tab, select the **SASHELP.BASEBALL** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. Assign columns to these roles and specify these options:

Role	Column Name
Dependent variable	**logSalary**
Classification variables	**League** **Division**
Continuous variables	**nAtBat** **nHits** **nHome** **nRuns** **nRBI** **nBB**

4. On the **Model** tab, click . The Model Effects Builder opens.
5. Select the **nAtBat**, **nHits**, **nHome**, **nRuns**, **nRBI**, **nBB**. **League**, and **Division** variables, and then click **Add**.



6 To run the task, click .

Data Set	SASHELP.BASEBALL
Dependent Variable	logSalary
Selection Method	Stepwise
Select Criterion	SBC
Stop Criterion	SBC
Effect Hierarchy Enforced	Single

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	
Number of Effects	9
Number of Parameters	11

Stepwise Selection Summary					
Step	Effect Entered	Effect Removed	Number Effects In	Number Parms In	SBC
0	Intercept		1	1	-57.2041
1	nHits		2	2	-124.6362
2	nBB		3	3	-137.9363*
* Optimal Value of Criterion					

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.

Assigning Data to Roles

To run the Predictive Regression Models task, you must select an input data source. To filter the input data source, click .

You also must assign a column to the **Dependent variable** role and a column to the **Classification variables** role or the **Continuous variables** role.

Role	Description
Roles	
Dependent variable	specifies the numeric variable to use as the dependent variable for the regression analysis.
Classification variables	specifies 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 termed levelization.
Parameterization of Effects	
Coding	specifies 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.
Treatment of 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 specified earlier in this table contains a missing value, regardless if it is used in the model.	

Role	Description
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Additional Roles	
Frequency count	lists 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.
Weight	specifies the numeric column to use as a weight to perform a weighted analysis of the data.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Building a Model

Requirements for Building a Model

By default, no effects are specified, which results in the task fitting an intercept-only model. Here is what you see on the **Model** tab.

To specify a model effect, you must assign at least one variable to the **Classification variables** role or the **Continuous variables** role. On the **Model** tab, click to open the Model Effects Builder.

When you close the Model Effects Builder, any effects that you created appear on the **Model** tab.

Single Effects

Create a Main Effect

1 Select the variable name in the **Variables** box.

2 Click **Add** to add the variable to the list of model effects.

Create Crossed Effects (Interactions)

1 Select two or more variables in the **Variables** box. To select more than one variable, press Ctrl.

2 Click **Cross**.

Create a Polynomial Degree Effect

1 Select one or more continuous variables in the **Variables** box.

2 In the list of single effects, click **Polynomial Degree=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select Age, click **Polynomial Degree=N**, and specify 3 as the value of N, the Age*Age*Age effect is created.

Create a Nested Effect

Nested effects are specified by following a main effect or crossed effect with a classification variable or list of classification variables enclosed in parentheses. Here are examples of nested effects: B(A), C(B*A), D*E(C*B*A). In this example, B(A) is read "B within A."

1 Select the classification variable in the Model Effects Builder.

2 Click **Nest**. The Nested window appears.

3 Select the variable to use in the nested effect. Click **Outer** or **Nested within Outer** to specify how to create the nested effect.

Note: The **Nested within Outer** button is available only when a classification variable is selected.

4 Select the effect that you want to nest.

5 Click **Add**.

Standard Models

Create a Two-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Two-Way Factorial**.

For example, if you select the Age and Height variables and then click **Two-Way Factorial**, the Age*Height effect is created.

Create a Full Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Full Factorial**.

For example, if you select the Height, Weight, and Age variables and then click **Full Factorial**, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, Height*Weight, and Age*Height*Weight.

Create an N-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **N-way Factorial** and specify the value of N.

For example, if you select the Height, Weight, and Age variables, click **N-way Factorial**, and then specify the value of N as 2, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, and Height*Weight. If N is set to a value greater than the number of variables in the model, N is effectively set to the number of variables.

Create Polynomial Effects of the Nth Order

1 Select one or more continuous variables in the **Variables** box.

2 In the list of standard models, click **Polynomial Order=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select the Age and Height variables, click **Polynomial Order=N**, and specify 3 as the value of N, these model effects are created: Age, Age*Age, Age*Age*Age, Height, Height*Height, and Height*Height*Height.

Selecting a Model

Option Name	Description
Model Selection	
Selection method	By default, the complete model that you specified is used to fit the model. However, you can also use one of these selection methods: **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.

Option Name	Description
Selection method (continued)	**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.
Add/remove effects with	specifies the criterion to use to determine whether an effect should be added or removed from the model.
Stop adding/removing effects with	specifies the criterion to use to determine whether effects should stop being added or removed from the model.
Select best model by	specifies the criterion to use to determine the best fitting model.
Selection Statistics	

<table>
<tr><th>Option Name</th><th>Description</th></tr>
<tr><td>Model fit statistics</td><td>specifies 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 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</td></tr>
<tr><td colspan="2">Selection Plots</td></tr>
<tr><td>Criteria plots</td><td>displays plots for these criteria: adjusted R-square, Akaike’s information criterion, Akaike’s information criterion corrected for small-sample bias, and the criterion used to select the best fitting model. You can choose to display these plots in a panel or individually.</td></tr>
<tr><td>Coefficient plots</td><td>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 used to select the best fitting model</td></tr>
<tr><td colspan="2">Details</td></tr>
<tr><td>Selection process details</td><td>specifies 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.</td></tr>
</table>

Option Name	Description
Add/remove classification effects	specifies 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 3 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.
Model Effects Hierarchy	
Model effects hierarchy	specifies 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 first be removed. Model hierarchy refers to the requirement that, for any term to be in the model, all effects 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.
Model effects subject to the hierarchy requirement	specifies whether to apply the model hierarchy requirement to the classification and continuous effects in the model or to only the classification effects.

Setting the Options for the Final Model

Option Name	Description
Statistics 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.	
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.
Plots for the Selected Model	
Diagnostic and Residual Plots	
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.	
More 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.

Option Name	Description
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*.
Label extreme points	identifies the extreme values on each different type of plot.
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.
Maximum number of plot points	specifies the maximum number of points to include in each plot.

Setting the Scoring Options

Option Name	Description
Scoring	
You can create a scored data set, which contains the predicted values and the residuals.	
Add SAS scoring code to the log	writes SAS DATA step code for computing predicted values of the fitted model either to a file or to a catalog entry. This code can then be included in a DATA step to score new data.

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Generalized Linear Models

About the Generalized Linear Models Task

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 task 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: You must license and install SAS/STAT to use this task.

Example: Analyzing the Sashelp.Baseball Data Set

To create this example:

1 In the **Tasks** section, expand the **Statistics** folder, and then double-click **Generalized Linear Models**. The user interface for the Generalized Linear Models task opens.

2 On the **Data** tab, select the **SASHELP.BASEBALL** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 From the **Distribution** drop-down list, select **Poisson**.

4 Assign columns to these roles:

Role	Column Name
Response	
Response variable	**nHome** From the **Link function** drop-down list, select **Logarithm**.
Explanatory Variables	
Classification variables	**League**
Continuous variables	**logSalary**

5 On the **Model** tab, click . The Model Effects Builder opens.

6 In the **Variables** pane, select **League** and **logSalary**.

7 Click **Add** to add these as main effects. Click **OK** to close the Model Effects Builder.

8 To run the task, click .

Here is a subset of the results:

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	

Algorithm converged.

Assigning Data to Roles

To run the Generalized Linear Models task, you must select an input data source. To filter the input data source, click .

You must also assign a column to the **Response variable** role for all distribution types except binomial. If you select a binomial distribution, you must assign either a single response variable or a pair of variables to the **Number of events** and **Number of trials** roles.

Option Name	Description
Roles	
Response	
Distribution	specifies 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
Options for Binomial Distribution	
Response data consists of numbers of events and trials	specifies that a pair of variables consists of response data for events and trials.
Number of events	specifies the column that contains the number of events.
Number of trials	specifies the column that contains the number of trials.
Response	specifies the single variable that contains response values. Use the **Event of interest** option to select a value of the response variable 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.
Options for All Distribution Types	

Option Name	Description
Response	specifies the variable that contains the response data. For most distribution types, you specify a single numeric variable.
Link function	specifies the link function for your model. The functions that are available depend on the selected distribution.
Explanatory Variables	
Classification variables	specifies 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.
Parameterization of Effects	
Coding	specifies 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.
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)	
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Offset variable	specifies 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.

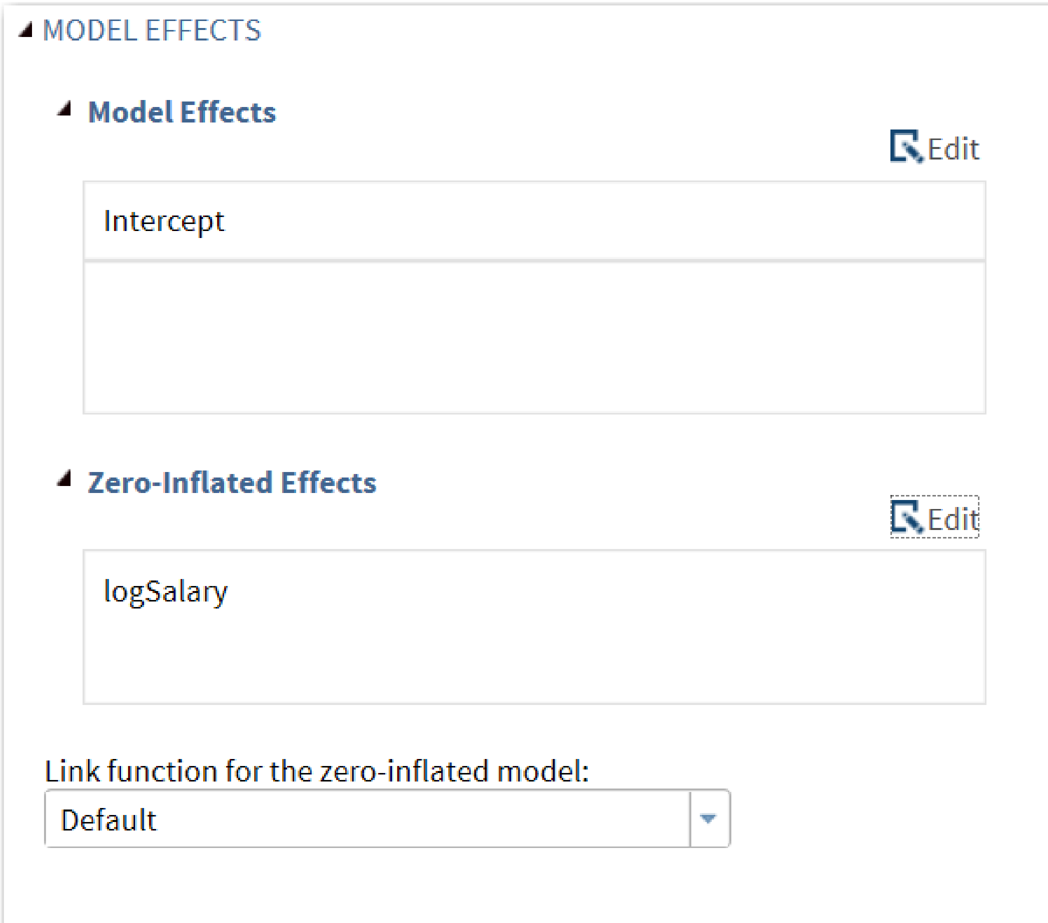
Option Name	Description
Additional Roles	
Frequency count	lists a numeric variable whose value represents the frequency of the observation. If you assign a variable to this role, the task assumes that each observation represents *n* observations, where *n* is the value of the frequency variable. If *n* 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.
Weight variable	specifies the numeric column to use as a weight to perform a weighted analysis of the data.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Building a Model

Understanding Effects for Generalized Linear Models

For all distribution types, you can create model effects. However, if you select **Zero-inflated negative binomial** or **Zero-inflated Poisson** as the distribution on the **Data** tab, you can also create zero-inflated effects.

Here is an example of the contents of the **Model** tab if you are using a zero-inflated distribution.



For model effects, the intercept is included by default. To add additional model effects, click to open the Model Effects Builder.

To add a zero-inflated effect, click to open the Zero-Inflated Effects Builder. After you create the effect and close the Zero-Inflated Effects Builder, specify the link function for the zero-inflated model.

Requirements for Building a Model

By default, no effects are specified, which results in the task fitting an intercept-only model. Here is what you see on the **Model** tab.

To specify a model effect, you must assign at least one variable to the **Classification variables** role or the **Continuous variables** role. On the **Model** tab, click to open the Model Effects Builder.

When you close the Model Effects Builder, any effects that you created appear on the **Model** tab.

Single Effects

Create a Main Effect

1 Select the variable name in the **Variables** box.

2 Click **Add** to add the variable to the list of model effects.

Create Crossed Effects (Interactions)

1 Select two or more variables in the **Variables** box. To select more than one variable, press Ctrl.

2 Click **Cross**.

Create a Nested Effect

Nested effects are specified by following a main effect or crossed effect with a classification variable or list of classification variables enclosed in parentheses. Here are examples of nested effects: B(A), C(B*A), D*E(C*B*A). In this example, B(A) is read "B within A."

1 Select the classification variable in the Model Effects Builder.

2 Click **Nest**. The Nested window appears.

3 Select the variable to use in the nested effect. Click **Outer** or **Nested within Outer** to specify how to create the nested effect.

Note: The **Nested within Outer** button is available only when a classification variable is selected.

4 Select the effect that you want to nest.

5 Click **Add**.

Standard Models

Create a Full Factorial Model

1 Select two or more variables in the **Variables** box.

2 Click **Full Factorial**.

For example, if you select the Height, Weight, and Age variables and then click **Full Factorial**, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, Height*Weight, and Age*Height*Weight.

Create an N-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **N-way Factorial** and specify the value of N.

For example, if you select the Height, Weight, and Age variables, click **N-way Factorial**, and then specify the value of N as 2, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, and Height*Weight. If N is set to a value greater than the number of variables in the model, N is effectively set to the number of variables.

Create Polynomial Effects of the Nth Order

1 Select one or more continuous variables in the **Variables** box.

2 In the list of standard models, click **Polynomial Order=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select the Age and Height variables, click **Polynomial Order=N**, and specify 3 as the value of N, these model effects are created: Age, Age*Age, Age*Age*Age, Height, Height*Height, and Height*Height*Height.

Setting Options

Option	Description
Methods	
Dispersion	

Option	Description
Adjust for overdispersion	adjusts 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.
Estimate dispersion parameter	enables you 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.
Optimization	
Maximum number of iterations	specifies the maximum number of iterations to perform for the selected optimization technique.
Statistics	
You can 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.	
Plots	

Option	Description
	You can select the plots to display 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.

Setting the Output Options

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, influence statistics, and the standard error of the linear predictor in the output data set.

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Mixed Models

About the Mixed Models Task

The Mixed Models task 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.

Example: Analyzing Age and Gender

1 In SAS Studio, click and select **New SAS Program**.

2 Create the Pr data set by copying and pasting this code into the **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 to create the Work.Pr data set.

3 In the **Tasks** section, expand the **Statistics** folder, and then double-click **Mixed Models**. The user interface for the Mixed Models task opens.

4 On the **Data** tab, select the **WORK.PR** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

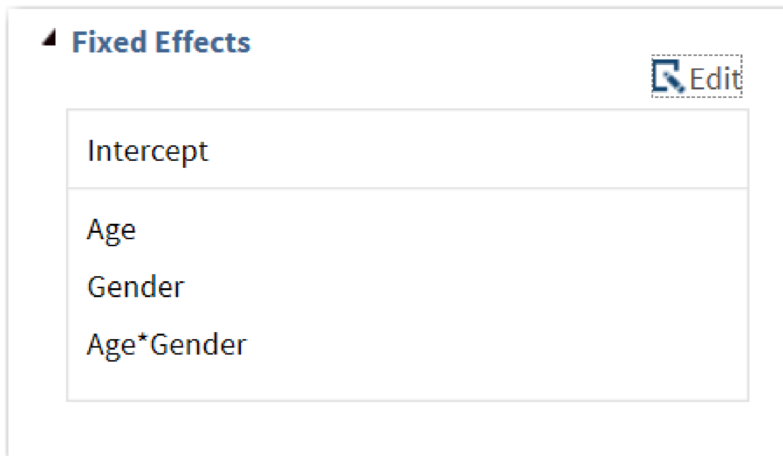
5 Assign columns to these roles:

Role	Column Name
Dependent variable	**y**
Classification variables	**Person** **Gender**
Continuous variables	**Age**

6 Create a two-way factorial fixed effect.

- **a** On the **Model** tab, click to create a fixed effect. The Fixed Effects Builder opens.
- **b** In the **Variables** pane, select **Gender** and **Age**. Click **Two-way Factorial**.
- **c** Click **OK** to close the Fixed Effects Builder.

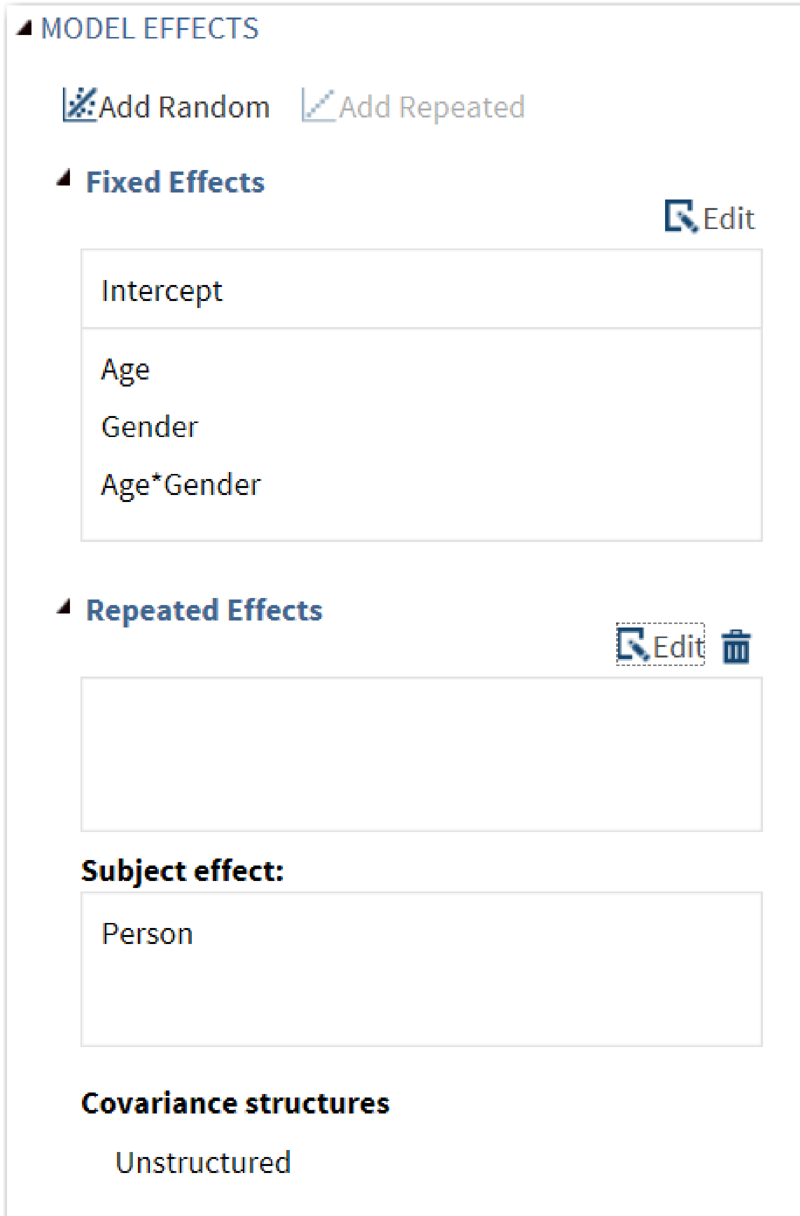
Here is the result on the **Model** tab:



7 Create a repeated subject effect.

- **a** On the **Model** tab, click to add a repeated effect.
- **b** Under the **Repeated Effect** heading, click . The Repeated Effects Builder opens.
- **c** In the Repeated Effects Builder, select the radio button for **Subject effect**. In the **Variables** pane, select **Person**, and then click **Add**.
- **d** Under the subject effect, click **Covariance Structures**. The Select Covariance Structures window appears.
- **e** From the drop-down list, select **Unstructured** and click **OK** to return to the Repeated Effects Builder.
- **f** Click **OK** to close the Repeated Effects Builder.

Here is the result on the **Model** tab:



8 On the **Options** tab:

- In the **Estimated method** drop-down list, select **Maximum likelihood**.
- In the **Select 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 To run the task, click .

Here is a subset of the results:

Model Information	
Data Set	WORK.PR
Dependent Variable	y
Covariance Structure	Unstructured
Subject Effect	Person
Estimation Method	ML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Between-Within

Class Level Information		
Class	Levels	Values
Person	27	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Gender	2	F M

Dimensions	
Covariance Parameters	10
Columns in X	6
Columns in Z	0
Subjects	27
Max Obs per Subject	4

Number of Observations	
Number of Observations Read	108
Number of Observations Used	108
Number of Observations Not Used	0

Estimated R Matrix for Person 1				
Row	Col1	Col2	Col3	Col4
1	5.1192	2.4409	3.6105	2.5222
2	2.4409	3.9279	2.7175	3.0624
3	3.6105	2.7175	5.9798	3.8235
4	2.5222	3.0624	3.8235	4.6180

Covariance Parameter Estimates								
Cov Parm	Subject	Estimate	Standard Error	Z Value	Pr Z	Alpha	Lower	Upper
UN(1,1)	Person	5.1192	1.4169	3.61	0.0002	0.05	3.1776	9.5997
UN(2,1)	Person	2.4409	0.9835	2.48	0.0131	0.05	0.5132	4.3686
UN(2,2)	Person	3.9279	1.0824	3.63	0.0001	0.05	2.4426	7.3427
UN(3,1)	Person	3.6105	1.2767	2.83	0.0047	0.05	1.1083	6.1127
UN(3,2)	Person	2.7175	1.0740	2.53	0.0114	0.05	0.6126	4.8225
UN(3,3)	Person	5.9798	1.6279	3.67	0.0001	0.05	3.7375	11.0806
UN(4,1)	Person	2.5222	1.0649	2.37	0.0179	0.05	0.4352	4.6093
UN(4,2)	Person	3.0624	1.0135	3.02	0.0025	0.05	1.0760	5.0487
UN(4,3)	Person	3.8235	1.2508	3.06	0.0022	0.05	1.3720	6.2749
UN(4,4)	Person	4.6180	1.2573	3.67	0.0001	0.05	2.8862	8.5580

Fit Statistics	
-2 Log Likelihood	419.5
AIC (Smaller is Better)	447.5
AICC (Smaller is Better)	452.0
BIC (Smaller is Better)	465.6

Assigning Data to Roles

To run the Mixed Models task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the numeric variable to use as the dependent variable for the analysis. You must assign a numeric variable to this role.
Classification variables	specifies the classification variables to use in the model. Examples of classification variables are Treatment, Race, Group, Sex, and Replication.
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)

Role	Description
Continuous variables	specifies any continuous variables to include in the model.
Additional Roles	
Weight	specifies the variable to use as a weight to perform a weighted analysis of the data.
Group analysis by	specifies to create a separate analysis for each group of observations.

Building a Model

About Mixed Models

The Form for a Mixed Model

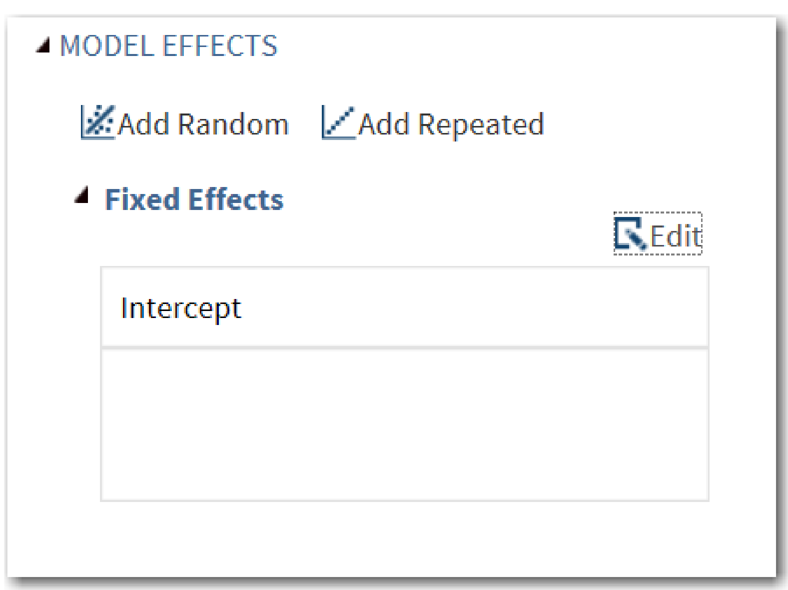
Here is the form for a mixed model: $y = X\beta + Z\gamma + \epsilon$.

In this equation, *y* represents univariate data, β is an unknown vector of fixed effects with known model matrix *X*, γ is an unknown vector of random effects with known model matrix *Z*, and ϵ is an unknown random error vector.

Using the Mixed Models task, you can add fixed, random, and repeated effects to your model.

By default, no effects are specified, which results in the task fitting an intercept-only model.

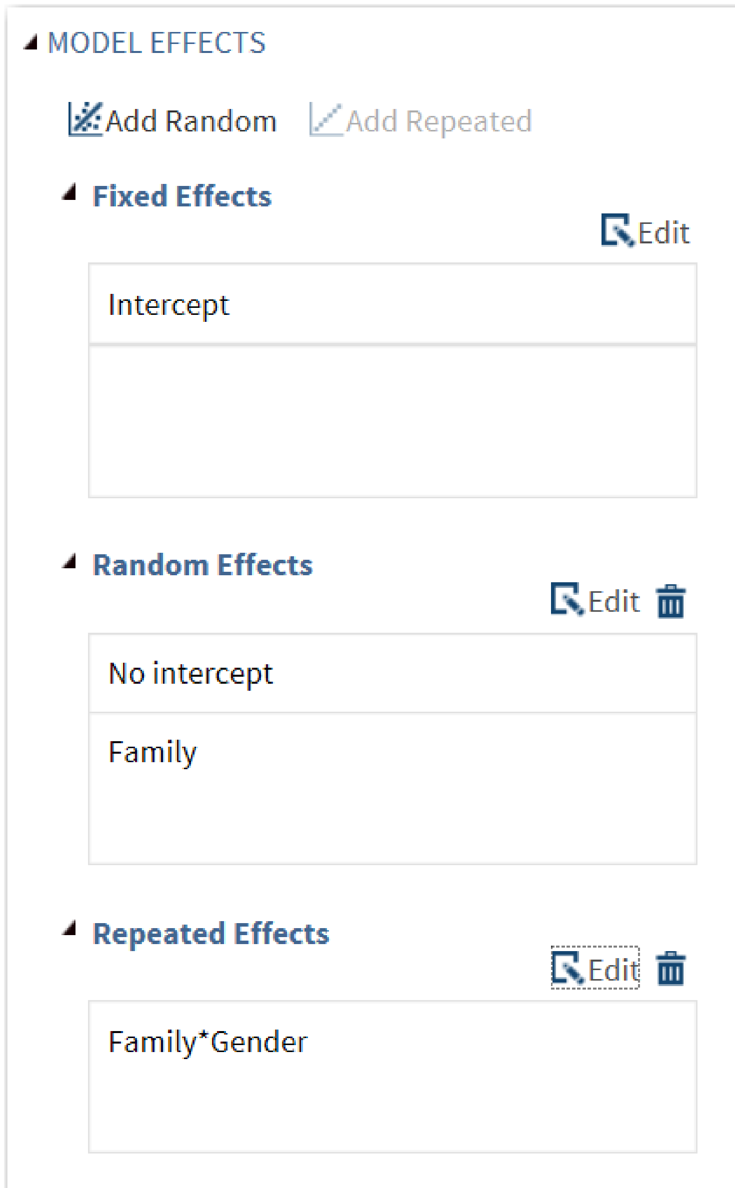
Here is what you see on the **Model** tab:



To specify a model effect, you must assign at least one variable to the **Classification variables** role or the **Continuous variables** role. On the **Model** tab, click  to open the Model Effects Builder.

In the Mixed Models task, you can create fixed effects, random effects, and repeated effects. (You can have only one repeated effect.) These effects are added to the model in the order in which they appear on the **Model** tab.

Here is an example of a **Model** tab that contains a fixed effect, a random effect, and a repeated effect.



Create a Fixed Effect

For fixed effects, the intercept is included by default. To add additional fixed effects, click  to open the Fixed Effects Builder.

Create a Random Effect

You can have multiple random effects in the model.

To create a random effect, click  to open the Random Effects Builder. In the Random Effects Builder, 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.

To create a subject effect or group effect:

1 In the Random Effects Builder, select the variable in the **Variables** pane.

2 Select the radio button for **Subject effect** or **Group effect**.

3 Click the button for the single effect that you want to create.

4 For subject effects, click **Covariance Structures** to specify the covariance structure of the *R* matrix. The default covariance structure is standard variance components.

Create a Repeated Effect

You can have only one repeated effect in the model. Only classification variables can be used to create a repeated effect.

To create a repeated effect, click  to open the Repeated Effects Builder. In the Repeated Effects Builder, 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. Y

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.

To create a subject effect or group effect:

1 In the Repeated Effects Builder, select the variable in the **Variables** pane.

2 Select the radio button for **Subject effect** or **Group effect**.

3 Click the button for the single effect that you want to create.

4 For subject effects, click **Covariance Structures** to specify the covariance structure of the *R* matrix. The default covariance structure is standard variance components.

Single Effects

Create a Main Effect

1 Select the variable name in the **Variables** box.

2 Click **Add** to add the variable to the list of model effects.

Create Crossed Effects (Interactions)

1 Select two or more variables in the **Variables** box. To select more than one variable, press Ctrl.

2 Click **Cross**.

Create a Polynomial Degree Effect

1 Select one or more continuous variables in the **Variables** box.

2 In the list of single effects, click **Polynomial Degree=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select Age, click **Polynomial Degree=N**, and specify 3 as the value of N, the Age*Age*Age effect is created.

Create a Nested Effect

Nested effects are specified by following a main effect or crossed effect with a classification variable or list of classification variables enclosed in parentheses. Here are examples of nested effects: B(A), C(B*A), D*E(C*B*A). In this example, B(A) is read "B within A."

1 Select the classification variable in the Model Effects Builder.

2 Click **Nest**. The Nested window appears.

3 Select the variable to use in the nested effect. Click **Outer** or **Nested within Outer** to specify how to create the nested effect.

   Note: The **Nested within Outer** button is available only when a classification variable is selected.

4 Select the effect that you want to nest.

5 Click **Add**.

Standard Models

Create a Two-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Two-Way Factorial**.

For example, if you select the Age and Height variables and then click **Two-Way Factorial**, the Age*Height effect is created.

Create a Full Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Full Factorial**.

For example, if you select the Height, Weight, and Age variables and then click **Full Factorial**, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, Height*Weight, and Age*Height*Weight.

Create an N-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **N-way Factorial** and specify the value of N.

For example, if you select the Height, Weight, and Age variables, click **N-way Factorial**, and then specify the value of N as 2, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, and Height*Weight. If N is set to a value greater than the number of variables in the model, N is effectively set to the number of variables.

Create Polynomial Effects of the Nth Order

1 Select one or more continuous variables in the **Variables** box.

2 In the list of standard models, click **Polynomial Order=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select the Age and Height variables, click **Polynomial Order=N**, and specify 3 as the value of N, these model effects are created: Age, Age*Age, Age*Age*Age, Height, Height*Height, and Height*Height*Height.

Setting the Options

Option Name	Description
Methods	
Estimation method	specifies 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**

Option Name	Description
Confidence level	specifies the level to use for the construction of confidence intervals.
Details	
Maximum number of iterations	specifies the maximum number of iterations. The default is 50.
Method to compute denominator degrees of freedom	specifies the method for computing the denominator degrees of freedom for the tests of fixed effects.
Statistics	
You can choose to include the default statistics in the results or choose to include additional statistics from these categories: Tests, Influence Statistics, Parameter Estimates, and Multiple Comparisons. The options available depend on the effects that you added to the **Model** tab.	
Plots	
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	

Creating Output Data Sets

You can specify whether to create these output data sets:

- 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

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Partial Least Squares Regression

About the Partial Least Squares Regression Task

The Partial Least Squares Regression task 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.

Example: Partial Least Squares Regression Analysis

To create this example:

1 In SAS Studio, click  and select **New SAS Program**.

2 Create the pentaTrain data set by copying and pasting this code into the **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 🏃 to create the Work.pentaTrain data set.

3 In the **Tasks** section, expand the **Statistics folder**, and then double-click **Partial Least Squares Regression**. The user interface for the Partial Least Squares Regression task opens.

4 On the **Data** tab, select the **WORK.PENTATRAIN** data set.

TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

5 Assign columns to these roles:

Role	Column Name
Dependent variable	**log_RAI**
Continuous variables	**S1–S5** **L1–L5** **P1–P5**

6 On the **Model** tab, click . Select all of the variable names in the **Variables** pane and click **Add**.

7 To run the task, click .

Here is a subset of the results:

Data Set	WORK.PENTATRAIN
Factor Extraction Method	Partial Least Squares
PLS Algorithm	NIPALS
Number of Response Variables	1
Number of Predictor Parameters	15
Missing Value Handling	Exclude
Number of Factors	15

Number of Observations Read	15
Number of Observations Used	15

Percent Variation Accounted for by Partial Least Squares Factors				
	Model Effects		Dependent Variables	
Number of Extracted Factors	Current	Total	Current	Total
1	16.9014	16.9014	89.6399	89.6399
2	12.7721	29.6735	7.8368	97.4767
3	14.6554	44.3289	0.4636	97.9403
4	11.8421	56.1710	0.2485	98.1889
5	10.5894	66.7605	0.1494	98.3383
6	5.1876	71.9481	0.2617	98.6001
7	6.1873	78.1354	0.2428	98.8428
8	7.2252	85.3606	0.1926	99.0354
9	6.7285	92.0891	0.0725	99.1080
10	7.9076	99.9967	0.0000	99.1080

Assigning Data to Roles

To run the Partial Least Squares Regression task, you must select an input data source. To filter the input data source, click .

You must also assign a column to the **Dependent variable** role.

Role	Description
Roles	

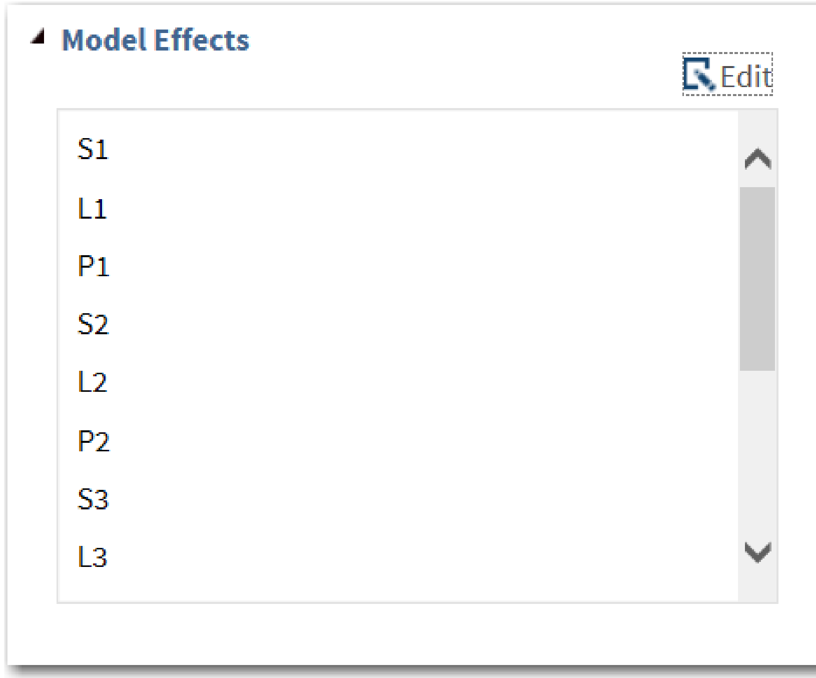
Role	Description
Dependent variable	specifies the numeric variables to use as the dependent variables for the analysis.
Classification variables	specifies the classification variables to use in the model. Examples of classification variables are Treatment, Race, Group, Sex, and Replication.
Treatment 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)	
Continuous variables	specifies any continuous variables to include in the model.
Additional Roles	
Group analysis by	specifies to create a separate analysis for each group of observations.

Building a Model

Requirements for Building a Model

By default, no effects are specified. To specify a model effect, you must assign at least one variable to the **Classification variables** role or the **Continuous variables** role. On the **Model** tab, click  to open the Model Effects Builder.

When you close the Model Effects Builder, any effects that you created appear on the **Models** tab.



Single Effects

Create a Main Effect

1 Select the variable name in the **Variables** box.

2 Click **Add** to add the variable to the list of model effects.

Create Crossed Effects (Interactions)

1 Select two or more variables in the **Variables** box. To select more than one variable, press Ctrl.

2 Click **Cross**.

Create a Polynomial Degree Effect

1 Select one or more continuous variables in the **Variables** box.

2 In the list of single effects, click **Polynomial Degree=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select Age, click **Polynomial Degree=N**, and specify 3 as the value of N, the Age*Age*Age effect is created.

Create a Nested Effect

Nested effects are specified by following a main effect or crossed effect with a classification variable or list of classification variables enclosed in parentheses. Here are examples of nested effects: B(A), C(B*A), D*E(C*B*A). In this example, B(A) is read "B within A."

1 Select the classification variable in the Model Effects Builder.

2 Click **Nest**. The Nested window appears.

3 Select the variable to use in the nested effect. Click **Outer** or **Nested within Outer** to specify how to create the nested effect.

   Note: The **Nested within Outer** button is available only when a classification variable is selected.

4 Select the effect that you want to nest.

5 Click **Add**.

Standard Models

Create a Two-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Two-Way Factorial**.

For example, if you select the Age and Height variables and then click **Two-Way Factorial**, the Age*Height effect is created.

Create a Full Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Full Factorial**.

For example, if you select the Height, Weight, and Age variables and then click **Full Factorial**, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, Height*Weight, and Age*Height*Weight.

Create an N-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **N-way Factorial** and specify the value of N.

For example, if you select the Height, Weight, and Age variables, click **N-way Factorial**, and then specify the value of N as 2, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, and Height*Weight. If N is set to a value greater than the number of variables in the model, N is effectively set to the number of variables.

Create Polynomial Effects of the Nth Order

1 Select one or more continuous variables in the **Variables** box.

2 In the list of standard models, click **Polynomial Order=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select the Age and Height variables, click **Polynomial Order=N**, and specify 3 as the value of N, these model effects are created: Age, Age*Age, Age*Age*Age, Height, Height*Height, and Height*Height*Height.

Setting Options

Option	Description
Methods	
Method	specifies the general factor extraction method to use. You can choose from these methods: ■ **Partial least squares regression** ■ **De Jong's SIMPLS** ■ **Principal components regression** ■ **Reduced rank regression**
Center the responses and predictors	includes the intercept in the model. By default, the responses and predictors are centered, and the intercept is not included in the model.
Specify the number of factors	specifies 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).
Cross Validation	
Cross validation method	specifies 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**
Details	

Option	Description
Algorithm	specifies 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 the 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.
Specify the maximum number of iterations	specifies the maximum number of iterations if you selected the **Iterative NIPALS** or **Iterative RLGW** algorithm.
Statistics	
You can choose to include the default statistics in the results, or you can choose to include these additional statistics: ■ **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. ■ **Variation accounted for in responses and predictors**. This option lists the amount of variance accounted for in each response and predictor. The option also includes the average response and predictor sum of squares 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 listed are different for different extraction methods.	
Plots	
Select the plots to include in the output. By default, only the correlation loading plot is included in the output. 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 create 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	

Creating Output Data Sets

You can specify whether to create an output data set, and you can choose the statistics to include in that data set.

Part 5

High-Performance Statistics Tasks

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Bin Continuous Data

About the Bin Continuous Data Task

The Bin Continuous Data task is a data preparation task. This task divides the data values of a continuous variable into intervals and replaces the values for each interval with a single value that is representative of the interval.

Note: This task is available only if you are running SAS 9.4 or later and if you license and install SAS/STAT.

Example: Winsorized Binning

In this example, the task provides the basic Winsorized statistical information for the input data.

To create this example:

1 To create the Work.Ex12 data set, enter this code into a **Program** tab:

```
data ex12;
   length id 8;
   do id=1 to 10000;
      x1 = ranuni(101);
      x2 = 10*ranuni(201);
      x3 = 100*ranuni(301);
      output;
   end;
run;
```

Click 

2 In the **Tasks** section, expand the **High-Performance Statistics** folder, and then double-click **Bin Continuous Data**. The user interface for the Bin Continuous Data task opens.

3 On the **Data** tab, select the **WORK.EX12** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 To the **Variables to bin** role, assign the **x1** and **x2** columns.

5 On the **Options** tab, set these options:

- In the **Number of bins** box, enter `10`.
- From the **Method** drop-down list, select **Winsorized binning**.

6 To run the task, click .

Here is a subset of the results:

Performance Information	
Execution Mode	Single-Machine
Number of Threads	4

Data Access Information			
Data	Engine	Role	Path
WORK.EX12	V9	Input	On Client

Binning Information	
Method	Winsor Binning
Number of Bins Specified	10
Number of Variables	2

Mapping				
Variable	Binned Variable	Range	Frequency	Proportion
x1	BIN_x1	x1 < 0.1377222289	1405	0.14050000
		0.1377222289 <= x1 < 0.2278648205	849	0.08490000
		0.2278648205 <= x1 < 0.3180074121	897	0.08970000
		0.3180074121 <= x1 < 0.4081500038	864	0.08640000
		0.4081500038 <= x1 < 0.4982925954	906	0.09060000
		0.4982925954 <= x1 < 0.588435187	899	0.08990000
		0.588435187 <= x1 < 0.6785777786	935	0.09350000
		0.6785777786 <= x1 < 0.7687203702	901	0.09010000
		0.7687203702 <= x1 < 0.8588629619	948	0.09480000
		0.8588629619 <= x1	1396	0.13960000
x2	BIN_x2	x2 < 1.3985003146	1385	0.13850000

Assigning Data to Roles

To run the Bin Continuous Data task, you must select an input data source. To filter the input data source, click .

You must assign a variable to the **Variables to bin** role.

Role	Description
Roles	
Variables to bin	specifies one or more variables as input variables for binning. The specified variables must be interval variables.

Role	Description
Additional Roles	
Frequency count	lists 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.

Setting Options

Option Name	Description
Methods	
Number of bins	specifies 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.
Method	specifies which binning method to use. ■ **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. ■ **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. ■ **Pseudo-quantile binning** mimics the results of the quantile binning method but is more efficient by consuming less CPU time and memory.
Compute weight of evidence and information value	specifies whether to compute the weight of evidence and information value.

Option Name	Description
Variables to bin	specifies the variable to use to calculate the weight of evidence and information value. If the target variable has more than two levels, you can also specify the order of the target variable.
Specify adjustment factor	specifies the adjustment factor for the weight-of-evidence calculation. You can specify a value from 0.0 to 1.0 inclusive. The default value is 0.5.
Statistics	
Select statistics to display	In the results, you can specify whether to include statistics. Here are the additional statistics that you can include: ■ **Basic statistics** displays the mean, pseudo-median, standard deviation, minimum, maximum, and number of bins for each binning variable. ■ **Quantile statistics** displays the estimated quantiles and extremes table.

Creating an Output Data Set

You can specify whether to save the results to an output data set. In the **Additional variables to include in the output data set** role, specify any columns from the input data set that you want to include in the output data set.

To view all or a subset of the output data set in the results, select **Show output data**. This option specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

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High-Performance Correlation Analysis

About the High-Performance Correlation Analysis Task

Correlation is a statistical procedure for describing the relationship between numeric variables. The relationship is described by calculating correlation coefficients for the variables. The High-Performance Correlation Analysis task computes Pearson statistics for investigating associations among variables. Correlations range from –1 to 1.

Note: This task is available only if you are running SAS 9.4 or later.

Example: Correlation between Weight, Oxygen, and Run Time

To create this example:

1 Create the Work.Fitness data set. For more information, see “FITNESS Data set” on page 588.

2 In the **Tasks** section, expand the **High-Performance Statistics** folder, and then double-click **Correlation Analysis**. The user interface for the High-Performance Correlation Analysis task opens.

3 On the **Data** tab, select the **WORK.FITNESS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 To the **Analysis variables** role, assign the **Weight**, **Oxygen**, and **RunTime** columns.

5 To run the task, click .

Here are the results:

Performance Information	
Execution Mode	Single-Machine
Number of Threads	4

Data Access Information			
Data	Engine	Role	Path
WORK.FITNESS	V9	Input	On Client

3 Variables:	Weight Oxygen RunTime

Pearson Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations			
	Weight	Oxygen	RunTime
Weight	1.00000 31	-0.15358 0.4264 29	0.20072 0.2965 29
Oxygen	-0.15358 0.4264 29	1.00000 29	-0.86843 <.0001 28
RunTime	0.20072 0.2965 29	-0.86843 <.0001 28	1.00000 29

Assigning Data to Roles

To run the High-Performance Correlation Analysis task, you must select an input data source. To filter the input data source, click .

You must assign two columns to the **Analysis variables** role.

Role	Description
Roles	
Analysis variables	specifies the columns to use to calculate the correlation coefficients.
Additional Roles	
Frequency count	lists 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.
Weight	specifies the weights to use in the calculation of Pearson weighted product-moment correlation.

Setting Options

Option Name	Description
Methods	

Option Name	Description
Missing values	specifies whether to include missing values in the calculations. ■ If you select the **Use nonmissing values for all selected variables** option, any observations that have missing values are excluded from the analysis. ■ If you select the **Use nonmissing values for pairs of variables** option, the data for an observation contributes to the correlation between two variables as long as both values are nonmissing. As a result, the correlations that are calculated for the analysis variable might be based on a different number of observations.
Statistics	
You can specify whether the results include only the statistics that the task automatically generates, the statistics that you selected, or no statistics. By default, only the correlations table is displayed in the results. You can include these statistics in the results: ■ correlations ■ covariances ■ sum of squares and cross-products ■ corrected sum of squares and cross-products ■ descriptive statistics	
Display p-values	specifies whether to display for each correlation coefficient the probability of observing a more extreme value than the observed coefficient.
Order correlations from highest to lowest (in absolute value)	displays the ordered correlation coefficients for each variable. Correlations are ordered from highest to lowest in absolute value.

Creating an Output Data Set

You can specify whether to save the results to an output data set. By default, the output data set contains the correlations. You can also include covariances, sum of squares and cross-products, and corrected sum of squares and cross-products.

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High-Performance Generalized Linear Models

About the Generalized Linear Models Task

The Generalized Linear Models task is a high-performance task that provides model fitting and model building for generalized linear models. The task 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 and provides forward, backward, and stepwise selection methods.

Note: This task is available only if you are running SAS 9.4 or later and if you license and install SAS/STAT.

Example: Model Selection

To create this example:

1 Create the Work.getStarted data set. For more information, see “GETSTARTED Data Set” on page 589.

2 In the **Tasks** section, expand the **High-Performance Statistics** folder, and then double-click **Generalized Linear Models**. The user interface for the Generalized Linear Models task opens.

3 On the **Data** tab, select the **WORK.GETSTARTED** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role or Option Name	Column Name
Distribution	**Poisson**
Response variable	**Y**
Classification variables	**C1** **C2** **C3** **C4** **C5**

5 On the **Models** tab, click to open the Model Effects Builder.

6 In the **Variables** box, select **C1–C5**.

7 Click **Add**. Then click **OK** to close the Model Effects Builder.

8 Click the **Selection** tab. From the **Selection method** drop-down list, select **Forward selection**.

9 To run the task, click .

Here is a subset of the results:

Performance Information	
Execution Mode	Single-Machine
Number of Threads	4

Data Access Information			
Data	Engine	Role	Path
WORK.GETSTARTED	V9	Input	On Client

Model Information	
Data Source	WORK.GETSTARTED
Response Variable	Y
Distribution	Poisson
Link Function	Log
Optimization Technique	Newton-Raphson with Ridging

Selection Information	
Selection Method	Forward
Select Criterion	Significance Level
Stop Criterion	Significance Level
Effect Hierarchy Enforced	Single
Entry Significance Level (SLE)	0.05
Stop Horizon	1

Number of Observations Read	100
Number of Observations Used	100

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.

Assigning Data to Roles

To run the Generalized Linear Models task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Response variable** role.

Option Name	Description
Roles	
Response	
Distribution	specifies the distribution for your model. You can choose from these distributions: ■ Binomial ■ Gamma ■ Inverse Gaussian ■ Multinomial ■ Negative binomial ■ Normal ■ Poisson ■ Tweedie
Options for Binomial Distribution **Note:** These options are available if you select **Binomial** from the **Distribution** drop-down list.	
Response data consists of numbers of events and trials	specifies whether the data consists of a variable that specifies the number of positive responses (events) and another variable that specifies the number of trials.
Number of events	specifies the column that contains the number of events.
Number of trials	specifies the column that contains the number of trials.

Option Name	Description
Response	specifies the variable that contains response values. If you create a binomial response model, you can specify the first or last ordered category as the reference category by using the **Event of interest** option. You can also select a custom category. **Note:** This option is available only if you do not select the **Response data consists of numbers of events and trials** check box.
Options for All Distribution Types	
Response	specifies the variable that contains response values. If you create a binomial response model or a nominal multinomial model, you can specify the first or last ordered category as the reference category by using the **Event of interest** option. You can also select a custom category. ■ To create a binomial response model, select **Binomial** as the distribution. For the binomial response model, specifying one response category as the reference is the same as specifying the other response category as the event category. ■ To create a nominal multinomial model, select **Multinomial** as the distribution and select **Generalized logit** as the link function. For the generalized logit model, each logit contrasts a nonreference category with the reference category.

<table>
<tr><th>Option Name</th><th>Description</th></tr>
<tr><td>Link function</td><td>specifies the link function for your model. The functions that are available depend on the selected distribution.

If you select Default for the link function, then the default link function for the model distribution is used.

Here is the list of distributions with the corresponding default link function:
■ Binomial distribution uses the logit link function.
■ Gamma distribution uses the reciprocal link function.
■ Inverse Gaussian distribution uses the reciprocal square link function.
■ Multinomial distribution uses the cumulative logit link function.
■ Negative binomial distribution uses the log link function.
■ Normal distribution uses the identity link function.
■ Poisson distribution uses the log link function.
■ Tweedie distribution uses the log link function.</td></tr>
<tr><td colspan="2">Explanatory Variables</td></tr>
<tr><td>Classification variables</td><td>specifies the variables to use to group (classify) data in the analysis. Classification variables can be either character or numeric.</td></tr>
<tr><td colspan="2">Parameterization of Effects</td></tr>
<tr><td>Coding</td><td>specifies 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:
■ GLM coding specifies less-than-full-rank, reference-cell coding. This coding scheme is the default.
■ Reference coding specifies reference-cell coding.</td></tr>
<tr><td colspan="2">Treatment of Missing Values</td></tr>
<tr><td colspan="2">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)</td></tr>
</table>

Option Name	Description
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Offset variable	specifies 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.
Additional Roles	
Frequency count	lists 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.
Weight variable	specifies the column to use as a weight to perform a weighted analysis of the data.

Building a Model

Requirements for Building a Model

By default, no effects are specified, which results in the task fitting an intercept-only model. Here is what you see on the **Model** tab.

To specify a model effect, you must assign at least one variable to the **Classification variables** role or the **Continuous variables** role. On the **Model** tab, click to open the Model Effects Builder.

When you close the Model Effects Builder, any effects that you created appear on the **Model** tab.

Single Effects

Create a Main Effect

1. Select the variable name in the **Variables** box.
2. Click **Add** to add the variable to the list of model effects.

Create Crossed Effects (Interactions)

1. Select two or more variables in the **Variables** box. To select more than one variable, press Ctrl.
2. Click **Cross**.

Create a Polynomial Degree Effect

1. Select one or more continuous variables in the **Variables** box.
2. In the list of single effects, click **Polynomial Degree=N**.
3. Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select Age, click **Polynomial Degree=N**, and specify 3 as the value of N, the Age*Age*Age effect is created.

Create a Nested Effect

Nested effects are specified by following a main effect or crossed effect with a classification variable or list of classification variables enclosed in parentheses. Here are examples of nested effects: B(A), C(B*A), D*E(C*B*A). In this example, B(A) is read "B within A."

1. Select the classification variable in the Model Effects Builder.
2. Click **Nest**. The Nested window appears.
3. Select the variable to use in the nested effect. Click **Outer** or **Nested within Outer** to specify how to create the nested effect.

   Note: The **Nested within Outer** button is available only when a classification variable is selected.

4 Select the effect that you want to nest.

5 Click **Add**.

Standard Models

Create a Two-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Two-Way Factorial**.

For example, if you select the Age and Height variables and then click **Two-Way Factorial**, the Age*Height effect is created.

Create a Full Factorial

1 Select two or more variables in the **Variables** box.

2 Click **Full Factorial**.

For example, if you select the Height, Weight, and Age variables and then click **Full Factorial**, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, Height*Weight, and Age*Height*Weight.

Create an N-Way Factorial

1 Select two or more variables in the **Variables** box.

2 Click **N-way Factorial** and specify the value of N.

For example, if you select the Height, Weight, and Age variables, click **N-way Factorial**, and then specify the value of N as 2, these model effects are created: Age, Height, Weight, Age*Height, Age*Weight, and Height*Weight. If N is set to a value greater than the number of variables in the model, N is effectively set to the number of variables.

Create Polynomial Effects of the Nth Order

1 Select one or more continuous variables in the **Variables** box.

2 In the list of standard models, click **Polynomial Order=N**.

3 Specify higher-degree crossings by adjusting the number in the **N** field.

For example, if you select the Age and Height variables, click **Polynomial Order=N**, and specify 3 as the value of N, these model effects are created: Age, Age*Age, Age*Age*Age, Height, Height*Height, and Height*Height*Height.

Setting the Model Selection Options

Option	Description
Model Selection	
Selection method	specifies the selection method for the model. The task 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.

Option	Description
Selection method (continued)	■ **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. ■ **LASSO** performs model selection by the group LASSO method. This method adds and removes effects by using a sequence of LASSO steps. For this method, you can select the criterion to use to stop the selection process and the criterion to use to choose the best model at each step in the selection process. Use the **Selection process details** option to determine the amount of details to display for the selection process. □ The **Selection summary** option produces only the selection summary, stop reason, selection reason, and selected effects tables. □ The **Details for each step** and **All** options produce this output: ▪ tables that provide information about the model that is selected at each step of the selection process ▪ entry and removal statistics for inclusion or exclusion candidates at each step ▪ a selection summary table that shows by step the effect that is added or removed from the model in addition to the criteria used ▪ a stop reason table that describes why the selection process stopped ▪ a selection reason table that describes why the selected model was chosen ▪ a selected effects table that lists the effects that are in the selected model
Select best model by	specifies the criterion to use to identify the best-fitting model.
Select effects to include in all models	specifies the effects to include in all the models. The list of effects is determined by the content of the model builder.
Details	
Selection process details	specifies 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.
Maintain hierarchy of effects	specifies to maintain the hierarchy of effects.

Setting Options

Option	Description
Methods	
Dispersion	
Dispersion parameter	enables you to specify a fixed dispersion parameter for those distributions that have a dispersion parameter. By default, this parameter is estimated.
Optimization	
Method	specifies the optimization technique to use.
Maximum number of iterations	specifies the maximum number of iterations to perform for the selected optimization technique.
Statistics	
You can select the statistics to include in the output. Here are the additional statistics that you can include: ■ confidence limits for estimates ■ correlations of parameter estimates ■ covariances of parameter estimates	

Setting the Output Options

You can specify whether to create an output data set. You can also specify whether to include predicted values, residuals, or any other variables in the output data set.

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Replace Missing Values

About the Replace Missing Values Task

The Replace Missing Values task replaces missing values in a data set with an estimate of the missing value. The task also creates binary imputation indicators.

Note: You must license and install SAS/STAT to use this task.

Assigning Data to Roles

To run the Replace Missing Values task, you must select an input data source. To filter the input data source, click .

Role	Description
Roles	
Replace missing values with the mean	replaces missing values with the mean for the variable.
Replace missing values with the pseudo-median	replaces missing values with the pseudo-median of the variable. If there is no nonmissing value, the pseudo-median is 0.
Replace missing values with a random number	replaces 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.
Additional Roles	

Role	Description
Frequency count	lists 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.

Setting the Output Options

On the **Output** tab, you can specify whether to create an output data set. This output data set includes the data, imputation indicator variables (0 for not imputed or 1 for imputed), and imputed variables. You can also include any variables from the input data set.

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Random Sampling

About the Random Sampling Task

The Random Sampling task is a high-performance procedure that performs either simple random sampling or stratified sampling. The output from this task includes an output data set and the sample data, a table with performance information, and a table with frequency information for the population and sample.

Note: This task is available only if you are running SAS 9.4 or later and if you license and install SAS/STAT.

Assigning Data to Roles

To run the Random Sampling task, you must select an input data set. To filter the input data source, click .

If you want to perform stratified sampling, you must assign a column to the **Stratify by** role. Otherwise, the **Stratify by** role is optional.

Role	Description
Stratify by	specifies the variables to use to partition the input table into mutually exclusive, nonoverlapping subsets that are known as strata. Each stratum is defined by a set of values of the strata variables, and each stratum is sampled separately. The complete sample is the union of the samples that are taken from all the strata. **Note:** If you do not assign any variables to this role, then the entire input table is treated as a single stratum. You can allocate the total sample size among the strata in proportion to the size of the stratum. For example, the variable GENDER has possible values of M and F, and the variable VOTED has possible values of Y and N. If you assign both GENDER and VOTED to the **Stratify by** role, then the input table is partitioned into four strata: males who voted, males who did not vote, females who voted, and females who did not vote. The input table contains 20,000 rows, and the values are distributed as follows: ■ 7,000 males who voted ■ 4,000 males who did not vote ■ 5,000 females who voted ■ 4,000 females who did not vote Therefore, the proportion of males who voted is 7,000/20,000=0.35 or 35%. The proportions in the sample should reflect the proportions of the strata in the input table. For example, if your sample table contains 100 observations, then 35% of the values in the sample must be selected from the males who voted stratum to reflect the proportions in the input table.
Ignore case of character stratification values	distinguishes stratified variables that share the same normalized value when you perform stratified sampling. For example, if a target has three distinct values, “A”, “B”, and “b”, and you want to treat “B” and “b” as different levels, you need to select this option. Otherwise, “B” and “b” are treated as the same level. The task normalizes a value as follows: 1 Leading blanks are removed. 2 The value is truncated to 32 characters. 3 Letters are changed from lowercase to uppercase.

Creating the Output Data Set

On the **Data** tab, you can select the numeric and character variables from the input data set to include in the output data. Select the **Include all input observations and a sampling indicator variable** to produce an output table with the same number of rows as the input table. The output table has an additional partition indicator (_PARTIND_) to indicate whether an observation is included in the sample (1) or not (0).

The **Show output data** option specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

Setting Options

Option Name	Description
Methods	
Sample by	specifies 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.
Specify the random seed	specifies the initial seed for the generation of random numbers. If you set this value to zero or a negative number, then a seed that is based on the system clock is used to produce the sample.

Part 6

Power and Sample Size

53

Pearson Correlation

About the Pearson Correlation Task

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 task 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.

Example: Pearson Correlation for Power and Sample Size Analysis

To create this example:

1. In the **Tasks** section, expand the **Power and Sample Size** folder, and then double-click **Pearson Correlation**. The user interface for the Pearson Correlation task opens.
2. Under the **Solve For** heading, select **Power**.
3. For the analysis test, select **Fisher's z transformation**.
4. For the number of sides, select **Two-sided test**.
5. Specify a significance level of 0.05.
6. Under the **Correlation** heading, select **Correlation, Null correlation** from the **Select a form** drop-down list.
7. Enter `.3` as the correlation, and enter `.1` as the null correlation.
8. For the sample size, enter `180`.

9 To run the task, click .

Here is a subset of the results:

Fisher's z Test for Pearson Correlation

Fixed Scenario Elements	
Distribution	Fisher's z transformation of r
Method	Normal approximation
Number of Sides	2
Null Correlation	0.1
Nominal Alpha	0.05
Correlation	0.3
Total Sample Size	180
Number of Variables Partialled Out	0

Computed Power	
Actual Alpha	Power
0.05	0.797

Assigning Properties

Properties	Description
Solve For	
requests a solution for power or total sample size.	
Analysis Details	
Select a transformation of the correlation coefficient	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.

Properties	Description
Select the number of sides of the test	specifies 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
Significance Level	
specifies the alpha value of the statistical test. The default is 0.05. Click + to specify multiple values. **Note:** Specify only one value per row.	
Correlation	
Select a form	specifies 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.
Correlation values	specifies the correlation values. Click + to specify multiple values. **Note:** Specify only one value per row.
Null correlation values	specifies the value of the null correlation. **Note:** This option is available only if you select a Fisher's *z* transformation and the **Correlation, null correlation** option from the **Select a form** drop-down list.
Sample Size	
Allow fractional sample sizes	enables fractional input and output for sample sizes.
Sample size values	specifies the sample size to use in the analysis.
Partial Variables	

Properties	Description
Specify the number of variables to partial out	specifies the number of variables adjusted for the correlation between the two primary variables. The default value is 0, which corresponds to a simple correlation.

Setting the Plot Options

Option Name	Description
Plots	
Power by sample size plot	creates 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.
Power (or sample size) by effect size plot	specifies 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.

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Multiple Regression

About the Multiple Regression Task

The Multiple Regression task calculates the power or sample size for multiple regression.

Example: Solve for Power

To create this example:

1. In the **Tasks** section, expand the **Power and Sample Size** folder, and then double-click **Multiple Regression**. The user interface for the Multiple Regression task opens.
2. Under the **Solve For** heading, select **Power**.
3. Under the **Analysis Details** heading, select **Random predictors**.
4. In the **Number of full model predictors** field, enter `7`.
5. In the **Number of reduced model predictors** field, enter `3`.
6. Under the **Variance Accounted For** heading, select **Partial correlation** from the **Select a form** drop-down list.
7. Enter `.3` as the partial correlation.
8. For the sample size, enter `100`.

   To add a second sample size, click **+**. In the second row, enter `50`.
9. To run the task, click .

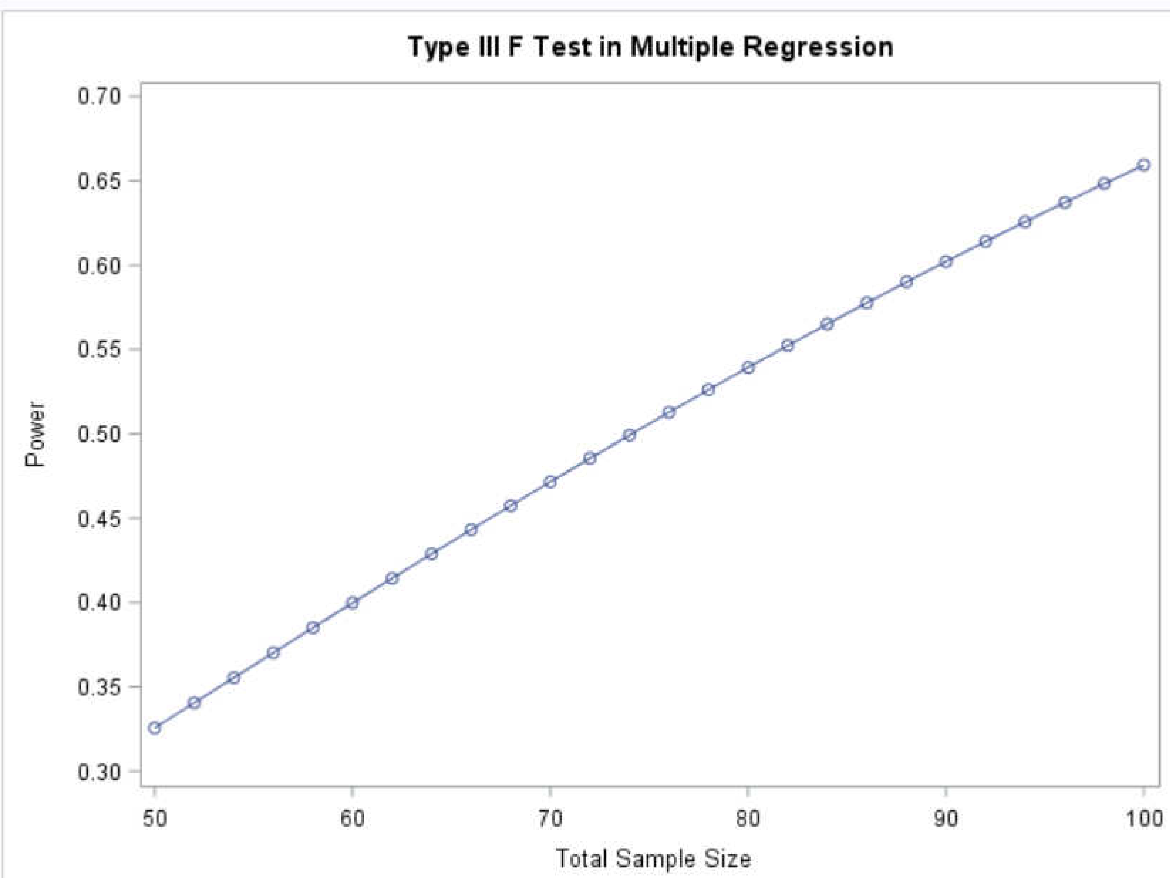
Here are the results:

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

Type III F Test in Multiple Regression



Assigning Properties

For many properties, you can specify more than one value. Click + to specify multiple values.

Note: Specify only one value per row.

Properties	Description
Solve For	
requests a solution for power or total sample size.	
Analysis Details	
specifies whether to use fixed or random predictors in the model. You can also specify whether to include the intercept in the model.	
Significance Level	
specifies the significance level.	
Number of Predictors	
specifies the number of full model and reduced model predictors.	
Variance Accounted For	
Select a form	specifies 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.
Sample Size	
Allow fractional sample sizes	enables fractional input and output for sample sizes.
Sample size values	specifies the total sample size.

Setting the Plot Options

Option Name	Description
Plots	

Option Name	Description
Power by sample size plot	creates 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.
Power (or sample size) by effect size plot	specifies 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.

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Confidence Intervals

About the Confidence Intervals Task

The Confidence Intervals task calculates the power or sample size for these confidence intervals:

- One-sample means is for confidence interval precision involving one sample.
- Paired means is for confidence interval precision involving paired samples.
- Two-sample means is for confidence interval precision involving two independent samples.
- One proportion is for confidence interval precision for a single binomial proportion.

Example: Confidence Interval for One-Sample Means

To create this example:

1. In the **Tasks** section, expand the **Power and Sample Size** folder, and then double-click **Confidence Intervals**. The user interface for the Confidence Intervals task opens.
2. From the **Type of confidence interval** drop-down list, select **One-sample mean**.
3. Under the **Solve For** heading, select **Prob(Width)**.
4. For the half width, enter `14`.
5. For the standard deviation, enter `8`.

6 For the sample size, enter `50`.

7 To run the task, click .

Here is a subset of the results:

Confidence Interval for Mean

Fixed Scenario Elements	
Distribution	Normal
Method	Exact
Number of Sides	2
Alpha	0.05
CI Half-Width	14
Standard Deviation	8
Total Sample Size	50
Prob Type	Conditional

Computed Prob(Width)
Prob(Width)
>.999

Assigning Properties

For many properties, you can specify more than one value. Click + to specify multiple values.

Note: Specify only one value per row.

Properties	Description
Type of Interval	
Type of confidence interval	specifies the confidence interval to use in the analysis. The options available in the task depend on the confidence interval that you choose. For more information about each confidence interval, see the descriptions in "About the Confidence Intervals Task" on page 333.
Solve For	

Properties	Description
specifies 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.	
Analysis Details	
Select an interval	specifies whether to perform the analysis for a one-sided or two-sided interval. **Note:** If you select **One proportion** as the confidence interval, this option is not available.
Select an interval type	specifies the interval to use if you selected **One proportion** from the **Type of confidence interval** drop-down list.
Confidence Level	
specifies the confidence level.	
Half-Width	
specifies the desired confidence interval half-width. The half-width is defined as the distance between the point estimate and a finite endpoint.	
Standard Deviation	
specifies the standard deviation.	
Proportion	
specifies the proportion if you selected **One proportion** as the confidence interval.	
Sample Size	
Allow fractional sample sizes	enables fractional input and output for sample sizes.
Sample size values	specifies the total sample size.

Setting the Plot Options

Option Name	Description
Plots	
Prob(Width) by sample size plot	specifies 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 value for power.
Power (or sample size) by effect size plot	specifies a plot with 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.

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Tests of Proportions

About the Tests of Proportions Task

The Tests of Proportions task calculates the power or sample size for tests of one proportion, two correlated proportions, and two independent proportions.

Example: Power Analysis for One Proportion

To create this example:

1 In the **Tasks** section, expand the **Power and Sample Size** folder, and then double-click **Tests of Proportions**. The user interface for the Tests of Proportions task opens.

2 From the **Type of test** drop-down list, select **One proportion**.

3 Under the **Solve For** heading, select **Power**.

Note: Only the **Power** option is available for a one-proportion test.

4 From the **Select the number of sides of the test** drop-down list, select **One-sided test**.

5 For the proportion, enter `0.2`. For the null proportion, enter `0.3`.

6 For the sample size, enter `119`.

7 To run the task, click .

Here is a subset of the results:

Exact Test for Binomial Proportion

Fixed Scenario Elements	
Method	Exact
Number of Sides	1
Null Proportion	0.3
Nominal Alpha	0.05
Binomial Proportion	0.2
Total Sample Size	119

Computed Power			
Lower Crit Val	Upper Crit Val	Actual Alpha	Power
27	.	0.0478	0.804

Create a One-Proportion Test

To create a one-proportion test:

1 From the **Type of test** drop-down list, select **One proportion**.

2 For the quantity to solve for, select **Power**.

Note: To solve for a total sample size, you must select **Approximate Z-test** or **Approximate continuity-adjusted Z-test** from the **Select a test** drop-down list.

3 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**

4 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.

5 Select whether to perform a one-sided test or a two-sided test.

6 Specify the significance level.

7 Specify the proportion and the null proportion.

8 Specify the sample size and whether to allow for fractional sample sizes.

Create a Two Correlated Proportions Test

To 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**.

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 a 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.

Create a Two Independent Proportions Test

To 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 a two-sided test.

5 Specify the significance level.

6 Specify the form of the proportion and any related values.

7 Specify whether to allow for fractional sample sizes and the form of the sample size.

Setting the Plot Options

Option Name	Description
Plots	
Power by sample size plot	creates 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.
Power (or sample size) by effect size plot	specifies 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.

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t Tests

About the t Tests Task

This task is in the Power and Sample Size category. The *t* Tests task calculates the power or sample size for t tests of means and mean ratios.

Example: One-Sample t Test for Mean

To create this example:

1. In the **Tasks** section, expand the **Power and Sample Size** folder, and then double-click **t Tests**. The user interface for the t Tests task opens.
2. From the **Type of t test** drop-down list, select **One-sample test**.
3. From the **Select the number of sides of the test** drop-down list, select **Two-sided test**.
4. For the mean, enter `8`.
5. For the standard deviation, enter `40`.
6. For the sample size, enter `150`.
7. To run the task, click .

Here is a subset of the results:

One-Sample t Test for Mean

Fixed Scenario Elements	
Distribution	Normal
Method	Exact
Number of Sides	2
Null Mean	0
Alpha	0.05
Mean	8
Standard Deviation	40
Total Sample Size	150

Computed Power
Power
0.682

Assigning Properties

For many properties, you can specify more than one value. Click + to specify multiple values.

Note: Specify only one value per row.

Properties	Description
Type of Test	
Type of t test	performs power and sample size analyses for t tests that involve one sample, paired samples, or two independent samples.
Solve For	
requests a solution for power or total sample size.	
Analysis Details	
Select the assumed distribution of the data	specifies the underlying distribution assumed for the test statistic. By default, the task assumes a normal distribution.
Select the number of sides of the test	specifies the number of sides (or tails) and the direction of the statistical test or confidence interval.

Properties	Description
Select a test	specifies whether to perform the Pooled *t* test or the Satterthwaite *t* test. **Note:** This option is available only for a two-sample test.
Significance Level	
specifies the alpha values for the test.	
Mean	
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.	
Standard Deviation **Note:** This option is available only if you specify a normal distribution.	
specifies the values for standard deviation. ■ 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.	
Coefficient of Variation **Note:** This option is available only if you specify a lognormal distribution.	
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.	
Correlation **Note:** This option is available only if you select a paired test.	
specifies the correlation between members of a pair.	
Sample Size	
specifies the sample size and whether to allow fractional sample sizes.	

Setting the Plot Options

Option Name	Description
Plots	
Power by sample size plot	creates 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.
Power (or sample size) by effect size plot	specifies 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.

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Cox Regression

About the Cox Regression Task

The Cox Regression task 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.

Example: Cox Regression

To create this example:

1 In the **Tasks** section, expand the **Power and Sample Size** folder, and then double-click **Cox Regression**. The user interface for the Cox Regression task opens.

2 Under the **Solve For** heading, select **Power**.

3 For the hazard ratio, enter `1.4`.

4 For the R-square value, enter `.15`.

5 For the standard deviation, enter `1.2`.

6 For the probabilities of uncensored events, enter `0.8`.

7 For the sample size, enter `80`.

8 To run the task, click .

Here is a subset of the results:

Cox Score Test in Proportional Hazards Regression

Fixed Scenario Elements	
Method	Hsieh-Lavori normal approximation
Number of Sides	2
Alpha	0.05
Probability of Event	0.8
R-square of Predictors	0.15
Test Hazard Ratio	1.4
Test Standard Deviation	1.2
Total Sample Size	80

Computed Power
Power
0.846

Assigning Properties

For many properties, you can specify more than one value. Click + to specify multiple values.

Note: Specify only one value per row.

Properties	Description
Solve For	
Select the quantity to solve for	requests a solution for power, total sample size, or total number of uncensored events.
Analysis Details	
Select the number of sides of the test	specifies whether to perform a one-sided test or two-sided test.
Significance Level	
specifies the alpha values.	
Hazard Ratio	

Properties	Description
specifies the hazard ratio for a one-unit increase in the predictor of interest 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.	
R-Square	
specifies 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 $\left(1 - R^2\right)$.	
Standard Deviation	
specifies the standard deviation for the predictor.	
Uncensored Events	
specifies the expected number of uncensored events.	
Sample Size	
specifies whether to allow fractional sample sizes. Specifies the form of the sample size.	

Setting the Plot Options

Option Name	Description
Plots	
Power by sample size plot	creates 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.
Power (or sample size) by effect size plot	specifies 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.

Part 7

Multivariate Analysis

59

Principal Component Analysis

About the Principal Component Analysis Task

Principal component analysis is a multivariate technique for examining relationships among several quantitative variables. Use principal component analysis if you are interested in summarizing data and detecting linear relationships.

Example: Principal Component Analysis of Sashelp.Class Data Set

To create this example:

1 In the **Tasks** section, expand the **Multivariate Analysis** folder, and then double-click **Principal Component Analysis**. The user interface for the Principal Component Analysis task opens.

2 On the **Data** tab, select the **SASHELP.CLASS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column
Analysis variables	**Age** **Height** **Weight**

4 To run the task, click .

Here is a subset of the results:

Observations	19
Variables	3

Simple Statistics			
	Age	Height	Weight
Mean	13.31578947	62.33684211	100.0263158
StD	1.49267216	5.12707525	22.7739335

Correlation Matrix			
	Age	Height	Weight
Age	1.0000	0.8114	0.7409
Height	0.8114	1.0000	0.8778
Weight	0.7409	0.8778	1.0000

Eigenvalues of the Correlation Matrix				
	Eigenvalue	Difference	Proportion	Cumulative
1	2.62135423	2.35296403	0.8738	0.8738
2	0.26839020	0.15813464	0.0895	0.9632
3	0.11025556		0.0368	1.0000

Eigenvectors			
	Prin1	Prin2	Prin3
Age	0.560811	0.795147	0.230722
Height	0.593307	-.191592	-.781843

Assigning Data to Roles

To run the Principal Component Analysis task, you must select an input data source. To filter the input data source, click .

You must assign a variable to the **Analysis variables** role.

Roles	Description
Roles	
Analysis variables	lists the variables for the principal component analysis.
Additional Roles	
Variables to partial out	lists the variables to analyze in a partial correlation or covariance matrix.
Frequency count	lists 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.
Weight	lists 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.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Methods	
Number of components	specifies the number of principal components to compute.

Option Name	Description
Details	
Analyze	specifies whether to compute the principal components from a correlation or covariance matrix.
Correct the covariances or correlations for the means	specifies whether to include the intercept in the model.
Standardize variance of scores	specifies how to standardize the principal component scores. The variance of the scores can be equal to 1 or equal to the corresponding eigenvalue.
Specify a prefix to label the components	specifies 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.
Plots	
By default, an eigenvalue by component plot (scree plot) is displayed in the results. You can also include any of these plots: ■ scores for pairs of components. You can specify whether to include a prediction ellipse. ■ component scores matrix. ■ component profile patterns. ■ patterns for pairs of components.	

Setting the Output Options

You can specify whether to create a component scores data set, a statistics data set, or both.

- The component scores data set contains the original variables from the input data set and the principal component scores.
- The statistics data set contains summary statistics, which include correlations or covariances, eigenvalues, eigenvectors, and so on.

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Factor Analysis

About the Factor Analysis Task

The Factor Analysis task performs a factor analysis with a variety of available methods and rotations.

Example: Factor Analysis

To create this example:

1 In the **Tasks** section, expand the **Multivariate Analysis** folder, and then double-click **Factor Analysis**. The user interface for the Factor Analysis task opens.

2 On the **Data** tab, select the **SASHELP.BASEBALL** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column
Analysis variables	**nAtBat**
	nHits
	nHome
	nRuns
	nRBI
	nBB
	YrMajor
	CrAtBat

4 On the **Options** tab, select these options:

- From the **Rotation method** drop-down list, select **Varimax**.
- For the type of rotation, select **Orthogonal rotation**.

5 To run the task, click .

Here is a subset of the results:

Table of Contents

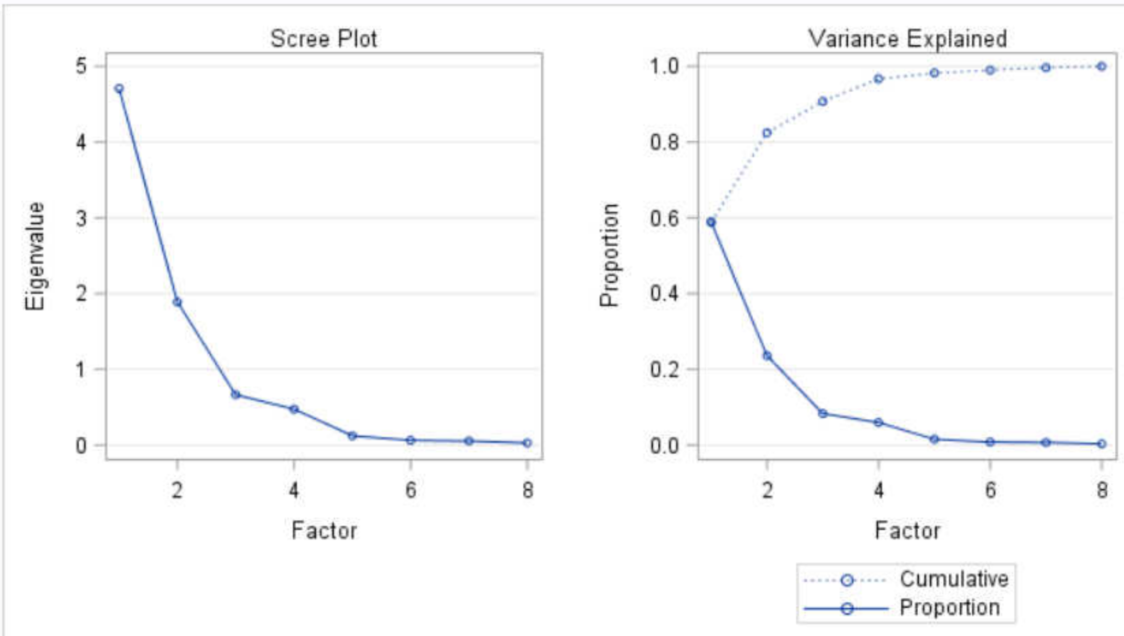
Input Data Type	Raw Data
Number of Records Read	322
Number of Records Used	322
N for Significance Tests	322

Initial Factor Method: Principal Components

Prior Communality Estimates: ONE

Eigenvalues of the Correlation Matrix: Total = 8 Average = 1				
	Eigenvalue	Difference	Proportion	Cumulative
1	4.70772244	2.81898447	0.5885	0.5885
2	1.88873797	1.22499933	0.2361	0.8246
3	0.66373863	0.18952935	0.0830	0.9075
4	0.47420928	0.35200013	0.0593	0.9668
5	0.12220915	0.06037596	0.0153	0.9821
6	0.06183320	0.00806094	0.0077	0.9898
7	0.05377225	0.02599518	0.0067	0.9965
8	0.02777708		0.0035	1.0000

8 factors will be retained by the NFACTOR criterion.



Factor Pattern									
		Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8
nAtBat	Times at Bat in 1986	0.92957	-0.14680	0.18780	-0.21882	-0.05841	-0.06884	0.12762	-0.08224
nHits	Hits in 1986	0.91912	-0.15102	0.21044	-0.26571	-0.02934	0.02632	0.00579	0.12627
nHome	Home Runs in 1986	0.76735	0.00853	-0.61180	0.12780	0.10687	-0.04547	0.07646	0.03371
nRuns	Runs in 1986	0.93433	-0.18233	0.14252	-0.02829	0.24358	0.05584	-0.08958	-0.04700
nRBI	RBIs in 1986	0.91863	-0.00528	-0.30806	-0.03929	-0.20783	0.05939	-0.10753	-0.03689
nBB	Walks in 1986	0.75774	0.02414	0.29875	0.57613	-0.05890	-0.00413	0.01892	0.01489
YrMajor	Years in the Major Leagues	0.13443	0.97515	0.01536	-0.03637	0.01668	0.15303	0.07526	-0.00941
CrAtBat	Career Times at Bat	0.31771	0.92711	0.07198	-0.06164	0.01570	-0.15573	-0.07743	0.00729

Variance Explained by Each Factor							
Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8
4.7077224	1.8887380	0.6637386	0.4742093	0.1222092	0.0618332	0.0537723	0.0277771

Final Communality Estimates: Total = 8.000000							
nAtBat	nHits	nHome	nRuns	nRBI	nBB	YrMajor	CrAtBat
1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000

Assigning Data to Roles

To run the Factor Analysis task, you must select an input data source. To filter the input data source, click .

You must assign a variable to the **Analysis variables** role.

Roles	Description
Roles	
Analysis variables	specifies the numeric variables to analyze.
Additional Roles	
Variables to partial out	specifies 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 covariance matrix.
Frequency count	lists 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.
Weight	specifies the relative weights for each observation in the input data set.
Group analysis by	enables you to obtain separate analyses of observations in groups that are defined by the BY variables.

Setting Options

Option Name	Description
Methods	
Factor Extraction	
Show only common extraction methods	specifies to include only the common extraction methods in the **Factor extraction method** drop-down list. The common extraction methods are iterated principal factor analysis, maximum likelihood, and principal component analysis.

Option Name	Description
Factor extraction method	specifies 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: ■ Alpha factor analysis ■ Harris component analysis ■ Image component analysis ■ Unweighted least squares factor analysis
Number of factors	specifies the maximum number of factors to be extracted. The default is the number of variables.
Details	
Estimation method for prior communalities	specifies 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**
Analyze	specifies whether to factor the correlation matrix or the covariance matrix.
Correct the covariances or correlations for the means	specifies whether to include the intercept in the analysis. Select this check box to include the intercept in the analysis and to correct the covariances or correlations for the mean.
Specify a prefix to label the factors	specifies 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.
Heywood cases: Set communalities to 1 that are greater than 1	sets any communality that is greater than 1 to 1. 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.
Specify the maximum number of iterations	specifies the maximum number of iterations for factor extraction. 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.
Rotation	

Option Name	Description
Rotation method and **Select type of rotation**	specifies 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**
Details	
Method to normalize factor pattern rows	specifies the method for normalizing the rows of the factor pattern for rotation. You can specify the maximum number of rotation cycles.
Statistics	
Specify the statistics to display in the results. In addition to the default statistics, you can also include these statistics: ■ 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.	
Plots	
By default, the eigenvalue by component (scree) plot and a plot of the variance explained are displayed in the results. 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.	

Setting the Output Options

You can specify whether to create a factor scores data set, a statistics data set, or both.

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Canonical Correlation

About the Canonical Correlation Analysis Task

Canonical correlation is a generalization of multiple correlations for analyzing the relationship between two sets of variables. The Canonical Correlation task performs canonical correlation, partial canonical correlation, and canonical redundancy analysis.

Example: Canonical Correlation Analysis

To create this example:

1 In SAS Studio, click  and select **New SAS Program**.

2 Copy and paste this code into the **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 to create the Work.Jobs data set.

3 In the **Tasks** section, expand the **Multivariate Analysis** folder, and then double-click **Canonical Correlation**. The user interface for the Canonical Correlation task opens.

4 On the **Data** tab, select the **WORK.JOBS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

5 Assign columns to these roles:

Role	Column
Variable set 1	**career** **supervisor** **finance**
Variable set 2	**variety** **feedback** **autonomy**

6 To run the task, click .

Here is a subset of the results:

Canonical Correlation Analysis

					Eigenvalues of Inv(E)*H = CanRsq/(1-CanRsq)				Test of H0: The canonical correlations in the current row and all that follow are zero				
	Canonical Correlation	Adjusted Canonical Correlation	Approximate Standard Error	Squared Canonical Correlation	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.

Assigning Data to Roles

To run the Canonical Correlation Analysis task, you must select an input data source and assign a variable to the **Variable set 1** role and the **Variable set 2** role. To filter the input data source, click .

Roles	Description
Roles	
Variable set 1	lists the variables to include in the first set.
Variable set 2	lists the variables to include in the second set.
Prefixes and Labels of Canonical Variables	
Prefix and label for variable set 1	specifies 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.
Prefix and label for variable set 2	specifies 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.
Additional Roles	
Variables to partial out	specifies to base 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**.
Frequency count	lists 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.

Roles	Description
Weight	specifies the numeric variable to compute weighted product-moment correlation coefficients.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Canonical Analysis	
Canonical redundancy statistics	produces canonical redundancy statistics.
Specify number of canonical variates	specifies 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.
Regression Analysis	
Perform regression	performs 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.
Regression Statistics	
You can include these regression statistics in the output: ■ regression coefficients ■ standardized regression coefficients ■ standardized error of coefficients ■ *t* statistics for coefficients ■ squared multiple correlation	
Correlations	

Option Name	Description
	You can include these correlation statistics in the output: ■ correlations of regression coefficients ■ partial correlations ■ squared partial correlations ■ semipartial correlations ■ squared semipartial correlations
Plots	specifies whether to create canonical variable plots. These plots are not created by default.

Setting the Output Options

You can specify whether to create a score data set, a statistics data set, or both.

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Discriminant Analysis

About the Discriminant Analysis Task

For a set of observations with one or more quantitative variables and a classification variable, the Discriminant Analysis task 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 task 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.

Example: Discriminant Analysis on Crops Data

To create this example:

1 In SAS Studio, click  and select **New SAS Program**.

2 Create the Crops data set by copying and pasting this code into a **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 to create this data set in the Work library.

3 In the **Tasks** section, expand the **Multivariate Analysis** folder, and then double-click **Discriminant Analysis**. The user interface for the Discriminant Analysis task opens.

4 On the **Data** tab, select the **WORK.CROPS** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

5 Assign columns to these roles:

Role	Column Name
Group variable	**Crop**
Quantitative variables	**x1** **x2** **x3** **x4**

6 To run the task, click .

Here is a subset of the results:

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	0.200000
Corn	Corn	7	7.0000	0.194444	0.200000
Cotton	Cotton	6	6.0000	0.166667	0.200000
Soybeans	Soybeans	6	6.0000	0.166667	0.200000
Sugarbeets	Sugarbeets	6	6.0000	0.166667	0.200000

Pooled Covariance Matrix Information	
Covariance Matrix Rank	Natural Log of the Determinant of the Covariance Matrix
4	21.30189

Generalized Squared Distance to Crop					
From Crop	**Clover**	**Corn**	**Cotton**	**Soybeans**	**Sugarbeets**
Clover	0	4.25308	0.86617	2.58313	1.48910
Corn	4.25308	0	1.88446	0.73031	2.89043
Cotton	0.86617	1.88446	0	1.43467	1.29556
Soybeans	2.58313	0.73031	1.43467	0	1.07646
Sugarbeets	1.48910	2.89043	1.29556	1.07646	0

Linear Discriminant Function for Crop					
Variable	**Clover**	**Corn**	**Cotton**	**Soybeans**	**Sugarbeets**
Constant	-9.79895	-6.08309	-9.67361	-5.49084	-8.01003
x1	0.08907	-0.04180	0.02462	0.0000369	0.04245
x2	0.17379	0.11970	0.17596	0.15896	0.20988
x3	0.11899	0.16511	0.15880	0.10622	0.06540
x4	0.15637	0.16768	0.18362	0.14133	0.16408

Assigning Data to Roles

To run the Discriminant Analysis task, you must select an input data source and assign a variable to the **Group variable** role. To filter the input data source, click .

Roles	Description
Roles	
Group variable	specifies the group variable for the discriminant analysis. To specify the prior probabilities of group membership, click **Priors**. By default, the prior probabilities are equal.
Quantitative variables	specifies the quantitative variables to use in the analysis.
Additional Roles	

Roles	Description
Frequency count	lists 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.
Weight	lists the relative weight for each observation in the data source.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Methods	
Classification criterion method	specifies 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.
Discriminant function	determines whether the pooled or within-group covariance matrix is the basis of the measure of the squared distance. ■ If you select **Linear**, the task uses the pooled covariance matrix in calculating the (generalized) squared distances. Linear discriminant functions are computed. ■ If you select **Quadratic**, the task uses the individual within-group covariance matrices in calculating the distances. Quadratic discriminant functions are computed.
Canonical analysis	specifies 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.

Option Name	Description
Validation	
Perform cross validation	specifies the cross validation classification of the input data set. When a parametric method is used, each observation in the input data set 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 used to compute the distances are based on all observations in the data set, excluding the observation being classified. However, the observation being classified is excluded from the nonparametric density estimation or the *k* nearest neighbors of that observation.
Perform data set validation	specifies the data set that contains the observations to be classified. The names of the quantitative variables in this data set must match the names in the input data set.
Create classification data set	creates an output SAS data set that contains all the data from the **Data set to classify** data set, plus the posterior probabilities and the class into which each observation is classified. If you select the **Canonical analysis** check box, the data set also contains new variables with canonical variable scores.
Create classification density data set	creates an output SAS data set that contains all the data from the **Data set to classify** data set, plus the group-specific density estimates for each observation.
Statistics	
Squared Mahalanobis distances	displays 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	displays the posterior probability error-rate estimates of the classification criterion based on the classification results.
Simple descriptive statistics	displays simple descriptive statistics for the total sample and within each class.
Classification results	displays the resubstitution classification results for each observation.
Misclassified observations	displays the resubstitution classification results for misclassified observations only.

Setting the Selection Options

Specify a selection method to select the variables to include in the model. The available options depend on the selection method.

Selection Method	Description
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.

Setting the Output Options

You can choose to create these data sets:

- classification results
- statistics
- density

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Correspondence Analysis

About the Correspondence Analysis Task

The Correspondence Analysis task performs simple or multiple correspondence analysis of qualitative data. You can specify either raw data or table data for the input data source.

Example: Correspondence Analysis

To create this example:

1 In SAS Studio, click  and select **New SAS Program**.

2 Copy and paste this code into the **Program** tab.

```
data PhD;
   input Science $ 1-21 y1973-y1978;
   label y1973 = '1973' y1974 = '1974' y1975 = '1975' y1976 = '1976'
      y1977 = '1977' y1978 = '1978';
datalines;
Life Sciences         4489 4303 4402 4350 4266 4361
Physical Sciences     4101 3800 3749 3572     3410 3234
Social Sciences       3354 3286 3344 3278 3137 3008
Behavioral Sciences   2444 2587 2749 2878     2960 3049
Engineering           3338 3144 2959 2791 2641 2432
```

```
Mathematics          1222 1196 1149 1003 959 959
;
```

Click to create the Work.PhD data set.

3 In the **Tasks** section, expand the **Multivariate Analysis** folder, and then double-click **Correspondence Analysis**. The user interface for the Correspondence Analysis task opens.

4 On the **Data** tab, select the **WORK.PHD** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

5 From the **Data layout** drop-down list, select **Table data**.

6 Assign columns to these roles:

Role or Option	Option Name or Column
Roles	
Analysis	**Simple correspondence analysis**
Columns of the contingency table	**y1973** **y1974** **y1975** **y1976** **y1977** **y1978**
Additional Roles	
Label contingency table rows	**Science**

7 To run the task, click .

Here is a subset of the results:

▸ Table of Contents

Inertia and Chi-Square Decomposition

Singular Value	Principal Inertia	Chi-Square	Percent	Cumulative Percent
0.05845	0.00342	368.653	96.04	96.04
0.00861	0.00007	7.995	2.08	98.12
0.00694	0.00005	5.197	1.35	99.48
0.00414	0.00002	1.852	0.48	99.96
0.00122	0.00000	0.160	0.04	100.00
	0.00356	383.856	100.00	

Degrees of Freedom = 25

Row Coordinates

	Dim1	Dim2
Life Sciences	0.0258	0.0081
Physical Sciences	-0.0413	-0.0024
Social Sciences	0.0014	-0.0114
Behavioral Sciences	0.1100	-0.0013
Engineering	-0.0704	-0.0037
Mathematics	-0.0639	0.0228

Assigning Data to Roles

To run the Correspondence Analysis task, you must select an input data source. To filter the input data source, click . In the Correspondence Analysis task, you can choose the data layout: raw data or table data. The **Roles** options differ depending on the data layout.

Simple Correspondence Analysis of Raw Data

These options are available if you select a data layout of raw data and the simple correspondence analysis.

To run a simple correspondence analysis of raw data, you must assign variables to the **Row variables** and **Column variables** roles.

Option Name	Description
Roles	
Row variables	specifies the values to use to construct the rows of the contingency table.
Column variables	specifies the values to use to construct the columns of the contingency table.

Option Name	Description
Treat missing values as a distinct level	specifies whether to include missing values in the analysis.
Additional Roles	
Supplementary row variables	specifies 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. **Note:** This role is not available if you assign row variables and select **The factorial combinations of levels of the row variables appear as table row** from the **Create the contingency table rows** drop-down list.
Supplementary column variables	specifies 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. **Note:** This role is not available if you assign column variables and select **The factorial combinations of levels of the column variables appear as table columns** option from the **Create the contingency table columns** drop-down list.
Weight variable	specifies weights for each observation and indicates supplementary observations for simple correspondence analyses.
Group analysis by	creates separate analyses of observations in groups that are defined by the BY variables.

Multiple Correspondence Analysis of Raw Data

These options are available if you select a data layout of raw data and the multiple correspondence analysis.

To run a multiple correspondence analysis of raw data, you must assign a variable to the **Column variables** role.

Option Name	Description
Roles	
Column variables	specifies the values to use to construct the columns of the contingency table. You must assign at least two variables to this role.
Treat missing values as a distinct level	specifies whether to include missing values in the analysis.
Additional Roles	
Supplementary column variables	specifies 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.
Weight variable	specifies weights for each observation and indicates supplementary observations for simple correspondence analyses.
Group analysis by	creates separate analyses of observations in groups that are defined by the BY variables.

Simple Correspondence Analysis of Table Data

These options are available if you select a data layout of table data and the simple correspondence analysis.

To run a simple correspondence analysis of table data, you must assign at least two variables to the **Columns of the contingency table** role.

Option Name	Description
Roles	
Columns of the contingency table	reads an existing contingency table, binary indicator matrix, fuzzy-coded indicator matrix, or Burt table, rather than raw data.
Additional Roles	

Option Name	Description
Supplementary columns of the contingency table	specifies 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.
Label contingency table rows	labels the rows of the tables with the values of this variable and includes this variable in the output data set.
Weight variable	specifies weights for each observation and indicates supplementary observations for simple correspondence analyses for table data.
Group analysis by	creates separate analyses of observations in groups that are defined by the BY variables.

Multiple Correspondence Analysis of Table Data

These options are available if you select a data layout of table data and the multiple correspondence analysis.

To run the Correspondence Analysis task, you must assign variables to the **Columns of the Burt table** role. A Burt table is a symmetric matrix of crosstabulations among several categorical variables.

Option Name	Description
Roles	
Columns of the Burt table	specifies the variables to use in the analysis.
Number of variables used to create the Burt table	specifies the number of classification variables to use to create the table.
Additional Roles	
Supplementary columns of the Burt table	specifies 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.

Option Name	Description
Group analysis by	creates separate analyses of observations in groups that are defined by the BY variables.

Setting Options

Option Name	Description
Methods	
Number of dimensions	specifies the number of dimensions or axes to use.
Details	
Display as frequencies or percents	specifies whether to include the frequencies, percents, or both in the output.
Standardize coordinates	specifies 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.
Statistics	
The available statistics depend on the type of analysis that you are performing. You can choose what statistics to display in the results. 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 a multiple correspondence analysis, these statistics are available: ■ column coordinates ■ column profile ■ inertia—P-value for chi-square, Benzécri adjusted inertia, and Greenacre adjusted inertia ■ frequencies—observed, expected, deviation, and cell contribution to chi-square	
Plots	
By default, the inertia plot and configuration plot are included in the output. You can choose to remove one or both of these plots from the output.	

Setting the Output Options

You can specify whether to create a coordinates data set.

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Multidimensional Preferences Analysis

About the Multidimensional Preference Analysis Task

The Multidimensional Preference Analysis task 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.

Example: Multidimensional Preference Analysis

To create this example:

1 In SAS Studio, click  and select **New SAS Program**.

2 Copy and paste this code onto the **Program** tab.

```
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 to create the Work.IceCream data set.

3 In the **Tasks** section, expand the **Multivariate Analysis** folder, and then double-click **Multidimensional Preference Analysis**. The user interface for the Multidimensional Preference Analysis task opens.

4 On the **Data** tab, select the **WORK.ICECREAM** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

5 Assign columns to these roles:

Role	Column Name
Raters	**consumer 1** **consumer 2** **consumer 3**

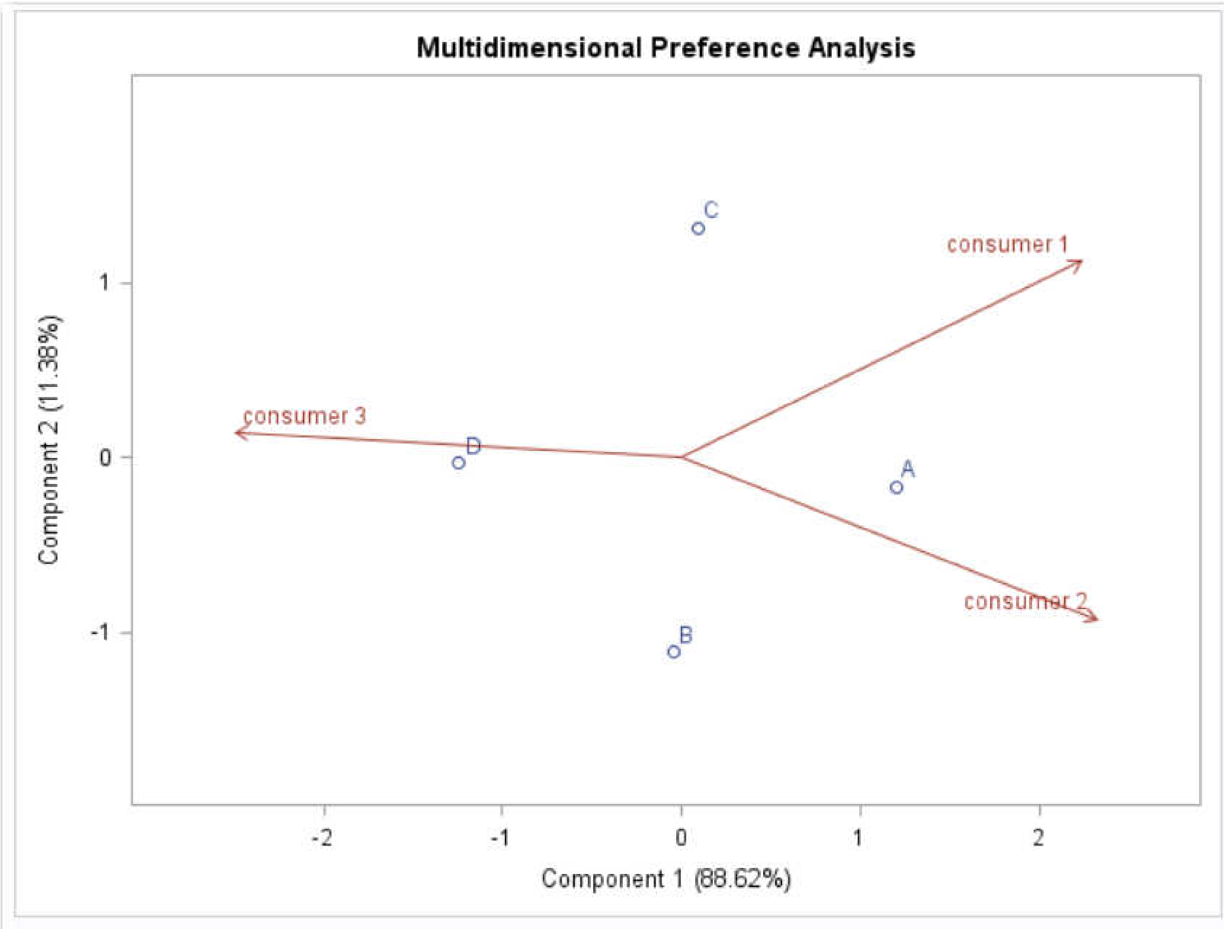
6 On the **Options** tab, assign **brand** to the **Label MDPREF plot points** role.

7 To run the task, click .

Here is a subset of the results:

PRINQUAL MTV Algorithm Iteration History					
Iteration Number	Average Change	Maximum Change	Proportion of Variance	Criterion Change	Note
1	0.01363	0.01987	0.99972		
2	0.00011	0.00017	1.00000	0.00028	
3	0.00000	0.00000	1.00000	0.00000	Converged

Algorithm converged.



Assigning Data to Roles

To run the Multidimensional Preferences Analysis task, you must select an input data source. 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 transpose of the usual multivariate data matrix. In other words, the columns are the people. In a more typical matrix, the rows represent people. To filter the input data source, click .

You must assign at least two variables to the **Raters** role.

Option Name	Description
Roles	
Raters	specifies the variables to analyze.
Level of measurement	specifies the level of measurement for the analysis variables.

<table>
<tr><th>Option Name</th><th>Description</th></tr>
<tr><td>Transformation</td><td>specifies the transformation to use in the analysis. The transformation options depend on the value 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.</td></tr>
<tr><td>Degree of spline</td><td>specifies 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.</td></tr>
<tr><td>Number of knots</td><td>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.</td></tr>
</table>

Option Name	Description
Larger values for preferences	specifies whether to reflect the transformation $y = -(y - \bar{y}) + \bar{y}$ 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.
Additional Roles	
Frequency count	lists 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.
Group analysis by	obtains separate analyses of observations in each unique group.

Setting Options

Option Name	Description
Methods	
Number of components	specifies the number of principal components to compute.
Details	
Analyze	specifies whether to compute the principal components from the correlation matrix or the covariance matrix.
Exclude observations with missing values	excludes 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 task computes the optimal transformations of the nonmissing values and estimates the missing values that minimize the squared error.
Standardize variance of scores	standardizes the principal component scores in the output data set to mean zero and variance one or a default mean of zero and variance equal to the corresponding eigenvalue.

Option Name	Description
Specify the maximum number of iterations	specifies the maximum number of iterations.
Plots	

By default, these plots appear 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.

Setting the Output Options

You can specify whether to create a component scores data set.

Part 8

Econometrics Tasks

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Causal Models

About the Causal Models Task

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 task, you can use these two techniques:

- two-stage least squares
- Heckman's two-step selection method

Two-Stage Least Squares

Example: Two-Stage Least Squares

To create this example:

1 In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Causal Models**. The user interface for the Causal Models task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
Dependent variable	**sale**
Exogenous explanatory variables	**price**
Endogenous explanatory variables	**cost**
Excluded instrumental variables	**price1** **price2**

4 To run the task, click .

Here is a subset of the results:

The MODEL Procedure

Model Summary	
Model Variables	2
Endogenous	1
Parameters	3
Equations	1
Number of Statements	1

Model Variables	cost sale
Parameters	c0 cy1 cx1
Equations	sale

The Equation to Estimate is	
sale =	F(c0(1), cy1(cost), cx1(price))
Instruments	1 cost price1 price2

NOTE: At 2SLS Iteration 1 CONVERGE=0.001 Criteria Met.

The MODEL Procedure
2SLS Estimation Summary

Data Set Options	
DATA=	SASHELP.PRICEDATA

Minimization Summary	
Parameters Estimated	3
Method	Gauss
Iterations	1

Assigning Data to Roles

To perform a two-stage least squares analysis, you must assign an input data set. To filter the input data source, click .

You also must assign variables to the **Dependent variable**, **Exogenous explanatory variables**, **Endogenous explanatory variables**, and **Excluded instrumental variables** roles. The number of variables that you assign to the **Excluded instrumental variables** role must be greater than or equal to the number of endogenous explanatory variables.

Role	Description
Roles	
Dependent variable	specifies the dependent variable for the equation. The equation is in this format: $y_1 = c_0 + c_1 * y_2 + c_2 * y_3 + c_3 * x_1 + c_4 * x_2$. In this equation: ■ y_1 is the dependent variable. ■ y_2 and y_3 are endogenous explanatory variables. ■ x_1 and x_2 are exogenous explanatory variables.
Exogenous explanatory variables	specifies a factor in the model whose values are not determined by the states of other variables in the system.
Endogenous explanatory variables	specifies a factor in the model whose values are determined by the states of other variables in the system.
Excluded instrumental variables	specifies the variables not to include in the equation.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option	Description
Methods	
Optimization method	specifies the optimization method to use. You can use the default method, or you can choose from these methods: ■ **Gauss-Newton** ■ **Marquardt-Levenberg**

Option	Description
Maximum number of iterations	specifies the maximum number of iterations for the selected method. You can use the default value or specify a custom value.
Statistics	
You can specify whether the results include the statistics that the task creates by default, the default statistics and any additional statistics that you select, or no statistics. Here are the additional 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	
Plots	
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	

Creating the Output Data Sets

You can create a data set that contains the parameter estimates from the analysis.

Heckman's Two-Step Selection Method

About Heckman's Two-Step Selection Method

The Heckman 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 **Tasks** section, expand the **Econometrics** folder, and then double-click **Causal Models**. The user interface for the Causal Models task opens.
2. On the **Data** tab, select the **SASHELP.JUNKMAIL** data set.

   > **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3. Under the **Analysis** heading, select **Heckman's two-step selection method**.
4. Assign columns to these roles:

Role	Column Name
Outcome Equation	
Dependent variable	**Business**
Continuous variables	**CapAvg** **CapTotal**
Selection Equation	
Dependent variable	**Class**
Categorical variables	**Make**

5. To run the task, click .

Here is a subset of 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

Class Level Information		
Class	Levels	Values
Make	142	0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18 0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26 0.27 0.28 0.29 0.3 0.31 0.32 0.33 0.34 0.35 0.36 0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44 0.45 0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53 0.54 0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62 0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71 0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89 0.9 0.93 0.95 0.96 0.97 0.98 0.99 1 1.01 1.02 1.03 1.04 1.05 1.06 1.07 1.08 1.09 1.11 1.12 1.14 1.16 1.17 1.18 1.19 1.23 1.24 1.26 1.31 1.36 1.39 1.42 1.44 1.47 1.49 1.61 1.63 1.75 1.88 2 2.12 2.27 2.32 2.35 2.43 2.77 2.85 3.03 3.84 3.94 4 4.34 4.54

Heckman First Step Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	Class
Number of Observations	4601
Log Likelihood	-2807
Maximum Absolute Gradient	0.00230
Number of Iterations	192
Optimization Method	Quasi-Newton
AIC	5897
Schwarz Criterion	6811

Assigning Data to Roles

To perform an analysis that uses Heckman's two-step selection method, you must assign an input data set. To filter the input data source, click . Then under the **Analysis** heading, select **Heckman's two-step selection method**.

You must assign columns to the **Dependent variable** roles for the selection and outcome equations.

Role	Description
Outcome Equation	

Role	Description
Dependent variable	specifies a single numeric column to use.
Continuous variables	specifies the independent variables (or regressors) to use in the model for the outcome equation dependent variable.
Categorical values	specifies the independent variables to use to group the values into levels.
Include the intercept	specifies whether to include the intercept in the selection equation.
Selection Equation	
Dependent variable	specifies a single numeric column that takes binary values. Select the value to use for the dependent variable from the **Select samples with dependent variable** drop-down list.
Continuous variables	specifies the independent variables (or regressors) to use in the model for the selection equation dependent variable.
Categorical variables	specifies the independent variables to use to group the values into levels.
Include the intercept	specifies whether to include the intercept in the selection equation.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option	Description
Methods	

Option	Description
Optimization method	specifies the iterative minimization method to use. You can use the default method, or you can choose from these methods: ■ **Conjugate-gradient** ■ **Double-dogleg** ■ **Nelder-Mead simplex** ■ **Newton-Raphson combining line-search with ridging** ■ **Quasi-Newton** ■ **Trust region**
Maximum number of iterations	specifies the maximum number of iterations for the selected method. You can use the default value or specify a custom value.
Variance estimation method	specifies whether to calculate the standard errors by using the corrected standard errors or the OLS standard errors.
Type of covariances of the parameter estimates	specifies 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).
Statistics	
You can specify whether the results include the statistics that the task creates by default, the default statistics and any additional statistics that you select, or no statistics. Here is the information 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	

Creating the Output Data Sets

You can create a data set that contains the parameter estimates from the analysis.

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Cross-sectional Data Models

About the Cross-Sectional Data Models Task

The Cross-Sectional Data Models task applies econometric techniques to analyze cross-sectional data. Conceptually, the models for this task are similar to the models for the Panel Data Models task. However, in the Cross-Sectional Data Models task, no panel structure (which consists of the cross-sectional ID and the time ID variables) is required.

Linear Models

Example: Linear Regression with Fixed Effects

To create this example:

1 Create the Work.Cigar data set. For more information, see “CIGAR Data Set” on page 563.

2 In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Cross-sectional Data Models**. The user interface for the Cross-Sectional Data Models task opens.

3 On the **Data** tab, select the **WORK.CIGAR** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Dependent variable	**sales**
Continuous variables	**price** **cpi** **ndi**
Categorical variables	**state**

5 On the **Model** tab, select **Linear** as the model type.

6 To run the task, click .

Here is a subset of the results:

Model: MODEL1
Dependent Variable: sales Cigarette sales in packs per capita

Number of Observations Read	1380
Number of Observations Used	1380

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	48	1091152	22732	129.69	<.0001
Error	1331	233302	175.28330		
Corrected Total	1379	1324454			

Root MSE	13.23946	R-Square	0.8239
Dependent Mean	123.95087	Adj R-Sq	0.8175
Coeff Var	10.68122		

Note: Model is not full rank. Least-squares solutions for the parameters are not unique. Some statistics will be misleading. A reported DF of 0 or B means that the estimate is biased.

Note: The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

state 51 =	Intercept - state 1 - state 3 - state 4 - state 5 - state 7 - state 8 - state 9 - state 10 - state 11 - state 13 - state 14 - state 15 - state 16 - state 17 - state 18 - state 19 - state 20 - state 21 - state 22 - state 23 - state 24 - state 25 - state 26 - state 27 - state 28 - state 29 - state 30 - state 31 - state 32 - state 33 - state 35 - state 36 - state 37 - state 39 - state 40 - state 41 - state 42 - state 43 - state 44 - state 45 - state 46 - state 47 - state 48 - state 49 - state 50

Parameter Estimates									
							Heteroscedasticity Consistent		
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standard Error	t Value	Pr > |t|
Intercept	Intercept	B	132.12906	2.61514	50.52	<.0001	3.02535	43.67	<.0001

Assigning Data to Roles

To perform an analysis of a linear model, you must assign an input data set. To filter the input data source, click .

You also must assign a variable to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the numeric variable for the analysis.

Role	Description
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group. **Note:** This role is not available if you have a categorical variable.

Setting the Model Options

To create a linear model:

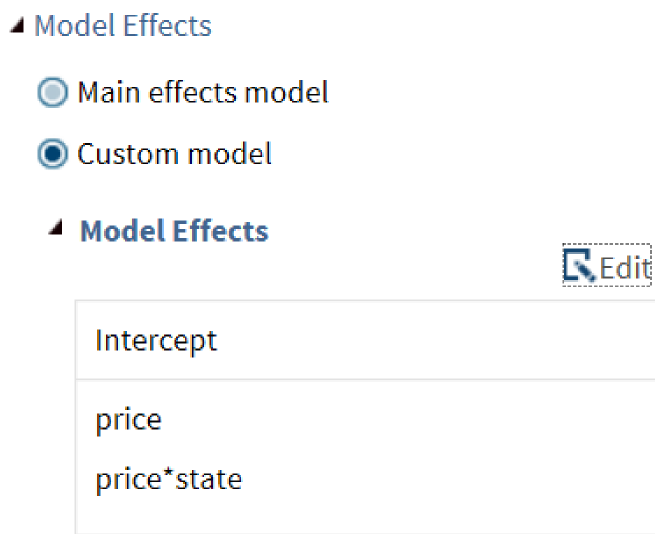
1. From the **Model type** drop-down list, select **Linear**.
2. Specify the effects for your model.

   You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

   - To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
   - To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

   When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies the method to calculate the covariance matrix of parameter estimates. You can select the default value, or you can choose from these methods: ■ **White** ■ **HC*n*** specifies a heteroscedasticity-corrected covariance matrix. ***n*** is a value from 0–3.
Statistics	
Select the statistics to display in the results. Here are the additional statistics that you can include in the results: ■ correlations of the parameter estimates ■ covariances of the parameter estimates ■ heteroscedasticity-consistent standard errors	
Plots	

Option Name	Description
	Select the plots to include in the results. By default, diagnostic, residual, and fit plots are included in the results. You can include these plots: ■ diagnostic plots, such as residuals for each explanatory variable, R-student statistic by predicted values, and normal quantile plot of the residuals ■ output plots, such as a fit plot for a single continuous variable, a plot of observed values by predicted values, and partial regression plots for each explanatory variable You can choose to display these plots as a panel of plots or as individual plots.

Creating the Output Data Sets

You can create an output data set that contains the parameter estimates.

Logit Model

Example: Logit Model

To create this example:

1 Create the Work.Moz data set. For more information, see “MROZ Data Set” on page 608.

2 In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Cross-sectional Data Models**. The user interface for the Cross-Sectional Data Models task opens.

3 On the **Data** tab, select the **WORK.MROZ** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Dependent variable	**inlf**
Continuous variables	**nwifeinc** **educ** **exper** **expersq**
Categorical variables	**kidsge6**

5 On the **Model** tab, select **Logit** as the model type.

6 On the **Options** tab, expand the **Heteroscedasticity** heading, and then select the **Analyze heteroscedasticity** check box. Assign the **nwifeinc** variable to the **Variables on the variance function** role.

7 To run the task, click .

Here is a subset of 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	-433.58187
Maximum Absolute Gradient	0.00920
Number of Iterations	148
Optimization Method	Quasi-Newton
AIC	895.16374
Schwarz Criterion	959.90066

Goodness-of-Fit Measures		
Measure	Value	Formula
Likelihood Ratio (R)	162.58	2 * (LogL - LogL0)
Upper Bound of R (U)	1029.7	- 2 * LogL0
Aldrich-Nelson	0.1776	R / (R+N)
Cragg-Uhler 1	0.1942	1 - exp(-R/N)
Cragg-Uhler 2	0.2606	(1-exp(-R/N)) / (1-exp(-U/N))

Assigning Data to Roles

To perform an analysis of a logit model, you must assign an input data set. To filter the input data source, click .

You also must assign a variable to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the numeric variable for the analysis.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a logit model:

1 From the **Model type** drop-down list, select **Logit**.

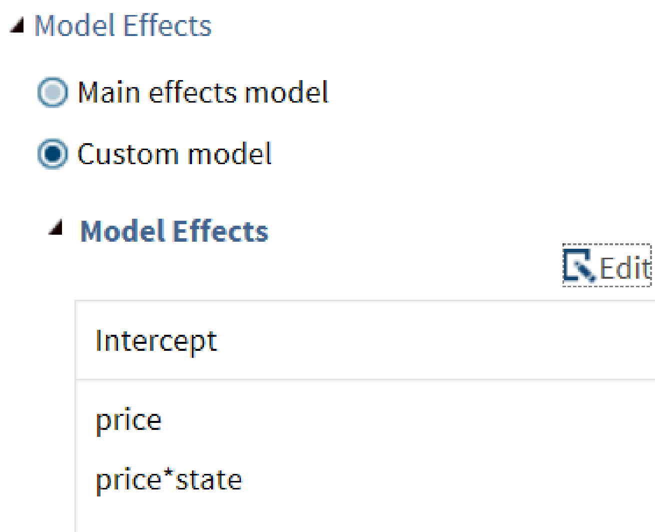
2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



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.

Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies the method to calculate the covariance matrix of parameter estimates. You can use the default method, 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.
Statistics	

<table>
<tr><th>Option Name</th><th>Description</th></tr>
<tr><td colspan="2">Select the statistics to display in the results.
Here are the additional 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</td></tr>
<tr><td colspan="2">Plots</td></tr>
<tr><td colspan="2">You can choose to display only the default plots, the selected plots, or no plots in the results.
You can choose from these types of plots:
diagnostic plots, such as error standard deviations by observed regressor and profiled log likelihood
output plots, such as predicted values by regressor, marginal effects by regressor, Inverse Mills ratio by regressor, predicted response probability by regressor, predicted probabilities for each level of the response by regressor, and linear predictor values by regressor</td></tr>
</table>

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional 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
- a parameter estimates data set

Probit Model

Example: Probit Model

To create this example:

1. Create the Work.Moz data set. For more information, see “MROZ Data Set” on page 608.
2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Cross-sectional Data Models**. The user interface for the Cross-Sectional Data Models task opens.
3. On the **Data** tab, select the **WORK.MROZ** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set

that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Dependent variable	**inlf**
Continuous variables	**nwifeinc** **educ** **exper** **expersq**
Categorical variable	**kidsge6**

5 On the **Model** tab, select **Probit** as the model type.

6 On the **Options** tab, expand the **Heteroscedasticity** heading, and then select the **Analyze heteroscedasticity** check box. Assign the **nwifeinc** variable to the **Variables on the variance function** role.

7 To run the task, click .

Here is a subset of 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	-433.82638
Maximum Absolute Gradient	0.00184
Number of Iterations	176
Optimization Method	Quasi-Newton
AIC	895.65275
Schwarz Criterion	960.38967

Goodness-of-Fit Measures		
Measure	Value	Formula
Likelihood Ratio (R)	162.09	2 * (LogL - LogL0)
Upper Bound of R (U)	1029.7	- 2 * LogL0
Aldrich-Nelson	0.1771	R / (R+N)
Cragg-Uhler 1	0.1937	1 - exp(-R/N)
Cragg-Uhler 2	0.2599	(1-exp(-R/N)) / (1-exp(-U/N))

Assigning Data to Roles

To perform an analysis of a probit model, you must assign an input data set. To filter the input data source, click .

You also must assign a variable to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the numeric variable for the analysis.

Role	Description
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a probit model:

1 From the **Model type** drop-down list, select **Probit**.

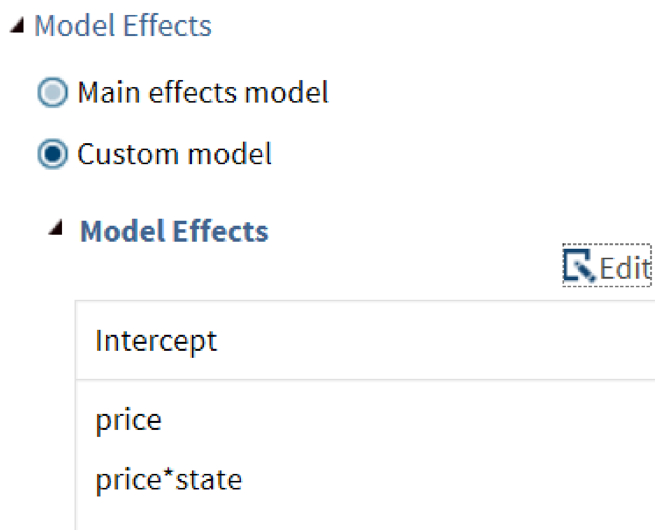
2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



3 Specify the threshold for the first category for the probit model. By default, this value is zero, but you can use an estimated value.

Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies the method to calculate the covariance matrix of parameter estimates. You can use the default method, 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.
Statistics	

<table>
<tr><th>Option Name</th><th>Description</th></tr>
<tr><td colspan="2">Select the statistics to display in the results.
Here are the additional 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</td></tr>
<tr><td colspan="2">Plots</td></tr>
<tr><td colspan="2">You can choose to display only the default plots, the selected plots, or no plots in the results.
You can choose from these types of plots:
■ diagnostic plots, such as error standard deviations by observed regressor and profiled log likelihood
■ output plots, such as predicted values by regressor, marginal effects by regressor, Inverse Mills ratio by regressor, predicted response probability by regressor, predicted probabilities for each level of the response by regressor, and linear predictor values by regressor</td></tr>
</table>

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional 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
- a parameter estimates data set

Poisson Models

Example: Poisson Model

To create this example:

1. Create the Work.Long97Data data set. For more information, see “LONG97DATA Data Set” on page 592.

2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Cross-sectional Data Models**. The user interface for the Cross-Sectional Data Models task opens.

3. On the **Data** tab, select the **WORK.LONG97DATA** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set

that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Dependent variable	**art**
Continuous variables	**ment** **phd**
Categorical variable	**kid5**

5 On the **Model** tab, select **Poisson** as the model type.

6 To run the task, click .

Here is a subset of 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	Poisson
Log Likelihood	-1663
Maximum Absolute Gradient	4.28024E-9
Number of Iterations	5
Optimization Method	Newton-Raphson
AIC	3338
SBC	3367

Algorithm converged.

Parameter Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**t Value**	**Approx Pr > |t|**
Intercept	1	-0.373132	0.288327	-1.29	0.1956
ment	1	0.026125	0.002014	12.97	<.0001
phd	1	0.009967	0.026401	0.38	0.7058
kid5 0	1	0.638080	0.279290	2.28	0.0223
kid5 1	1	0.595185	0.283222	2.10	0.0356
kid5 2	1	0.453861	0.288904	1.57	0.1162
kid5 3	0	0	.	.	.

Assigning Data to Roles

To perform a Poisson model analysis, you must assign an input data set. To filter the input data source, click .

You also must assign a variable to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the numeric column that contains the count values. In the input data set, this variable must contain only nonnegative integer values.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a Poisson model:

1 From the **Model type** drop-down list, select **Poisson**.

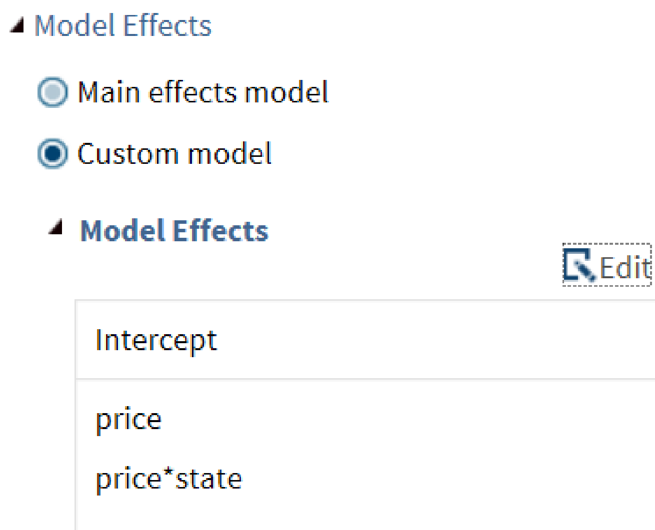
2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.
Statistics	

Option Name	Description
Select the statistics to display in the results. Here are the additional 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	
Plots	
Select the plots to display in the results. By default, a profile likelihood plot and an overdispersion diagnostic plot are included in the results. You can also include these probability plots: overall predictive probabilities plot and predictive probability profiles plot.	

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional statistics, such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor
- a parameter estimates data set

Negative Binomial Models

Example: Negative Binomial Model

To create this example:

1. Create the Work.Long97Data data set. For more information, see "LONG97DATA Data Set" on page 592.

2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Cross-sectional Data Models**. The user interface for the Cross-Sectional Data Models task opens.

3. On the **Data** tab, select the **WORK.LONG97DATA** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4. Assign columns to these roles:

Role	Column Name
Dependent variable	**art**
Continuous variables	**ment** **phd**
Categorical variable	**kid5**

5 On the **Model** tab, select **Negative binomial** as the model type.

6 To run the task, click .

Here is a subset of 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	NegBin(p=1)
Log Likelihood	-1570
Maximum Absolute Gradient	1.37378E-7
Number of Iterations	5
Optimization Method	Newton-Raphson
AIC	3155
SBC	3189

Algorithm converged.

Parameter Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**t Value**	**Approx Pr > |t|**
Intercept	1	-0.283627	0.333108	-0.85	0.3945
ment	1	0.024425	0.002637	9.26	<.0001
phd	1	0.030702	0.034281	0.90	0.3705
kid5 0	1	0.501945	0.319248	1.57	0.1159
kid5 1	1	0.452377	0.325080	1.39	0.1640
kid5 2	1	0.326922	0.333020	0.98	0.3263
kid5 3	0	0	.	.	.

Assigning Data to Roles

To perform a negative binomial model analysis, you must assign an input data set. To filter the input data source, click .

You also must assign a variable to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the numeric column that contains the count values. In the input data set, this variable must contain only nonnegative integer values.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a negative binomial model:

1 From the **Model type** drop-down list, select **Negative binomial**.

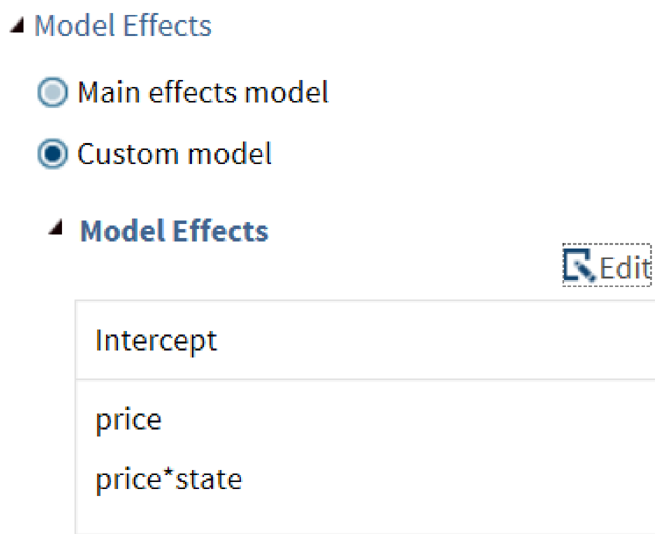
2 Create the model effects.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.
Statistics	

Option Name	Description
Select the statistics to display in the results. Here are the additional 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	
Plots	
Select the plots to display in the results. By default, a profile likelihood plot and an overdispersion diagnostic plot are included in the results. You can also include these probability plots: overall predictive probabilities plot and predictive probability profiles plot.	

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional statistics, such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor
- a parameter estimates data set

Censored Regression

Example: Censored Regression

To create this example:

1 Create the Work.Cigar data set. For more information, see “CIGAR Data Set” on page 563.

2 In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Cross-sectional Data Models**. The user interface for the Cross-Sectional Data Models task opens.

3 On the **Data** tab, select the **WORK.CIGAR** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Dependent variable	**sales**
Continuous variables	**price** **cpi** **ndi**
Categorical variables	**state**

5 On the **Model** tab, complete these steps:

   a Select **Censored regression** as the model type.

   b 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`.

6 On the **Options** tab, expand the **Heteroscedasticity** heading, and then select the **Analyze heteroscedasticity** check box. Assign the **price** variable to the **Variables on the variance function** role.

7 To run the task, click .

Here is a subset of the results:

Summary Statistics of Continuous Responses							
Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
sales	124.7499	29.834058	Censored	90		101	

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	1380
Log Likelihood	-5147
Maximum Absolute Gradient	0.20088
Number of Iterations	108
Optimization Method	Quasi-Newton
AIC	10397
Schwarz Criterion	10664

Algorithm converged.

Parameter Estimates						
Parameter		DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept		1	131.389455	2.617528	50.20	<.0001
price		1	-0.570545	0.035411	-16.11	<.0001

Assigning Data to Roles

To perform a censored regression analysis, you must assign an input data set. To filter the input data source, click .

You also must assign a variable to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the numeric variable for the analysis.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.

Role	Description
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a censored regression model:

1 From the **Model type** drop-down list, select **Censored regression**.

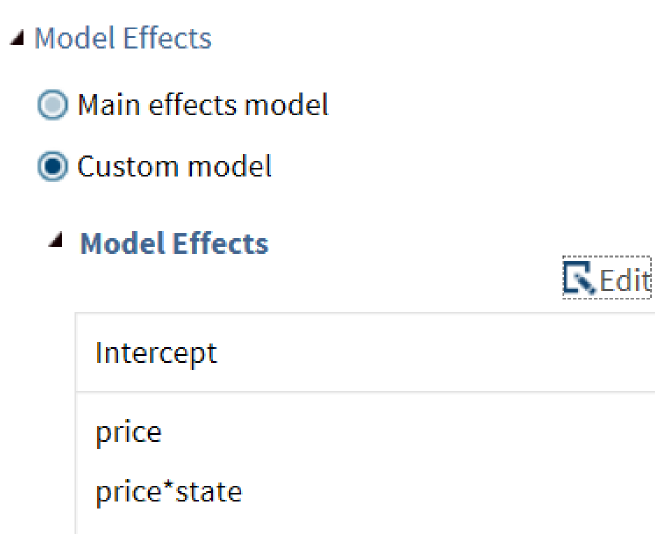
2 Create the model effects.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



3 Set the upper and lower bounds of the censored variables.

Note: If you do not specify an upper bound or a lower bound, the result is a linear regression model.

Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.
Statistics	
Select the statistics to display in the results. Here are the additional 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	

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional statistics, such as predicted values, residuals, error standard deviation, linear predictor, and so on.
- a parameter estimates data set

Truncated Regression

Example: Truncated Regression

To create this example:

1. Create the Work.Cigar data set. For more information, see “CIGAR Data Set” on page 563.
2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Cross-sectional Data Models**. The user interface for the Cross-Sectional Data Models task opens.
3. On the **Data** tab, select the **WORK.CIGAR** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4. Assign columns to these roles:

Role	Column Name
Dependent variable	**sales**
Continuous variables	**price** **cpi** **ndi**
Categorical variables	**state**

5. On the **Model** tab, complete these steps:
   a. Select **Truncated regression** as the model type.
   b. 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`.
6. On the **Options** tab, expand the **Heteroscedasticity** heading, and then select the **Analyze heteroscedasticity** check box. Assign the **price** variable to the **Variables on the variance function** role.
7. To run the task, click .

Here is a subset of the results:

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	0.07317
Number of Iterations	100
Optimization Method	Quasi-Newton
AIC	9963
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.

Assigning Data to Roles

To perform a truncated regression analysis, you must assign an input data set. To filter the input data source, click .

You also must assign a variable to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the numeric variable for the analysis.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.

Role	Description
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a truncated regression model:

1 From the **Model type** drop-down list, select **Truncated regression**.

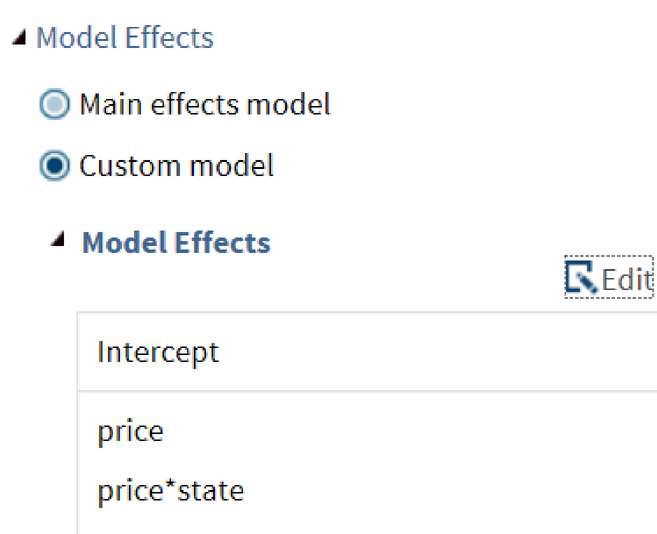
2 Specify the effects for the model.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



3 Set the upper and lower bounds of the truncated variables.

Note: If you do not specify an upper bound or a lower bound, the result is a linear regression model.

Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.
Statistics	
Select the statistics to display in the results. Here are the additional 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	

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional statistics, such as predicted values, residuals, error standard deviation, linear predictor, and so on.
- a parameter estimates data set

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Panel Data Models

About the Panel Data Models Task

From this task, you can 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 task also handles cross-sectional data (data without the time ID values). Cross-sectional data can be considered a special case of panel data.

Linear Models

Example: Linear Regression with Fixed Effects

To create this example:

1 Create the Work.Cigar data set. For more information, see “CIGAR Data Set” on page 563.

2 In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Panel Data Models**. The user interface for the Panel Data Models task opens.

3 On the **Data** tab, select the **WORK.CIGAR** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Panel Structure	
Cross-sectional ID	**state**

Role	Column Name
Time ID	**year**
Roles	
Dependent variable	**sales**
Continuous variables	**price** **cpi** **ndi**

5 On the **Model** tab, select **Linear** as the model type.

6 To run the task, click .

Here is a subset of the results:

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
price	1	-0.52202	0.0336	-15.54	<.0001	Price per pack of cigarettes
cpi	1	0.982287	0.0504	19.49	<.0001	Consumer price index with (1983=100)
ndi	1	-0.00477	0.000455	-10.50	<.0001	Per capita disposable income

Assigning Data to Roles

To perform an analysis of a linear model, you must assign an input data set. To filter the input data source, click .

You also must assign variables to the **Cross-sectional ID**, **Time ID**, and **Dependent variable** roles. The task sorts the values in the input data set by the variables that you assign to the **Cross-sectional ID** and **Time ID** roles. Within each cross section, the values of the time ID must be unique.

Role	Description
Panel Structure	
Cross-sectional ID	specifies the cross section for each observation. The task verifies that the input data is sorted by the cross-sectional ID and by the time series ID within each cross section.
Time ID	specifies the time period for each observation. For each cross section, the values of the time ID must be unique.
Roles	
Dependent variable	specifies the numeric variable to use in the analysis.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group. **Note:** This role is not available if you have a categorical variable.

Setting the Model Options

To create a linear model:

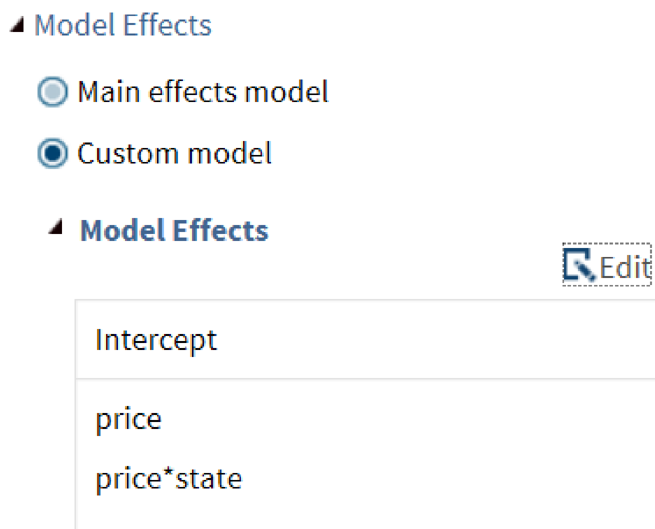
1. From the **Model type** drop-down list, select **Linear**.
2. Specify the effects for the model.

   You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

   - To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
   - To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



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.

Setting the Options

Option Name	Description
Methods	

<table>
<tr><th>Option Name</th><th>Description</th></tr>
<tr><td>Covariance matrix estimator</td><td>specifies the method to calculate the covariance matrix of parameter estimates.
You can use the default value, or you can choose from these methods:
■ Newey and West
■ OLS estimator specifies that the variance-covariance matrix is not corrected.
■ HCCMEn 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.</td></tr>
<tr><td colspan="2">Statistics</td></tr>
<tr><td colspan="2">Select the statistics to display in the results.
Here are the additional 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
■ 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</td></tr>
<tr><td colspan="2">Plots</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the statistics from the analysis
- a parameter estimates data set
- a transformed series data set

  Note: This option is available only if you are creating a linear model that contains one-way fixed effects and one-way random effects.

Logit Model

Example: Logit Model

To create this example:

1. Create the Work.Mroz data set. For more information, see “MROZ Data Set” on page 608.
2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Panel Data Models**. The user interface for the Panel Data Models task opens.
3. On the **Data** tab, select the **WORK.MROZ** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4. Assign columns to these roles:

Role	Column Name
Panel Structure	
Cross-sectional ID	**kidslt6**
Roles	
Dependent variable	**inlf**
Continuous variables	**nwifeinc** **educ** **exper** **expersq**
Categorical variable	**kidsge6**

5. On the **Model** tab, select **Logit** as the model type.
6. To run the task, click .

Here is a subset of 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	-425.94501
Maximum Absolute Gradient	0.00482
Number of Iterations	154
Optimization Method	Quasi-Newton
AIC	879.89001
Schwarz Criterion	944.62693
RE Subject Variable	kidslt6
RE Model Integration Method	Gaussian Quadrature
Quadrature Points	20

Goodness-of-Fit Measures		
Measure	Value	Formula
Likelihood Ratio (R)	177.86	2 * (LogL - LogL0)

Assigning Data to Roles

To perform an analysis of a logit model, you must assign an input data set. To filter the input data source, click .

You also must assign variables to the **Cross-sectional ID** and **Dependent variable** roles.

Role	Description
Panel Structure	

Role	Description
Cross-sectional ID	specifies the cross section for each observation. The task verifies that the input data is sorted by the cross-sectional ID. **Note:** For the logit model, character variables are not supported.
Time ID	specifies 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.
Roles	
Dependent variable	specifies the numeric variable that takes discrete values.
Continuous variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Categorical variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a logit model:

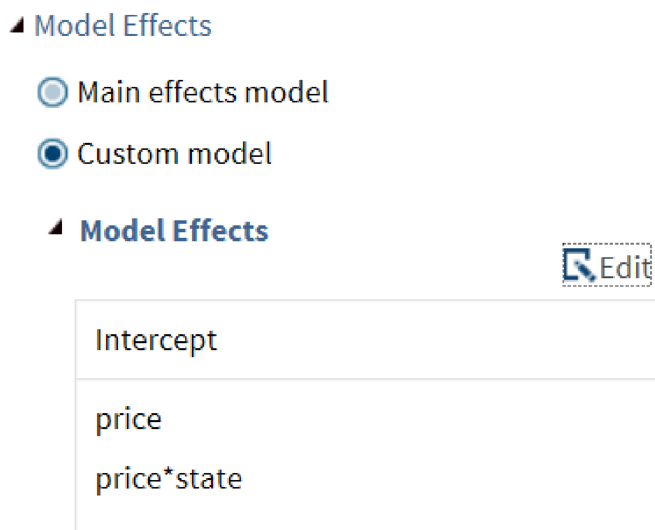
1. From the **Model type** drop-down list, select **Logit**.
2. Specify the effects for the model.

   You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

   - To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
   - To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

   When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Note: Random effects are automatically included in the model. This functionality is experimental.

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.

Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies the method to calculate the covariance matrix of parameter estimates. You can use the default method, 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.
Statistics	

Option Name	Description
	Select the statistics to display in the results. Here are the additional 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
Plots	
	You can choose to display only the default plots, the selected plots, or no plots in the results. You can choose from these types of plots: ■ diagnostic plots, such as error standard deviations by observed regressor and profiled log likelihood ■ output plots, such as predicted values by regressor, marginal effects by regressor, Inverse Mills ratio by regressor, predicted response probability by regressor, predicted probabilities for each level of the response by regressor, and linear predictor values by regressor

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional 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
- a parameter estimates data set

Probit Model

Example: Probit Model

To create this example:

1. Create the Work.Moz data set. For more information, see “MROZ Data Set” on page 608.
2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Panel Data Models**. The user interface for the Panel Data Models task opens.
3. On the **Data** tab, select the **WORK.MROZ** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set

that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Panel Structure	
Cross-sectional ID	**kidslt6**
Roles	
Dependent variable	**inlf**
Continuous variables	**nwifeinc** **educ** **exper** **expersq**
Categorical variable	**kidsge6**

5 On the **Model** tab, select **Probit** as the model type.

6 To run the task, click .

Here is a subset of the results:

Discrete Response Profile of inlf		
Index	**Value**	**Total Frequency**
1	0	325
2	1	428

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	inlf
Number of Observations	753
Log Likelihood	-434.44106
Maximum Absolute Gradient	6.67589E-6
Number of Iterations	12
Optimization Method	Quasi-Newton
AIC	880.88212
Schwarz Criterion	908.62651
RE Subject Variable	kidslt6
RE Model Integration Method	Gaussian Quadrature
Quadrature Points	20

Goodness-of-Fit Measures		
Measure	**Value**	**Formula**
Likelihood Ratio (R)	160.86	2 * (LogL - LogL0)
Upper Bound of R (U)	1029.7	- 2 * LogL0
Aldrich-Nelson	0.176	R / (R+N)

Assigning Data to Roles

To perform an analysis of a probit model, you must assign an input data set. To filter the input data source, click .

You also must assign variables to the **Cross-sectional ID** and **Dependent variable** roles.

Role	Description
Panel Structure	

Role	Description
Cross-sectional ID	specifies the cross section for each observation. The task verifies that the input data is sorted by the cross-sectional ID. **Note:** For the probit model, character variables are not supported.
Time ID	specifies 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.
Roles	
Dependent variable	specifies the numeric variable that takes discrete values.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a probit model:

1 From the **Model type** drop-down list, select **Probit**.

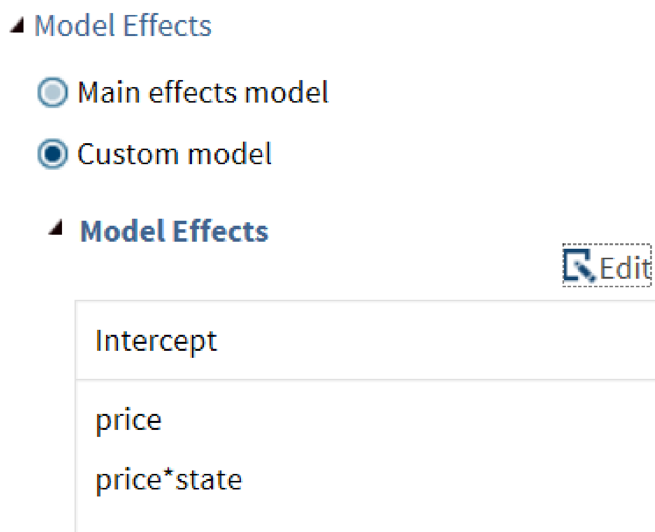
2 Specify the model effects.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Note: Random effects are automatically included in the model. This functionality is experimental.

3 Specify the threshold for the first category for the probit model. By default, this value is zero, but you can use an estimated value.

Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies the method to calculate the covariance matrix of parameter estimates. You can use the default method, 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value or specify a custom value.
Statistics	

Option Name	Description
Select the statistics to display in the results. Here are the additional 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	
Plots	
You can choose to display only the default plots, the selected plots, or no plots in the results. You can choose from these types of plots: ■ diagnostic plots, such as error standard deviations by observed regressor and profiled log likelihood ■ output plots, such as predicted values by regressor, marginal effects by regressor, Inverse Mills ratio by regressor, predicted response probability by regressor, predicted probabilities for each level of the response by regressor, and linear predictor values by regressor	

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional 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
- a parameter estimates data set

Poisson Models

Example: Poisson Model

To create this example:

1. Create the Work.Long97Data data set. For more information, see "LONG97DATA Data Set" on page 592.
2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Panel Data Models**. The user interface for the Panel Data Models task opens.
3. On the **Data** tab, select the **WORK.LONG97DATA** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set

that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Panel Structure	
Cross-sectional ID	**fem**
Roles	
Dependent variable	**art**
Continuous variables	**ment** **phd**
Categorical variable	**kid5**

5 On the **Model** tab, select **Poisson** as the model type.

6 To run the task, click 🏃.

Here are 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	Poisson
Error Component	Fixed
Number of Cross Sections	2
Log Likelihood	-1645
Maximum Absolute Gradient	7.64333E-6
Number of Iterations	4
Optimization Method	Newton-Raphson
AIC	3300
SBC	3324

Algorithm converged.

Parameter Estimates					
Parameter	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
ment	1	0.025223	0.002021	12.48	<.0001
phd	1	0.007103	0.026378	0.27	0.7877

Assigning Data to Roles

To perform a Poisson model analysis, you must assign an input data set. To filter the input data source, click .

You also must assign variables to the **Cross-sectional ID** and **Dependent variable** roles.

Role	Description
Panel Structure	
Cross-sectional ID	specifies the cross section for each observation. The task verifies that the input data is sorted by the cross-sectional ID.

Role	Description
Time ID	specifies 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.
Roles	
Dependent variable	specifies the numeric column that contains the count values. In the input data set, this variable must contain only nonnegative integer values.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a Poisson model:

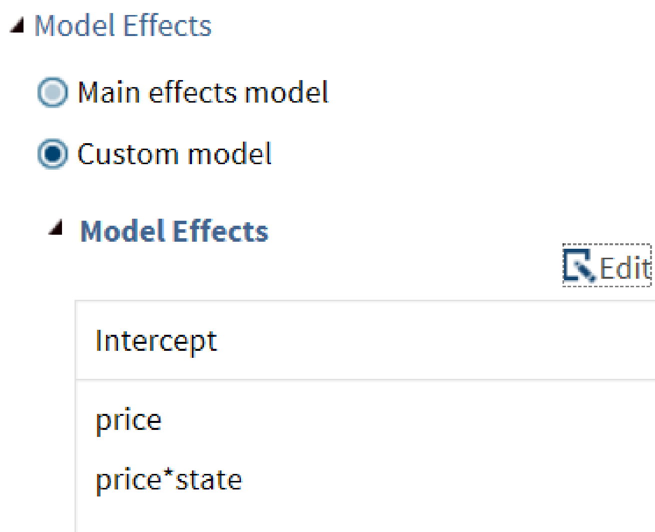
1. From the **Model type** drop-down list, select **Poisson**.
2. Specify the model effects.

   You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

   - To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
   - To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

   When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



3 Specify the error component to include in the model. The error component can be for fixed effects or random effects.

Setting the Options

Option Name	Description
Methods **Note:** The covariance matrix estimator is the inverse Hessian matrix.	
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.
Statistics	
Select the statistics to display in the results. Here are the additional 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	

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional statistics, such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor
- a parameter estimates data set

Negative Binomial Models

Example: Negative Binomial Model

To create this example:

1 Create the Work.Long97Data data set. For more information, see “LONG97DATA Data Set” on page 592.

2 In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Panel Data Models**. The user interface for the Panel Data Models task opens.

3 On the **Data** tab, select the **WORK.LONG97DATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4 Assign columns to these roles:

Role	Column Name
Panel Structure	
Cross-sectional ID	**fem**
Roles	
Dependent variable	**art**
Continuous variables	**ment** **phd**
Categorical variable	**kid5**

5 On the **Model** tab, select **Negative binomial** as the model type.

6 To run the task, click .

Here is a subset of 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	1.16715E-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

Assigning Data to Roles

To perform a negative binomial model analysis, you must assign an input data set. To filter the input data source, click .

You also must assign variables to the **Cross-sectional ID** and **Dependent variable** roles.

Role	Description
Panel Structure	

Role	Description
Cross-sectional ID	specifies the cross section for each observation. The task verifies that the input data is sorted by the cross-sectional ID.
Time ID	specifies 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.
Roles	
Dependent variable	specifies the numeric column that contains the count values. In the input data set, this variable must contain only nonnegative integer values.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a negative binomial model:

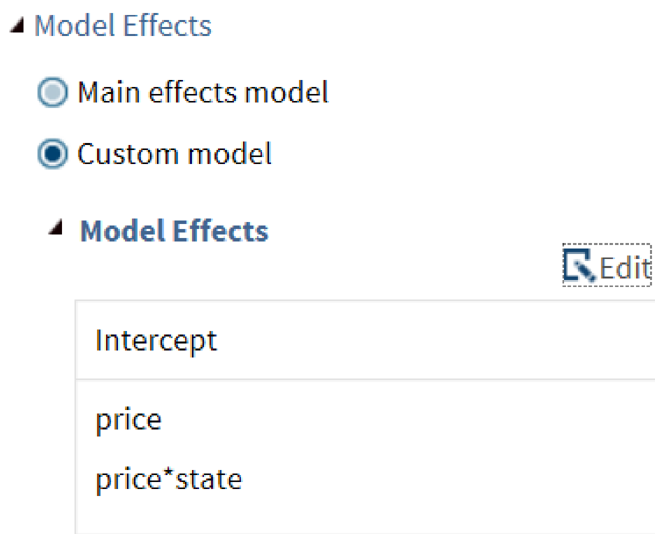
1. From the **Model type** drop-down list, select **Negative binomial**.
2. Specify the model effects.

   You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

   - To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
   - To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

   When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



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**

Setting the Options

Option Name	Description
Methods **Note:** The covariance matrix estimator is the inverse Hessian matrix.	
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.
Statistics	
Select the statistics to display in the results. Here are the additional 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	

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional statistics, such as predicted values, the probability of the dependent variable taking the current value, and the linear predictor
- a parameter estimates data set

Censored Regression

Example: Censored Regression

To create this example:

1. Create the Work.Cigar data set. For more information, see “CIGAR Data Set” on page 563.
2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Panel Data Models**. The user interface for the Panel Data Models task opens.
3. On the **Data** tab, select the **WORK.CIGAR** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4. Assign columns to these roles:

Role	Column Name
Panel Structure	
Cross-sectional ID	**state**
Roles	
Dependent variable	**sales**
Continuous variables	**price** **cpi** **ndi**

5. On the **Model** tab, complete these steps:

   a. Select **Censored regression** as the model type.

b 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`.

6 To run the task, click .

Here is a subset of the results:

Summary Statistics of Continuous Responses							
Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
sales	124.7499	29.834058	Censored	90		101	

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	sales
Number of Observations	1380
Log Likelihood	-5317
Maximum Absolute Gradient	0.0004909
Number of Iterations	31
Optimization Method	Quasi-Newton
AIC	10646
Schwarz Criterion	10677
RE Subject Variable	state
RE Model Integration Method	Gaussian Quadrature
Quadrature Points	20

Algorithm converged.

Parameter Estimates					
Parameter	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	122.056488	1.082366	112.77	<.0001
price	1	-0.587091	0.036229	-16.20	<.0001
cpi	1	1.024186	0.044646	22.94	<.0001

Assigning Data to Roles

To perform a censored regression analysis, you must assign an input data set. To filter the input data source, click .

You also must assign variables to the **Cross-sectional ID** and **Dependent variable** roles.

Role	Description
Panel Structure	

Role	Description
Cross-sectional ID	specifies the cross section for each observation. The task verifies that the input data is sorted by the cross-sectional ID. **Note:** For the censored regression model, character variables are not supported.
Time ID	specifies 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.
Roles	
Dependent variable	specifies the numeric variable for the analysis.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a censored regression model:

1. From the **Model type** drop-down list, select **Censored regression**.

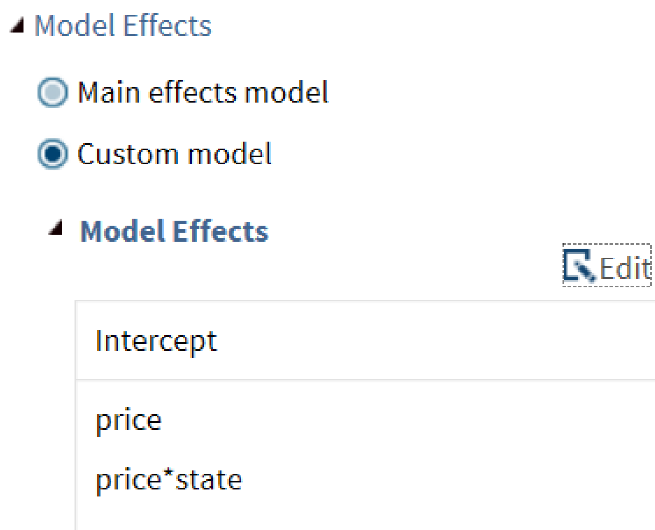
2. Specify the model effects.

   You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

   - To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
   - To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

   When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Note: Random effects are automatically included in the model. This functionality is experimental.

3 Set the upper and lower bounds of the censored variables.

Note: If you do not specify an upper bound or a lower bound, the result is a linear regression model.

Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

Option Name	Description
Statistics	
	Select the statistics to display in the results. Here are the additional 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

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional statistics, such as predicted values, residuals, the error standard deviation, and the linear predictor
- a parameter estimates data set

Truncated Regression

Example: Truncated Regression

To create this example:

1. Create the Work.Cigar data set. For more information, see "CIGAR Data Set" on page 563.
2. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Panel Data Models**. The user interface for the Panel Data Models task opens.
3. On the **Data** tab, select the **WORK.CIGAR** data set.

   TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

4. Assign columns to these roles:

Role	Column Name
Panel Structure	
Cross-sectional ID	**state**

Role	Column Name
Roles	
Dependent variable	**sales**
Continuous variables	**price** **cpi** **ndi**

5 On the **Model** tab, complete these steps:

   a Select **Truncated regression** as the model type.

   b 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`.

6 To run the task, click .

Here are the results:

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	-5082
Maximum Absolute Gradient	0.01470
Number of Iterations	32
Optimization Method	Quasi-Newton
AIC	10177
Schwarz Criterion	10208
RE Subject Variable	state
RE Model Integration Method	Gaussian Quadrature
Quadrature Points	20

Algorithm converged.

Parameter Estimates					
Parameter	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	138.242923	1.202021	115.01	<.0001
price	1	-0.740977	0.048462	-15.29	<.0001

Assigning Data to Roles

To perform a truncated regression analysis, you must assign an input data set. To filter the input data source, click .

You also must assign variables to the **Cross-sectional ID** and **Dependent variable** roles.

Role	Description
Panel Structure	

Role	Description
Cross-sectional ID	specifies the cross section for each observation. The task verifies that the input data is sorted by the cross-sectional ID. **Note:** For the truncated regression model, character variables are not supported.
Time ID	specifies 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.
Roles	
Dependent variable	specifies the numeric variable for the analysis.
Continuous variables	specifies the independent covariates (regressors) for the regression model. If you do not specify a continuous variable, the task fits a model that contains only an intercept.
Categorical variables	specifies the classification variables. The task generates dummy variables for each level of the categorical variable.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To create a truncated regression model:

1 From the **Model type** drop-down list, select **Truncated regression**.

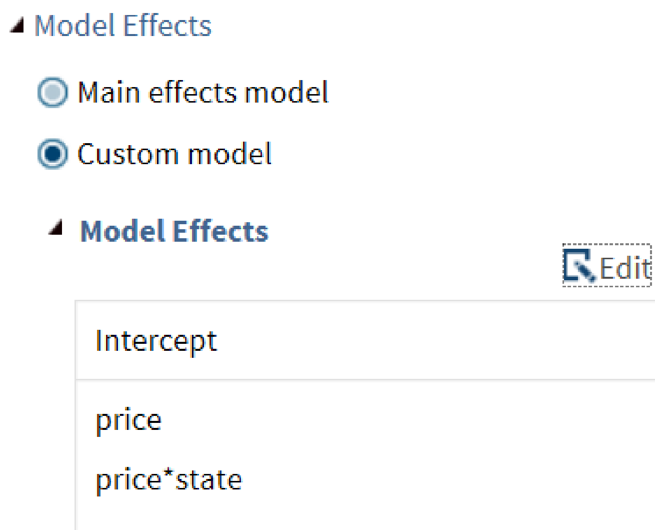
2 Specify the model effects.

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Note: Random effects are automatically included in the model. This functionality is experimental.

3 Set the upper and lower bounds of the censored variables.

Note: If you do not specify an upper bound or a lower bound, the result is a linear regression model.

Setting the Options

Option Name	Description
Methods	
Covariance matrix estimator	specifies 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).
Optimization	
Method	specifies the optimization method to use.
Maximum number of iterations	specifies the maximum number of iterations in the optimization process. You can use the default value, or you can specify a custom value.

Option Name	Description
Statistics	
	Select the statistics to display in the results. Here are the additional 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

Creating the Output Data Sets

You can create these output data sets:

- an output data set that contains the default statistics from the analysis and additional statistics, such as predicted values, residuals, the error standard deviation, and the linear predictor
- a parameter estimates data set

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Time Series Analysis

About the Time Series Analysis Task

The Time Series Analysis task fits models to equally spaced time series data of any frequency, such as monthly, quarterly, or weekly data. You can have a single dependent variable or multiple dependent variables. You can also include one or more explanatory variables in the model. The time series could be correlated over time with either constant variance or non-constant variance. The family of GARCH models are used to model series with non-constant (heteroscedastic) variance.

Time Series Analysis for One Dependent Variable

Example: Analyzing Sales Data

To create this example:

1 In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Time Series Analysis.** The user interface for the Time Series Analysis task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles:

Role	Column Name
Dependent variables	**sale**
Continuous variables	**price**
Categorical variables	**productName**

4 To run the task, click .

Here is a subset of the results:

Dependent Variable	sale
	Unit Sale

Ordinary Least Squares Estimates			
SSE	1068278.64	**DFE**	1002
MSE	1066	**Root MSE**	32.65190
SBC	10112.4119	**AIC**	10023.7159
MAE	24.0301805	**AICC**	10024.3992
MAPE	5.77737689	**HQC**	10057.3942
Durbin-Watson	1.4750	**Total R-Square**	0.8037

NOTE: Model is not full rank. OLS estimates for the parameters are not unique. Some statistics will be misleading. A reported DF of 0 or B means that the estimate is biased. The parameter estimate for the following LHS variable is set to 0, since this variable is a linear combination of other RHS variables as shown.

productName Product9 =	Intercept - productName Product1 - productName Product10 - productName Product11 - productName Product12 - productName Product13 - productName Product14 - productName Product15 - productName Product16 - productName Product17 - productName Product2 - productName Product3 - productName Product4 - productName Product5 - productName Product6 - productName Product7 - productName Product8

Parameter Estimates						
Variable	**DF**	**Estimate**	**Standard Error**	**t Value**	**Approx Pr > |t|**	**Variable Label**
Intercept	B	1879	51.7737	36.30	<.0001	
price	1	-8.2298	0.3044	-27.04	<.0001	price
productName Product1	B	-1058	36.3616	-29.09	<.0001	productName Product1
productName Product10	B	-1028	34.3603	-29.92	<.0001	productName Product10
productName Product11	B	-1093	32.5399	-33.60	<.0001	productName Product11

Yule-Walker Estimates			
SSE	994747.855	DFE	1001
MSE	993.75410	Root MSE	31.52387
SBC	10046.6694	AIC	9953.04577
MAE	22.4686541	AICC	9953.80577
MAPE	5.38615354	HQC	9988.59505
Durbin-Watson	2.0123	Transformed Regression R-Square	0.7432
		Total R-Square	0.8172

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	1903	47.5488	40.02	<.0001	
price	1	-8.3680	0.2786	-30.04	<.0001	price
productName Product1	1	-1074	33.7330	-31.85	<.0001	productName Product1
productName Product10	1	-1043	31.9260	-32.68	<.0001	productName Product10
productName Product11	1	-1108	30.2854	-36.59	<.0001	productName Product11
productName Product12	1	-237.3228	10.2033	-23.26	<.0001	productName Product12
productName Product13	1	-546.7174	15.7292	-34.76	<.0001	productName Product13
productName Product14	1	-1015	33.5476	-30.26	<.0001	productName Product14
productName Product15	1	-501.5609	16.0410	-31.27	<.0001	productName Product15
productName Product16	1	-752.5208	25.6032	-29.39	<.0001	productName Product16
productName Product17	1	-842.3915	26.1999	-32.15	<.0001	productName Product17
productName Product2	1	-538.2864	17.3346	-31.05	<.0001	productName Product2
productName Product3	1	-1282	38.8173	-33.02	<.0001	productName Product3
productName Product4	1	-912.1902	29.5290	-30.89	<.0001	productName Product4
productName Product5	1	-1169	38.1103	-30.67	<.0001	productName Product5
productName Product6	1	-1140	34.7338	-32.81	<.0001	productName Product6

Assigning Data to Roles

To perform a time series analysis, you must assign an input data set. To filter the input data source, click .

You also must assign a variable to the **Dependent variables** role.

Role	Description
Roles	

Role	Description
Dependent variables	specifies the dependent variable for the analysis. **Note:** You can assign more than one dependent variable. The remaining task options differ slightly if you have multiple dependent variables. For more information, see "Time Series Analysis for Multiple Dependent Variables" on page 475.
Independent Variables	
Continuous variables	specifies the independent variables for the model.
Categorical variables	specifies the classification variables to use in the analysis. The analysis produces a singular model.
Additional Roles	
Group analysis by	specifies how to sort the data. Analyses are performed on each group. **Note:** This role is not available if you have a categorical variable.

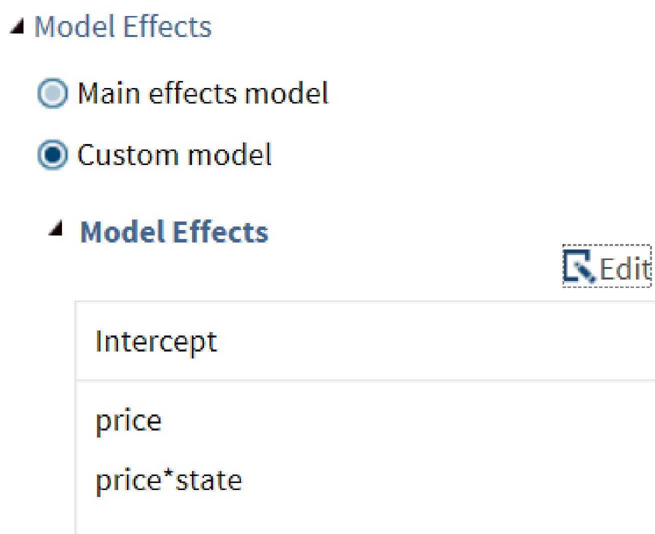
Setting the Model Options

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Here are the remaining options on the **Model** tab.

Option Name	Description
Error Model Options	
Automatically select error process orders	removes insignificant autoregressive parameters. The parameters are removed in order of least significance.
Autoregressive order (p), **Maximum autoregressive order (p)**	specifies the order of the autoregressive error process.
Garch Conditional Heteroscedasticity	
ARCH process order (q)	specifies the order of the process or the subset of ARCH terms to be fitted.
GARCH process order (p)	specifies 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.

Option Name	Description
GARCH model type	specifies the type of model. Here are the valid options: ■ **Exponential GARCH** ■ **Power GARCH** ■ **Quadratic GARCH** ■ **Threshold GARCH** ■ **GARCH with no constraints** **Note:** This option is available only if you specify the ARCH process order greater than 0.

Setting the Options

Option Name	Description
Methods	
Method	specifies the optimization method to use. By default, no optimization method is used.
Maximum number of iterations	specifies the maximum number of iterations. The default is 100 iterations.
Tests	
Tests for Autocorrelation	
Generalized Durbin-Watson test	runs the Durbin-Watson test for the first order.
Tests for Heteroscedasticity	
specifies 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**	
Tests of Normality	
Bera-Jarque normality test	specifies the Jarque-Bera's normality test statistic for regression residuals.
Tests for Independence	

Option Name	Description
	specifies tests of independence. Here are the valid tests: ■ **Brock-Dechert-Scheinkman (BDS) test** ■ **Runs test** ■ **Turning point test** ■ **Rank version of the von Neumann ratio test**
Plots	
	You can choose to use the default results, include selected plots in the results, or include no plots in the results. You can also include these plots in the results: ■ autocorrelation plot ■ inverse-autocorrelations plot ■ partial-autocorrelations plot ■ Q-Q plot of residuals ■ residuals ■ studentized residuals ■ standardized residuals ■ white noise probabilities ■ histogram of residuals

Creating an Output Data Set

You can create these output data sets:

- an output data set that contains the predicted values, residuals, and confidence limits for the predictions
- a parameter estimates data set

Time Series Analysis for Multiple Dependent Variables

Example: Analyzing Sales and Cost Data

To create this example:

1. In the **Tasks** section, expand the **Econometrics** folder, and then double-click **Time Series Analysis**. The user interface for the Time Series Analysis task opens.
2. On the **Data** tab, select the **SASHELP.PRDSALE** data set.
3. Assign columns to these roles:

Role	Column Name
Dependent variables	**ACTUAL** **PREDICT**
Categorical variables	**PRODUCT**

4 To run the task, click .

Here is a subset of the results:

Number of Observations	1440
Number of Pairwise Missing	0

Simple Summary Statistics							
Variable	Type	N	Mean	Standard Deviation	Min	Max	Label
ACTUAL	Dependent	1440	507.17847	287.03131	3.00000	1000.00000	Actual Sales
PREDICT	Dependent	1440	490.48264	285.76679	0.00000	1000.00000	Predicted Sales
PRODUCT BED	Independent	1440	0.20000	0.40014	0.00000	1.00000	PRODUCT BED
PRODUCT CHAIR	Independent	1440	0.20000	0.40014	0.00000	1.00000	PRODUCT CHAIR
PRODUCT DESK	Independent	1440	0.20000	0.40014	0.00000	1.00000	PRODUCT DESK
PRODUCT SOFA	Independent	1440	0.20000	0.40014	0.00000	1.00000	PRODUCT SOFA

Type of Model	VARX(1,0)
Estimation Method	Least Squares Estimation

Model Parameter Estimates						
Equation	Parameter	Estimate	Standard Error	t Value	Pr > |t|	Variable
ACTUAL	CONST1	494.70473	24.94174	19.83	0.0001	1
	XL0_1_1	-0.74071	23.95605	-0.03	0.9753	PRODUCT BED(t)
	XL0_1_2	20.85948	23.96755	0.87	0.3843	PRODUCT CHAIR(t)
	XL0_1_3	24.31640	23.95208	1.02	0.3102	PRODUCT DESK(t)
	XL0_1_4	20.63685	23.97691	0.86	0.3895	PRODUCT SOFA(t)
	AR1_1_1	0.00335	0.02642	0.13	0.8991	ACTUAL(t-1)
	AR1_1_2	-0.00515	0.02655	-0.19	0.8462	PREDICT(t-1)
PREDICT	CONST2	505.52730	24.82129	20.37	0.0001	1

Assigning Data to Roles

To perform a time series analysis, you must assign an input data set. To filter the input data source, click .

To perform a time series analysis with multiple dependent variables, you also must assign at least two variables to the **Dependent variables** role.

Role	Description
Roles	
Dependent variables	specifies the dependent variables for the analysis.
Independent Variables	
Continuous variables	specifies the independent variables for the model.
Categorical variables	specifies the classification variables to use in the analysis.

Role	Description
Time series ID	specifies the datetime values for the series. If you assign a SAS date or datetime variable to this role, the task automatically determines the time interval for these values. You can change this interval and also specify the multiplier, shift, and seasonal length. For more information about these options, see “Understanding SAS Time Intervals” on page 483. **Note:** This role is available only if you have multiple dependent variables.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

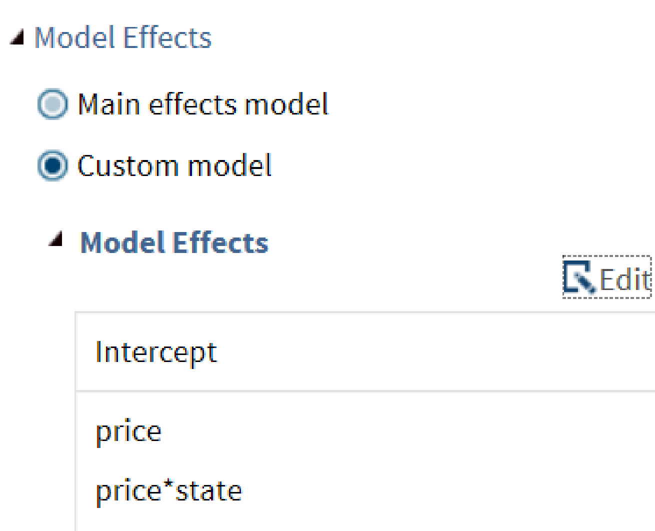
Setting the Model Options

You can display the main effects model or create a custom model. To create a custom model, select the **Custom Model** option, and then click **Edit**. The Model Effects Builder opens. All continuous variables and categorical variables are listed in the **Variables** pane.

- To create a main effect, select the variable in the **Variables** pane, and then click **Add**.
- To create a crossed effect, select the variables in the **Variables** pane. (You can use Ctrl to select multiple variables.) Then click **Cross**.

When you finish, click **OK**. The effects that you specified now appear on the **Model** tab.

Here is an example of model effects on the **Model** tab.



Here are the remaining options on the **Model** tab.

Option Name	Description
Model Settings	
Process Model	
Automatically select process orders	removes insignificant autoregressive and moving average orders based on the value of the information criteria.
Autoregressive order (p), **Maximum autoregressive order (p)**	specifies the order of the autoregressive process.
Moving average order (q), **Maximum average order (q)**	specifies the order of the moving average process.
Exogenous variables lag (xlag)	specifies the lags for the exogenous variables.
GARCH Conditional Heteroscedasticity	
ARCH process order (q)	specifies the order of the ARCH process to be fitted.
GARCH process order (p)	specifies the order of the GARCH process to be fitted. **Note:** This option is available only if you specify an ARCH process order greater than 0.
GARCH model representation	specifies the type of multivariate GARCH model representation. Here are the valid options: ■ **BEKK** ■ **Constant conditional correlation** ■ **Dynamic conditional correlation** **Note:** This option is available only if you specify an ARCH process order greater than 0.
GARCH model type	specifies the subform type of GARCH model. Here are the valid options: ■ **Exponential GARCH** ■ **Power GARCH** ■ **Quadratic GARCH** ■ **Threshold GARCH** ■ **GARCH with no constraints** **Note:** This option is available only if you select constant conditional correlation representation or the dynamic conditional correlation representation.

Option Name	Description
Vector Error Correction	
Cointegration rank	specifies the cointegration rank of the cointegrated system. The rank of cointegration must be less than the number of dependent variables.
Select a normalization variable	specifies a dependent variable whose cointegrating vectors are normalized.

Setting the Options

Option Name	Description
Methods	
Optimization method	specifies the optimization method to use. By default, no optimization method is used.
Maximum number of iterations	specifies the maximum number of iterations. You can use the default value or specify a custom value.
Statistics	
You can include these statistics in the results: ■ **Dickey-Fuller unit root test** ■ **Cointegration tests** ■ **Estimated correlations of the parameter estimates** ■ **Estimated covariances of the parameter estimates** ■ **Residual diagnostics and model diagnostics** ■ **Impulse response function** ■ **Impulse response function related to exogenous (independent) variables** ■ **Eigenvalues of the companion matrix associated with the AR characteristic function** ■ **Yule-Walker estimates of the autoregressive model for the dependent variables**	
Plots	
You can choose to include the default plots in the results, only selected plots, all of the plots, or none of the plots. You can also include these plots in the results: ■ forecast plot ■ impulse response function ■ dependent variables and the one-step-ahead predicted values	

Creating an Output Data Set

You can create these output data sets:

- 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

Part 9

Forecasting Tasks

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Time Series Data Preparation

About the Time Series Data Preparation Task

The Time Series Data Preparation task turns time-stamped transactional data into equally spaced time series data. This format is required for further time series analysis. This task does not require a time ID variable. If no time ID variable is specified, the observation number is the ID for the time series.

Understanding SAS Time Intervals

The Time Data Preparation task analyzes the variable assigned to the time ID role to detect the time interval of the data. SAS assumes that all of the values in the time ID variable are either date or datetime values and distinguishes between the values by their magnitude. This assumption fails if you have dates extending beyond July 21, 2196, or datetimes before January 1, 1960.

For many businesses, their time series data is equally spaced, or any two consecutive indices have the same difference between the time intervals. The following table shows an equally spaced time series with a one-year interval.

Year	Number of Sales
2012	42,100
2013	45,000

Year	Number of Sales
2014	47,000
2015	50,000

If the time interval cannot be detected from the variable that you assign, then you need to specify the interval and season length. For example, the following table shows an unequally spaced time series.

Year	Number of Sales
2009	32,100
2010	45,000
2014	47,000
2015	50,000

Often the time interval cannot be detected with transactional data (timestamped data that is recorded at no particular frequency). If this is the case, the task accumulates the data into observations that correspond to the interval that you specify. For nontransactional data, you might need to specify the interval and season length if there are numerous gaps (missing values) in the data. In this case, the task supplies the missing values. A validation routine checks the values of the time ID to determine whether they are spaced according to the interval that you specified.

The interval determines the frequency of the output. You can modify the time interval. You can change the interval from a higher frequency to a lower frequency or from a lower frequency to a higher frequency. Time intervals are specified in SAS by using character strings. Each of these strings is formed according to a set of rules that enables you to create an almost infinite set of attributes. For each time interval, you can specify the type (such as monthly or weekly), a multiplier, and a shift (the offset for the interval). You can specify a greater time interval than that found in the input data. A smaller interval should not be used, because a small interval will generate a large number of observations.

Seasonal cycle length specifies the length of a season. This value is populated automatically if the task can determine the season length from the time ID variable. However, you can specify a season length other than the default if you want to model a cycle in the data. For example, your data might contain a 13-week cycle, so you need to specify a 13-week season length.

Here is the syntax for an interval:

name<multipler><.shift>

Here is an explanation of each of the user-supplied values:

name
: is the name of the interval.

multipler
: specifies the multiplier of the interval. This value can be any positive number. By default, the multiplier is 1. For example, YEAR2 indicates a two-year interval.

.shift
: specifies the starting point for the interval. By default, this value is one. A value greater than 1 shifts the start to a later point within the interval. The unit for the shift depends on the interval. For example, YEAR.4 specifies a shift of four months, so the year is from April 1 through March 31 of the following year.

The examples in the following table show how the values that you specify for the interval, season length, multiplier, and shift work together.

Interval Name (in SAS code format)	Default	Shift Period	Example
YEARm.s	January 1	Months	YEAR2.7 specifies an interval of every two years. Because the value for the shift is 7, the first month in the year is July.
QTRm.s	January 1 April 1 July 1 October 1	Months	QTR3.2 - three-month intervals starting on April 1, July 1, October 1, and January 1.
MONTHm.s	First of each month	Months	MONTH2.2 - February-March, April-May, June-July, August-September, October-November, and December-January of the following year.
WEEKm.s	Each Sunday	Days (1=Sunday . . . 7=Saturday)	WEEK6.3 specifies six-week intervals starting on Tuesdays.
DAYm.s	Each day	Days	DAY3 - three-day intervals starting on Sunday.

Example: Transforming the Data in the Sashelp.PriceData Data Set

To create this example:

1 In the **Tasks** section, expand the **Forecasting** folder, and then double-click **Time Series Data Preparation**. The user interface for the Time Series Data Preparation task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

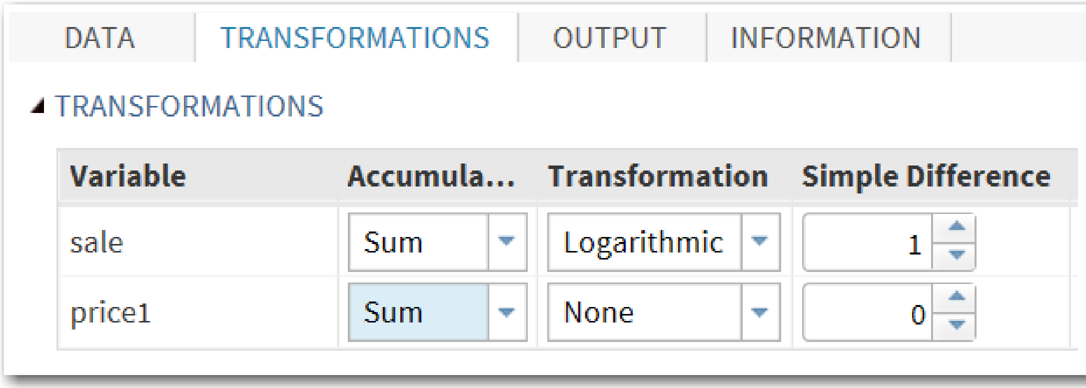
3 Assign columns to these roles:

Role	Column
Roles	
Time series variable	**sale** **price1**
Additional Roles	
Time ID	**date**
Properties	
Interval	**Quarter**

4 Click the **Transformations** tab and specify these values for the sale variable.

- From the **Accumulation** drop-down list, select **Sum**.
- From the **Transformation** drop-down list, select **Logarithmic**.
- In the **Simple Difference** box, enter `1`.
- In the **Seasonal Difference** box, enter `0`.

5 For the price variable, select **Sum** from the **Accumulation** drop-down list.



6 On the **Output** tab, select the **Show output data** check box. In the **Number of observations to show** box, enter `10`.

7 To run the task, click .

The results show the first 10 observations in the output data set.

Subset of WORK.tsPrep0001

Obs	date	log_sale	price1
1	1998:1	.	2667.30
2	1998:2	0.043039	2533.93
3	1998:3	-0.032879	2667.30
4	1998:4	-0.065875	2667.30
5	1999:1	0.045693	2667.30
6	1999:2	0.060370	2667.30
7	1999:3	-0.014812	2667.30
8	1999:4	-0.083388	2578.39
9	2000:1	0.039337	2533.93
10	2000:2	0.043167	2667.30

Assigning Data to Roles

To run the Time Series Data Preparation task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Time series variable** role.

Roles and Options	Description
Roles	

Roles and Options	Description
Time series variable	lists the variables that contain timestamped data
Treatment of missing values	specifies how to treat missing values in the timestamped data. You can choose from these options: ■ **Missing value** ■ **Average value of the accumulated time series** ■ **Minimum value of the accumulated time series** ■ **Median value of the accumulated time series** ■ **Maximum value of the accumulated time series** ■ **First nonmissing value of the accumulated time series** ■ **Last nonmissing value of the accumulated time series** ■ **The previous period's accumulated nonmissing value** - The missing values are set to the previous accumulated nonmissing value. Missing values at the beginning of the accumulated series remain missing. ■ **The next period's accumulated nonmissing value** - The missing values are set to the next accumulated nonmissing value. Missing values at the end of the accumulated series remain missing. ■ **Numeric value** specifies the value to use for the missing value.
Additional Roles	
Time ID	specifies the column that contains the time ID values.
Properties	
Interval	specifies the interval for the time ID variable. For more information about time intervals, see "Understanding SAS Time Intervals" on page 483.
Multiplier	specifies the multiplier for the time interval. By default, the multiplier is 1. This value cannot be negative.
Shift	specifies the shift for the time interval. By default, the shift is 1. This value cannot be negative.

Roles and Options	Description
Season length	specifies the seasonality of the time interval. The default value depends on the time interval.
Additional Roles	
Season length	enables you to specify the seasonality of the data when you do not assign a time ID variable.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Transformations Options

The **Transformations** table contains a row for each column that you assigned to the **Time series variable** role.

Option Name	Description
Accumulation	specifies the accumulation method for the variable. This option is available if you assigned a variable to the **Time ID variable** role. You can choose from these options: None does not accumulate the vector values. Sum accumulates the vector values based on the summation of their values. $$a = \sum_{q=1}^{Q} r_q$$ Missing values are ignored in the summation. If $Q_N = 0$, then *a* is set to missing. Average accumulates the vector values based on the average of their values. $$a = \bar{r}$$ $$= \frac{1}{Q_N} \sum_{q=1}^{Q} r_q$$ Missing values are ignored in the summation. If $Q_N = 0$, then *a* is set to missing.

Option Name	Description
Transformation	specifies the transformation to apply to the time series variable. You can choose from these transformations: ▪ **Logarithmic** ▪ **Square-root** ▪ **Logistic**
Simple differencing	specifies a value for the simple difference.
Seasonal differencing	specifies a value for the seasonal difference. This option is available if the value of the **Seasonal length** option on the **Data** tab is greater than 1.

Creating the Output Data Set

The **Show output data** option specifies whether to display the output data set on the **Results** tab. You can choose to display all of the data or a subset of the output data. The task always creates an output data set that appears on the **Output Data** tab. The output data is also saved as a SAS data set.

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Time Series Data Exploration

About the Time Series Exploration Task

The Time Series Exploration task creates graphs and statistics that enable you to view and analyze your time series data.

Example: Exploring the Sashelp.PriceData Data Set

To create this example:

1 In the **Tasks** section, expand the **Forecasting** folder, and then double-click **Time Series Exploration**. The user interface for the Time Series Exploration task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles and specify these options:

a To the **Dependent variable** role, assign the **sale** variable.

b Expand the **Additional Roles** heading. To the **Time ID** role, assign the **date** variable. From the **Interval** drop-down list, select **Quarter**.

c In the **Transformations** table, find the sale variable. From the **Accumulation** drop-down list, select **Sum**.

4 Click the **Analyses** tab, and select these series plots:

- **Time Series**
- **Series histogram**
- **Seasonal cycles**

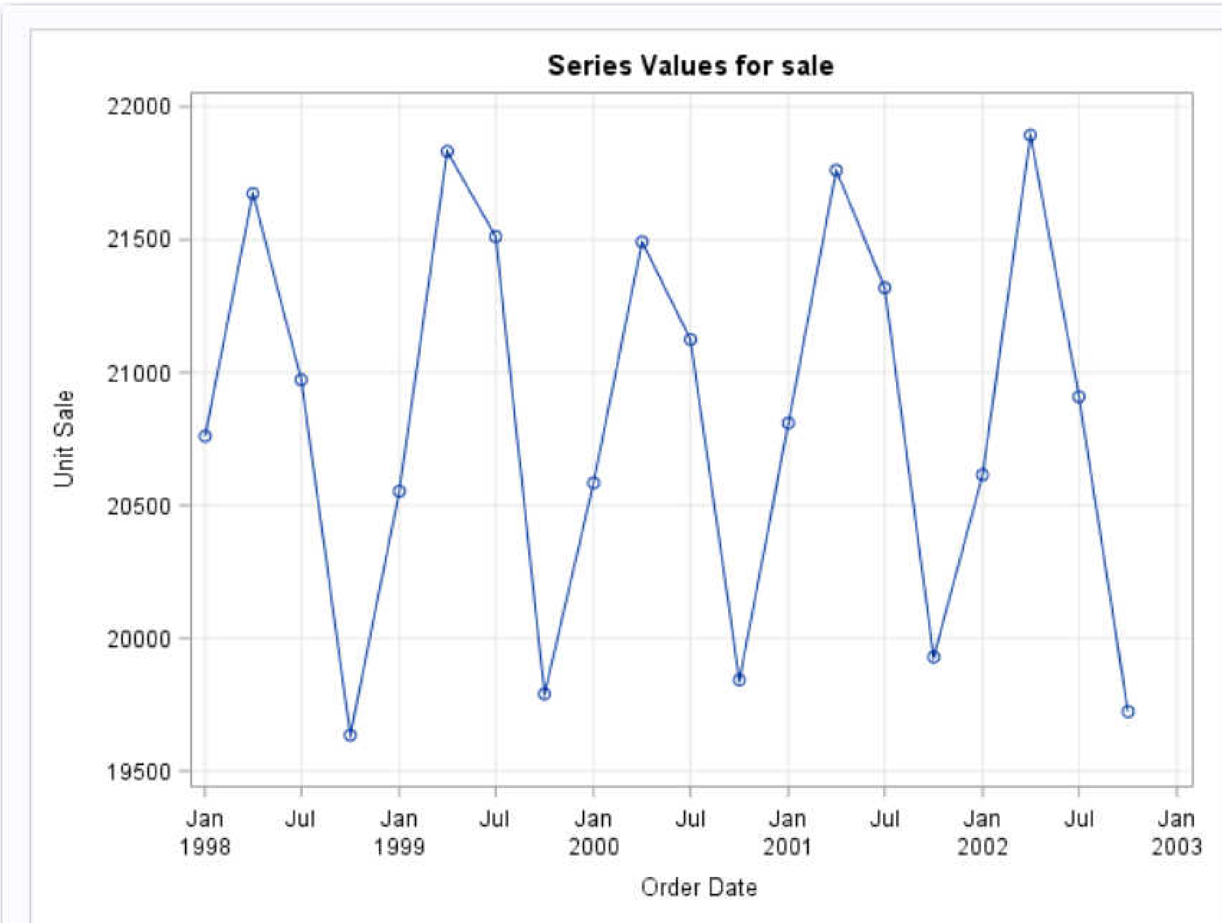
5 To run the task, click .

The first part of the results describes the input data set. This information shows the name and interval of the time ID variable and information about the dependent variable.

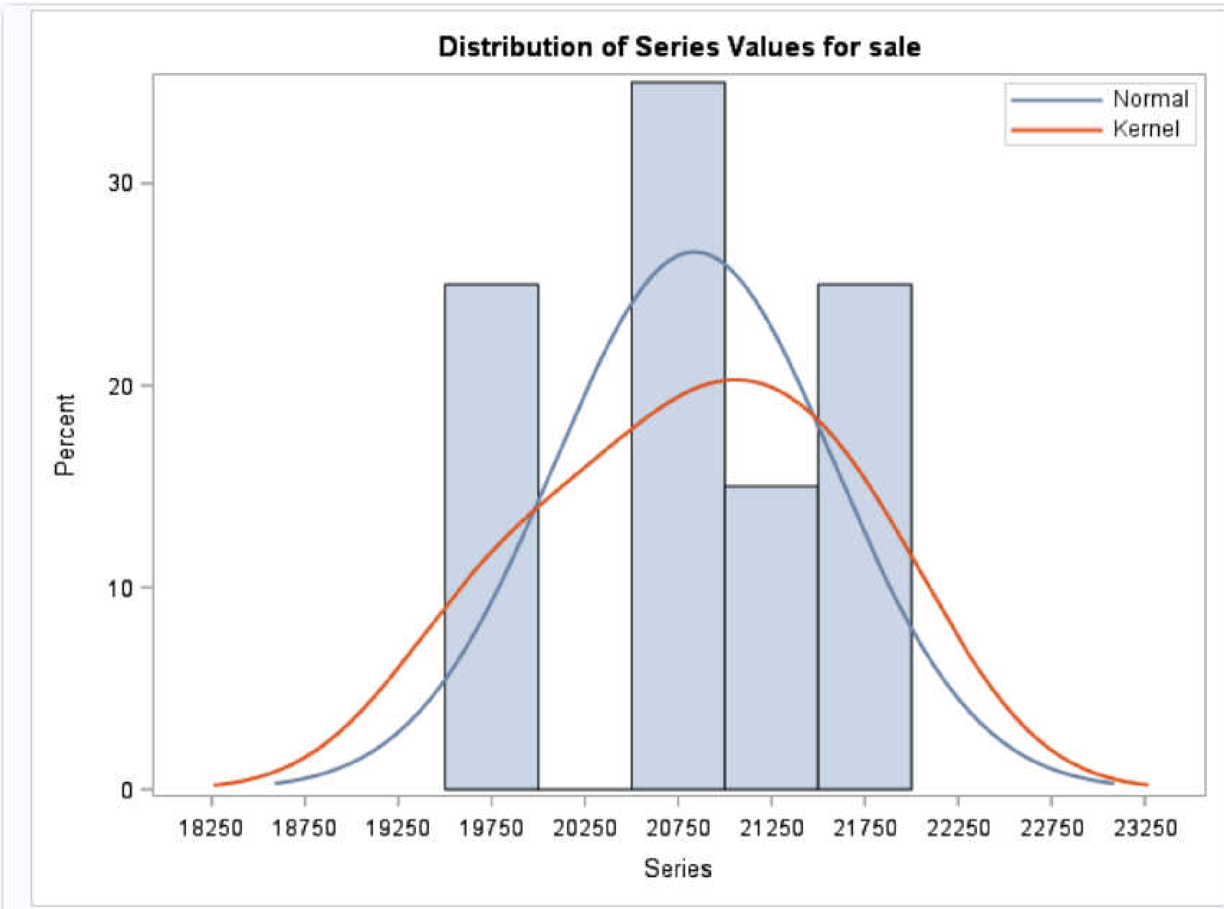
Input Data Set	
Name	WORK.PREPROCESSEDDATA
Label	Simulated monthly sales data with hierarchy of region, line, product
Time ID Variable	date
Time Interval	QTR
Length of Seasonal Cycle	4

Variable Information	
Name	sale
Label	Unit Sale
First	1998:1
Last	2002:4
Number of Observations Read	1020

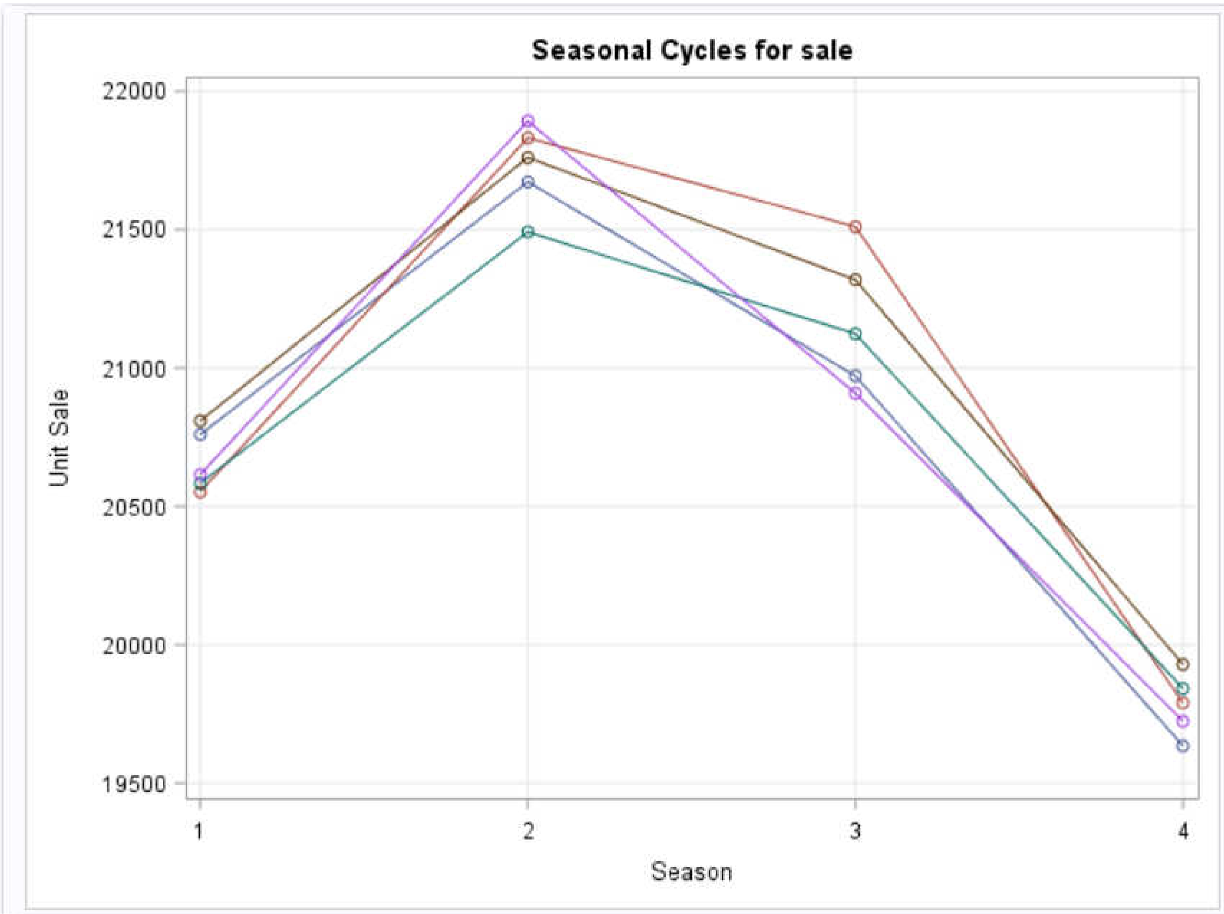
The time series plot suggests that there is a cyclical nature to sales for this product.



The histogram shows the distribution of sales for the series. Both a normal distribution and a kernel distribution are overlaid on the histogram.



The seasonal cycle plot shows that sales peak in Quarter 2 and are the lowest in Quarter 4.



Assigning Data to Roles

To run the Time Series Exploration task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the dependent variable.
Independent variables	specifies any explanatory, input, predictor, or causal factor variables. You can assign only numeric variables to this role.

Role	Description
Transformations	specifies the transformations and simple differencing for the dependent and independent variables. If you assign a variable to the **Time ID** role, you can also specify an accumulation method. If the season length is greater than 1, you can specify seasonal differencing.
Additional Roles	
Time ID	specifies the column that contains the time ID values.
Properties	
Interval	specifies the interval for the time ID variable. For more information about SAS time intervals, see “Understanding SAS Time Intervals” on page 483.
Multiplier	specifies the multiplier for the time interval. By default, the multiplier is 1. This value cannot be negative.
Shift	specifies the shift for the time interval. By default, the shift is 1. This value cannot be negative.
Season length	specifies the seasonality of the time interval. The default value depends on the time interval.
Additional Roles	
Season length	enables you to specify the seasonality of the data when you do not assign a time ID variable.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Analyses Options

Option Name	Description
Series Plots	

Option Name	Description
You can include these series plots in your results: ▪ time series plot ▪ series histogram ▪ seasonal cycles	
Statistics	
You can include these statistics in your results: ▪ the descriptive statistics for the accumulated time series ▪ a table of the seasonal statistics ▪ the seasonal decomposition and adjustment table ▪ the trend statistics table	
Autocorrelation Analysis	
Perform autocorrelation analysis	specifies to include an autocorrelation analysis in the results.
Select plots to display	specifies the plots to display in the results. By default, the results show the autocorrelation analysis panel. However, you can select whether to include these plots in the results as well: ▪ autocorrelation function ▪ normalized autocorrelation function ▪ partial autocorrelation function ▪ normalized partial autocorrelation function ▪ inverse autocorrelation function ▪ normalized inverse autocorrelation function ▪ white noise probability test ▪ white noise probability test (log scale)
Number of lags	specifies the lag values. By default, the number of lags is 0.
Cross-Correlation Analysis **Note:** To perform a cross-correlation analysis, you must assign a variable to the **Independent variables** role.	
Perform cross-correlation analysis	specifies to include a cross-correlation analysis in the results.
Plots	specifies the plots to include in the results. A cross-series plot is included by default. You can also include a cross-correlation function plot and a normalized cross-correlation function plot.

Option Name	Description
Decomposition Analysis **Note:** To perform a decomposition analysis, the seasonal cycle length must be greater than 1.	
Perform decomposition analysis	specifies to include a decomposition analysis in the results.
Select plots to display	specifies the plots to include in the results. By default, the decomposition panel is included. You can choose to include these plots as well: ■ a plot of the components ■ a plot of the seasonally adjusted series ■ a plot of the seasonally adjusted series (percent change)
Decomposition method	specifies the decomposition method to use when creating the selected decomposition analysis plots.
Spectral Density Analysis	
Spectral density estimate plot	specifies whether to include a spectral density plot in the results.
Minimum period	specifies the minimum period to include in the spectral density plot. This value must be an integer greater than or equal to 0 and less than or equal to 32,767.
Details	
Adjust the series by its mean prior to the analysis	specifies whether the series should be adjusted by its mean before performing the Fourier decomposition.
Analysis domain	specifies how the smoothing function is interpreted. You can choose from these options: ■ **Frequency** smooths the periodogram ordinates. This is the default. ■ **Time** applies the kernel as a filter to the time series autocovariance function.
Kernel Specifications	

Option Name	Description
Kernel function	specifies the kernel function to use in the analysis. By default, no kernel function is specified. You can choose from these options: ■ **Parzen kernel** ■ **Bartlett kernel** ■ **Tukey-Hanning kernel** ■ **Truncated kernel** ■ **Quadratic spectral kernel**
Scale coefficient	specifies the scale coefficient for the kernel function.
Exponent	specifies the exponent for the kernel function.
Unit Root Test Analysis	
Perform augmented Dickey-Fuller test	specifies whether to perform an augmented Dickey-Fuller test.
Augmenting order	specifies the augmenting order for the Dickey-Fuller test. This value must be an integer greater than or equal to 0 and less than or equal to 1,000.

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Modeling and Forecasting Task

About the Modeling and Forecasting Task

The Modeling and Forecasting task creates forecasting models that use your time series data. This task requires data in a valid time series format. To create this data, use the Time Series Data Preparation task before running the Modeling and Forecasting task.

Example: Creating a Random Walk Model for the SASHELP.PRICEDATA Data Set

To create this example:

1 In the **Tasks** section, expand the **Forecasting** folder, and then double-click **Modeling and Forecasting**. The user interface for the Modeling and Forecasting task opens.

2 On the **Data** tab, select the **SASHELP.PRICEDATA** data set.

TIP If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

3 Assign columns to these roles and specify these options:

Role	Column
Roles	
Dependent variable	**sale**
Additional Roles	
Time ID	**date**
Properties	
Season length	**12**

4 On the **Model** tab, select these options:

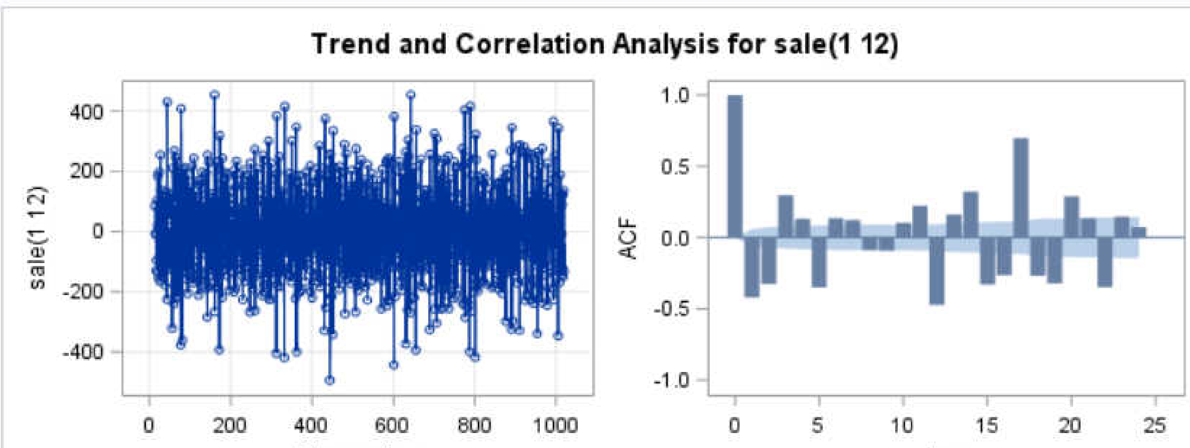
- From the **Forecasting model type** drop-down list, select **Random walk**.
- Under the **Model settings** heading, select the **Drift** and **Seasonal** check boxes.

5 To run the task, click .

The results show the Random Walk model for the Sashelp.Pricedata data set.

Name of Variable = sale	
Period(s) of Differencing	1,12
Mean of Working Series	-0.06058
Standard Deviation	151.8625
Number of Observations	1007
Observation(s) eliminated by differencing	13

Autocorrelation Check for White Noise									
To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
6	532.26	6	<.0001	-0.419	-0.325	0.297	0.131	-0.348	0.134
12	855.03	12	<.0001	0.122	-0.088	-0.092	0.104	0.223	-0.474
18	1745.31	18	<.0001	0.161	0.321	-0.328	-0.266	0.698	-0.270
24	2107.58	24	<.0001	-0.321	0.290	0.133	-0.347	0.145	0.074



Assigning Data to Roles

To run the Modeling and Forecasting task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Dependent variable** role, and you must specify a forecasting model type on the **Model** tab.

Roles and Options	Description
Roles	
Dependent variable	specifies the dependent variable.
Additional Roles	

Roles and Options	Description
Time ID	specifies the column that contains the time ID values.
Properties	
Interval	shows the interval for the time ID variable. For more information about SAS time intervals, see "Understanding SAS Time Intervals" on page 483. **Note:** This value is determined by the input data set. You cannot change this value in the Modeling and Forecasting task.
Multiplier	shows the multiplier for the time interval. By default, the multiplier is 1. **Note:** This value is determined by the input data set. You cannot change this value in the Modeling and Forecasting task.
Shift	shows the shift for the time interval. By default, the shift is 1. **Note:** This value is determined by the input data set. You cannot change this value in the Modeling and Forecasting task.
Season length	specifies the seasonality of the time interval. The default value depends on the time interval.
Additional Roles	
Season length	enables you to specify the seasonality of the data when you do not assign a time ID variable.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting the Model Options

To use the Modeling and Forecasting task, you must select a forecasting model type. You can choose from six model types: random walk, moving average, exponential smoothing, ARIMA, ARIMAX, and unobserved components.

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. You can choose from a variety of series plots, residual plots, and forecast plots.

Moving Average

The formula for the moving average model with width *k* is

$$y_t = \frac{[y_{t-1} + \ldots + y_{t-k}]}{k} + error.$$

In ARIMA notation, this model is ARIMA(k, 0, 0) with no intercept and with the autoregressive parameters (AR) fixed: $AR = \frac{1}{k}, \frac{1}{k}, \ldots, \frac{1}{k}$.

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. You can choose from a variety of series plots, residual plots, and forecast plots.

Exponential Smoothing

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
- Double (Brown) exponential smoothing
- Linear (Holt) exponential smoothing

- Damped trend exponential smoothing
- Additive seasonal exponential smoothing
- Multiplicative seasonal exponential smoothing
- Winters multiplicative model
- Winter 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. You can choose from a variety of model plots, error plots, and forecast plots.

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 simple 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. You can choose from a variety of series plots, residual plots, and forecast plots.

ARIMAX

When you create an Autoregressive Integrated Moving Average (ARIMA) model, you can specify the autoregressive and moving average polynomials of an ARIMA model. In an ARIMAX model, you can 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 simple 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 set 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. You can choose from a variety of series plots, residual plots, and forecast plots.

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 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 and slope component, then a locally linear trend is obtained. If you omit the slope component, then a local level is used.

   a 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.

   b 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 one. 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. You can choose from a variety of residual plots, smoothed component estimates, filtered component estimates, and series decomposition and forecast plots.

Setting the Forecasting Options

Option	Description
Forecast Settings	
Number of periods to forecast	specifies 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.
Forecast confidence level	specifies the confidence level for the series. By default, this confidence level is 95% .
Number of periods to hold back	specifies 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.
Outlier Detection **Note:** This option is not available if you selected **Exponential smoothing** as the forecasting model type.	
Perform outlier detection	specifies that any outliers that are automatically detected during the creation of the model are inputs in the model.

Setting the Output Options

To create an output data set, click the **Output** tab. The types of output data sets that you can create depend on the forecasting model type.

Part 10

Statistical Process Control

72

Control Charts

About the Control Charts Task

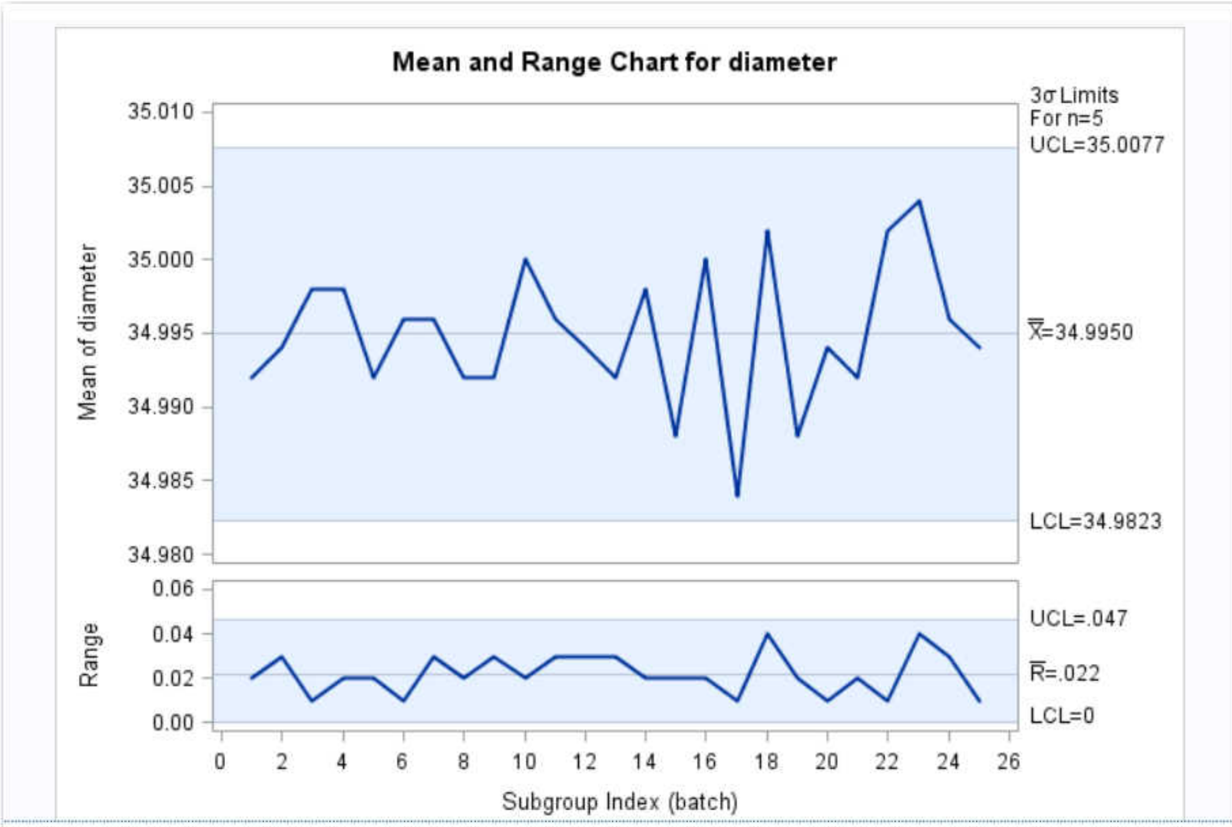
The Control Charts task creates Shewhart control charts for deciding whether a process is in a state of statistical control. Using the Control Charts task, you can create these types of charts.

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.

Here is an example of a Mean and Range chart:

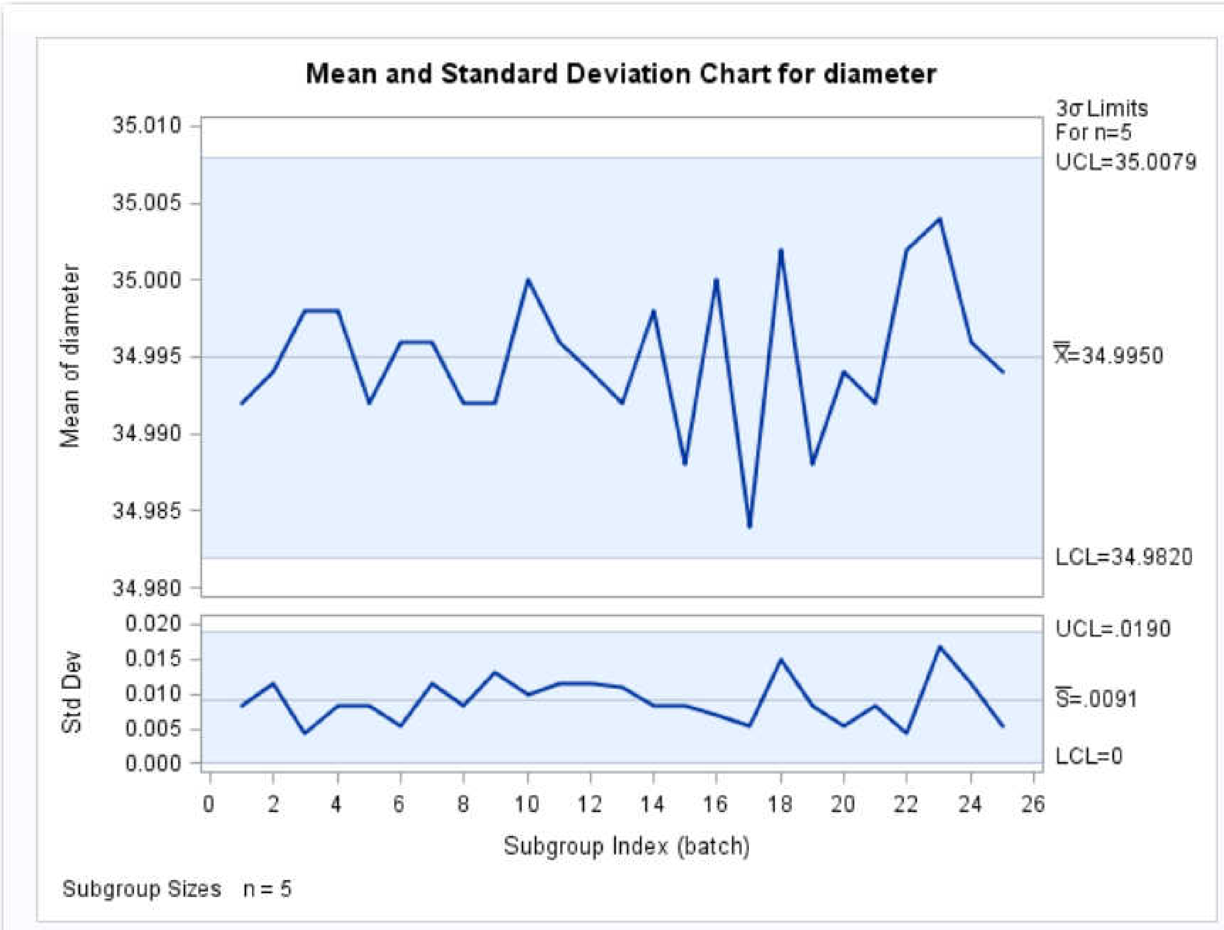


Mean and Standard Deviation Chart

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.

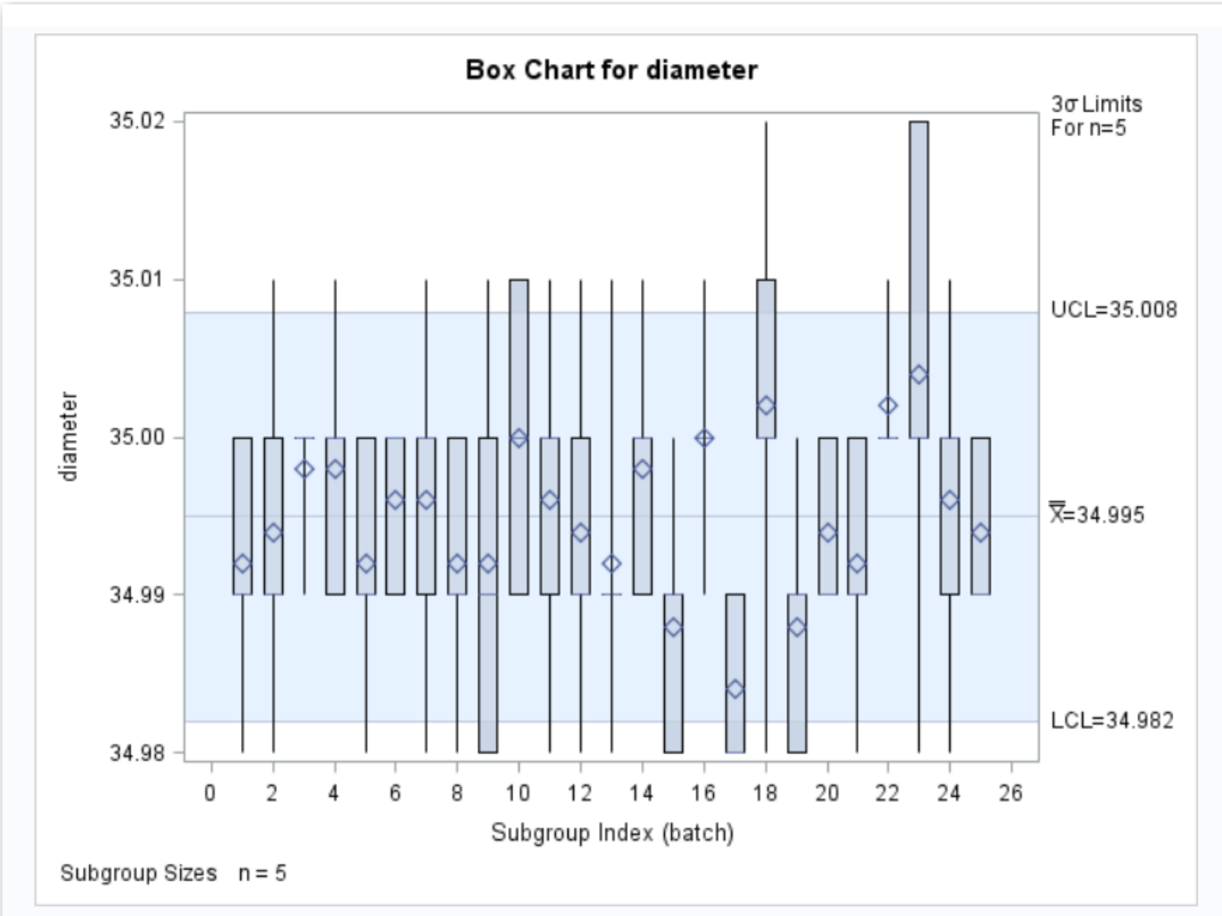
Here is an example of a Mean and Standard Deviation chart:



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.

Here is an example of a Mean with Box-and-Whisker plot:

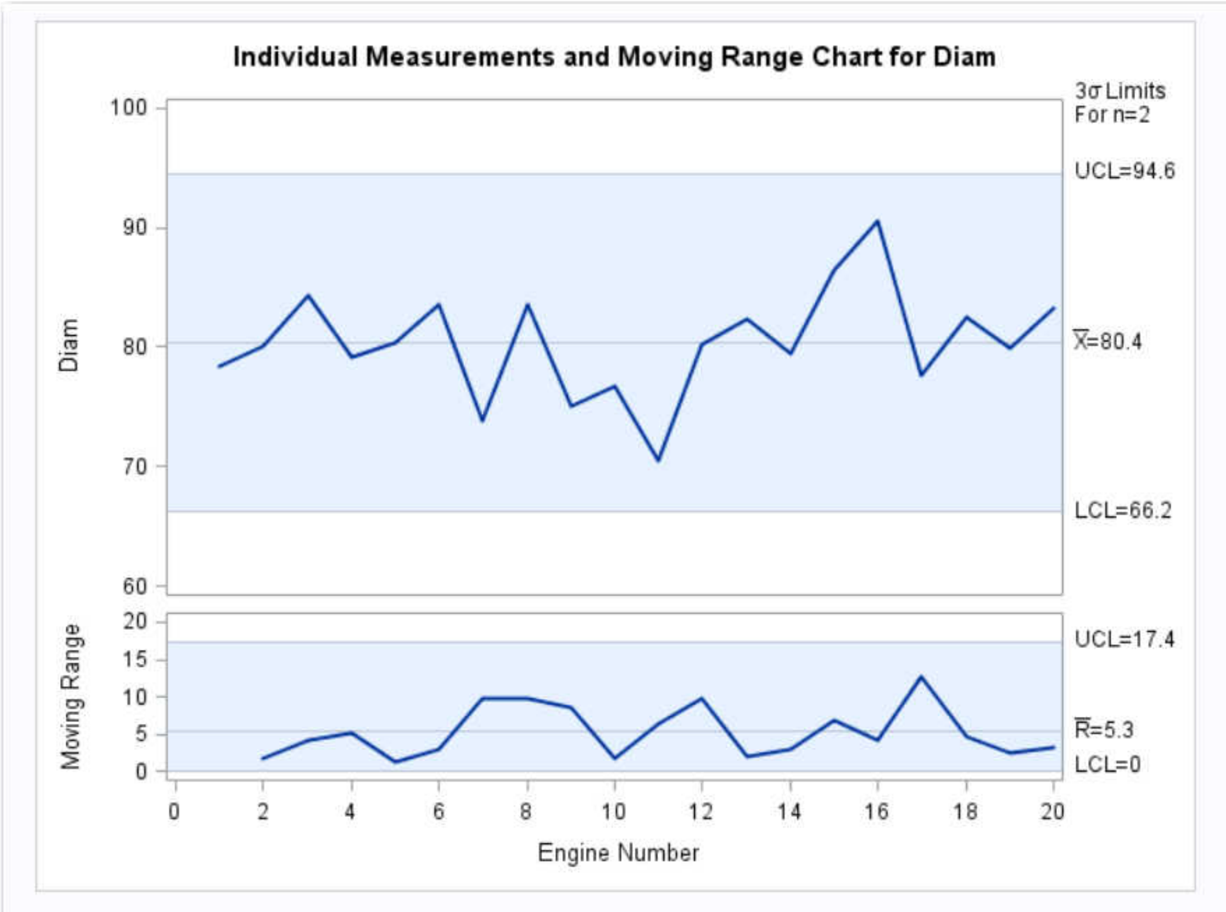


Individual Measurements

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 task 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.

Here is an example of an Individual Measurements chart:



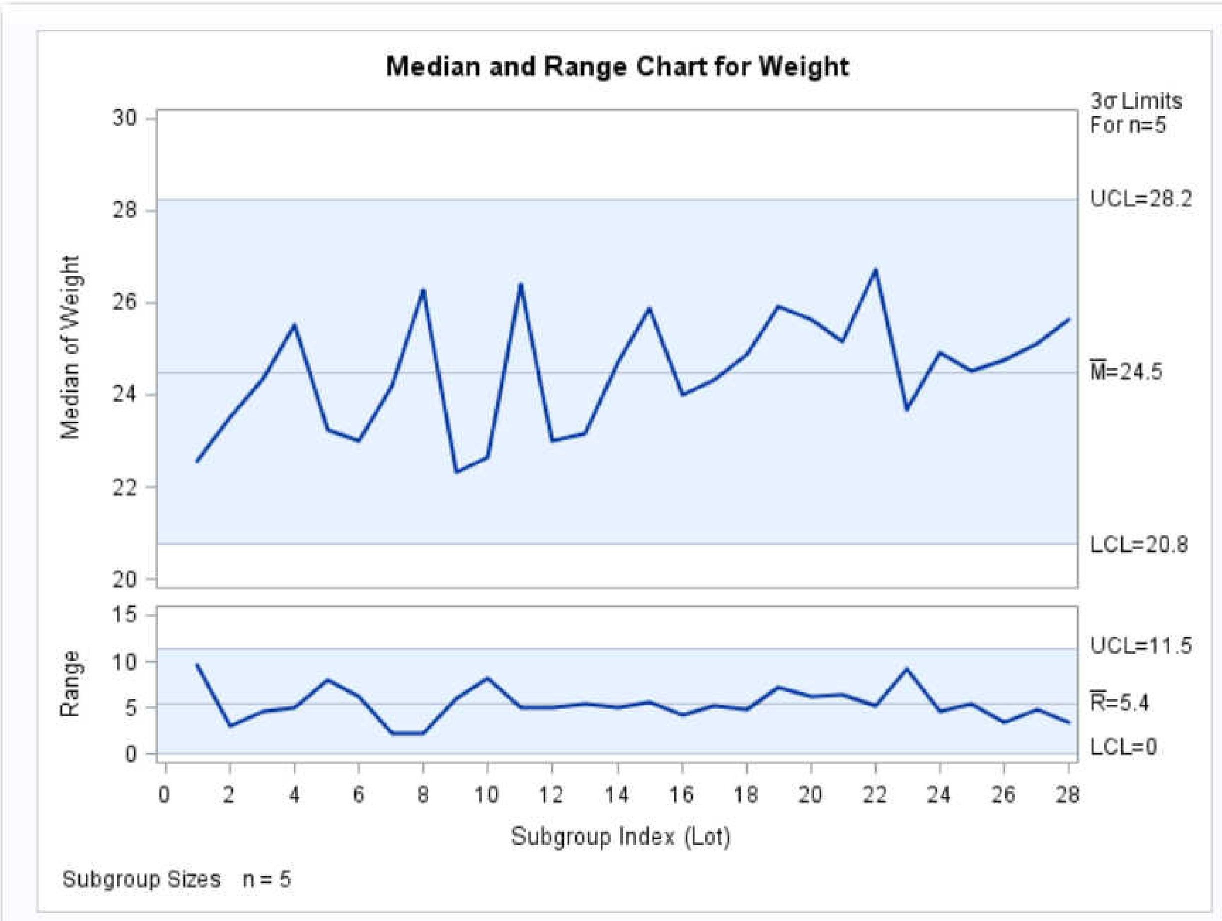
Median and Range Chart

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.

Here is an example of a Median and Range chart:

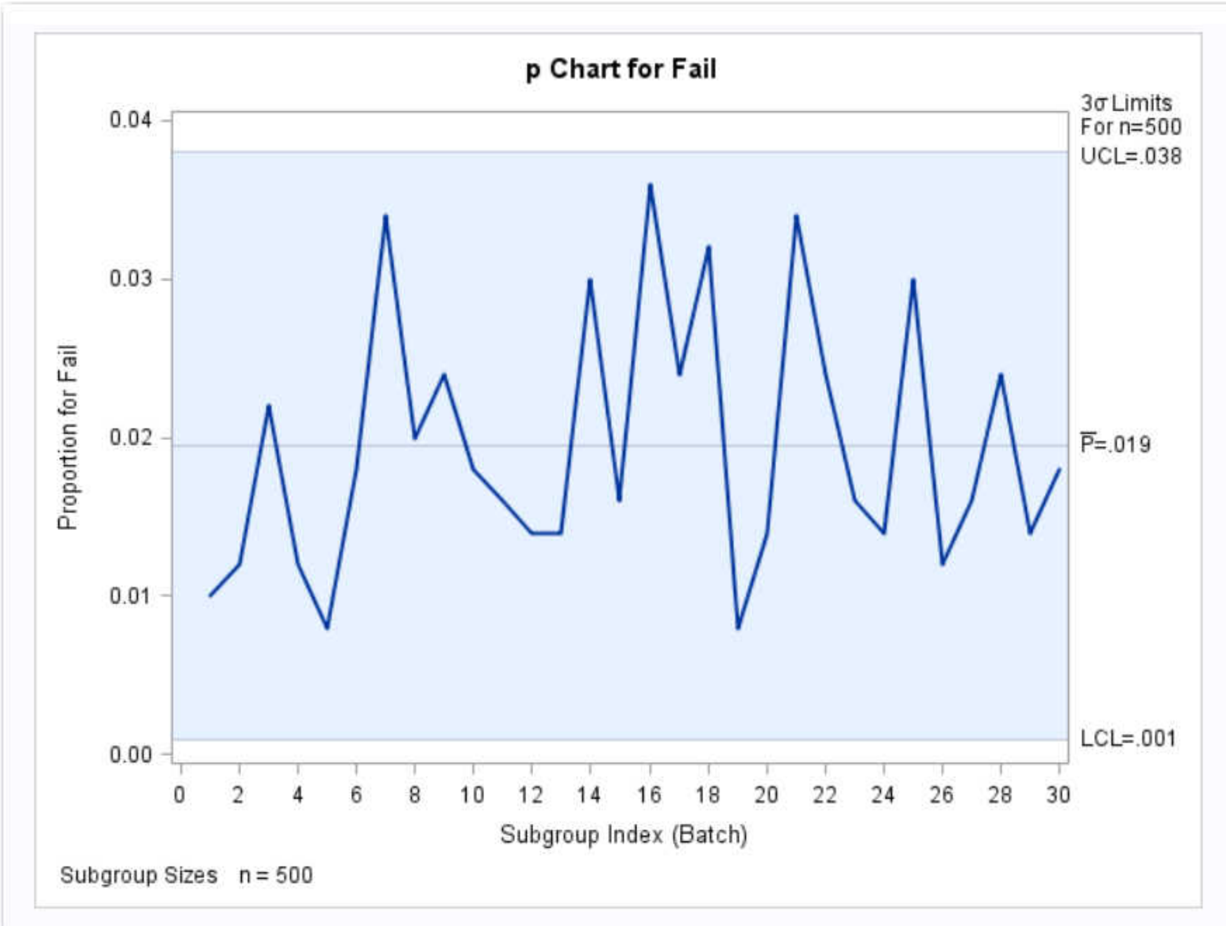


p Charts

p charts display proportions of nonconforming (defective) items in the subgroup samples. You might want to use this task 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.

Here is an example of a p chart:

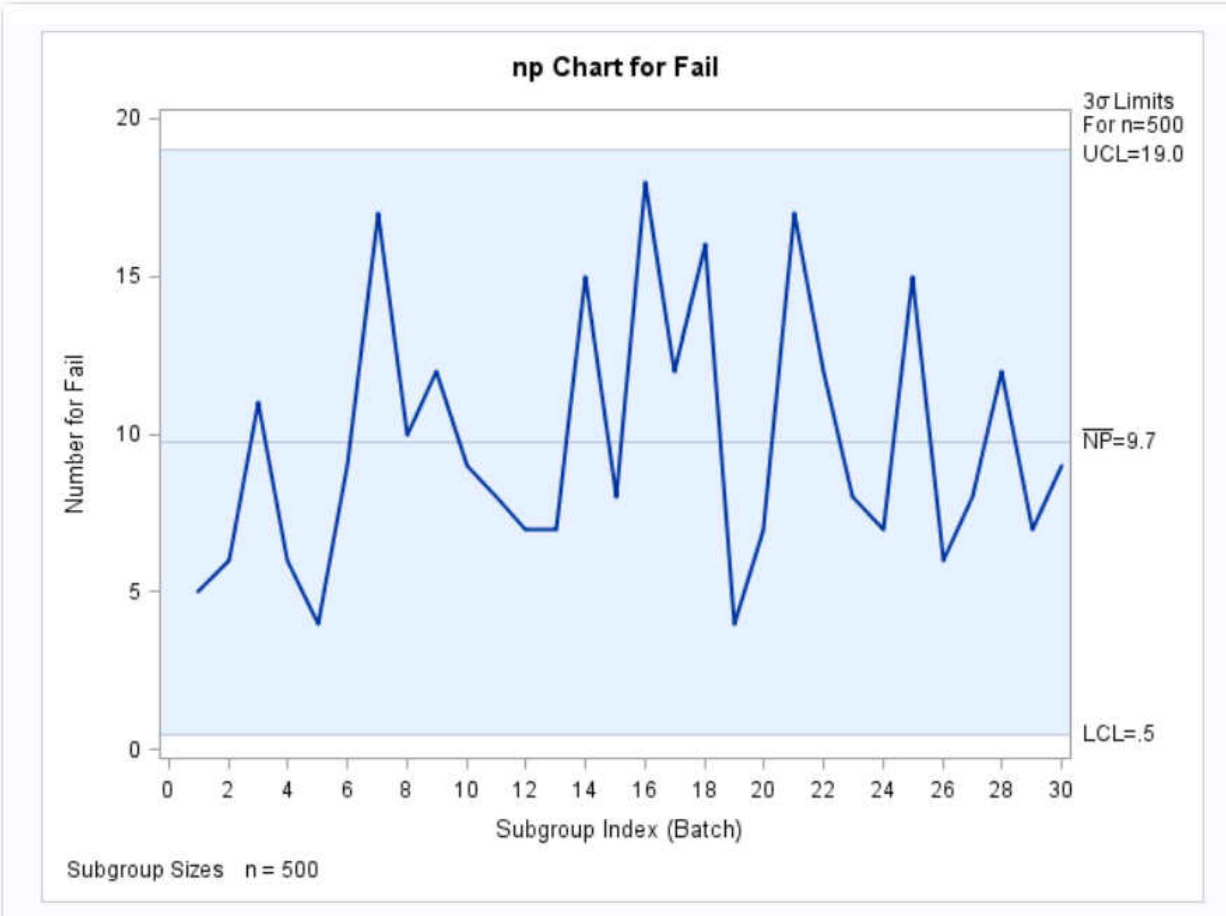


np Charts

np charts display the numbers of nonconformities (defects) in the subgroup samples. You might want to use this task 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.

Here is an example of an np chart:

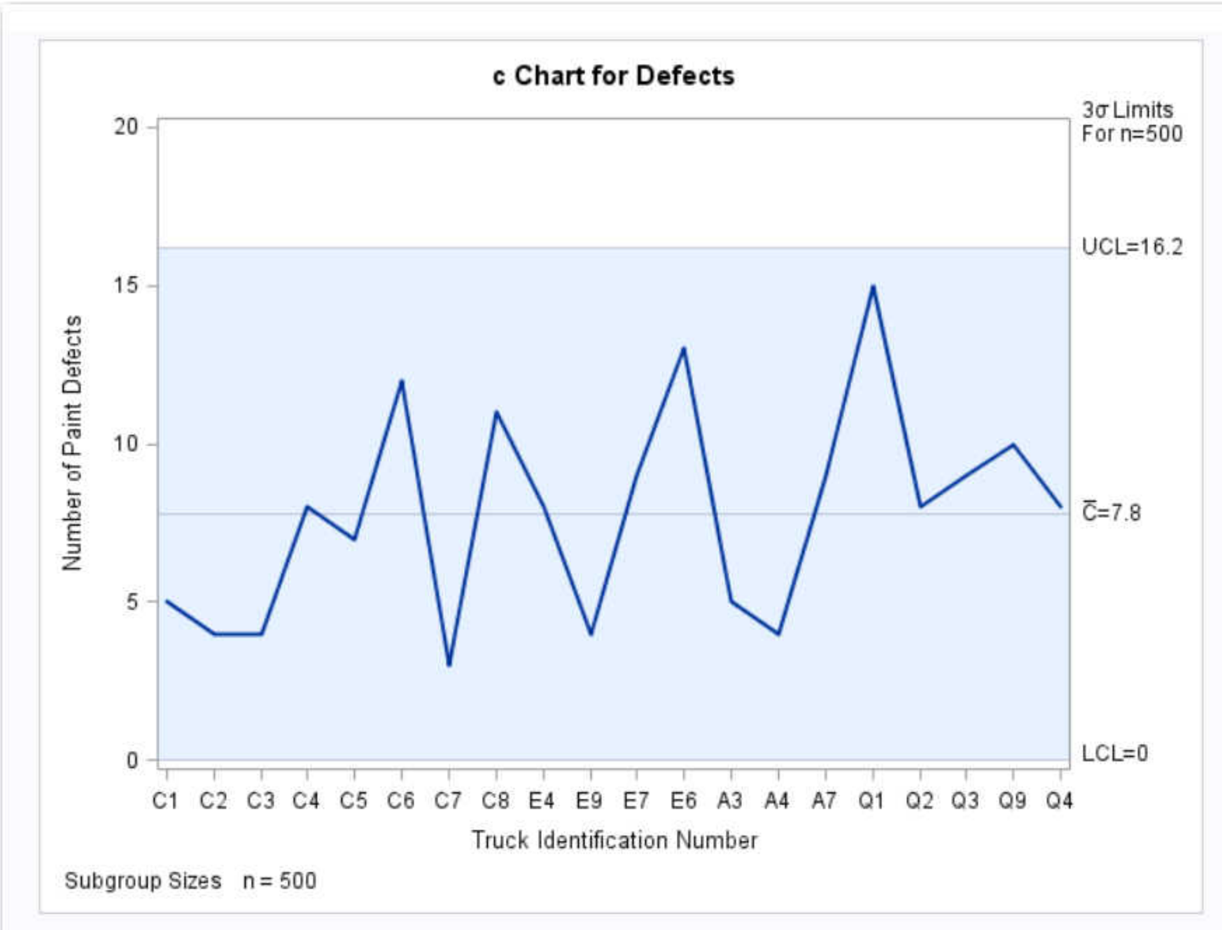


c Chart

c charts display 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.

Here is an example of a c chart:

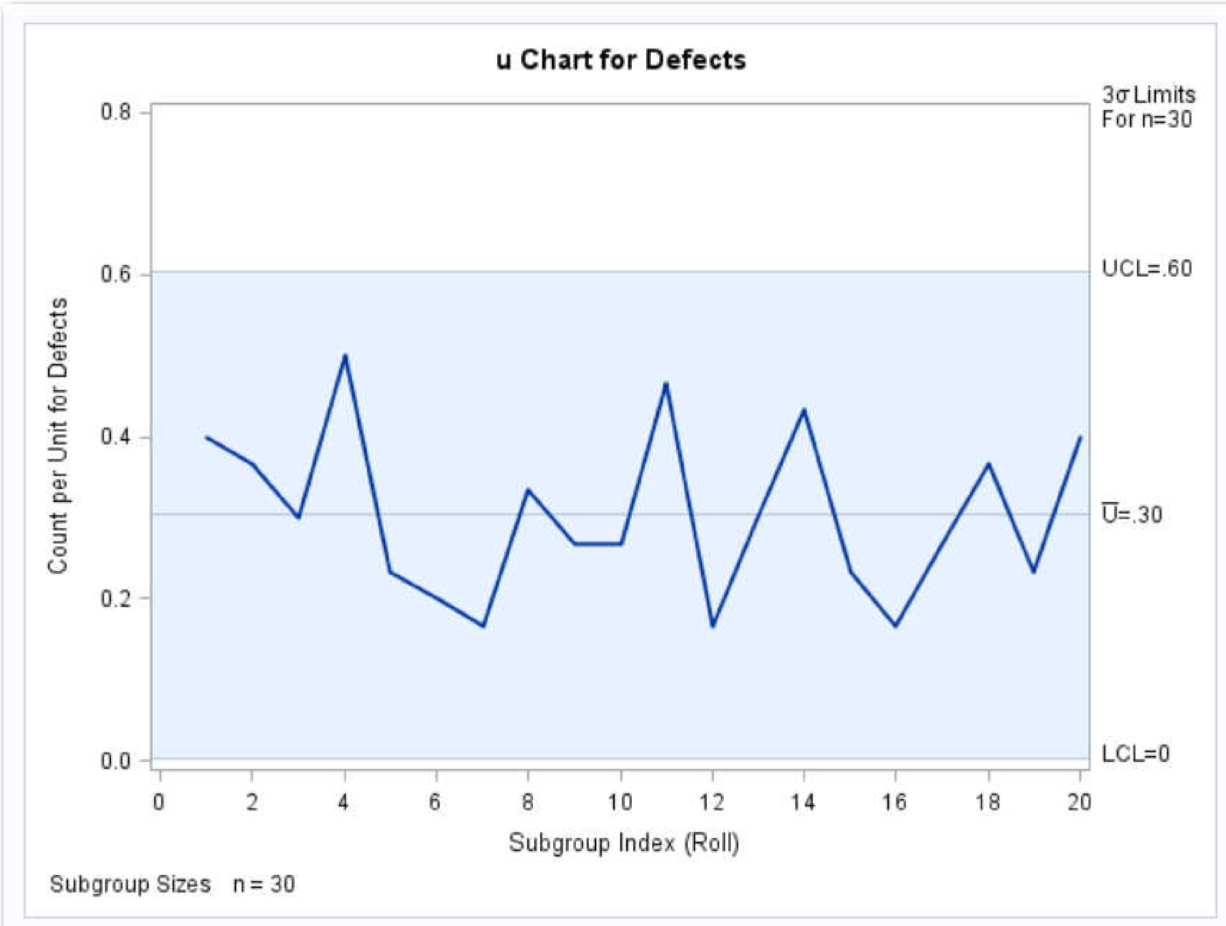


u Chart

u charts display the numbers of nonconformities (defects) per inspection unit in the subgroup samples that contain arbitrary numbers of units. You might want to use this task 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.

Here is an example of a u chart:



Example: Determine the Mean and Range for the Diameters of Wafers

To create this example:

1 In SAS Studio, click  and select **New SAS Program**.

2 Copy and paste this code into the **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;
```

Click to create the Work.Wafers data set.

3 In the **Tasks** section, expand the **Statistical Process Control** folder, and then double-click **Control Charts**. The user interface for the Control Charts task opens.

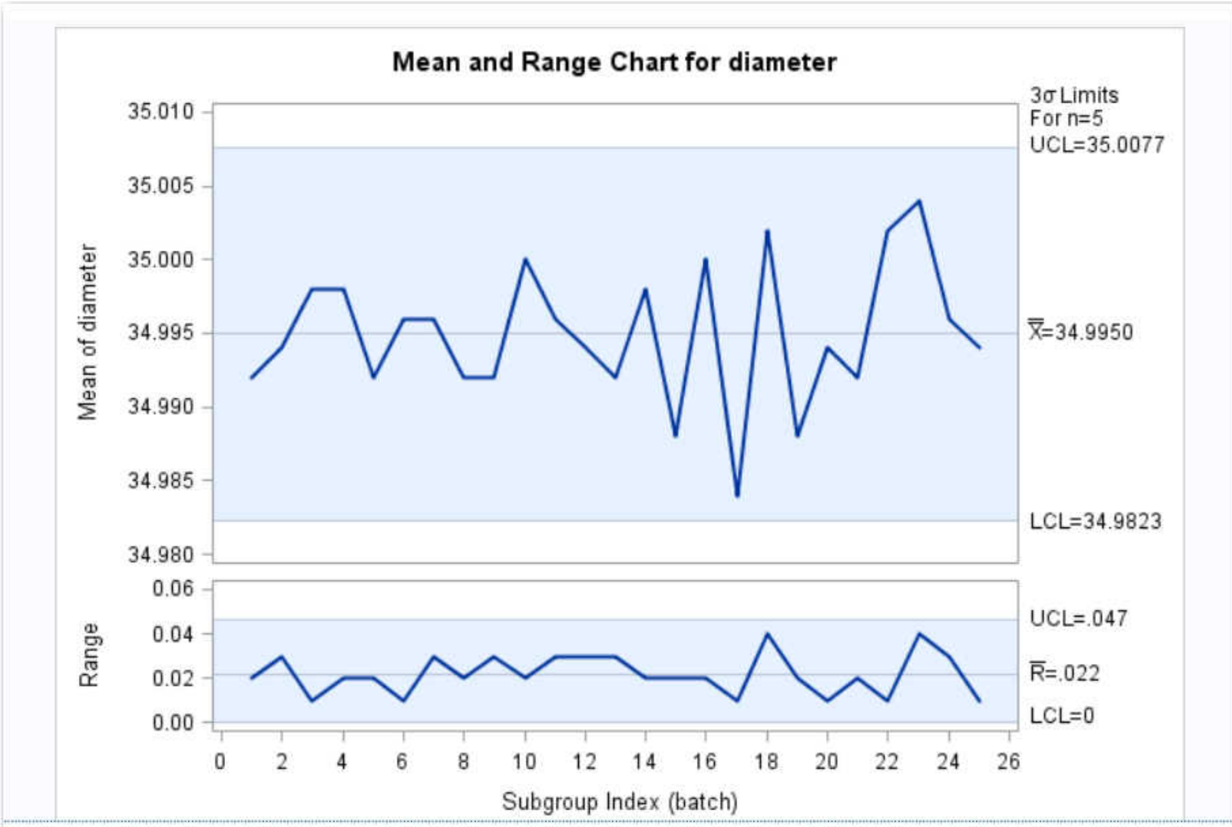
4 On the **Data** tab, select the **WORK.WAFERS** data set.

5 Assign columns to these roles:

Role	Column Name
Process variable	**diameter**
Subgroup variable	**batch**

6 To run the task, click .

Here is a subset of the results:



Assigning Data to Roles

To run the Control Charts task, you must select an input data source and assign a column to the **Process variable** and **Subgroup variable** roles. To filter the input data source, click .

Option Name	Description
Roles	
Process variable	specifies the variable for the process that you want to test.

Option Name	Description
Subgroup variable	specifies the variable that identifies the subgroups in the data. The values of this variable indicate how the observations in the input data set 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
Chart type	specifies the type of control chart to create. For more information about the different chart types, see “About the Control Charts Task” on page 513.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Control Limits	
Method	specifies whether to compute the control limits by using the current input data set or to compute the control limits from a different data set. ■ If you use the current input data, you can set the **Limits based on** option. ■ If you want to compute the data from a different data set, select **Use stored limits**. Then select the data set to use. The data set that you select must be a LIMITS= data set. For more information about the variables that are required in a LIMITS= data set, see the procedure documentation for the chart that you are creating. In the Control Charts task, you can create this data set by selecting the **Save control limits** check box on the **Output** tab.
Limits based on	specifies the width of the control limits as a multiple of the standard error (sigma) of the summary subgroup statistic that is plotted on the chart. The width must be positive. The default multiple is 3.

Option Name	Description
Tests for Special Causes **Note:** These tests are available only when you are computing the control limits from the current data set and 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.	
Show zones A, B and C	adds lines that delineate zones A, B, and C for the selected tests.
Specify Tests	
You can select from these 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**	
Chart Options	
Display markers for subgroup points	adds markers to indicate the subgroup points.
Display vertical needles	connects plotted points to the central line with vertical line segments.
Tabular Output	
Display table of points that are out of control or violate tests	creates a table that lists the subgroups for which a test is positive or 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.

Setting the Output Options

You can choose to save the summary statistics data set, the control limits data set, or both sets of statistics in the same data set. To use the control limits data set to compute the control limits, select the **Method** option on the **Options** tab.

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Capability Analysis

About the Capability Analysis Task

Capability analysis compares the distribution of a process to its specification limits. When you run the Capability Analysis task, 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.

Example: Analysis of Plating Thickness

To create this example:

1 In SAS Studio, click and select **New SAS Program**.

2 Copy and paste this code into the **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;
```

Click to create the Work.Trans data set.

3 In the **Tasks** section, expand the **Statistical Process Control** folder, and then double-click **Capability Analysis**. The user interface for the Capability Analysis task opens.

4 On the **Data** tab, select the **WORK.TRANS** data set.

5 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 To run the task, click .

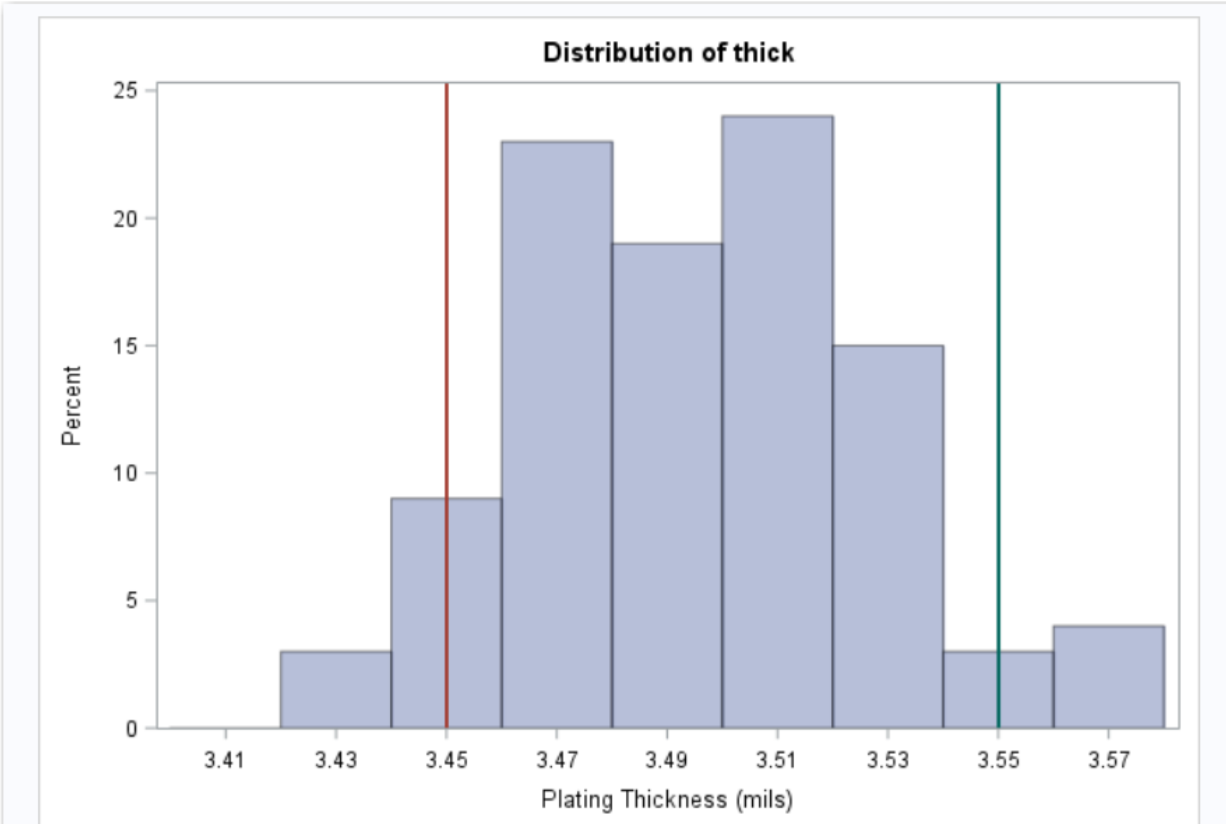
Here is a subset of the results:

Variable: thick (Plating Thickness (mils))

Moments			
N	100	Sum Weights	100
Mean	3.49533	Sum Observations	349.533
Std Deviation	0.03211691	Variance	0.0010315
Skewness	0.17389138	Kurtosis	-0.3731858
Uncorrected SS	1221.8353	Corrected SS	0.10211811
Coeff Variation	0.91885208	Std Error Mean	0.00321169

Basic Statistical Measures			
Location		Variability	
Mean	3.495330	Std Deviation	0.03212
Median	3.496000	Variance	0.00103
Mode	3.461000	Range	0.14700
		Interquartile Range	0.04700

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.988865	Pr < W	0.5740



Assigning Data to Roles

To run the Capability Analysis task, you must select an input data source and assign a column to the **Process variable** role. To filter the input data source, click .

Option Name	Description
Roles	
Process variable	specifies the variable that you want to analyze.
Specification Limits	
Lower limit	specifies the value for the lower specification limit.
Target value	specifies the target value.
Upper limit	specifies the value for the upper specification limit.
Additional Roles	

Option Name	Description
Classification variable	specifies one or two variables 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.
Group analysis by	specifies to create separate analyses of observations by using the values of this variable.

Setting Options

Option Name	Description
Plots	
By default, a histogram is included in the results. You can choose to include a probability plot and a quantile-quantile plot in the output. For each type of plot, you can select the theoretical distribution to use.	
Inset Options	
Include inset table	adds a table of summary statistics to the graph. The inset 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.

Setting the Output Options

You can specify whether to create an output data set.

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Pareto Analysis

About the Pareto Analysis Task

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.

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 mixture 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 In SAS Studio, click  and select **New SAS Program**.

2 Copy and paste this code onto the **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;
```

Click to create the Work.Failure data set.

3 In the **Tasks** section, expand the **Statistical Process Control** folder, and then double-click **Pareto Analysis**. The user interface for the Control Charts task opens.

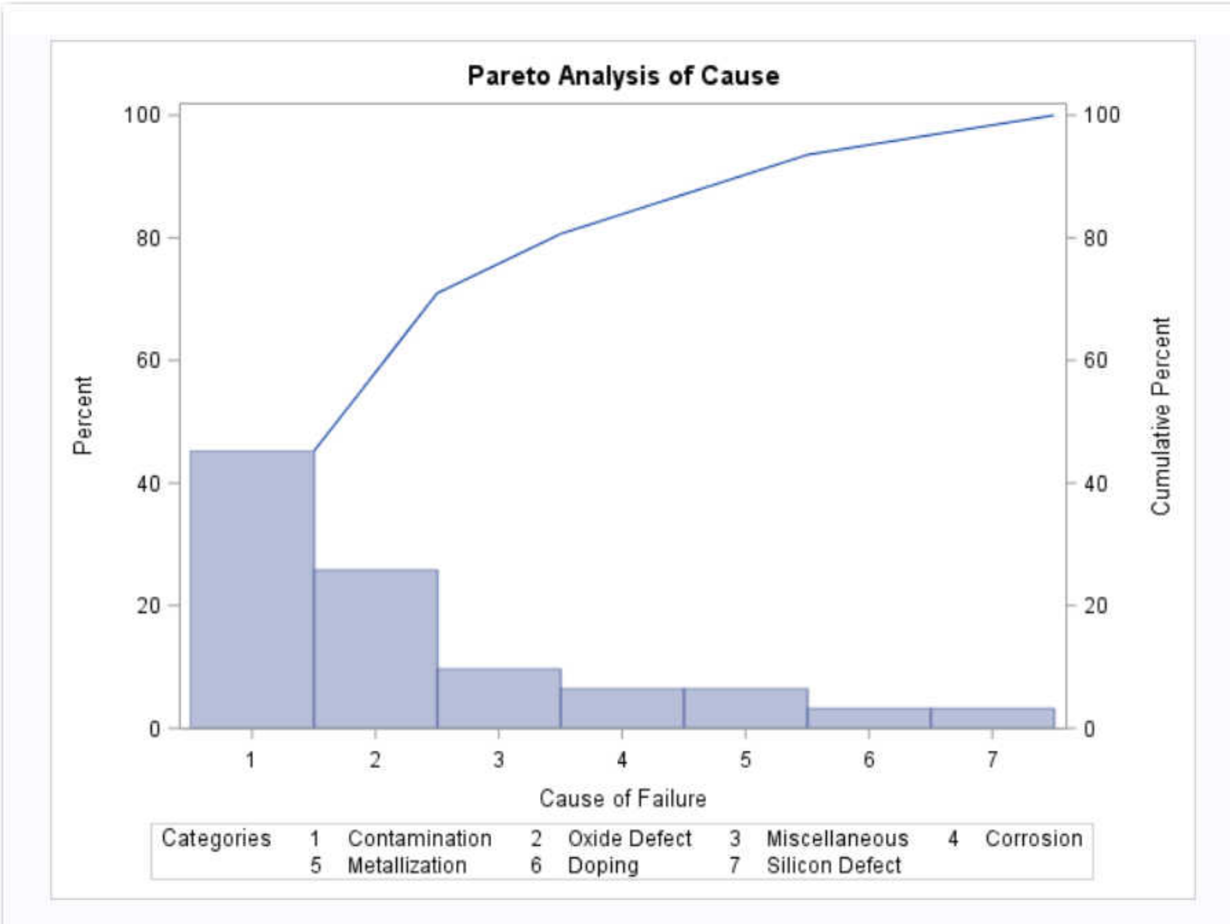
4 On the **Data** tab, select the **WORK.FAILURE** data set.

> **TIP** If the data set is not available from the drop-down list, click . In the Choose a Table window, expand the library that contains the data set that you want to use. Select the data set for the example and click **OK**. The selected data set should now appear in the drop-down list.

5 To the **Process variable** role, assign the **Cause** variable.

6 To run the task, click .

Here are the results:



Assigning Data to Roles

To run the Pareto Analysis task, you must select an input data source. To filter the input data source, click .

You must assign a column to the **Process variable** role.

Option Name	Description
Roles	
Process variable	specifies the variable to analyze.
Additional Roles	
Frequency variable	specifies the counts (numbers of occurrences) of the unique values in the process variable.

Option Name	Description
Classification variable	creates a comparative Pareto chart by using the levels of the variable.
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Plots	
Select plot type	uses either vertical or horizontal bars to measure the frequencies in the Pareto chart.
Display cumulative percentage curve	displays the cumulative percentage curve.
Display sample size legend	displays the legend for the sample size.
Number of categories to display	requests that only the Pareto categories with the *n* highest frequencies be displayed.
Merge smaller categories	merges smaller categories into one category to display on the Pareto chart.

Setting the Output Options

You can specify whether to create an output data set.

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Analysis of Means

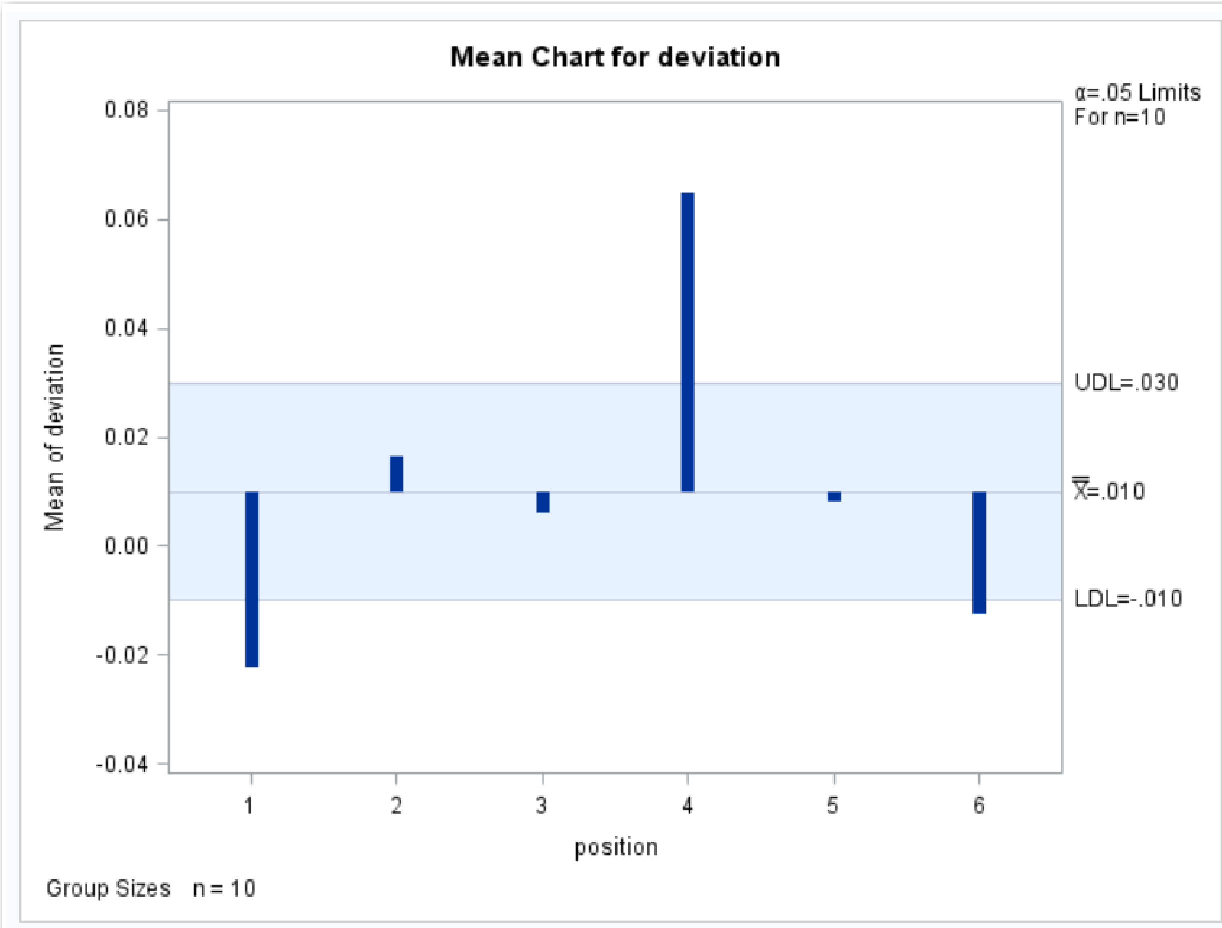
About the Analysis of Means Task

Analysis of means is a method for simultaneously comparing treatment means with their overall mean.

Mean Chart

The mean chart shows the deviation of the mean for the groups identified by the **Group variable**.

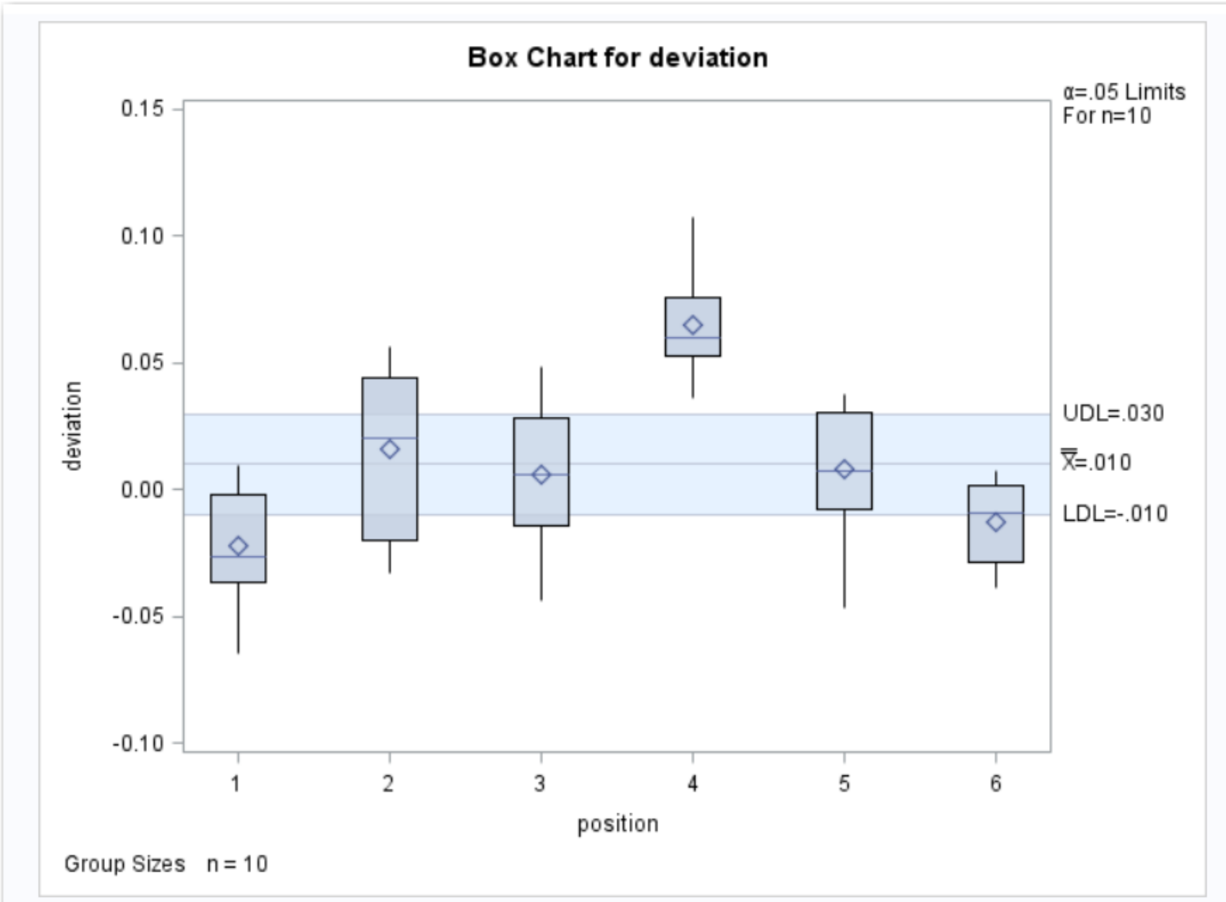
Here is an example of a mean chart. For more information, see “Example: Determine the Deviation of Label Positions” on page 541.



Mean Chart with Boxes

You can choose to include box charts to show the deviation of the mean for each group.

Here is an example of a mean chart with boxes:

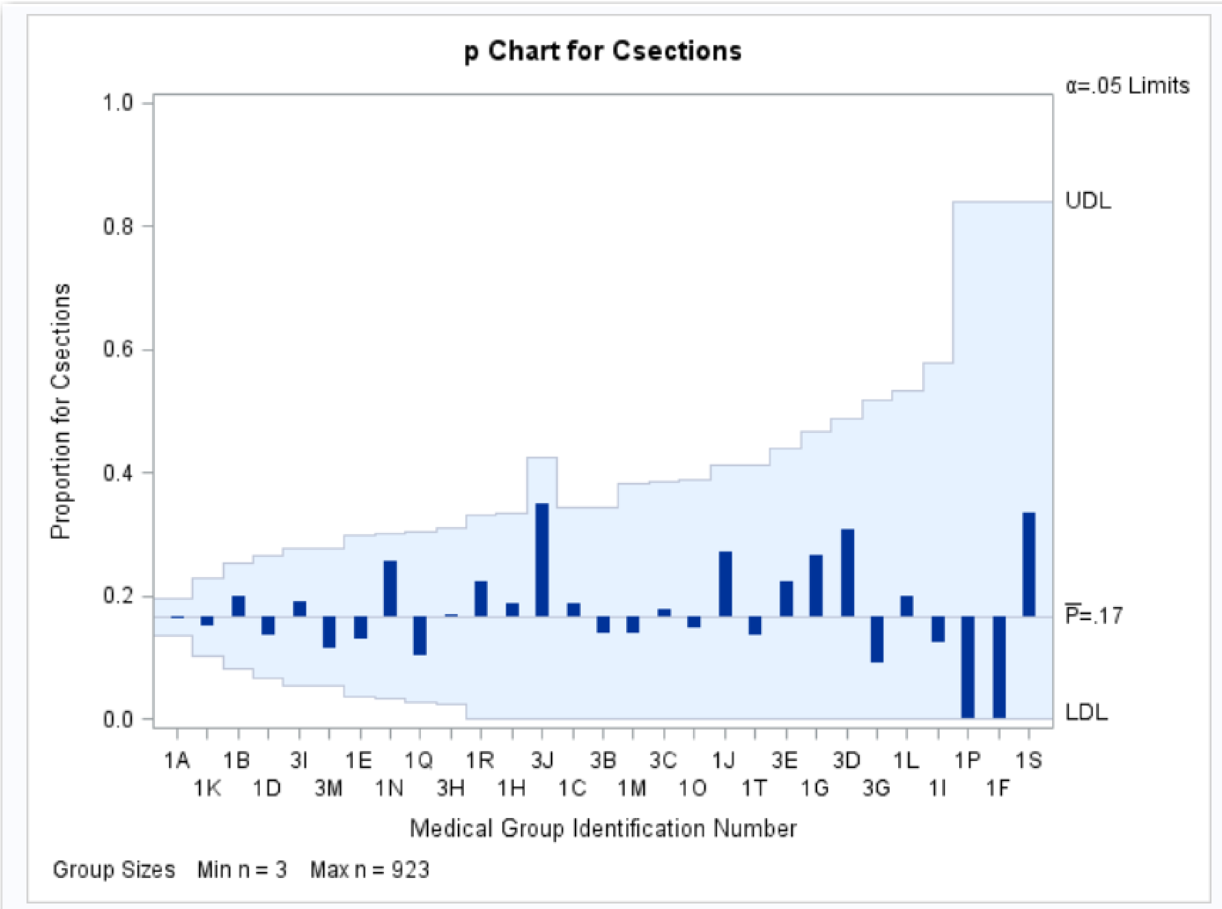


Proportion Chart

Proportion charts (also called *p* charts) are for 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.



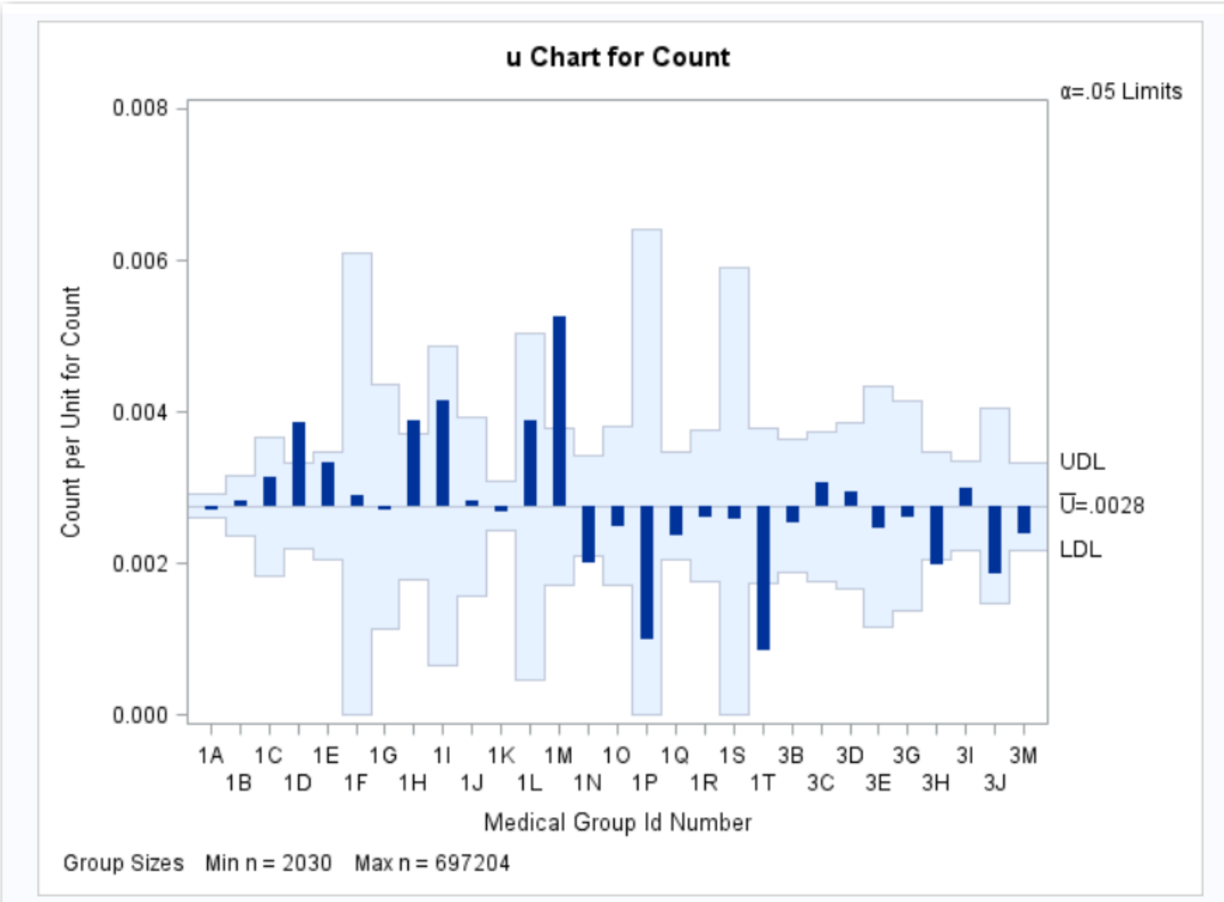
Each point on the *p* chart represents the proportion of C-sections for a particular group. For example, the value plotted for group 1A is 150/923=0.163. Because all the points fall within the decision limits, it can be concluded that the variation in proportions of C-sections across medical groups is strictly due to chance. By default, the decision limits shown correspond to a significance level of $\alpha = 0.05$. 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).

For the analysis, the health care administrator creates this u chart.



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 $\alpha = 0.05$. 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.

Example: Determine the Deviation of Label Positions

A manufacturing engineer carries out 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 In SAS Studio, click  and select **New SAS Program**.

2 Copy and paste this code into the **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;
```

Click  to create the Work.LabelDeviations data set.

3 In the **Tasks** section, expand the **Statistical Process Control** folder, and then double-click **Analysis of Means**. The user interface for the Analysis of Means task opens.

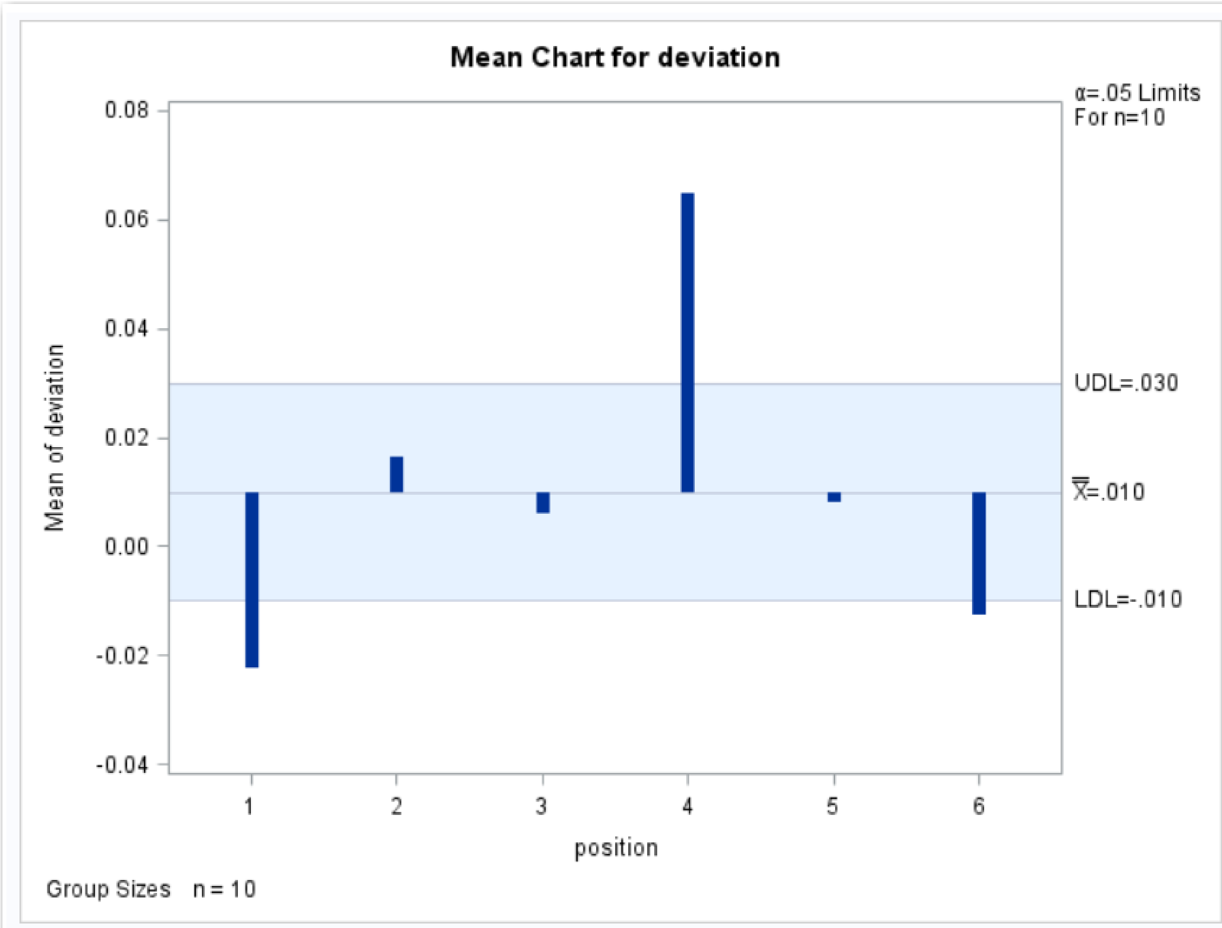
4 On the **Data** tab, select the **WORK.LABELDEVIATIONS** data set.

5 Assign columns to these roles:

Role	Column Name
Response variable	**deviation**
Group variable	**position**

6 To run the task, click .

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.

Assigning Data to Roles

To run the Analysis of Means task, you must select an input data source and assign a column to the **Response variable** and **Group variable** roles. To filter the input data source, click .

Option Name	Description
Roles	
Response variable	specifies the responses to analyze.

Option Name	Description
Group variable	specifies the variable that identifies the groups in the data.
Chart type	specifies the type of chart to create. For more information about each chart type, see"About the Analysis of Means Task" on page 537.
Additional Roles	
Group analysis by	enables you to obtain separate analyses of observations for each unique group.

Setting Options

Option Name	Description
Decision Limits	
Method	specifies whether to compute the decision limits by using the current input data set or to compute the decision limits from a different data set. ■ If you want to compute the decision limits by using the current data, you must specify the probability of Type I error. ■ If you want to compute the data from a different data set, select **Use stored limits**. Then select the data set to use. Each observation in a LIMITS= data set provides decision limit information for a response. The data set that you select must be a LIMITS= data set. In the Analysis of Means task, you can create this data set by selecting the **Save decision limits** check box on the **Output** tab.
Tabular Output	
Display table of points that exceed limits	creates a basic table for those subgroups for which 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.
Inset Options	

Option Name	Description
You can specify whether to include an insert table in the output. You can also choose the statistics to include in this table: significance level, degrees of freedom, average of group means, and mean square error.	

Setting the Output Options

You can choose to create a decision limits data set or a data set that contains both the statistics and decision limits.

Part 11

Data Mining Tasks

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Rapid Predictive Modeler

About the Rapid Predictive Modeler

Overview of the Rapid Predictive Modeler

SAS Rapid Predictive Modeler is designed to build models for the following types of data mining classification and regression problems:

- classification models that predict the value of a discrete variable. Some examples are classification models that predict the value of a variable, such as True or False; Purchase or Decline; High, Medium, or Low; and Churn or Continues.
- regression models that predict the value of a continuous variable. Some examples are regression models that might predict amounts such as revenue, sales, or success rate by using continuous values.

To create a model by using the SAS Rapid Predictive Modeler, you must supply a data set, where every row contains a set of independent predictor variables (known as inputs) and at least one dependent variable (known as a target). The SAS Rapid Predictive Modeler decides whether variables are continuous or categorical, and chooses the input variables that should be included in the model.

Your model can be saved as SAS code and then deployed in a SAS environment. You can use the SAS model code to score new data, and then use the results to make more informed business decisions. This process is called model scoring. For example, you can use scored data to decide which customers to select for churn, or to detect transactions that might be fraudulent.

Sampling Strategies for the SAS Rapid Predictive Modeler

The SAS Rapid Predictive Modeler uses a composite sampling approach. The number of observations that are included in the data sample depend on these factors:

- number of input variables
- total number of observations in the data source
- whether the data contains rare event targets
- number of events in the data

Here are the guidelines that the SAS Rapid Predictive Modeler uses to determine the number of observations that are processed:

Number of Input Variables	Number of Observations Processed
<100	80,000
100–200	40,000
>200	20,000

To understand the conditions in the following table, here are some key points:

- The number of observations being processed is determined by the number of input variables. See the preceding table.
- In predictive modeling, if you are modeling a binary target, your target variable has an event level of 0 or 1. The event level could also be formatted to use No or Yes. Here is an example. A bank is trying to predict whether a customer will have bad credit. In the training data, each customer with bad credit is set to Yes, which means an event occurred for that customer. Each customer with good credit is considered a non-event.

	Rare Event	
Condition	**Yes**	**No**
total number of observations < number of observations being processed OR total number of events < (0.10*number of observations being processed)	Sample the data so that there is a 10:1 ratio of non-events to events.	no samplin g

	Rare Event	
Condition	Yes	No
total number of events > (0.10*number of observations being processed)	Sample the following proportion of the rare events: $10 * \frac{(0.10 * numberofobservationsbeingprocessed)}{numberofevents}$	stratified samplin g

Organizing Data for the SAS Rapid Predictive Modeler

Before you can build a model, you need input data that represents historical events and characteristics that can be used for prediction. You also need target data that represents the event or value that you want to predict. In many cases, the input data is derived from one time period and the target data is derived from a later time period. The combined input and target data that you use to develop your model is called *training data*.

For example, you might mine last year's sales receipts to predict next year's expected revenue or to predict which customers will respond to a special offer. Using historical data from past events to predict performance on future events is called *model training*.

For the best model results, your model training data should contain a large number of observations stored as rows of data. For example, many retail customer models use input data that has tens of thousands of observations.

If your target variable contains a rare event (for example, an offer that perhaps only 1% of your customers will respond to), you must ensure that your training data contains a significant number of these customers in your data set. You might want to oversample your training data to make sure you select all customers who accepted the offer, and provide an equal number of customers who did not accept. Oversampling makes it easier for a model with a rare event target to find a stable solution.

When you perform oversampling to boost rare event occurrences in your training data, you artificially inflate the occurrence of targeted events in your training data relative to the natural population. To compensate for the difference between the training data and the population data, the SAS Rapid Predictive Modeler provides you with a prior probability setting. Prior probability settings specify the true proportional frequencies of the targeted event in the population data.

The data that you mine using the SAS Rapid Predictive Modeler should be organized into rows (observations) and columns (variables). One of the columns should represent a target variable.

Consider the following example:

Name	Age	Gender	Income	Treatment	Purchase
Ricardo	29	M	33000	Y	Y
Susan	35	F	51000	Y	N

Name	Age	Gender	Income	Treatment	Purchase
Jeremy	49	M	110000	N	Y

Name
: a column that contains ID values for each observation. The SAS Rapid Predictive Modeler does not process ID variable columns for analytical content.

Age, Gender, Income, and Treatment
: input columns that are used by the SAS Rapid Predictive Modeler.

Purchase
: a target column.

When you configure your table of input data, you can also designate a frequency column. The values in the frequency column are nonnegative integers and must sum to 1.

By using the **Variables to exclude from the model** role, you can also select columns that you want the SAS Rapid Predictive Modeler to ignore during your analysis.

Training data always requires input and target variable values. Data that you use for scoring requires only input variable values; a target column is optional. When the model is used to make predictions from new data, the target column is not required. When the model is used to monitor effectiveness, the target column is required. Data that you use for scoring also typically includes an ID column.

Reserved Prefixes for Variables

SAS Enterprise Miner uses several default prefixes for generated nodes. If one of the variables in your input data uses any of these prefixes, you might see an error in the SAS log. If any of the variables in your input data set use these prefixes, it is recommended that you change the name of the variable in the input data set.

Table 76.1 *Reserved Prefixes*

BL_	BP_	CL_	CP_
D_	E_	EL_	EP_
F_	I_	IC_	M_
P_	Q_	R_	RA_
RAS_	RAT_	RD_	RDS_
RDT_	ROI_	RS_	RT_
S_	T_	U_	V_

Assigning Data to Roles

To run the Rapid Predictive Modeler, you must select an input data source. To filter the input data source, click .

You must assign a variable to the **Dependent variable** role.

Role	Description
Roles	
Dependent variable	specifies the value that you want to predict or classify. The dependent variable is also known as the target variable. **Note:** The dependent variable must have 10 or less nonmissing levels. If the number of missing levels is greater than 10, you cannot run the task until you select a different dependent variable.

<table>
<tr><th>Role</th><th>Description</th></tr>
<tr><td>Decisions and Priors</td><td>specifies this information:

Event level specifies the class target value that you want to model. The SAS Rapid Predictive Modeler automatically builds a model that provides the probabilities for each target event, but reporting improves when the desired target level is known.
Prior probabilities displays the counts and proportions of the target variable levels that occur in the model training data. You can adjust these values when your target variable is a categorical variable, and the training data and population data have different target distributions.
For example, consider a model that was trained on oversampled data, where 50% of observations are responders and 50% of observations are non-responders. However, the population data that the model scores historically contains only 10% responders and 90% non-responders. You can use prior probability settings to inform the model of the historically expected proportions of responders to non-responders.

If you do not want to specify prior probabilities, select None (which is the default).
To specify equal probabilities for all levels of the target variable, select Equal.
To specify your own custom prior probabilities for target variable levels in the scored data, select User-defined and specify the probabilities. The prior probabilities that you specify must sum to 1.
Note: Prior probabilities are supported only if the dependent variable has 10 or fewer values.

Decision function specifies the costs, profits, or weights that you want to associate with the predicted results. The table of values is called a decision matrix. You use a decision matrix to associate a value with each possible decision outcome.

If your model does not require a decision matrix, select None.
To use your model to maximize profit, select Maximum, and if desired, enter a higher weight in the true positive cell of the matrix.
To use your model to minimize cost, select Minimum, and if desired, enter a higher weight in the true negative cell of the matrix.
To use your model to predict rare events, select Inverse to identify true positive and true negative predictions, at the risk of misestimating false positive and false negative predictions. Inverse is the default value.
Note: The decision matrix is supported only if the dependent variable has 10 or fewer values.

</td></tr>
</table>

Role	Description
Additional Roles	
Variables to exclude from the model	specifies the variables that you do not want to include in your analysis.
Frequency count	specifies the variable to use to represent the frequency value. The data is treated as if each case is replicated as many times as the value of the frequency variable.
ID variables	specifies variables that are useful for reporting and scoring selection functions. These variables are not included in the analysis.

Setting the Model Options

Choosing a Model

With these options, you can specify the complexity level of the model that you want to build. The modeling methods are in a hierarchy: the intermediate method includes basic and intermediate models, and the advanced method includes basic, intermediate, and advanced models.

The models that you create using the basic method will probably run faster than the models that you create using the intermediate method, but the basic method also might create a less accurate model. The same is often true when you compare the models that you create with the intermediate and advanced methods.

SAS Enterprise Miner modeling functions are executed when you run the SAS Rapid Predictive Modeler. The modeling functions that the software runs depend on the selected modeling method.

Modeling Methods

You can choose from these modeling methods:

Basic
: The basic method samples the data only if you have a rare target event, and then partitions the data by using the target as a stratification variable. Next, the basic method performs a one-level variable selection step. The input variables that were selected are then binned according to the strength of their relationship to the target and passed to a forward stepwise regression model.

Intermediate
: The intermediate method is an extension of the basic method. Several variable selection techniques are performed and then followed by multiple variable transformations. A decision tree, a regression model, and a logistic regression are used as modeling techniques. Variable interactions are represented using the node variable that was exported from a decision tree.

The intermediate method also runs the basic method, and then chooses the best performing model.

Advanced
The advanced method is an extension of the intermediate method and includes a neural network model, an advanced regression analysis, and ensemble models. The advanced method also runs the intermediate and basic methods, and then chooses the best performing model.

Understanding the Models for the SAS Rapid Predictive Modeler

The SAS Rapid Predictive Modeler provides you with basic, intermediate, and advanced models. The models increase in sophistication and complexity.

- The basic model is a simple regression analysis.
- The intermediate model includes a more sophisticated analysis, plus the analysis from the basic model, and chooses the better model.
- The advanced model includes an even more sophisticated analysis, plus the analyses from the basic and intermediate models, and chooses the best model.

Basic
The basic model performs a series of three data mining operations.

- Variable Selection: The basic model chooses the top 100 variables for modeling.
- Transformation: The basic model performs an Optimal Binning transformation on the top 100 variables selected for modeling. The Optimal Binning transformation compensates for missing variable values, so missing value imputation is not performed.
- Modeling: The basic model uses a forward regression model. The forward regression model chooses variables one at a time in a stepwise process. The stepwise process adds one variable at a time to the linear equation until the variable contributions are insignificant. The forward regression model seeks to exclude variables with no predictive ability (or variables that are highly correlated with other predictor variables) from the analytic analysis.

Intermediate
The intermediate model performs a series of seven data mining operations.

- Variable Selection: The intermediate model chooses the top 200 variables for modeling.
- Transformation: The intermediate model performs a best power transformation on the 200 variables that were selected for modeling. The best power transformations are a subset of the general class of transformations that are known as Box-Cox transformations. The best power transformation evaluates a subset of exponential power transformations, and then chooses the transformation that has the best results for the specified criterion.
- Imputation: The intermediate model performs an imputation to replace missing variables with the average variable values. The imputation operation also creates indicator variables that enable observations that contain imputed variable values to be identified.

- Variable Selection: The intermediate model uses the chi-square and R-square criteria tests to remove variables that are not related to the target variable.
- Union of Variable Selection Techniques: The intermediate model merges the set of variables that were selected by the chi-square and R-square criteria tests.
- Modeling: The intermediate model submits the training data to three competing model algorithms. The models are a decision tree, a logistic regression, and a stepwise regression. In the case of the logistic regression model, the training data is first submitted to a decision tree that creates a NODE_ID variable that is passed as input to the regression model. The NODE_ID variable is created to enable variable interaction models.
- Champion Model Selection: The intermediate model performs an analytic assessment of the predictive or classification performance of the competing models. The model that demonstrates the best predictive or classification performance is selected to perform the modeling analysis. The intermediate model for champion model selection evaluates the performance of not only the intermediate models, but also the basic models.

After the SAS Rapid Predictive Modeler chooses the intermediate champion model, it compares the predictive performance of the intermediate champion model to the basic model, and then chooses the better model as the result.

Advanced
The advanced model performs a series of seven data mining operations.

- Variable Selection: The advanced model chooses the top 400 variables for modeling.
- Transformation: The advanced model performs the multiple transformation algorithm on the 400 variables that were selected for modeling. The multiple transformation operation creates several variable transformations that are intended for use in later variable selections. Multiple transformations result in an increase in the number of input variables. Because of the increase in input variables, SAS Rapid Predictive Modeler selects the best 400 input variables from the output that was generated by the multiple transformation algorithm.
- Imputation: The advanced model performs an imputation to replace missing variables with the average variable values. The imputation operation also creates indicator variables that enable the user to identify observations that contain imputed variable values.
- Variable Selection: The advanced model uses the chi-square and R-square criteria tests to remove variables that are not related to the target variable. AOV16 variables are created during the R-square analysis.
- Union of Variable Selection Techniques: The advanced model merges the set of variables that were selected by the chi-square and R-square criteria tests.
- Modeling: The advanced model submits the training data to four competing model algorithms. The models are a decision tree model, a neural network model, a backward regression model, and an ensemble model. The neural network model conducts limited searches in order to find an optimal feed-forward network. Backward regression is a linear

regression model that eliminates variables by removing one variable at a time until the R-squared scores drop significantly. The ensemble model creates new models by combining the posterior probabilities (for class targets) or the predicted values (for interval targets) from multiple predecessor input models. The new ensemble model is then used to score new data. The ensemble model that you use in the advanced model is created from the output of the basic model, the champion model from the intermediate model, and the champion model from the advanced model.

- Champion Model Selection: The advanced model performs an analytic assessment of the predictive or classification performance of the competing decision tree, neural, and regression models. The model that demonstrates the best predictive or classification performance is then used as an input, along with the champion model from the basic and intermediate models, to create an ensemble model. Then the newly created advanced ensemble model, decision tree model, neural model, and backward regression model are analytically compared to select the best model from the sample space of all basic, intermediate, and advanced champion models.

After the SAS Rapid Predictive Modeler selects a champion model, it runs and compares the predictive performance of the advanced model to the champion models for the intermediate and basic models, and then chooses the best performing champion model as the result.

Setting the Report Options

About the Reports

The reports identify significant terms in the model and generate common business graphics, such as lift charts. The results include statistics for training and validation data. The SAS Rapid Predictive Modeler process divides the input data into training data and validation data. Training data is used to compute the parameters for each model, resulting in the training fit statistics. Validation data is then scored with each model, resulting in the validation fit statistics. The validation fit statistics are used to compare models and detect overfitting. If the training statistics are significantly better than the validation statistics, then you would suspect overfitting, which occurs when the model is trained to detect random signals in the data. Models with the best validation statistics are generally preferred.

The SAS Rapid Predictive Modeler automatically generates a concise set of core reports that provide a summary of the data source and variables that were used for modeling, a ranking of the important predictor variables, multiple fit statistics that evaluate the accuracy of the model, and a model scorecard.

About the Standard Reports for the SAS Rapid Predictive Modeler

Here are the standard reports that are automatically generated by the SAS Rapid Predictive Modeler:

Gains chart
: Gains chart plots are available only for models that have class target variables. This chart shows percentiles of the data ranked by predicted value. Lift is a measure of the ratio of the number of target events that the model identified, compared to the number of target events that were found by random selection.

Receiver Operating Characteristic plot (ROC)
: The Receiver Operating Characteristic plot shows the maximum predictive power of a model for the entire sample (rather than for a single decile). The data is plotted as sensitivity versus (1 – specificity). The separation between the model curve and the diagonal line (which represents a random selection model) is called the Kolmogorov-Smirnov (KS) value. Higher KS values represent more powerful models.

Scorecard
: The results include a scorecard so that the model's characteristics can be interpreted for business purposes. When the software builds a scorecard, each interval variable is binned into distinct ranges of values. Then, each variable is ranked by model importance and scaled to a maximum of 1,000 points. The distinct value for each variable then receives a portion of the scaled point total.

Project information
: The project information shows which user created the model, when the model was created, and where the model's component files are stored.

Setting the Output Options

Option	Description
Output Data Set	

Option	Description
Save Enterprise Miner project data	specifies whether to save the SAS Enterprise Miner data from this task. A model from the SAS Rapid Predictive Modeler is an example of a SAS Enterprise Miner project. When you save SAS Enterprise Miner data, you can use the SAS Enterprise Miner interface to open and edit the model that you created using the SAS Rapid Predictive Modeler. In SAS Enterprise Miner, you can save and export your analysis for use outside of SAS Enterprise Miner, and register your model with a SAS Metadata Repository. ■ If you have a workstation installation of SAS Enterprise Miner, the project is saved locally in the workstation location that is specified. ■ If you have a client/server installation of SAS Enterprise Miner, the project is saved in the User Root folder (for example, `C:\users\username\Documents`) on the server. If you used SAS Management Console to define a SYSTEM root location (for example, `C:\projects`) on the server, no directory path is specified. In this case, you can specify the location for your project storage. If this field is left blank and you do not specify a location before attempting to save the project, an error message is displayed that prompts you to specify a valid location. The project data for several runs of the Rapid Predictive Modeler task can be saved in the same folder.
Export scoring code	saves the scoring code from this task to the specified location. You can then run this code to score other sets of data in other SAS products.
Score input data set	specifies the name of the output data set that contains the scored values. The values in the input data set are scored by the model that the SAS Rapid Predictive Modeler builds.

Part 12

Appendixes

Appendix 1

Input Data Sets for Task Examples

About the Task Data Sets

To complete some of the examples in the task documentation, you might need to create one or more data sets. This appendix provides the SAS code that you need. To create these data sets, copy and paste this code (from the HTML version of *SAS Studio: User's Guide*) into a **Program** tab in SAS Studio and click .

CIGAR Data Set

To create the Cigar data set, enter this code into a **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
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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
;
```

FITNESS Data set

To create the Fitness data set, enter this code into a **Program** tab:

```
data Fitness;
   input Age Weight Oxygen RunTime @@;
   datalines;
44 89.47 44.609 11.37
40 75.07 45.313 10.07
44 85.84 54.297 8.65
42 68.15 59.571 8.17
38 89.02 49.874 .
47 77.45 44.811 11.63
40 75.98 45.681 11.95
43 81.19 49.091 10.85
```

```
44 81.42 39.442 13.08
38 81.87 60.055 8.63
44 73.03 50.541 10.13
45 87.66 37.388 14.03
45 66.45 44.754 11.12
47 79.15 47.273 10.60
54 83.12 51.855 10.33
49 81.42 49.156 8.95
51 69.63 40.836 10.95
51 77.91 46.672 10.00
48 91.63 46.774 10.25
49 73.37 . 10.08
57 73.37 39.407 12.63
54 79.38 46.080 11.17
52 76.32 45.441 9.63
50 70.87 54.625 8.92
51 67.25 45.118 11.08
54 91.63 39.203 12.88
51 73.71 45.790 10.47
57 59.08 50.545 9.93
49 76.32 . .
48 61.24 47.920 11.50
52 82.78 47.467 10.50
;
```

GETSTARTED Data Set

To create the getStarted data set, enter this code into a **Program** tab:

```
data getStarted;
   input C1-C5 Y Total;
   datalines;
0 3 1 1 3 2 28.361
2 3 0 3 1 2 39.831
1 3 2 2 2 1 17.133
1 2 0 0 3 2 12.769
0 2 1 0 1 1 29.464
0 2 1 0 2 1 4.152
1 2 1 0 1 0 0.000
0 2 1 1 2 1 20.199
1 2 0 0 1 0 0.000
0 1 1 3 3 2 53.376
2 2 2 2 1 1 31.923
0 3 2 0 3 2 37.987
2 2 2 0 0 1 1.082
0 2 0 2 0 1 6.323
1 3 0 0 0 0 0.000
1 2 1 2 3 2 4.217
0 1 2 3 1 1 26.084
1 1 0 0 1 0 0.000
1 3 2 2 2 0 0.000
2 1 3 1 1 2 52.640
1 3 0 1 2 1 3.257
2 0 2 3 0 5 88.066
```

```
2 2 2 1 0 1 15.196
3 1 3 1 0 1 11.955
3 1 3 1 2 3 91.790
3 1 1 2 3 7 232.417
3 1 1 1 0 1 2.124
3 1 0 0 0 2 32.762
3 1 2 3 0 1 25.415
2 2 0 1 2 1 42.753
3 3 2 2 3 1 23.854
2 0 0 2 3 2 49.438
1 0 0 2 3 4 105.449
0 0 2 3 0 6 101.536
0 3 1 0 0 0 0.000
3 0 1 0 1 1 5.937
2 0 0 0 3 2 53.952
1 0 1 0 3 2 23.686
1 1 3 1 1 1 0.287
2 1 3 0 3 7 281.551
1 3 2 1 1 0 0.000
2 1 0 0 1 0 0.000
0 0 1 1 2 3 93.009
0 1 0 1 0 2 25.055
1 2 2 2 3 1 1.691
0 3 2 3 1 1 10.719
3 3 0 3 3 1 19.279
2 0 0 2 1 2 40.802
2 2 3 0 3 3 72.924
0 2 0 3 0 1 10.216
3 0 1 2 2 2 87.773
2 1 2 3 1 0 0.000
3 2 0 3 1 0 0.000
3 0 3 0 0 2 62.016
1 3 2 2 1 3 36.355
2 3 2 0 3 1 23.190
1 0 1 2 1 1 11.784
2 1 2 2 2 5 204.527
3 0 1 1 2 5 115.937
0 1 1 3 2 1 44.028
2 2 1 3 1 4 52.247
1 1 0 0 1 1 17.621
3 3 1 2 1 2 10.706
2 2 0 2 3 3 81.506
0 1 0 0 2 2 81.835
0 1 2 0 1 2 20.647
3 2 2 2 0 1 3.110
2 2 3 0 0 1 13.679
1 2 2 3 2 1 6.486
3 3 2 2 1 2 30.025
0 0 3 1 3 6 202.172
3 2 3 1 2 3 44.221
0 3 0 0 0 1 27.645
3 3 3 0 3 2 22.470
2 3 2 0 2 0 0.000
1 3 0 2 0 1 1.628
1 3 1 0 2 0 0.000
3 2 3 3 0 1 20.684
```

```
3 1 0 2 0 4 108.000
0 1 2 2 1 1 4.615
0 2 3 2 2 1 12.461
0 3 2 0 1 3 53.798
2 1 1 2 0 1 36.320
1 0 3 0 0 0 0.000
0 0 3 2 0 1 19.902
0 2 3 1 0 0 0.000
2 2 2 1 3 2 31.815
3 3 3 0 0 0 0.000
2 2 1 3 3 2 17.915
0 2 3 2 3 2 69.315
1 3 1 2 1 0 0.000
3 0 1 1 1 4 94.050
2 1 1 1 3 6 242.266
0 2 0 3 2 1 40.885
2 0 1 1 2 2 74.708
2 2 2 2 3 2 50.734
1 0 2 2 1 3 35.950
1 3 3 1 1 1 2.777
3 1 2 1 3 5 118.065
0 3 2 1 2 0 0.000
;
```

GREENE Data Set

To create the Greene data set, enter this code into a **Program** tab:

```
data greene;
   input firm year production cost @@;
datalines;
1 1955   5.36598   1.14867  1 1960   6.03787   1.45185
1 1965   6.37673   1.52257  1 1970   6.93245   1.76627
2 1955   6.54535   1.35041  2 1960   6.69827   1.71109
2 1965   7.40245   2.09519  2 1970   7.82644   2.39480
3 1955   8.07153   2.94628  3 1960   8.47679   3.25967
;
```

IN Data Set

To create the In data set, enter this code into a **Program** tab:

```
data in;
   label q = "Quantity"
         p = "Price"
         s = "Price of Substitutes"
         y = "Income"
         u = "Unit Cost";
   drop i e1 e2;
   p = 0; q = 0;
   do i = 1 to 60;
```

```
      y = 1 + .05*i  + .15*rannor(123);
      u = 2          + .05*rannor(123) + .05*rannor(123);
      s = 4 - .001*(i-10)*(i-110) + .5*rannor(123);
      e1 = .15 * rannor(123);
      e2 = .15 * rannor(123);
      demandx = 1 + .3 * y + .35 * s + e1;
      supplyx = -1 - 1 * u + e2 - .4*e1;
      q = 1.4/2.15 * demandx + .75/2.15 * supplyx;
      p = ( - q + supplyx ) / -1.4;
      output;
   end;
run;
```

LONG97DATA Data Set

To create the In data set, enter this code into a **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

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
;
```

MROZ Data Set

To create the Mroz data set, enter this code into a **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
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
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	.
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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	.
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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	.
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0	22.225	11	4	16	40	0	2	.
0	17.635	12	2	4	46	0	1	.
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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	.
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0	19.876	11	1	1	33	0	3	.
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0	22.15	11	0	0	56	0	0	.
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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	.
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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	.
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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	.
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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	.
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0	17.64	12	4	16	36	1	2	.
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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	.
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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	.
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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    .
;
```

Appendix 2

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- *SAS Studio: User's Guide*
- *SAS Studio: Developer's Guide*

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