



Salford Predictive Modeler<sup>®</sup>

Introducing SPM<sup>®</sup> Infrastructure

© 2018 by Minitab Inc. All rights reserved.

Minitab®, SPM®, SPM Salford Predictive Modeler®, Salford Predictive Modeler®, Random Forests®, CART®, TreeNet®, MARS®, RuleLearner®, and the Minitab logo are registered trademarks of Minitab, Inc. in the United States and other countries. Additional trademarks of Minitab, Inc. can be found at [www.minitab.com](http://www.minitab.com). All other marks referenced remain the property of their respective owners.

## Introducing SPM® Infrastructure

The SPM® application is structured around major predictive analysis scenarios. In general, the workflow of the application can be described as follows.

- ◆ Bring data for analysis to the application.
- ◆ Research the data, if needed.
- ◆ Configure and build a predictive analytics model.
- ◆ Review the results of the run. Discover the model that captures valuable insight about the data.
- ◆ Score the model. For example, you could simulate future events.
- ◆ Export the model to a format other systems can consume. This could be PMML or executable code in a mainstream or specialized programming language.
- ◆ Document the analysis.

The nature of predictive analysis methods you use and the nature of the data itself could dictate particular unique steps in the scenario. Some actions and mechanisms, though, are common. For any analysis you need to bring the data in and get some understanding of it. When reviewing the results of the modeling and preparing documentation, you can make use of special features embedded into charts and grids. While we make sure to offer a display to visualize particular results, there's always a **Summary** window that brings you a standard set of results represented the same familiar way throughout the application. The SPM® also provides a handy unified way to document the analysis.

This guide discusses common mechanisms available all over the user interface. It augments the information specific to Analysis Engines (CART®, TreeNet® etc.) provided by other guides.

## Installing and Starting SPM®

The SPM® can be installed on Windows 7 and higher versions of Windows. Although application may run on older versions of the Windows Operating System we strongly recommend that you rely on the latest version of Windows.


### Minimum Windows System Requirements

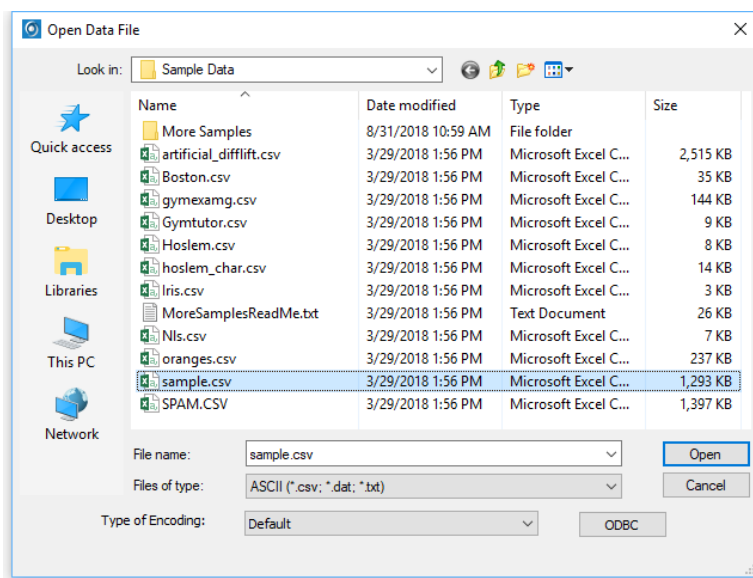
- ◆ Operating System Windows 7 SP 1 or later, Windows 8 or 8.1, Windows 10.
- ◆ RAM 2 GB.
- ◆ Processor Intel® Pentium® 4 or AMD Athlon™ Dual Core, with SSE2 technology.
- ◆ Hard Disk Space 2 GB (minimum) free space available.
- ◆ Screen Resolution 1024 x 768 or higher.

### Minimum Linux System Requirements

- ◆ Operating System Ubuntu 14.04 or 16.04, CentOS 6.9 or 7.5, RHEL 6.9 or 7.5.
- ◆ RAM 2 GB.
- ◆ Processor Intel® Pentium® 4 or AMD Athlon™ Dual Core, with SSE2 technology
- ◆ Hard Disk Space 2 GB (minimum) free space available.

## Reading Data

There can only be one dataset open in the SPM® at a time. To specify the current dataset you can use the **File>Open> Data File** menu item. There is also a toolbar button  and keyboard shortcut **[Ctrl]+[O]** that you can use anywhere in the application. As a result, the Open Data File Dialog appears.



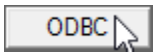
You can select the type of file you would like to open from the Files of type combo box. The SPM® supports quite a few types for input data. The supported formats are

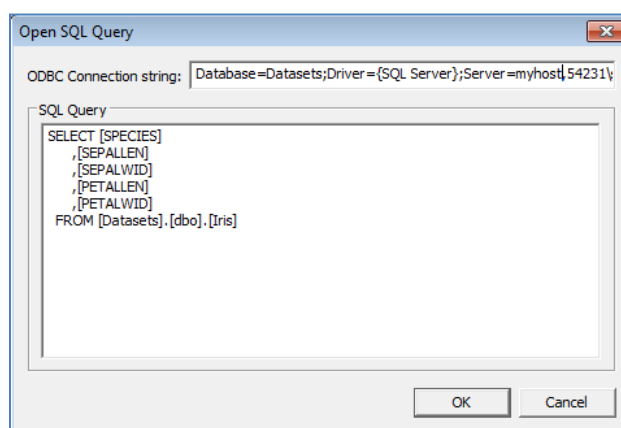
- ◆ Access (\*.mdb)
- ◆ ASCII (\*.csv; \*.dat; \*.txt)
- ◆ dBASE and compatible (\*.dbf)
- ◆ Delimited (\*.csv; \*.dat; \*.txt)
- ◆ DDI XML + Delimited data (\*.xml)
- ◆ Epi Info (\*.rec)
- ◆ Excel (\*.xls; \*.xlsx)
- ◆ FoxPro (\*.dbf)
- ◆ Gauss (\*.dat)
- ◆ GenStat (\*.gsh)
- ◆ Gretl (\*.gdt)
- ◆ HTML (\*.htm; \*.html)
- ◆ JMP (\*.jmp)
- ◆ JSON-stat (\*.json)
- ◆ Limdep & NLogit (\*.lpi)
- ◆ Lotus 1-2-3 (\*.wk\*)
- ◆ Matlab (\*.mat)
- ◆ Mineset (\*.schema; \*.sch)
- ◆ Minitab (\*.mtw)
- ◆ OpenDocument Spreadsheet (\*.ods)
- ◆ OSIRIS (\*.dict; \*.dct)
- ◆ Paradox (\*.db)
- ◆ Quattro Pro (\*.wq?; \*.wb?)
- ◆ R Workspace (\*.rdata)
- ◆ S-Plus (\*.\*)
- ◆ SAS for Windows and OS/2 (\*.sas7bdat; \*.sd2)
- ◆ SAS for Mac OS and Unix (\*.sas7bdat; \*.ssd\*)
- ◆ SAS Transport (\*.xpt; \*.tpt)
- ◆ Shift-JIS (\*.csv; \*.dat; \*.txt)
- ◆ SPSS Data (\*.sav)
- ◆ SPSS Portable (\*.por)
- ◆ SPSS Syntax and Data (\*.sps)
- ◆ Stata (\*.dta)
- ◆ Stata Program and Data (\*.do)
- ◆ Statistica (\*.sta)
- ◆ SYSTAT for Windows (\*.syd; \*.sys)
- ◆ Triple S (\*.sss)

For any of the formats you can specify character encoding using the **Type of Encoding** combo box. Default will let the data reading layer to determine the encoding. The supported encodings are

- ◆ US-ASCII
- ◆ SHIFT-JIS
- ◆ SHIFT\_JIS
- ◆ CP932
- ◆ EUC-JP
- ◆ ISO-2022-JP
- ◆ ISO-2022-JP-1
- ◆ ISO-2022-JP-2
- ◆ UTF-8
- ◆ UTF-16

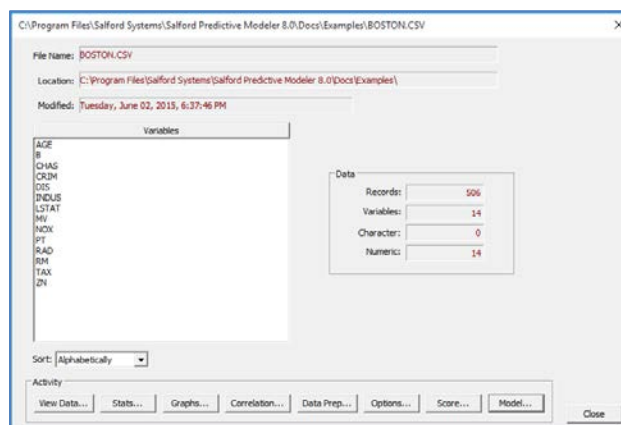
## ODBC

The  button lets you specify a dataset using standard Windows ODBC Select Data Source dialog. There are, however, many cases when this dialog is not adequate. Often to access data in an RDBMS, your DBA will provide you a connection string and SQL query. For such cases you would want to use the Open SQL Query dialog:



## Activity Window

Once the data is open successfully you will be presented with the **Activity** window.



This window shows metadata of the current dataset and provides one-click access to main features of the application.

- ◆ Exploring Data (Graphs..., Stats..., Correlation..., View Data...)
- ◆ Predictive Analytics modeling (Model...)
- ◆ Scoring a Predictive Analytics model (Score...)
- ◆ Configuring the application (Options)
- ◆ Scripting in the SPM Notepad. (Data Prep)

## General Data Requirements

The following requirements must be met to read your data successfully in the SPM:

- ◆ Data must be organized into a “flat table” with rows for observations (cases) and columns for variables (features).
- ◆ The maximum number of cells (rows x columns) allowed in the analysis will be limited by your license.
- ◆ The maximum number of variables. 32768.
- ✓ You can use –V for both GUI and nonGUI applications to increase maximal number of variables.
- ◆ The SPM is case insensitive for variable names; all reports show variables in upper case.
- ◆ The SPM supports both character and numeric variable values.
- ◆ Variable names must not exceed 32 characters.
- ◆ Variable names must have only letters, numbers, or underscores (spaces, %, \*, &, -, \$, etc. are **NOT ALLOWED**). If characters other than letters, numbers, or underscores are encountered, the SPM will attempt to remedy the problem by substituting the illegal characters with underscores. The only exception is that character variables in ASCII files must end with a \$ sign (see the next section).
- ◆ Variable names must start with a letter.
- ☛ Be especially careful to follow the variable name requirements because failure to do so may cause the SPM to operate improperly. When you experience difficulties reading your data, first make sure the variable names are legal.

Below are some examples of acceptable and unacceptable variable names:

AGE_1	OK
GENDER	OK
POLPARTY	OK
1WORLD	Unacceptable; leading character other than letter
%WEIGHT	Unacceptable; leading character other than letter
SOCIAL_SECURITY_NUMBER_AND_ACCOUNT	Unacceptable, too long. Variable name will be truncated to 32 characters.
SALT&PEPPER	Unacceptable, "&" not letter, number or underscore. This character will be replaced with an underscore.

Numeric variables may optionally have subscripts from 0 to 99 but the SPM does not use them in any special way:

CREDIT(1)	OK
SCORE(99)	OK
ARRAY(0)	OK
ARRAY(100)	Unacceptable; parenthesis will be replaced with underscore.
(1)	Unacceptable; parenthesis will be replaced with underscore.
x()	Unacceptable; parenthesis will be replaced with underscore.
x(1)(2)	Unacceptable; parenthesis will be replaced with underscore.

- ☛ When using raw ASCII text does not check for, or alter, duplicate variable names in your datasets. SPM does not check for, or alter, duplicate variable names in your dataset.

## Comments on Specific Data Formats

Many data analysts already have preferred database formats and use widely known systems such as SAS® to manage and store data. If you use a format we support, then reading in data is as simple as opening the file. The Excel file format is the most challenging because Excel allows you to enter data and column headers in a free format that may conflict with most data analysis conventions. To successfully import Excel spreadsheets, be sure to follow the variable (column header) naming conventions below.

If you prefer to manage your data as plain ASCII files you will need to follow the simple rules we list below to ensure successful data import.

### Reading ASCII Files

The SPM has the built-in capability to read various forms of delimited raw ASCII text files<sup>[50]</sup>. Optionally, spaces, tabs or semicolons instead of commas can separate the data, although a single delimiter must be used throughout the text data file.

ASCII files must have one observation per line. The first line shall contain variable names (see the necessary requirements for variable names in the previous section). As previously noted, variable names and values are usually separated using the comma (",") character. For example:

```
DPV,PRED1,CHAR2$,PRED3,CHAR4$,PRED5,PRED6,PRED7,PRED8,PRED9,PRED10,IDVAR
0,-2.32,"MALE",-3.05,"B",-0.0039,-0.32,0.17,0.051,-0.70,-0.0039,1
0,-2.32,"FEMALE",-2.97,"O",0.94,1.59,-0.80,-1.86,-0.68,0.940687,2
1,-2.31,"MALE",-2.96,"H",0.05398,0.875059,-1.0656,0.102,0.35215,0.0539858,3
1,-2.28,"FEMALE",-2.9567,"O",-1.27,0.83,0.200,0.0645709,1.62013,-1.2781,4
```

The SPM uses the following assumptions to distinguish numeric variables from character variables in ASCII files:

- ◆ When a variable name ends with "\$," or if the data value is surrounded by quotes (either ' or ") on the first record, or both, it is processed as a character variable. In this case, a \$ will be added to the variable name if needed.
- ◆ If a variable name does NOT end with "\$," and if the first record data value is NOT surrounded by quotes, the variable is treated as numeric.
- ✓ It is safest to use "\$" to indicate character fields. Quoting character fields is necessary if "\$" is not used at the end of the variable name or if the character data string contains commas (which would otherwise be construed as field separators).

- ✓ Character variables are automatically treated as discrete (categorical). Logically, this is because only numeric values can be continuous in nature.
- ◆ When a variable name does not end with a \$ sign, the variable is treated as numeric. In this case, if a character value is encountered it is automatically replaced by a missing value.

### Missing Value Indicators

When a variable contains missing values, SPM® uses the following missing values indicator conventions.

- ◆ **Numeric**

Either a dot or nothing at all (e.g., comma followed by comma). In the following example records, the third variable is missing.

```
DPV$, PRED1, PRED2, PRED3  
"male", 1, , 5  
"female", 2, ., 6
```



### ◆ Character

Either an empty quote string (quote marks with nothing in between), or nothing at all (e.g., comma followed by comma). In the following example records, the first and fourth variables are missing.

```
DPV$,CHAR1$,PRED2, CHAR3$,PRED4
"male", "",1,3.5,, "Calif"
"female",,2,4,', "Illinois"
```

### Reading Excel Files

We have found that many users like to use Excel files. However, care must be exercised when doing this. Make sure that the following requirements are met:

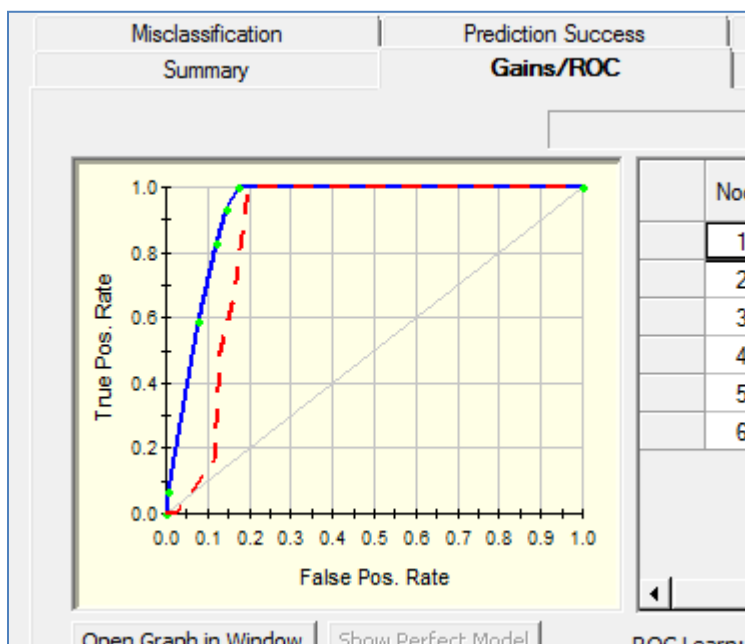
- ◆ The Excel file must contain only a single data sheet; no charts, macros or other items are allowed.
- ◆ Currently, the Excel data format limits the number of variables to 256 and the number of records to 65535.
- ◆ The Excel file must not be currently open in another application (e.g. Microsoft Office Excel) otherwise the Operating System will block any access to it by an external application such as the SPM. On some Operating Systems, if the Excel file was recently open in Excel, the Excel application must be closed to entirely release the file to be opened by the SPM.
- ◆ The first row must contain legal variable names (see the beginning of this chapter for details).
- ◆ Missing values must be represented by blank cells (no spaces or any other visible or invisible characters are allowed).
- ◆ Any cell with a character value will cause the entire column to be treated as a character variable (will show up ending in a \$ sign within the Model Setup). This situation may be difficult to notice right away, especially in large files.
- ◆ Any cell explicitly declared as a character format in Excel will automatically render the entire column as character even though the value itself might look like a number
- ☛ Such cases are extremely difficult to track down.
- ◆ It is best to use the cut-and-paste-values technique to replace all formulas in your spreadsheet with actual values. Formulas have sometimes been reported to cause problems with reading data correctly.
- ◆ Alternatively, you may save a copy of your Excel file as a comma-delimited file (.CSV) and read it as an ASCII file
- ☛ Caution: make sure no commas are part of the data values.

## Working with Charts

Charts play an important role in visualizing results of predictive analytics algorithms. For many step-wise algorithms the main display contains one or a family of performance curves. A number of tabs in the **Summary** window are graphical and some algorithms produce special kinds of plots to visualize results.

### Default keyboard and mouse shortcuts for 2D charts

Most of the 2D charts recognize keyboard and mouse shortcuts to transform the chart. Let's review these features using a Gains Chart as an example. Gains Charts can be found in a **Summary** window. An unmodified chart looks like this.

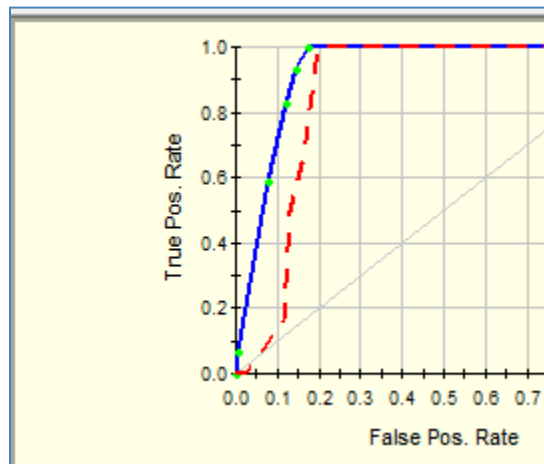


✓ Many of the actions include the **[Left Mouse] button + [Right Mouse] button** combination. To perform, you need to press the **[Left]** and **[Right]** mouse buttons simultaneously. Best is to press the **[Right Mouse]** button first and hold it until the **[Left Mouse]** button is pressed. This way, the right-click menu will not be triggered. You can also use the **[Middle Mouse]** button if your mouse is equipped with one.

✓ To return the chart to its original state, click anywhere in the chart to give it keyboard focus and press the **[R]** key on the keyboard.

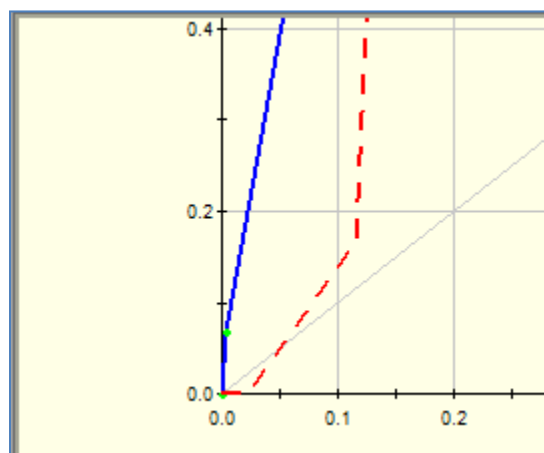
**Move the chart – [Shift] button + [Left Mouse] button + [Right Mouse] button**

Move the mouse to move the chart. The chart in the screenshot below was moved to the right.



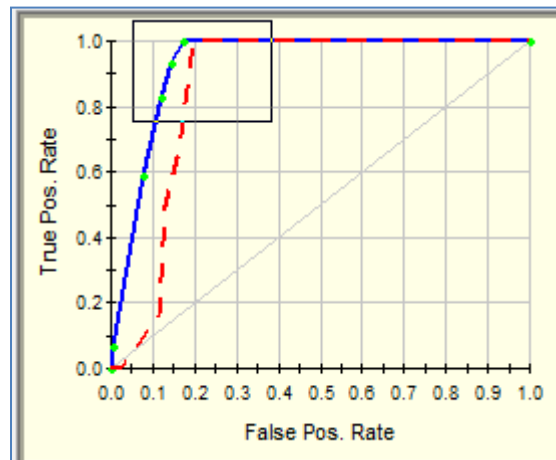
**Scale the chart – [Ctrl] button + [Left Mouse] button + [Right Mouse] button**

Move the mouse to scale the chart. The chart in the screenshot below was scaled and then moved up and right to see the axes origin.

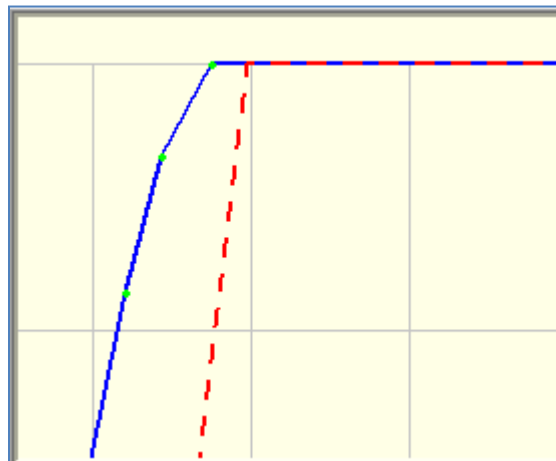


**Zoom the chart graphically – [Ctrl] button + [Left Mouse] button**

Holding the **[Left Mouse]** button, draw a rectangle around the area of interest.



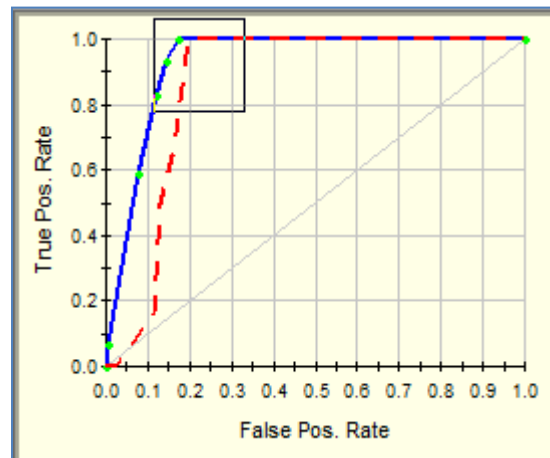
When you release the **[Left Mouse]** button you will get a larger picture of the selected area.



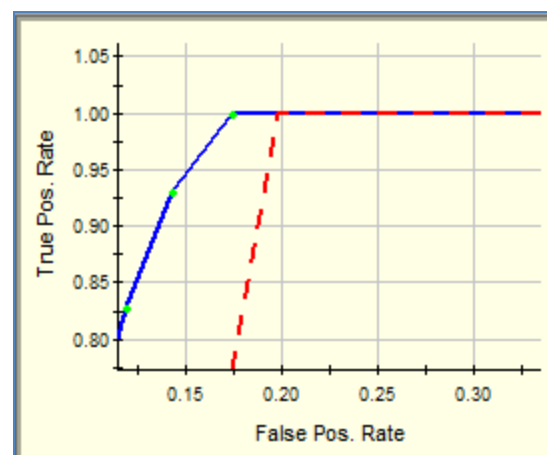
You can repeat the action again on the resulting view.

**Zoom the axes of the chart – [Shift] button + [Left Mouse] button**

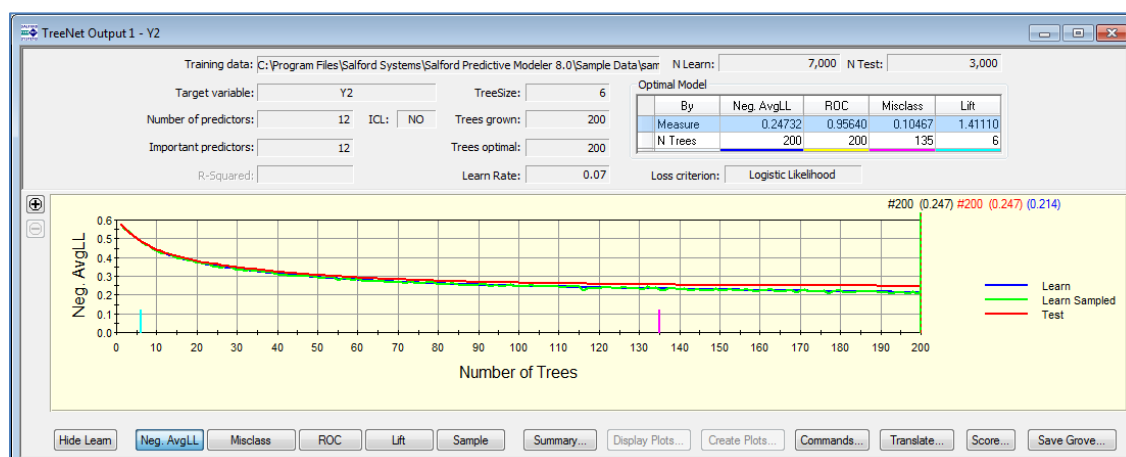
Holding the **[Left Mouse]** button, draw a rectangle around the area of interest.



When you release the **[Left Mouse]** button, the axes will be clipped to the values inside the rectangle. This will result in a larger view of the selected chart area with axes. Compare the following image with results of the graphical zoom.

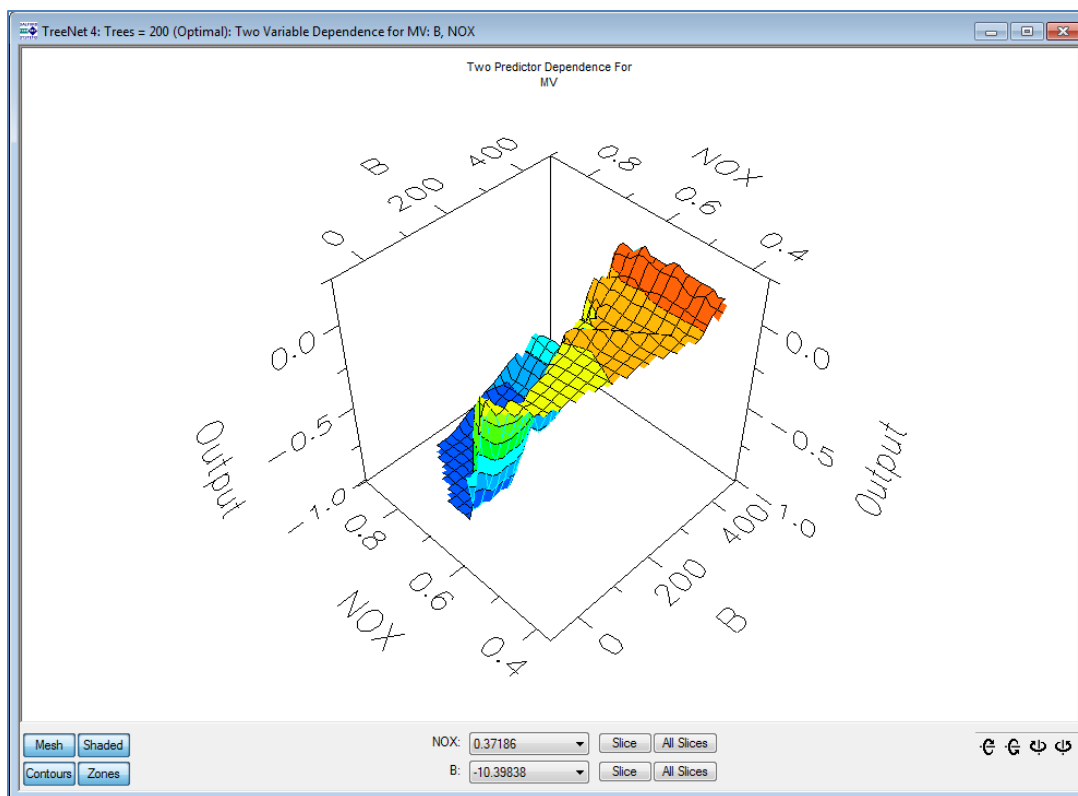


✓ A notable exception is interactive charts like, for example, TreeNet® Performance Curve in TreeNet® results window. Default keyboard and mouse actions are superseded by custom interactive behavior.



## Default keyboard and mouse shortcuts for 3D charts

Most of the 3D charts recognize keyboard and mouse shortcuts to transform the chart. Let's review these features using a TreeNet® two variable dependency plot.

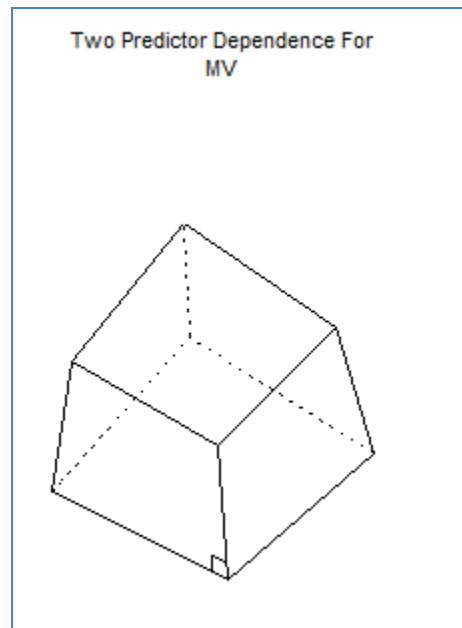


✓ Many of the actions include the **[Left Mouse] button + [Right Mouse] button** combination. To perform, you need to press the **[Left]** and **[Right]** mouse buttons simultaneously. Best is to press the **[Right Mouse]** button first and hold it until the **[Left Mouse]** button is pressed. This way, the right-click menu will not be triggered. You can also use the **[Middle Mouse]** button if your mouse is equipped with one.

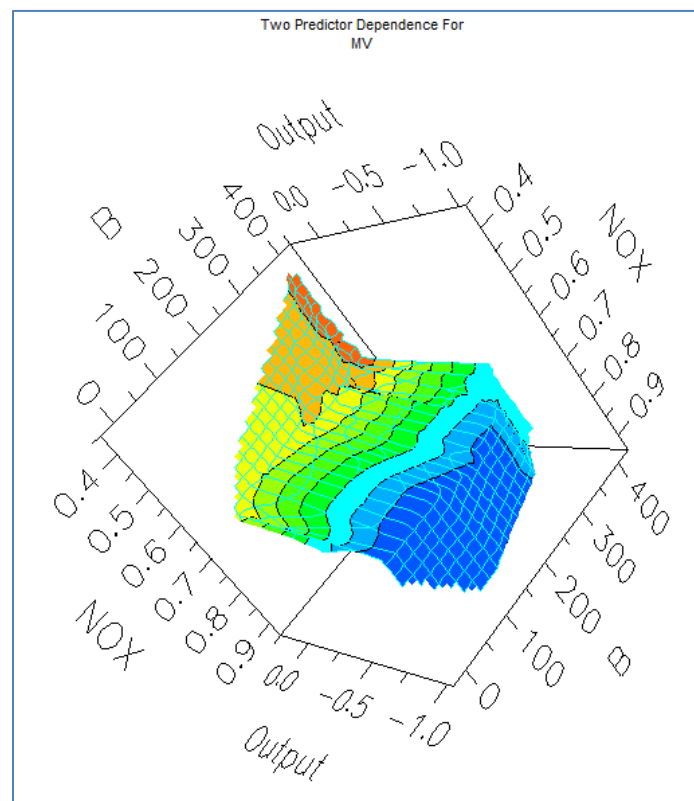
✓ To return the chart to its original state, click anywhere in the chart to give it keyboard focus and press the **[R]** key on the keyboard.

### Rotate the chart – **[Left Mouse] button + [Right Mouse] button**

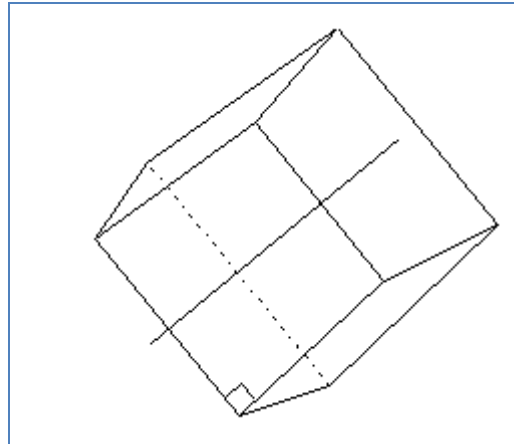
Press and hold both mouse buttons. A guiding cube will appear on the screen. The cube will rotate in response to the movement of the mouse.



When you release both mouse buttons you will see the rotated chart.



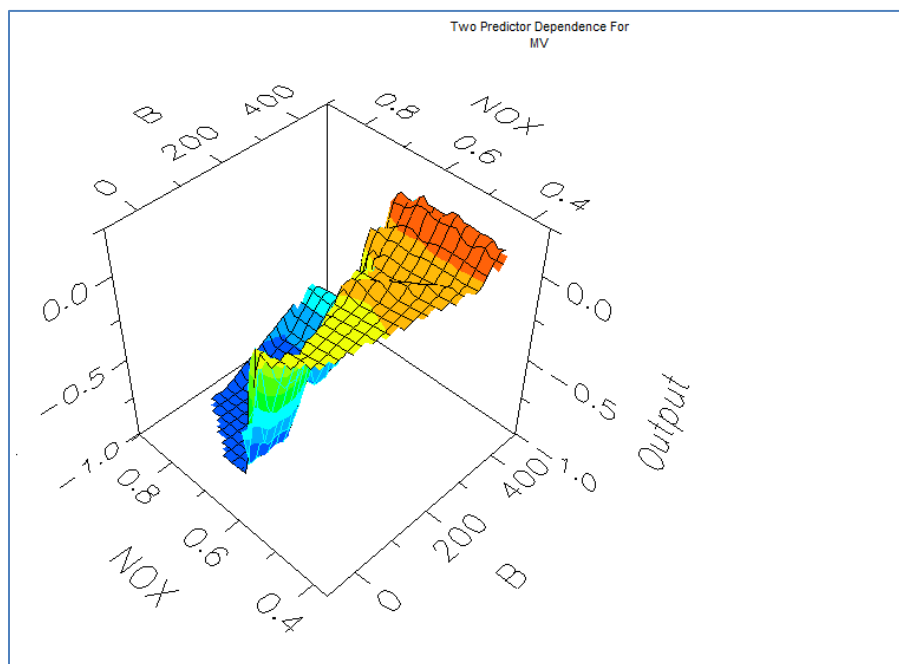
✓ During rotation, you can press the [X], [Y] or [Z] button to rotate only around a specific axis or [E] to rotate around a custom axis. Press [N] to return to free rotation. The rotation cube shows the rotation axis if one of these keys was pressed.



- ☛ In contrast to other transformations, the 'R' keyboard key does not reset the rotated chart to its original state. Most charts can be closed and reopened again to revert to the original look.

**Move the chart – [Shift] button + [Left Mouse] button + [Right Mouse] button**

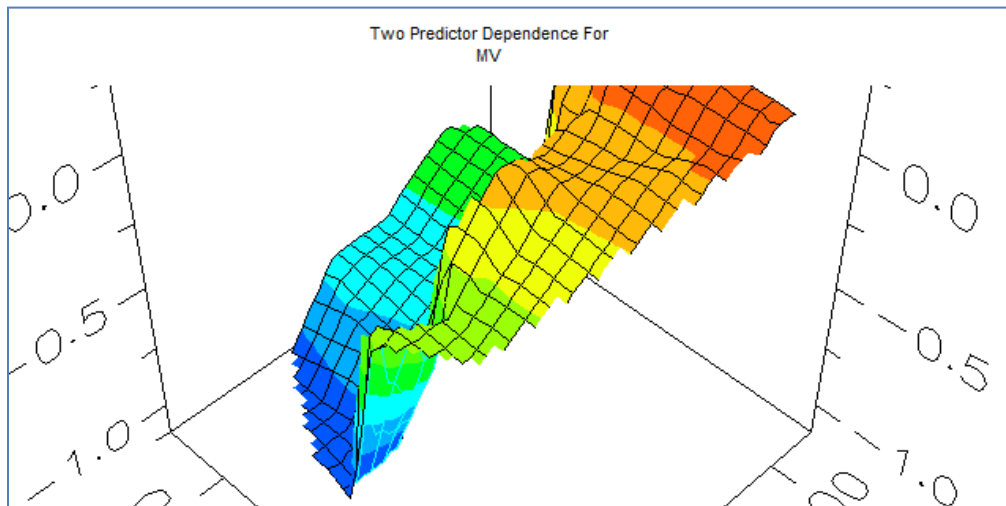
Move the mouse to move the guiding cube. The chart in the screenshot below was moved to the right.





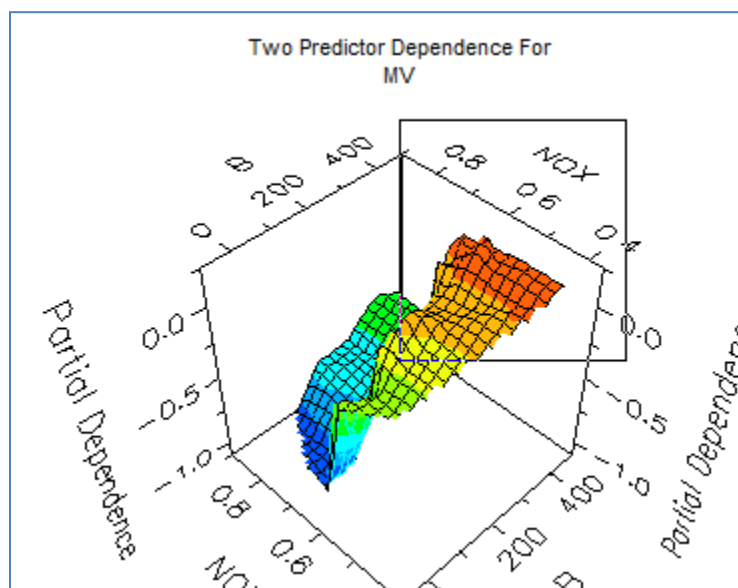
**Scale the chart – [Ctrl] button + [Left Mouse] button + [Right Mouse] button**

Move the mouse to scale the guiding cube. Once you release the mouse the scaled chart will appear.

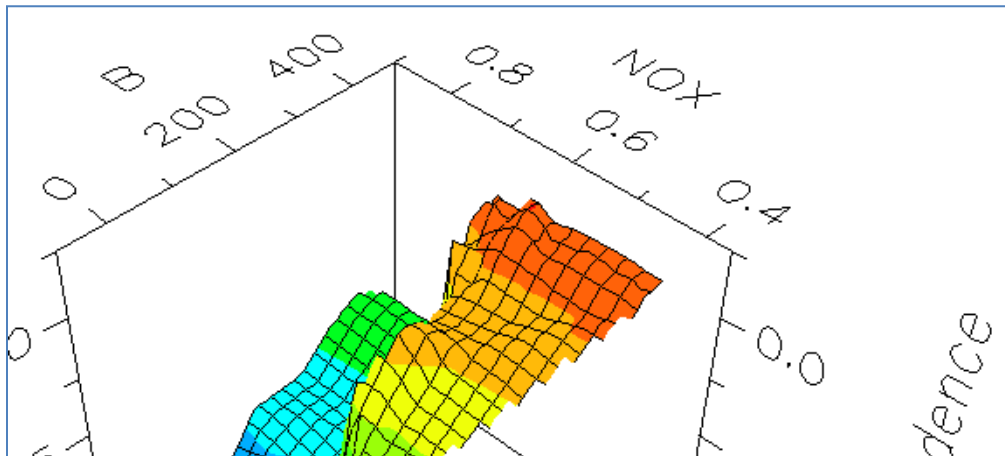


**Zoom the chart graphically – [Ctrl] button + [Left Mouse] button**

Holding the [Left Mouse] button, draw a rectangle around the area of interest.

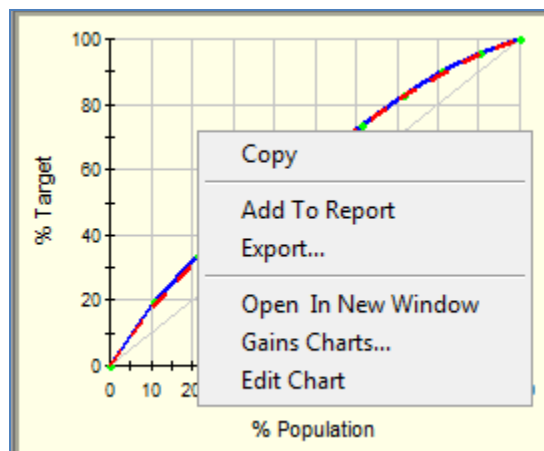


When you release the **[Left Mouse]** button you will get a larger picture of the selected area.



### Standard right-click menu for charts

When you right-click on the chart a context menu appears.



The items on the menu allow you to perform the following actions.

#### Copy

Copies the image of the chart to the Clipboard.

#### Add To Report

Appends the image to the Report window.

#### Export

Exports the image of the chart to one of the supported graphical file formats.

#### Open in New Window

Opens a separate chart window with a copy of the chart in it.

## Edit Chart

Shows Chart Editor for the chart.

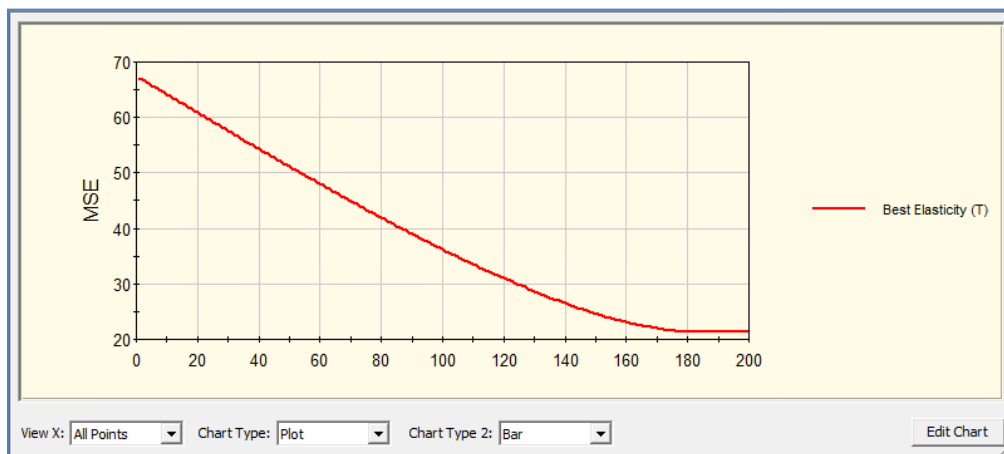
## Custom items

A chart right-click menu might have custom items. For example, the Gains Chart on the screenshot above has a Gains Charts... menu item. It opens a **Gains Charts comparison** window.

## Separate chart window

A chart in the SPM UI can be open in a separate window. Usually, you open this display by clicking on the Open in New Window menu item.

✓ This is very useful when standard manipulations of the chart are limited, like for performance curves with interactive components. But you can manipulate, for example, a GPS performance curve in a separate window.

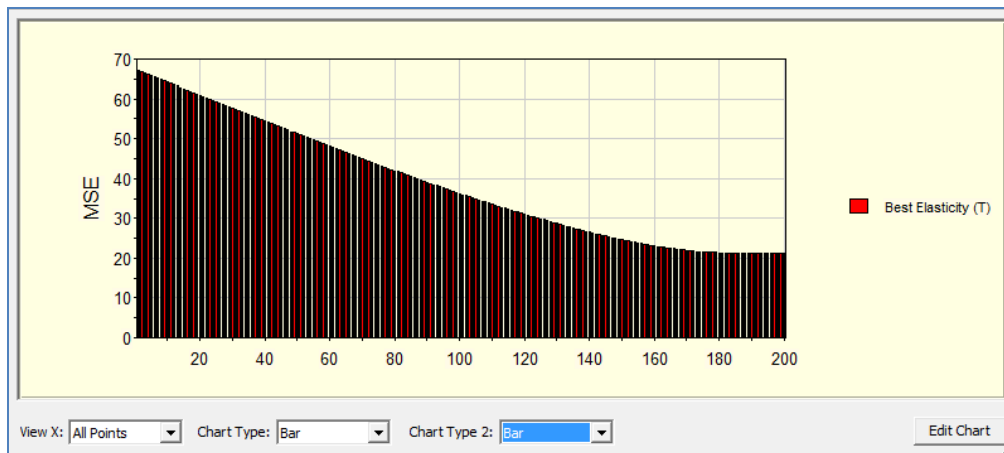


In this window you can still use all of the general chart manipulation features described earlier. The window is a handy copy to apply these manipulations to. Also, some of the features available through shortcuts and menus are also available via the bottom toolbar.

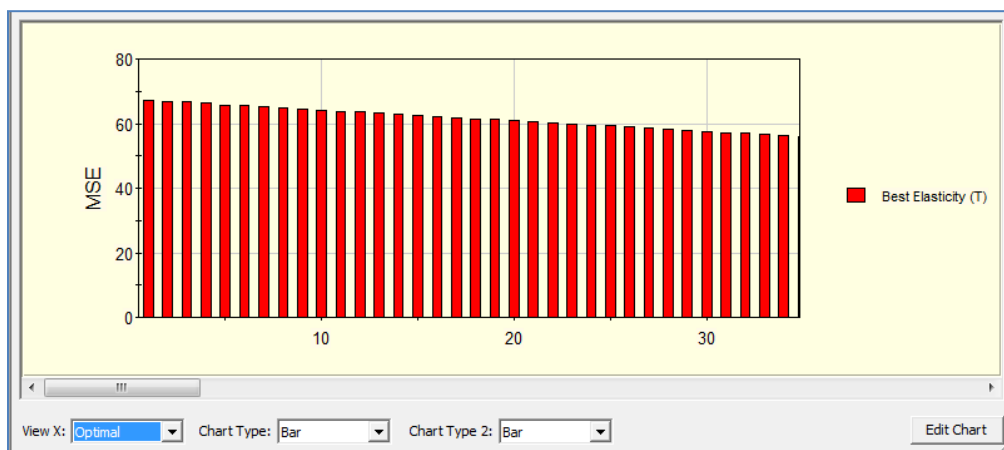
✓ You can always create a fresh copy of the plot by invoking the **Open Chart in New Window** right-click menu item from the original display.

## View X combo box

In All Points mode, all the data points for the X dimension are visualized. Sometimes it doesn't produce the best look, for example, on the following screenshot. We switched the Chart Type from Plot to Bar.



In this case it makes sense to switch View X to Optimal mode. This mode enables a horizontal scrollbar to display only an adequate number of data points for a given view.



### Chart Type combo box

Once the chart is in a separate window, you can switch the chart type.

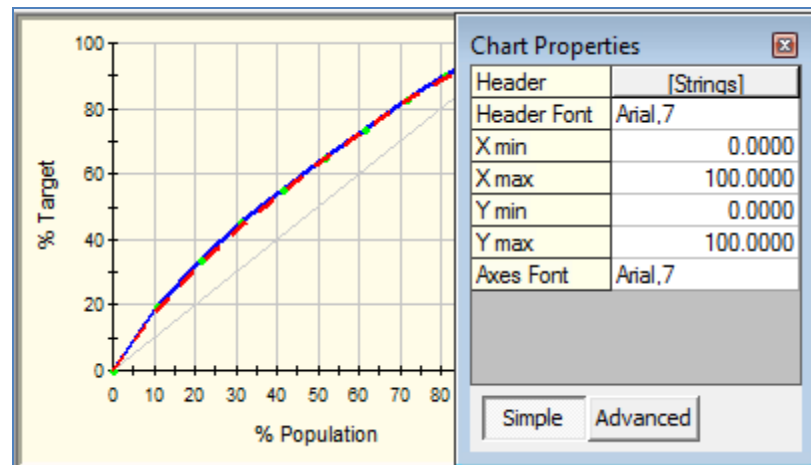
- ☛ Not all charts lend themselves well to every chart type. For example, a Scatter Plot can be shown as **Plot** but not as a Bar. A chart can go blank if the chart's data are inadequate for a given type. Just switch the chart type back to the original type if this happens.

### Edit Chart button

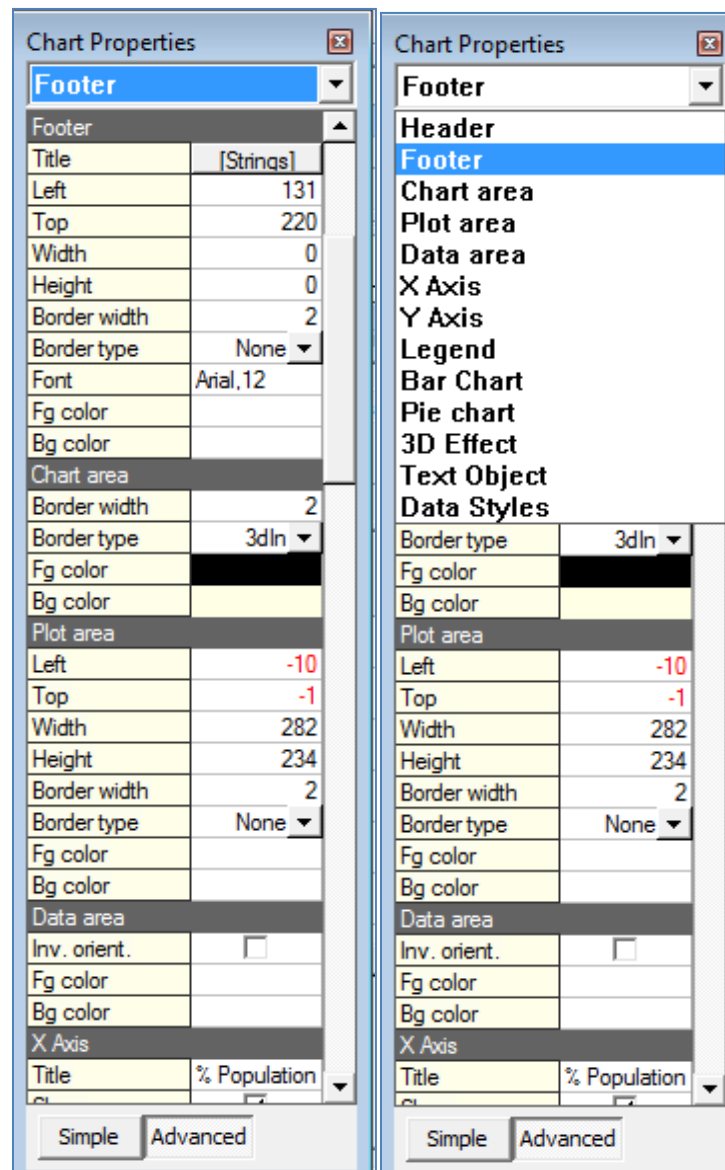
Shows Edit Chart toolbox for the chart.

### Edit Chart toolbox

The Edit Chart toolbox exposes quite a few chart properties. By default, the Edit Chart toolbox is in Simple mode. It gives access to the properties you most likely are going to need if you would like to tweak the look of the chart. These are properties like data ranges on axes, chart headers text, and fonts.
















Advanced mode gives you many more properties to work with.
















The combo box at the top helps navigating to a particular section. The changes you make are immediately reflected on the chart associated with the toolbox.

## Working with Grids

All the predictive modeling artifacts are ultimately numeric results. Many of these results can be effectively represented as a table. Thus, grid controls are employed quite heavily in the application. For example, the grid below shows Scores of **Variable Importance** in the model.











Error Outliers %	Error Outliers Counts	Residual Box Plot	Coefficients
Summary	Dataset	<b>Variable Importance</b>	Error Statistics %
Variable Importance			
Variable		Score	
RM		100.0000	
LSTAT		86.5649	
PT		49.5720	
DIS		38.8971	
B		28.8292	
CHAS		26.1690	
CRIM		25.4283	
NOX		21.4485	
INDUS		20.8143	
TAX		20.3409	
ZN		18.0133	
RAD		10.6355	
AGE		10.2804	

You can click on the title of any column to sort it in Ascending or Descending order. A sort indicator will appear in the title of the column sorted. For example, a click on the **Variable** column will sort the grid by Variable name.

Variable	Score	
AGE	10.2804	
B	28.8292	
CHAS	26.1690	
CRIM	25.4283	
DIS	38.8971	
INDUS	20.8143	
LSTAT	86.5649	
NOX	21.4485	
PT	49.5720	
RAD	10.6355	
RM	100.0000	
TAX	20.3409	
ZN	18.0133	

### Standard right-click menu for grids

When you right-click on the grid, a context menu appears:

Variable	Score	
RM	100.0000	
LSTAT	86.5649	
PT	49.5720	
DIS		
B		
CHAS		
CRIM		
NOX		
INDUS	20.8143	
TAX	20.3409	
ZN	18.0133	
RAD	10.6355	
AGE	10.2804	

The items in the menu allow you to perform the following actions.

### Copy

Copies text from the currently selected cells to Clipboard.

### Add To Report

Appends the grid to the Report window. You have an option to request the entire grid or just the selected cells.

### Export

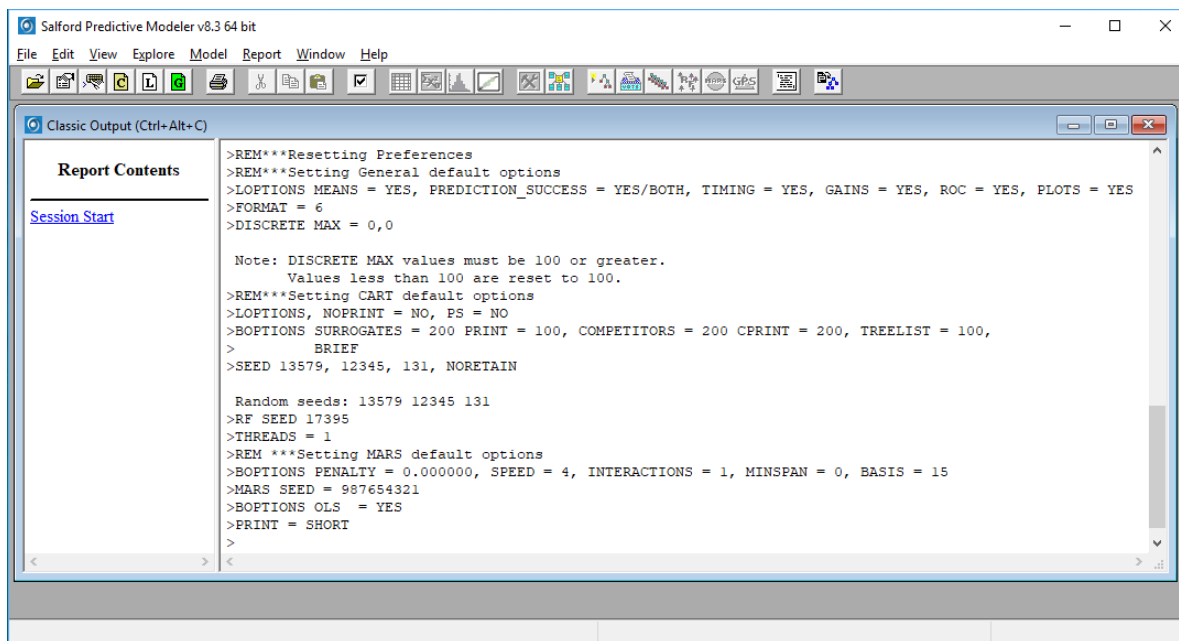
Exports the grid to either MS Excel 97 (\*.xls) or Grid Control's internal format (\*.ss8). You can use the latter to overcome Excel's limitation of 65536 rows by 256 columns. To access a saved .ss8 file, use **File>Open>Open Grid** main menu item.

## Classic Output Window

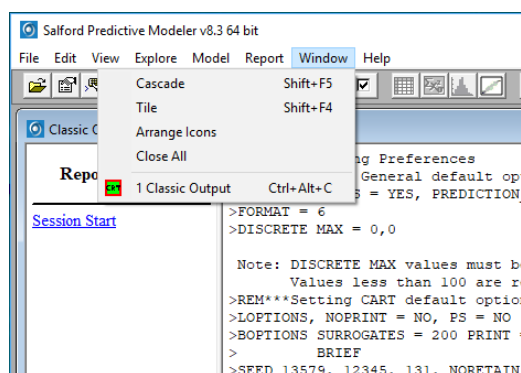
The classic text output window contains the detailed technical log produced by the SPM engine. The SPM is platform-independent and can be fully controlled via Command Language. The SPM UI uses the same Command Language to interact with the engine. Classic Output is printed in response to commands. In the non-GUI version of the software, this is the primary way to get feedback from the engine.


Classic Output represents the instance of the engine in the GUI so this is the first window you see when you launch the GUI application.

- ☛ If you try to close this window you will be prompted that the entire application will have to be closed if you would like to proceed.

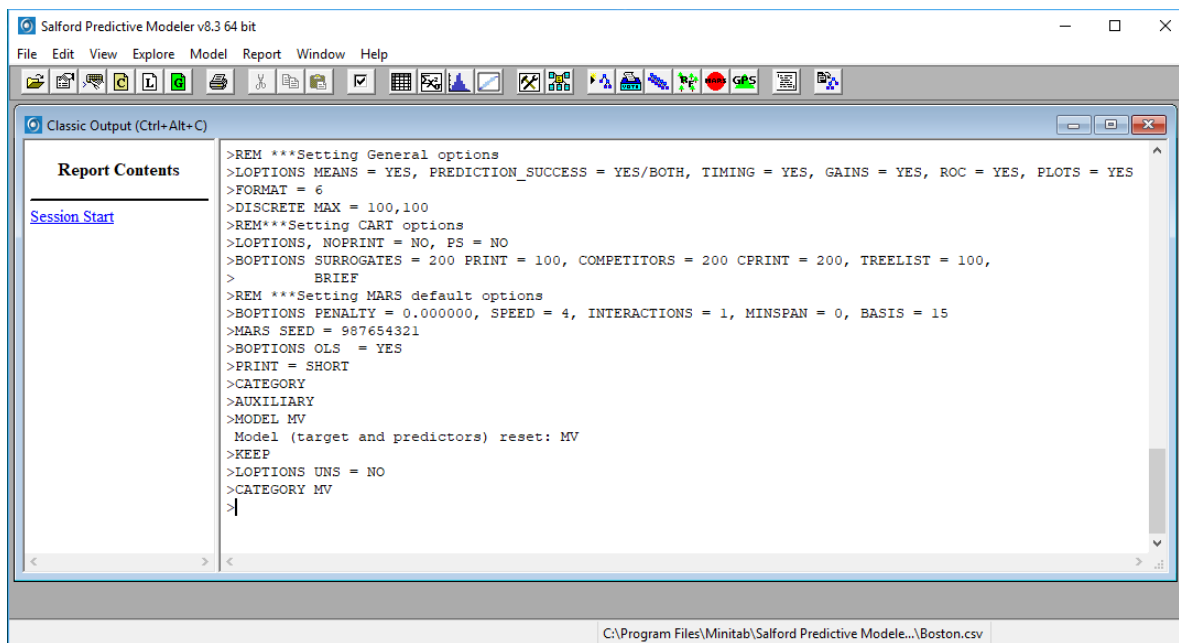


Classic Output is the first item in the **application's Window** menu and you can always bring it up using the **[Ctrl]+[Alt]+[C]** keyboard shortcut.



The right-hand pane of the window is a text editor that works like a console window. It has a reduced set of features available in a **Notepad** window. You have an option to enable the command prompt to type commands directly into the Classic Output window via the **File>Command Prompt** menu item or the  toolbar button. Whether an interactive prompt is enabled or not, the engine prints out all commands issued to it. Each command is prepended with the '>' symbol. On the screenshot below you can see commands to setup a CART® model that uses MV (Boston Housing Dataset) as a Target variable. The cursor is at the prompt where you can, for example, type **CART® GO** to start the analysis. The effect will be the same if you run a CART® model from the GUI.

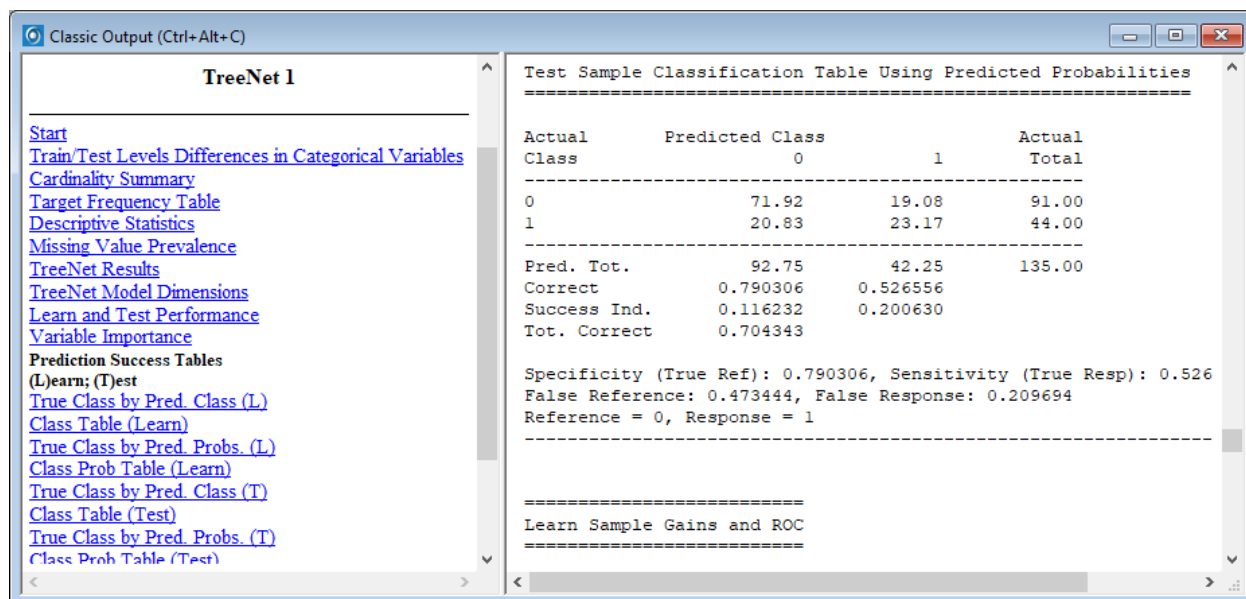




- For your convenience, the Classic Output window is editable. You can add and remove text anywhere and even remove the prompt symbol itself. In this case it is useful to know that when you press Enter after the last line of the editor, that line is passed to the engine as a command. Alternatively, you can use the File>Command Prompt menu or toolbar button to disable and enable the command prompt again.

## Report Contents pane

The left-hand pane of the **Classic Output** window is **Report Contents**. It provides useful navigation links into the console output on the right, structured by model and organized into sections. The screenshot below is produced by running a TreeNet® logistic binary model.

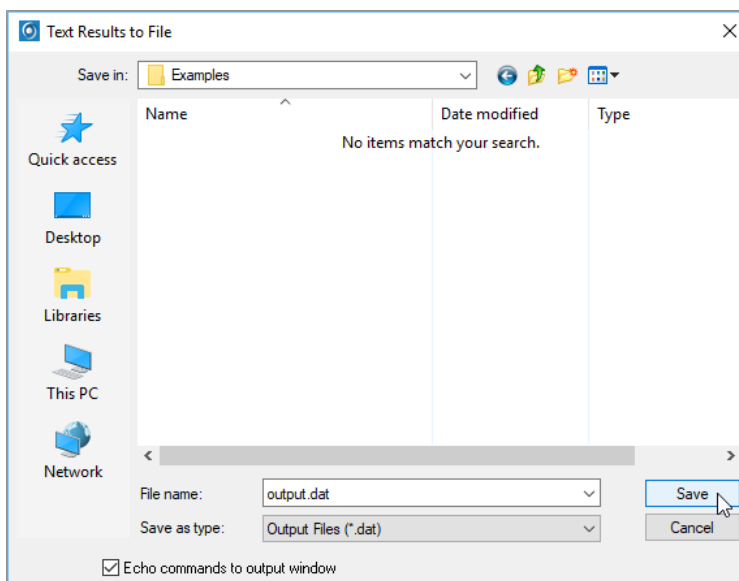


- ✓ You can always regenerate most of the classic output from a model saved into a Grove file by using the **TRANSLATE** facility built into every grove.

## Saving Classic Output

Some models can generate an excessive amount of output. Showing it all in the Classic Output window will eventually put considerable pressure on the UI sub-system of the OS. As a safeguard against UI resource exhaustion, Classic Output will prompt you to save the captured output after it reaches 1 million lines. After you confirm, the output will be preserved in the file of your choice and the window will be cleared to receive more output. If you would like to ensure that a lengthy job runs uninterrupted, you should switch the **File>Log Results to...** menu setting into **File** mode. You will be prompted for a file in which to store the output of the engine.

- ☛ Please be sure to turn Echo commands to output window OFF if you would like to avoid copious output. The checkbox is at the bottom of the Text Results to File dialog that is open when you choose to redirect the output to a File.



In command language you can accomplish this using

```
OUTPUT "<file_name.dat>"
```

To direct the output back to the **Classic Output** window, switch **File>Log Results to...** menu into **Window** mode. Command language for this is

```
OUTPUT *
```

✓ A useful engine command to suppress text output from the engine is **ECHO OFF**. This command is often used when scripting the SPM using Command Language.

At any time you can capture text from the Classic Output window in a file using the **File>Save>Save Output** menu item.

## Changing the Font of Classic Output

The font used in the Classic Output window can be changed by selecting **Edit>Fonts** via the menu. We recommend using a mono-spaced font such as one in the Courier family to maintain the alignment of tabular output.

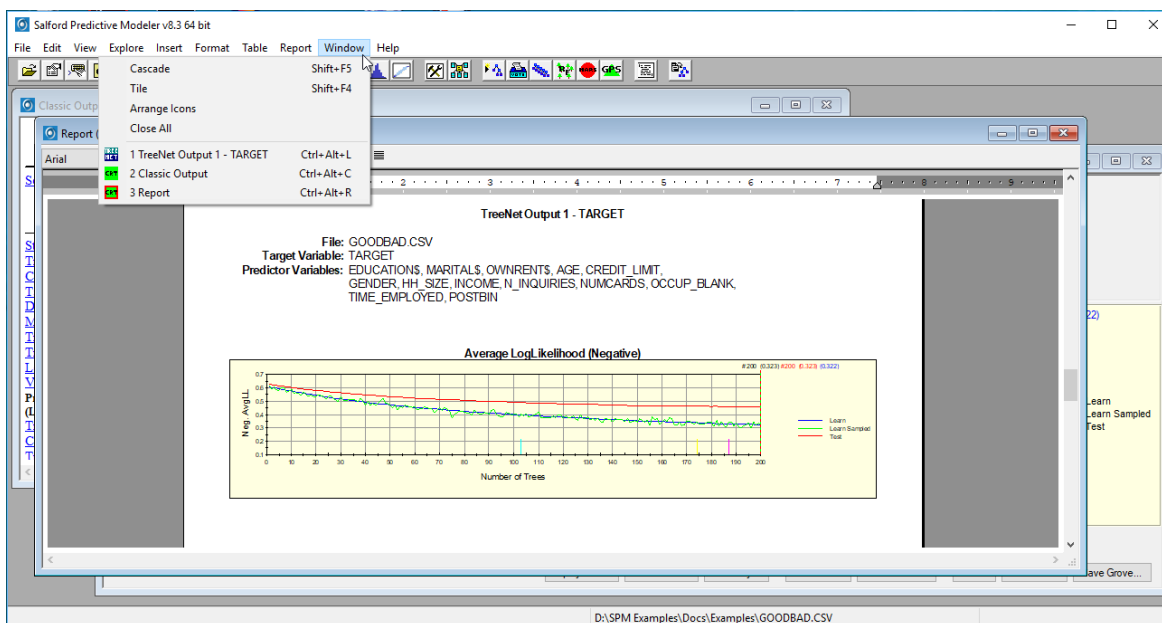
## Report Writer

The SPM includes a facility called Report Writer. This is a report generator, word processor and text editor. It allows you to construct custom reports from results, diagrams, tables and graphs as well as the “classic” SPM’s output appearing in the **Classic Output** window.

Using the Report Writer is easy! One way is to copy certain reports and diagrams to the **Report** window as you view the SPM results dialog or output windows. Once processing is complete, a SPM results window appears, allowing you to explore the performance with a variety of graphic reports, statistics, and diagrams. Virtually any graph, table, grid display, or diagram can be copied to the Report Writer. Simply **right-click** the item you wish to add to the Report Writer and select **Add to Report**. The selection will be appended to the content in the **Report** window.

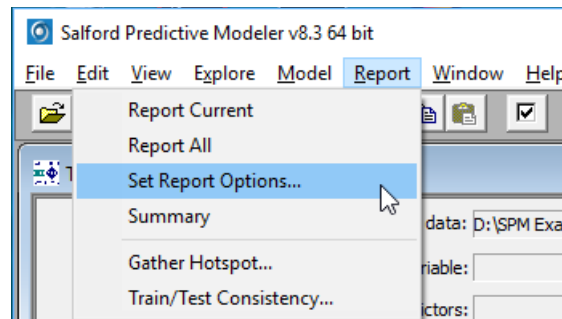
The SPM also produces Classic output for those users more comfortable with a text-based summary of the model and its performance. To add any (or all) of the SPM’s classic output to the Report window, highlight text in the Classic Output window, copy it to the Windows clipboard (**Ctrl+C**), switch to the Report window and paste (**Ctrl+V**) at the point you want the text inserted. Thus, you can combine those SPM result elements you find most useful—either graphic in nature and originating in the SPM results dialog, or textual in nature from the Classic Output – into a single custom report.

There can be only one Report window in the application. It opens automatically when you request a report for the first time during a session. After this, the Report window is accessible via the **Window** menu or the **[Ctrl]+[Alt]+[R]** keyboard shortcut.



You can access standard word processor functionality via the main menu and toolbars.

Report functionality is available from anywhere in the application via the **Report** menu:



The SPM can produce a “stock report” with the click of a button. You decide which components of the SPM output would be most useful to you on the **Report>Set Report Options...** menu and then select them. The stock report will be the same for all SPM results in the session. and then select them. The stock report will be the same for all SPM results in the session.

## Report Current

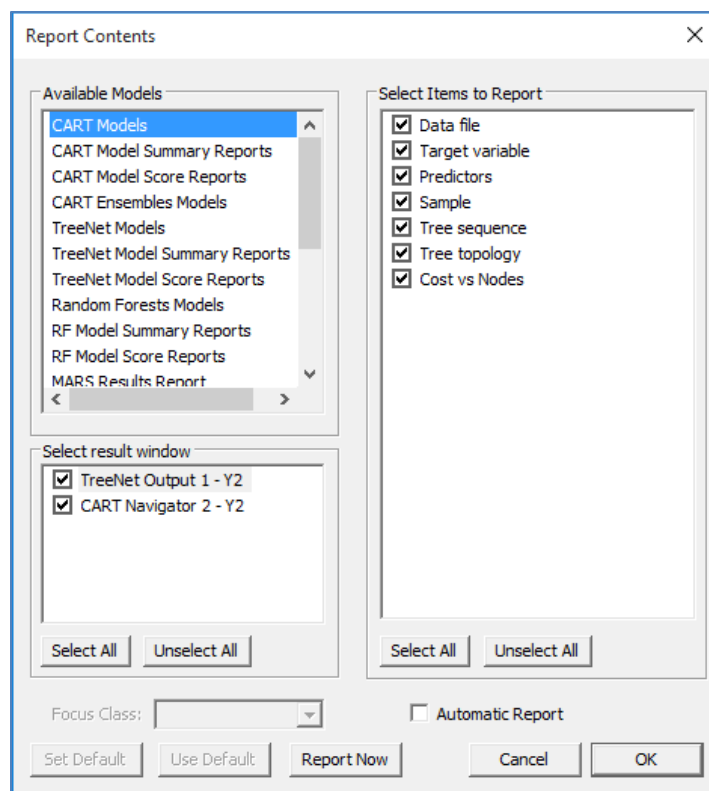
A stock report for the SPM results that are currently active (i.e., in the foreground) can be generated by choosing **Report>Report Current**. [OBJ] item will be disabled.

## Report All

If you have several SPM results windows open, you can generate a report for all of them (in the order in which they were built) by choosing the **Report>Report All** menu item.

## Set Report Options

Opens Report Contents dialog.



Available Models group shows types of reportable Results windows currently supported. When you click on any of them, you can use the Select Items to Report group of controls to edit the default set of elements to be added to the stock report. The **[Automatic Report]** button specifies whether Results of this specific type should be added to the report automatically. It is also tracked for each Result window type.

Select Results window group shows actual reportable Results windows. When a concrete window is selected, Select Items to Report shows options for this particular window. When you press Report Now, the specified items for a model are added to the report at once. You can save the settings you configured for a concrete window as a default group of settings for future SPM sessions by clicking the **[Set Default]** button. These default options will then persist from session to session. You may recall these settings at any time with the **[Use Default]** button

## Default Focus Class

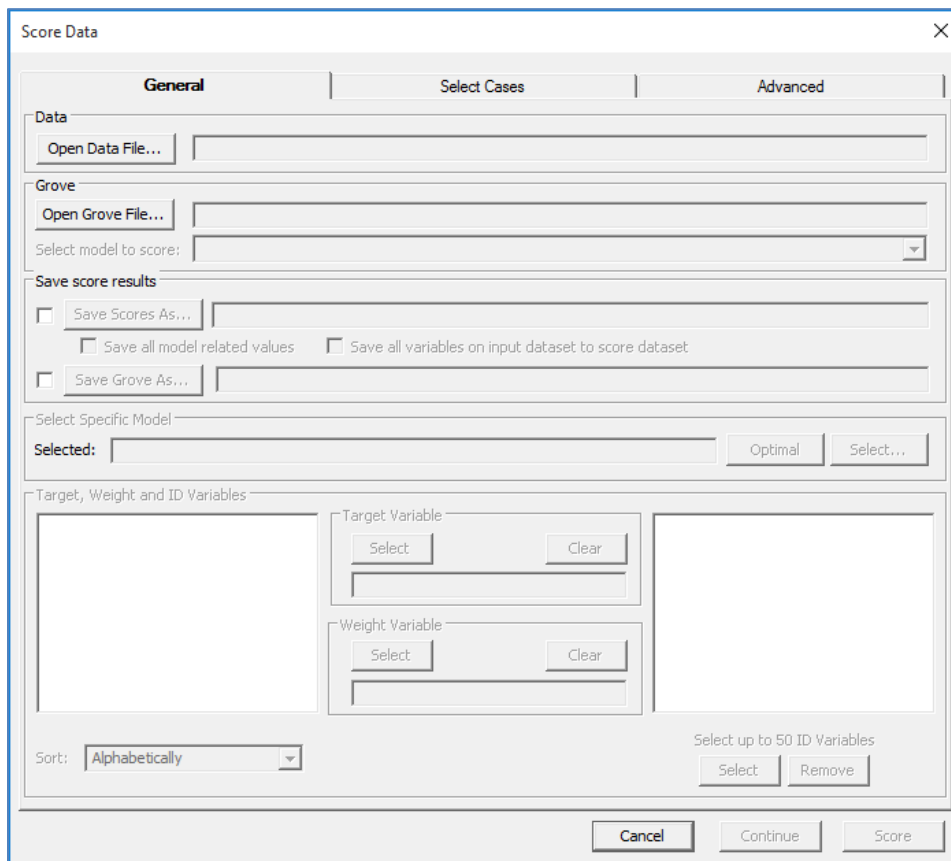
Reports summarizing class performance (e.g., gains charts) require a focus class. For binary models (i.e., 0/1 or 1/2), the second level is assumed to be the focus class. For multinomial models (e.g., 1, 2, 3, 4), the lowest class is assumed to be the focus class.

## Score Data dialog

There are many reasons to score data with an SPM model. You might want to run a quick test of the model's predictive power on new data, or you might actually embed your model into a business process. The SPM gives you several options for doing this:

- ◆ The SPM can score data from any source using any previously-built SPM model. All you need to do is to attach to your data source, let the SPM know which grove file to use, and decide where you want the results to be stored.
- ◆ The SPM scoring engines are available for deployment on high performance servers that can rapidly process millions of records in batch processes.
- ◆ You can TRANSLATE your model into one of several programming languages including C, SAS, Java and PMML. The code produced needs little or no modification and is ready to be run in the target environment.


You can score a model using the **Model>Score Model...** menu item or the  button on the toolbar.



## General tab

You need to specify a Data File and a Grove file to perform scoring operation. You can do this using the following controls.

### Open Data File...

 USE <file>

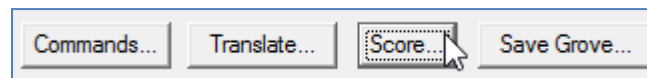
When you press this button, the Open File dialog allows specifying the dataset. For the best results this dataset should contain all the predictors used when building a model.

- ◆ Absent predictors and levels of categorical variables will be treated by Scoring engine as missing data. Scoring engine matches variables by name.

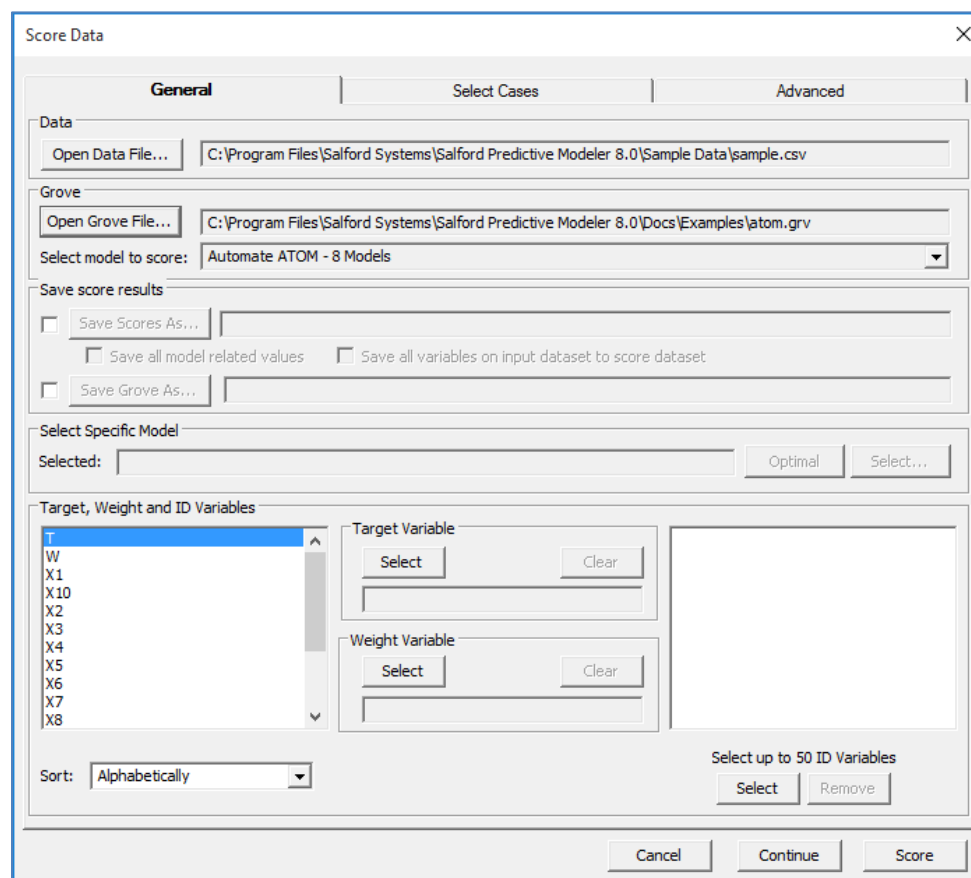
**Open Grove File...** GROVE <file>

When you press this button, the Open File Dialog allows specifying the Grove file containing the model you would like to score.

✓ If you have a Grove file already open in the application, the dialog will use it by default. A display associated with a grove usually has a [Score...] button in the bottom right corner. This is a handy way to score a model you're working with.




Once you configured essential required parameters, the [Score] button becomes available. You can run the simulation right away with the default settings.



The rest of the controls in the dialog allow you to configure the scoring process.


## Select model to score

 HARVEST ENGINE=<Engine Name>, SELECT <Model Selection parameters>

A Grove file may contain multiple models. For example, on the screenshot above the grove contains 8 models produced as a result of AUTOMATE ATOM. Using this combo box, you can either specify an individual model or request to score all the models at once as an ensemble.


✓ HARVEST command is quite versatile and flexible. To make good use of it, please check the documentation.

## Select Specific Model

 HARVEST PRUNE <Model Specific parameters>

Many of the algorithms produce a group of related models. These models represent various tradeoffs between simplicity and accuracy. For more details, please see documentation on a specific algorithm (CART®, TreeNet, etc.). Select Specific Model group of controls allows you to either request an optimal model to be scored or invoke a model-specific selection dialog.

## Save Scores As

 SAVE <file> [MODEL, COMPLETE]

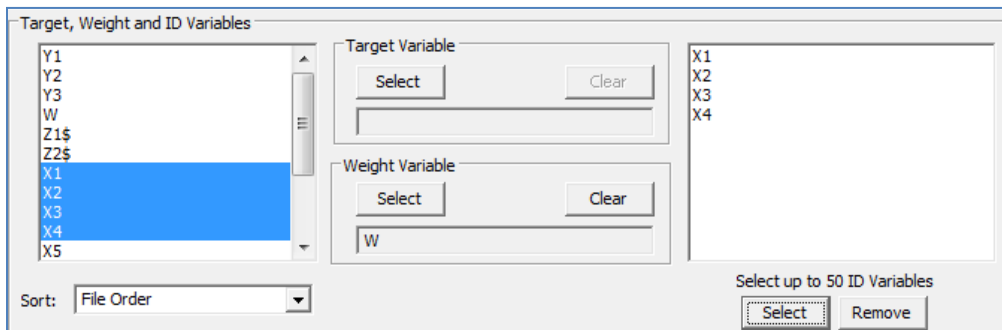
You can specify that you would like raw scores to be saved in a dataset. You can request additional data to be saved for each observation, along with the raw scores. Save all model related values instructs the engine to save model-specific data. For example, classification models can produce class probabilities. Save all variables on input dataset to score dataset adds all the variables used to construct the model to the resulting dataset. Target, Weight and ID Variables group gives a more flexible, alternative way to handle variables in the simulation dataset.

## Save Grove As

 SCORE GROVE=<file>

Scoring engine produces descriptive information about the simulation (Performance Stats, Prediction Success table, etc.). All these results are displayed in the GUI and can be saved into a Grove file for later reference.

## Target, Weight and ID Variables



Target, Weight and ID Variables

Y1  
Y2  
Y3  
W  
Z1\$  
Z2\$  
X1  
X2  
X3  
X4  
X5

Sort: File Order

Target Variable  
Select Clear

Weight Variable  
Select Clear  
W

X1  
X2  
X3  
X4

Select up to 50 ID Variables  
Select Remove



The list on the left-hand side contains all the variables in the simulation dataset. The controls in the group allow you to include specific variables into the resulting dataset and assign specific roles to them.


### Target Variable

 SCORE DEPVAR=<variable>

Specifies which variable in the source dataset contains actual values of the Target variable. When actual Target is available, the Scoring engine can produce scoring performance measures. If available, actual target variable is saved to the resulting dataset.


- ✓ By default, the engine matches the Target variable by name.

### Weight Variable

 WEIGHT <variable>

You can use a variable to identify Case Weights during simulation.

### ID Variables

 IDVAR <var1>, <var2>, ....

Allows you to specify which variables should be included into the resulting dataset. The variable does not necessarily have to be a variable used to build a model.

### Select Cases tab

Please refer to **Select Cases** tab documentation for **Model Setup**.

## Advanced tab

You can use the following advanced settings to configure the Scoring engine.

### Include predicted probabilities

SCORE PROBS=<N>

For classification models, this specifies that predicted probabilities for each target class should be included in the resulting dataset.

### Compute Variable Importance via Randomization Test

SCORE VARIMP=<YES | NO> , NPREPS=<n>

The scoring engine will evaluate variable importance for predictors in CART®, TreeNet®, MARS®, GPS, RandomForests, Logistic Regression, and Regression models by randomly perturbing predictor data and evaluating model performance measures for the perturbed data relative to those for unperturbed data. The number of random perturbations can be specified.

### Impute variable(s)

SCORE IMPTARGET=<YES | NO>

This command requests that target values, if missing in the input data, are replaced with their predicted values for purposes of summary statistics and in any saved dataset. Missing data imputation can also be based on non-model based statistics produced with the STATS command, in which case the MEAN, MEDIAN, and MODE options are used to specify how missing continuous data are to be imputed.

**In place variable importance** SCORE INPLACE=<YES | NO>

When IMPTARGET=YES, this option will control whether imputations are made “in place” or not. Missing values will be replaced with imputations while leaving all non-missing data points unchanged. Without this option, the original variable is unchanged and an imputed version of the variable is added to the output dataset.

**Create missing value indicator(s)** SCORE MVI=<YES | NO>

When IMPTARGET=YES, this option can be used to create an additional “missing value indicator” variable that flags whether the original value was missing or not (i.e. was it imputed).


**CART® Options – Save "Path Down the Tree" Indicators** SCORE PATH =<YES | NO>

For CART® models, requests that for each observation an index is recorded of each node the observation is assigned to. Variables in form PATH\_<number> are added to the output dataset. Each column contains either


- ◆ 1-based index of an intermediate node.
- ◆ A negative number, the absolute value of which is a 1-based index of a terminal node.
- ◆ 0 to indicate no node assignment. Used as a placeholder after an assignment to a terminal node is recorded.

**CART® Options – Save -1/0/+1 Node Indicators** SCORE ND=<YES | NO>

For CART® models, requests that node dummies be added to the output dataset.

**TreeNet® Scoring Offset** SCORE OFFSET=<x>

OFFSET defines an "offset value" for binary and regression TreeNet® models. It is similar to the INIT option but is specified as a literal value (not a variable name).

 SCORE INIT=<variable>

INIT defines a "start value" for binary and regression TreeNet® models. It is the scoring counterpart to the TRENET INIT option used when building the model. INIT is a variable on your dataset, while OFFSET is a literal value.

**Save MARS® Basis Functions** SCORE BASIS=<YES | NO>


This option adds values for each of the basis functions in a MARS® model to the output dataset. This allows the possibility for a rich set of second-stage models.

### Report Verbose

 SCORE IMPUTE=<YES|NO>, MEAN | MEDIAN | MODE, VERBOSE


Requests that target values, if missing in the input data, are replaced with their predicted values for purposes of summary statistics and in any saved dataset.

### Report Outlier Stats

 SCORE OUTLIER=<YES|NO>

Produces several tables in Classic Output showing model performance measures as a function of outlier trimming.

### Performance Options – Enable buffered scoring

 SCORE BUFFERED=<YES|NO>

The Scoring engine will score each model separately, passing once through the dataset for each model, and will reconcile all the model scores in a post-processing step. Use this option to minimize the memory footprint of your scoring process for large groves with many models to score.

### Save individual tree predictions and terminal node numbers for every tree in a RandomForest

 SCORE TREESCORES=<YES|NO>, TREENODES=<YES|NO>

For classification and regression RandomForest models, this command requests that predictions of each tree and terminal node numbers are saved along with the prediction of the forest.

### Run GPS to post-process a TreeNet® model

 SCORE GPS=<YES|NO>


Builds a second-stage pipeline model on the TreeNet® model, using options on the GPS command.

### Automate Options – Create Ensemble Model

 SCORE ENSEMBLE=<YES|NO>

If a grove contains more than one model you can request whether they will be scored together as an ensemble or each model will be scored individually. In latter case the output dataset will contain scores for all the models in the grove.

### Automate Options – Omit Baseline/Reference Model if present

 SCORE OFT=<YES|NO>

Some automates produce first model as a baseline to compare other models against. In most cases when such a Grove is scored as an ensemble it is recommended to exclude the baseline from it. Turn this option ON if you would like baseline model to be part of the ensemble.

### Automate Options – Generate Predicted Outcome via Voting

### Automate Options – Generate Predicted Outcome via Averaging Model Scores

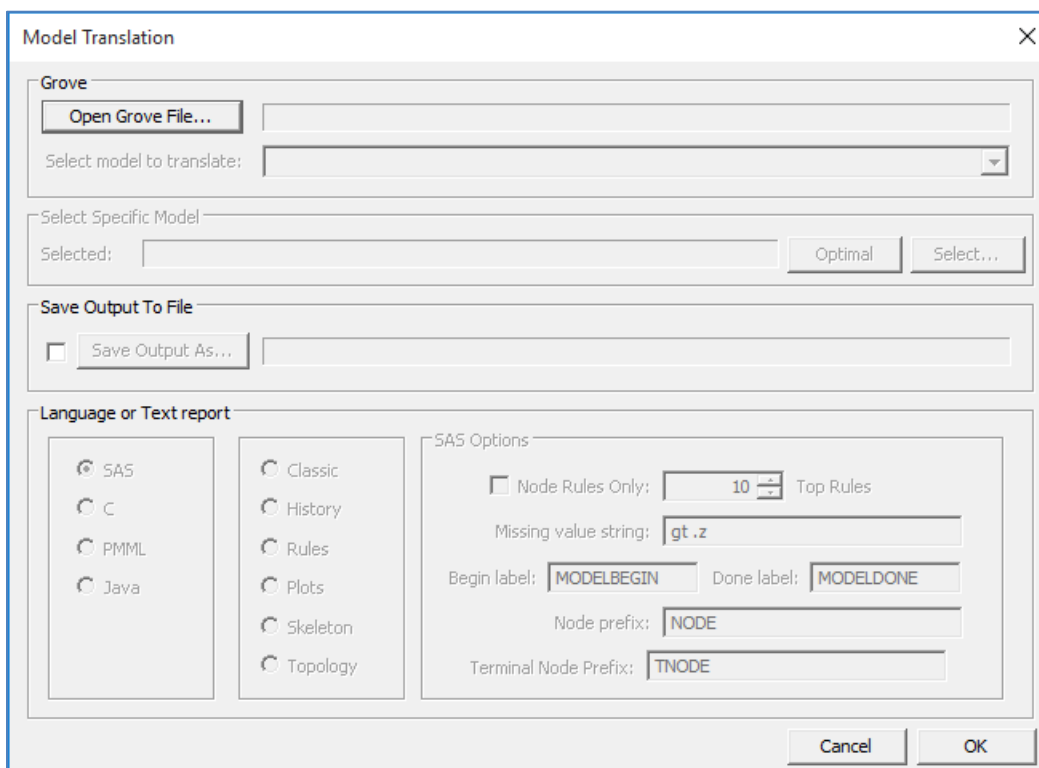
 SCORE TNAVERAGE=<YES | NO>

The Scoring engine will score ensembles composed of classification or logistic binary TreeNet® models in a special way. Most categorical ensembles are scored using a voting approach, in which the predicted class of each individual model is noted and the class with the most instances, or "votes", is determined to be the predicted class of the ensemble as a whole. However, with classification or logistic binary TreeNet® ensembles, another approach which is typically more accurate is used by default: the raw scores of the individual class-specific TreeNet®s are averaged over all the models in the ensemble, and the predicted probabilities and the class are then determined.

## Model Translation Dialog

One of the effective ways to deploy a predictive model to production is to translate it in a form that your environment can execute. You can translate a model from a saved grove using **Model>Translate**

**Model...** menu item or  button on the toolbar.



The **Model Translation** dialog box is used to configure the translation of a model. It contains the following sections:

- Grove**: Includes an **Open Grove File...** button and a **Select model to translate:** dropdown menu.
- Select Specific Model**: Includes a **Selected:** text field, an **Optimal** button, and a **Select...** button.
- Save Output To File**: Includes a checkbox for **Save Output As...** and a text field.
- Language or Text report**: Includes two columns of radio buttons for selecting the output format:
  - Left Column**: SAS (selected), C, PMML, Java.
  - Right Column**: Classic, History, Rules, Plots, Skeleton, Topology.
- SAS Options**: Includes a checkbox for **Node Rules Only:** (set to 10), **Top Rules**, **Missing value string:** (gt.z), **Begin label:** (MODELBEGIN), **Done label:** (MODELDONE), **Node prefix:** (NODE), and **Terminal Node Prefix:** (TNODE).

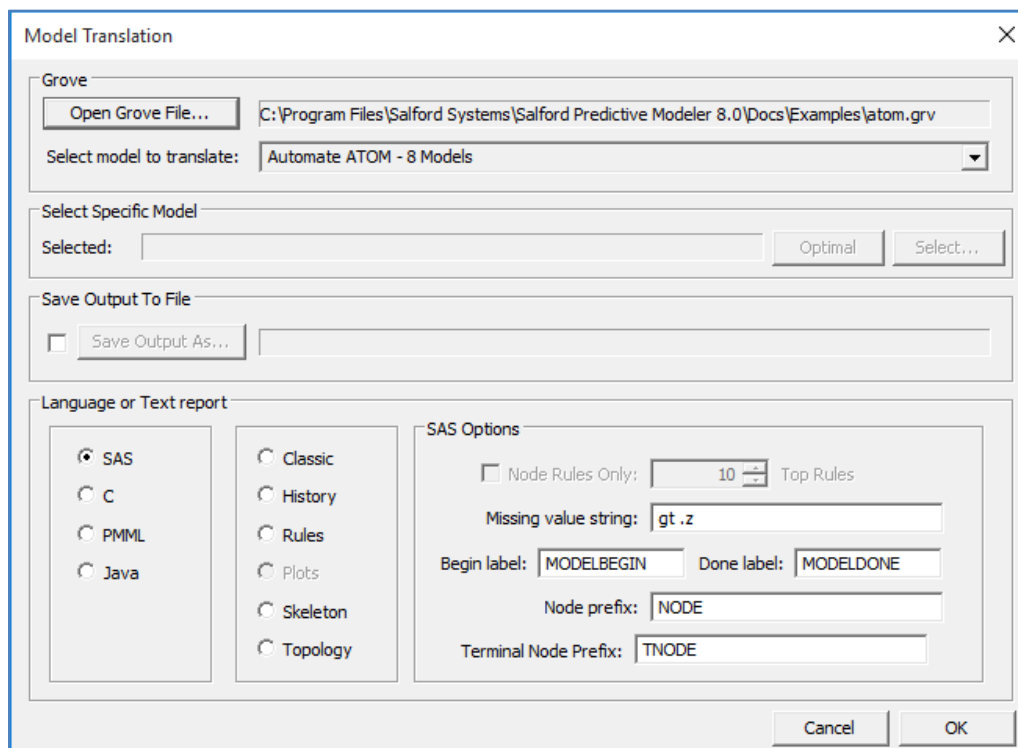
Buttons at the bottom: **Cancel** and **OK**.

You need to specify a Grove file to perform the translation. Do this in the **Open File** dialog when you press the **[Open Grove File]** button.

If you have a Grove file already open in the application, the dialog will use it by default. A display associated with a grove usually has the [Translate] button in the bottom right corner that will also lead to this **Model Translation** window.




This is a handy way to translate a model you're working with.



The rest of the controls in the dialog allow you to configure the translation process.

### Select model to translate

 HARVEST ENGINE=<Engine Name>, SELECT <Model Selection parameters>

A Grove file can contain multiple models. For example, on the screenshot above the grove contains 8 models produced as a result of AUTOMATE ATOM. With this combo box you can either specify an individual model or request to score all the models at once as an ensemble.


✓ HARVEST command is quite versatile and flexible. To make good use of it, please check the documentation.

### Select Specific Model

 HARVEST PRUNE <Model Specific parameters>

Many of the algorithms produce a group of related models. These models represent various tradeoffs between simplicity and accuracy. For more details, please see documentation on a specific algorithm (CART®, TreeNet®, etc.). Select Specific Model group of controls allows you to either request an optimal model to be scored or invoke a model-specific selection dialog.

## Save Output to File

 TRANSLATE OUTPUT=<file>

By default, the translation results are printed to the Classic Output window. You can request translation results to be saved into a file. The default extension is the conventional extension for the Translation Language currently selected.


## Language

 TRANSLATE LANGUAGE = CLASSIC | SAS | C | PMML | JAVA | HISTORY | SKELETON  
| PLOTS | TOPOLOGY | RULES

Choose the language you would like your model to be translated to. You can choose from the following options:


- ◆ SAS – produces implementation of the model in SAS/STAT® software programming language.
- ◆ C – produces implementation of the model in C programming language.
- ◆ PMML – translates the model into Predictive Model Markup Language.
- ◆ Java – produces implementation of the model in Java language.
- ◆ Classic – prints out Classic Output for the model. This way you can always review the Classic Output if the model was saved into a grove.
- ◆ History – lists the commands that were issued during the session up until the model was built.
- ◆ Rules – translates node rules using SAS syntax. For CART® and TreeNet® models, the default is to list all rules (all nodes other than the root nodes). For RuleLearner® models, the default is to list 10 rules, but this can be changed with the NRULES option.
- ◆ Plots – produces an XML file containing plot information produced by TreeNet® models.
- ◆ Skeleton – produces a brief topology display with node numbers only, no split information (CART® only).
- ◆ Topology – produces a set of FORCE commands for each split in a CART® model being translated. You can then apply these commands to a compatible dataset and see whether and how terminal nodes will be split for the new data.

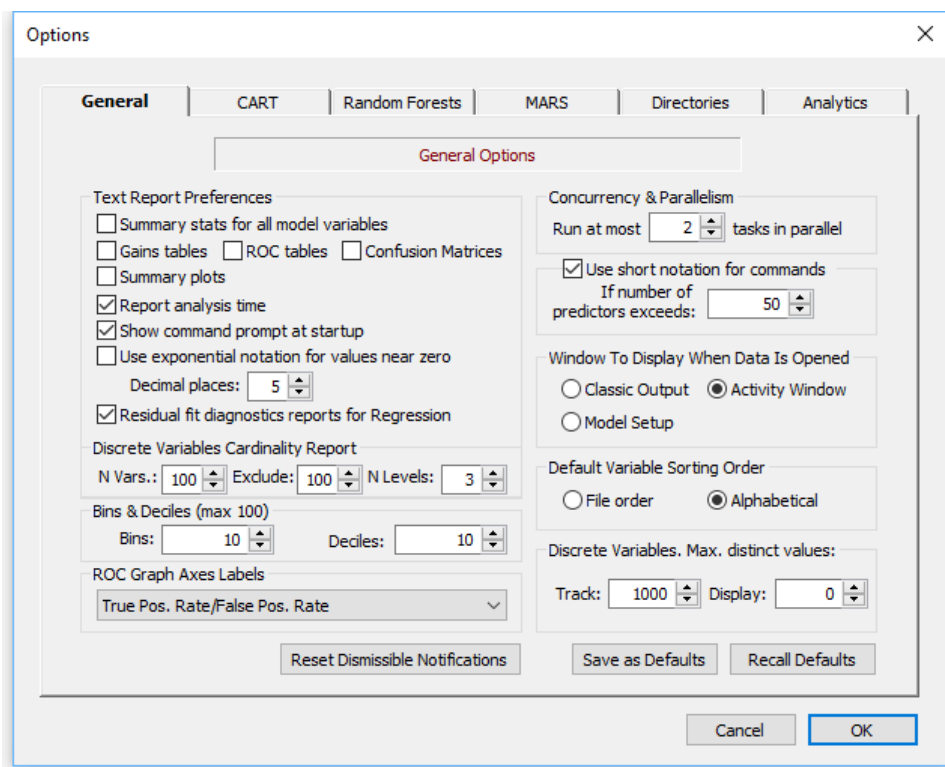
## SAS Options

 TRANSLATE SMI = "SAS missing value string", SBE = "SAS begin label", SDO = "SAS done label", SNO = "SAS node prefix", STN = "SAS terminal node prefix", SNE = "SAS TreeNet® prefix"

When translating into SAS, you may also specify additional SAS-related preferences. The definitions should become clear once you look at a sample SAS output.

## Options Dialog

You can configure your environment when working with the application via the Options Dialog. You can invoke it using the **Edit>Options...** menu item or the  button on the toolbar.



Each tab in the dialog contains the buttons to control the life-time of the settings with considerable flexibility.

### Save as Defaults

Persist the settings on a tab between sessions of the application. When you launch the application again, these settings will be applied on startup.

- Settings saved as Defaults are not automatically applied to the current session. Make sure to press the [OK] button if you want them to be applied at once. The [Cancel] button will restore the settings before the dialog was open.

### Recall Defaults

Populate current tab with settings currently persisted between sessions.

This way you can apply peculiar configurations to particular sessions and still have the preferred configuration you want to be in effect by default.

## General tab

This tab contains most common used global settings in the application.

### Text Report Preferences

The report preferences allow you to turn on and off the following parts in the SPM Classic Output.



### Summary stats for all model variables

 LOPTIONS MEANS=<YES|NO>


Report the summary statistics including mean, standard deviation, minimum, maximum, etc. In classification models, the stats are reported for the overall train and test samples and then separately for each level of the target.

### Gains tables

 LOPTIONS GAINS=<YES|NO>


Report Gains tables for CART® classification models.

### ROC tables

 LOPTIONS ROC=<YES|NO>

Report ROC tables for CART® classification models.


### Confusion Matrices (prediction success tables)

 LOPTIONS CONFUSION\_MATRIX=<YES|NO> / [CLASS|PROB|BOTH]

 LOPTIONS PREDICTION\_SUCCESS=<YES|NO> / [CLASS|PROB|BOTH]


Report Confusion Matrix with misclassification counts and percents by class level. For some reports, two tables are available: one based on class predictions and one based on predicted probabilities. You can control them individually or request both.

### Summary plots

 LOPTIONS PLOTS=<YES|NO> / "<plot\_character>"


Enables summary plots in the text output and allows a user-specified plotting symbol.

### Report analysis time

 LOPTIONS TIMING=<YES|NO>


Report CPU time required for each stage of the analysis.

### Use exponential notation for values near zero / Decimal places

 FORMAT=<#> / UNDERFLOW

Precision to which the numerical output is printed. This will affect all the UI as well as text output from the engine after this option is applied. The UNDERFLOW option prints tiny numbers in scientific notation.

### Residual fit diagnostics reports for Regression

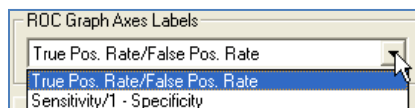
 LOPTIONS RESIDUALDIAG=<YES | NO>

Enables or suppresses residual model fit diagnostic reports for regression models only.

## Other Controls

### ROC Graph Labels

ROC graphs are traditionally labeled differently in different industries. You can select from the two labeling schemes displayed below:



### Concurrency & Parallelism

 THREADS=<n>

Specifies maximal degree of parallelism (maximal number of worker threads permitted to run in the application). By default, the GUI application uses number of physical cores (not hyperthreading cores) on the machine.

- 💡 In our experience setting a number of tasks to run in parallel higher than the number of physical cores may significantly degrade performance.

### Use Short Command Notation

Sets the minimal number of predictors that triggers a short command notation in the command log. When the number of predictors is small, each predictor is printed in the command log (for example, KEEP or CATEGORY commands). However, when the number of predictors exceeds the limit, the SPM uses “dash” convention to indicate ranges of predictors (for example, X1-X5).

- ✓ This setting only affects how the GUI generates commands. The command parser supports both short and standard command notations.

### Window to Display When Data Is Opened

When you open a data file, the SPM gives you three choices for what to do next:

- ♦ Classic Output – use this if you don’t want any task-specific dialogs to pop up as soon as a dataset is open. Useful when authoring command files.
- ♦ Activity Window – this dialog gives you a convenient way to access common data mining tasks once a new dataset is open.
- ♦ Model Setup – in many common analysis scenarios, the window to navigate to from the Activity Window is Model Setup. For convenience, you have an option to bypass the Activity Window for a newly open dataset.

### Default Variable Sorting Order

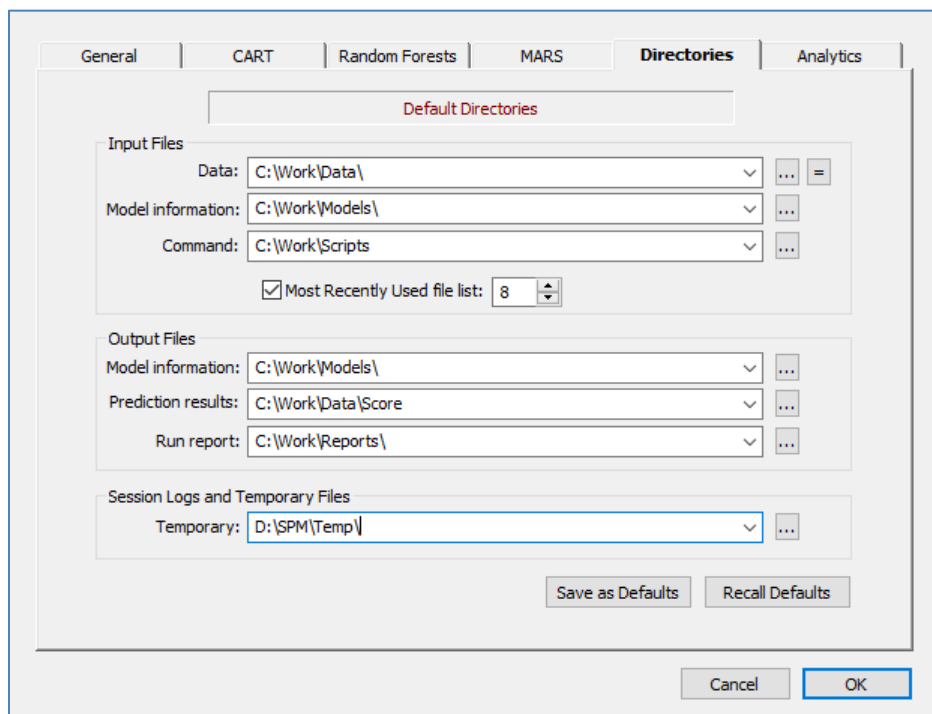
Many GUI displays include a list of variables and you can always change the sort order between Alphabetical and File Order (the order in which the variables appear in your data file). This setting allows you to determine the ordering that will always show first when a dialog is opened.

## Algorithm-specific tabs

Please refer to documentation on a specific algorithm (CART®, TreeNet®, etc.) for information about tabs with algorithm-specific options. The settings on these tabs are usually configured for a newly installed instance of the application and only changed rarely, if ever, after that. In contrast, the Model Setup dialog contains settings that are likely to change for every engine run.

## Directories tab

This tab allows you to setup working directories. The SPM gives you flexibility to specify working directories for different categories of files.



### Input Files Locations

By default, the SPM GUI looks for files at the following locations:

- ◆ Data – datasets for modeling.
- ◆ Model information – previously-saved the SPM model files.
- ◆ Command – command files or scripts.

### Output Files Locations

By default, the SPM GUI writes files to the following locations:

- ◆ Model information – the SPM model files saved for later scoring or export.
- ◆ Prediction results – output datasets containing scores or predictions.
- ◆ Run report – classic plain text output.

✓ Depending on your working style you may choose to store input and output files at the same location or use separate locations for them.

## Temporary Files

Specifies the location where the SPM creates temporary files, including command log files for entire application sessions.

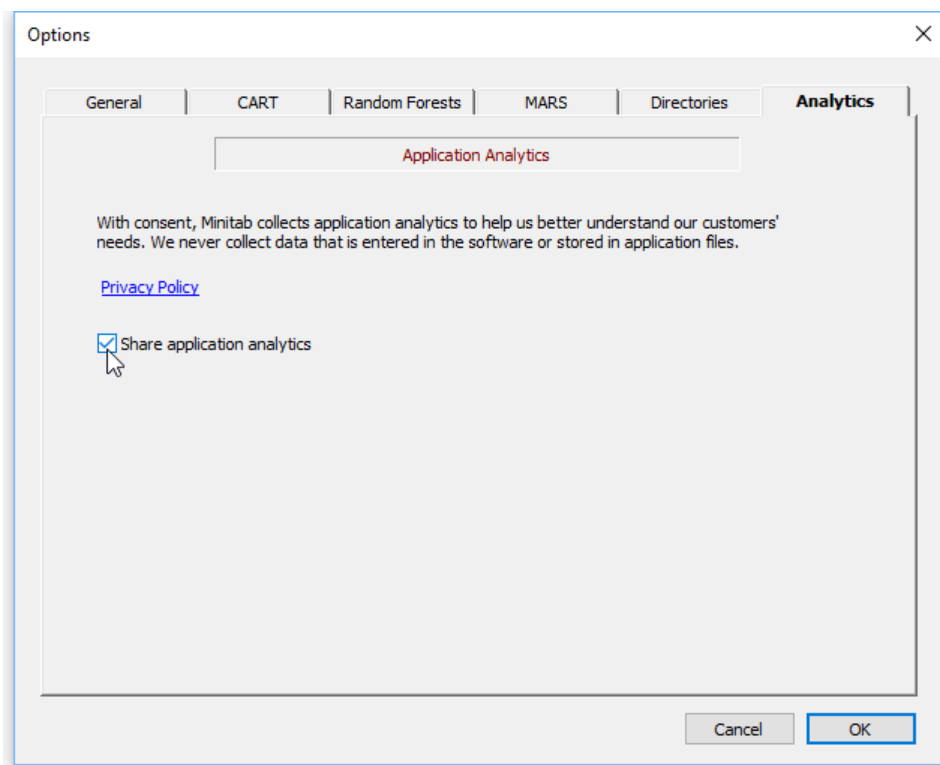
By default the SPM queries OS for current user's default directory for temporary files. When selecting a directory for temporary files please take the following into consideration.

- ◆ Make sure that the drive where the temporary folder is located will have enough space (at least the size of the largest data set you are planning to use).
- ◆ Temporary files with names like SPMU1227120944\_s2as\_\_.txt are records of your previous sessions. The first part of the name refers to today's date (December 27<sup>th</sup> 2012) followed by a random series of digits and letters to give the file a unique name. These command logs provide a record of what you were doing during any session and will be stored even if you experience an Operating System crash or power outage. You may find this record invaluable if you ever need to reconstruct work you were doing.
- ✓ You can browse these session logs using **View>Past Session Logs** menu.
- ◆ Temporary files with names other than SPMUnnnnn.txt are normally deleted when you shut the SPM down. If you find such files in your temporary directory it is safe to delete them as they contain no useful information.






## Analytics tab

With consent, Minitab collects application analytics to help better understand our customers' needed. If you would like to participate, please check the "Share application analytics" box.

- ✓ We never collect data that is entered in the software or stored in application files.




## Additional Control Functions

- ♦  –Control icon that automatically changes all path references to make them identical with the Data: entry.
- ♦  –Control icon that starts the Select Default Directory dialog, allowing the user to browse for the desired directory.
- ♦  –Control that allows you to select from a list of previously-used directories.
- ♦  Most Recently Used file list:  – Control that allows the user to specify how many files to show in the Most Recently Used (MRU) menu. The maximum allowable is **20** files. files. files.

## Model Setup Dialog

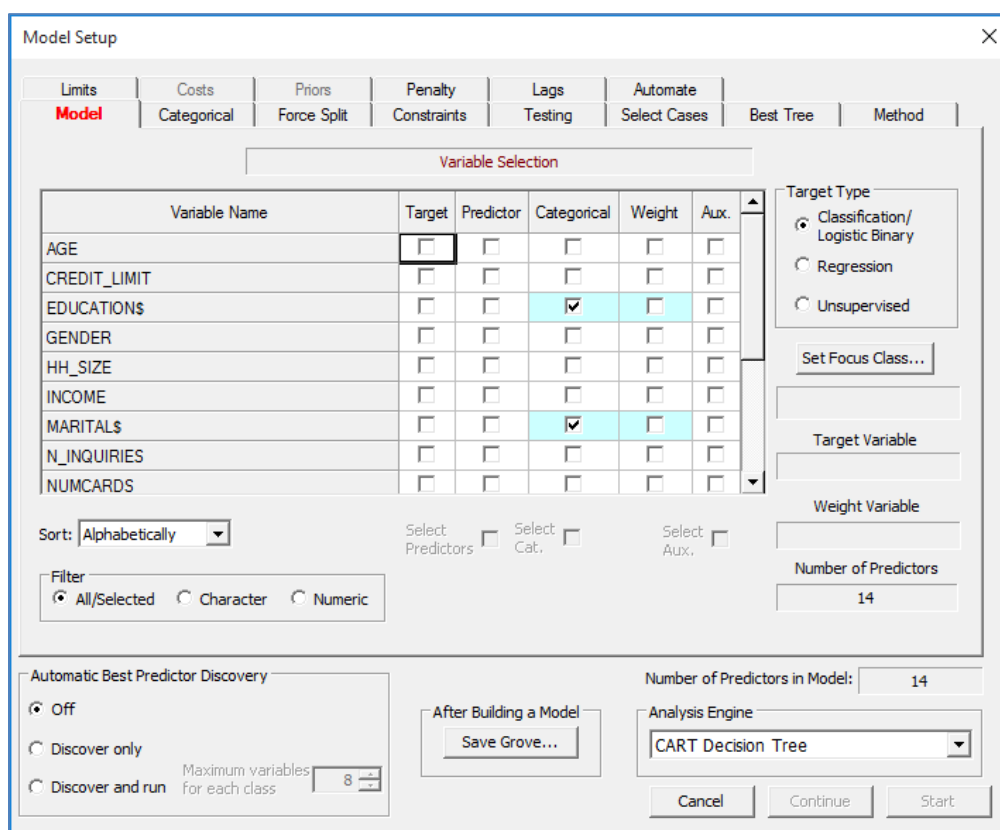
The Model Setup dialog is a primary tool for configuring and running the SPM analyses. Virtually all users of the SPM, from novices to seasoned experts, use it in their work daily. The power of this dialog is that knowledge of the most important part of the SPM Command Language is encapsulated into the streamline GUI. Depending on your goal, you can get your predictive model all configured and running in seconds or generate the first version of a Command Language script.

In this section we will use the **GOODBAD.CSV** dataset. Open the dataset in the SPM (Reading Data walks through opening a dataset in details). Once you do this you can get to the Model Setup via

**Model>Construct Model** or  toolbar button. You can also navigate to this dialog from the Activity Window.

Controls are grouped into tabs in such a way that you have to visit only a minimal number of tabs to set up a particular the SPM run. Simplest runs can be configured by only visiting the first Model tab.

Tab headings are displayed in **RED** when the tab requires information from you before a model can be built. For example, when a dataset is open right after startup, the Model Setup dialog looks like this.



Model Setup

Limits Costs Priors Penalty Lags Automate  
**Model** Categorical Force Split Constraints Testing Select Cases Best Tree Method

Variable Selection

Variable Name	Target	Predictor	Categorical	Weight	Aux.
AGE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CREDIT_LIMIT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATIONS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GENDER	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HH_SIZE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INCOME	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITALS	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NUMCARDS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort: Alphabetically

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Target Type: ☒ Classification/Logistic Binary ☐ Regression ☐ Unsupervised

Set Focus Class...

Target Variable

Weight Variable

Number of Predictors: 14

Automatic Best Predictor Discovery: ☒ Off ☐ Discover only ☐ Discover and run

Maximum variables for each class: 8

After Building a Model: Save Grove...

Number of Predictors in Model: 14


Analysis Engine: CART Decision Tree

Cancel Continue Start

The tab is red because we have not yet selected a **TARGET** variable. Without this information, the SPM does not know which of the variables we are trying to analyze or predict. This is the only required step in setting up a model. Everything else is optional.

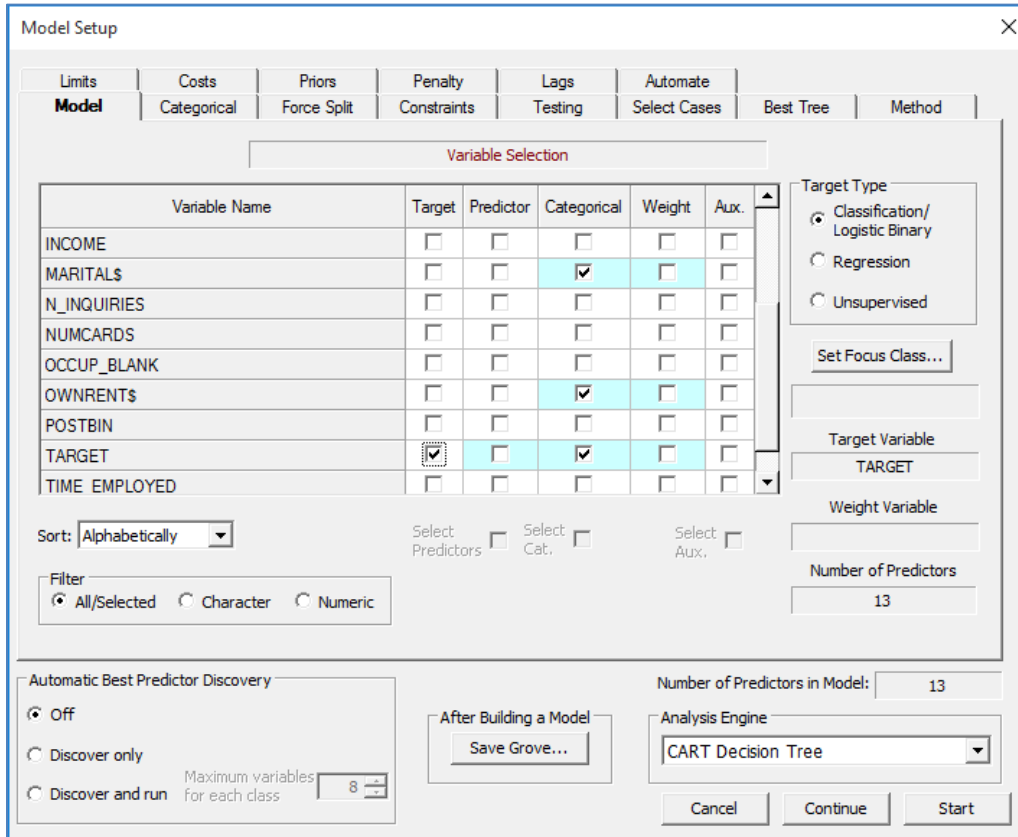
## Selecting Target and Predictor Variables

 MODEL <depvar>

 KEEP <var1>, <var2>, ....

Variables are selected in the **Variable Selection** grid on the Model tab.

For this walkthrough, the binary categorical variable TARGET (coded 0/1) is the target (or dependent) variable. To mark the target variable, check the box in the Target column.



Model Setup

Limits Costs Priors Penalty Lags Automate  
**Model** Categorical Force Split Constraints Testing Select Cases Best Tree Method

Variable Selection

Variable Name	Target	Predictor	Categorical	Weight	Aux.
INCOME	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITALS	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NUMCARDS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OCCUP_BLANK	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OWNRENTS	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
POSTBIN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TARGET	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TIME_EMPLOYED	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort: Alphabetically

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Target Type: ☒ Classification/Logistic Binary ☐ Regression ☐ Unsupervised

Set Focus Class...

Target Variable: TARGET

Weight Variable:

Number of Predictors: 13

Automatic Best Predictor Discovery: ☒ Off ☐ Discover only ☐ Discover and run (Maximum variables for each class: 8)

After Building a Model: Save Grove...

Number of Predictors in Model: 13

Analysis Engine: CART Decision Tree

Cancel Continue Start

- ✓ In contrast to previous versions of the SPM, once there's a check in the Target column, the Categorical column becomes locked. You should use the Target Type radio group to specify whether you're working with a continuous or categorical target.

Next we indicate which variables are to be used as predictors. Many algorithms in the SPM are automatic variable selectors, so you do not have to do any selection at all, but in many circumstances you will want to exclude certain variables from the model.

- ✓ If you do not explicitly select the predictors the SPM is allowed to use, then the SPM will screen all variables for potential inclusion in its model.
- ✓ Even if all the variables available are reasonable candidates for model inclusion, it can still be useful to focus on a subset for exploratory analyses.

In this run we will select all the variables except POSTBIN. Do this by clicking on the Predictor column heading to highlight the column, checking the Select Predictors box underneath the column and then unchecking **POSTBIN**. Your screen should now look as follows.

**Model Setup**

Limits | Costs | Priors | Penalty | Lags | Automate | **Model** | Categorical | Force Split | Constraints | Testing | Select Cases | Best Tree | Method

**Variable Selection**

Variable Name	Target	Predictor	Categorical	Weight	Aux.
INCOME	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITAL\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NUMCARDS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OCCUP_BLANK	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OWNRENT\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
POSTBIN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TARGET	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TIME EMPLOYED	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort: **Alphabetically**

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Automatic Best Predictor Discovery: ☒ Off ☐ Discover only ☐ Discover and run (Maximum variables for each class: 8)

After Building a Model: **Save Grove...**

Number of Predictors in Model: 12


Analysis Engine: **CART Decision Tree**

Buttons: Cancel, Continue, Start

✓ It is always a good idea to exclude bookkeeping columns such as ID variables. These are not suitable for prediction.

✓ You can select groups of cells with mouse and keyboard and then use checkboxes under the grid to check and uncheck boxes in all selected rows at once. The grid supports selecting nonadjacent cells when you press and hold the **[Ctrl]** key and adjacent cells when you press and hold the **[Shift]** key.

### Categorical Predictors

 CATEGORY <var1>, <var2>, ....

Categorical column allows you to specify which of the numeric variables are categorical by nature. Character variables, like MARITAL\$, have been automatically checked as categorical. Let's select **GENDER** as a numeric categorical predictor.



**Model Setup**

Limits | Costs | Priors | Penalty | Lags | Automate |  
**Model** | Categorical | Force Split | Constraints | Testing | Select Cases | Best Tree | Method

Variable Selection

Variable Name	Target	Predictor	Categorical	Weight	Aux.
AGE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CREDIT_LIMIT	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATIONS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GENDER	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HH_SIZE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INCOME	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITALS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NUMCARDS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort: Alphabetically

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Target Type: ☒ Classification/Logistic Binary ☐ Regression ☐ Unsupervised

Set Focus Class...

Target Variable: TARGET

Weight Variable:

Number of Predictors: 12

Automatic Best Predictor Discovery: ☒ Off ☐ Discover only ☐ Discover and run

Maximum variables for each class: 8

After Building a Model: Save Grove...

Number of Predictors in Model: 12

Analysis Engine: CART Decision Tree

Cancel Continue Start

## Case Weights

WEIGHT <wgtvar>

In addition to selecting target and predictor variables, the **Model** tab allows you to specify a case-weighting variable.

Case weights, which are stored in a variable of the dataset, typically vary from observation to observation. An observation's case weight can, in some sense, be thought of as a repetition factor. A `OB` `OB` `OB`

To select a variable as the case weight, simply put a checkmark against that variable in the **Weight** column. For the sake of example let's uncheck **NUMCARDS** as a predictor and check it as a WEIGHT variable.

Model Setup

Limits Costs Priors Penalty Lags Automate

**Model** Categorical Force Split Constraints Testing Select Cases Best Tree Method

Variable Selection

Variable Name	Target	Predictor	Categorical	Weight	Aux.
MARITAL\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NUMCARDS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
OCCUP_BLANK	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OWNRENT\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
POSTBIN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TARGET	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TIME_EMPLOYED	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort: Alphabetically

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Target Type: ☒ Classification/Logistic Binary ☐ Regression ☐ Unsupervised

Set Focus Class...

Target Variable: TARGET

Weight Variable: NUMCARDS

Number of Predictors: 11

Automatic Best Predictor Discovery: ☒ Off ☐ Discover only ☐ Discover and run

Maximum variables for each class: 8

After Building a Model: Save Grove...

Number of Predictors in Model: 11

Analysis Engine: CART Decision Tree

Cancel Continue Start

- ☛ If you are using a test sample contained in a separate dataset, the case weight variable must exist and have the same name in that dataset as in your main (learn sample) dataset.

## Auxiliary Variables

☛ `AUXILIARY <var1>, <var2>, ....`

Auxiliary variables are variables that are tracked throughout the work of the engine but are not necessarily used as predictors. By marking a variable as Auxiliary, you indicate that you want, for example, to be able to retrieve basic summary statistics for such variables in any node in the CART® tree. Let's mark **AGE**, **CREDIT\_LIMIT** and **N\_INQUIRIES** as Auxiliary variables.

Model Setup

Limits Costs Priors Penalty Lags Automate

**Model** Categorical Force Split Constraints Testing Select Cases Best Tree Method

Variable Selection

Variable Name	Target	Predictor	Categorical	Weight	Aux.
AGE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CREDIT_LIMIT	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
EDUCATION\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GENDER	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HH_SIZE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INCOME	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITAL\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
NUMCARDS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Sort: Alphabetically

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Target Type: ☒ Classification/Logistic Binary ☐ Regression ☐ Unsupervised

Set Focus Class...

Target Variable: TARGET

Weight Variable: NUMCARDS

Number of Predictors: 11

Automatic Best Predictor Discovery: ☒ Off ☐ Discover only ☐ Discover and run

Maximum variables for each class: 8

After Building a Model: Save Grove...

Number of Predictors in Model: 11

Analysis Engine: CART Decision Tree

Cancel Continue Start

☛ Aux. column is hidden when Auxiliary variables are not supported by the current analysis engine.

## Analysis Engine

With this combo box you select an Analysis Engine you would like to apply to the data. Depending on your license, you will see all or some Analysis Engines supported by the SPM (CART®, TreeNet®, etc.).

✓ Currently selected Analysis Engine determines which tabs are available. Also, the content of the tabs themselves could change according to the specifics of the Analysis Engine.

## Save Grove...

GROVE <file>

Grove is a universal container file format used by the SPM engine to store any kind of modeling results. It includes complete information about the model-building process. For example, for CART® analyses it contains multiple collections of trees with pruning sequences.

Application's UI can visualize the modeling results saved to a grove just like it does for a model you build in the current session. Actually, if you don't specify the Grove file here, a temporary one will be created. Depending on your workflow, you would want to specify a Grove file for your analysis here or use the [Save Grove] button in the **Results** window.

✓ Specifying Grove file name in advance makes sense for analyses that take a long time to run.

You can always open a saved Grove file via **File>Open>Open Grove...** or the toolbar button. This file is used for Scoring and Translating of the model.

## Automatic Best Predictor Discovery

 TREENET DISCOVER = (MANUAL | AUTO)[, TOP = <n>]

You can use the TreeNet® algorithm to discover most important predictors before you run the analysis. This could be useful if the desired Analysis Engine could benefit from narrowing down the predictor list. Discover only will show results of the discovery and give you control to select the predictors while Discover and run will make a selection automatically and proceed to run the analysis.

- ☛ In many cases it is advisable to just run a TreeNet® model and explore its results rather than using auto-discovery. **Variable Importance** tab has a facility to configure the SPM engine with the list of most important predictors.

## Model tab

The **Variable Selection** grid is described in the Selecting Target and Predictor Variables section. The tab also has the following controls.

### Setting Focus Class

In classification runs, some of the reports generated by the SPM (gains, prediction success, color-coding, etc.) have one target class in focus. By default, the SPM will put the first class it finds in the dataset in focus. A user can overwrite this by pressing the [Set Focus Class] button

### Sorting Variable List

The variable list can be sorted either in physical order or alphabetically by changing the **Sort:** control box. Depending on the dataset, one of those modes will be preferable, which is usually helpful when dealing with large variable lists.

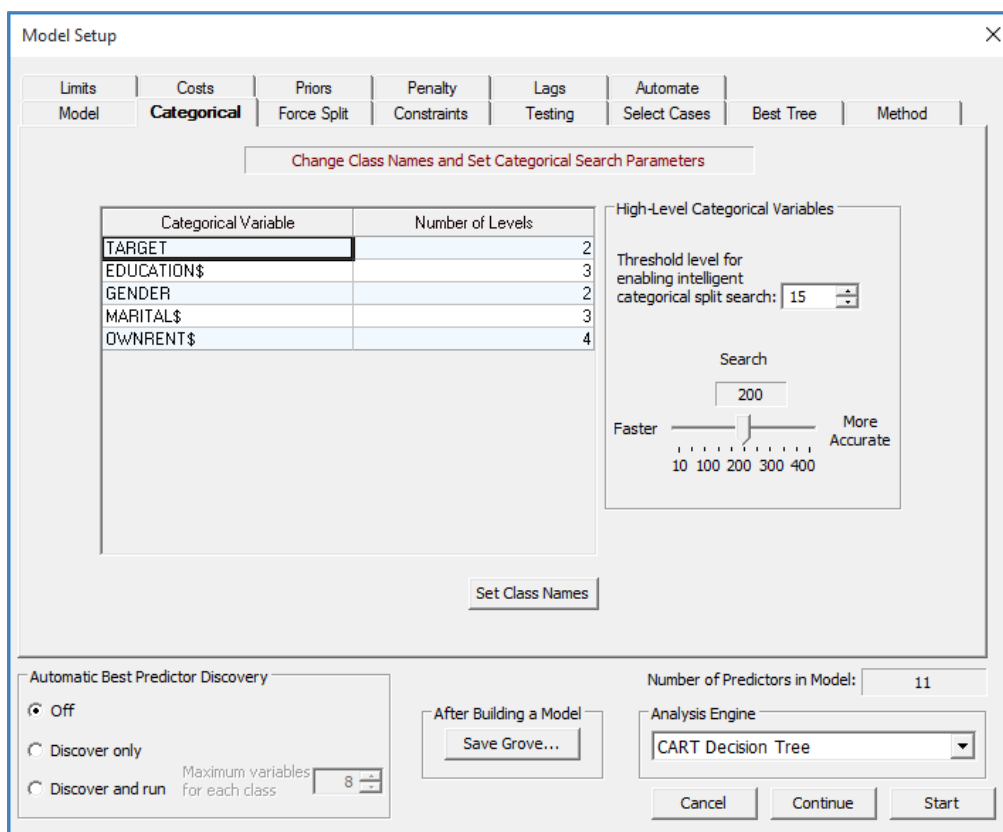
### Specifying Target Type

The SPM uses the Target Type radio group to determine how the Target variable will be interpreted by the engine. The following Target Types are supported:


- ♦ **Classification/Logistic Binary** – the Target is categorical or binary, may have 2 or more categories.
- ♦ **Regression** – the Target is continuous.
- ♦ **Unsupervised** – no Target variable is required in the data.
- ✓ The content of other tabs depends quite substantially on the Target Type selected.

## Categorical tab

**Categorical** tab allows you to manage text labels for categorical predictors and it also offers controls related to how we search for binary tree splitters on high-level categorical predictors.



### Setting Class Names

 `CLASS <variable> <level>=<string>, <level>=<string>, ...`

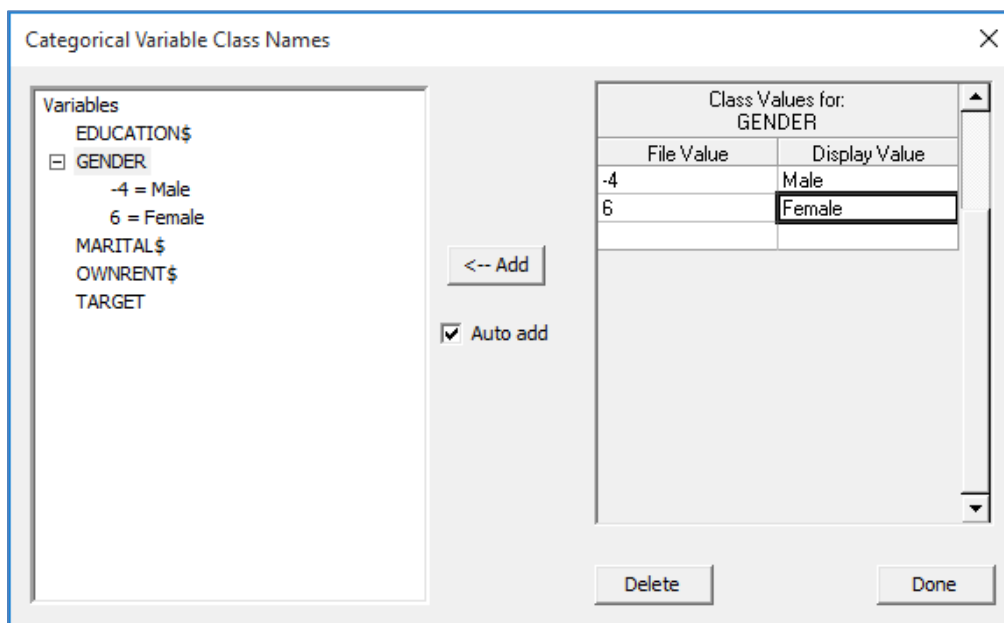
You can specify more descriptive names for levels of categorical variables. Press the [Set Class Names] button to get started. In the left panel, select a variable for which labels are to be defined. If any class labels are currently defined for this variable, they will appear in the left panel and, if the variable is selected, in the right panel as well (where they may be altered or deleted). To enter a new class name in the right panel for the selected variable, define a numeric value (one that will appear in your data) in the File Value column and its corresponding text label in the Display Value column. Repeat for as many class names as necessary for the selected variable.

You need not define labels for all levels of a categorical variable. A numeric level, which does not have a class name, will appear in the SPM output as it always has, as a number. Also, it is acceptable to define labels for levels that do not occur in your data. This allows you to define a broad range of class names for a variable, all of which will be stored in a command script (.CMD file), but only those actually appearing in the data will be used.

In a classification tree, class names have the greatest use for categorical numeric target variables (i.e., in a classification tree). For example, for a four-level target variable PARTY, classes such as "Independent," "Liberal," "Conservative," and "Green" could appear in the SPM reports and the navigator rather than levels "1", "2", "3", and "4."


- Only the first 32 characters of a class name are used, and some text reports use fewer due to space limitations.

For example, let's give more descriptive names to the levels of GENDER variable. The Categorical Variable Class Names dialog appears as follows.



✓ If you use the GUI to define class names and wish to reuse the class names in a future session, save the command log before exiting the SPM. Cut and paste the CLASS commands appearing in the command log into a new command file.

### High-Level Categorical Predictors in Decision Trees

 BOPTIONS NCLASSES=<n>

 BOPTIONS HLC= <n1>, <n2>

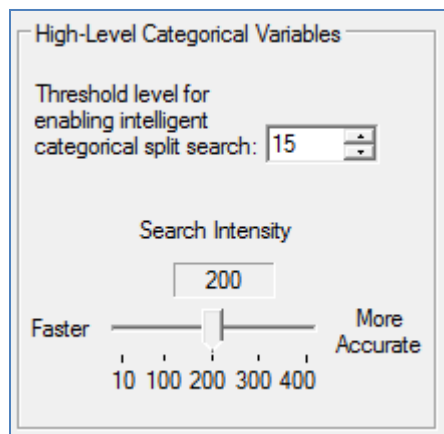
We take great pride in noting that the SPM is capable of handling categorical predictors with thousands of levels (given sufficient RAM workspace) when searching for a split for a decision tree. However, using such predictors in their raw form is generally not a good idea. Rather, it is usually advisable to reduce the number of levels by grouping or aggregating levels, as this will likely yield more reliable predictive models. It is also advisable to impose the HLC penalty on such variables (from the **Model Setup—Penalty** tab). These topics are discussed at greater length later in the Guide. In this section we discuss the simple mechanics for handling any HLC predictors you have decided to use.

For the binary target, high-level categorical predictors pose no special computational problem as exact short cut solutions are available and the processing time is minimal no matter how many levels there are.

For the multi-class target variable (more than two classes), we know of no similar exact short cut methods, although research has led to substantial acceleration. HLCs present a computational challenge because of the sheer number of possible ways to split the data in a node. The number of distinct splits that can be generated using a categorical predictor with K levels is  $2^{K-1} - 1$ . If K=4, for example, the number of candidate splits is 7; if K=11, the total is 1,023; if K=21, the number is over one million; and if K=35, the number of splits is more than 34 billion! Naïve processing of such problems could take days, weeks, months, or even years to complete!

To deal more efficiently with high-level categorical (HLC) predictors, the SPM has an intelligent search procedure that efficiently approximates the exhaustive split search procedure normally used. The HLC procedure can radically reduce the number of splits actually tested and still find a near optimal split for a high-level categorical.

The controls to configure options for high-level categorical predictors look as follows.



The settings above indicate that for categorical predictors with 15 or fewer levels, we search all possible splits and are guaranteed to find the overall best partition. For predictors with more than 15 levels we use intelligent shortcuts that will find very good partitions but may not find the absolute overall best. The threshold level of 15 for enabling the short cut intelligent categorical split searches can be increased or decreased. In the short cut method we conduct “local” searches that are fast but explore only a limited range of possible splits. The default setting for the number of local splits to search is around 200. To change this default and thus search more or less intensively, increase or decrease the search intensity gauge. Our experiments suggest that 200 is a good number to use and that little can be gained by pushing this above 400. A higher number leads to more intensive and longer searching whereas a lower number leads to faster, less thorough searching.

- ✓ You can configure more aggressive searching using command language.
- ✓ Remember that these controls are only relevant if your target variable has more than two levels. For the two-level binary target (the YES/NO problem), the SPM has special shortcuts that always work.
- ✓ Remember that there are actually disadvantages to searching too aggressively for the best HLC splitter. Such searches increase the likelihood of overfitting the model to the training data.

## Testing Tab

Testing is a vital stage in most algorithms. Without testing, we cannot know how well a given model can be expected to perform on new data. The SPM allows you to choose from different test strategies.

### No Independent Testing

PARTITION NONE

This option skips the entire testing phase and relies fully on the Learn Sample. We recommend you use this option familiar with the data set, as this option provides no way to assess the performance of the model when applied to new data.

Bypassing the test phase can be useful when you are using CART® to generate a quick cross tabulation of the target against one of your predictors. This use of CART® is discussed in more detail in other sections.

✓ This mode is not supported by some algorithms.

### Fraction of Cases Selected at Random

PARTITION [ LEARN=<x>, TEST=<x>, HOLDOUT=<x>, FAST|EXACT ]

Use this option to let the SPM automatically separate a specified percentage of data for test purposes. Because no optimal fraction is best for all situations, you will want to experiment. In the original CART® monograph the authors suggested a 2/3, 1/3 train/test split, which would have you set the test fraction to



.33. In later work, Jerome Friedman suggested using a value of .20. In our work with large datasets, we favor a value of .50 and in some cases we even use .70 when we want to quickly extract a modest-sized training sample. So our advice is: don't be reluctant to try different values.

The advantage of using PARTITION TEST=.50 is that the train and test samples are almost identical in size, facilitating certain performance comparisons.

Setting PARTITION TEST=.80, for example, is a fast way to pull a relatively small extract from a large database. Just be sure to check the size of the sample that is selected for training. If it is too small you cannot expect reliable results.

This mechanism does not provide you with a way of tagging the records used for testing. If you need to know which records were set aside for testing you should create a flag marking them for test and then use the SEPVAR method for testing (see below).

The SPM offers two different methods in selecting the random partition: fast and exact. FAST provides agreement with previous versions of the SPM and does independent random draws per record (default). EXACT carries out a random draw step before the data are processed, producing final partition-specific record counts that are likely to be exactly, or very close, to what one would expect.

### Test Sample Contained in a Separate File


 PARTITION FILE="filename.ext"

Two separate files are assumed—one for learning and one for testing. The files can be in different database formats and their columns do not need to be in the same order.

💡 The train and test files must both contain ALL variables to be used in the modeling process.

✓ In general we recommend that you keep your train and test data in the same file for data management purposes. This helps to ensure that if you process your training data you also process the test data in exactly the same way.

### V-fold Cross-validation

 PARTITION CROSS [ = <n> ]

Cross validation is a marvelous way to make the maximal use of your training data, although it is typically used when data sets are small. For example, because the **HOSLEM.CSV** dataset contains only 189 records, it would be painful to segregate some of those data for the sake of testing alone. Cross validation allows you to build your tree using all the data. The testing phase requires running an additional 10 models (in 10-fold CV), each of which is tested on a different 10% of the data. The results from those 10 test runs are combined to create a table of synthesized test results.

Cross validation is discussed in greater detail in the Command Language Guide. When deciding whether or not to use cross validation, keep these points in mind:

✓ Cross validation is always a reasonable approach to testing. However, it is primarily a procedure that substitutes repeated analyses of different segments of your data for a more typical train-test methodology. If you have plentiful data, you can save quite a bit of time by reserving some of the data for testing.

Cross validation can give you useful reports regarding the sensitivity of results to small changes in the data.

Even in a large data set the class of interest may have only a handful of records. When you have only a small number of records in an important target class you should think of your data set as small no matter

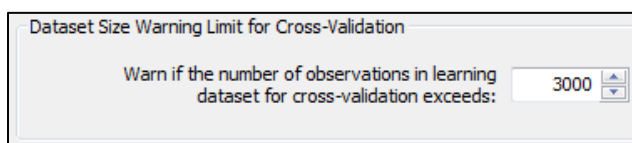
how many records you have for other classes. In such circumstances, cross validation may be the only viable testing method.

Reducing the number of cross validation folds below ten is generally not recommended. In the original CART® monograph, Breiman, Friedman, Olshen and Stone report that the CV results become less reliable as the number of folds is reduced below 10. Further, for classification problems there is very little benefit from going up to 20 folds.

If there are few cases in the class of interest you may need to run with fewer than 10 CV folds. For example, if there are only 32 YES records in a YES/NO classification data set (and many more NOs) then eight-fold cross validation would allow each fold to contain four of these cases. Choosing 10-fold for such data would probably induce the SPM to create nine folds with three YES records and one fold with five YES records. In general, the better balance obtained from the eight-fold CV would be preferable.

There is nothing technically wrong with two-fold cross validation but the estimates of the predictive performance of the model tend to be too pessimistic. With 10-fold cross validation you get more accurate assessments of the model's predictive power.

- ☛ Every target class must have at least as many records as the number of folds in the cross validation. Otherwise, the process breaks down, an error message is reported (e.g. for CART® “No Tree Built” situation occurs). This means that if your data set contains only nine YES records in a YES/NO problem, you cannot run more than nine-fold cross validation. Modelers usually run into this problem when dealing with, say, a three-class target where two of the classes have many records and one class is very small. In such situations, consider either eliminating rare class cases from the dataset or merging them into a larger class.
- ✓ If your dataset has more than 3,000 records and you select cross validation as your testing method for CART® analysis, a dialog will automatically open informing you that you must increase the setting for the “maximum number of observations in learning dataset with cross validation” in the **Model Setup — Limits** tab. This warning is intended to prevent you from inadvertently using cross validation on larger datasets and thus growing eleven trees instead of just one. To raise the threshold, adjust the value as shown below:



### Variable Determines CV Bins

 PARTITION CROSS [ = <n> | <variable>, OOB=<"filename.ext"> ]

You can create your own partitioning for cross-validation. You must add a variable with bin number to the dataset and use the Variable determines CV bins testing strategy.

Whether the bins are generated (see previous section) or specified, you can gain useful insight from predictions for each record when the record is in the test partition. You can specify a file you want to save these scores to using Save OOB Predictions control. OOB stands for **Out Of Bag**.

- ✓ Most algorithms do report Test partition performance measures when Cross-Validation is used.

### Variable Separates Learn, Test (and Validate) Samples

 PARTITION SEPVAR=<variable>


A variable on your data set can be used to indicate which records are to be used for learning (training) and which are to be used for testing or validation.

- ◆ Use a numeric variable to define simple learn/test/holdout partitions. Such variables shall be coded with 0 indicating “train”, 1 indicating “test” and -1 indicating “holdout”.
- ◆ If you prefer you can use a text variable with the values “LEARN”, “TEST” and “HOLDOUT”. (You can use lower case if you prefer.)


This option gives you complete control over train/test partitions because you can dictate which records are assigned to which partition during the data preparation process.

✓ Consider creating several separation variables to explore the sensitivity of the model-building process to random data partition variation.

## Select Cases tab

 SELECT <var\$> <relation> '<string\$>'

This tab allows you to specify up to ten selection criteria. A selection criterion can be specified in terms of any variable appearing in the data set, whether or not that variable is involved in the model, and is constructed as follows:. A selection criterion can be specified in terms of any variable appearing in the data set, whether or not that variable is involved in the model, and is constructed as follows:

- ◆ Select a variable in the variable list puts it to **Select** text box.
- ◆ Select one of the predefined logical relations by clicking its button.
- ◆ Enter a value of the variable to compare against in the **Value** text box.
- ◆ Click the **[Add to List]** to add the constructed criterion to the right window (and use the **[Delete from List]**  button to remove).

For example, if you want to exclude all people over 35 years of age from the analysis, double-click on AGE. Click on the =< button and enter 35 in the **Value** text box. When you click on the **[Add to List]** button, AGE=<35 will now appear in the previously-blank panel on the right, as illustrated above.

Model Setup

Limits Costs Priors Penalty Lags Automate  
Model Categorical Force Split Constraints Testing **Select Cases** Best Tree Method

A Selected Record Must Satisfy ALL of the Conditions

AGE  
CREDIT\_LIMIT  
EDUCATION\$  
GENDER  
HH\_SIZE  
INCOME  
MARITAL\$  
N\_INQUIRIES  
NUMCARDS  
OCCUP\_BLANK  
OWNRENT\$  
POSTBIN  
TARGET  
TIME\_EMPLOYED

AGE <= 35

Sort: Alphabetically

Add To List Delete From List

Variable: AGE

= > > < < < >

Value: 35

Automatic Best Predictor Discovery  
☒ Off  
☐ Discover only  
☐ Discover and run  
Maximum variables for each class: 8

After Building a Model  
Save Grove...

Number of Predictors in Model: 11

Analysis Engine  
CART Decision Tree

Cancel Continue Start

✓ The **SELECT** criteria are “ANDed,” meaning that if you specify two conditions, both must be satisfied for a record to be selected into the analysis. If you want to create logical selection criteria that allow some but not all conditions to be met, you will need to use the built-in BASIC programming language.

## Cost Tab

✓ This is a classification-only feature.

MISCLASSIFY COST=<value> CLASSIFY <origin\_class> AS <predicted>

Because not all mistakes are equally serious or equally costly, decision makers are constantly weighing quite different costs. If a direct mail marketer sends a flyer to a person who is uninterested in the offer the marketer may waste \$1.00. If the same marketer fails to mail to a would-be customer, the loss due to the foregone sale might be \$50.00. A false positive on a medical test might cause additional more costly tests amounting to several hundreds of dollars. A false negative might allow a potentially life-threatening illness to go untreated. In data mining, costs can be handled in two ways:

- ◆ On a post-analysis basis where costs are considered after a cost-agnostic model has been built.
- ◆ During analysis in which case costs are allowed to influence the details of the model.

The SPM is unique in allowing you to incorporate costs into your analysis and decision making using either of these two strategies.

To incorporate costs of mistakes directly into your SPM model, complete the matrix in the **Model Setup—Costs** tab illustrated below. For example, if misclassifying bad loans (TARGET=1) is more costly than misclassifying good loans (TARGET=0), you may want to assign a penalty of two to misclassifying class 1 as 0. (See the Guide for the algorithm of your choice for a detailed discussion of misclassification costs.)

Model Setup

Model | Categorical | Force Split | Constraints | Testing | Select Cases | Best Tree | Method | Limits | **Costs** | Priors | Penalty | Lags | Automate

Costs For: TARGET

Level	0	1
0		1.00
1	2.00	

Defaults

Symmetrical

Class Distance

Distance Step: 1.00

1 misclassified as 0 Cost: 2.00

Automatic Best Predictor Discovery

☒ Off

☐ Discover only

☐ Discover and run

Maximum variables for each class: 8

After Building a Model

Save Grove...

Number of Predictors in Model: 11

Analysis Engine: CART Decision Tree

Cancel Continue Start

✓ Only cell ratios matter, that is, the actual value in each cell of the cost matrix is of no consequence—setting costs to 1 and 2 for the binary case is equivalent to setting costs to 10 and 20.

✓ In a two-class problem, set the lower cost to 1.00 and then set the higher cost as needed. You may find that a small change in a cost is all that is needed to obtain the balance of correct and incorrect and the classifications you are looking for. Even if one cost is 50 times greater than another, using a setting like 2 or 3 may be adequate.

✓ On binary classification problems, manipulating costs is equivalent to manipulating priors and vice versa. On multilevel problems, however, costs provide more detailed control over various misclassifications than do priors.

By default, all costs are set to one (unit costs).

To change costs anywhere in the matrix, click on the cell you wish to alter and enter a positive numeric value in the text box called Cost. To specify a symmetrical cost matrix, enter the costs in the upper right triangle of the cost matrix and click on the **[Symmetrical]** button. The SPM automatically updates the remaining cells with symmetrical costs. Click on the **[Defaults]** button to restore the unit costs.

☛ The SPM requires all costs to be strictly positive (zero is not allowed). Use small values, such as .001, to effectively impose zero costs in some cells.

☛ We recommend conducting your analyses with the default costs until you have acquired a good understanding of the data from a cost-neutral perspective.

## Priors tab

✓ This is a classification-only feature.


 PRIORS EQUAL

 PRIORS DATA

 PRIORS MIX

 PRIORS LEARN

 PRIORS TEST

 PRIORS SPECIFY `<class1>=<value1>, <class2>=<value2>, ...`

The **Model Setup—Priors** tab is one of the most important options you can set in shaping a classification analysis and you need to understand the basics of it to get the most out of the SPM. Although the PRIORS terminology is unfamiliar to most analysts, the core concepts are relatively easy to grasp. Market researchers and biomedical analysts make use of the priors concepts routinely but in the context of a different vocabulary.

We start by discussing a straightforward 0/1 or YES/NO classification problem. In most real world situations, the YES or 1 group is relatively rare. For example, in a large field of prospects only a few become customers, relatively few borrowers default on their loans, only a tiny fraction of credit card transactions and insurance claims are fraudulent, etc. The relative rarity of a class in the real world is usually reflected in the data available for analysis. A file containing data on 100,000 borrowers might include no more than 4,000 bankrupts for a mainstream lender.

Such unbalanced data sets are quite natural for SPM and pose no special problems for analysis. This is one of SPM's great strengths and differentiates SPM from other analytical tools that do not perform well unless the data are "balanced".

The SPM default method for dealing with unbalanced data is to conduct all analyses using measures that are relative to each class. In our example of 100,000 records containing 4,000 bankrupts, we will always work with ratios that are computed relative to 4,000 for the bankrupts and relative to 96,000 for the non-bankrupts. By doing everything in relative terms we bypass completely the fact that one of the two groups is 24 times the size of the other.

This method of bookkeeping is known as PRIORS EQUAL. It is the default method used for classification models and it often works supremely well. This is the setting we almost always use to start our exploration of new data. This default setting frequently gives the most satisfactory results because each class is treated as equally important for the purpose of achieving classification accuracy.

Priors are usually specified as fractions that sum to 1.0. In a two-class problem EQUAL priors would be expressed numerically as 0.50, 0.50, and in a three-class problem they would be expressed as 0.333, 0.333, 0.333.

- PRIORS may look like weights but they are not weights. Priors reflect the relative size of a class after SPM has made its adjustments. Thus, PRIORS EQUAL assures that no matter how small a class may be relative to the other classes, it will be treated as if it were of equal size.
- PRIORS DATA (or PRIORS LEARN or PRIORS TEST) makes no adjustments for relative class sizes. Under this setting small classes will have less influence on the SPM tree and may even be ignored if they interfere with the SPM's ability to classify the larger classes accurately.

✓ PRIORS DATA is perfectly reasonable when the importance of classification accuracy is proportional to class size. Consider a model intended to predict which political party will be voted for with the alternatives of Conservative, Liberal, Fringe1 and Fringe2. If the fringe parties together are expected to represent about 5% of the vote, an analyst might do better with PRIORS DATA, allowing SPM to focus on the two main parties for achieving classification accuracy.

Six different Priors options are available, as follows:

- ◆ **EQUAL** Equivalent to weighting classes to achieve BALANCE (default setting)
- ◆ **DATA** Larger classes are allowed to dominate the analysis
- ◆ **MIX** Priors set to the average of the DATA and EQUAL options
- ◆ **LEARN** Class sizes calculated from LEARN sample only
- ◆ **TEST** Class sizes calculated from TEST sample only
- ◆ **SPECIFY** Priors set to user-specified values

Model Setup

Model Limits | Categorical Costs | Force Split Priors | Constraints Penalty | Testing Lags | Select Cases Automate | Best Tree | Method

Priors For: TARGET

- ☒ EQUAL: All categories have equal probability
- ☐ LEARN: Probabilities match learn sample frequencies
- ☐ TEST: Probabilities match test sample frequencies
- ☐ DATA: Probabilities match total sample frequencies
- ☐ MIX: The average of EQUAL and DATA
- ☐ SPECIFY: Specify priors for each level

Specify Priors

Target Class	Priors
0	1
1	1

Automatic Best Predictor Discovery

- ☒ Off
- ☐ Discover only
- ☐ Discover and run

Maximum variables for each class: 8

After Building a Model: Save Grove...

Number of Predictors in Model: 11

Analysis Engine: CART Decision Tree

Cancel Continue Start

You can change the priors setting by clicking on the new setting's radio button. If you select SPECIFY, you must also enter a value for each level of your target variable. Simply highlight the corresponding class and type in the new value.

✓ Only the ratios of priors matter—internally, SPM normalizes the specified priors so that the values always sum to one.

- ◆ Certain combinations of priors may result in no model being built. This means that, according to this set of priors, having no model (a trivial model, which makes the same class assignment everywhere) is no worse than having a tree. Knowing that your target cannot be predicted from your data can be very valuable and in some cases is a conclusion you were looking for.

- If the target variable contains >5000 values, you must use the Command Language for user-specified priors.

## Penalty tab

✓ This section uses CART® to demonstrate how penalties work, but they are available for other Analysis Engines too.

```
PENALTY <var>=<penalty>, /MISSING=<mis_val1>,<mis_val2> ,
```

```
HLC=<hlc_val1>,<hlc_val2>
```

```
PENALTY /MISSING=1,1, HLC=1,1
```

The penalties available in SPM were introduced by Salford Systems starting in 1997 and represent important extensions to machine learning technology. Penalties can be imposed on variables to reflect a reluctance to use a variable as a predictor. Of course, the modeler can always exclude a variable; the penalty offers an opportunity to permit a variable into the model but only under special circumstances. The three categories of penalty are:

- ◆ Missing Value Penalty: Predictors are penalized to reflect how frequently they are missing. The penalty is recalculated for every node in the tree.
- ◆ High Level Categorical Penalty: Categorical predictors with many levels can distort a tree due to their explosive splitting power. The HLC penalty levels the playing field.
- ◆ Predictor Specific Penalties: Each predictor can be assigned a custom penalty.

In CART®, a penalty will lower a predictor's improvement score, thus making it less likely to be chosen as the primary splitter. Penalties specific to particular predictors are entered in the left panel next to the predictor name and may range from zero to one inclusive.

Penalties for missing values (for categorical and continuous predictors) and a high number of levels (for categorical predictors only) can range from "No Penalty" to "High Penalty" and are normally set via the slider on the **Penalty** tab, as seen in the following illustration.



**Model Setup**

Model | Categorical | Force Split | Constraints | Testing | Select Cases | Best Tree | Method  
Limits | Costs | Priors | **Penalty** | Lags | Automate

**Penalty**

**Penalties on Variables**

Variable	Value
AGE	0.00
CREDIT_LIMIT	0.00
EDUCATION\$	0.00
GENDER	0.00
HH_SIZE	0.00
INCOME	0.00
MARITAL\$	0.00
N_INQUIRIES	0.00
OCCUP_BLANK	0.00
OWNRENT\$	0.00
TIME_EMPLOYED	0.00

Sort: Alphabetically | Reset to zero

**Missing Penalty**

No Penalty | High Penalty  
Set 1 | Penalty = 0.00

**High Level Categorical Penalty**

No Penalty | High Penalty  
Set 1 | Penalty = 1.00

Advanced

**Automatic Best Predictor Discovery**

☒ Off  
☐ Discover only  
☐ Discover and run  
Maximum variables for each class: 8

After Building a Model  
Save Grove...

Number of Predictors in Model: 11

Analysis Engine  
CART Decision Tree

Cancel | Continue | Start

In the screenshot above, we have set both the Missing Values and the HLC penalties to the frequently useful values of 1.00. Advanced users wishing control over the missing value and high-level categorical penalty details can click the **[Advanced]** button.

### Penalties on Variables

In CART®, the penalty specified is the amount by which the variable's improvement score is reduced before deciding on the best splitter in a node. Imposing a 0.10 penalty on a variable will reduce its improvement score by 10%. You can think of the penalty as a “handicap”: with a 0.10 penalty we are saying that the penalized variable must be at least 10% better than any other variable to qualify as the splitter.

✓ Penalties may be placed to reflect how costly it is to acquire data. For example, in database and targeted marketing, selected data may be available only by purchase from specialized vendors. By penalizing such variables we make it more difficult for such variables to enter the tree, but they will enter when they are considerably better than any alternative predictor.

✓ Predictor-specific penalties have been used effectively in medical diagnosis and triage models. Predictors that are “expensive” because they require costly diagnostics, such as CT scans, or that can only be obtained after a long wait (say 48 hours for the lab results), or that involve procedures that are unpleasant for the patient, can be penalized. If penalizing these variables leads to models that are only slightly less predictive, the penalties help physicians to optimize diagnostic procedures.

☛ Setting the penalty to one is equivalent to effectively removing this predictor from the predictor list.

### Missing Values Penalty

In CART® at every node every predictor competes to be the primary splitter. The predictor with the best improvement score becomes one. Variables with no missing values have their improvement scores computed using all the data in the node, while variables with missings have their improvement scores calculated using only the subset with complete data. Since it is easier to be a good splitter on a small number of records, this tends to give quite a big advantage to variables with missing values. To level the playing field, variables can be penalized in proportion to the degree to which they are missing. This proportion missing is calculated separately at each node in the tree. For example, a variable with good data for only 30% of the records in a node would receive only 30% of its calculated improvement score. In contrast, a variable with good data for 80% of the records in a node would receive 80% of its improvement score. A more complex formula is available for finer control over the missing value penalty using the Advanced version of the **Penalty** tab.

Missing Penalty--Fract. of Improvement Kept

Fraction  x (fractionNotMissing)

Suppose you want to penalize a variable with 70% missing data very heavily, while barely penalizing a variable with only 10% missing data. The **Advanced** tab lets you do this by setting a fractional power on the percent of good data. For example, using the square root of the fraction of good data to calculate the improvement factor would give the first variable (with 70% missing) a .55 factor and the second variable (with 10% missing) a .95 factor.

The expression used to scale improvement scores is:

$$S = a * (\text{proportion\_not\_missing})^b$$

The default settings of  $a = 1$ ,  $b = 0$  disable the penalty entirely; every variable receives a factor of 1.0. Useful penalty settings set  $a = 1$  with  $b = 1.00$ , or 0.50. The closer  $b$  gets to 0 the smaller the penalty. The fraction of the improvement kept for a variable is illustrated in the following table, where "%good" = the fraction of observations with non-missing data for the predictor.

%good	b=.75	b=.50
0.9	0.92402108	0.948683298
0.8	0.84589701	0.894427191
0.7	0.76528558	0.836660027
0.6	0.68173162	0.774596669
0.5	0.59460355	0.707106781
0.4	0.50297337	0.632455532
0.3	0.40536004	0.547722558
0.2	0.29906975	0.447213595
0.1	0.17782794	0.316227766

Looking at the bottom row of this table we see that if a variable is only good in 10% of the data it would receive 10% credit if  $b=1$ , 17.78% credit if  $b=.75$ , and 31.62% credit if  $b=.50$ . If  $b=0$ , the variable would receive 100% credit because we would be ignoring its degree of missingness.

✓ In most analyses we find that the overall predictive power of a tree is unaffected by the precise setting of the missing value penalty. However, without any missing value penalty you might find heavily missing variables appearing high up in the tree. The missing value penalty thus helps generate trees that are more appealing to decision makers.

## High-Level Categorical Penalty

Categorical predictors present a special challenge to decision trees. Because a 32-level categorical predictor can split a data set in over two billion ways, even a totally random variable has a high probability of becoming the primary splitter in many nodes. Such spurious splits will not prevent the SPM from eventually detecting the true data structure in large datasets, but they make the process inefficient. First, they add unwanted nodes to a tree, and as they promote the fragmentation of the data into added nodes, the reduced sample size as we progress down the tree makes it harder to find the best splits.

To protect against this possibility, SPM offers a high-level categorical predictor penalty used to reduce the measured splitting power. On the **Basic Penalty** dialog, this is controlled with a simple slider.

The **Advanced Penalty** dialog allows access to the full penalty expression. The improvement factor is expressed as:

$$S = \min \left\{ 1, 1 + c * \left( \left( \frac{\log_2[\text{node\_size}]}{N\_categories - 1} \right)^d - 1 \right) \right\}$$

By default,  $c = 1$  and  $d = 0$ ; these values disable the penalty. We recommend that the categorical variable penalty be set to ( $c = 1$ ,  $d = 1$ ), which ensures that a categorical predictor has no inherent advantage over a continuous variable with unique values for every record.

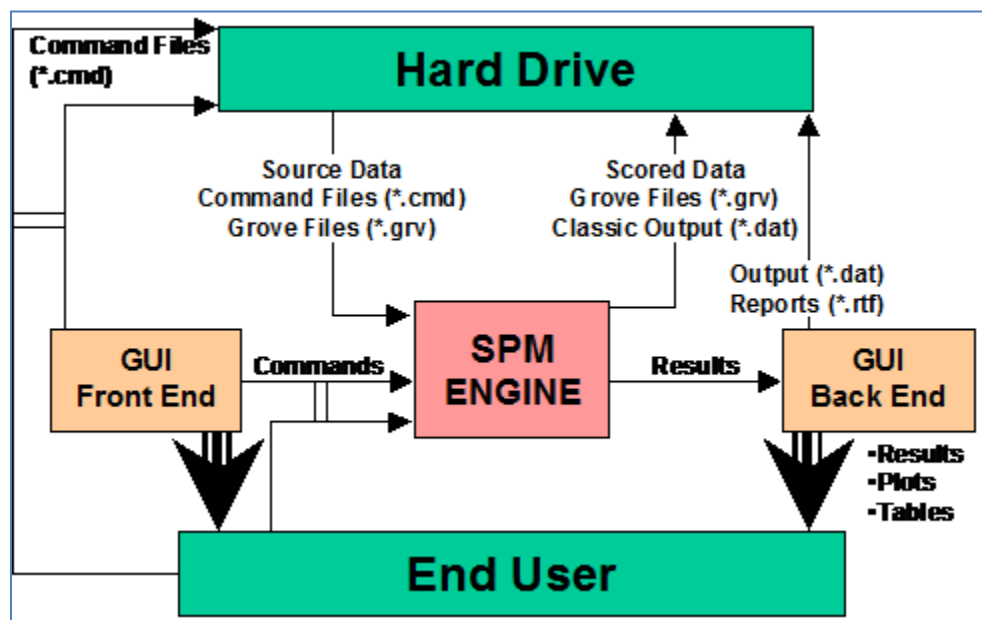
- ⚙️ The missing value and HLC penalties apply uniformly for all variables. You cannot set different HLC or missing value penalties to different variables. You choose one setting for each penalty and it will apply to all variables.
- ✓ You can set variable-specific penalties and general missing value and HLC penalties. Thus, if you have a categorical variable Z that is also sometimes missing you could have all three penalties applying to this variable at the same time.

## Working with the SPM® Command Language

### Introduction to the Command Language

This chapter describes the situations in which a GUI user may want to take advantage of the two alternative modes of control in SPM, command-line and batch, and provides a guide for each of the modes. For users running SPM non-GUI (particularly on a UNIX platform), this chapter contains a detailed guide to command syntax and options and describes how GUI version may assist you in learning the command-line language.

The following picture illustrates common channels of interaction between a user and SPM.



First, note that SPM itself is a sophisticated analytical engine controlled via command sequences sent to its input that can generate various pieces of output when requested.

An inexperienced user can communicate with the engine via the GUI front and back ends. The GUI front end provides a set of setup screens and “knows” how to issue the right command sequences according to the user’s input. It is also possible to request the GUI front end to save command sequences into an external command file. The GUI back end captures the results produced by the engine and displays various plots, tables, and reports. Most of these can be directly saved to the hard drive for future reference. The whole cycle (marked by the large arrows in the diagram) is completely automated so that the user does not need to worry about what is taking place underneath.

A more demanding user may write separate command files with or without the help of the GUI front end. This feature is especially attractive for audit trail or various process automation tasks. Given that the current release of SPM for UNIX is entirely command-line driven, the user running SPM for UNIX will fall into this category.

The SPM engine performs the following essential operations.

- ◆ Read data for modeling or scoring
- ◆ Read grove files for scoring and translation.

- ◆ Read and executes command files.
- ◆ Write new data composed of original data and scoring information.
- ◆ Save models into grove files.
- ◆ Save classic text output.

The following sections provide in-depth discussions for users who have chosen to use command line controls.

## Alternative Control Modes in SPM® for Windows

In addition to controlling SPM with the graphical user interface (GUI), you can control the program via commands issued at the command prompt or via submission of a command (.cmd) file. This built-in flexibility enables you to avoid repetition, create an audit trail, and take advantage of the BASIC programming language.

### Avoiding Repetition

You may need to interact with several dialogs to define your model and set model estimation options. This is particularly true when a model has a large number of variables or many categorical variables, or when more than just a few options must be set to build the desired model. Suppose that a series of runs are to be accomplished, with little variation between each. A batch command file, containing the commands that define the basic model and options, provides an easy way to perform many SPM command functions in one user step. For each run in the series, the “core” batch command file can be submitted to SPM, followed by the few graphical user interface selections necessary for the particular run in question.

### Creating an Audit Trail

The Command Log window can help you create an audit trail when one is needed. Imagine not being able to reproduce a particular analysis track, perhaps because the specific set of options used to create a model (e.g., the name of the data set itself) was never recorded. The updated command log provides you with the entire command set necessary to exactly reproduce your analysis, provided the input data do not change.

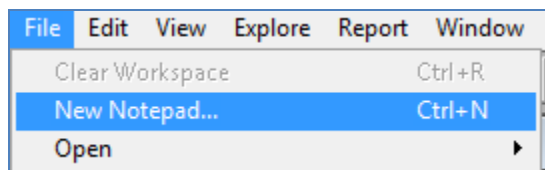
### Taking Advantage of SPM’s Built-In Programming Language

SPM offers an integrated BASIC programming language that allows the user to define new variables, modify existing variables, access mathematical, statistical and probability distribution functions, and define flexible criteria to control case deletion and the partitioning of data into learn and test samples. Small BASIC programs are defined near the beginning of your analysis session, after you have opened your dataset but before you estimate (or apply) the model and usually before defining the list of predictor variables. BASIC is powerful enough that in many cases users do not need to resort to a stand-alone data manipulation program.

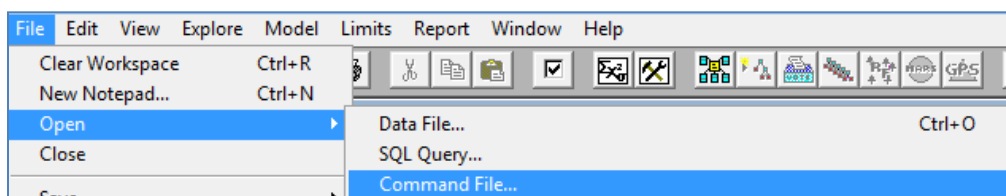
## Open a Notepad

Notepad window facilitates both creating and executing the scripts or Command Files. To create a new Command File you can

- ◆ Create **New Notepad** from main menu.



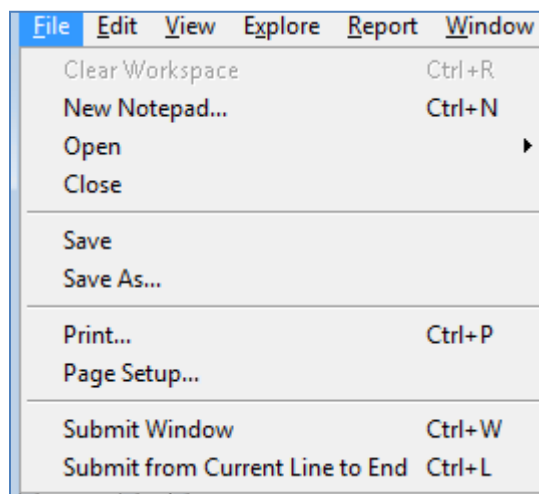
- ✓ Note that you can use the **[Ctrl]+[N]** shortcut anywhere in the application.
- ◆ Open an existing Command File using the main menu.



Alternatively, there's an **[Open Command File]** button  on the main toolbar.

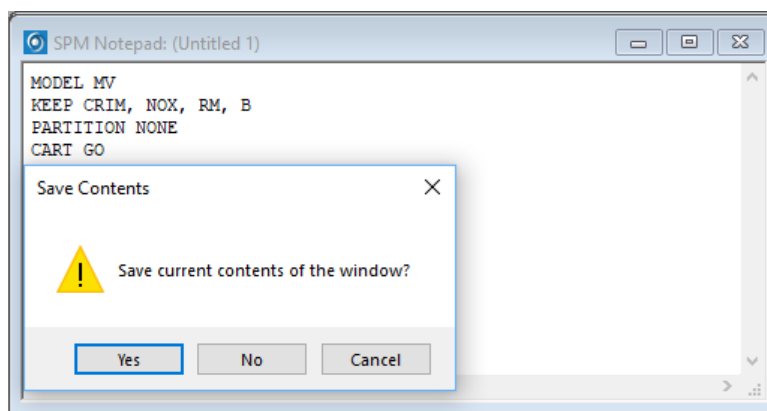
## Document Operations

When in a **Notepad** window, you can access all the operations on a Command File via the **File** menu of main menu:




In addition to regular operations with a document, you can Submit commands from a current Notepad to SPM engine. There's an option to submit all the commands, or just the commands from the line where cursor is positioned till the end of the Command File.

Submit Window command can also execute just a selected range of commands. If there's text selected in a Notepad, the application will prompt whether only the commands in the selection should be executed.



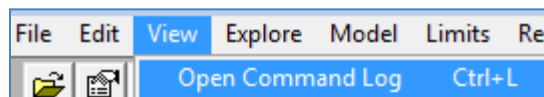
## Running Existing Command Files

You don't have to have a command file open in a **Notepad** to run it. **File>Submit Command File** main menu item (or  button on the toolbar) allows you to submit an existing command file to the engine.

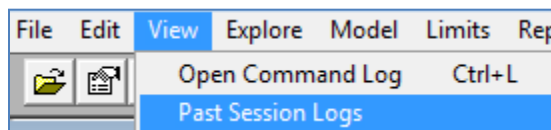
- ☛ All the GUI results produced by the SPM engine as a result are suppressed. This is very convenient when you need to build a considerable number of models and you would prefer to explore them later by opening saved Grove files.

## Command Log

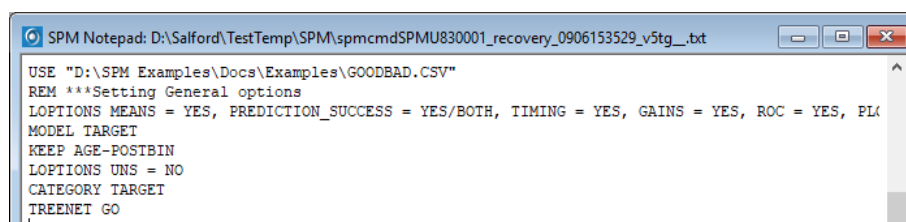
The Command Log is a special kind of **Notepad** window. It is tailored to give access to the log of commands issued during the current session of the application. You can access the command log from anywhere in the application via the application's main menu or using the **[Ctrl]+[L]** keyboard shortcut.



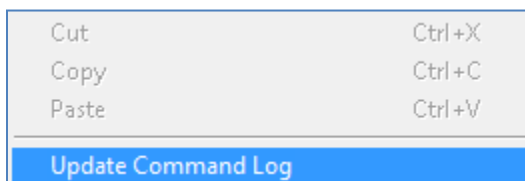
- ✓ There's a convenient way to browse commands logged from past sessions. These logs can be accessed via the **View>Past Sessions Log** main menu command.



Once a Command Log is open you can edit the content, execute commands and otherwise use it as a regular Notepad. Thus, the Command Log does not get updated automatically when SPM executes new commands. Instead, the Command Log title shows how long ago the last command log was captured.



To refresh the Command Log, **[Right-Click]** anywhere in the **Command Log** window and select Update Command Log menu item:



⚠ All the modifications to the **Command Log** window will be lost during the update. To preserve the edits they must be copied to a regular **Notepad** window.

✓ This feature is helpful for learning command syntax.

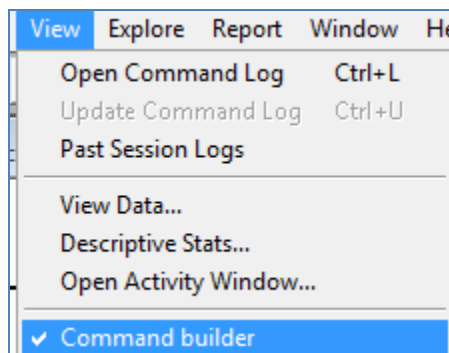
✓ You may save the Command Log into a command file on your hard drive using the **File>Save** menu. CART® session, the resulting command file will contain the audit trail of the entire session.

## Authoring Command Files

One of the common scenarios to author a command file is to take a Command Log and extract the relevant commands. This way you can reproduce the analysis you did at any time in the future. This is also a good starting point to acquire practical understanding of the SPM Command Language. Even most experienced users in many cases prefer using the **Model Setup** window to prepare a sketch of the command file and then take generated command log as a basis for the script.

When working with a script, the **Command Builder** window comes in handy to lookup command syntax, variables available in the current dataset, and code snippets for typical tasks.

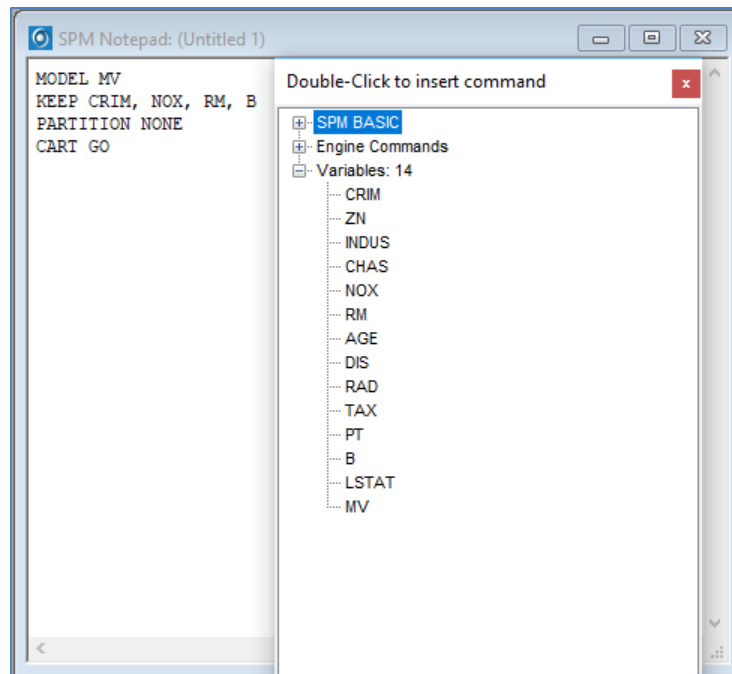
The **Command Builder** window can be turned ON and OFF via **View** menu item of the main menu.



## Command Builder content structure

Lookup information in the Command Builder is organized into 3 major sections.

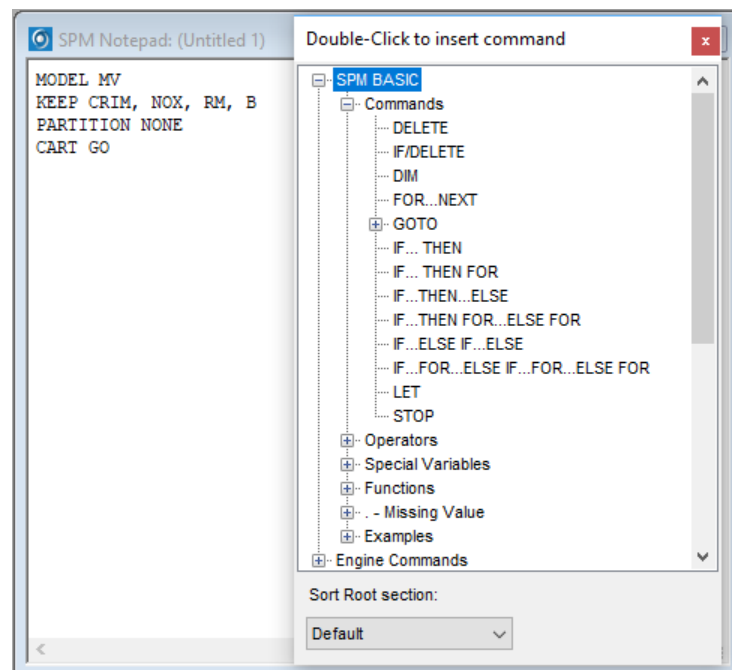




### SPM BASIC language

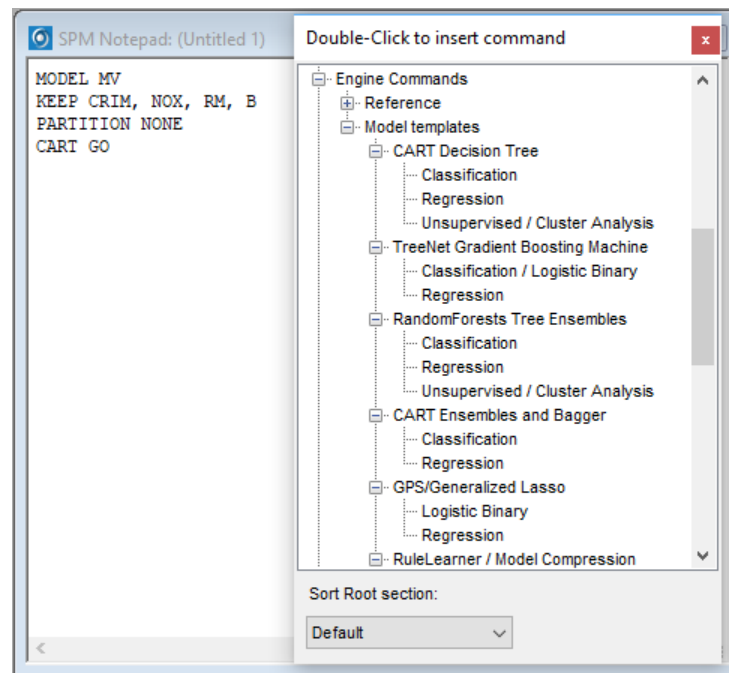
The SPM BASIC section contains reference and examples for built-in BASIC language. The language facilitates data manipulation. It is quite effective in prepping the data for analysis. Please refer to the **SPM BASIC Guide** for more detail.

This lookup information section provides reference to all the language elements as well as some examples.



### The SPM Engine Commands section

This lookup information section contains reference to the commands to perform predictive analytics tasks.



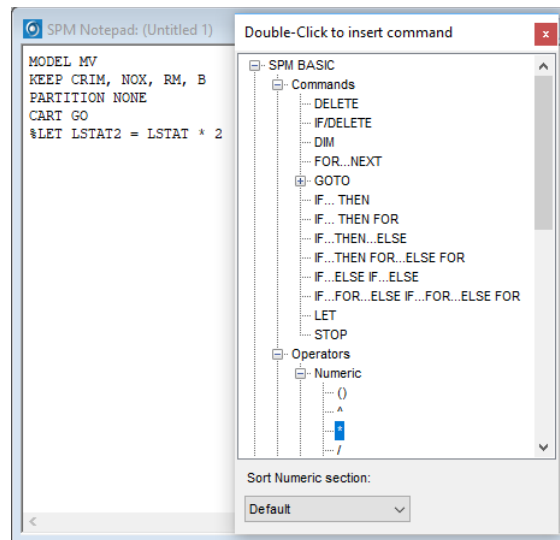
The section contains command reference and source code snippets for common analysis types supported by the engine. These code snippets are one of the ways to quickly get started with authoring Command Files.

### Variables section

If a dataset is currently open in the application, the Variables section lists all available variables. This is quite convenient when one needs to supply a particular variable name as an argument to a command.

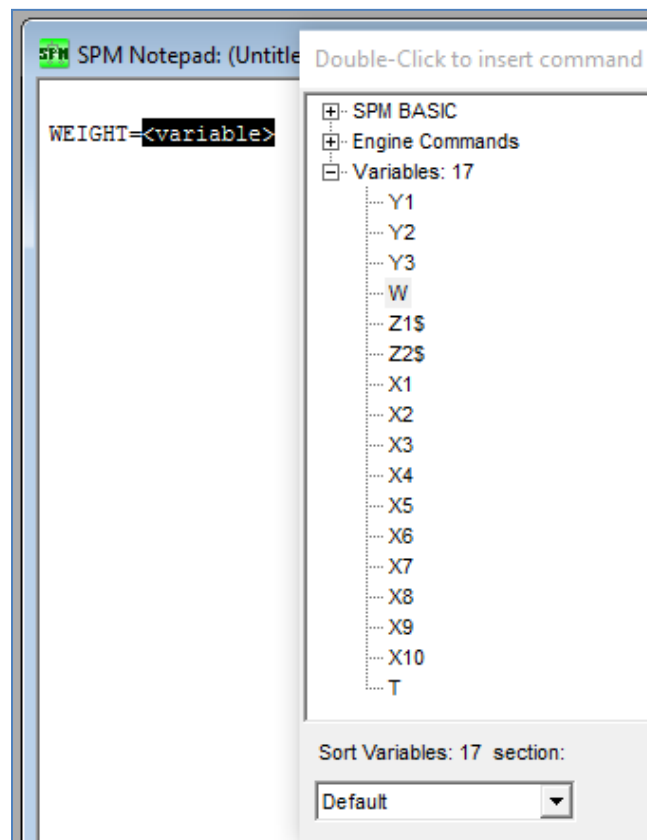
### Using Command Builder

A double-click of the mouse on a specific element in Command Builder inserts a corresponding code snippet into a Notepad. There are two kinds of elements. Some elements, for example, Numeric operators in CART® BASIC, need to be part of an expression. Instead, they do not make sense on a separate line. So when you double-click on such an element it is inserted at current input cursor position.

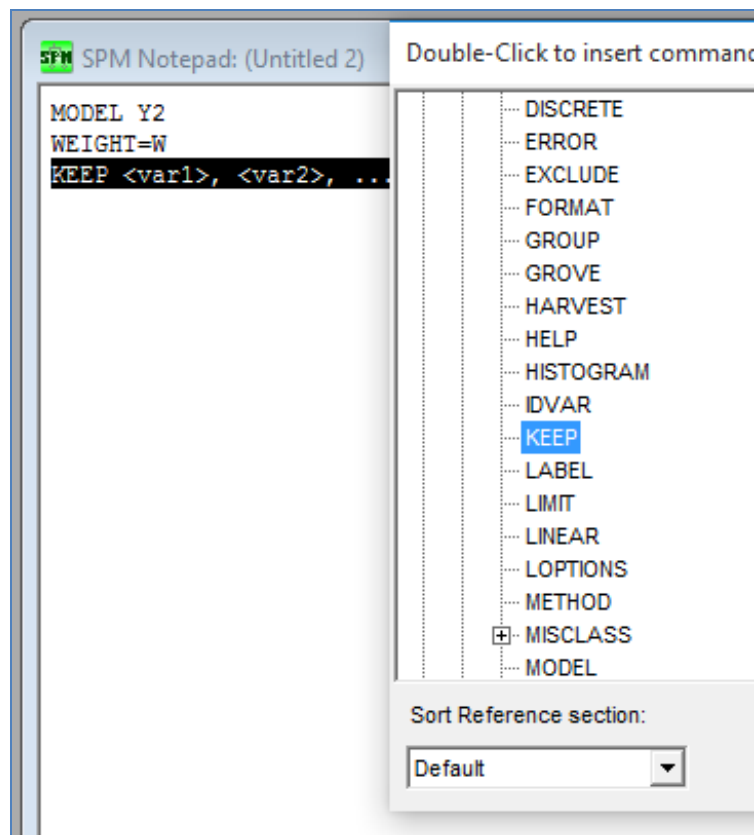


All the elements from the Variables section are also inserted at the cursor position.

- ✓ A useful trick is to select a placeholder text and double-click on the variable name of interest.



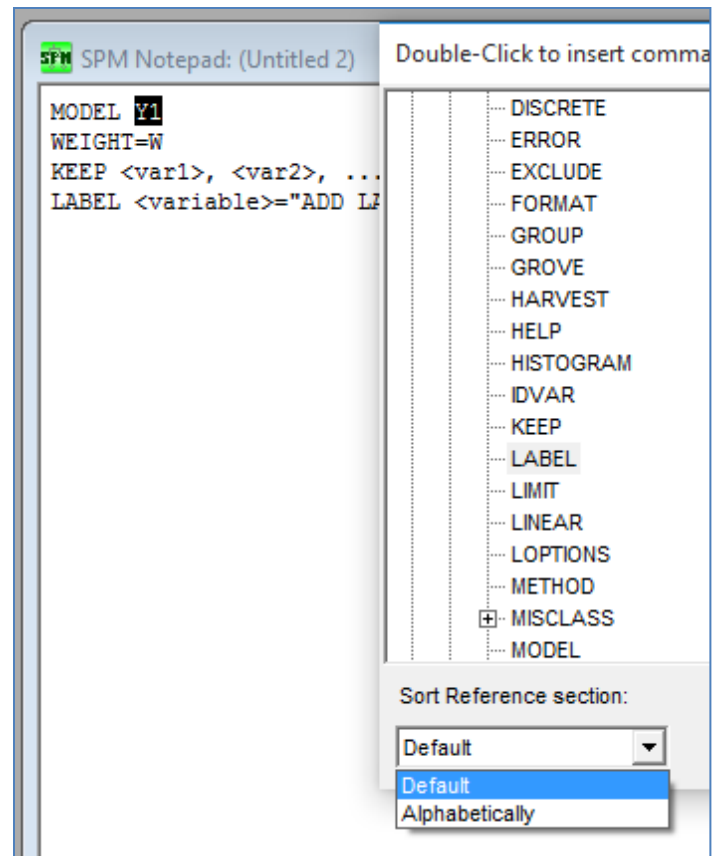
In contrast, other elements like the SPM Engine commands occupy the entire line. So when double-clicked, they are inserted as a separate line after the line where the cursor currently is.



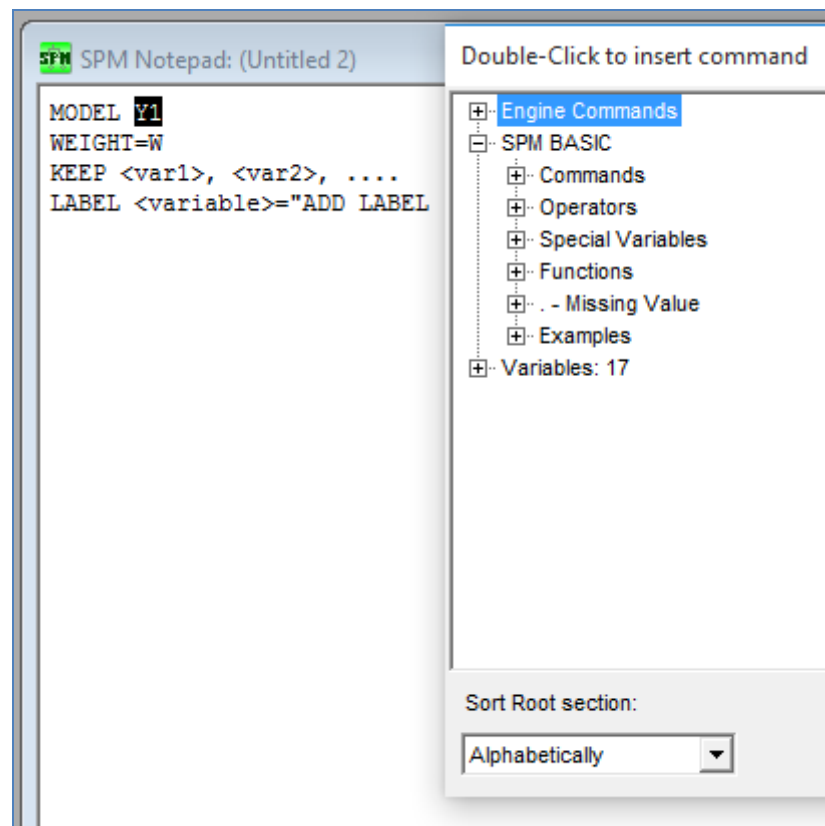
“Separate line” elements do not replace selected text. This allows you to double-click several commands and the placeholders will appear on consecutive lines. This reflects the process of authoring a Command File line by line.

### Sorting elements and variables

When an element of Command Builder tree is selected, the Sort combo box at the bottom of the window allows re-ordering of its siblings in the sub-section. The label above the combo box reflects the name of the parent section. In some sections, like Reference ones, elements are in alphabetical order by default but there are sections where elements are arranged in a logical order. For example, the default order of elements in the SPM BASIC language section helps outline the language structure.



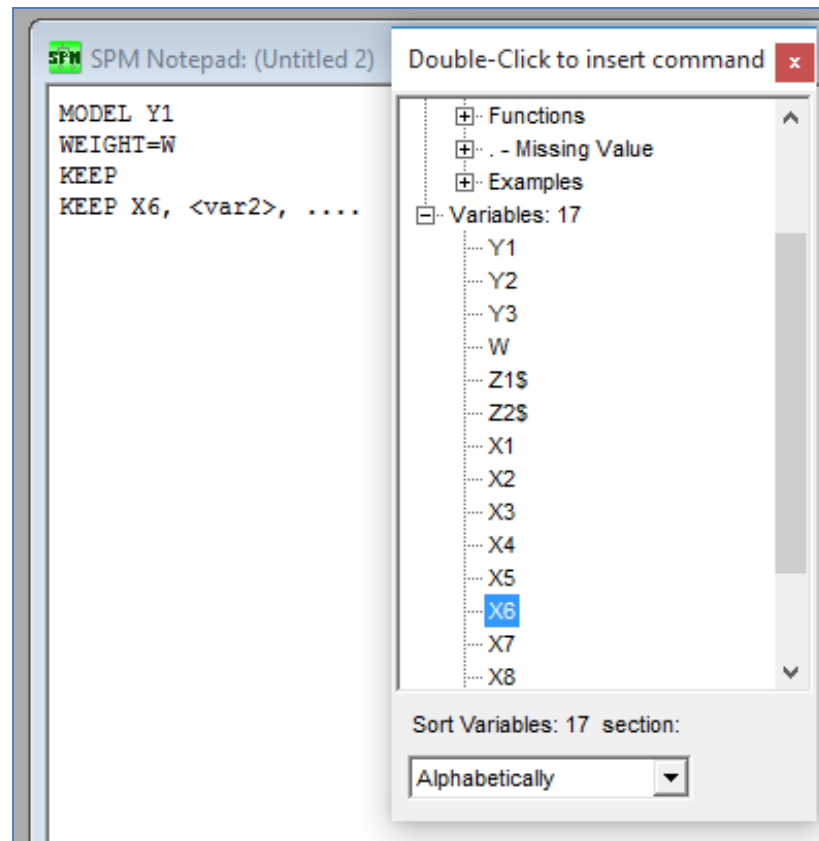
To locate the required element faster, you can change the order of elements to alphabetical.



This feature comes in handy when working with a variables list. In some datasets, the order of columns makes logical sense. In others, however, variable naming convention and the sheer number of variables makes navigation through variables listed in natural order almost impossible. It is very easy to locate a known variable in a list sorted alphabetically.

To view the **Variables list** in alphabetical order:

- ◆ **Expand** Variables section.
- ◆ Make sure one of the variables is selected. You should see "Sort Variables" above the Sort combo box.
- ◆ **Select** between Default and Alphabetical order.



## Command Syntax Conventions

The SPM command syntax follows the following conventions:

- ◆ Commands are case insensitive.
- ◆ Each command takes one line starting with a reserved keyword.
- ◆ A command may be split over multiple lines using a comma “,” as the line continuation character.
- ◆ No line may exceed 256 characters.

Please refer to the **Command Language Guide** for more details.

## Example: A sample classification run

The contents of a **CLASS.CMD** sample command file is shown below. This file is included with the SPM installation. Line-by-line descriptions and comments follow.

```

SPM Notepad: C:\Program Files\Salford Systems\Salford Predictive Modeler 8.0\Sample Data\CL...
| REM*****
| REM SAMPLE CLASSIFICATION RUN
| REM*****
| REM =INPUT/OUTPUT FILES=
| REM*****
1>> USE "C:\Program Files\Salford Systems\Salford Predictive Modeler\Sample Data\sample.csv"
2>> GROVE "class.grv"
3>> OUTPUT "class.dat"
| REM*****
| REM =OPTIONS SETTINGS=
| REM*****
4>> BOPTIONS SURROGATES=5 PRINT=5, COMPETITORS=5, TREELIST=10,
| BRIEF, SERULE=0, IMPORTANCE=1, MISSING=NO
5>> LOPTIONS MEANS=YES, NOPRINT=NO, PREDICTIONS=YES/BOTH,
| TIMING=YES, PLOTS=YES, GAINS=NO, ROC=NO
6>> FORMAT=7/UNDERFLOW
7>> LIMIT MINCHILD=100, ATOM=200, NODES=50000, DEPTH=50,
| LEARN=100000, TEST=100000, SUBSAMPLE=100000
| REM*****
| REM =MODEL SETUP=
| REM*****
8>> MODEL Y2
9>> CATEGORY Y2
10>> PRIORS SPECIFY -1 = .5, 1 = .5
11>> Misclassify Cost = 2 Classify 1 as -1
12>> Misclassify Cost = 3 Classify -1 as 1
13>> KEEP Z1$, Z2$, X1, X2, X3, X4, X5, X6, X7, X8, X9, X10
14>> PARTITION SEPVAR = T
15>> METHOD GINI POWER = 0
16>> WEIGHT W
| PENALTY / MISSING = 1, 1, HLC = 1, 1
| REM*****
| REM =BUILD MODEL=
| REM*****
17>> CART GO
| REM*****
| REM =QUIT SPM=
| REM*****
18>> QUIT
| <

```

All lines starting with **REM** are comments and will be ignored by the command parser.

We have marked commands of special interest with **RED** numbers.

#### Commands 1 through 3 control which files will be used or created.

- 1>> The **USE** command specifies the data set to be used in modeling.
- 2>> The **GROVE** command specifies the grove file to be created in the current directory. .
- 3>> The **OUTPUT** command specifies the file to save Classic Output to.

#### Commands 4 through 7 control various engine settings.

- 4>> The **BOPTIONS** command sets important model-building options.
- 5>> The **LOPTIONS** command sets various reporting options.
- 6>> The **FORMAT** command sets the number of decimal digits to be reported.
- 7>> The **LIMIT** command sets various limits, including how many observations and variables are allowed, the largest tree size allowed, the largest tree depth, the smallest node size allowed, and whether sub-sampling will be used.

You can omit the commands above in your script unless you need fine control over the SPM engine. In this case, reasonable defaults will be used.

#### Commands 8 through 16 specify model settings that usually change from run to run.



**8>>** The **MODEL** command sets the target variable.

**9>>** The **CATEGORY** command lists all categorical numeric variables.

✓ Character variables are always treated as categorical and need not be listed here.

✓ For classification models, numeric targets must be declared categorical.

**10>>** The **PRIORS** command sets the prior probabilities for all target classes.

◆ The commands **PRIORS DATA** or **PRIORS EQUAL** are useful aliases for common situations.

**11>>** The **MISCLASSIFY** commands set the cost matrix.

✓ Only non-unit costs need to be introduced explicitly.

✓ There will be as many **MISCLASSIFY** commands as there are non-unit cost cells in the cost matrix.

**12>>** The **KEEP** command sets the predictor list.

☛ This command is NOT cumulative.

**13>>** The **PARTITION** command specifies the LEARN/TEST partition method.

✓ In this example, a dummy variable T separates the TEST part (T=1) from the LEARN part (T=0).

**14>>** The **METHOD** command sets the improvement calculation method.

✓ The commands **METHOD GINI** and **METHOD TWOING** are the most widely-used methods.

✓ **POWER>0** results in more even splits.

**15>>** The **WEIGHT** command sets the weight variable, if applicable.

**16>>** The **PENALTY** command induces additional penalties on missing-value and high-level categorical predictors.

✓ We recommend always using the listed penalties.

**The remaining two commands are “action” commands.**

**17>>** The **BUILD** command signals the SPM engine to start the model-building process.

**18>>** The **QUIT** command terminates the program.

☛ Anything following **QUIT** in the command file will be ignored.

Multiple runs may be conducted using a single command file by inserting additional commands.

### Example: A sample regression run

The contents of a **REG.CMD** (or **REGRESS.CMD**) sample command file are shown below. This file is included with the SPM installation. Line-by-line descriptions and comments follow.

All lines starting with **REM** are comments and will be ignored by the command parser.

We have marked commands of special interest with **RED** numbers.

If you have already mastered the classification run described in the previous section, note that the only differences are:

- ◆ The requested output file names have been changed in lines 2 and 3.
- ◆ The **MODEL** command (line 8) now uses a continuous target.
- ◆ The **CATEGORY** command (line 9) no longer lists our target.
- ◆ The **PRIORS** and **Misclassify** commands are no longer needed.
- ◆ The **METHOD** is changed to **LS** (least squares, line 12).

A detailed description of each command in this command file is provided below.

**Commands 1 through 3 control which files will be used or created during this run.**

- 1>>** The **USE** command specifies the data set to be used in modeling.
- 2>>** The **GROVE** command specifies the grove file to be created in the current directory.
- 3>>** The **OUTPUT** command specifies the file to save Classic Output to.

82

**Commands 4 through 7 control various engine settings.**

- 4>>** The **BOPTIONS** command sets important model-building options.
- 5>>** The **LOPTIONS** command sets various reporting options.
- 6>>** The **FORMAT** command sets the number of decimal digits to be reported.
- 7>>** The **LIMIT** command sets various limits, including how many observations and variables are allowed, the largest tree size allowed, the largest tree depth, the smallest node size allowed, and whether sub-sampling will be used.

For the most part, these commands should be left unchanged unless you need fine control over the SPM engine. A more detailed description can be found in the Appendix III Command Reference.

**Commands 8 through 16 specify model settings that usually change from run to run.**

- 8>>** The **MODEL** command sets the target variable.
- 9>>** The **CATEGORY** command lists all categorical numeric variables.
  - ✓ Character variables are always treated as categorical and need not be listed here.
  - ✓ In regression runs, the target is always a continuous numeric variable.
- 10>>** The **KEEP** command sets the predictor list.
  - ☛ This command is NOT cumulative.
- 11>>** The **PARTITION** command specifies the LEARN/TEST partition method.
  - ✓ In this example, a dummy variable T separates the TEST part (T=1) from the LEARN part (T=0).
- 12>>** The **METHOD** command sets the loss function.
  - ✓ For regression CART® models, LS is least squares loss and LAD is least absolute deviation loss.
- 13>>** The **WEIGHT** command sets the weight variable if applicable.
- 14>>** The **PENALTY** command induces additional penalties on missing-value and high-level categorical predictors.
  - ✓ We recommend always using the listed penalties.

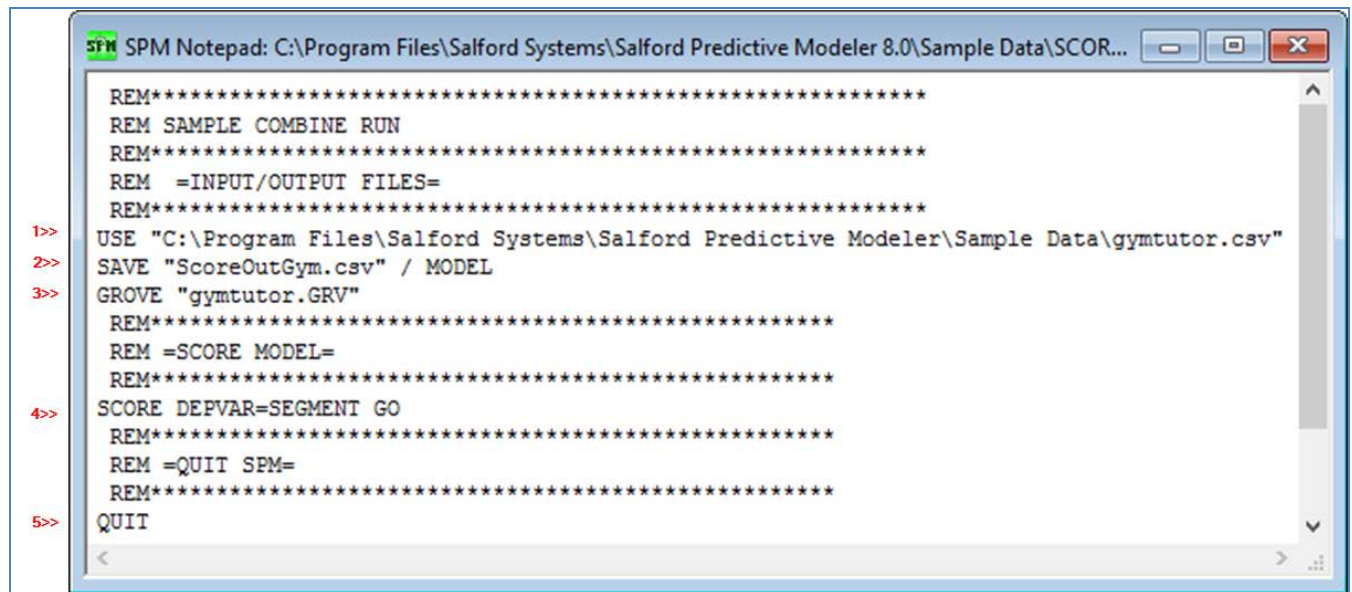
**The remaining two commands are “action” commands.**

- 15>>** The **BUILD** command signals the SPM engine to start the model-building process.
- 16>>** The **QUIT** command terminates the program.
  - ✓ Anything following QUIT in the command file will be ignored.

Multiple runs may be conducted using a single command file by inserting additional commands.

**Example: A sample scoring run**

The contents of a **SCORE.CMD** sample command file are shown below. This file is included with the SPM installation. Line-by-line descriptions and comments follow.

A screenshot of a Notepad window titled "SPM Notepad: C:\Program Files\Salford Systems\Salford Predictive Modeler 8.0\Sample Data\SCOR...". The window contains a text file with several lines of commands, some of which are preceded by red line numbers (1>>, 2>>, 3>>, 4>>, 5>>). The commands are: REM (multiple lines), USE "C:\Program Files\Salford Systems\Salford Predictive Modeler\Sample Data\gymtutor.csv", SAVE "ScoreOutGym.csv" / MODEL, GROVE "gymtutor.GRV", REM (multiple lines), SCORE DEFVAR=SEGMENT GO, REM (multiple lines), and QUIT. The text is in a monospaced font, and the window has standard Windows window controls (minimize, maximize, close) in the top right corner.

```
SPM Notepad: C:\Program Files\Salford Systems\Salford Predictive Modeler 8.0\Sample Data\SCOR...
REM*****
REM SAMPLE COMBINE RUN
REM*****
REM  =INPUT/OUTPUT FILES=
REM*****
1>> USE "C:\Program Files\Salford Systems\Salford Predictive Modeler\Sample Data\gymtutor.csv"
2>> SAVE "ScoreOutGym.csv" / MODEL
3>> GROVE "gymtutor.GRV"
REM*****
REM  =SCORE MODEL=
REM*****
4>> SCORE DEFVAR=SEGMENT GO
REM*****
REM  =QUIT SPM=
REM*****
5>> QUIT
```

A detailed description of each command in this command file is provided below.

**Commands 1 through 3 control which files will be used or created during this run.**

- 1>> The **USE** command specifies the data set to be used in modeling.
- 2>> The **SAVE** command specifies the case-by-case prediction output file. The specified file may contain case-by-case predictions, model variable values, path information, and class probabilities.
- 3>> The **GROVE** command specifies the binary grove file to be used for scoring.

**Commands 4 through 5 control various engine settings.**

- 4>> The **SCORE** command signals the SPM engine to start the scoring process.
- 5>> The **QUIT** command terminates the program.

## Introduction to Model Restoration

This guide describes this new feature in SPM 8.0 used to save and restore the “state of the session” allowing model restoration at a future point in time.

### Introductory User Story:

Morgan has just spent the last two hours working with a data file containing 2,000 variables of which only 1,600 are to be selected as predictors. Some of the variables are categorical. Morgan experimented with many different test methods, various selection methods, and experimented with defining control parameters, options, and settings. Morgan is happy with resulting model based on the last two hours of work.

### Question:

How does Morgan save the work accumulated over the last two hours and return to this stopping point at some later point in time? Morgan would also like to send the progress to colleagues who can use as a starting point for further modeling.

### Answer:

What Morgan needs is the ability to capture the state of the modeling session currently being worked with into some type of file (container). The history of a session leading up to any given point in time results in an “engine state” of the session, complete with hundreds of user parameters, options, and settings. This file will contain an “engine state” and a “session state” which will be discussed later in the walk-about.

As a result, SPM introduces the functionality of “Model Restoration”. The concept of Model Restoration is to use a file (container) to recall and restore Morgan’s modeling session. As a result, SPM enables Morgan to return to a previous modeling session, allowing Morgan and his colleagues to pick up work where they left off.

Given the user’s story above, this functionality can significantly reduce the manual burden on setting up and running models in the graphical user interface. With 1,500 variables to select, automatically identifying and selecting target, predictor, and categorical variables alone is a time saver. Considering all other factors and activities that usually take place during the modeling cycle, various time savings that may result from being able to restore engine and session settings becomes significant added value to the modeler.

### Getting Started with Model Restoration

The next stage of this walk-about is a guided tutorial through the detailed steps of setting up, creating, and saving the modeling session file. This is followed by the saving of the model file (container), and finally the recall and restore step.

## Requirements and Approaches


What are the requirements and approaches for model restoration? The following is an outline of the requirements which are discussed later in this document.

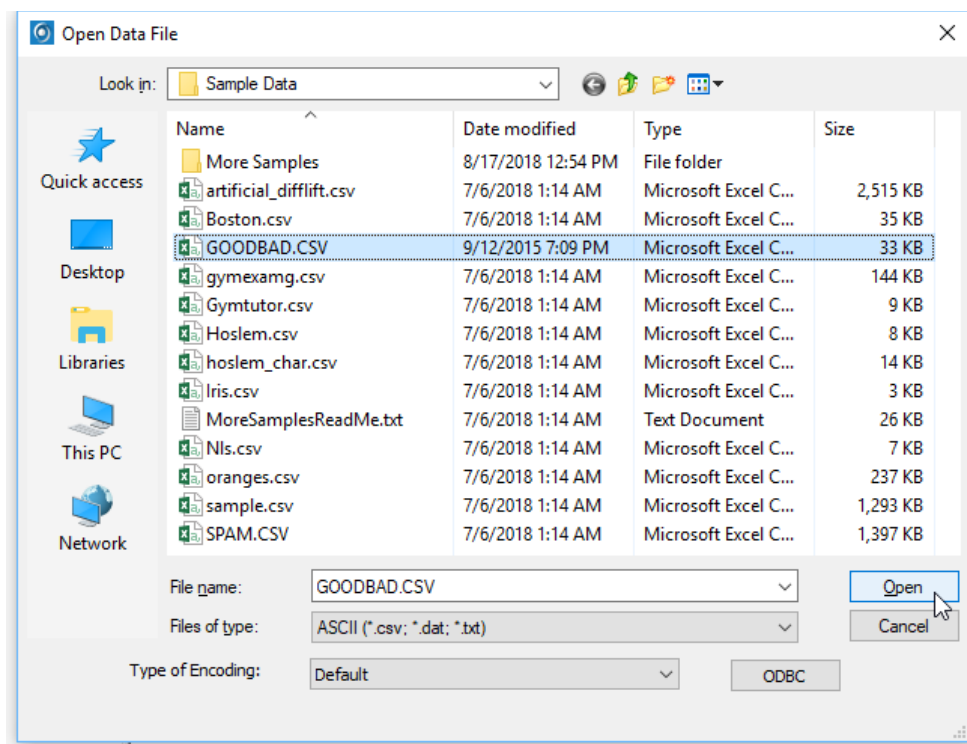
- ◆ Grove Must be Created with SPM v8.3.
  - While earlier versions of groves can still be used for scoring and model translation, this feature is not supported for grove files created in earlier versions of SPM.
- ◆ Input Data File
  - File name
  - Variable names
  - Variable ordering
  - Variable count (more, less, etc.)

## Model Restoration Tutorial

This tutorial will show you how to save and restore a SPM model. For this tutorial we will be building and saving a simple binary TreeNet® model using the data file **GOODBAD.CSV** which is used in many examples in this reference publication.

To open the input file GOODBAD . CSV:

- ◆ Select **Open>Data File...** from the **File** menu.
- ✓ You may simply click on the  button in the toolbar.
- ◆ Use the **Open Data File** dialog window to navigate to the *Sample Data* folder in the SPM installation directory.
- ◆ To speed up further access to the given location, you may want to set up the corresponding working directory first via Options dialog.
- ◆ Choose **Delimited (\*.csv,\*.dat,\*.txt)** in the **Files of type:** selection box.
- ◆ Highlight GOODBAD . CSV.



- ◆ Click the **[Open]** button to load the data set into TreeNet®.
- ☛ Make sure that the data set is not currently being accessed by another application. If it is, the data loading will fail. This is a common source of problems when dealing with Excel and ASCII files.
- ◆ In the resulting **Activity** window showing the basic info about the dataset, click the **Model...** button
- ✓ The activity window step can be skipped using the **Options** dialog.

## Setting up the Model

Controls are grouped into tabs in such a way that you need to visit only a minimal number of tabs to set up a SPM run. Simplest runs can be configured by only visiting the first Model tab.

In this tutorial we will visit only a selected set of these tabs to demonstrate some of the GUI controls which can be saved and restored in the Model Restoration process.

Tab headings are displayed in **RED** when the tab requires information from you before a model can be built. For example, when a dataset is open right after startup, the Model Setup dialog looks like this.

- ✓ **Note:** To ensure the ordering of variables match this guide, ensure you have select File Order for the Sort order.

Model Setup

Limits Costs Priors Penalty Lags Automate  
**Model** Categorical Force Split Constraints Testing Select Cases Best Tree Method

Variable Selection

Variable Name	Target	Predictor	Categorical	Weight	Aux.
TARGET	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AGE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CREDIT_LIMIT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATION\$	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GENDER	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HH_SIZE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INCOME	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITAL\$	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
N INQUIRIES	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort: File Order

Filter  
☒ All/Selected ☐ Character ☐ Numeric

Automatic Best Predictor Discovery  
☒ Off  
☐ Discover only  
☐ Discover and run Maximum variables for each class: 8

After Building a Model  
 Save Grove...

Number of Predictors in Model: 14

Analysis Engine  
 CART Decision Tree

Cancel Continue Start

The tab is red because we have not yet selected a **TARGET** variable. Without this information, SPM does not know which of the variables we are trying to analyze or predict. This is the only required step in setting up a model. Everything else is optional.



## Selecting Target and Predictor Variables

Variables are selected in the **Variable Selection** grid on the Model tab.

For this walk-about, the binary categorical variable TARGET (coded 0/1) is the target (or dependent) variable. To mark the target variable, check the box in the Target column.

Model Setup

TN Interact. | Class Weights | Penalty | Lags | Automate |  
**Model** | Categorical | Testing | Select Cases | TreeNet | Plots&Options | TN Advanced

Variable Selection

Variable Name	Target	Predictor	Categorical	Weight
TARGET	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
AGE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CREDIT_LIMIT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATION\$	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
GENDER	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HH_SIZE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INCOME	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITAL\$	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort: File Order

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Target Type: ☒ Classification/Logistic Binary ☐ Regression ☐ Unsupervised

Set Focus Class...

Target Variable: TARGET

Weight Variable:

Number of Predictors: 13

Automatic Best Predictor Discovery: ☒ Off ☐ Discover only ☐ Discover and run

Maximum variables for each class: 8

After Building a Model: Save Grove...

Number of Predictors in Model: 13

Analysis Engine: TreeNet Gradient Boosting Machine

Cancel Continue Start

Next, we indicate which variables are to be used as predictors. Many algorithms in SPM are automatic variable selectors, so you do not have to do any selection at all, but in many circumstances, you will want to exclude certain variables from the model.

✓ If you do not explicitly select the predictors SPM can use, then all variables will be screened for potential inclusion in its model.

✓ Even if all the variables available are reasonable candidates for model inclusion, it can still be useful to focus on a subset for exploratory analyses.

In this run we will select all the variables except POSTBIN. Do this by clicking on the Predictor column heading to highlight the column, checking the Select Predictors box underneath the column and then unchecking **POSTBIN**. Your screen should now look as follows.

```
MODEL TARGET
KEEP AGE, CREDIT_LIMIT, EDUCATION$, GENDER, HH_SIZE, INCOME, MARITAL$,
      N_INQUIRIES, NUMCARDS, OCCUP_BLANK, OWNRENT$, TIME_EMPLOYED
```

Variable Name	Target	Predictor	Categorical	Weight
INCOME	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITAL\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NUMCARDS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OCCUP_BLANK	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OWNRENT\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
TIME_EMPLOYED	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
POSTBIN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort:

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Select Predictors ☐ Select Cat. ☐

Target Type: ☒ Classification/Logistic Binary ☐ Regression ☐ Unsupervised

Set Focus Class...


Target Variable: TARGET

Weight Variable:

Number of Predictors: 12

### Categorical Predictors

The Categorical column allows you to specify which of the numeric variables are categorical by nature. Character variables, like EDUCATION\$, MARITAL\$, and OWNRENT\$, have been automatically checked as categorical because they contain non-numeric characters. For this walk-about, let's also select **GENDER** as a numeric categorical predictor.

 CATEGORY TARGET, GENDER

Variable Name	Target	Predictor	Categorical	Weight
TARGET	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
AGE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CREDIT_LIMIT	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATION\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
GENDER	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
HH_SIZE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INCOME	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITAL\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort:

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Select Predictors ☐ Select Cat. ☐

Target Type: ☒ Classification/Logistic Binary ☐ Regression ☐ Unsupervised

Set Focus Class...

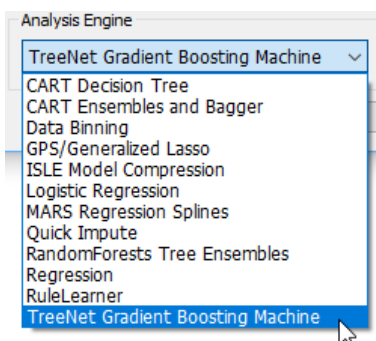
Target Variable: TARGET

Weight Variable:

Number of Predictors: 12

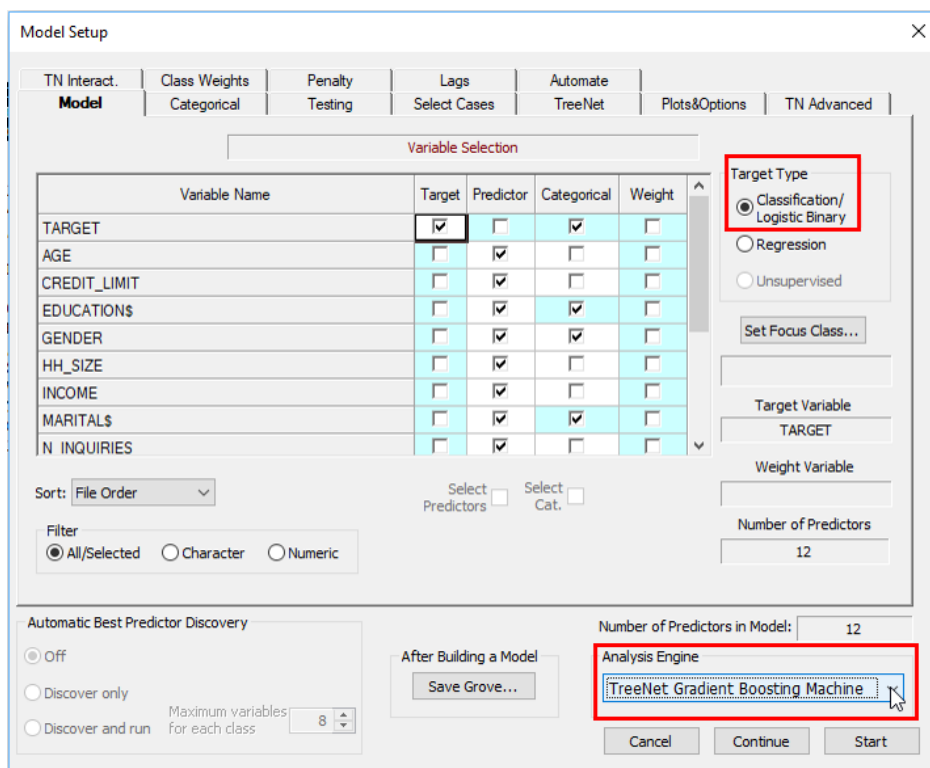
## Analysis Engine

This combo box allows you to select the Analysis Engine you would like to apply to the data. This walk-about is focused on TreeNet® Gradient Boosting Machine



✓ The currently selected Analysis Engine determines which tabs are available. Also, the content of the tabs themselves could change according to the specifics of the Analysis Engine.

- ◆ Choose the **Classification/Logistic Binary** radio button in the section labeled **Target Type**. In addition, be sure to select **TreeNet Gradient Boosting Machine** as the **Analysis Engine**.




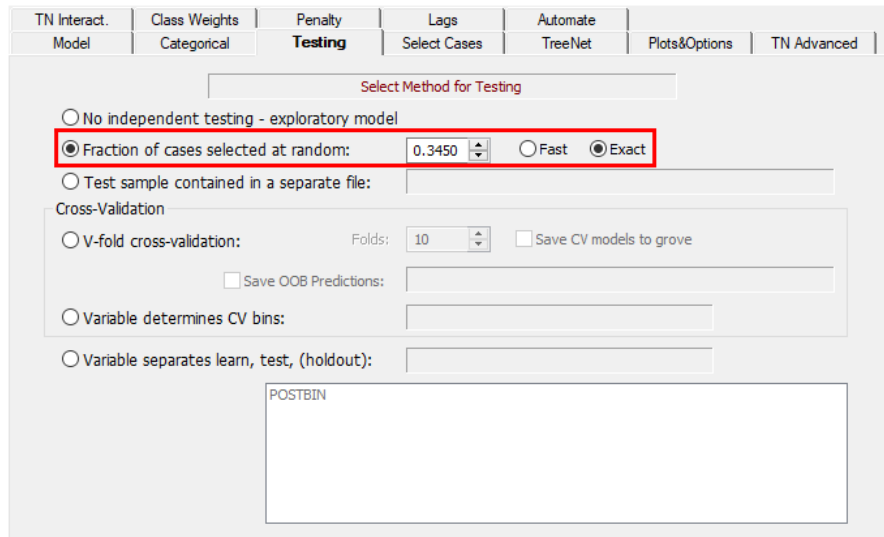
## Additional Model Setup Controls

Now that we have setup our Target and Predictor variables, let's make some changes in additional tabs which will demonstrate the value of Model Restoration. In this stage of the walk-about, we will visit the following Model Setup dialog tabs making changes to various control parameters, options, and settings. One of the objectives of Model Restoration that you will see is that all settings made in these next steps will be preserved and become restorable for future use.

- Testing tab
- Select Cases tab
- TreeNet tab
- Plots & Options tab
- TN Interact tab
- Class Weights tab
- Penalty tab

- ◆ Select the **Testing** tab and choose the **Fraction of cases selected at random**: enter the value **0.345** and click the **Exact** radio button.

 PARTITION TEST = 0.345, DRAW = EXACT



TN Interact. | Class Weights | Penalty | Lags | Automate |  
 Model | Categorical | **Testing** | Select Cases | TreeNet | Plots&Options | TN Advanced |

Select Method for Testing

☐ No independent testing - exploratory model  
☒ Fraction of cases selected at random: 0.3450 ☐ Fast ☒ Exact  
☐ Test sample contained in a separate file:


Cross-Validation

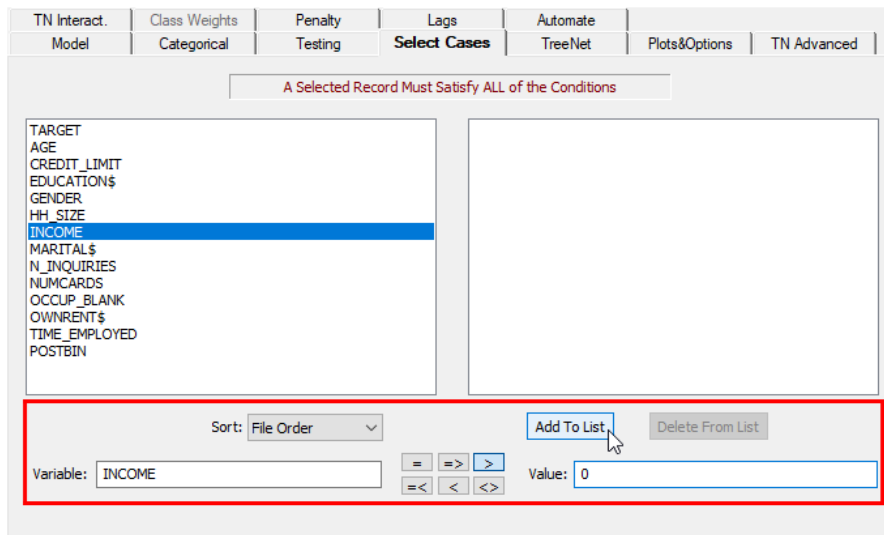
☐ V-fold cross-validation: Folds: 10 ☐ Save CV models to grove  
☐ Save OOB Predictions:

☐ Variable determines CV bins:  
☐ Variable separates learn, test, (holdout):

POSTBIN

- ◆ Select the **Select Cases** tab and add a selection rule for the continuous variable INCOME. In this tutorial we will select only those cases with INCOME greater than 0. Using the highlighted controls, add the rule **INCOME > 0** and click the **[Add To List]** button.

 SELECT INCOME > 0



TN Interact. | Class Weights | Penalty | Lags | Automate |  
 Model | Categorical | Testing | **Select Cases** | TreeNet | Plots&Options | TN Advanced |

A Selected Record Must Satisfy ALL of the Conditions


TARGET  
 AGE  
 CREDIT\_LIMIT  
 EDUCATION\$  
 GENDER  
 HH\_SIZE  
**INCOME**  
 MARITAL\$  
 N\_INQUIRIES  
 NUMCARDS  
 OCCUP\_BLANK  
 OWNRENT\$  
 TIME\_EMPLOYED  
 POSTBIN

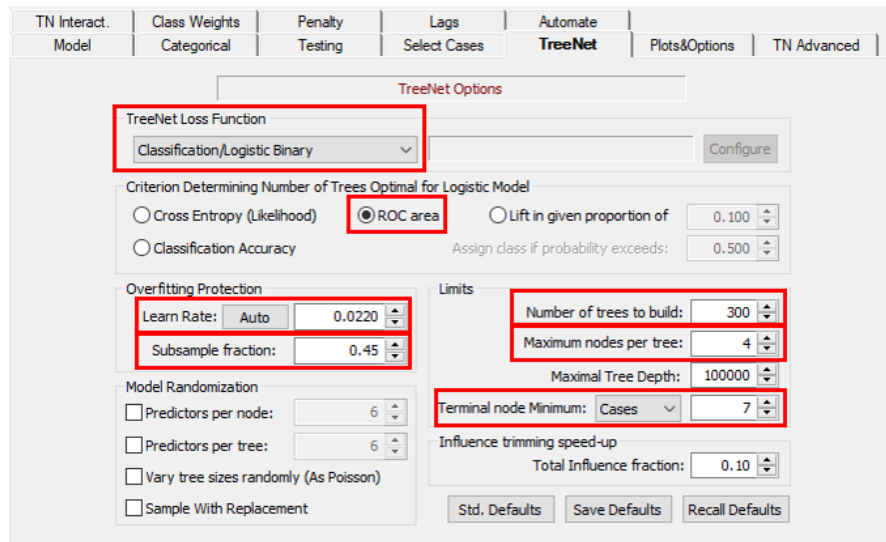
Sort: File Order

Add To List | Delete From List

Variable: INCOME | Value: 0


- ◆ Select the **TreeNet** tab and set the following selections and entries.
  - TreeNet Loss Function set to **Classification/Logistic Binary** (default setting)
  - Optimal Model Criterion set to **ROC area**.
  - Learn Rate: **0.022**
  - Subsample fraction: **0.45**
  - Number of trees to build: **300**
  - Max nodes per tree: **4**
  - Terminal Node Minimum: **7**

 TREENET    LOSS=CLASS, OPTIMAL=ROC, LEARNRATE=0.022,  
SUBSAMPLE=0.45, TREES=300, NODES=4, MINCHILD=7



The screenshot shows the 'TreeNet Options' dialog box. The 'TreeNet Loss Function' is set to 'Classification/Logistic Binary'. Under 'Criterion Determining Number of Trees Optimal for Logistic Model', 'ROC area' is selected. In the 'Limits' section, 'Number of trees to build' is 300, 'Maximum nodes per tree' is 4, and 'Terminal node Minimum' is 7. Other settings include Learn Rate: 0.0220, Subsample fraction: 0.45, and Maximal Tree Depth: 100000.

- ◆ Select the **Plots & Options** tab and set the following selections and entries.
  - Check the ☒ **One variable dependence** box.
    - Most important variables: **5**
    - N Grid Points: **555**
  - Check the ☒ **Two variable dependence** box.
    - Most important variables: **3**
    - At most: **333**
    - N Grid Points: **3333**

 TREENET    PLOTS=YES, YES, NO, NO, MV=5, 3, 0, 0,  
MP=0, 333, 0, 0, PP=555, 3333, 0, 0

TreeNet Plots and Options

☒ One variable dependence  
Most important variables: All 5 N Grid Points: 555

☒ Two variable dependence  
Most important variables: All 3 at most 333 N Grid Points: 3333

Plots  
☒ Center Plotted Values 12 predictors Plots Estimated: 8  
☐ Save Plot Data

Classic Output and Misc  
N Bins for ROC/Lift: 10 Random Number Seed: 12345  
☐ Variable containing Start Values for Model Continuation: AGE

For each performance criterion(ROC, Lift, R2, MAD, etc) save detailed info for how many top ranked models: 1

- ◆ Select the **TN Interact** tab and set the following selections and entries.

- Click the **Selected variables interact at what degree** button and enter: 2

- Use the button to add the five variables to the “**Selected for interaction**” list.

- Check the ☒ **General Interaction Strength Reports** box.
  - Check the ☒ **Max 2-way interactions to report** box and enter: 5

TREENET INTER=YES, VPAIR=NO  
ICL N2WAY=5, PENALTY=0  
ICL ALLOW=INCOME, CREDIT\_LIMIT, N\_INQUIRIES, NUMCARDS,  
TIME\_EMPLOYED/ 2

TN Interact

Interaction Control Language (ICL)  
☐ All vars interact ☐ No vars interact (Additive)  
☒ Selected variables interact at degree: 2

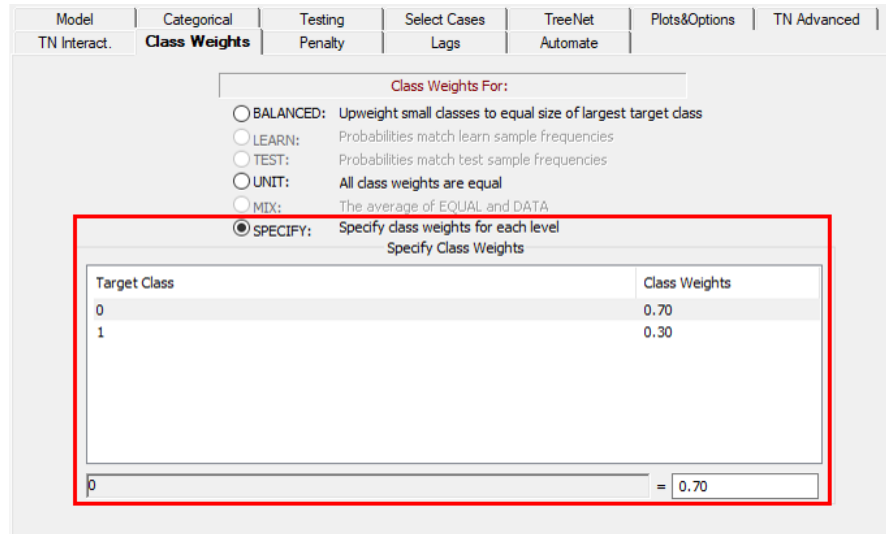
Available Predictors  
AGE  
EDUCATION\$  
GENDER  
HH\_SIZE  
MARITAL\$  
OCCUP\_BLANK  
OWNRENT\$

Selected for interaction  
CREDIT\_LIMIT  
INCOME  
N\_INQUIRIES  
NUMCARDS  
TIME\_EMPLOYED

Reporting  
☒ General Interaction Strength Reports ☐ Pairwise interactions details ☒ Max 2-Way interactions to report: 5

- ◆ Select the **Class Weights** tab and set the following selections and entries.
  - Click the **SPECIFY** radio button and set values for Target Class 0 and 1.
    - Target Class 0: **.70**
    - Target Class 1: **.30**

 CW SPECIFY 0 = 0.7, 1 = 0.3



Class Weights For:


☐ BALANCED: Upweight small classes to equal size of largest target class  
☐ LEARN: Probabilities match learn sample frequencies  
☐ TEST: Probabilities match test sample frequencies  
☐ UNIT: All class weights are equal  
☐ MIX: The average of EQUAL and DATA  
☒ SPECIFY: Specify class weights for each level

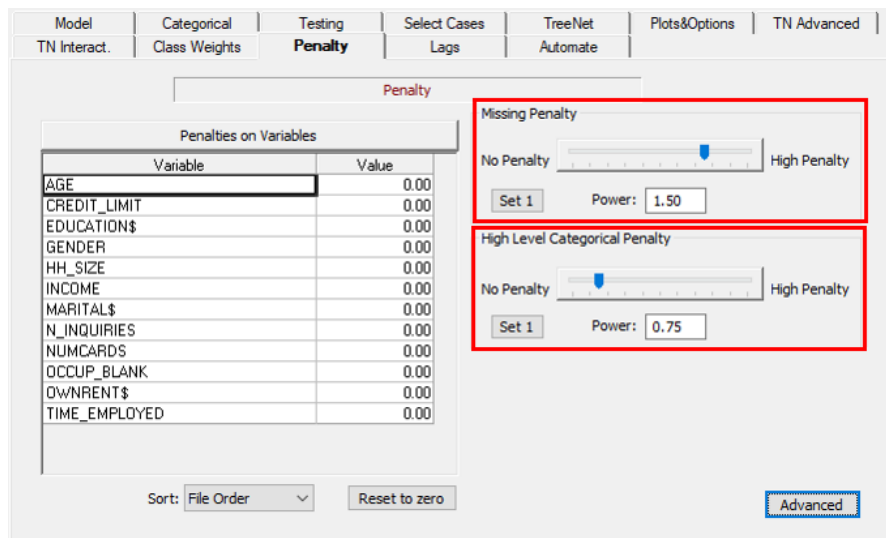
Specify Class Weights

Target Class	Class Weights
0	0.70
1	0.30

0 = 0.70

- ◆ Select the **Penalty** tab and set the following selections and entries.
  - Click the **Missing Penalty** control to set penalty on missing values for predictor variables.
    - Set Power: **1.50**
  - Click the **High Level Categorical Penalty** control to set penalty on high level categorical predictor variables.
    - Set Power: **0.75**

 PENALTY / MISSING = 1.0000, 1.50, HLC = 1.0000, 0.75



Penalty

Penalties on Variables

Variable	Value
AGE	0.00
CREDIT_LIMIT	0.00
EDUCATION\$	0.00
GENDER	0.00
HH_SIZE	0.00
INCOME	0.00
MARITAL\$	0.00
N_INQUIRIES	0.00
NUMCARDS	0.00
OCCUP_BLANK	0.00
OWNRENT\$	0.00
TIME_EMPLOYED	0.00

Sort: File Order

Missing Penalty

No Penalty  High Penalty

Set 1 Power: 1.50

High Level Categorical Penalty

No Penalty  High Penalty

Set 1 Power: 0.75



## Saving the Grove File

Now that we have completed the model setup by defining of our model parameters, options, settings and values, we need to ensure we save our work prior to, or after, launching and running the model.

Before we walk through saving the grove we need to define what the grove file is.

### What is a grove file?

The grove file (.GRV) is a proprietary binary file (universal container) used by the SPM engine to store any kind of modeling results. It includes complete information about the model-building process, including the model itself. For example, the TreeNet® modeling engine will generate a series of trees, performance statistics, dependency plots, interaction reports and other pieces of information. All these details will be saved into the grove file.

The grove can be used to score new data and to produce descriptive information about the scoring process (performance stats, prediction success table, etc.). The grove can also be used to translate the model into one of the supported languages.

SPM can display the modeling results saved to a grove just like it does for a model you build in the current session. In fact, if one does not specify a grove file, a temporary file will be created.

Depending on workflow, one could specify a named grove file for the analysis using the [Save Grove...] button in the model results window.

- ☛ The grove file will be created on your hard drive only after the process is completely finished. You won't be able to create more plots using interactive GUI controls after you save the model.
- ✓ Specifying Grove file name in advance makes sense for analyses that take a long time to run.
- ✓ You can also save the grove file from the results window (see below) after the run is finished.

 GROVE <file>

### Grove contains “engine state”

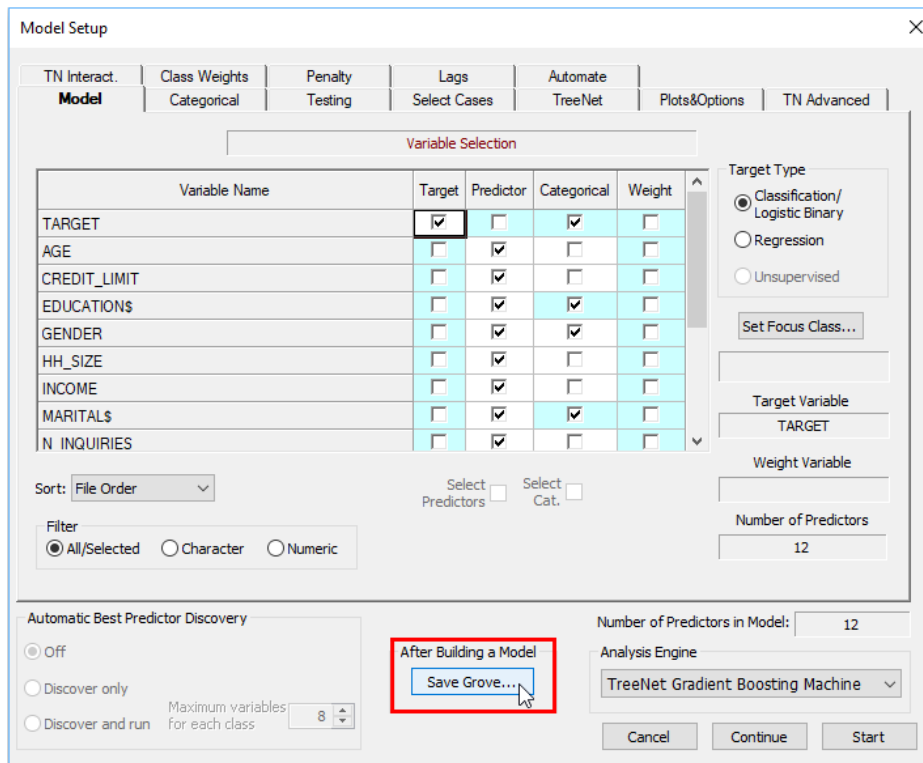
The grove file (.GRV) now contains the “engine state”. The engine state allows SPM to collect all user settings into a session object which is now saved as part of the grove structure. This allows the grove to be saved and later recalled in a new session at any point in time. Upon saving and recalling of the session, the principal goal is to be able to capture and save a comprehensive set of user parameters and settings at any moment in time during a model building session. This is the “state of the engine”, or “engine state”. It represents the history of a session leading up to any given point in time, complete with hundreds of user options.

Another way to think about it is that at any given point in time during a modeling session, the user might launch a modeling session via an action command, or via a GUI control. It is at that moment that the user has both a history (of actions during the session) and a state. The history constitutes all the actions the user has taken during the session, while the state represents the settings of all SPM control parameters at a given point in time.

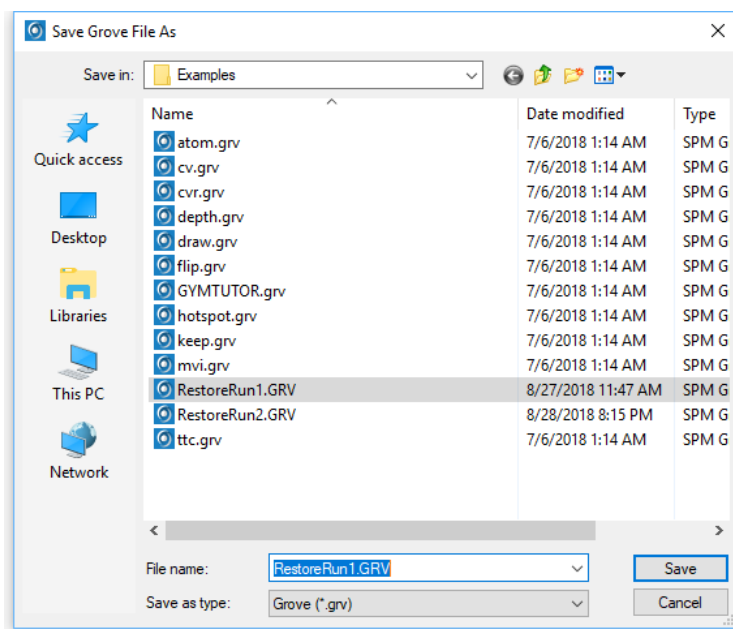
When any GUI action or command is given which starts a process, the user can elect to preserve the state of the session by saving the grove (.GRV).

## Saving the Grove (.GRV)

Anytime during model setup, the **[Save Grove...]** button can be used to save the currently active TreeNet® model to a grove file. The grove file, a binary file that contains all the information about the TreeNet® model, including the engine-state, must be saved if you want to apply the model to a new data set or translate the model into one of the supported languages.



After the **[Save Grove...]** button is pressed, the **Specify Grove File** dialog window appears:

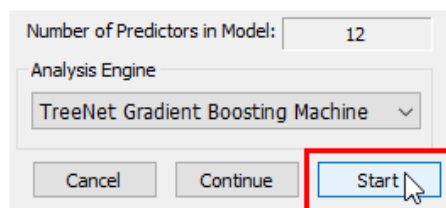


Type in the name **RestoreRun1.GRV** to be created and click the **[Save]** button.

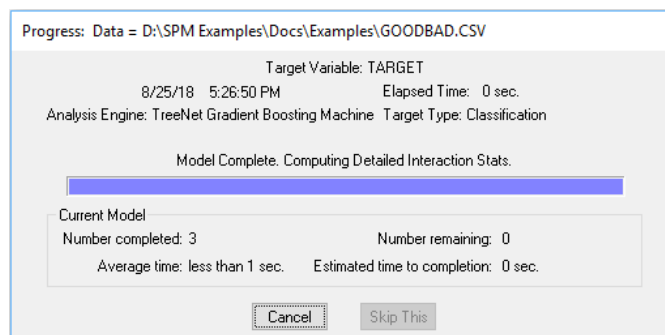
- 💡 The grove file will be created on your hard drive only after the process is finished. You won't be able to create more plots using interactive GUI controls after you save the model.
- ✓ Specifying Grove file name in advance makes sense for analyses that take a long time to run.
- ✓ You can also save the grove file from the results window (see below) after the run is finished.

## Running the Model

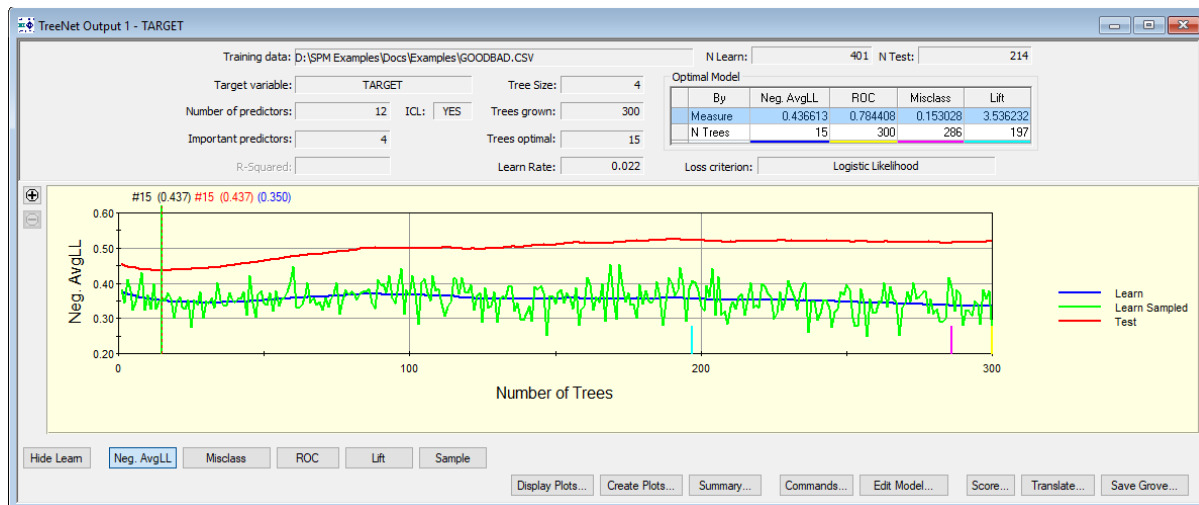
The next stage of our walk-about is to begin the TreeNet® modeling process. From the Model Setup dialog, click the **[Start]** button.



The following progress indicator will appear on the screen while the model is being built, letting you know how much time the analysis should take and approximately how much time remains.



Once the analysis is complete, text output will appear in the **Classic Output** window, and a new window displaying the **TreeNet Output** are displayed.



At this stage, we are complete with the model building process and have saved the model session to the grove file RestoreRun1.GRV.

## Command Line Users

### Create and Save

Throughout this walk-about we use references to SPM command line language. The references will look something like the following.

```
USE <file>
USE "D:\SPM Examples\Docs\Examples\GOODBAD.CSV"
```

Below, we have included the complete command file which can create and save the model session to the grove file `RestoreRun1.GRV`. The referenced command file below is **\*\*COMMENTED\*\***, breaking apart and describing each section. Each commented section corresponds with a Model Setup tab you visited in the setup pages above.

- ✓ In the following example, we use the `\\SPM Examples\Docs\Examples\`. Depending on your configuration, this location may vary.

```
USE "D:\SPM Examples\Docs\Examples\GOODBAD.CSV"
NEW CLEAR
OUTPUT "D:\SPM Examples\Docs\Examples\RestoreRun1.DAT"
rem **DEFINE THE GROVE OUTPUT FILE PRIOR TO RUNNING THE MODEL**
GROVE "D:\SPM Examples\Docs\Examples\RestoreRun1.GRV"
rem **DEFINE MODEL TAB SETTINGS**
MODEL TARGET
KEEP AGE, CREDIT_LIMIT, EDUCATION$, GENDER, HH_SIZE, INCOME, MARITAL$,
    N_INQUIRIES, NUMCARDS, OCCUP_BLANK, OWNRENT$, TIME_EMPLOYED
CATEGORY GENDER, TARGET
rem **DEFINE TEST TAB SETTING**
PARTITION TEST=0.345, DRAW=EXACT
rem **DEFINE SELECT TAB SETTINGS**
SELECT INCOME > 0
rem **DEFINE TREENET TAB SETTINGS**
TREENET LOSS=CLASS, LEARNRATE=.022, SUBSAMPLE=0.45, TREES=300, NODES=4, MINCHILD=7
rem **DEFINE PLOTS & OPTIONS TAB SETTINGS**
TREENET PLOTS=YES, YES, NO, NO, MV=5, 3, 0, 0, MP=0, 333, 0, 0, PP=555, 3333, 0, 0
rem **DEFINE TREENET INTERACT SETTINGS**
TREENET INTER = YES, VPAIR = NO
ICL N2WAY = 5, PENALTY = 0
ICL ALLOW = INCOME, CREDIT_LIMIT, N_INQUIRIES, NUMCARDS, TIME_EMPLOYED/ 2
rem **DEFINE CLASS WEIGHTS TAB SETTINGS**
CW SPECIFY 0 = 0.7, 1 = 0.3
rem **DEFINE PENALTY TAB SETTINGS**
PENALTY / MISSING = 1.0000, 1.50, HLC = 1.0000, 0.75

rem **HOT COMMAND WHICH START THE MODELING PROCESS**
TREENET GO
REM eof
```

### Recall & Restore

Command line non-GUI users can also recall and restore a previous session. To restore the SPM model setup from a previous session, use the `SESSION` option, for example:

```
USE "D:\SPM Examples\Docs\Examples\GOODBAD.CSV"
GROVE "D:\SPM Examples\Docs\Examples\RestoreRun1.GRV" SESSION
TREENET GO
```

## Session Recall & Restore

The next stage of this walk-about is to revisit the grove file we created in the previous stage and open it within the SPM user interface allowing you to recall and restore the previous TreeNet® model that we patiently set up.

### Requirements and Approaches

There are several requirements you should understand about the model restoration process.

- Groves must be created and saved in SPM v8.3.
  - While earlier versions of groves can still be used for model viewing, scoring, and translation, the restore and recall functionality is not supported for grove files created with earlier versions of SPM.
- Input Data File
  - File names: There are no additional requirements other than the standard SPM input data file requirements. By default, the process will first look for the original filenames and directory path used to create the model.
- Variable names
  - Original variables: Every variable that was used to build the model when the session state was created must be present in the input data used during the recall and restore process. If any of the variables expected is not available, the process will stop with variable mismatch.
  - Variable ordering: The recall and restore process is agnostic to the order in which variables are arranged within the input data file.
  - Different variable count: There are no issues with additional variables appearing within the input data file if the original modeling variables are present.

### Paths to Successful Recall/Restore

There are several paths one could choose to recall and restore the session state. All of them have to do with three main questions we can ask sequentially to determine the next step following the opening of a grove (.GRV) file. They are as follows. After opening a grove and selecting the option:

**Q1.)** Does the user want to restore engine session (YES/NO)?

- a. If YES, then ask Q2.
- b. If NO, stop and open standard results window.

**Q2.)** Is there a data file open (YES/NO)?

- a. If YES, then ask Q3.
- b. If NO, pause and display the Open Data File window identifying the original filename to locate. This pause allows the user to locate and open a data file selected for recalling/restoring the session state.

**Q3.)** Do all the variables needed by the session being recalled appear in the selected data file (YES/NO)?

- a. If YES, stop and return users to model setup dialog with restored session state available.
- b. If NO, stop and open standard results window.

The three paths to successful recall and restore can be described as follows using our original example data file GOODBAD.CSV.

**Scenario 1.)** The grove was initially created using the data set GOODBAD.CSV, which is currently loaded, and original variables are present.

**Scenario 2.)** The grove was initially created using the data set GOODBAD.CSV, but user currently has a different data set loaded.

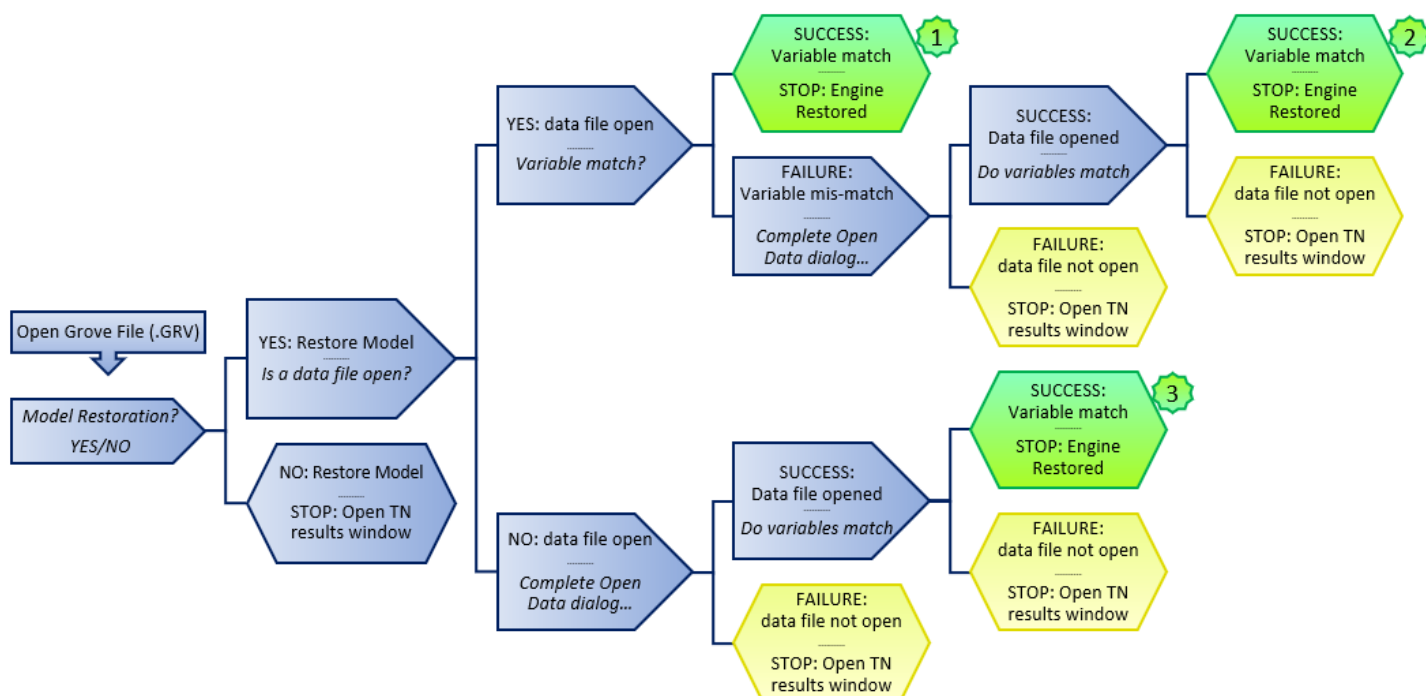
**Scenario 3.)** The grove was initially created using the data set GOODBAD.CSV, but user currently does not have any data set loaded (fresh session start).

Below is a flow diagram of the possible scenarios. When recalling and restoring the session state, we are only interested in three paths of success. These three scenarios are indicated below.

All other paths represent end points where the user is not able to open a data file which contains a 100% original variable match. In these cases, the end point is a return to the currently open results window. In this example, you will be returned to the TreeNet® Output window. These paths will be demonstrated in our fourth scenario.

**Scenario 4.)** The grove was initially created using the data set GOODBAD.CSV, but the user currently does NOT have a data file with a 100% original variable match.

### Model Restoration Flow




## Successful Recall/Restore: Scenario 1

The grove was initially created using the data set GOODBAD.CSV, which is currently loaded, and original variables are present.

### Open Data

To open the original input data file GOODBAD.CSV:

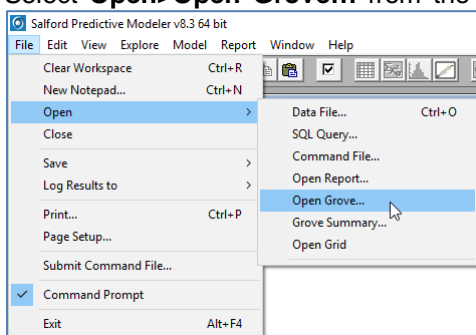
- ◆ Select **Open>Data File...** from the **File** menu or simply click on the  button in the toolbar.
- ◆ Use the **Open Data File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Choose **Delimited (\*.csv,\*.dat,\*.txt)** in the **Files of type:** selection box.
- ◆ Highlight GOODBAD.CSV.
- ◆ Click the **[Open]** button to load the data set into TreeNet®.
- ◆ In the resulting **Activity** window showing the basic info about the dataset, click the **[Close]** button

```
USE <file>
USE "D:\SPM Examples\Docs\Examples\GOODBAD.CSV"
```

### Open Grove File

To open the grove file RestoreRun1.GRV created in our original example modeling exercise:

- ◆ Select **Open>Open Grove...** from the **File** menu or simply click on the  button in the toolbar.



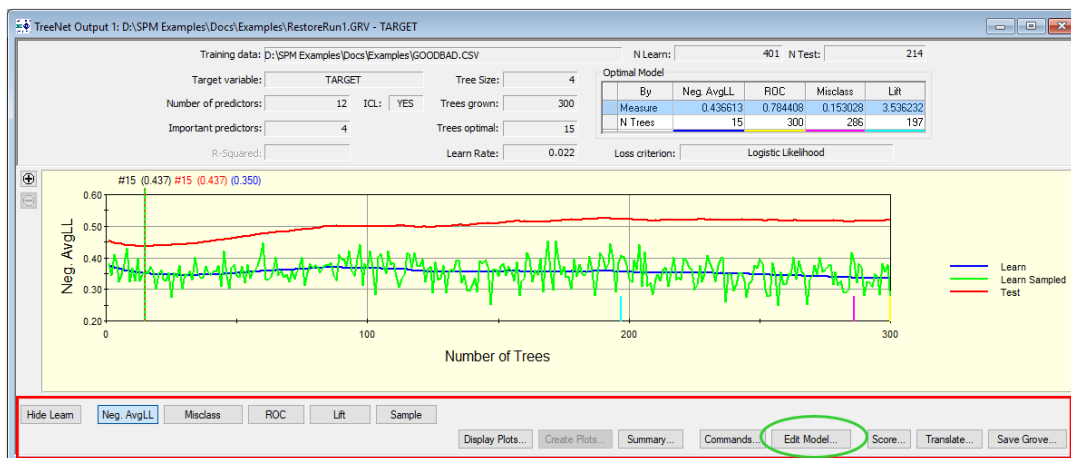
- ◆ Use the **Open Grove File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Default **Files of type:** Grove (\*.grv).
- ◆ Highlight RestoreRun1.GRV.
- ◆ Click the **[Open]** button to load the grove.

At this point you will see the TreeNet Output window stored within grove. If you can recall this is exactly what we saw when the model was originally created. See section *Running the Model* above for details.

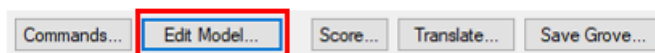


## Recall & Restore via [Edit Model...]

Now that the grove has successfully been opened, we can focus on the lower section of the TreeNet Output window. There are many buttons, but for this walk-about we are only interested in one.



The primary focus is the [Edit Model...] button.



- ◆ With the original data set GOODBAD.CSV open and the TreeNet Output (RestoreRun1.GRV) window in the foreground, click the [Edit Model...] button.
- ◆ Once the [Edit Model...] button is clicked, SPM immediately displays the Model Setup dialog box we used when defining various control parameters, options, and settings.
- ✓ Behind the scenes SPM has checked the currently loaded data file to ensure the first requirement for original variable names.

Every variable that was used to build the model when the session state was created, must be present in the input data file use in the recall/restore process. If all the variables are not available, the process will stop.

Model Setup

TN Interact. | Class Weights | Penalty | Lags | Automate | Plots&Options | TN Advanced

**Model**

Variable Selection

Variable Name	Target	Predictor	Categorical	Weight
TARGET	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
AGE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CREDIT_LIMIT	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATION\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
GENDER	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
HH_SIZE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INCOME	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MARITAL\$	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
N_INQUIRIES	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sort: File Order

Filter: ☒ All/Selected ☐ Character ☐ Numeric

Automatic Best Predictor Discovery

☒ Off

☐ Discover only

☐ Discover and run

Maximum variables for each class: 8

After Building a Model

Save Grove...

Number of Predictors in Model: 12

Analysis Engine

TreeNet Gradient Boosting Machine

Buttons: Cancel, Continue, Start

## Session State Restored

At this point with the restored **Model Setup** dialog in the foreground, one can begin to explore through the individual tabs modified in our initial stage of model setup. They included:

- Model tab
- Testing tab
- Select Cases tab
- TreeNet tab
- Plots & Options tab
- TN Interact tab
- Class Weights tab
- Penalty tab

Here we display mini-captures of each Model Setup dialog with the features originally modified highlighted. As we can see, all our settings are restored and ready for use.

Model Setup dialog, Model tab. The Variable Selection table is highlighted with a red box. The Target Type is set to Classification/Logistic Binary.

Variable Name	Target	Predictor	Categorical	Weight
AGE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CREDIT_LIMIT	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
EDUCATIONS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
GENDER	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
HH_SIZE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
INCOME	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
MARITALS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
N_INQUIRIES	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
NUMCARDS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
OCCUP_BLANK	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
OWNRENTS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TIME_EMPLOYED	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Model Setup dialog, Plots & Options tab. The TreeNet Plots and Options section is highlighted with a red box.

TreeNet Plots and Options

☒ One variable dependence  
Most important variables: All 5 N Grid Points: 555

☒ Two variable dependence  
Most important variables: All 3 at most 333 N Grid Points: 3333

Plots  
☒ Center Plotted Values 12 predictors Plots Estimated: 8

☐ Save Plot Data

Classic Output and Misc  
N Bins for ROC/Lift: 10 Random Number Seed: 987654321

☐ Variable containing Start Values for Model Continuation: AGE

For each performance criterion (ROC, Lift, R2, MAD, etc) save detailed info for how many top ranked models: 1

Model Setup dialog, Testing tab. The Select Method for Testing section is highlighted with a red box.

Select Method for Testing

☐ No independent testing - exploratory model

☒ Fraction of cases selected at random: 0.3450 ☐ Fast ☒ Exact

☐ Test sample contained in a separate file:

Cross-Validation  
☐ V-fold cross-validation: Folds: 10 ☐ Save CV models to grove

☐ Save OOB Predictions:

☐ Variable determines CV bins:

☐ Variable separates learn, test, (holdout):

POSTBIN

Model Setup dialog, TN Interact tab. The Interaction Control Language (ICL) section is highlighted with a red box.

TN Interact. Class Weights Penalty Lags Automate

Interaction Control Language (ICL)  
☐ All vars interact ☐ No vars interact (Additive)

☒ Selected variables interact at degree: 2

Available Predictors  
AGE  
EDUCATIONS  
GENDER  
HH\_SIZE  
INCOME  
MARITALS  
OCCUP\_BLANK  
OWNRENTS  
TIME\_EMPLOYED

Selected for interaction  
CREDIT\_LIMIT  
INCOME  
N\_INQUIRIES  
NUMCARDS  
TIME\_EMPLOYED

Reporting  
☒ General Interaction Strength Reports ☐ Pairwise interactions details ☒ Max 2-Way interactions to report: 5

Model Setup dialog, Select Cases tab. The A Selected Record Must Satisfy ALL of the Conditions section is highlighted with a red box.

A Selected Record Must Satisfy ALL of the Conditions

INCOME > 0

Sort: File Order

Variable: TARGET Value:

Model Setup dialog, Class Weights tab. The Class Weights For: section is highlighted with a red box.

TN Interact. Class Weights Penalty Lags Automate

Class Weights For:

☐ BALANCED: Upweight small classes to equal size of largest target class

☐ LEARN: Probabilities match learn sample frequencies

☐ TEST: Probabilities match test sample frequencies

☐ UNITS: All class weights are equal

☒ SPECIFY: Specify class weights for each level

Specify Class Weights

Target Class	Class Weights
0	0.70
1	0.30

0 = 0.70

Model Setup dialog, TreeNet tab. The TreeNet Loss Function and Limits sections are highlighted with red boxes.

TreeNet Loss Function  
Classification/Logistic Binary

Criterion Determining Number of Times Optimal for Logistic Model  
☐ Cross Entropy (Likelihood) ☒ ROC area ☐ Lift in given proportion of 0.100

☐ Classification Accuracy Assign class if probability exceeds: 0.500

Model Randomization  
☐ Predictors per node: 6 ☐ Predictors per tree: 6 ☐ Vary tree sizes randomly (As Poisson) ☐ Sample With Replacement

Limits  
Number of trees to build: 300  
Maximum nodes per tree: 4  
Maximal Tree Depth: 100000

Terminal node Minimum: Cases 7

Influence trimming speed-up  
Total Influence fractions: 0.10

Std. Defaults Save Defaults Recall Defaults

Model Setup dialog, Penalty tab. The Missing Penalty section is highlighted with a red box.

TN Interact. Class Weights Penalty Lags Automate

Penalty

Penalties on Variables

Variable	Value
AGE	0.00
CREDIT_LIMIT	0.00
EDUCATIONS	0.00
GENDER	0.00
HH_SIZE	0.00
INCOME	0.00
MARITALS	0.00
N_INQUIRIES	0.00
NUMCARDS	0.00
OCCUP_BLANK	0.00
OWNRENTS	0.00
TIME_EMPLOYED	0.00

Sort: File Order Reset to zero Advanced

Missing Penalty  
No Penalty  High Penalty   
Set 1 Power: 1.50

High Level Categorical Penalty  
No Penalty  High Penalty   
Set 1 Power: 0.75

**Next Steps**

With the model session restored, you are now able to:

- ◆ Recreate your model. As an exercise, at this point we can replicate our original model by clicking the **[Start]** button.
- ◆ Quickly modify the various control parameters, options, and settings of the model.

**Scenario 1: Conclusion and Summary**


- ◆ Opened original data file GOODBAD.CSV.
- ◆ Opened original model session stored in RestoreRun1.GRV.
- ◆ Restored model session by clicking the **[Edit Model...]** button.
- ◆ Began working with successfully restored model session.

This concludes the Scenario 1 walk-about. Please see other *Successful Recall/Restore: Scenario #* for further examples.

## Successful Recall/Restore: Scenario 2

The grove was initially created using the data set GOODBAD.CSV, but user currently has a new and different data set loaded which contains variable mis-matches.


### Open Data

- ◆ For this scenario, we are using a different data file rather than the original GOODBAD.CSV. This example will start with the data file GYMTUTOR.CSV. This is just another data file which can be found in the *Sample Data* folder. We are using GYMTUTOR.CSV because this scenario demonstrates what occurs when the user attempts to recall/restore a session when the original model variables are not present in active data file.
- ◆ Select **Open>Data File...** from the **File** menu or simply click on the  button in the toolbar.
- ◆ Use the **Open Data File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Choose **Delimited (\*.csv,\*.dat,\*.txt)** in the **Files of type:** selection box.
- ◆ Highlight GYMTUTOR.CSV.
- ◆ Click the **[Open]** button to load the data set into TreeNet®.
- ◆ In the resulting **Activity** window showing the basic info about the dataset, click the **[Close]** button

```
USE <file>
USE "D:\SPM Examples\Docs\Examples\GYMTUTOR.CSV"
```

### Open Grove File

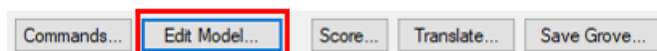
To open the grove file RestoreRun1.GRV created in our original example modeling exercise:

- ◆ Select **Open>Open Grove...** from the **File** menu or simply click on the  button in the toolbar. See “Successful Recall/Restore: Scenario 1” for more details.
- ◆ Use the **Open Grove File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Default **Files of type:** Grove (\*.grv).
- ◆ Highlight RestoreRun1.GRV.
- ◆ Click the **[Open]** button to load the grove.

At this point you will see the TreeNet® Output window stored within grove. If you can recall this is exactly what we saw when the model was originally created. See section *Running the Model* above for details.

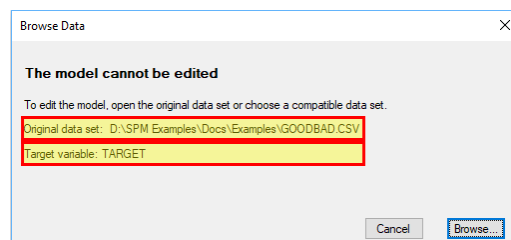
### Recall & Restore via [Edit Model...]

Now that the grove has successfully been open, we can focus on the lower section of the TreeNet Output window. There are many buttons, but for this walk-about we are only interested in one. The primary focus is the **[Edit Model...]** button.



- ◆ With the original data set GOODBAD.CSV open and the TreeNet Output (RestoreRun1.GRV) window in the foreground, click the **[Edit Model...]** button.

- ◆ In this scenario, we see the following informational message appear. This message is informing the user that this model cannot be restored because the data file currently opened does not contain a complete an original variable match.
- ◆ Note the message provides the user information about the original data filename and the target variable used in the stored session.



- ◆ User can click the [Browse...] button to search and located a file to open or select [Cancel] returning the user to the TreeNet Output window. For our walk-about, click the [Browse...] button.
- ◆ Use the **Open Data File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Choose **Delimited (\*.csv,\*.dat,\*.txt)** in the **Files of type:** selection box.
- ◆ Highlight GOODBAD.CSV.
- ◆ Click the **[Open]** button to load the data set into TreeNet®.
- ◆ SPM will process for a moment and then displays the Model Setup dialog box we used when defining various control parameters, options, and settings. See “*Successful Recall/Restore: Scenario 1*” for more graphical details.
- ✓ Behind the scenes SPM has check the currently loaded data file to ensure the first requirement for original variable names.

Every variable that was used to build the model when the session state was created, must be present in the input data file use in the recall/restore process. If all the variables are not available, the process will stop.

## Next Steps

With the model session restored, you are now able to:

- ◆ Recreate your model. As an exercise, at this point we can replicate our original model by clicking the **[Start]** button.
- ◆ Quickly modify the various control parameters, options, and settings of the model.

## Scenario 2: Conclusion and Summary

- ◆ Open sample data file GYMTUTOR.CSV in an exercise to demonstrates what occurs when a user attempts to recall/restore a session when the original model variables are not present in active data file (variable mis-match).
- ◆ Opened the original model session stored in RestoreRun1.GRV.
- ◆ Attempted to restore model session by clicking the **[Edit Model...]** button.
- ◆ Failed to restore session informing the user that the model cannot be restored because there is no data file currently loaded with all original variables present.
- ◆ Browse for the original data source opening GYMTUTOR.CSV with success.
- ◆ Began working with successfully restored model session.

This concludes the Scenario 2 walk-about. Please see other *Successful Recall/Restore: Scenario #* for further examples.

### Successful Recall/Restore: Scenario 3


The grove was initially created using the data set GOODBAD.CSV, but user currently does NOT currently have a data file open.

#### Open Data

For this scenario, we are beginning from a fresh start of SPM with no data file currently loaded.

#### Open Grove File

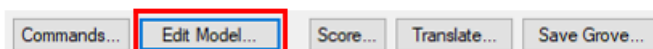
To open the grove file `RestoreRun1.GRV` created in our original example modeling exercise:

- ◆ Select **Open>Open Grove...** from the **File** menu or simply click on the  button in the toolbar. See “Successful Recall/Restore: Scenario 1” for more details.
- ◆ Use the **Open Grove File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Default **Files of type:** Grove (\*.grv).
- ◆ Highlight `RestoreRun1.GRV`.
- ◆ Click the **[Open]** button to load the grove.

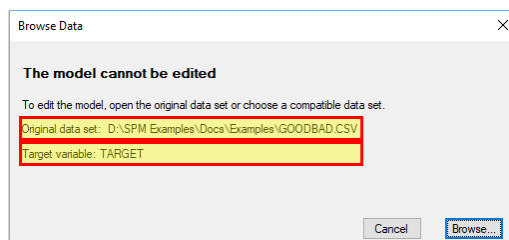
At this point you will see the TreeNet Output window stored within grove. If you can recall this is exactly what we saw when the model was originally created. See section *Running the Model* above for details.

#### Recall & Restore via [Edit Model...]

Now that the grove has successfully been open, we can focus on the lower section of the TreeNet Output window. There are many buttons, but for this walk-about we are only interested in one. The primary focus is the **[Edit Model...]** button.



- ◆ With the TreeNet Output (`RestoreRun1.GRV`) window in the foreground, click the **[Edit Model...]** button.
- ◆ In this scenario, we see the following informational message appear. This message is informing the user that this model cannot be restored because there is no data file currently open.
- ◆ Note the message provides the user information about the original data filename and the target variable used in the stored session.



- ◆ User can click the **[Browse...]** button to search and located a file to open or select **[Cancel]** returning the user to the TreeNet Output window. For our walk-about, click the **[Browse...]** button.

- ◆ Use the **Open Data File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Choose **Delimited (\*.csv,\*.dat,\*.txt)** in the **Files of type:** selection box.
- ◆ Highlight `GOOBBADmorevariables.csv`.
- ◆ Click the **[Open]** button to load the data set into TreeNet®.
  - ✓ *NOTE: We are using a different data file `GOOBBADmorevariables.csv`. It is a version of the original data file with ten additional variables added (x1-x10). This addition to the scenario demonstrates that SPM does not care if additional variables are part of the data file if the first requirement is passed.*
- ◆ SPM will process for a moment and then displays the Model Setup dialog box we used when defining various control parameters, options, and settings. See “*Successful Recall/Restore: Scenario 1*” for more graphical details.
  - ✓ Behind the scenes SPM has checked the currently loaded data file to ensure the first requirement for original variable names.

Every variable that was used to build the model when the session state was created, must be present in the input data file used in the recall/restore process. If all the variables are not available, the process will stop.

### Next Steps

With the model session restored, you are now able to:

- ◆ Recreate your model. As an exercise, at this point we can replicate our original model by clicking the **[Start]** button.
- ◆ Use the restored session as the starting point of additional modeling sessions.
- ◆ Quickly modify the various control parameters, options, and settings of the model.
- ◆ Continue to work with `RestoreRun1.GRV` in other tasks like scoring new data or translating the model into one of the supported languages later.

### Scenario 3: Conclusion and Summary

- ◆ From a fresh SPM start with no data file loaded, opened the original model session stored in `RestoreRun1.GRV`.
- ◆ Attempted to restore model session by clicking the **[Edit Model...]** button.
- ◆ Failed to restore session informing the user that the model cannot be restored because there is no data file currently open.
- ◆ Browse for the original data source opening `GYMTUTOR.CSV` with success.
- ◆ Began working with successfully restored model session.

This concludes the Scenario 3 walk-about. Please see other *Successful Recall/Restore: Scenario #* for further examples.

## Failed Recall/Restore: Scenario 4


The grove was initially created using the data set GOODBAD.CSV, but user does NOT currently have a data file with a 100% original variable match.

### Open Data

For this scenario, we are beginning from a fresh start of SPM with no data file currently loaded.

### Open Grove File

To open the grove file `RestoreRun1.GRV` created in our original example modeling exercise:

- ◆ Select **Open>Open Grove...** from the **File** menu or simply click on the  button in the toolbar. See “Successful Recall/Restore: Scenario 1” for more details.
- ◆ Use the **Open Grove File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Default **Files of type:** Grove (\*.grv).
- ◆ Highlight `RestoreRun1.GRV`.
- ◆ Click the **[Open]** button to load the grove.

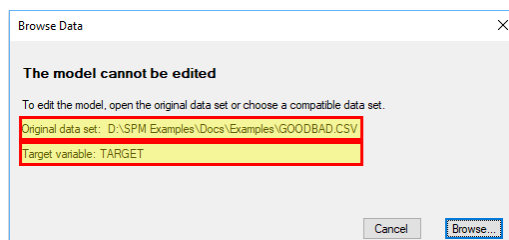
At this point you will see the TreeNet Output window stored within grove. If you can recall this is exactly what we saw when the model was originally created. See section *Running the Model* above for details.

### Recall & Restore via [Edit Model...]

Now that the grove has successfully been open, we can focus on the lower section of the TreeNet Output window. There are many buttons, but for this walk-about we are only interested in one. The primary focus is the **[Edit Model...]** button.



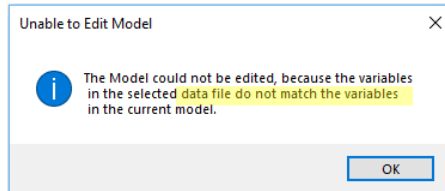
- ◆ With the original data set `GOODBAD.CSV` open and the TreeNet Output (`RestoreRun1.GRV`) window in foreground, click the **[Edit Model...]** button.
- ◆ In this scenario, we see the following informational message appear. This message is informing the user that this model cannot be restored because there is no data file currently open.
- ◆ Note the message provides the user information about the original data filename and the target variable used in the stored session.



- ◆ User can click the **[Browse...]** button to search and located a file to open or select **[Cancel]** returning the user to the TreeNet Output window. For our walk-about, click the **[Browse...]** button.



- ◆ Use the **Open Data File** dialog window to navigate into the *Sample Data* folder in the SPM installation directory.
- ◆ Choose **Delimited (\*.csv,\*.dat,\*.txt)** in the **Files of type:** selection box.
- ◆ Highlight `GOODBADlessvariables.csv`.
- ◆ Click the **[Open]** button to load the data set into TreeNet®.
- ✓ **NOTE:** We are using the different data file `GOODBADlessvariables.csv`. It is a version of the original data file with seven variables removed. This addition to the scenario demonstrates the first requirement failing.
- ◆ SPM will process for a moment and then displays the following error.



- ✓ Behind the scenes, SPM has checked the currently loaded data file to ensure the first requirement for original variable names.

Every variable that was used to build the model when the session state was created, must be present in the input data file used in the recall/restore process. If all the variables are not available, the process will fail and stop. The user is returned to the original TreeNet Output window.

## Next Steps

With the model session restored, you are now able to:

- ◆ Model restoration failed in this scenario
- ◆ Continue to work with `RestoreRun1.GRV` in other tasks like scoring new data or translating the model into one of the supported languages later.

## Scenario 4: Conclusion and Summary

- ◆ From a fresh SPM start with no data file loaded, opened the original model session stored in `RestoreRun1.GRV`.
- ◆ Attempted to restore model session by clicking the **[Edit Model...]** button.
- ◆ Failed to restore session informing the user that the model can not be restored because there is no data file currently open.
- ◆ Browse for the original data source opening `GOODBADlessvariables.csv` failed due to variable mis-match.
- ◆

This concludes the Scenario 4 walk-about. Please see other *Successful Recall/Restore: Scenario #* for further examples.

***This concludes our introductory Model Restoration tutorial and walk-about.***

## UNIX/Console Usage Notes

The nature of UNIX-like operating environments affects the operation of the SPM in non-trivial ways. This section discusses the operation of the SPM in the UNIX operating environment and the operation of console (non-GUI) SPM in general. Both GUI and console SPM are offered for Windows; only the console is offered for UNIX or Linux.

### Case Sensitivity

The SPM command interpreter is **case-insensitive**; in fact, commands are generally converted internally to upper-case letters. The only exception to this rule is that the text placed between quotation marks is not converted, remaining in its original case. UNIX file systems, on the other hand, are **case-sensitive**, meaning that upper and lower case letters are treated as completely different characters. Thus, one could not refer to a file named “this.csv” as “THIS.CSV,” or vice-versa.

It is therefore important to remember that unquoted filenames are assumed to be upper case; lower and mixed case names must be quoted.

### Use Caution When Transferring PC Files

It is always important to use binary mode when copying non-text files from a DOS/Windows environment to a UNIX environment (or vice-versa). Failure to do so will cause the files to be corrupted.

### Supporting Database Conversion Libraries

On selected platforms, the SPM will use the Stat/Transfer database engine to read and write any file format supported by Stat/Transfer.

- ☛ The SPM executable can function without Stat/Transfer interface. Proper installation for supported platform installs Stat/Transfer modules too and makes them discoverable by SPM.

To access data through the Stat/Transfer interface, one simply uses the USE, SAVE, or PROPORTION FILE commands; the file name must be quoted.


To disable the Stat/Transfer interface, one can use the command "LOPTIONS STATTRAN=NO"; likewise, to re-enable the Stat/Transfer interface, one uses the command "LOPTIONS STATTRAN=YES".

- ☛ If data translation engine is disabled, the only supported file format is plain-text CSV.

✓ Since v6, SPM includes native support for text datasets, which are, for many users, the most flexible and natural formats in which to maintain data. A single delimiter is used throughout the dataset. It is usually a comma, but semicolon, space, and tab are also supported as delimiters.


### The FPATH Command

The FPATH command can be used to specify locations for different types of input and output files. For example, the following command will cause SPM to read and write files in the directory “Salford,” under your home directory by default (on UNIX-like systems):


```
 FPATH "~/Salford"
```

Thereafter, if one gives an input/output command such as USE, OUTPUT, or SAVE, SPM will look in ~/Salford unless the filename is quoted or the FPATH command is canceled by giving an FPATH command without arguments.


One can also specify different default directories for different sorts of files. To specify a default directory for input datasets, use:

```
 FPATH <pathname> /use
```


To specify a default directory for output datasets, use:

```
 FPATH <pathname> /save
```

For command files, use:


```
 FPATH <pathname> /submit
```

For text output files, use:

```
 FPATH <pathname> /output
```

FPATH without arguments restores the default, which is to use the current working directory. FPATH with an option but no pathname restores the default for the specified file type.

## Built-in Help

```
 HELP [<command>]
```

Console SPM has its own built-in help system, which can be accessed by opening the SPM in interactive mode and typing "HELP" at the prompt. To read the entry for a particular command, type "HELP" followed by the name of the command.

## Workspace Allocation

Console SPM can allocate arbitrary amounts of memory. The default workspace size is 25 MB, but this can be altered with either the SALFORD\_M environment variable, or the -m command line flag. We suggest that SALFORD\_M be set in the system-wide startup files (/etc/profile and /etc/csh.login on most UNIX-like systems), as appropriate for the hardware.

## Limit on Number of Variables

By default, the SPM will read datasets with up to 32,768 variables. This number can be increased with the -v command line flag.

## Modes of Operation

Console SPM can be invoked interactively by launching it at the command prompt without arguments. You will get a series of startup messages looking something like this:

```
This launch supports up to 32768 variables.
This launch supports unlimited data.
```

```
Salford Predictive Modeler(R) software suite version 8.3.0.001
```

```
CART(R) ProEX, TreeNet(R) ProEX, MARS(R) ProEX, RandomForests(R) ProEX,
GPS/Generalized Lasso(TM) ProEX, RuleLearner(R), ISLE, Logit ProEX,
REGRESS ProEX
Copyright, 1991-2018, Salford Systems, San Diego, California, USA
```

SPM Salford Predictive Modeler(R) software suite includes selected versions of the following:


```
CART(R) (c)1984-2018 California Statistical Software, Inc.  
TreeNet(R) (c)2001-2018 Salford Systems  
MARS(R) (c)1991-2018 Jeril, Inc.  
RandomForests(R) (c)2002-2018 Leo Breiman, Adele Cutler and Salford Systems  
PRIM(TM) (c)1997-2018 Jeril, Inc.  
GeneralizedPathSeeker(TM) (c)2009-2018 Jeril, Inc.  
PathSeeker(TM) (c)2004-2018 Jeril, Inc.  
RuleLearner(R) (c)2012-2018 Salford Systems  
ISLE (c)2012-2018 Salford Systems  
2SLS (c)1988-2018 Salford Systems
```

SPM uses zlib software from [www.zlib.net](http://www.zlib.net)  
SPM uses LZ compression.


The license supports unlimited learn sample data.

You can then enter commands and receive responses. Your session ends when you enter the QUIT command.

Since the SPM in interactive mode will accept commands through standard input and send responses through standard output, it is sometimes convenient to invoke it in the following way from a script or batch file. For example, the commands below read the SPM commands from a set of command files and write results to output.dat.

```
 $ cat runit1.cmd runit2.cmd runit3.cmd | SPM >output.dat
```

Generally, the more convenient way to run console SPM is in batch mode, which can be invoked by specifying a command file as an argument. For example, let's execute runit1.cmd in batch mode.

```
 $ SPM runit1.cmd
```

When operating in batch mode, the SPM does not send any output to your screen, other than startup and error messages, unless ECHO ON is in effect, or the -e command line flag has been specified. It is therefore a good idea to specify an output file with the OUTPUT command inside your command file. Otherwise you may never see Classic Output results at all. The SPM will terminate either when it has encountered a QUIT command, or there are no more commands to be executed.

## Startup File

When console SPM is started in interactive mode, it looks for a file named SALFORD.CMD, first in your current working directory and then in the directory pointed to by the SALFORD environment variable. If the file is found, the SPM will execute its contents before displaying the command prompt. This allows one to specify default settings for all Salford Systems applications. SALFORD.CMD is not automatically executed in batch mode.

## Command Line Startup Options

The SPM has a number of other command-line options. You can get the list of options by invoking the SPM with the -h flag.

The command line syntax is:

```
SPM [options] [commandfile] [options]
```

Options are:

-e	Echo results to console
-q	Quiet, suppress all output including errors
-o<output_file>	Direct text results to a file
-u<use_file>	Attach to a dataset
-g<use_file>	Identify a grove file
-w<Path>	Identify Stat/Transfer dll path
-t<Path>	Identify scratch file path
-s<MBytes>	Data amount in MB, subject to license threshold
-m<MBytes>	Model space in MB, subject to hardware limits
-l<optional_logfile>	Error/warnings to text logfile
-mt<Nnumeric,Nchar>	Lookup table capacities, 0 to grow without bound
-v<N>	Specifies max N variables for the session

Examples:

```
SPM -e modell.cmd
SPM \DataMining\Jobs-1\simulate.cmd -q
SPM job1.cmd -o\RESULTS\job1.txt -u\AnalysisData\sample1.sys
SPM -u\MyData\joint_data.xls[xls5]
SPM -s512 -m128
```

Environment variables can be used in lieu of command line switches:

```
SALFORD_S    in lieu of -s
SALFORD_M    in lieu of -m
```

Examples:

```
SPM -e modell.cmd
SPM /DataMining/Jobs-1/simulate.cmd -q
SPM job1.cmd -o/RESULTS/job1.txt -u/AnalysisData/sample1.sys
SPM -d/Progra~1/DBMSCopy7 -u/MyData/joint_data.xls[xls5]
SPM -s512 -p64 -m128
```

Environment variables can be used in lieu of command line switches:

```
SALFORD_S    in lieu of -s
SALFORD_M    in lieu of -m
```

## An Overview of Model Summary Window

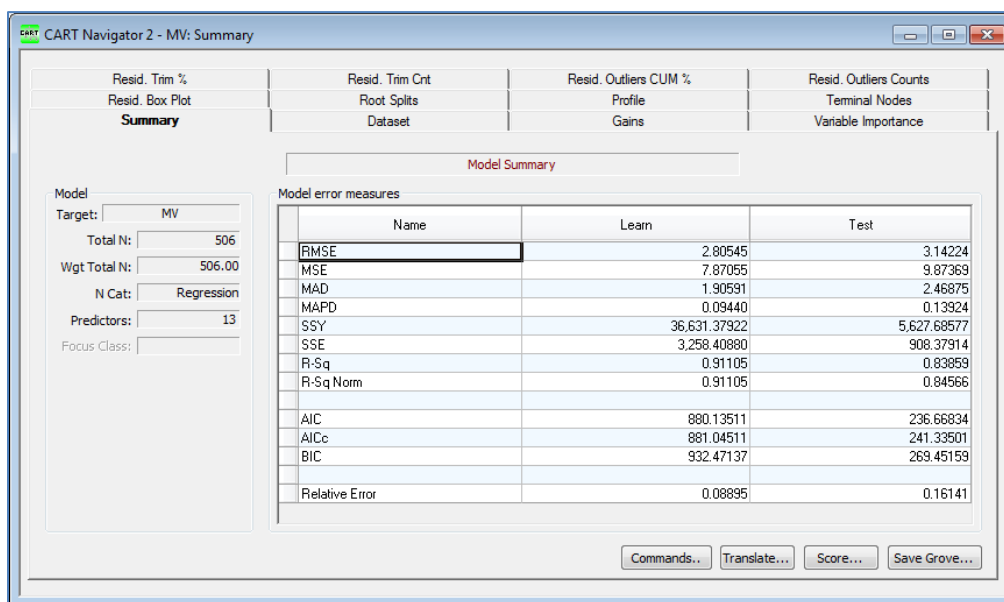
**Model Summary** window is a unified way to represent information about the model. It's usually accessible from model results windows (e.g. CART Navigator, TreeNet Output) via the **[Summary]** button.

✓ After some analyses, this is the default Results window.

The information in **Model Summary** window is organized in tabs. This chapter describes general ones, the tabs that are applicable to several or all of the Analysis Engines.

### Summary tab

**Summary** tab is usually the first tab in a **Model Summary** window.



Model group to the left lists Target variable name and counts of Observation, Predictors, and categories of the Target. For Regression models, the Target is continuous and the word "Regression" is used to indicate that.

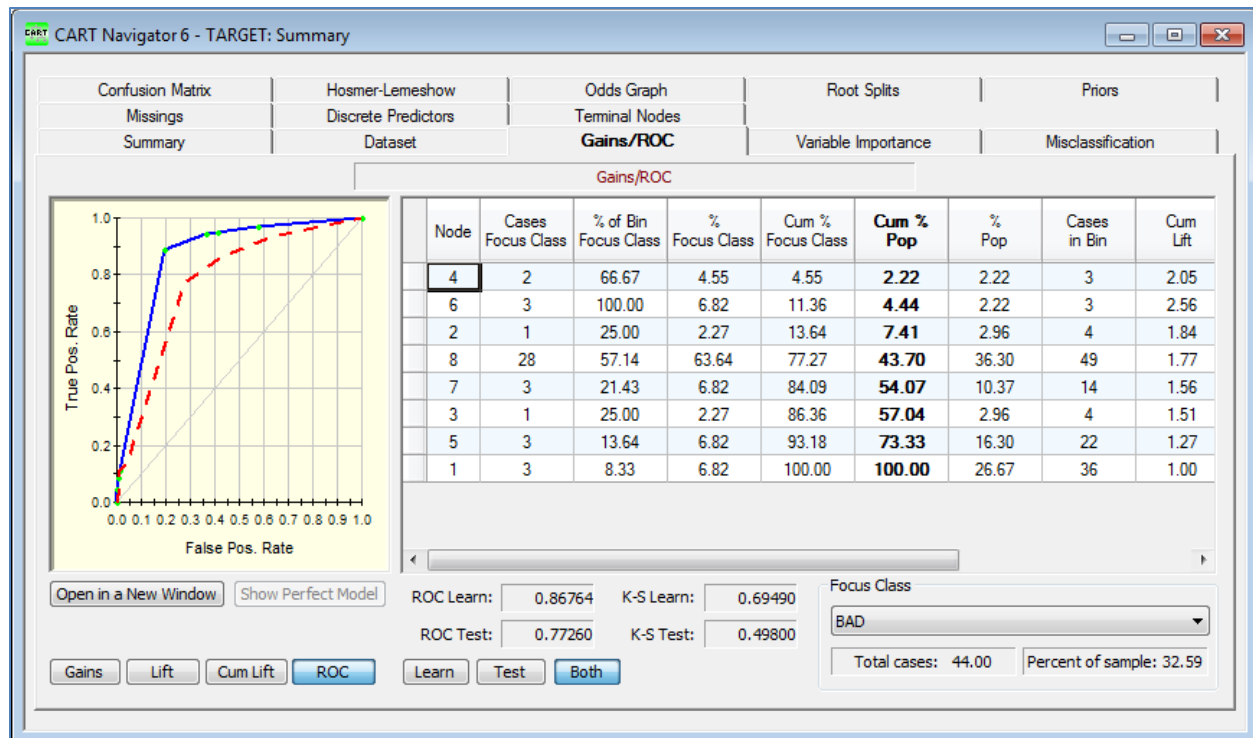
In some cases we show additional information like number of coefficients for linear models.

Model error measures grid shows performance statistics for each data sample in the model. Depending on Target Type and other aspects of the model, appropriate performance measures are available. The screenshot above shows the Summary for a CART® Regression model. Some of the regression performance measures (MSE, MAD, R-Sq., etc.) are universally used for regression models. Relative Error is specific to CART® models.

### Dataset tab

**Dataset** tab represents information about the dataset used to build the model. It contains sizes of each data sample, statistical information about the Target and number of records that may have been deleted by one of the following reasons:



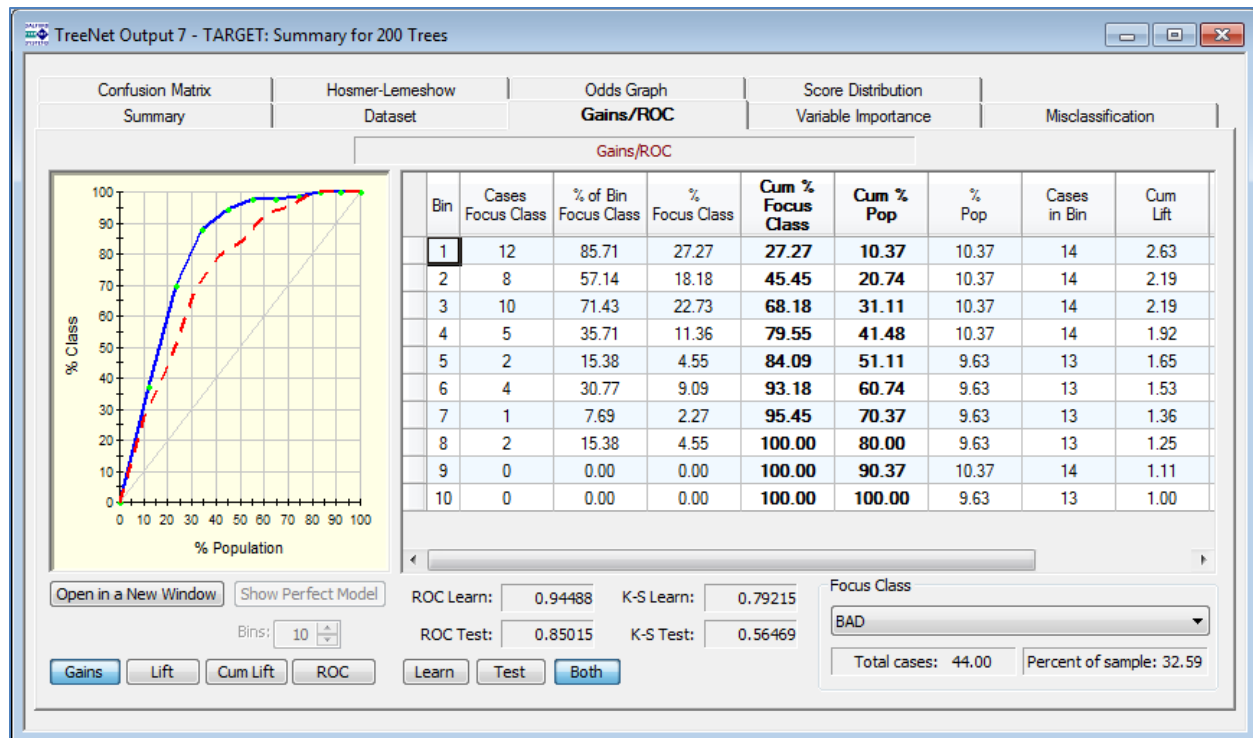


Reading the gains curve is straightforward. Consider the data sorted in order from most likely to be BAD to least likely. If we were to look only at the top 10% of the data (most likely to be BAD) what fraction of all the BADs would we capture? Looking at the graph it appears that we would capture about 30% of all BADs. The ratio 30/10 or 3 is known as the lift among market researchers and relative risk in the biomedical world. Clearly, the larger the lift the better because it indicates more precise discrimination.

✓ Click on **Show Perfect Model** to provide a reference to compare against. The perfect model would isolate all the BAD cases into their own nodes.

Nodes in CART® models are used as natural bins for constructing a Gains Chart. For other Analysis Engines when such a natural partitioning is not available, the data is sorted by Class Probability and then an intelligent binning is applied. For example, here are Gains for an analogous TreeNet® model.





The table displays the following information for each bin or node (scroll the grid to view the last two columns):

Node/Bin	Terminal Node number for CART® models, otherwise the Bin number in the data partitioned by Class Probability.
Cases Focus Class	Number of cases belonging to Focus Class.
% of Bin Focus Class	Percent of cases belonging to Focus Class.
% Focus Class	Percent of cases in the population that belong to Focus Class.
Cum % Focus Class	Cumulative percent of cases in the population that belong to Focus Class.
% Pop	Percent of all data.
Cum % Pop	Cumulative percent of all data.
Cases in Bin	Number of cases in the Node/Bin
Cum Lift	Cum % Focus Class divided by Cum % Pop
Lift Pop	% of Bin Focus Class divided by % Pop

You can use the following buttons to select which Gains data columns are plotted.

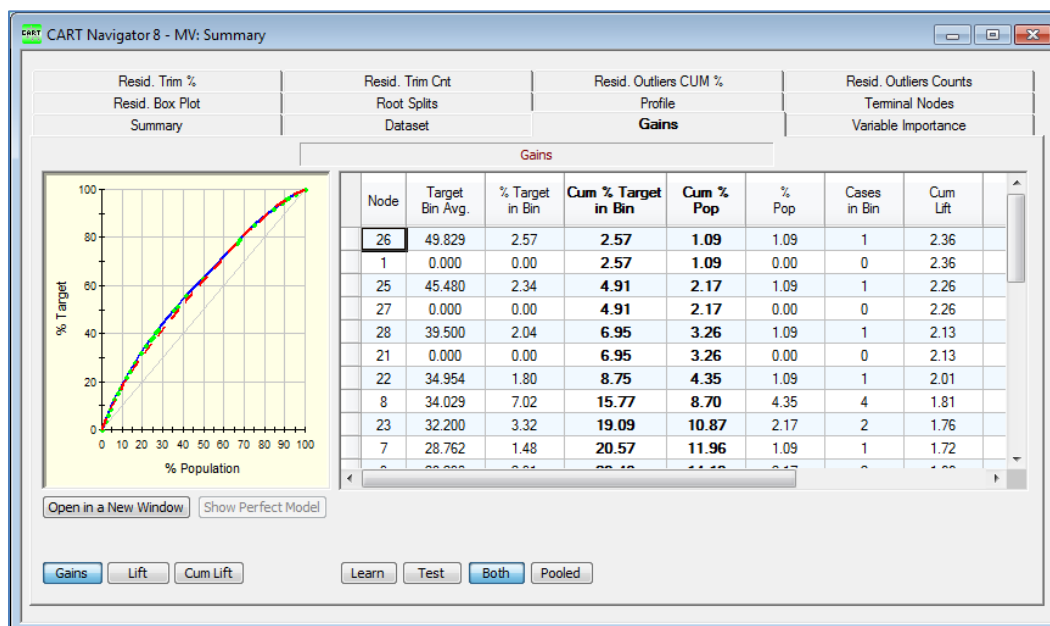
- ◆ [Gains] button– **Cum % Focus Class** versus **Cum % Pop**.

- ♦ **[Lift]** button– **Lift Pop** versus **Cum % Pop**.
  - ♦ **[Cum. Lift]** button– **Cum Lift** versus **Cum % Pop**.
  - ♦ **[ROC]** button–**Sensitivity** versus **1 –Specificity**. This is the Receiver Operating Characteristic curve. It is an approximation of the curve, which is used to compute ROC Performance Measure (Area under ROC curve).
- ✓ The ROC curve, while similar to the Gains curve, has a number of theoretical advantages, especially when considering the model performance on the dominant class (in which case the Gains curve may degenerate into the 45-degree line).

The number of bins control.  control.

**[Learn]**, **[Test]** and **[Both]** buttons select the data sample for which Gains are shown.

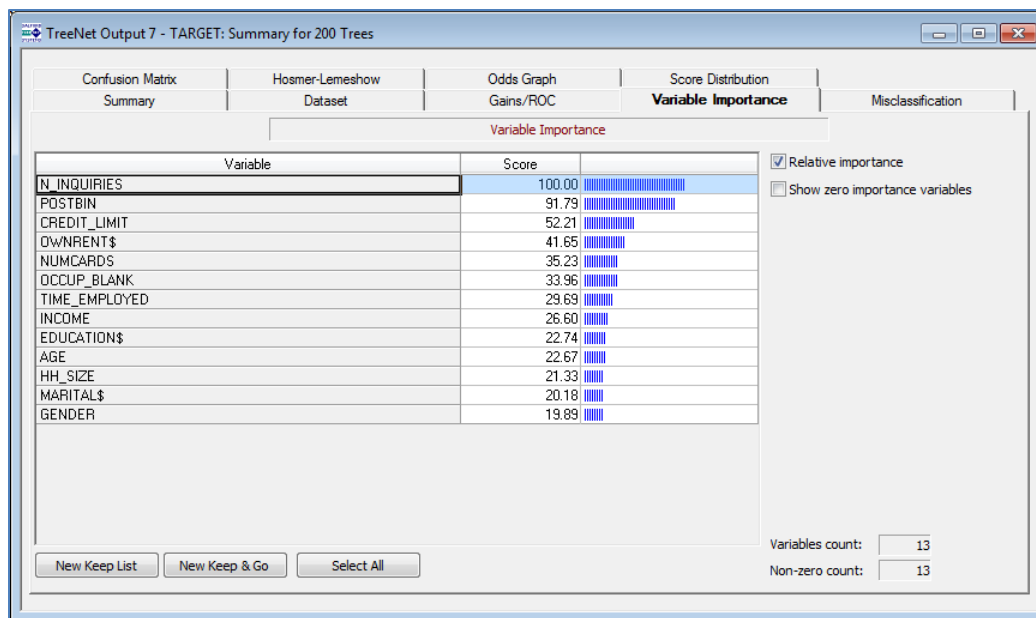
Note that for regression models, the **Gains** tab will look differently.



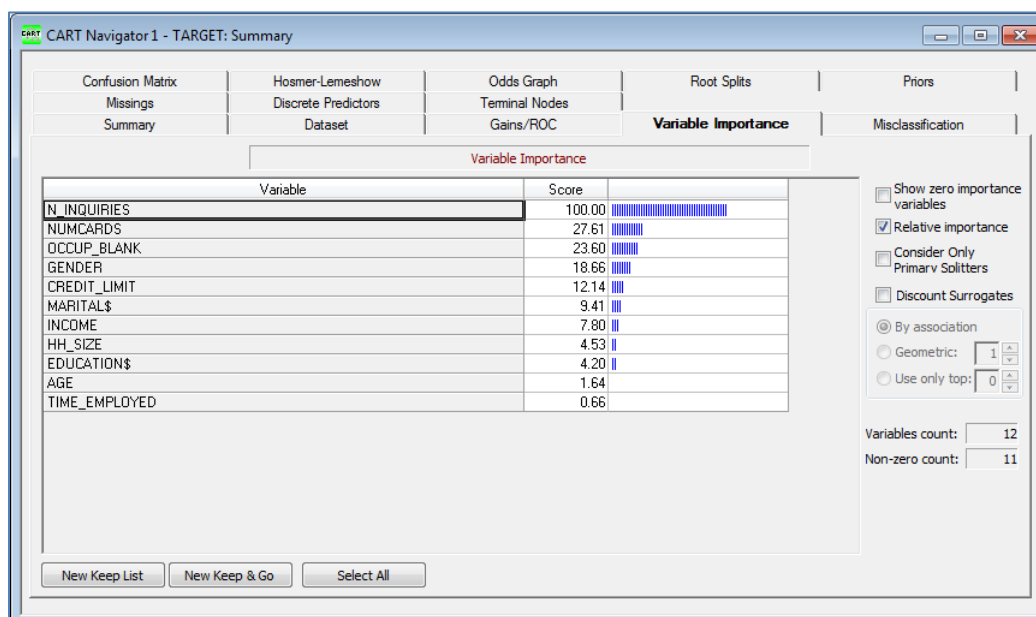
In the table instead of Focus Class we show average of the Target.

## Variable Importance tab

The tab shows variables ranked by their importance in the model:



Each engine has a peculiar way to compute variable importance and might introduce specific features on the tab. Please refer to the guide for a particular engine for more details. For example, here's how Variable Importance for a CART® model looks:



In any version of Variable Importance, you can highlight some variables in the grid and generate commands to mark the selected variables as predictors using the **[New Keep List]** button. You can request these commands to be applied at once via the **[New Keep & Go]** button. The **[Select All]** button is a handy shortcut to select all the variables in the grid.

Relative importance checkbox toggles between raw and normalized scores.

## Confusion Matrix tab

- ✓ This is a classification-only feature.
- ✓ This tab is called **Prediction Success** in previous versions of SPM.

The confusion matrix is a standard summary for classifiers of all kinds and has been used to assess statistical models such as logistic regression as well as more exotic data mining models. We call it the Confusion Matrix or Prediction Success table following Nobel Prize-winning economist Daniel McFadden's 1979 paper on the subject. The table is a simple report cross-classifying true class membership against the predictions of the model.

Actual Class	Total Class	Percent Correct	Predicted Classes	
			0 N = 82	1 N = 53
0	91	76.92%	70	21
1	44	72.73%	12	32
Total:	135			
Average:		74.83%		
Overall % Correct:		75.56%		
Specificity		76.92%		
Sensitivity/Recall		72.73%		
Precision		60.38%		
F1 statistic		65.98%		

Actual Class column lists actual levels of the Target Variable. For each class:

- ◆ Total Class column shows total number of observations for the class.
- ◆ Percent Correct column shows percent of the class observations that were classified correctly.
- ◆ Other columns show how the model breaks down observations by the predicted class, the one assigned by the model.

You have an option to see Counts (the default, the **[Count]** button), percentages of actual class (the **[Row %]** button) and percentages of predicted class (the **[Column %]** button). The buttons are in the lower right corner of the display.

Under the confusion matrix you can find summary statistics for Percent Correct column. We show Average percent correct and Overall % Correct. The latter is the percent of correctly classified cases out of all cases in the dataset.

- ✓ For binary target models, class assignments are based on a specific threshold, which can be changed using the Threshold control at the bottom. A higher threshold will decrease sensitivity and increase specificity. There is the **[Baseline]** button that will set threshold to percent of target class in the sample. The **[Balance]** button tries to find a threshold that minimizes difference in **Percent Correct** between classes. The **[Show Table...]** button opens a new window with a table summarizing misclassification stats for each available threshold.

For binary targets we provide values for **Specificity**, **Sensitivity/Recall**, **Precision**, and **F1 statistic**. These values are shown for the Focus class specified in the Focus Class combo box.

Sensitivity/Recall	Probability for the Focus class cases to be classified by the model as Focus class ones. Computed as number of correctly classified Focus class cases divided by total number of Focus class cases in the dataset. This measure is also known as Recall.
Specificity	Probability for the non-Focus class cases to be classified as non-Focus class ones. Computed as number of correctly classified non-Focus class cases divided by total number of non-Focus class cases in the dataset.
Precision	Computed as number of correctly classified Focus class cases divided by total number of cases classified as Focus class.
F1 statistic	$2 \times \text{Precision} \times \text{Recall} / (\text{Precision} + \text{Recall})$

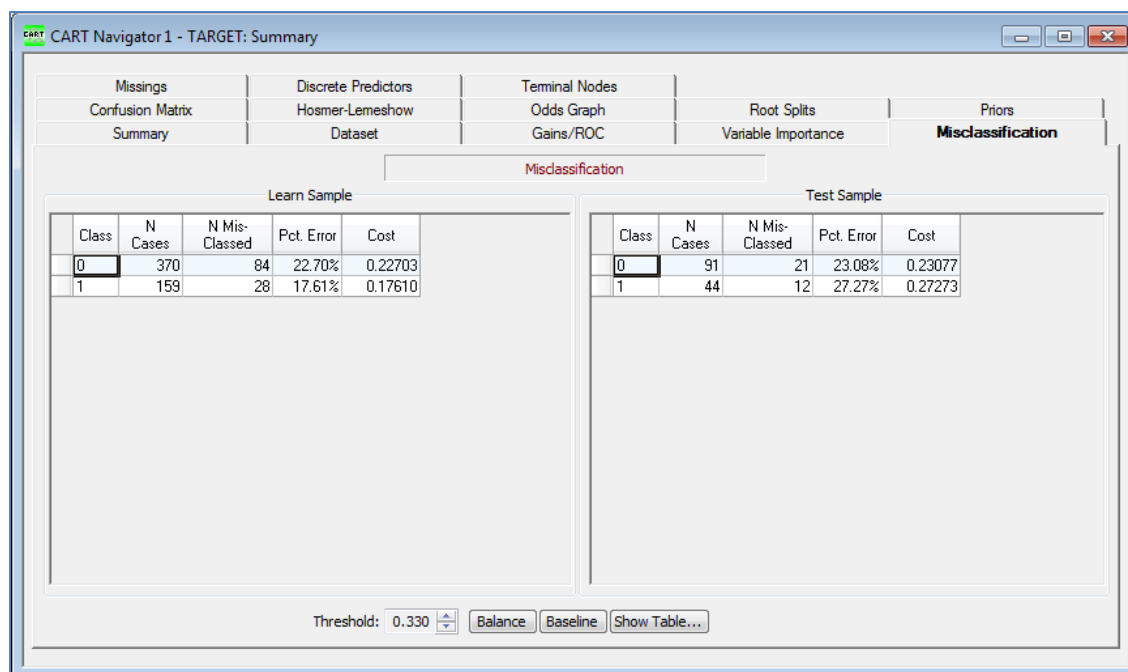
**Prediction success** tables based on the learn sample are usually too optimistic. You should always use prediction success tables based on the test sample (or on cross validation, when a separate test sample is not available) as fair estimates of a Classification Model performance.

### Misclassification tab

✓ This is a classification-only feature.

The Misclassification report shows how many cases were incorrectly classified in the overall tree for both learn and test samples.

✓ Stats for cross-validated samples are shown as Test.



For binary target models, class assignments are based on a specific threshold, which can be changed using the Threshold control at the bottom. A higher threshold will decrease sensitivity and increase specificity. The **[Balance]**, **[Baseline]** and **[Show table...]** buttons are explained in the **Confusion Matrix** tab sub-section.

### Hosmer-Lemeshow tab

- ✓ This is a binary classification-only feature.

This tab shows the results of Hosmer-Lemeshow goodness of fit test for binary classification models. Responses from model are binned into ten deciles and several statistics are computed for each bin.

For a given bin  $i$  Chi squared component is computed by the following formula.

$$X_i^2 = \frac{(ResponseObserved_i - ResponseExpected_i)^2}{ResponseExpected_i \cdot (1 - \frac{ResponseExpected_i}{n_i})}$$

Under the table we show the Total Chi-Square value (sum of Chi-Sq statistics per each bin) and **P-value of Hosmer-Lemeshow statistics** (HL Stat. P-value) under the grid.

TreeNet Output 2 - TARGET: Summary for 200 Trees

Summary	Dataset	Gains/ROC		Variable Importance		Misclassification	
Confusion Matrix	Hosmer-Lemeshow	Odds Graph		Score Distribution			

Hosmer-Lemeshow Table

	Decile	1	2	3	4	5	6	7	8	9	10
Response	Observed	0	1	1	3	4	2	7	7	9	10
	Expected	1.31	1.39	1.47	1.65	2.11	2.80	4.71	6.85	8.36	9.64
Non-Response	Observed	14	13	13	11	10	11	6	6	4	3
	Expected	12.69	12.61	12.53	12.35	11.89	10.20	8.29	6.15	4.64	3.36
Avg. Observed Prob.		0.00	0.07	0.07	0.21	0.29	0.15	0.54	0.54	0.69	0.77
Avg. Predicted Prob.		0.09	0.10	0.11	0.12	0.15	0.22	0.36	0.53	0.64	0.74
Chi-Sq Component		1.44	0.12	0.17	1.26	2.01	0.29	1.75	0.01	0.14	0.05
Log Odds Observed			-2.56	-2.56	-1.30	-0.92	-1.70	0.15	0.15	0.81	1.20
Log Odds Predicted		-2.27	-2.21	-2.14	-2.01	-1.73	-1.29	-0.57	0.11	0.59	1.05
Records in Bin		14	14	14	14	14	13	13	13	13	13
% Records in Bin		10.37	10.37	10.37	10.37	10.37	9.63	9.63	9.63	9.63	9.63

Precision: 2 Equal width Balanced Total Chi-Sq: 7.23231 HL Stat, P-value: 0.511788 Learn Test Holdout

- ✓ For a binary target, the choice of Focus class does not affect the essence of the results.

Response Observed	Sum of Case Weights for Focus Class observations in the bin.
Response Expected	Sum of Model responses for Focus Class observations in the bin.
Non-Response Observed	Sum of Case Weights for non-Focus Class observations in the bin.
Non-Response Expected	Sum of Model responses for non-Focus Class observations in the bin.
Avg. Observed Prob.	<b>Response Observed</b> divided by sum of Case Weights of all observations in the bin.
Avg. Predicted Prob.	<b>Response Expected</b> divided by sum of Model responses for all observations in the bin
Chi-Sq Component	Contains Chi squared component computed by formula described above
Log Odds Observed	Log from <b>Avg. Observed Prob.</b> divided by $(1 - \text{Avg. Observed Prob.})$
Log Odds Predicted	Log from <b>Avg. Predicted Prob.</b> divided by $(1 - \text{Avg. Predicted Prob.})$

Records in Bin	Number of cases in the bin
% Records in Bin	Percent of cases in the bin from total number in sample

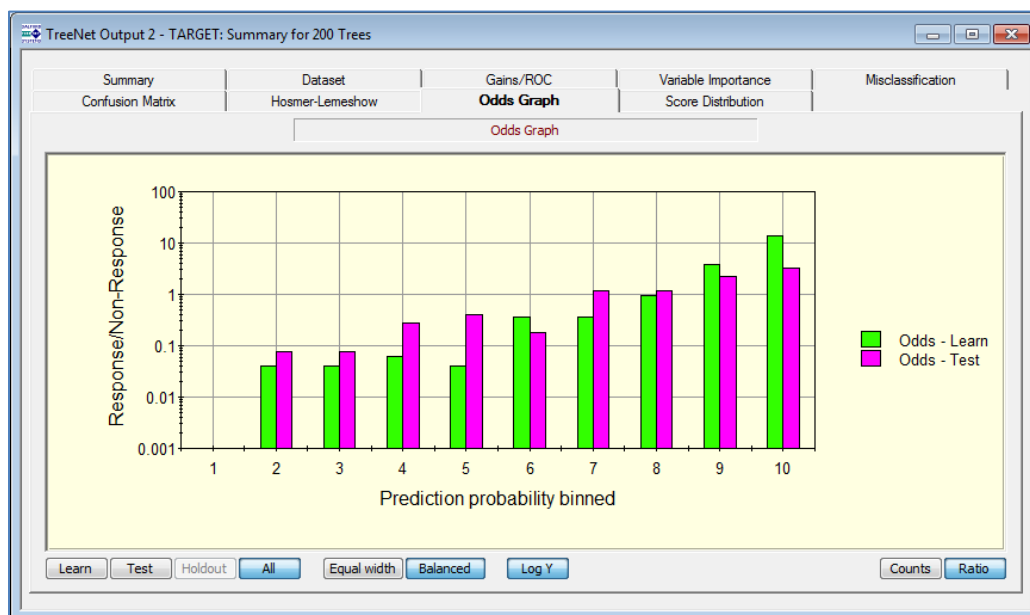
You can switch between the following alternative breakdowns of records into bins

- **[Equal width]** – each bin is populated with cases with predicted probabilities in the range of a decile (e.g. a decile of probabilities between 0.1 and 0.2).
  - **[Balanced]** – each bin has the same sum of Case Weights.
- ☛ **CART®** uses nodes as bins so this condition cannot be satisfied exactly.

## Odds Graph tab

✓ This is a binary classification-only feature.

Odds graph visualizes the **Hosmer-Lemeshow** table as a chart.



The chart supports the following modes.

- ♦ **[Counts]** button – shows just raw sum of weights for cases predicted as focus class (Response\Non-Response Expected rows).
- ♦ **[Ratio]** button – shows ratio of Response Expected divided to Non-Response Expected.

**[Log Y]** button switches Y-axis between normal and logarithmic scales.

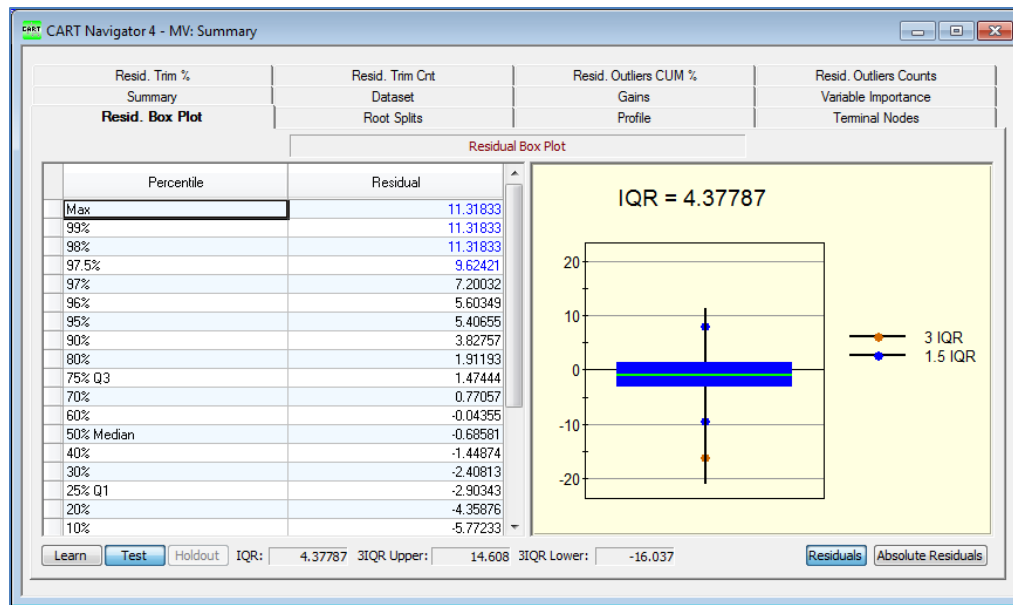
See **Hosmer-Lemeshow** tab for descriptions of other controls.

## Residual Box Plot tab

✓ This is a regression-only feature.

This tab shows a percentile table and box plot for residuals between values of the Target variable and predicted responses.





At the bottom we show Inter Quartile Range (IQR) of the distribution, Lower, and Upper bound of 3\*IQR. There are markers on the plot for Upper and Lower bounds of 1.5, 3 and 5 multiples of IQR. Lower bound is computed as  $Q1 - 1.5 * IQR$  and upper bound as  $Q3 + 1.5 * IQR$ .

You can switch the display to show absolute values of the residuals using the [Absolute Residuals] button.

## Residual Trim % and Residual Trim Counts tabs

- ✓ This is a regression-only feature.
- ✓ These tabs are called Error Statistics % and Error Statistics Counts in previous versions of the SPM.

Each of the **Residual Trim** tabs shows the effect on performance measures of the model if some quantities of residual records are excluded from performance estimation.

Residual Trim % shows a set of performance measures computed after some **percentage** of residuals is trimmed. **N** column shows outlying records count after residuals are trimmed. First row shows performance stats for the entire data sample.

CART Navigator 4 - MV: Summary

Summary		Dataset		Gains		Variable Importance	
Resid. Box Plot		Root Splits		Profile		Terminal Nodes	
Resid. Trim %		Resid. Trim Cnt		Resid. Outliers CUM %		Resid. Outliers Counts	

Performance By Largest (absolute value) Residuals Trimming

Percentile	N Residuals	R-Sq	MSE	MAD	RMSE	MAPD	SSE	AIC	AICc	BIC
100.00%	92	0.65390	21.17136	3.17326	4.60123	0.17906	1,947.76474	306.84372	311.51039	339.62697
99.00%	92	0.65390	21.17136	3.17326	4.60123	0.17906	1,947.76474	306.84372	311.51039	339.62697
98.00%	91	0.73102	16.61232	2.97866	4.07582	0.16813	1,511.72070	281.72313	286.45040	314.36431
97.50%	90	0.77111	14.26960	2.84418	3.77751	0.16290	1,284.26404	265.23183	270.02130	297.72935
97.00%	90	0.77111	14.26960	2.84418	3.77751	0.16290	1,284.26404	265.23183	270.02130	297.72935
96.00%	89	0.75565	12.99055	2.74897	3.60424	0.16219	1,156.15937	254.21581	259.06914	286.56808
95.00%	88	0.73173	11.68244	2.65159	3.41796	0.16146	1,028.05470	242.31164	247.23056	274.51702
90.00%	83	0.78082	8.62086	2.33686	2.93613	0.13359	715.53159	204.79737	210.07273	236.24229
80.00%	74	0.85138	5.75873	1.93344	2.39974	0.10963	426.14617	155.55308	161.61975	185.50593
75.00%	69	0.87870	4.49523	1.72469	2.12020	0.09805	310.17115	129.70822	136.32640	158.75161
70.00%	65	0.89868	3.60771	1.56345	1.89940	0.09140	234.50127	109.39979	116.53705	137.66683
60.00%	56	0.93314	2.24087	1.25758	1.49695	0.07533	125.48893	71.18449	79.85116	97.51406
50.00%	46	0.95284	1.31611	0.97994	1.14722	0.05181	60.54125	38.63544	50.01044	62.40778
40.00%	37	0.97405	0.78175	0.76378	0.88417	0.03917	28.92473	16.88983	32.71591	37.83176
30.00%	28	0.98761	0.38090	0.55333	0.61717	0.03062	10.66530	-1.02587	24.97413	16.29279
25.00%	23	0.99070	0.26299	0.46681	0.51282	0.02502	6.04869	-4.71999	35.72445	10.04143
20.00%	19	0.99023	0.19625	0.40483	0.44301	0.02340	3.72882	-4.93860	67.86140	7.33911
10.00%	10	0.99042	0.09125	0.36416	0.39606	0.01442	0.91252	-0.90704	149.21555	4.92155

Precision: 5

N Learn: 414 N Test: 92

Learn Test Holdout

As follows from the grid above, if we consider just 90% of the data, excluding 10% of most outlying records (total of 9 records is trimmed), MSE, for example, drops from 21.2 to 8.6.

Residual Trim Counts shows a set of performance measures computed after some **number** of residuals is trimmed. Percentile column shows how much data, in percents, remains in the sample.

CART Navigator 4 - MV: Summary

Summary	Dataset	Gains	Variable Importance
Resid. Box Plot	Root Splits	Profile	Terminal Nodes
Resid. Trim %	Resid. Trim Cnt	Resid. Outliers CUM %	Resid. Outliers Counts

Performance By Largest (absolute value) Residuals Trimming

Percentile	N Residuals	R-Sq	MSE	MAD	RMSE	MAPD	SSE	AIC	AICc	BIC
100.00%	92	0.65390	21.17136	3.17326	4.60123	0.17906	1,947.76474	306.84372	311.51039	339.62697
98.91%	91	0.73102	16.61232	2.97866	4.07582	0.16813	1,511.72070	281.72313	286.45040	314.36431
94.57%	87	0.74566	10.91001	2.57998	3.30303	0.15989	949.17068	233.90221	238.88851	265.95901
89.13%	82	0.79211	8.20270	2.28548	2.86404	0.12971	672.62173	198.56604	203.91898	229.85339
72.83%	67	0.89446	4.01651	1.64092	2.00412	0.09419	269.10635	119.15774	126.02566	147.81874
45.65%	42	0.96329	1.05996	0.88285	1.02954	0.04600	44.51816	28.44556	41.44556	51.03527

Precision: 5

N Learn: 414

N Test: 92

Learn

Test

Holdout

## Residual Outliers % and Residual Outliers Counts tabs

- ✓ This is a regression-only feature.
- ✓ These tabs are called Error Outliers % and Error Outliers Counts in previous versions of SPM.

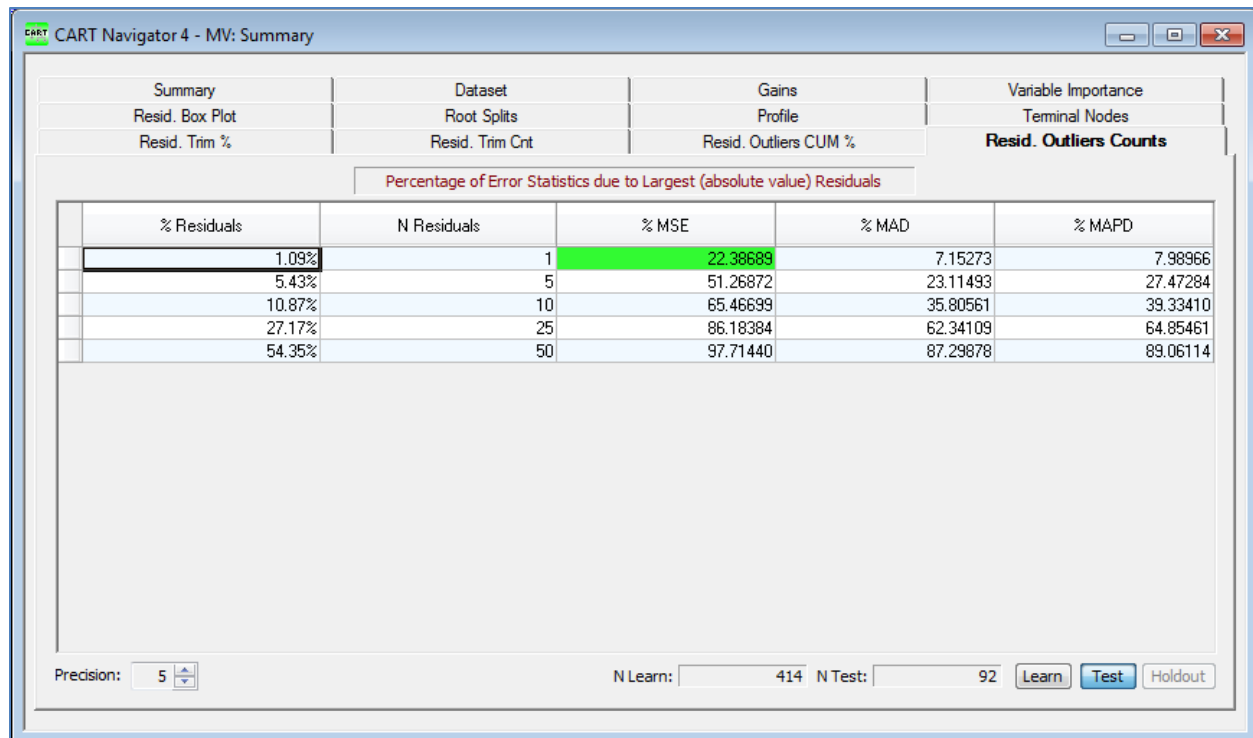
Each of the **Residual Outliers** tabs shows the effect on performance measures of the model if some quantities of outlier records are excluded from performance estimation.

**Residual Outlier CUM %** tab shows for each performance measure a percentage of performance measure value that is attributed to specific **percent of outliers**. N column shows number of outlying records for each percentage of outliers.

% Residuals	N Residuals	% MSE	% MAD	% MAPD
1.00%	1	22.38689	7.15273	7.98966
2.00%	2	34.06472	12.31875	15.11106
2.50%	3	40.64173	16.19569	20.85111
3.00%	3	40.64173	16.19569	20.85111
4.00%	4	47.21874	20.07263	24.73044
5.00%	5	51.26872	23.11493	27.47284
10.00%	10	65.46699	35.80561	39.33410
20.00%	19	79.37954	52.68763	55.62794
25.00%	23	84.07553	59.23684	61.84212
30.00%	28	88.73912	66.52399	69.04957
40.00%	37	93.97447	76.85345	79.29492
50.00%	46	96.89176	84.55936	86.50950
60.00%	56	98.63969	90.85387	92.16946
70.00%	65	99.52379	95.09688	95.66739
75.00%	69	99.68945	96.32232	96.75137
80.00%	74	99.83525	97.61230	97.82569
90.00%	83	99.96566	99.22494	99.31732
95.00%	88	99.99999	99.99999	99.99999

As follows from the grid above, removing 1 record (1 percent) of outlying records will reduce MSE by 22%.

**Residual Outliers Counts** tab shows for each performance measure a percentage that is attributed to specific **count of outliers**. %Residuals column shows the percentage of outlying records for each number of residuals.



Performance measure cells for which percent of error divided by percent of residuals is greater than 20% are highlighted **green**.

For example, in the screenshot above, 1% of residuals are responsible for 22% of MSE.