



THE  
POWER  
TO KNOW.

# Getting Started with **SAS<sup>®</sup> Enterprise Miner<sup>™</sup> 4.3**



The correct bibliographic citation for this manual is as follows: SAS Institute Inc. 2004. *Getting Started with SAS® Enterprise Miner™ 4.3*. Cary, NC: SAS Institute Inc.

**Getting Started with SAS® Enterprise Miner™ 4.3**

Copyright © 2004, SAS Institute Inc., Cary, NC, USA

ISBN 1-59047-231-4

All rights reserved. Produced in the United States of America. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, or otherwise, without the prior written permission of the publisher, SAS Institute Inc.

**U.S. Government Restricted Rights Notice.** Use, duplication, or disclosure of this software and related documentation by the U.S. government is subject to the Agreement with SAS Institute and the restrictions set forth in FAR 52.227-19 Commercial Computer Software-Restricted Rights (June 1987).

SAS Institute Inc., SAS Campus Drive, Cary, North Carolina 27513.

1st electronic book, March 2009

SAS Publishing provides a complete selection of books and electronic products to help customers use SAS software to its fullest potential. For more information about our e-books, e-learning products, CDs, and hard-copy books, visit the SAS Publishing Web site at [support.sas.com/pubs](http://support.sas.com/pubs) or call 1-800-727-3228.

SAS® and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries. ® indicates USA registration.

Other brand and product names are registered trademarks or trademarks of their respective companies.

---

# Contents

## **Chapter 1 △ Introduction to SAS Enterprise Miner Software 1**

Data Mining Overview	1
Layout of the SAS Enterprise Miner Window	2
Using the Application Main Menus	3
Using the Toolbox	8
Using the Pop-Up Menus	8
Unavailable and Dimmed Items	9
Enterprise Miner Documentation	9

## **Chapter 2 △ Working with Projects 11**

Project Overview	11
Project Directory Structure	12
Viewing and Specifying Project Properties	13
Creating a New Local Project	16
Creating a Client/Server Project	17
Opening a Process Flow Diagram	25
Opening an Existing Project	26
Saving a Project Diagram	27
Running a Project Diagram	27
Closing Projects and Diagrams	28
Creating a New Diagram	28
Deleting Projects and Diagrams	28
Project Troubleshooting Tips	29
Exporting Enterprise Miner 4.3 Projects	30
Opening Enterprise Miner Release 4.2 and Earlier Projects	30

## **Chapter 3 △ Building Process Flow Diagrams 33**

Components Used to Build Process Flow Diagrams	33
Using the Diagram Workspace Pop-up Menu	35
Adding Nodes to a Diagram	35
Using the Node Pop-up Menu	36
Connecting Nodes in a Diagram	37
Cutting Connections in a Diagram	38
Deleting Nodes from a Diagram	39
Moving Nodes in a Diagram	40
Copying and Pasting a Node	40
Cloning a Node	40

## **Chapter 4 △ Process Flow Diagram Logic 43**

Organization of Enterprise Miner Nodes	43
Sampling Nodes	44

Exploring Nodes	45
Modifying Nodes	46
Modeling Nodes	47
Assessing Nodes	48
Scoring Nodes	48
Utility Nodes	49
Subdiagrams	50
Usage Rules for Nodes	54

## **Chapter 5 △ Common Features among Nodes 57**

Functionality	57
Data Tab	57
Variables Tab	58
Notes Tab	60
Results Browser	60
Viewing and Setting Node Defaults	60

## **Chapter 6 △ Data Structure Examples 63**

Types of Data Structures	63
Regression Data	64
Association Discovery Data	66

## **Chapter 7 △ Example Process Flow Diagram 69**

Process Flow Diagram Scenario	69
Task 1. Creating a New Local Project	72
Task 2. Defining the Input Data Set	73
Task 3. Setting the Target Variable	74
Task 4. Defining a Target Profile for the GOOD_BAD Target Variable	74
Task 5. Examining Summary Statistics for the Interval and Class Variables	79
Task 6. Creating Training and Validation Data Sets	79
Task 7. Creating Variable Transformations	81
Task 8. Creating a Stepwise Logistic Regression Model	84
Task 9. Creating a Multilayer Perceptron Neural Network Model	87
Task 10. Creating a Tree Model	92
Task 11. Assessing the Models	95
Task 12. Defining the Score Data Set	98
Task 13. Scoring the Score Data Set	99
Task 14. Viewing the Expected Losses in the Score Data Set	100
Task 15. Creating a Score Card of the Good Credit Risk Applicants	104
Task 16. Closing the Diagram	106

## **Appendix 1 △ References 107**

References	107
------------	-----

## **Appendix 2 △ Variable Layout for SAMPSIO.DMAGECR (German Credit Data Set) 109**

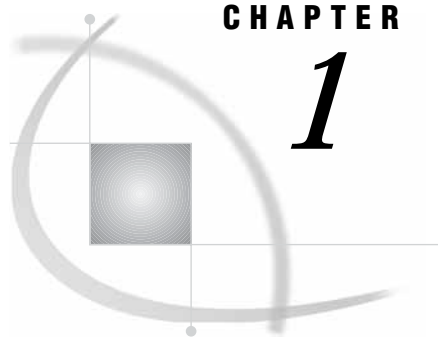
SAMPSIO.DMAGECR (German Credit Data Set)	109
--	-----

## **Appendix 3 △ Recommended Reading 111**

Recommended Reading	111
---------------------	-----

## **Glossary 113**

## **Index 123**



## CHAPTER

## 1

# Introduction to SAS Enterprise Miner Software

<i>Data Mining Overview</i>	1
<i>Layout of the SAS Enterprise Miner Window</i>	2
<i>Using the Application Main Menus</i>	3
<i>Using the Toolbox</i>	8
<i>Using the Pop-Up Menus</i>	8
<i>Unavailable and Dimmed Items</i>	9
<i>Enterprise Miner Documentation</i>	9

## Data Mining Overview

SAS defines *data mining* as the process of uncovering hidden patterns in large amounts of data. Many industries use data mining to address business problems and opportunities such as fraud detection, risk and affinity analyses, database marketing, householding, customer churn, bankruptcy prediction, and portfolio analysis. The SAS data mining process is summarized in the acronym SEMMA, which stands for sampling, exploring, modifying, modeling, and assessing data.

- *Sample* the data by creating one or more data tables. The sample should be large enough to contain the significant information, yet small enough to process.
- *Explore* the data by searching for anticipated relationships, unanticipated trends, and anomalies in order to gain understanding and ideas.
- *Modify* the data by creating, selecting, and transforming the variables to focus the model selection process.
- *Model* the data by using the analytical tools to search for a combination of the data that reliably predicts a desired outcome.
- *Assess* the data by evaluating the usefulness and reliability of the findings from the data mining process.

You might not include all of these steps in your analysis, and it might be necessary to repeat one or more of the steps several times before you are satisfied with the results. After you have completed the assessment phase of the SEMMA process, you apply the scoring formula from one or more champion models to new data that might or might not contain the target. The goal of most data mining tasks is to apply models that are constructed using training and validation data to make accurate predictions about observations of new, raw data.

The SEMMA data mining process is driven by a process flow diagram, which you can modify and save. The GUI is designed in such a way that the business analyst who has little statistical expertise can navigate through the data mining methodology, while the quantitative expert can go “behind the scenes” to fine-tune the analytical process.

Enterprise Miner contains a collection of sophisticated analysis tools that have a common user-friendly interface that you can use to create and compare multiple

models. Statistical tools include clustering, self-organizing maps / Kohonen, variable selection, trees, linear and logistic regression, and neural networking. Data preparation tools include outlier detection, variable transformations, data imputation, random sampling, and the partitioning of data sets (into train, test, and validate data sets). Advanced visualization tools enable you to quickly and easily examine large amounts of data in multidimensional histograms and to graphically compare modeling results.

Enterprise Miner is designed for PCs that are running under Windows 95, 98, NT, 2000, XP, or subsequent releases of those operating environments. The figures and screen captures presented in this document were taken on a PC running under Windows NT 4.0.

---

## Layout of the SAS Enterprise Miner Window

To start Enterprise Miner, start SAS and then type **miner** on the SAS command dialog bar. The SAS Enterprise Miner window opens:



The SAS Enterprise Miner window contains the following interface components:

- Project Navigator — You use the Project Navigator to manage projects and diagrams, add tools to the Diagram Workspace, and view HTML reports that are created by the Reporter node. Note that when a tool is added to the Diagram Workspace, it is referred to as a node. The Project Navigator has three tabs:
  - Diagrams tab — lists the current project and the diagrams within the project. By default, Enterprise Miner creates a local project that uses your user ID as the name (for this example, **Phoenix**) and a process flow diagram that is named **Untitled**. When you reopen Enterprise Miner, the last project you were working with is loaded.
  - Tools tab — contains the Enterprise Miner Tools Palette. The Tools Palette presents all the data mining tools that are available for constructing process flow diagrams. The tools are grouped according to the SEMMA data mining methodology.
  - Reports tab — contains the HTML report entries for the project. You generate reports using Enterprise Miner's Reporter node.

- **Diagram Workspace** — enables you to build, edit, run, and save process flow diagrams.
- **Tools Bar** — contains a customizable subset of Enterprise Miner tools that are commonly used to build process flow diagrams in the Diagram Workspace. You can add or delete tools from the Tools Bar.
- **Progress Indicator** — displays a progress indicator bar that indicates the execution status of an Enterprise Miner task.
- **Message Panel** — displays messages about the execution of an Enterprise Miner task.
- **Connection Status Indicator** — displays the remote host name and indicates whether or not the connection is active for a client/server project.

---

## Using the Application Main Menus

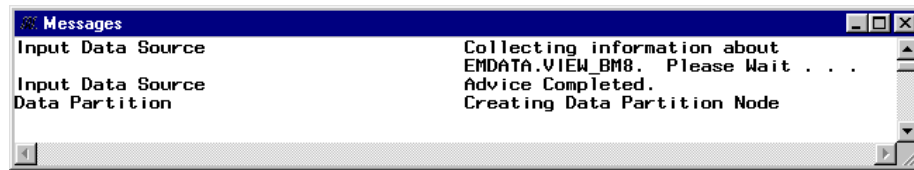
You use Enterprise Miner's application menus to perform common tasks. Different windows have different menus. Here is a brief summary of the SAS Enterprise Miner window pull-down menus:

- **File**
  - **New**
    - **Project** – creates a new project.
    - **Diagram** – creates a new diagram.
  - **Open** – opens a new or existing diagram within the current project.
  - **Save Diagram** – saves the current diagram to the project.
  - **Save Diagram as** – names and saves the current diagram to the project.
  - **Print Setup** – specifies printing options.
  - **Print** – prints the contents of the SAS Enterprise Miner window.
  - **Delete current project** – deletes the current project. If you select this menu item, then a message appears that asks you to verify the deletion.
 

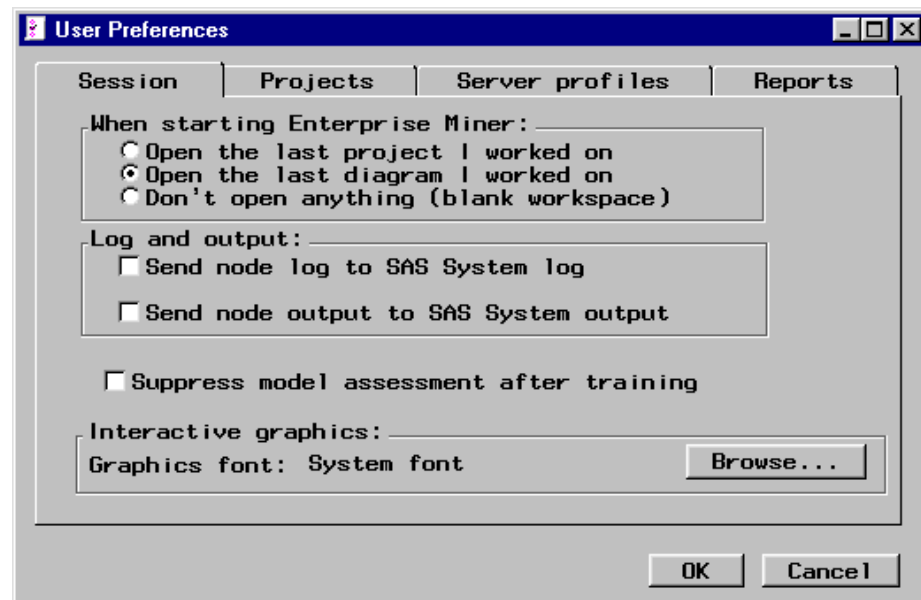
To delete the project, select Yes. All files in the project folder and any subfolders will be deleted. You cannot delete a project that someone else has opened.
  - **Close diagram** – closes and saves the diagram.
  - **Close project** – closes the project.
  - **Exit Enterprise Miner** – ends the Enterprise Miner session.
- **Edit**
  - **Copy diagram to clipboard** – copies the diagram to the clipboard.
  - **Undelete** – restores the last deleted node.
  - **Copy** – copies a node or object to the paste buffer. You must first select the node or object that you want to copy.
  - **Delete** – deletes the selected node or connection from the Diagram Workspace.
  - **Clone** – copies the current node and adds it to the Custom folder of the Tools Palette.
  - **Paste** – pastes the node, diagram, or object from the clipboard.
  - **Select all** – selects all nodes in the Diagram Workspace.
  - **Create subdiagram** – creates a subdiagram that you use to collapse a set of selected nodes and connections into a single Subdiagram node icon.

□ **View**

- **Messages** – opens the Messages window that displays collected messages for this diagram.



- **Refresh** – refreshes the Project Navigator and the Diagram Workspace view.
- **Up One Level** – displays the next higher level of the process flow diagram. If there are no subdiagrams in your process flow diagram, then only one level can be displayed. If there are subdiagrams in your process flow diagram, then the subdiagrams can be displayed either in their condensed form (hiding the internal structure of the subdiagram) or in their expanded form (showing their internal structure). The higher level displays subdiagrams in condensed form.
- **Top Level** – displays the process flow diagram in its most condensed form. All subdiagrams are condensed.
- **Options**
  - **User preferences** – opens the User Preferences window that enables you to specify start-up options, set the default directories for new projects, set up server profiles for client/server projects, and specify the HTML report items that you want to display when you run the Reporter node.

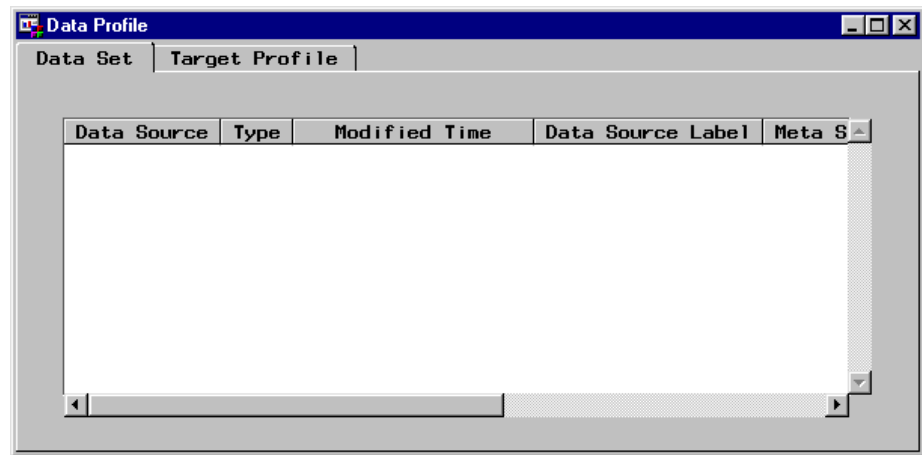


□ **Project**

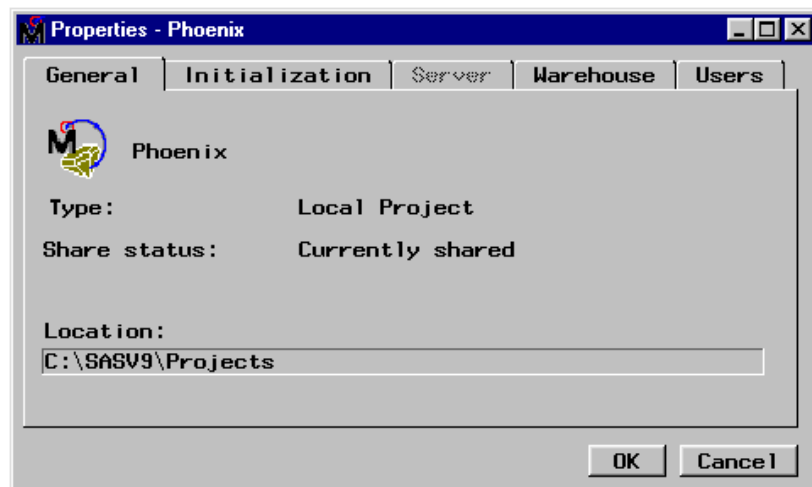
- **Data Profiles** – opens the Data Profile window that you use to define target profile information for a data set. For details, see the Target Profiler Help.

Help ► EM Reference Target Profiler



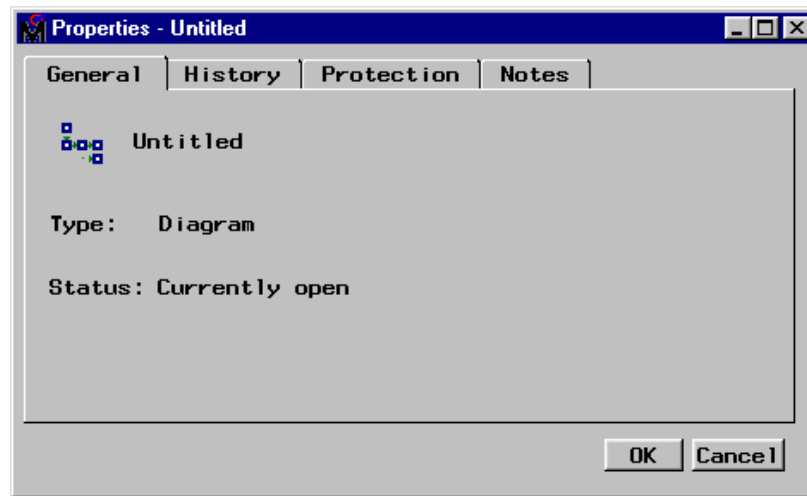


- **Properties** – shows project properties, such as the project name and type, share status, project location, server information, and a list of users that have the project open. You can also specify start-up and exit code that runs when the project is opened and closed, specify the SAS warehouse path, or update the project server profile. These settings can be specified if the project is opened by one user.



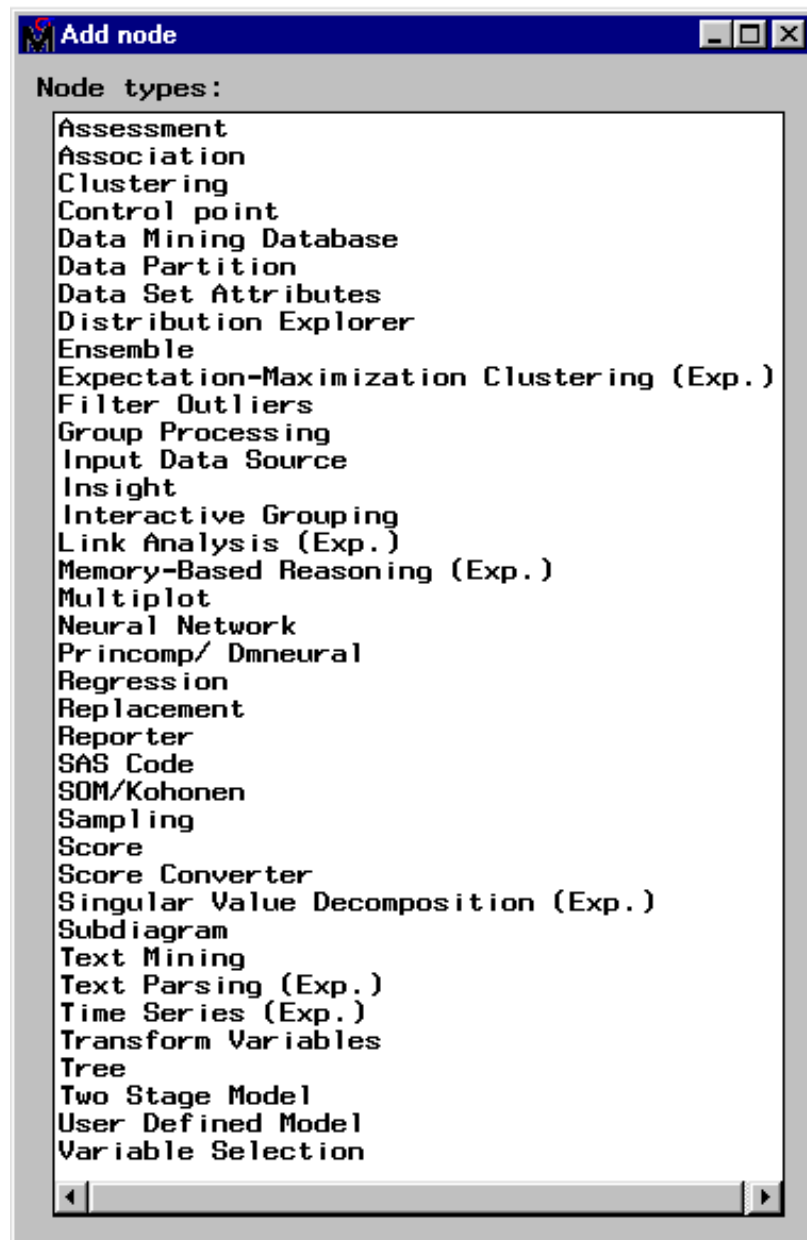
- **Diagram**
  - **Connect items** – a mode of editing where node icons are fixed in location, so that you can more easily make connections among them.
  - **Move items** – a mode of editing where node icons cannot be connected, so that you may more easily move the icons where you want them in the process flow diagram.
  - **Move and Connect**– (default) a mode of editing where node icons can be moved and connected in the Diagram Workspace.
  - **Large icons** – displays large node icons in the Diagram Workspace. This item is dimmed if a node is selected in the Diagram Workspace.
  - **Small icons** – (default) displays small node icons in the Diagram Workspace. This item is dimmed if a node is selected in the Diagram Workspace.
  - **Properties** – opens the Properties window that enables you to view diagram properties, such as the name, type, status, date created, and

date last modified. You can also apply password protection to the diagram and store notes about it.



☐ **Actions**

- ☐ **Open** – opens the selected node.
- ☐ **Run** – runs the selected node and any predecessor nodes in the process flow that have not been previously run.
- ☐ **Results**– opens the Results Browser for those nodes that generate results.
- ☐ **Add Node** – opens the Add node window that enables you to add a new node to the Diagram Workspace.



- **Add Endpoints** – adds endpoints to the process flow.
- **Help**
  - **Getting Started with Enterprise Miner Software** – an interactive Enterprise Miner Tutorial that provides an overview of data mining and the Enterprise Miner software.
  - **Help** – Enterprise Miner Reference Help. This is a hierarchical Help listing. You can also access Help for a given window in Enterprise Miner by clicking the **what's This?** icon from the Enterprise Miner Toolbox. After your mouse pointer changes into a question mark, click inside the window frame you would like Help on.
  - **About Enterprise Miner** – Production release information about your copy of Enterprise Miner.

## Using the Toolbox

In Enterprise Miner, the toolbox at the top of the SAS window appears as follows:



Tool tips are displayed when you hold your mouse pointer over a tool icon. The icons represent the following:

- 1 Open – opens a diagram within a project. You can also perform this task by using the main menu:

File ► Open

- 2 Save Diagram – saves the current diagram. You can also perform this task by using the main menu

File ► Save diagram

- 3 Delete Current Project – deletes the current project. You can also perform this task by using the main menu:

File ► Delete current project

- 4 User Preferences – opens the User Preferences window that you use to specify start-up options, set the default directories for new projects, set up server profiles for client/server projects, and specify the HTML report items that you want to display when you run the Reporter node. You can also open the User Preferences window from the main menu:

Options ► User preferences

- 5 Print Diagram – prints the current process flow diagram. You can also perform this task by using the main menu:

File ► Print

- 6 Copy Diagram to Clipboard – copies the diagram to the clipboard. You can also perform this task by using the main menu:

Edit ► Copy diagram to clipboard

- 7 What's This? – turns the mouse pointer into a question mark, indicating that Enterprise Miner is in Help mode. Click the question mark inside an Enterprise Miner window to get Help on the contents of the selected window frame.

- 8 Getting Started – launches the Enterprise Miner 4.3 online tutorial.

## Using the Pop-Up Menus

Many of the functions that are found in the Enterprise Miner main menus are available in pop-up menus. Right-click a GUI object within Enterprise Miner to get pop-up menus.

For example, instead of using the main menu to insert a diagram, follow these steps:

- 1 Select the Diagrams tab of the Project Navigator and right-click either the Project folder, the diagram icon, or anywhere in the background of the tab. A pop-up menu appears.
- 2 Select the **New Diagram** pop-up menu item. A new diagram is added to the project.

---

## Unavailable and Dimmed Items

At times particular window objects and menu items are unavailable for use. When a window object or menu item is unavailable, it appears dimmed and does not respond to mouse clicks. When the data mining settings are changed so that the object's use is contextually appropriate, then the objects become active and will accept user input.

When you configure statistical settings within a node, dimmed objects prevent you from selecting inappropriate option combinations. Selecting some options enables additional option settings that you should specify to completely configure your data mining node.

---

## Enterprise Miner Documentation

For more information, see

- *Enterprise Miner Reference Help* – describes how to use each Enterprise Miner node as well as other features of Enterprise Miner, such as the Target Profiler. Help is available through the Enterprise Miner main menu:

Help ► EM Reference

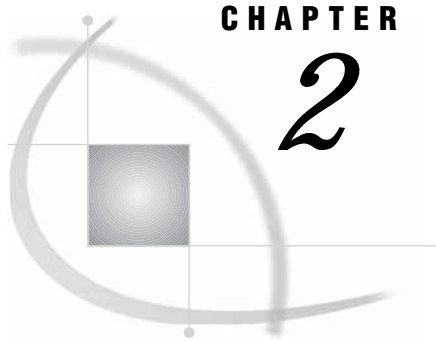
*Note:* You can search for text strings in the EM Reference Help, using the menu choices:

Edit ► Find

and typing in a search string. △

- *Frame Help* – Enterprise Miner nodes have Help available at the window frame level. For Help on a field or object that is contained in a particular window frame:
  - 1 Click the **What's This?** tool icon in the Enterprise Miner Toolbox. The mouse pointer changes into a question mark.
  - 2 Click inside the window that you would like help on.
- *Add-In Tools for SAS/Warehouse Administrator Software* – To download information about these tools, go to the SAS/Warehouse Administrator product page: <http://support.sas.com/rnd>.
- *Data Mining Using SAS Enterprise Miner: A Case Study Approach, Second Edition* – provides simple directions about how to begin accessing data and how to complete an analysis.





## CHAPTER

## 2

## Working with Projects

---

<i>Project Overview</i>	11
<i>Project Directory Structure</i>	12
<i>Project Location</i>	12
<i>EMDATA Directory</i>	13
<i>EMPROJ Directory</i>	13
<i>REPORTS Directory</i>	13
<i>Viewing and Specifying Project Properties</i>	13
<i>Creating a New Local Project</i>	16
<i>Creating a Client/Server Project</i>	17
<i>Defining a New Server Profile</i>	18
<i>How to Create a Client/Server Project</i>	22
<i>Using a Server Profile in Batch Mode to Connect to a Server</i>	25
<i>Opening a Process Flow Diagram</i>	25
<i>Opening an Existing Project</i>	26
<i>Saving a Project Diagram</i>	27
<i>Running a Project Diagram</i>	27
<i>Closing Projects and Diagrams</i>	28
<i>Creating a New Diagram</i>	28
<i>Deleting Projects and Diagrams</i>	28
<i>Project Troubleshooting Tips</i>	29
<i>Exporting Enterprise Miner 4.3 Projects</i>	30
<i>Opening Enterprise Miner Release 4.2 and Earlier Projects</i>	30

---

## Project Overview

A *project* is a collection of Enterprise Miner process flow diagrams and information that pertains to them. Projects are often differentiated by the type of data that you intend to analyze. In other words, it is a good idea to create a separate project for each major data mining problem that you intend to investigate. Local projects are useful when the data is available locally on your machine. If you need to access databases on a remote host or distribute the data-intensive processing to a more powerful remote host, then you should create a client/server project.

Both local projects and client/server projects are *shareable*; that is, multiple users can work on the same project simultaneously. In order for the project to be shareable, all parties must access the same client files. The server.cfg client file uses the remote server path to point to the server, allowing multiple users to work on the same project on both the client and server side.

Although projects are shareable, only one user can open a diagram at a time. Users can create, edit, and delete diagrams without affecting the work of others who are sharing that project, because each diagram is an independent unit. Node clones and

target profiles that were created by one user may be shared by other users for use in their own diagrams.

Updates to the project start-up or exit code, warehouse path, or server profile can be made only when there is one and only one person using the project. To learn about how to update these project settings, see “Viewing and Specifying Project Properties” on page 13. In a shared environment, it may be necessary to request everyone to close that project from within their own Enterprise Miner sessions, while an administrator makes the required changes. The same applies to renaming or deleting a project.

In an Enterprise Miner client/server project, the server profile is stored with the project, and is thus shared by all users of that project. Storing the profile with the project facilitates profile maintenance in a shared project environment.

---

## Project Directory Structure

For each project, Enterprise Miner dynamically creates a number of subdirectories that have the following structure:



*Note:* To view your project files in a Windows file browser, select the Diagrams tab of the Enterprise Miner Project Navigator, right-click a named project icon, and then select **Explore**. △

When you create a project, Enterprise Miner automatically assigns the EMDATA and EMPROJ librefs to the EMDATA and EMPROJ subdirectories, respectively. Enterprise Miner uses a standard directory structure and stores a given project's files in the root of the project directory. This enables you to back up or copy Enterprise Miner projects simply by placing a copy of the project directory and its subdirectories in the new location. Enterprise Miner does not limit the number of projects. There is a limit of 100,000 diagrams per project.

---

### Project Location

The project location directory contains the .dmp file that corresponds to the project definition, and the various .dmd files which represent the various diagrams that were created within the project. The name of the .dmp file defines the name of the project.

The following display shows the directory layout for a project named **Phoenix**.





This project contains a diagram named **My diagram.dmd**.

---

## EMDATA Directory

The EMDATA directory contains potentially large files that are created when you run the process flows in your project. When you are running a project in client/server mode, files are written to the server data directory instead. However, samples taken from the remote location are stored in your EMDATA directory so you can continue to work when a connection to the server is unavailable.

---

## EMPROJ Directory

Project files that contain information for each diagram and its nodes, the target profiler, and various registries are stored in the EMPROJ directory. Diagram lock (.lck) files are also placed in the EMPROJ directory every time a diagram is opened. This prevents two users from opening the same diagram at the same time. The name of the lock file is always identical to the name of the diagram in question, except for the .lck extension. For example, a diagram file that is named **My diagram.dmd** has a corresponding **My diagram.lck** lock file.

The USERS subdirectory contains files that represent the users currently sharing the project.

---

## REPORTS Directory

HTML reports generated by the Reporter node are stored in this directory. Each report has its own subdirectory. The name of the subdirectory defines the name of the report.

---

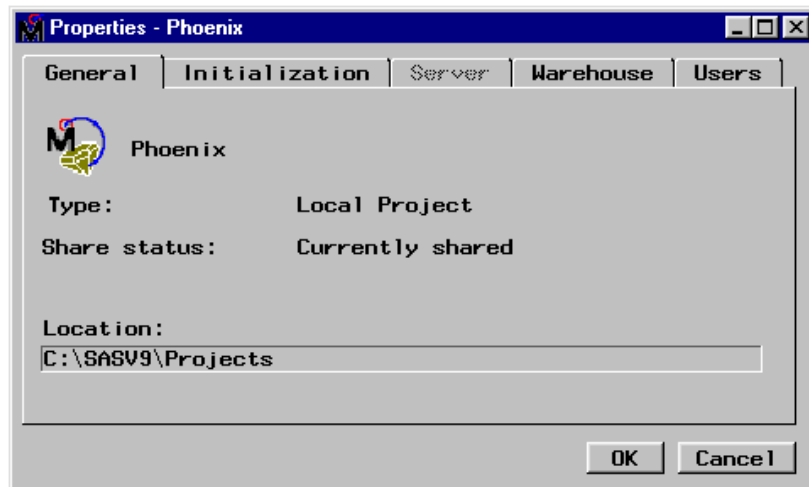
# Viewing and Specifying Project Properties

To view and customize properties for a project, use the main menu to select

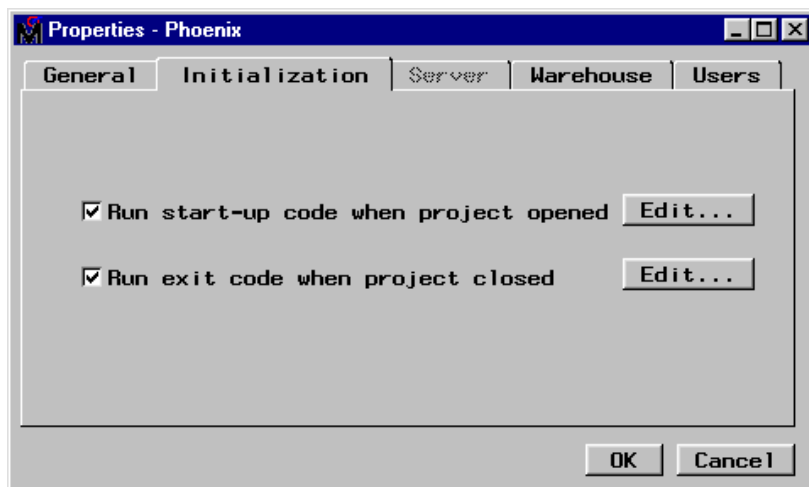
**Options** ► **Project** ► **Properties**

The Properties window opens. The properties window contains five tabs:

- General — displays the project name, type, share status, and location.

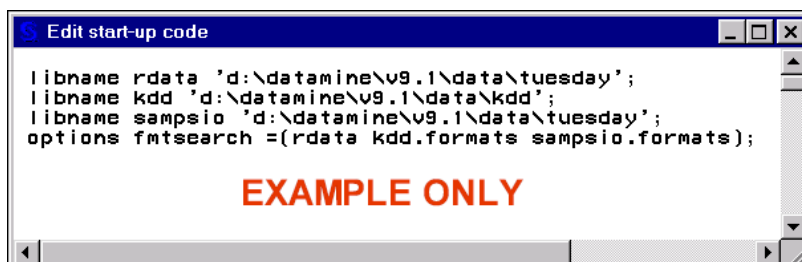


- Initialization — specifies whether to run start-up code (such as, assigning librefs to data sources for the project or specifying the format search paths via the FMTSEARCH option) when the project is opened, and exit code (such as clearing libref assignments and resetting global SAS options) when the project is closed.



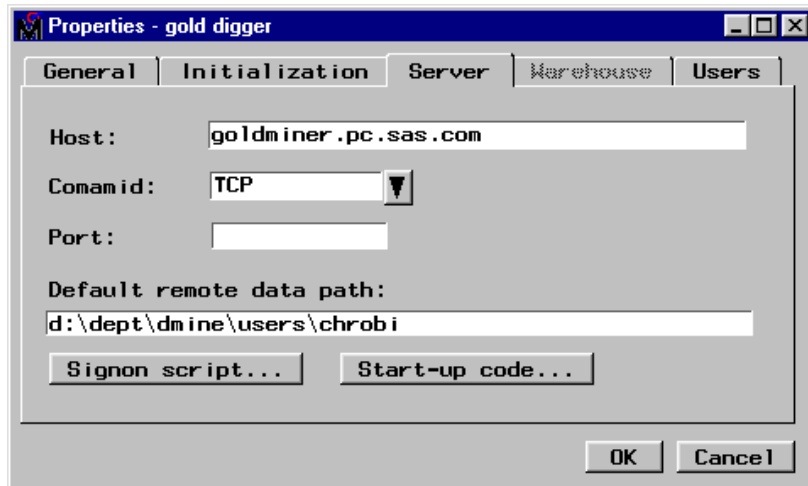
By default, start-up and exit code are enabled. To prevent either the start-up or exit code from running, deselect the appropriate check box. These options appear dimmed if the project is currently shared.

To define start-up or exit code, select **Edit** and type the code in the editor.

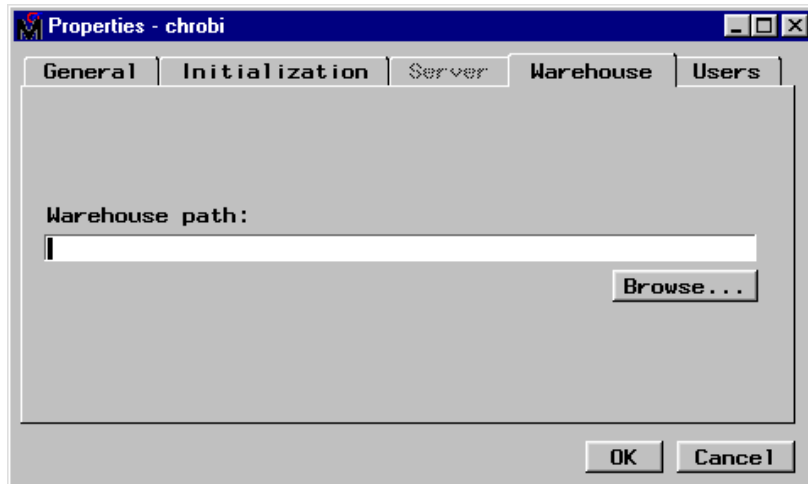


After entering your start-up code, close the window and save your changes.

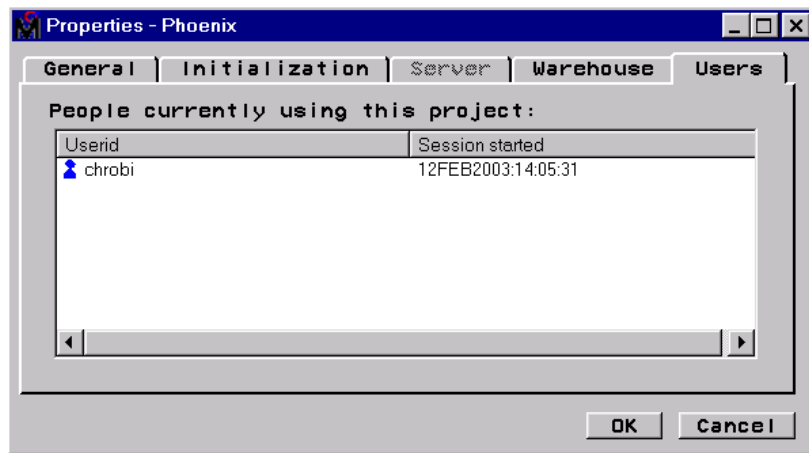
- **Server** — enables you to view and configure a default server profile. A server profile contains all the configuration information that is necessary to establish a connection on a remote server. You may edit the project server profile only when no one else is using the project. For details about this task, see “Creating a Client/Server Project” on page 17. Note that the Server tab is dimmed unless you are viewing the properties for a client/server project.



- **Warehouse** — enables you to type the warehouse path where the metadata sample was created from the Enterprise Miner Add-ins to the SAS/Warehouse Administrator. Alternatively, you can select **Browse** to find and set the warehouse path via an explorer interface.



- **Users** — lists the user ID and sign-on time for all of the users who currently have the project open.



After you have set the project properties, select **OK** in the Properties window or select **Cancel** to cancel your settings.

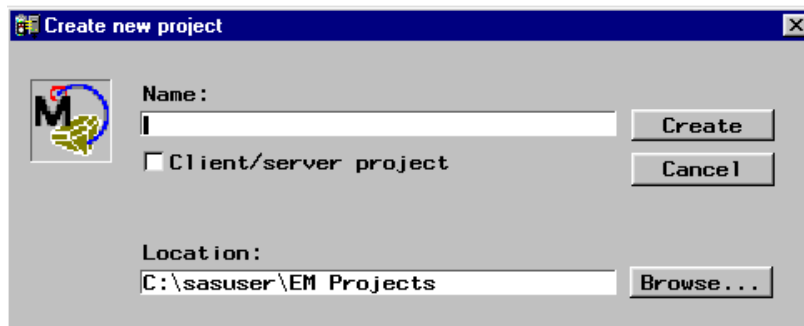
## Creating a New Local Project

To create a new local project:

- 1 From the **File** pull-down menu, select

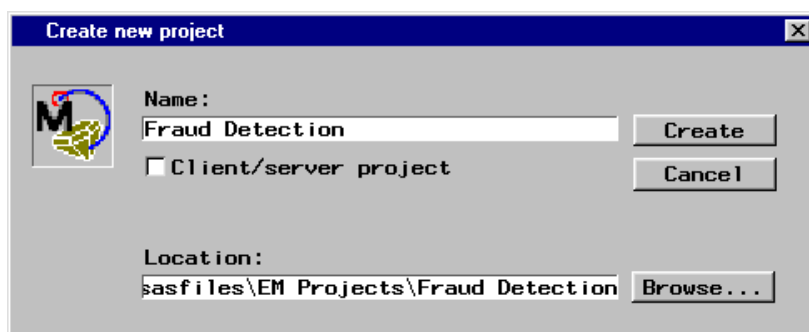
**New** ► **Project**

The Create New Project window opens:

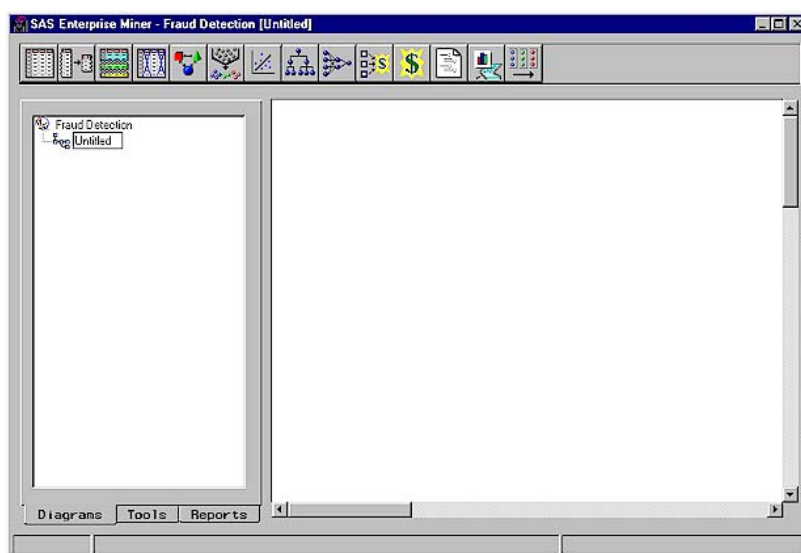


*Note:* To reset the default directory for new projects, use the **Options** pull-down menu to select **User preferences**. Select the **Directory** tab of the User Preferences window and specify the default directory path for new projects. △

- 2 Type the location where you want the project to be stored in the **Location** field. You can also select **Browse** to browse through the folders on your machine and set the project **Location** via an explorer interface.
- 3 Type the project name in the **Name** entry field.



- 4 To create the project, select **OK**. Enterprise Miner creates the project directories, and then loads the project as the active project in the SAS Enterprise Miner window. The project contains a default diagram named **Untitled**.



## Creating a Client/Server Project

Enterprise Miner enables you to access data sources (such as SAS data sets or database management systems) on a server to use with your local SAS Enterprise Miner session. SAS/CONNECT is the cooperative processing software that establishes the client/server connection between the remote and local hosts. For details, see the *SAS/CONNECT User's Guide*.

The client/server functionality provides the following advantages:

- distributes data-intensive processing to the most appropriate machine
- minimizes network traffic by processing the data on the server machine
- minimizes data redundancy by maintaining one central data source
- enables you to toggle between remote and local processing.

Defining a client/server project consists of two basic steps, which are accomplished via a project wizard:

- 1 Define the client location for the project by providing the name and a location for the project.
- 2 Provide a server profile. You can specify an existing profile or create a new profile.

*Note:* To use data sets that have user-defined formats on the server, you must ensure that the formats are available both locally and on the server. At the client, assign a format search path in a project's start-up code. At the server, use the server seed code to point to the format catalogs that reside on both the client and server. △

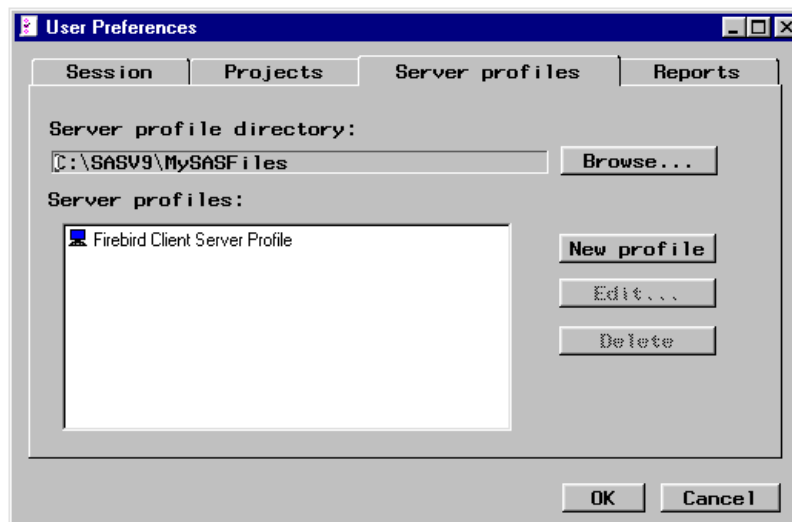
## Defining a New Server Profile

Before you define the location and name for the client/server project, you might want to define a new server profile as part of your user preferences. A server profile contains all of the information that is necessary to establish a connection to the remote server.

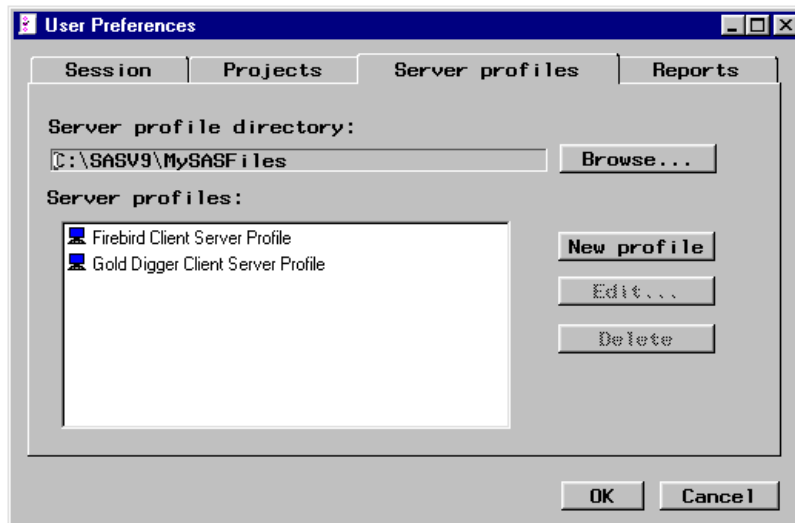
To define a new server profile, follow these steps:

- 1 Use the **Options** pull-down menu from the SAS Enterprise Miner window to select the **User Preferences** item.

The User Preferences window opens. You define the server profile in the Server profiles tab. This tab lists the current server profile directory and all of the profiles that are stored in this directory. By default, server profiles are stored in the SASUSER folder where Enterprise Miner was installed. To set the profile directory, select **Browse** to find and set the directory.

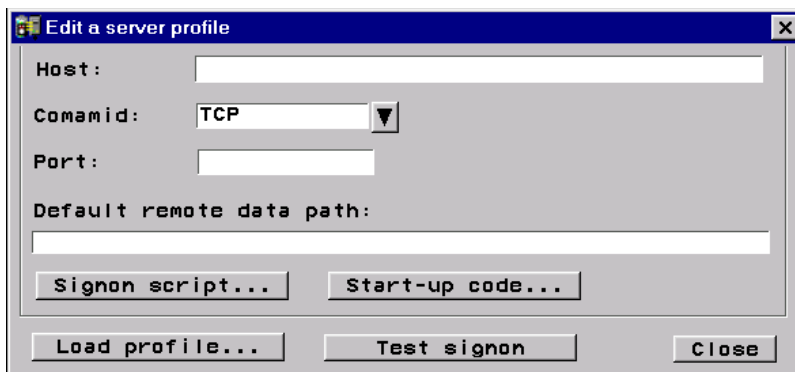


- 2 To create a new profile, select **New profile**. A new profile entry that is named **Untitled** is added to the list of server profiles. You can highlight the new profile to select it and type in a new name, such as Gold Digger.



*Note:* To edit an existing profile, click **Edit**. To rename a profile, right-click on the server profile in the list and select **Rename**. Type the profile name. To delete a profile, click **Delete**. △

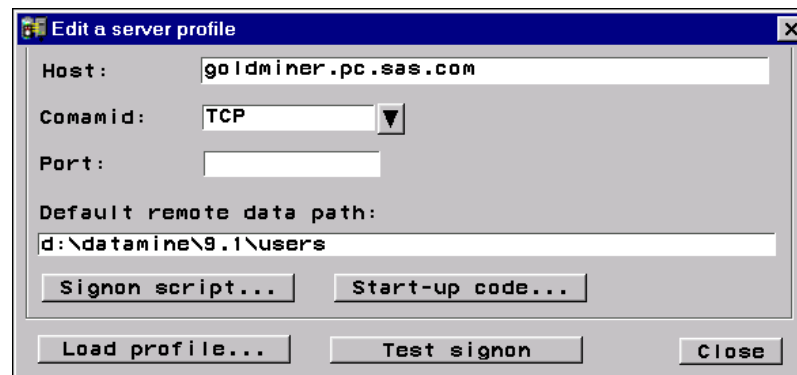
- 3 Type a more descriptive profile name.
- 4 Click **Edit**. The Edit a Server Profile window opens.



*Note:* To load the profile settings from an existing profile, select **Load profile**. Select the \*.srv file that contains the profile settings for the existing server. △

- 5 Type the remote host address name. The **Host** can be the machine name (for example, golddigger.pc.sas.com) or its numeric IP address (123.321.12.99). The address name for a NETBIOS network can contain a maximum of eight characters.
- 6 Select the drop-down arrow to set the **Comamid** parameter. The **Comamid** parameter identifies the communication access method that is used to connect to the remote host.
- 7 If a spawner is necessary to establish the remote connection, then type the share port that the agent spawner runs on. You can type either the service name (for example, shr3) or the port number (for example, 5012). The **Port** field is required if you are running a Windows NT server where the agent spawner has been set up to run on the share port. It is not required on other platforms.
- 8 Type the **Default remote data path** where Enterprise Miner will store large intermediate files on the server. The path should be specified according to the host machine's naming convention. The server must be able to reference this location,

and you must have write access to this path. Files in this path are accessed via remote library services when needed; they are not moved to the client.



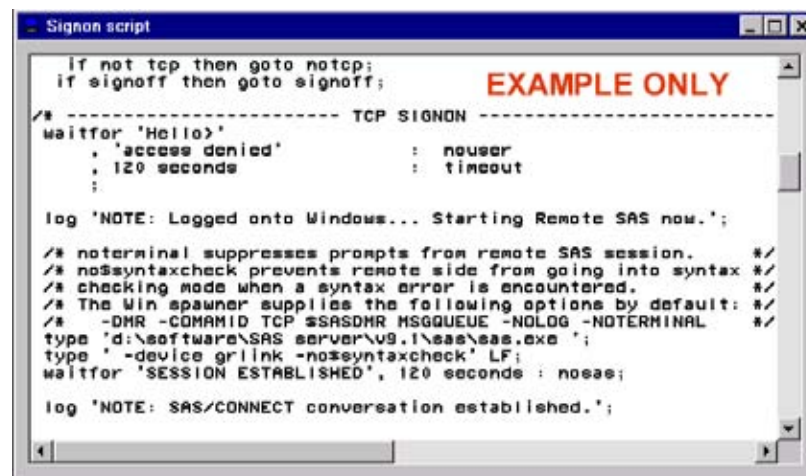
- 9 Set the sign on script file. If **Comamid** is set to **TCP**, then you must set the script file that is used to initiate and terminate the remote session. A *script file* is an external file on the local system that contains special SAS statements that control the connection. To set the script file, follow these steps:

- a Select **Signon script**. The Signon Script window opens. At this stage, you can open an existing script, or create a new one.
- b To open an existing script, use the main menu commands:

**File** ► **Open**

Alternatively, you can select the Open tool icon (third tool icon on the toolbox). Find and select the script (.scr) file in the Open window and then click **Open**. The script file is copied to the Signon Script window.

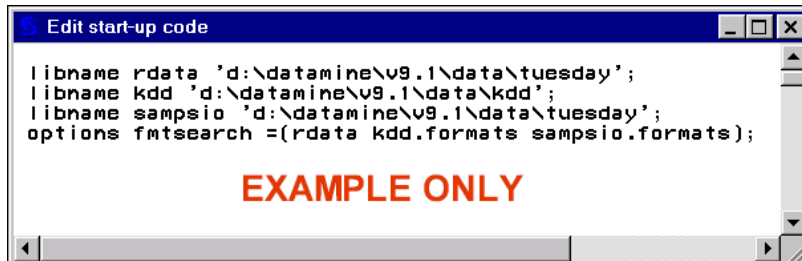
- c To create a new script file, type the script file statements in the Signon Script window or modify an existing script file. Save the script file by using the **File** pull-down menu to select **Save As**.



- d After you have set the script file, close the Signon Script window to return to the Edit a Server Profile window.
- 10 If you need to enter start-up code that runs when the server is initialized, select **Start-up Code**. The Start-up Code window opens. Type the start-up code in the Start-up Code window. You do not need to enclose the statements in an RSUBMIT



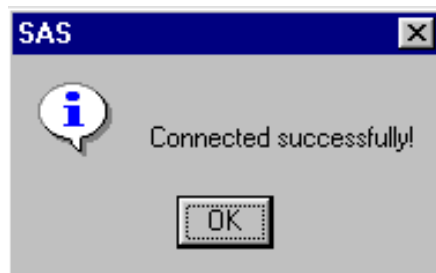
block. You might want to use this feature to assign a libref to a remote directory that contains SAS data sets via a LIBNAME statement or assign the SAS format search path via the FMTSEARCH option. When you have finished entering your start-up code, close the window. Your code is saved, and you return to the Edit a Server Profile window.



11 To test the server profile, select **Test signon**.



The Test Result window opens, indicating whether Enterprise Miner was able to establish a connection to the server.



If the connection failed, review the above steps to determine where you might have incorrectly configured the server profile. You might want to consult your systems administrator.

After you have configured the server profile, close the Edit a Server Profile window. A message window opens that prompts you to save your changes to the server profile. Select **Yes** to save your changes. Select **No** to prevent your changes from being saved and to return to the SAS Enterprise Miner window. Select **Cancel** to return to the Edit a Server Profile window.

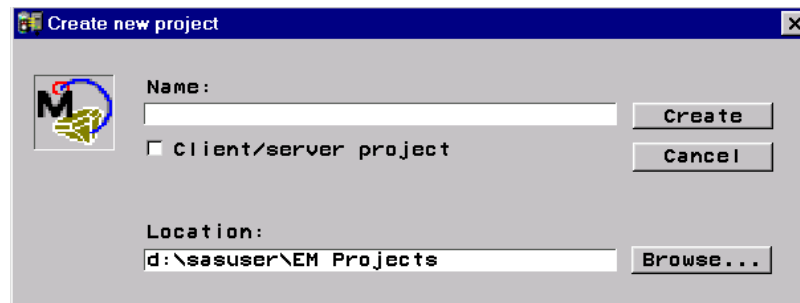
## How to Create a Client/Server Project

To create a client/server project, follow these steps:

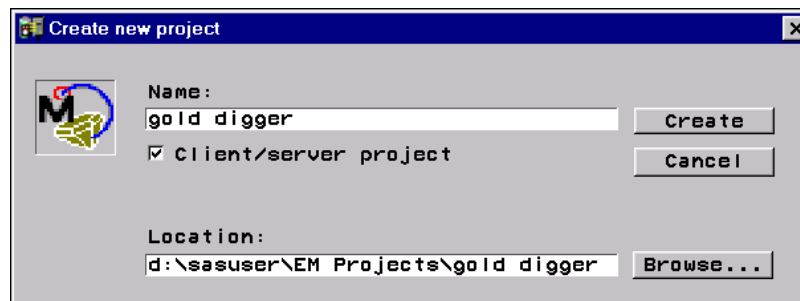
- 1 Use the main menu to select

File ► New ► Project

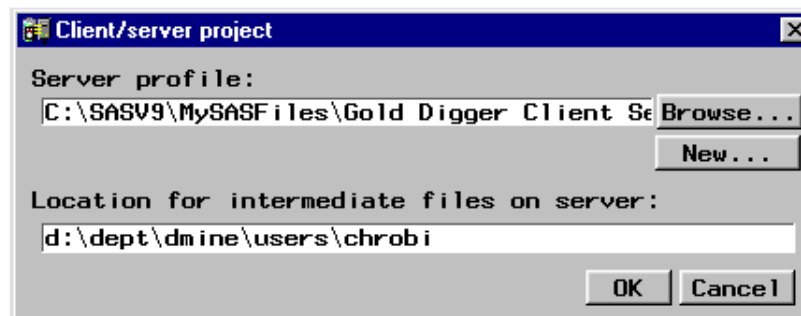
The Create New Project window opens:



- 2 Type a name in for the project and select the **Client/server project** box. Use the **Location** field to specify the path where you want to store your project files. The path that you specify becomes the root of your project directory structure.



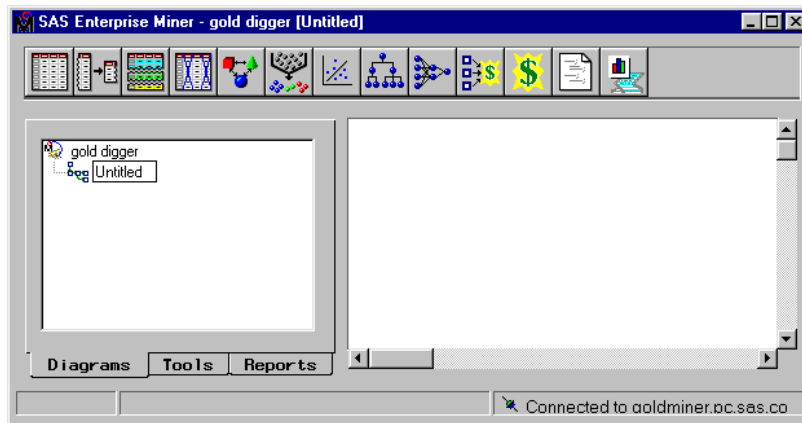
- 3 Select **Create**. The Client/server project window opens.
- 4 Specify an existing **Server profile** or create a new one.
  - To specify an existing server profile (a .srv file), use **Browse** to find and set the server profile or type the server profile pathname. You can also define a server profile in advance as part of the user preferences.



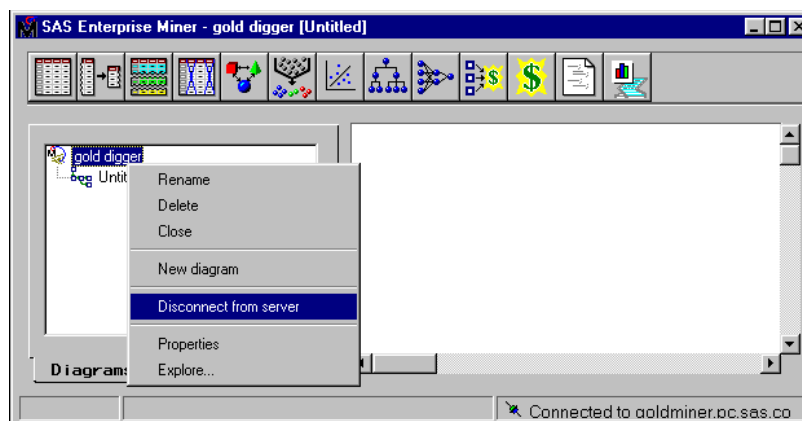
- To create a new server profile, select **New**. Follow the steps outlined in “Defining a New Server Profile” on page 18.
- 5 After you have defined the server profile, select **OK** to create the client/server project.
  - 6 A message window opens asking you if you want to connect to the server.



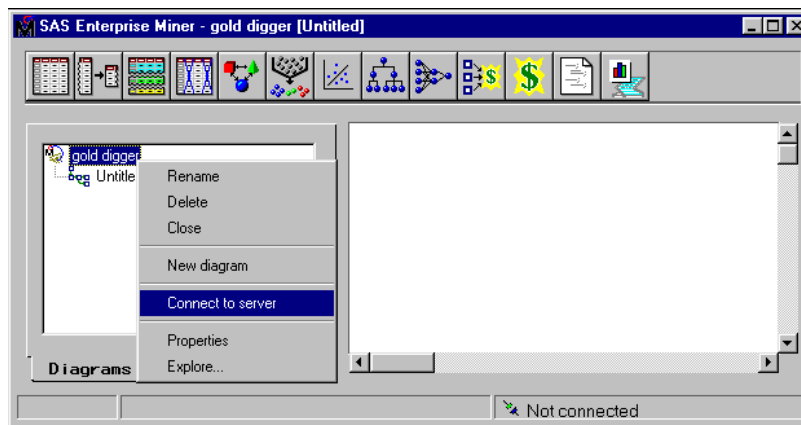
Select **Yes** to connect to the server or select **No** to run the project locally. The project is automatically loaded as the active project in the SAS Enterprise Miner window. The connection status indicator at the lower-right corner of the window indicates whether the project is connected to the server.



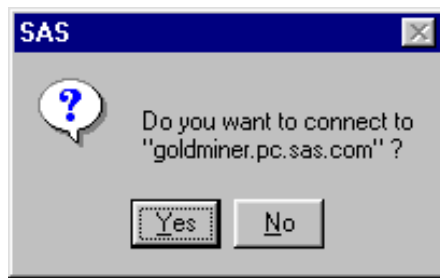
To disconnect from the server, right-click on the project folder in the Project Navigator and select **Disconnect from server** from the pop-up menu.



To connect to the server, right-click on the project folder in the Project Navigator and select **Connect to server** from the pop-up menu.

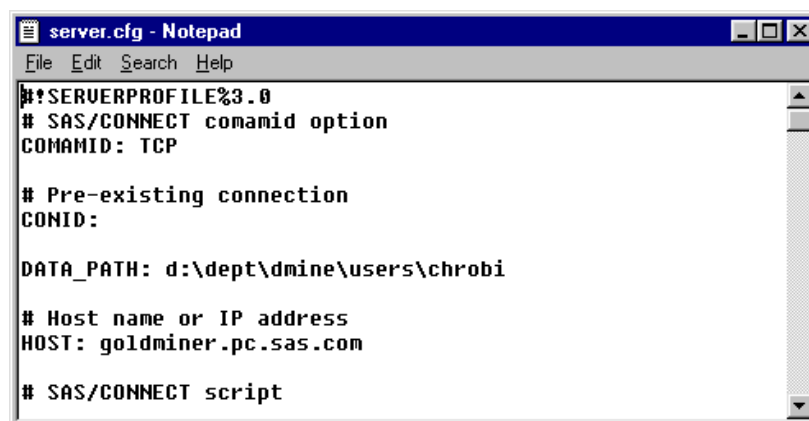


Select **Yes** in the confirmation prompt window.



*Note:* You can also double-click on the connection status indicator to connect to the server. △

If you have an application that launches Enterprise Miner, but establishes a connection beforehand, you can ensure that Enterprise Miner uses the existing connection by editing the server.cfg file in your project's EMPROJ subdirectory.



Type the CONID for the existing connection. For example, if your application connects to a server using CONID=myhost, then you would type this value for the CONID option in your server.cfg file. When you make these changes, Enterprise Miner will not try to make a connection when opening the project if a connection already

exists. If Enterprise Miner opens a project and uses an existing connection instead of creating one, the connection is not terminated when you close the project.

---

## Using a Server Profile in Batch Mode to Connect to a Server

You can use your server profile in batch mode to connect to the server by submitting the following code from the SAS Program Editor window:

```
%let profile=c:\profiles\my server.srv;
proc display c=sashelp.dmcon.connect.scl;
run;
```

*Note:* The code assumes that your server profile is named 'my server.srv' and is stored in **c:\profiles**. You should modify those parameters to match the server profile name and storage path with those on your installation. △

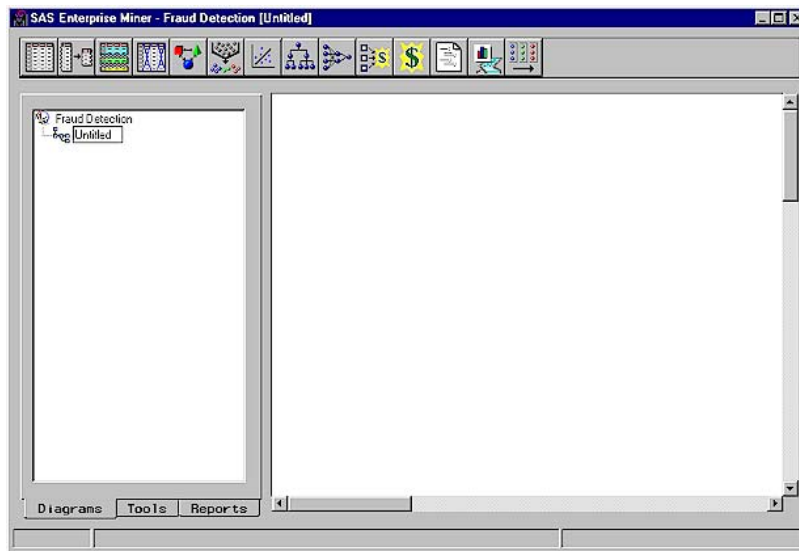
---

## Opening a Process Flow Diagram

To open a process flow diagram within the project:

- 1 Select the Diagrams tab of the Project Navigator if it is not already active.
- 2 Double-click on the diagram icon or label that you want to open. Alternatively, you can right-click on the diagram label and select **Open** from the pop-up menu.

When a selected diagram is opened, the Diagram Workspace becomes active, and the diagram can be edited, run, and saved. A diagram contains the data mining process flow that you build interactively. You can think of a diagram as a type of graphical computer program. For details about building process flow diagrams, see Chapter 3, “Building Process Flow Diagrams,” on page 33.



*Note:* The fraud detection project contains one diagram named **Untitled**. You can have more than one diagram for each project. △

## Opening an Existing Project

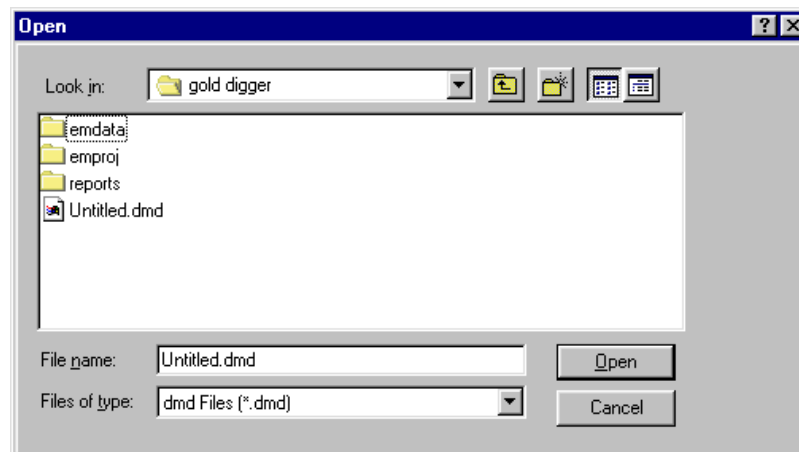
To open an existing project or a diagram within that project, follow these steps:

- 1 Use the main menu to select

**File** ► **Open**

or you can just click the Open tool icon in the toolbox.

In the Open window, browse through the folders on your machine to find the project .dmp file or the diagram .dmd file.



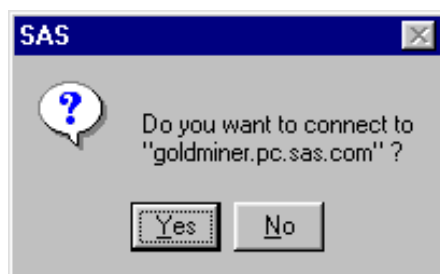
- 2 Select the project .dmp file or the diagram .dmd file that you want to open. If you select a diagram .dmd file that is already opened by another user, then a message window appears and indicates that the diagram is locked.

Select **OK** to open the project.

After you have opened a project, you must work with an existing diagram in the project, create a new diagram, or wait until a locked diagram becomes available.

*Note:* Multiple users can open the same project (.dmp file) but not the same diagram (.dmd file) within the project. △

If the project is a client/server project, then a message window appears and asks if you want to connect to the server.



Select **Yes** to establish a connection to the server or select **No** to run the project locally.

## Saving a Project Diagram

To save a project diagram, first close any open nodes in the Diagram Workspace. Then, use the **File** pull-down menu to select **Save diagram**.

**File** ► **Save diagram**

Note that you can also perform this function by selecting the Save Diagram tool icon on the Tools Bar.

To save the current diagram to a different name, use the **File** menu to select **Save diagram as**. The Save Diagram As window opens. Type the diagram name in the **Save as** field and then select **OK**.

## Running a Project Diagram

To generate results from a process flow diagram, you must run the process flow path to execute the code that is associated with each node. The paths can be run in several ways:

- When the node in the Diagram Workspace is closed and selected (a dotted line surrounds selected nodes), you can use the main menu:

**Actions** ► **Run**

- Also if the node in the Diagram Workspace is closed, you can
  - 1 Right-click the node to open a pop-up menu.
  - 2 Select **Run** from the pop-up menu.
- Many nodes, including all of the modeling nodes, can be run when the nodes' tabbed configuration window is open. To run an open modeling node, select the **Run** icon on the toolbox or use the main menu:

**Tools** ► **Train Model**

For non-modeling nodes, select from the main menu

**Tools** ► **Run <Node Name>**

You must run the predecessor nodes in your process flow diagram before you can run an open node.

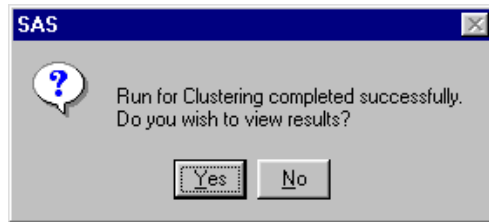
When a node in a process flow diagram is run, a green box surrounds each node icon in succession as information is passed from node to node in the process flow. When you run a process flow diagram that contains a Group Processing node, a blue box surrounds the Group Processing node icon to indicate the beginning of each loop iteration. If the process flow diagram contains a Reporter node, yellow boxes surround the predecessor nodes to indicate that the HTML reports are being generated. Red boxes surround nodes that fail when executed. To determine the error condition that is associated with a failed node, use the main menu

**View** ► **Messages**

In most cases, if you have *not* run the predecessor nodes in the process flow, then these nodes automatically run when you run the selected successor node. If you *have* already run the predecessor nodes in the process flow, and you have not changed any of the node settings in the interim, then they do not run when you run the selected successor node. Any nodes that follow the selected node are *not* run.

When the path has executed, a message dialog box appears and states that the task is completed.

Select **Yes** to close the message dialog box.



You can view the results for nodes that generate results by right-clicking the node icon in the process flow diagram and selecting **Results** from the pop-up menu. Alternatively, use the main menu:

**Actions** ► **Results**

---

## Closing Projects and Diagrams

To close a project that is open, right-click the project folder in the Project Navigator and select **Close**. You can also use the main menu:

**File** ► **Close project**

Both methods automatically save your changes to the project.

To close a diagram, use the main menu:

**File** ► **Close diagram**

---

## Creating a New Diagram

To create a new diagram, follow these steps:

- 1 Open the project that will contain the new diagram.
- 2 Right-click anywhere in the Diagram tab of the Project Navigator and select the **New Diagram**.
- 3 By default, a new diagram named **Untitled** is added to the project. An *n* subscript is added to the diagram name to distinguish untitled diagrams.

Alternatively, you can use the main menu:

**File** ► **New** ► **Diagram**

The diagram becomes active in the Diagram Workspace. To rename the diagram, right-click on the diagram label in the Project Navigator and select **Rename**.

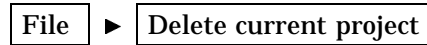
---

## Deleting Projects and Diagrams

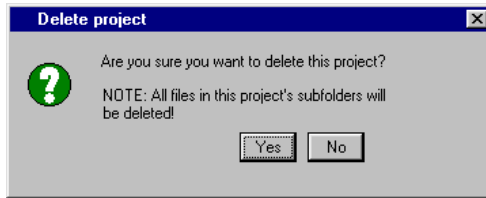
To delete a project, first open the project to be deleted, then right-click on the project name in the Project Navigator and select **Delete current project**.



Alternately, you could select the project name in the Project Navigator and use the main menu:



A dialog box prompts you to verify the deletion.



**CAUTION:**

If you placed your own files within the project's directory tree structure (for example, a SAS data set), then these files are also deleted when you delete the project. *All files within the project folder are deleted!* △

Other ways to delete a project include the following:

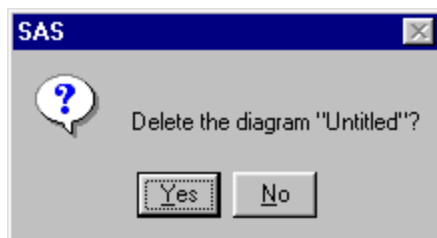
- Delete the root project directory from outside Enterprise Miner by using another tool, such as Windows Explorer. In order to delete it from outside Enterprise Miner, the project must not be open. You can delete only local projects with this method.



You can delete a project only if you are the sole user.

If you delete a client/server project when you have a connection to the server, then all of the project files are deleted — including those on the remote host. If you have no connection to the server, and choose not to reconnect, then only the local project files are deleted. A local “kill” file named “*projectname\_kill.sas*” is written to the project root directory. When you submit this kill file from the SAS Program Editor window, a connection is established to the server and then the project remote files are deleted.

To delete a diagram, right-click on the diagram name in the Project Navigator and then select the **Delete** pop-up menu item. A dialog box prompts you to verify the deletion.



## Project Troubleshooting Tips

If an Enterprise Miner program fails or halts, then the .lck file for the diagram is not usually deleted. The file will prevent you from reopening the diagram in a new

Enterprise Miner session, because you will hold a lock on the diagram. If this occurs, follow these steps:

- 1 Close your Enterprise Miner session.
- 2 Use Windows Explorer or another file utility to locate and open the EMPROJ subfolder for the project.
- 3 Find the .lck file that matches the diagram that you were working on and delete it.
- 4 Restart Enterprise Miner and open the diagram.

If you restart Enterprise Miner and the Project Properties window indicates the project is currently being shared, but you know that you are the only person using the project, then Enterprise Miner was also probably not shut down properly. In this case, follow these steps:

- 1 Close all Enterprise Miner sessions.
- 2 Make sure that no one else is using the project.
- 3 Use Windows Explorer or another file utility to open the EMPROJ folder for the project.
- 4 Open the USERS folder and delete its contents, but not delete the USERS folder.
- 5 Restart Enterprise Miner and reopen the project.

If you try to open a project and are informed by a message window that the project libraries could not be assigned, then either the EMPROJ or EMDATA library is still in use. A few reasons why the EMPROJ or EMDATA library is still in use include the following:

- An FSVIEW window for a data set in either library could be open.
- A CATALOG window is open.
- A data set or some other SAS file was not closed properly by Enterprise Miner.

You should first try to find and close the window that is using the data set or file. If you are still unable to open the project, you should close and then restart Enterprise Miner. If this step fails as well, then close and restart SAS.

---

## Exporting Enterprise Miner 4.3 Projects

In Enterprise Miner 4.3, the project export wizard has been removed. Since Enterprise Miner 3.x and 4.x projects are self-contained in the project root directory, exporting a project simply involves copying or moving the entire project to the desired target location using an external application such as Windows Explorer. You might also want to use a third-party application such as Winzip to archive the project before exporting it to a new location. You can unzip the project in your new directory.

For Enterprise Miner 3.x and 4.x client/server projects, you should archive the server files separately from the client files.

---

## Opening Enterprise Miner Release 4.2 and Earlier Projects

Enterprise Miner 4.3 runs on SAS 9.1, but can still open most Enterprise Miner projects that were created in versions of Enterprise Miner that used SAS Versions 7 and 8. To open a project that was saved in Enterprise Miner 3.x, 4.0, 4.1, or 4.2, you must convert the project files for use with SAS System 9.

**CAUTION:**

You should **ALWAYS** back up your legacy Enterprise Miner projects and data files before attempting to convert them to Enterprise Miner 4.3 format! After you have converted your Enterprise Miner projects to comply with SAS 9.1, you will not be able to reopen them in earlier versions of Enterprise Miner.    △

To open a project from an Enterprise Miner 3.x, 4.1, or 4.2 release, follow these steps:

- 1 Back up the project file that you are preparing to convert and put it in a safe location.
- 2 Invoke Enterprise Miner 4.3 and from the main menu, select  

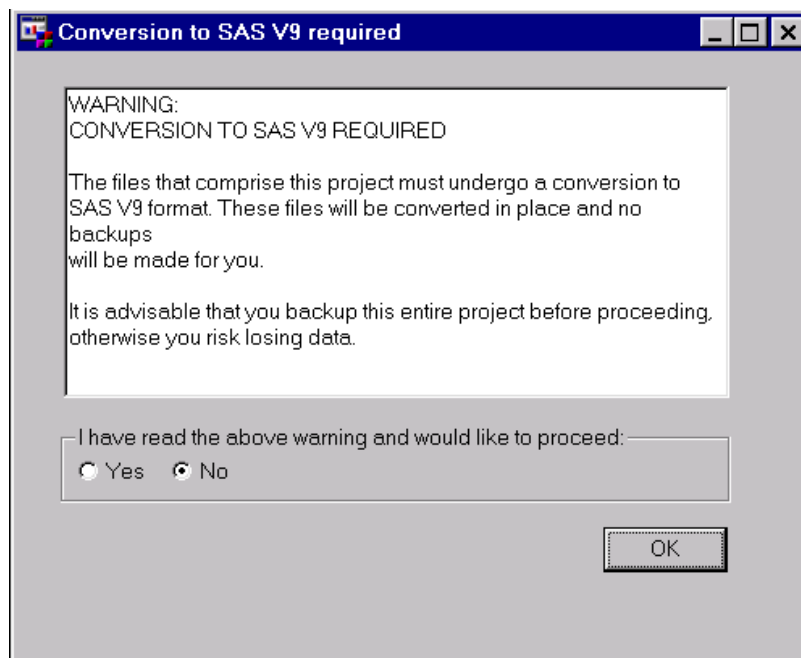
File

 ► 

Open
- 3 Use the interface to locate the \*.dmp project file from the prior release or version of Enterprise Miner. In the legacy project directory, select the project and click 

Open

.
- 4 A Conversion to SAS V9 Required window opens.



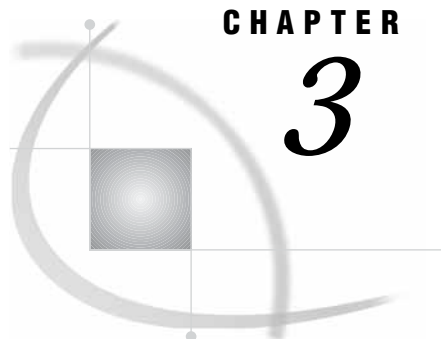
*Note:* Do not revisit converted project files using SAS Release 6.12, SAS Versions 7 or 8 after the conversion. Attempts to add and delete diagrams will corrupt the project file. If you want to use separate versions of Enterprise Miner on the same project, you should make a copy of the project files to use with your legacy version of Enterprise Miner, and use a different copy for conversion and use in Enterprise Miner 4.3.    △

- 5 Select **yes** and 

OK

 to proceed with the conversion.





## CHAPTER 3

# Building Process Flow Diagrams

### *Components Used to Build Process Flow Diagrams* 33

*The Tools Palette* 34

*The Tools Bar* 34

*The Messages Window* 34

*Using the Diagram Workspace Pop-up Menu* 35

*Adding Nodes to a Diagram* 35

*Using the Node Pop-up Menu* 36

*Connecting Nodes in a Diagram* 37

*Cutting Connections in a Diagram* 38

*Deleting Nodes from a Diagram* 39

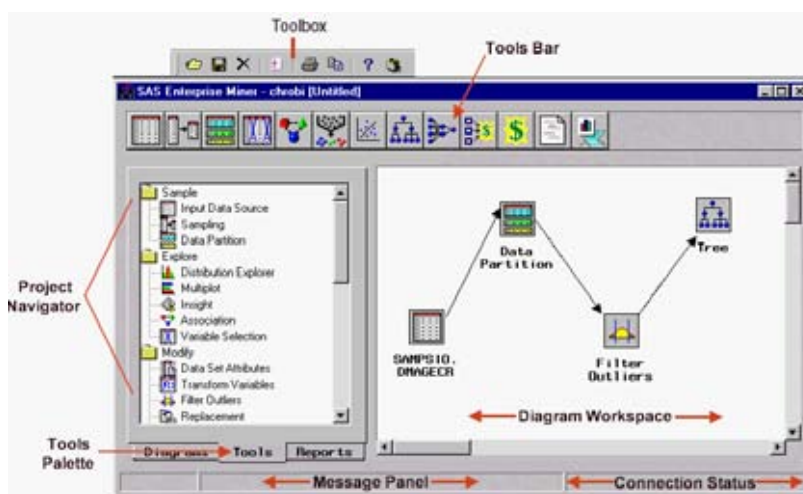
*Moving Nodes in a Diagram* 40

*Copying and Pasting a Node* 40

*Cloning a Node* 40

## Components Used to Build Process Flow Diagrams

After opening a project diagram, you use the Diagram Workspace, the Tools Palette of the Project Navigator, and the Tools Bar to edit and modify the diagram; that is, you can add nodes, connect nodes, cut connections, and delete nodes.



The Tools Bar and the application main menus at the top of the SAS Enterprise Miner window also contain useful items for constructing process flow diagrams. For details about using the Main Menu, see “Using the Application Main Menu” on page 3.

## The Tools Palette

The Tools Palette in the Project Navigator displays all of the data mining tools that are available for constructing process flow diagrams. The tools are grouped according to the phase of the SEMMA data mining process. You drag nodes from the Tools Palette onto the Diagram Workspace.

To view the properties of a node, right-click on the tool icon and select the **Properties** pop-up menu item. For details about this task, see “Viewing and Setting Node Defaults” on page 60.

For a description of the nodes, see “Organization of Enterprise Miner Nodes” on page 43.

## The Tools Bar

By default, the Tools Bar contains a subset of Enterprise Miner tools that are commonly used to build process flow diagrams in the Diagram Workspace. You can also drag tools from the Tools Bar onto the Diagram Workspace. To display tool tips, move your mouse pointer slowly over the icons on the Tools Bar.

To reposition a tool on the Tools Bar, drag the tool icon to the desired location.

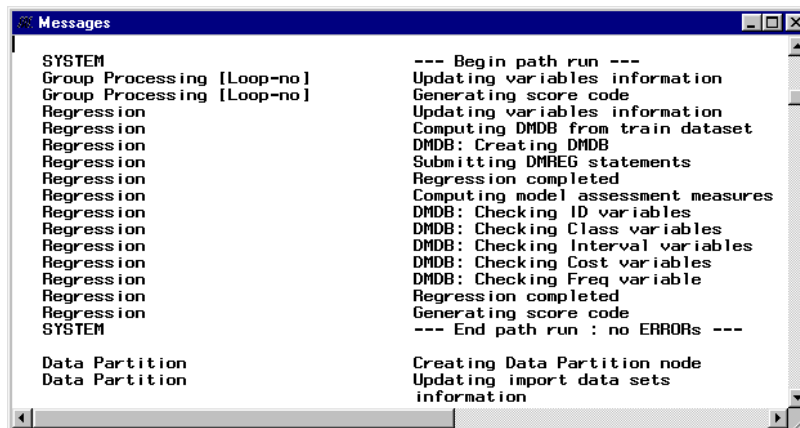
To add a node from the Tools Palette to the Tools Bar, drag the tool icon from the Tools Palette to the Tools Bar.

To remove a tool from the Tools Bar, right-click on the tool icon and select **Remove from tool bar**.

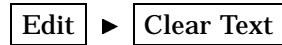
To view the properties for a tool, right-click on a tool icon and select **Tool Properties**.

## The Messages Window

The Messages window displays messages that are generated by the creation or execution of a process flow diagram. The Messages window is useful for detecting errors that might have occurred when you were running a node or a process flow path. To display the Messages window, use the **View** pull-down menu to select **Messages**. The Messages window appears. You must close the Messages window to continue working with the process flow diagram.



The messages are stored as part of the diagram. They can be cleared from within the Messages window by selecting from the main menu:



*Note:* Messages are also displayed in the message panel when you create or execute a process flow diagram. △

---

## Using the Diagram Workspace Pop-up Menu

You can use the Diagram Workspace pop-up menus to perform many tasks. To open the pop-up menu, right-click in an open area of the Diagram Workspace. (Note that you can also perform many of these tasks by using the pull-down menus.) The pop-up menu contains the following items:

- **Add node** — accesses the Add Node window.
- **Add endpoints** — adds enter and exit endpoints to a subdiagram.
- **Paste** — pastes a node from the clipboard to the Diagram Workspace.
- **Undelete** — undeletes the last deleted node.
- **Delete** — deletes the selected node.
- **Select All** — selects all nodes in the process flow diagram.
- **Create subdiagram** — creates a subdiagram (see “Subdiagrams” on page 50). To create a subdiagram, you must first select the nodes and connections that are to be included in the subdiagram.
- **Refresh** — refreshes the image that is displayed in the Enterprise Miner window.
- **Up one level** — collapses a subdiagram.
- **Top level** — moves to the top level of the process flow diagram. At the top level, all subdiagrams are condensed.
- **Connect items** — a mode of editing in which node icons are fixed in one location so that it is easier to connect nodes.
- **Move items** — a mode of editing in which node icons cannot be connected so that it is easier to move nodes.
- **Move and connect** — the default mode of editing in which node icons can be moved and connected.

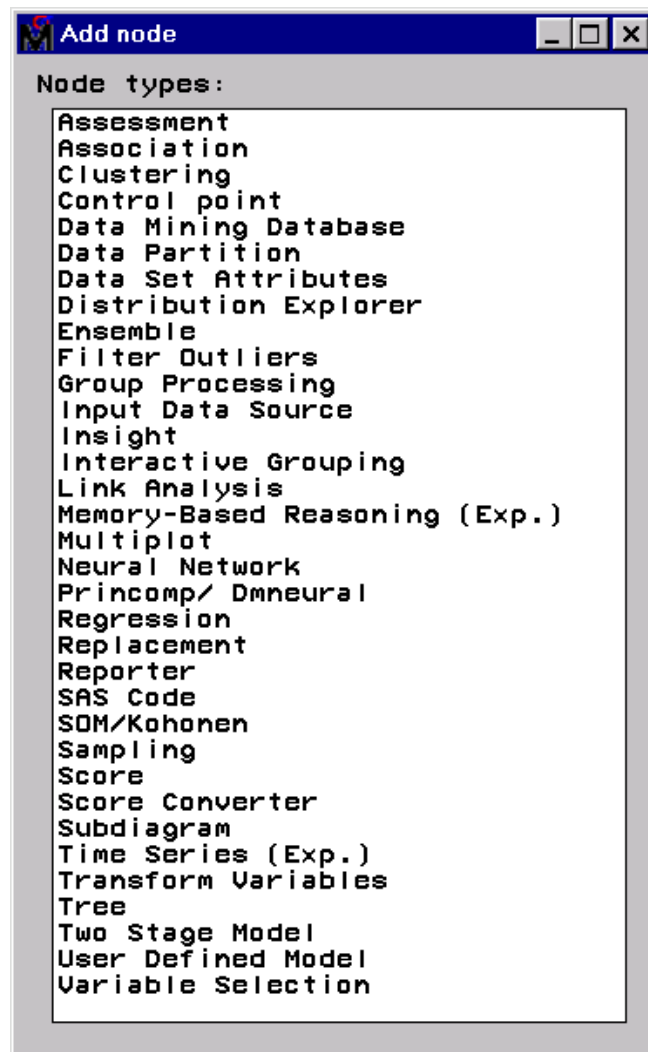
---

## Adding Nodes to a Diagram

You add nodes to the Diagram Workspace to create a process flow. Nodes should be connected in a logical order that represents the desired components of the sample, explore, modify, model, and assess (SEMMA) methodology.

You can add nodes to a process flow diagram in several ways:

- Drag node icons from the Tools Palette of the Project Navigator to the Diagram Workspace.
- Drag node icons from the Tools Bar to the Diagram Workspace. This task is accomplished the same way that you drag nodes from the Tools Palette.
- Use the Diagram Workspace pop-up menu. Right-click on an open area in the Diagram Workspace, and select **Add node**. The Add Node window appears.



Select a node from the list. The node appears in the Diagram Workspace.

- Double-click an open area in the Diagram Workspace to display the Add Node window.
- Use the **Actions** main menu to select the **Add Node** menu item. This action opens the Add Node window.

---

## Using the Node Pop-up Menu

To open a node pop-up menu, right-click on a node icon in the Diagram Workspace. The node pop-up menu contains the following items:

- **Open** — opens the node.
- **Run** — runs both the selected node and all predecessor nodes in the process flow diagram that have not been run.
- **Results** — opens the node Results Browser for those nodes that generate results. You must run the node before you can open the Results Browser.
- **Copy** — copies the node to the paste buffer.

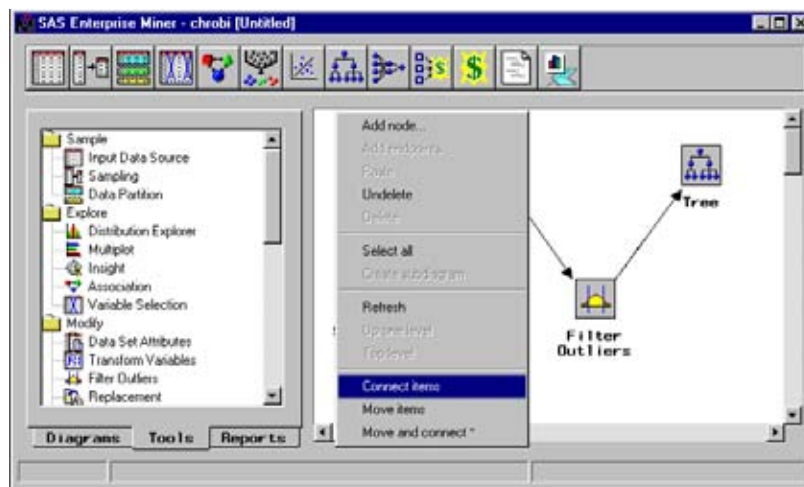
Note: To paste the node onto the Diagram Workspace, use the **Edit** pull-down menu to select the **Paste** menu item.



- **Delete** — deletes the node.
- **Clone** — clones a node.
- **About** — displays node properties in the About window.
- **Connect items** — a mode of editing in which node icons are fixed in location so that it is easier to connect nodes.
- **Move items** — a mode of editing in which node icons cannot be connected so that it is easier to move nodes.
- **Move and connect** — the default mode of editing in which node icons can be moved and connected.

## Connecting Nodes in a Diagram

You connect nodes in the Diagram Workspace to create a logical process flow. When you create a process flow, you should follow the Sample, Explore, Modify, Model, and Assess (*SEMMA*) data mining methodology. Information flows from node to node in the direction that the connecting arrows point.

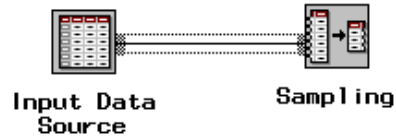


There are three editing modes available in the Diagram Workspace. You can right-click on a node to access these modes.

- **Connect items** — Create connections between nodes. In this editing mode, the nodes are fixed in location, so that you can more easily make connections.
- **Move items** — Move nodes from one location to another within the Diagram Workspace. In this editing mode, you cannot make connections.
- **Move and connect** — Move and Connect is the default mode for moving and connecting items.

As an exercise in connecting nodes, connect the Input Data Source node to the Sampling node. If the Input Data Source node is located to the left of the Sampling node, the steps to create a connection are

- 1 Move the mouse pointer to the right edge of the Input Data Source icon. The mouse pointer changes from an arrow to a cross.
- 2 Select and hold the left mouse button down, drag the mouse pointer to the left edge of the Sampling node icon, and release the mouse button. A successful connection results in a line segment that joins the two nodes.



Note that if the Input Data Source icon moves (instead of making a connection), then you should right-click on the node icon and select the **Connect items** pop-up menu item. You can also move the mouse pointer away from the icons and single-click the left mouse button, and then attempt to make the connection.

- 3 Move the mouse pointer away from the node icons, and click a blank area. The line segment that connects the tool icon becomes an arrow, coming from the Input Data Source node icon and pointing at the Sampling node icon. The direction of the arrow is important because it indicates the direction of the information flow from one node to the next. In this example, the Input Data Source node is the predecessor node, and the Sampling node is the successor node in the process flow.



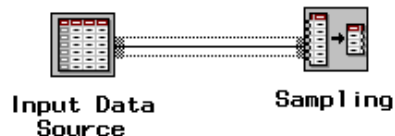
You use this same technique to connect additional nodes. Most nodes can have multiple predecessor and successor nodes. See “Usage Rules for Nodes” on page 54 for more information.

---

## Cutting Connections in a Diagram

To cut a connection between two nodes:

- 1 Select the arrow that connects the nodes. The arrow changes to a line segment.



- 2 Allow the mouse pointer to remain on the line segment, and then right-click to open a pop-up menu.
- 3 Select the **Delete** pop-up menu item. The line segment disappears from the Diagram Workspace, and the nodes are no longer connected. Cutting the connection between node icons cuts the information flow between those nodes.

## Deleting Nodes from a Diagram

To delete a node from a process flow diagram:

- 1 Right-click on the node icon to open a pop-up menu.
- 2 Select the **Delete** pop-up menu item. A verification window appears that asks you to verify that you want to delete this node. If you select **OK**, then the node is removed from the process flow diagram. If you select **Cancel**, then the node remains in the process flow diagram.

*Note:* This task can also be performed by selecting the node and using the Delete tool icon from the toolbox. △

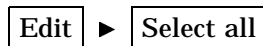
To restore the deleted node, right-click in an open area of the Diagram Workspace area and select the **Undo** pop-up menu item. The node is copied to the Diagram Workspace, but any previous connections are lost. You must redraw your node connections.

To delete multiple nodes:

- 1 Select a node icon that you want to delete, and then SHIFT-click or CTRL-click the remaining node icons that you want to delete. The selected nodes become highlighted. Alternatively, you can select multiple nodes by dragging your mouse pointer around the nodes that you want to delete. A box appears around the selected node icons. This technique is referred to as “rubber banding” nodes.
- 2 Allow the mouse pointer to remain on the selected icons, and then right-click to open a pop-up menu.
- 3 Select the **Delete** pop-up menu item. A verification window appears that asks you to verify that you want to delete these nodes. If you select **OK**, then the nodes and their connections are removed from the process flow diagram. If you select **Cancel**, then the nodes remain in the process flow diagram.

To delete all nodes in the process flow diagram:

- 1 From the main menu, select



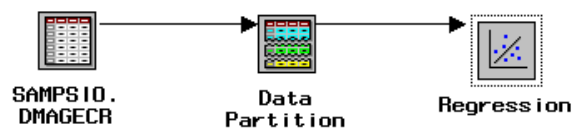
- 2 After all the nodes are selected, from the main menu select



or click the **Delete** icon from the toolbox.

*Note:* You cannot restore a multiple-node deletion. △

When you delete a predecessor node in a process flow diagram, the results are still available in the successor node or nodes. It is important to note that the results may not be reliable or accurate. For example, assume that you defined the following process flow diagram and ran the flow from the Regression node:



You then decide to delete the existing Data Partition node and add a new Data Partition node to the flow. The Regression node will still store the results from the first

run of the flow. To obtain the updated regression results, you need to re-run the entire process flow diagram.

---

## Moving Nodes in a Diagram

To move a node within a process flow diagram:

- 1 Use the mouse pointer to drag the node that you want to move. A box appears around the icon to indicate that it has been selected.
- 2 Drag the node icon to a new position in the Diagram Workspace. Note that when you drag the node icon, the mouse pointer becomes the shape of a hand. The connection arrows will typically bend or stretch (or both) to accommodate the move.

*Note:* To move multiple nodes, select them all by using keyboard and mouse combinations. CTRL-click to select multiple individual nodes that you want to move as a group. △

---

## Copying and Pasting a Node

You can copy an existing node to memory and paste it in the Diagram Workspace. The same node attributes that you copy are used in the new node. You can copy a node from one diagram and paste it to another diagram if you want. However, you cannot copy a node from one project to another project. To copy an existing node:

- 1 Right-click on the node that you want to copy in the Diagram Workspace. Select the **Copy** pop-up menu item.
- 2 Right-click on the location where you want to paste the node. Select the **Paste** pop-up menu item.

Because a Subdiagram node can represent multiple nodes in a diagram, you can use the Subdiagram node to copy multiple nodes at one time.

---

## Cloning a Node

You may want to clone a node if you plan to use the node repeatedly in a project. For example, assume that you have defined an input data set in an Input Data Source node. If you want to use the same input data set in the current diagram or in another diagram of the project, then you can clone the existing Input Data Source node. When you clone a node, it is added as a new node on the Tools Palette in the **Custom** section. When you want to use the node, you simply drag it from the Tools Palette onto the Diagram Workspace. The information that is contained in the original (parent) node is included in the cloned node; for example, the target variable, the roles and measurement levels for other variables and for the metadata sample are the same. You can also redefine the attributes of the cloned node.

If you did not clone the node, you would have to add a new Input Data Source node to the Diagram Workspace, set the node options, and create the metadata sample. If you are going to use the same data set often in the project, then cloning an existing node will save time.

*Note:* If you are going to use the same data set in several projects or diagrams, you can use the SAS/Warehouse Administrator to set up the data sets, and use the

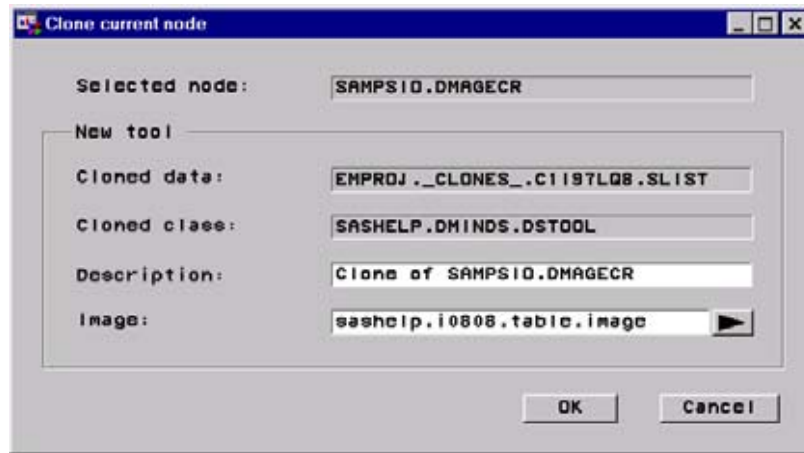
Enterprise Miner add-in tools for applying whatever measurement levels and roles you want in your data. Any users who use this data will pick up the metadata sample, along with the roles and measurement levels that are already assigned. △

To clone multiple nodes, condense the nodes into a subdiagram node (see “Subdiagrams” on page 50) and then clone the subdiagram node.

To clone a node:

- 1 Select the node that you want to clone (the parent node) in the Diagram Workspace.
- 2 Right-click the node and select the **C**lone pop-menu item.

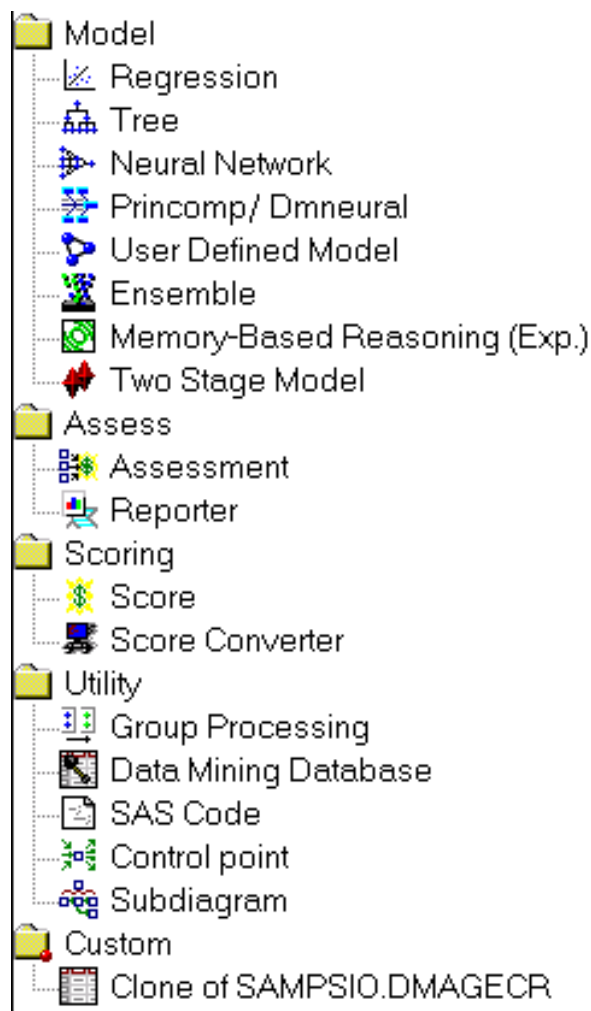
The Clone Current Node window opens.



The Clone Current Node window lists the selected node and the following new tool (node) information:

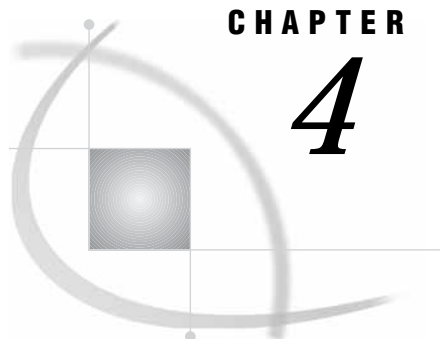
- Cloned data — the SAS entry that contains the new node information.
  - Cloned class — the catalog entry that identifies the parent node.
  - Description — the name of the cloned node. By default, the description is set to **Clone of node-name**. You can type a new description in the entry field if you want.
  - Image — the icon that is used for the cloned node on the Tools Palette, Tools Bar, and the Diagram Workspace. By default, the parent node icon is used as the clone node icon. To change the icon image, select the arrow and then select an icon from the list.
- 3 Type a node description. This example uses the default description **Clone of SAMPSIO.DMAGECR**.
  - 4 Select the **I**mage arrow and then select a new icon.
  - 5 Select **OK** to return to the Diagram Workspace.

The node is added as **Clone of SAMPSIO.DMAGECR** under the folder named Custom in the Tools Palette of the Project Navigator.



The cloned node (for this example, SAMPSIO.DMAGECR) can be used just like any other node on the Tools Palette. It can be redefined and/or connected to other nodes in a process flow, deleted, copied to the Tools Bar, and used in other process flow diagrams of the project.

*Note:* If you are working in a shared project environment, you should periodically refresh the Tools Palette in order to see and use clones that might have been created by other users.  $\Delta$



## CHAPTER

## 4

## Process Flow Diagram Logic

---

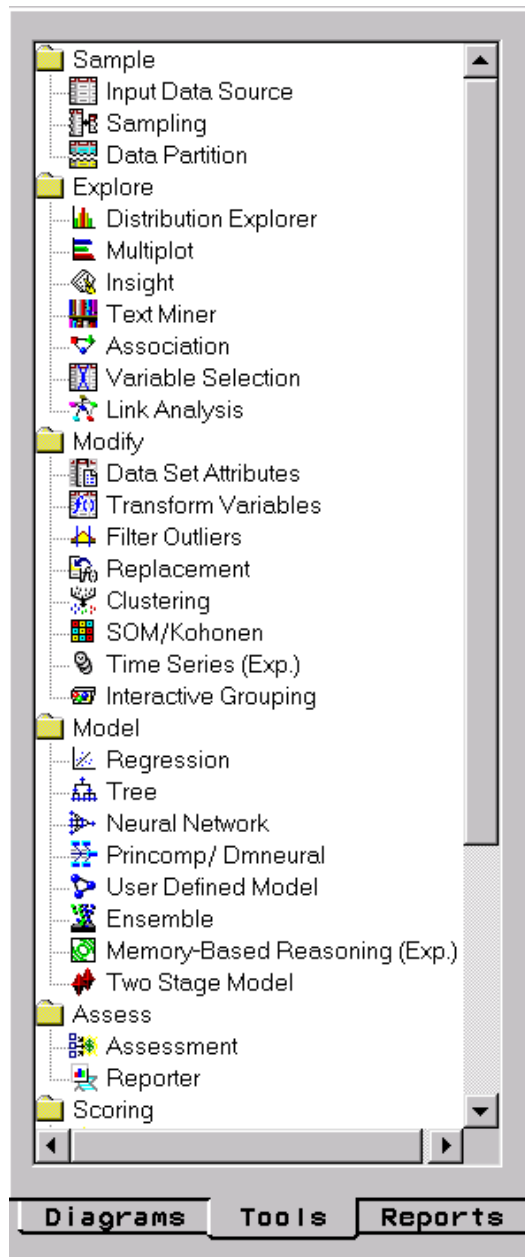
<i>Organization of Enterprise Miner Nodes</i>	43
<i>Sampling Nodes</i>	44
<i>Exploring Nodes</i>	45
<i>Modifying Nodes</i>	46
<i>Modeling Nodes</i>	47
<i>Assessing Nodes</i>	48
<i>Scoring Nodes</i>	48
<i>Utility Nodes</i>	49
<i>Subdiagrams</i>	50
<i>Subdiagram Example 1</i>	50
<i>Subdiagram Example 2</i>	52
<i>Usage Rules for Nodes</i>	54

---

### Organization of Enterprise Miner Nodes

The nodes of Enterprise Miner are organized into categories of the Sample, Explore, Modify, Model, and Assess (SEMMA) data mining methodology. In addition, there are also Scoring and Utility node tools. You use the Scoring node tools to score your data models and to create freestanding code. You use the Utility node tools to submit SAS programming statements, to create data mining databases, to perform group processing, to define control points in the process flow diagram, and to create subdiagrams.

All of the Enterprise Miner nodes are listed in a set of folders that are located on the Tools tab of the Enterprise Miner Project Navigator. The nodes are listed under the folder that corresponds to their data mining functions.



Remember that in a data mining project, repeating parts of the data mining process can offer advantages. For example, you may want to explore data and plot data at several intervals throughout your project. It may be advantageous to fit models, assess the models, and then refit the models and then assess them again.

---

## Sampling Nodes

- Use the Input Data Source node to access SAS data sets and other types of data. This node reads data sources and defines their attributes for processing by Enterprise Miner. Meta information (the metadata sample) is automatically created for each variable when you import a data set with the Input Data Source



node. Initial values are set for the measurement level and the model role for each variable. You can change these values if you are not satisfied with the automatic selections that the node makes. Summary statistics are displayed for interval and class variables.

- Use the Sampling node to take random, stratified random samples, and to take cluster samples of data sets. Sampling is recommended for extremely large databases because it can significantly decrease model training time. If the random sample sufficiently represents the source data set, then data relationships that Enterprise Miner finds in the sample can be extrapolated upon the complete source data set. The Sampling node writes the sampled observations to an output data set and saves the seed values that are used to generate the random numbers for the samples so that you may replicate the samples.
- Use the Data Partition node to partition data sets into training, test, and validation data sets. The training data set is used for preliminary model fitting. The test data set is an additional hold-out data set that you can use for model assessment. The validation data set is used to monitor and tune the model weights during estimation and is also used for model assessment. This node uses simple random sampling, stratified random sampling, or user defined partitions to create partitioned data sets.

---

## Exploring Nodes

- The Distribution Explorer node is an advanced visualization tool that enables you to quickly and easily explore large volumes of data in multidimensional histograms. You can view the distribution of up to three variables at a time with this node. When the variable is binary, nominal, or ordinal, you can select specific values to exclude from the chart. To exclude extreme values for interval variables, you can set a range cutoff. The node also generates summary statistics for the charting variables.
- The Multiplot node is another visualization tool that enables you to explore larger volumes of data graphically. Unlike the Insight or Distribution Explorer nodes, the Multiplot node automatically creates bar charts and scatter plots for the input and target variables without requiring you to make several menu or window item selections. The code that is created by this node can be used to create graphs in a batch environment, whereas the Insight and Distribution Explorer nodes must be run interactively.
- Use the Insight node to open a SAS/INSIGHT session. SAS/INSIGHT software is an interactive tool for data exploration and analysis. With it, you explore data through graphs and analyses that are linked across multiple windows. You can analyze univariate distributions, investigate multivariate distributions, and fit explanatory models by using generalized linear models.
- Use the Association node to identify association relationships within the data. For example, if a customer buys a loaf of bread, how likely is the customer to also buy a gallon of milk? You also use the Association node to perform sequence discovery if a time stamp variable (a sequence variable) is present in the data set. Binary sequences are constructed automatically, but you can use the Event Chain Handler to construct longer sequences that are based on the patterns that the algorithm discovered.
- You use the Variable Selection node to evaluate the importance of input variables in predicting or classifying the target variable. To preselect the important inputs, the Variable Selection node uses either an R-Square or a Chi-Square selection

(tree based) criterion. You can use the R-Square criterion to remove variables in hierarchies, remove variables that have large percentages of missing values, and remove class variables that are based on the number of unique values. The variables that are not related to the target are set to a status of **rejected**. Although rejected variables are passed to subsequent nodes in the process flow diagram, these variables are not used as model inputs by a more detailed modeling node, such as the Neural Network and Tree nodes. You can reassign the status of the input model variables to **rejected** in the Variable Selection node.

- Use the Link Analysis node to transform data from differing sources into a data model that can be graphed. The data model supports simple statistical measures, presents a simple interactive graph for basic analytical exploration, and generates cluster scores from raw data that can be used for data reduction and segmentation.

---

## Modifying Nodes

- Use the Data Set Attributes node to modify data set attributes, such as data set names, descriptions, and roles. You can also use the Data Set Attributes node to modify the metadata sample that is associated with a data set, and to specify target profiles for a target. An example of a useful Data Set Attributes application is to generate a data set in the SAS Code node and then modify its metadata sample with this node.
- Use the Transform Variables node to transform variables. For example, you can transform variables by taking the square root of a variable or by taking its natural logarithm. Additionally, the Transform Variables node supports user-defined formulas for transformations and provides a visual interface for grouping interval-valued variables into buckets or quantiles. Transforming variables to similar scale and variability may improve the fit of models, and subsequently, the classification and prediction precision of fitted models.
- Use the Filter Outliers node to identify and remove outliers or “noise” from data sets. Checking for outliers is recommended as outliers may greatly affect modeling results and, subsequently, the classification and prediction precision of fitted models.
- Use the Replacement node to impute (fill in) values for observations that have missing values. You can replace missing values for interval variables with the mean, median, midrange, or mid-minimum spacing, or with a distribution-based replacement. Alternatively, you can use a replacement M-estimator such as Tukey’s biweight, Huber’s, or Andrew’s Wave. You can also estimate the replacement values for each interval input by using a tree-based imputation method. Missing values for class variables can be replaced with the most frequently occurring value, distribution-based replacement, tree-based imputation, or a constant.
- Use the Clustering node to segment your data so that you can identify data observations that are similar in some way. When displayed in a plot, observations that are similar tend to be in the same cluster, and observations that are different tend to be in different clusters. The cluster identifier for each observation can be passed to other nodes for use as an input, ID, or target variable. It can also be passed as a group variable that enables you to automatically construct separate models for each group.
- Use the SOM/Kohonen node to generate self-organizing maps, Kohonen networks, and vector quantization networks. The SOM/Kohonen node performs unsupervised learning in which it attempts to learn the structure of the data. As with the Clustering node, after the network maps have been created, the characteristics can

be examined graphically by using the SOM/Kohonen Results Browser. The SOM/Kohonen node provides the analysis results in the form of an interactive map that illustrates the characteristics of the clusters. Furthermore, the SOM/Kohonen node Results Browser provides a report that indicates the importance of each variable.

- The Time Series experimental node converts transactional data to time series data, and performs seasonal and trend analysis on an interval target variable.
- Use the Interactive Grouping node to interactively group variable values into classes. The Interactive Grouping functionality is required to create a specific type of predictive model that is called a score card. Statistical and plotted information can be interactively rearranged as you explore various variable groupings. Score card models are frequently used for application and behavioral scoring in the credit scoring industry.

---

## Modeling Nodes

- Use the Regression node to fit both linear and logistic regression models to your data. You can use continuous, ordinal, and binary target variables. You can use both continuous and discrete variables as inputs. The node supports the stepwise, forward, and backward selection methods. A point-and-click interaction builder enables you to create higher-order modeling terms.
- Use the Tree node to fit decision tree models to your data. The implementation includes features that are found in a variety of popular decision tree algorithms (for example, CHAID, CART, C4.5, and C5.0.) The Tree node supports both automatic and interactive training. When you run the Tree node in automatic mode, it automatically ranks the input variables based on the strength of their contribution to the tree. This ranking may be used to select variables for use in subsequent modeling. You may override any automatic step with the option to define a splitting rule and delete explicit nodes or subtrees. Interactive training enables you to explore and evaluate a large set of trees as you develop them.
- Use the Neural Network node to construct, train, and validate multilayer feedforward neural networks. By default, the Neural Network node constructs multilayer feedforward networks that have one hidden layer that contains three neurons. In general, each input is fully connected to the first hidden layer, each hidden layer is fully connected to the next hidden layer, and the last hidden layer is fully connected to the output. The Neural Network node supports many variations of this general form.
- Use the Princomp/Dmneural node to fit an additive nonlinear model that uses the bucketed principal components as inputs to predict a binary or an interval target variable. The Princomp/Dmneural node also performs a principal components analysis and passes the scored principal components to the successor nodes.
- Use the User Defined Model node to generate assessment statistics using predicted values from a model that you built with the SAS Code node (for example, a logistic model using the SAS/STAT LOGISTIC procedure) or the Variable Selection node. The predicted values can also be saved to a SAS data set and then imported into the process flow with the Input Data Source node.
- Use the Ensemble node to create a new model by averaging the posterior probabilities (for class targets) or the predicted values (for interval targets) from multiple models. The new model is then used to score new data. One common ensemble approach is to resample the training data and fit a separate model for each sample. The component models are then integrated by the Ensemble node to form a potentially stronger solution.

- The Memory-Based Reasoning experimental node uses a  $k$ -nearest neighbor algorithm to categorize or predict observations.
- The Two Stage Model node computes a two-stage model to predict a class target and an interval target. The interval target variable is usually the value that is associated with a level of the class target variable.

*Note:* These modeling nodes use a directory table facility, called the Model Manager, in which you can store and assess models on demand. The modeling nodes also enable you to modify the target profile(s) for a target variable. △

---

## Assessing Nodes

- The Assessment node provides a common framework for comparing models and predictions from any of the modeling nodes (Regression, Tree, Neural Network, and User Defined Model nodes). The comparison is based on the expected and actual profits or losses that would result from implementing the model. The node produces the following charts that help to describe the usefulness of the model: lift, profit, return on investment, receiver operating curves, diagnostic charts, and threshold-based charts.
- The Reporter node assembles the results from a process flow analysis into an HTML report that can be viewed with your favorite Web browser. Each report contains header information, an image of the process flow diagram, and a separate subreport for each node in the flow. Reports are managed in the Reports tab of the Project Navigator.

---

## Scoring Nodes

- The Score node enables you to generate and manage predicted values from a trained model. Scoring formulas are created for both assessment and prediction. Enterprise Miner generates and manages scoring formulas in the form of SAS DATA step code, which can be used in most SAS environments with or without Enterprise Miner.
- Use the Score Converter node to translate the SAS DATA step score code that is produced by predecessor nodes in a process flow diagram into the C and Java programming languages. It is an open-ended tool that is intended for use by experienced C and Java programmers.

The Score Converter node supports input from the following Enterprise Miner nodes:

- Sampling Nodes:
  - Input Data Source
  - Sampling
  - Data Partition
- Exploring Nodes:
  - Distribution Explorer

- Multiplot
- Insight
- Association
- Variable Selection
- Link Analysis
- Modifying Nodes:
  - Data Set Attributes
  - Transform Variables
  - Filter Outliers
  - Replacement
  - Clustering
  - SOM/Kohonen
  - Interactive Grouping
- Modeling Nodes:
  - Regression
  - Tree
  - Neural Networking
  - User Defined Model
  - Ensemble
  - Two Stage Model
- Assessing Nodes:
  - Assessment
  - Reporter
- Scoring Nodes:
  - Score
- Utility Nodes:
  - Group Processing
  - Data Mining Database
  - Control Point
  - Subdiagram

---

## Utility Nodes

- The Group Processing node enables you to perform group BY processing for class variables such as GENDER. You can also use this node to analyze multiple targets, and you can process the same data source repeatedly by setting the group processing mode to index.
- The Data Mining Database node enables you to create data mining databases (DMDBs) for batch processing. For non-batch processing, DMDBs are automatically created as they are needed.
- Use the SAS Code node to incorporate new or existing SAS code into process flow diagrams. The ability to write SAS code enables you to include additional SAS procedures into your data mining analysis. You can also use a SAS DATA step to

create customized scoring code, to conditionally process data, and to concatenate or to merge existing data sets. The node provides a macro facility to dynamically reference data sets used for training, validation, testing, or scoring and variables, such as input, target, and predict variables. After you run the SAS Code node, the results and the data sets can then be exported for use by subsequent nodes in the diagram.

- Use the Control Point node to establish a control point to reduce the number of connections that are made in process flow diagrams. For example, suppose three Input Data Source nodes are to be connected to three modeling nodes. If no Control Point node is used, then nine connections are required to connect all of the Input Data Source nodes to all of the modeling nodes. However, if a Control Point node is used, only six connections are required.
- Use the Subdiagram node to group or condense a portion of a process flow diagram into a subdiagram. For complex process flow diagrams, you may want to create subdiagrams to better design and control the process flow.

---

## Subdiagrams

Some process flow diagrams may be quite complex. To help control the process flow, you can create subdiagrams and collapse a set of nodes and connections into a single node icon. Subdiagrams can be opened to display the complete structure of the process flow diagram.

*Note:* You cannot uncondense the nodes in a subdiagram. △

There are two major approaches to creating subdiagrams:

- You know in advance that you will use a subdiagram. First, you add a Subdiagram node, and then add nodes within the subdiagram. See “Subdiagram Example 1” on page 50.
- You realize later that if a particular set of nodes were condensed into a subdiagram, then the process flow would be much easier to control. See “Subdiagram Example 2” on page 52.

---

### Subdiagram Example 1

Suppose you want a process flow diagram to contain a subdiagram for the following nodes: Sampling, Data Partition, Filter Outliers, and Transform Variables.

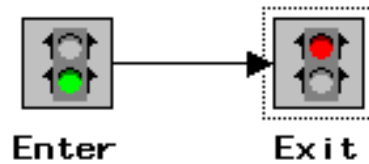
To create a subdiagram for these nodes, follow these steps:

- 1 Add and define any predecessor nodes from the Tools Palette that you do not want as part of the subdiagram to the Diagram Workspace.
- 2 Add a Subdiagram node to the process flow diagram.



- 3 Connect the predecessor node to the Subdiagram node and then open the Subdiagram node by double-clicking the node icon. Alternatively, you can right-click the node icon and select **Open**.

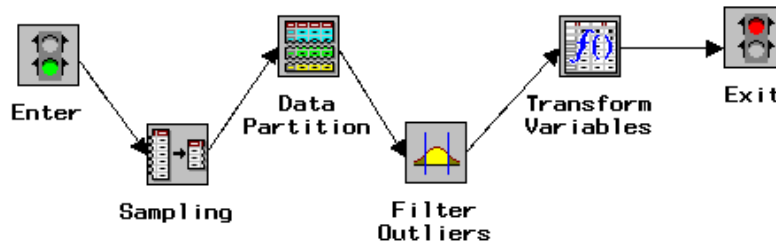
Within the Subdiagram node are Enter and Exit nodes, which by default are connected.



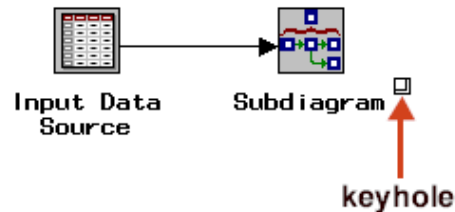
- 4 Cut the connection between the Enter and Exit nodes by right-clicking the connection arrow and selecting the **Delete** pop-up menu item.

*Note:* The Enter and Exit nodes are connected to allow for independent subdiagrams. △

- 5 Move the Enter and Exit nodes to the appropriate locations in the process flow diagram, and then add and connect the desired nodes.

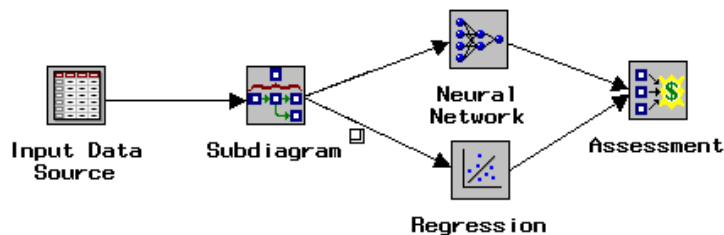


- 6 Condense the subdiagram, by using the **View** pull-down menu (or the pop-up menu) to select **Up One Level**.



*Note:* When a subdiagram has been defined, a keyhole appears beside the Subdiagram node. To open the subdiagram, you can select the keyhole or you can double-click the node icon. △

- 7 Position the Subdiagram node in the appropriate location within the process flow diagram, and then connect the Subdiagram node to the appropriate nodes.

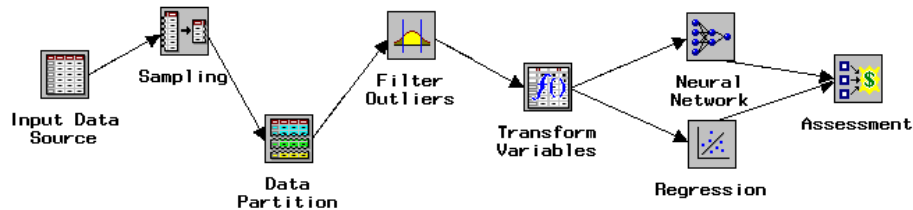


This example process flow diagram has an Input Data Source node that is connected to the Subdiagram node, which in turn connects to a Neural Network node and a Regression node. The resulting models are compared and assessed in an Assessment node.

*Note:* You can clone a node if you need to use it often in the project. See “Cloning a Node” on page 40 for an example.  $\triangle$

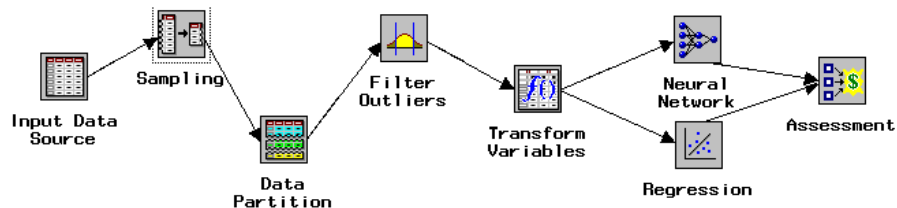
## Subdiagram Example 2

In this example, you are developing a process flow diagram:



You realize that you could create a subdiagram to contain the following nodes: Sampling, Data Partition, Filter Outliers, and Transform Variables. By condensing these nodes into a subdiagram, you can more easily view other portions of the complete process flow diagram. To create a subdiagram for these nodes, follow these steps:

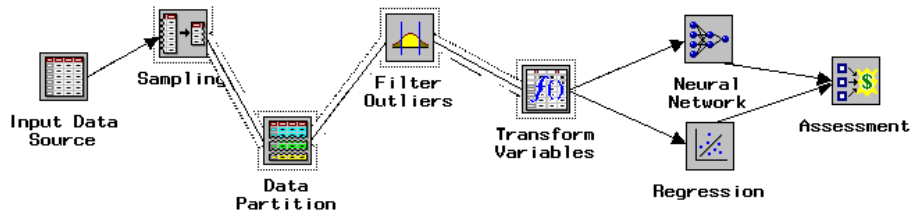
- 1 Select the first node to be included in the subdiagram. A box appears around the selected node (for this example, the Sampling node).



- 2 Place the mouse pointer on the arrow that connects the node that you selected in step 1 and the second node to be included in the subdiagram, then CTRL-click or SHIFT-click on the arrow. The selected arrow changes from an arrow to a line segment.
- 3 CTRL-click or SHIFT-click on the second node that you want to include in the subdiagram.
- 4 Repeat steps 2 and 3 until all nodes and arrows that you want to place in the subdiagram are selected. Note that for large process flow diagrams that contain many nodes only the nodes and arrows that are selected are used to create the subdiagram.

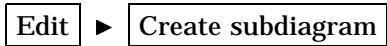
*Note:* As an alternative to steps 1 through 4, you can select all the multiple nodes and arrows at one time. That is, place the mouse pointer in the process flow diagram near the nodes to be included in the subdiagram (where “near” is on one side of the set of node icons and either above or below the node icons), click and hold the left mouse button, and stretch the dotted box around the appropriate node icons.



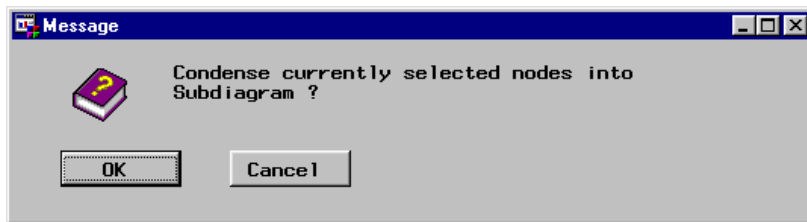


△

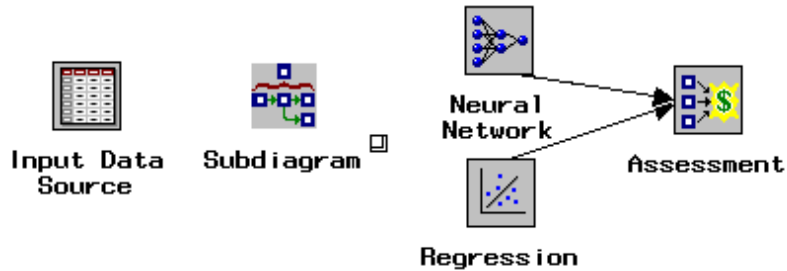
- 5 Use the main menu to select



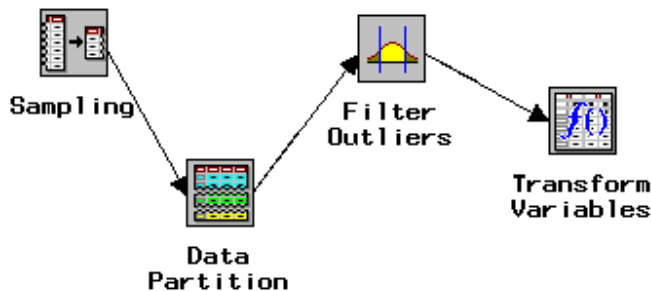
A dialog box appears that asks you to verify that the currently selected nodes and arrows are to be condensed into a subdiagram.



If you click **Cancel**, then the subdiagram is not created. If you click **OK**, then the subdiagram is created, and a subdiagram node icon replaces the selected nodes and arrows.

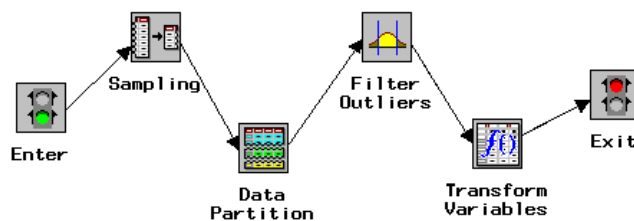


- 6 To open the Subdiagram node, double-click on the node icon or select the keyhole.

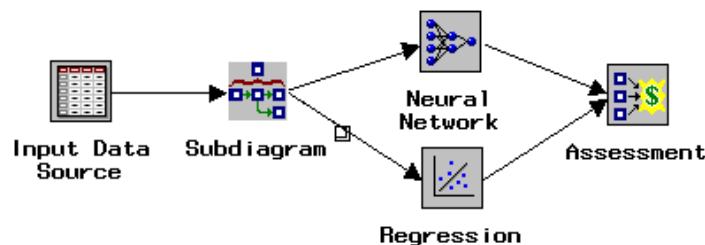


- 7 Add endpoints (a pair of nodes that consist of an Enter node and an Exit node) to the subdiagram to indicate where information enters the subdiagram and where it

exits the subdiagram. To add endpoints, right-click on an open area of the Diagram Workspace and select **Add endpoints**. By default, the Enter node is connected to the Exit node. Cut the connection between the Enter and Exit nodes, and then position the Enter node to the left of the subdiagram (so that it precedes the subdiagram) and the Exit node to the right of the subdiagram (so that it follows the subdiagram). Connect the Enter node to the subdiagram (the connection arrow should point to the subdiagram), and connect the subdiagram to the Exit node (the connection arrow should point to the Exit node).



- 8 Condense the subdiagram by using the **view** pull-down menu (or the pop-up menu) to select **Up One Level**.
- 9 Connect the Subdiagram node to the appropriate nodes. In this example, an Input Data Source node passes information to the Subdiagram node, which passes information to the Regression and Neural Network nodes, which in turn pass information to the Assessment node.



You cannot uncondense the nodes in a subdiagram. There is no restriction on how many Subdiagram nodes you can nest in the process flow diagram.

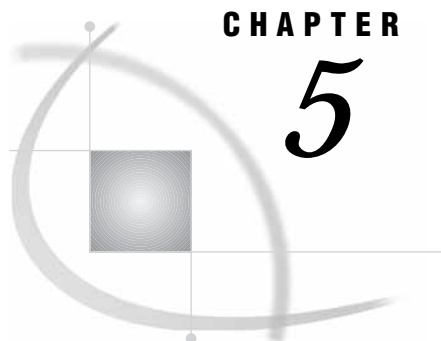
## Usage Rules for Nodes

Here are some general rules that govern the placement of nodes in a process flow diagram:

- ☐ The Input Data Source node cannot be preceded by any other nodes.
- ☐ All nodes except the Input Data Source and SAS Code nodes must be preceded by a node that exports a data set.
- ☐ The SAS Code node can be defined in any stage of the process flow diagram. It does not require an input data set that is defined in the Input Data Source node. If you create a SAS data set with code you write in the SAS Code node (for example, a data set that contains target and predict variables), you can use a successor Data Set Attributes node to assign model roles to the variables in the SAS data set.

- The Assessment node must be preceded by one or more modeling nodes.
- The Score node must be preceded by a node that produces score code. For example, the modeling nodes produce score code.
- The Data Set Attributes can have only one node preceding it.
- The Ensemble node must be preceded by a modeling node.
- The Reporter node generates HTML reports for all of the predecessor nodes. It does not generate reports for the successor nodes. When you run the flow from the Reporter node, Enterprise Miner makes a first pass through the flow to analyze the data. After the analysis is complete, Enterprise Miner makes a second pass to generate the HTML reports. The node icons are colored green during the analysis pass and yellow during the reporting pass.
- You can have one Group Processing node per process flow. Group processing occurs when you run the process flow path. The Group Processing node can be connected to any successor node, but the only nodes that accumulate results from each pass are the modeling nodes and the Score node.





## CHAPTER

## 5

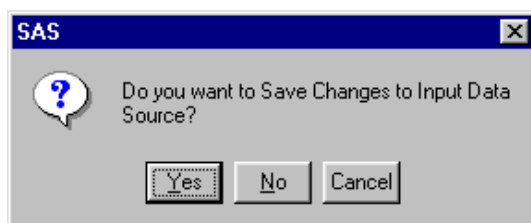
## Common Features among Nodes

<i>Functionality</i>	57
<i>Data Tab</i>	57
<i>Variables Tab</i>	58
<i>Notes Tab</i>	60
<i>Results Browser</i>	60
<i>Viewing and Setting Node Defaults</i>	60

### Functionality

The following functionalities are common to all or most nodes.

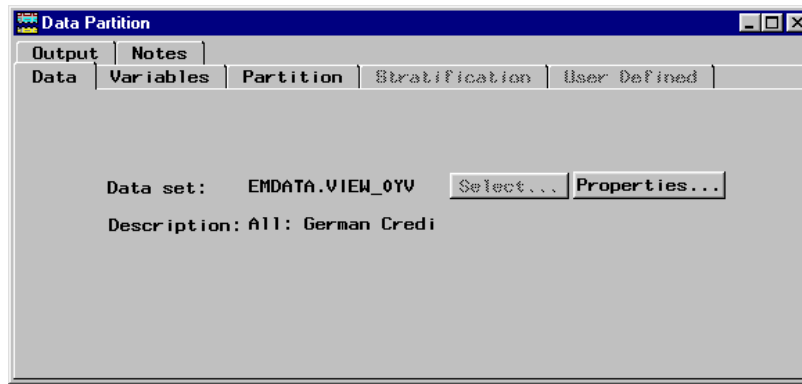
- If you make changes to a node and then close it, the following message window appears. The message window does not appear if you did not make any changes to the node settings.



- When a node is run, information flows through the process flow diagram. A green box appears around each node as it processes the incoming information. If a node cannot process the information, then a red box appears around it, and you should check the Message Panel, the message window, or the Log window and adjust the settings as necessary.
- When the analysis for the selected node has run, a message window prompts you to view the results. Select **Yes** to close the message window and open the Results Browser. Select **No** to close the message window and return to the Diagram Workspace.

### Data Tab

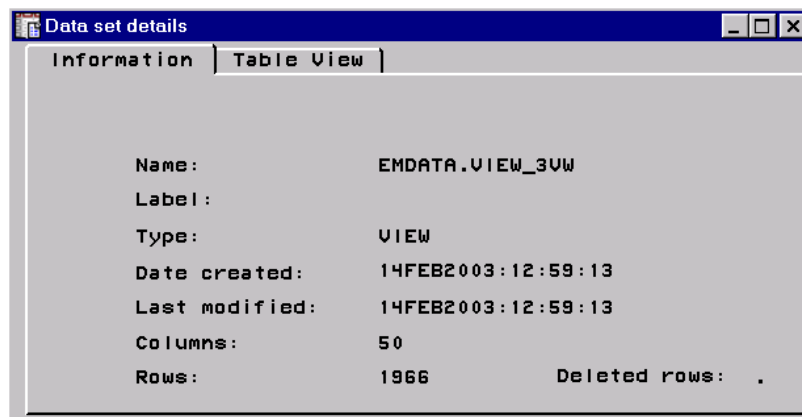
Most node configuration interfaces use a Data tab. The Data tab displays the names of the available predecessor data sets, which can include some or all of the training, validation, test, and score data sets. You can select a predecessor data set from this list.



By default, Enterprise Miner exports the data set that precedes the current node. To substitute another data set, click **Select**. Use the file utility window to find and select another data set. The **Select** button is dimmed and remains unavailable if only one node that exports a data set precedes the current node.

*Note:* Many nodes contain training, test, validation, and score buttons on the tab. You can use these to assign a specific data set to each data set role. △

Click **Properties** on the Data tab to view administrative information about the data set. The administrative information includes the data set name, label, type, date created, date last modified, number of columns, number of rows, and number of deleted rows.



To see a table view of the data, select the Table View tab.

## Variables Tab

Most Enterprise Miner nodes have a Variables tab. Typically, the Variables tab displays variable attribute information, such as

- the names of the variables in the input data set. The values that are displayed in the Name column of most Variable tabs are protected.
- the status of the variables, which can be **use** or **don't use**. You can change the status of a variable in one of the sampling or modeling nodes. For most explore nodes, you cannot change the variable's status. To change the status of a variable, follow these steps:

- 1 Right-click on the appropriate cell of the **Status** column.
- 2 Select **Set Status**.
- 3 Select the appropriate status (either **don't use** or **use**).

*Note:* The Variables tab of the Input Data Source node does not contain a **Status** column. To assign the rejected model role to a variable, right-click on the appropriate cell of the **Model Role** column to open a pop-up menu. Select **Set Model Role** and then select **rejected**. You use this same protocol to assign the rejected role to variables in the Manual Selection tab of the Variable Selection node. △

This example shows the Variables tab of the Data Partition node:

Name	Model Role	Measurement	Type	Format	Label
CHECKING	input	ordinal	num	BEST12.	
DURATION	input	interval	num	BEST12.	
HISTORY	input	ordinal	num	BEST12.	
PURPOSE	input	nominal	char	\$8.	
AMOUNT	input	interval	num	BEST12.	
SAVINGS	input	ordinal	num	BEST12.	
EMPLOYED	input	ordinal	num	BEST12.	

In this node, the Variables tab contains the following columns:

- **Name** — the variable name.
- **Model Role** — the variable model role. Examples of model roles include cost, freq, ID, input, predict, rejected, sequence, target, and trial. The role of a variable is automatically assigned in the Input Data Source node based on the information in the metadata sample. You can change the role that is automatically assigned to a variable by right-clicking on the appropriate role cell.
- **Measurement** — the measurement type of the variable. Examples of measurement types include binary, interval, ordinal, and nominal. The measurement type of variables is automatically assigned in the Input Data Source node based on the information in the metadata sample.
- **Type** — either character (char) or numeric (num). The variable type is displayed in the Input Data Source node, but it cannot be changed (the values in this column are protected).
- **Format** — the format of the variable. Examples of formats include \$18. (18 characters) and BEST12. (12-digit numeric). The variable formats are assigned in the Input Data Source node.
- **Label** — the descriptive variable label, which is assigned in the Input Data Source node. To change the label for a variable, type a new value in the appropriate cell of the Label column.

You can sort by clicking the column header. Successive clicks on the header toggle the sort between ascending and descending order.

Subsetting (displaying a subset of the variables) can be performed for the variable attributes of status, model role, measurement, and type:

- 1 Right-click in any row of the attribute that you want to subset.
- 2 Select **Subset by <attribute>** from the menu. A selection list box appears that contains the set of attribute values that are available for subsetting.

- 3 Select the appropriate attribute values for subsetting.
- 4 To accept the selections and display the subsetting, click **OK**. To cancel the subsetting dialog box, click **Cancel**.

To find a value within a column:

- 1 Right-click on the column heading or a cell within the column and select **Find column name**. The Find column name window opens, which is modeled after the Find dialog box in Internet Explorer.
- 2 Type the text that you want to find.
- 3 Specify the search direction (up or down) and whether you want the text to match the whole field.
- 4 Click **OK**.

If Enterprise Miner finds the text that you are searching for in the column and direction that you specified, it moves the row that contains the text to the top of the table. If it does not, it displays **No match detected** at the bottom of the screen and issues a beep signal.

---

## Notes Tab

You use the Notes tab to type and store notes such as those about the project, the analysis, and the results. When you run a process flow diagram that contains a Reporter node, the notes are printed in the resulting HTML report.

---

## Results Browser

Enterprise Miner nodes that produce output generally use a Results Browser to display and graphically manipulate the data mining results. To open the Results Browser of an Enterprise Miner node

- If the node is closed,
  - 1 right-click on the node icon and select **Results**.
  - 2 from the main menu, select
 

Actions

 ► 

Results
- If the node is open,
  - 1 select the Results Browser tool icon on the Toolbox.
  - 2 from the main menu, select
 

Tools

 ► 

Results Browser

*Note:* After you run particular nodes, such as the Tree or the Data Partition node, a message window appears that asks you if you want to view the results. Click **Yes** to open the Results Browser for that node. △

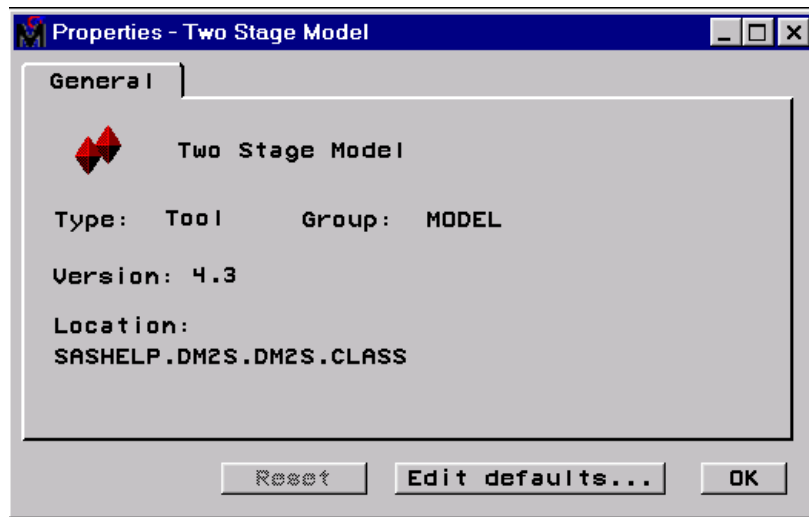
---

## Viewing and Setting Node Defaults

To view the properties for any node, right-click on the node icon in the Tools Palette of the Project Navigator, or click the Tools Bar at the top of the SAS Enterprise Miner



window, and select **Properties**. The Properties *Node Name* window opens, which summarizes the node properties.

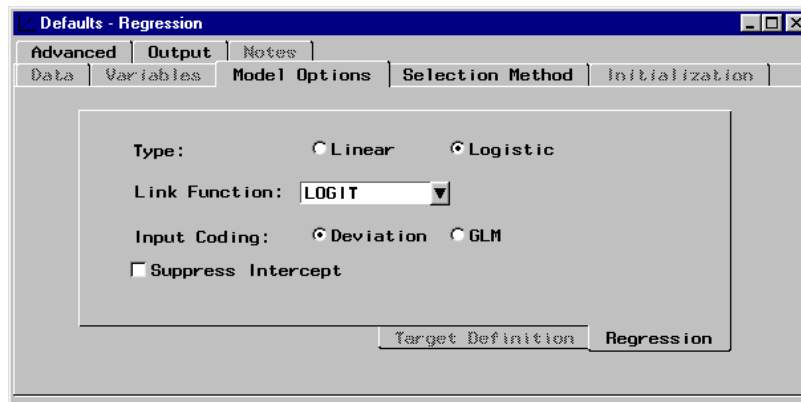


*Note:* The **Reset** button is dimmed if the node is set to the defaults. △

You can customize the default settings for the following nodes:

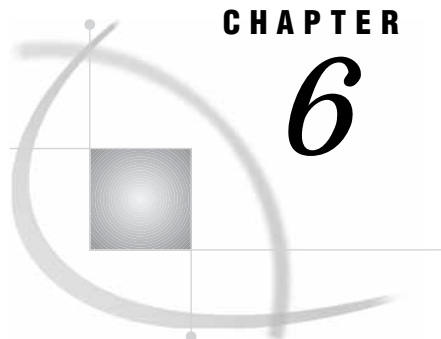
- ☐ Data Partition
- ☐ Sampling
- ☐ Multiplot
- ☐ Insight
- ☐ Association
- ☐ Variable Selection
- ☐ Replacement
- ☐ Clustering
- ☐ SOM/Kohonen
- ☐ Time Series
- ☐ Regression
- ☐ Tree
- ☐ Neural Network
- ☐ Princomp /DMNeural
- ☐ Two Stage Model
- ☐ Assessment
- ☐ Score
- ☐ Score Converter
- ☐ Group Processing

To customize the default node settings, select **Edit defaults** in the Properties *Node Name* window and make the desired selections in the tabs of the Defaults window:



After you have set the node defaults, close the Defaults window to return to the Properties window.

To reset the node to the defaults, click **Reset**.



## CHAPTER

## 6

## Data Structure Examples

*Types of Data Structures* 63

*Regression Data* 64

*Association Discovery Data* 66

### Types of Data Structures

Data structures for data mining data sets and data marts include

- *Regression Data* (see “Regression Data” on page 64), which has the following characteristics:
  - one observation per customer.
  - a binary target (dependent) variable, a continuous (interval) target variable, or both. Often only one target variable is modeled per run, but you can use a Group Processing node to model multiple targets. An example of a binary target variable is Purchase or No-purchase, which is useful for modeling customer profiles. An example of a continuous (interval) target variable is Value of Purchase, which is useful for modeling the best customers for particular products, catalogs, or sales campaigns.
  - many or few input variables, such as ID (identification) variables, demographic data, and history or previous purchases.
  - cross-sectional data, which is data that is collected across multiple customers, products, geographic regions, but that typically is not collected across multiple time periods.
- *Association Discovery Data* (see “Association Discovery Data” on page 66), also called basket analysis data, which is a common data structure of online transaction processing systems (OLTPs). Such data structures have the following characteristics:
  - multiple observations per customer. The data set must contain a separate observation for each transaction.
  - a target (dependent) variable – often a class variable that has a level for each product.
  - one or more ID variables to identify the customers.
  - a sequence variable if you are performing a sequence discovery. The sequence variable identifies the ordering of the purchases.
- *Time Series data analysis*, which is more fully supported in SAS/ETS (econometric and time series) software. Analyses that use SAS/ETS procedures can be submitted in the SAS Code node.

- *Time Series Cross-Sectional (panel) data analysis*, which is more fully supported in the SAS/ETS and SAS/STAT products. Analyses that use SAS/ETS and SAS/STAT procedures can be submitted in the SAS Code node.

## Regression Data

Here is an example of the regression data.

	Int	Num	Num	Int	Int	Int	Int
	CUST_NUM	LASTNAME	FIRSTNAM	PUR_YN	PUR_AMT	CAP	T_SHIRT
1	1	Money	Earnest	0	0.00	0	0
2	2	Drest	Natalie	1	87.50	3	1
3	3	Conquest	Norman	1	47.25	2	1
4	4	Turner	Page	0	0.00	0	0
5	5	Dodger	Artful	1	25.00	0	1
6	6	Suppe	Campbell	1	17.50	1	0
7	7	Bone	Hamm	0	0.00	0	0
8	8	Sniffle	Arnold	1	11.50	1	0
9	9	Gunn	Thomas	1	95.50	2	1
10	10	Plate	Homer	1	37.25	1	0
11	11	L'Pew	Peppy	0	0.00	0	0
12	12	Lapan	Louis	1	35.00	0	0
13	13	Dover	Eileen	1	145.25	2	2
14	14	Salt	Morton	1	39.00	1	0
15	15	Eerwiker	Humphrey	0	0.00	0	0
16	16	Roe	Richard	1	21.00	0	1

*Note:* Some of the variables in the example data set are hidden in this SAS/INSIGHT display.  $\triangle$

Following are all of the variables in the example data set:

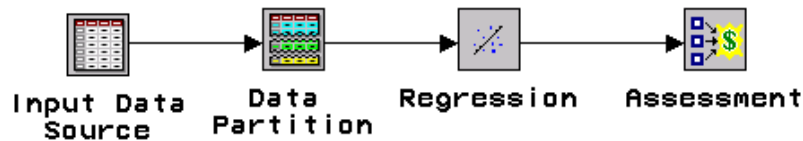
- CUST\_NUM, customer number, an ID (identification) variable.
- LASTNAME, the customer's last name.
- FIRSTNAM, the customer's first name.
- PUR\_YN, a binary variable where "0" indicates no purchase, and "1" indicates purchase.
- PUR\_AMT, a continuous variable that contains the amount of purchase.
- CAP, a continuous variable that contains the number of baseball caps purchased.
- T\_SHIRT, a continuous variable that contains the number of t-shirts purchased.
- SW\_SHIRT, a continuous variable that contains the number of sweatshirts purchased.
- MARRIED, a binary variable where "0" indicates the customer is not currently married, and "1" indicates that the customer is married.
- CHILDREN, a binary variable where "0" indicates the customer has no children, and "1" indicates that the customer has children.
- SALARY, a continuous variable that contains the customer's annual salary in thousands.
- OWN\_RENT, a binary variable where "0" indicates that the customer rents a home, and "1" indicates that the customer owns a home.
- PREV\_PUR, a binary variable where "0" indicates the customer has not made previous purchases, and "1" indicates that the customer has made previous purchases.

For a regression model that uses PUR\_AMT as the target variable and MARRIED, CHILDREN, SALARY, OWN\_RENT, and PREV\_PUR as input variables, the Variables tab of the Input Data Source node would appear as follows:

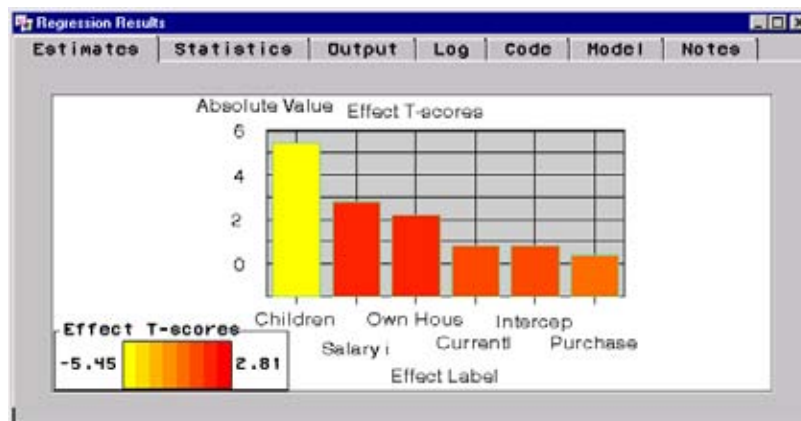
Input Data Source					
Data		Variables		Interval Variables	Class Variables
Name	Model Role	Measurement	Type	Format	Variable Label
CUST_NUM	rejected	interval	num	BEST12.	Customer ID Number
LASTNAME	rejected	nominal	char	\$\$.	
FIRSTNAM	rejected	nominal	char	\$\$.	
PUR_YN	rejected	binary	num	BEST12.	Purchase 0=No 1=Yes
PUR_AMT	target	interval	num	BEST12.	Purchase Amount
CAP	rejected	ordinal	num	BEST12.	Baseball Caps
T_SHIRT	rejected	ordinal	num	BEST12.	Logo T Shirts
SU_SHIRT	rejected	ordinal	num	BEST12.	Logo Sweatshirts
MARRIED	input	binary	num	BEST12.	Currently Married 0=No 1=
CHILDREN	input	binary	num	BEST12.	Children 0=No 1=Yes
SALARY	input	interval	num	BEST12.	Salary in 000s
OWN_RENT	input	binary	num	BEST12.	Own House or Rent, 0=Rent
PREV_PUR	input	binary	num	BEST12.	Purchase in Previous Year

Note that the binary variable PUR\_YN has been excluded from the analysis along with six other variables.

The process flow diagram might be as follows:



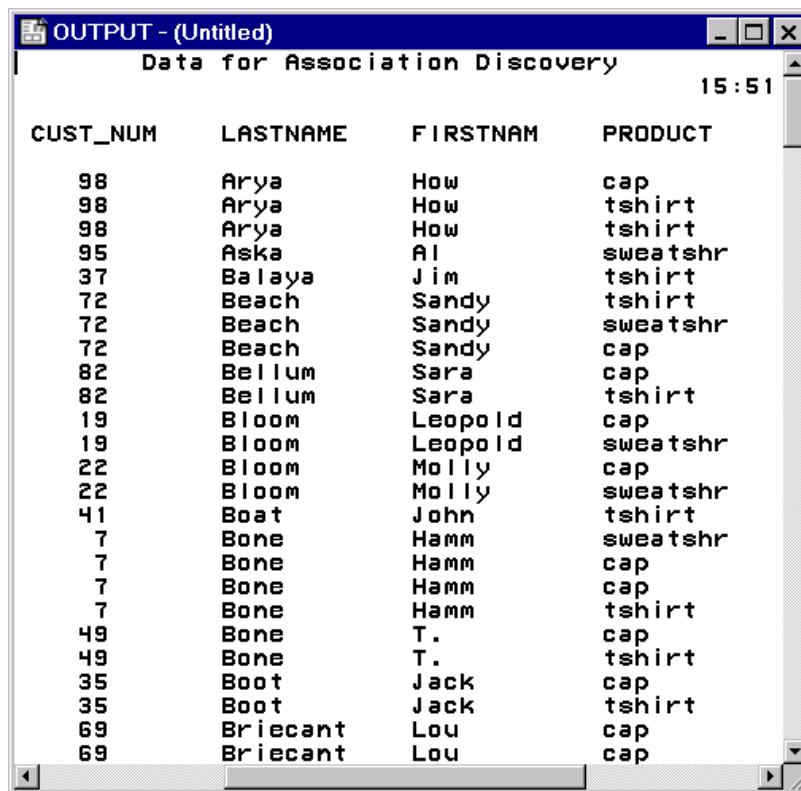
After you run the process flow diagram, you can view the regression results by right-clicking the Regression node icon and selecting **Results**.



You can also open the Assessment node to create assessment charts that indicate the usefulness of the model.

## Association Discovery Data

Here is an example of association discovery data.

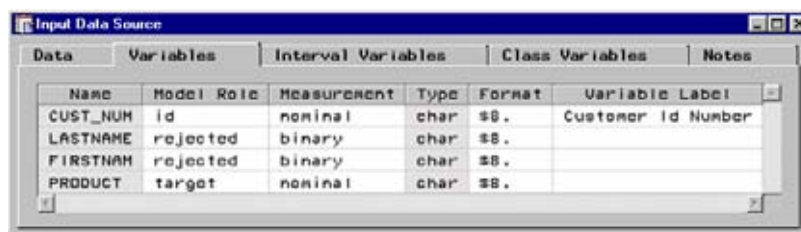


CUST_NUM	LASTNAME	FIRSTNAM	PRODUCT
98	Arya	How	cap
98	Arya	How	tshirt
98	Arya	How	tshirt
95	Aska	Al	sweatshr
37	Balaya	Jim	tshirt
72	Beach	Sandy	tshirt
72	Beach	Sandy	sweatshr
72	Beach	Sandy	cap
82	Bellum	Sara	cap
82	Bellum	Sara	tshirt
19	Bloom	Leopold	cap
19	Bloom	Leopold	sweatshr
22	Bloom	Molly	cap
22	Bloom	Molly	sweatshr
41	Boat	John	tshirt
7	Bone	Hamm	sweatshr
7	Bone	Hamm	cap
7	Bone	Hamm	cap
7	Bone	Hamm	tshirt
49	Bone	T.	cap
49	Bone	T.	tshirt
35	Boot	Jack	cap
35	Boot	Jack	tshirt
69	Briecant	Lou	cap
69	Briecant	Lou	cap

This output contains the following variables:

- ☐ CUST\_NUM, customer number, an ID (identification) variable.
- ☐ LASTNAME, the customer's last name.
- ☐ FIRSTNAM, the customer's first name.
- ☐ PRODUCT, a nominal (class) variable that contains the product purchased.

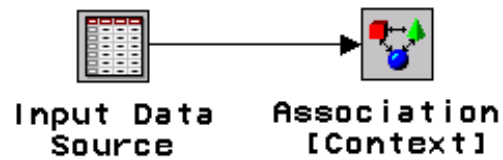
For an association discovery analysis (basket analysis) that uses PRODUCT as the target variable and CUST\_NUM as the ID (identification) variable, the Variables tab of the Input Data Source node would appear as follows:



Name	Model Role	Measurement	Type	Format	Variable Label
CUST_NUM	id	nominal	char	\$B.	Customer id Number
LASTNAME	rejected	binary	char	\$B.	
FIRSTNAM	rejected	binary	char	\$B.	
PRODUCT	target	nominal	char	\$B.	

*Note:* The values in the **Name** and **Type** columns are dimmed and unavailable because they are protected fields.  $\triangle$

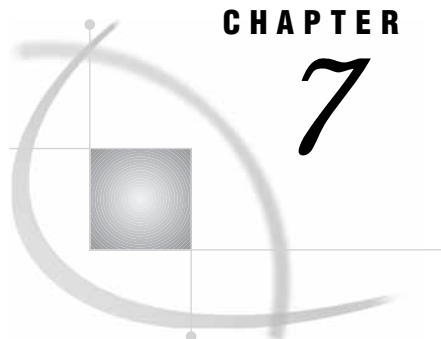
The process flow diagram appears as follows:



You can also use the Association node to perform sequence discovery. Sequence discovery goes one step further than association discovery by taking into account the ordering of the relationship among items. For example sequence discovery asks, “Of those customers who purchase a new computer, 25% of them will purchase a laser printer in the next quarter.” To perform sequence discovery, you must also assign a sequence model role to a time stamp variable. For information about sequence discovery, see the online documentation for the Association node.







## CHAPTER

## 7

## Example Process Flow Diagram

---

<i>Process Flow Diagram Scenario</i>	<b>69</b>
<i>Task 1. Creating a New Local Project</i>	<b>72</b>
<i>Task 2. Defining the Input Data Set</i>	<b>73</b>
<i>Task 3. Setting the Target Variable</i>	<b>74</b>
<i>Task 4. Defining a Target Profile for the GOOD_BAD Target Variable</i>	<b>74</b>
<i>Task 5. Examining Summary Statistics for the Interval and Class Variables</i>	<b>79</b>
<i>Task 6. Creating Training and Validation Data Sets</i>	<b>79</b>
<i>Task 7. Creating Variable Transformations</i>	<b>81</b>
<i>Task 8. Creating a Stepwise Logistic Regression Model</i>	<b>84</b>
<i>Task 9. Creating a Multilayer Perceptron Neural Network Model</i>	<b>87</b>
<i>Task 10. Creating a Tree Model</i>	<b>92</b>
<i>Task 11. Assessing the Models</i>	<b>95</b>
<i>Task 12. Defining the Score Data Set</i>	<b>98</b>
<i>Task 13. Scoring the Score Data Set</i>	<b>99</b>
<i>Task 14. Viewing the Expected Losses in the Score Data Set</i>	<b>100</b>
<i>Task 15. Creating a Score Card of the Good Credit Risk Applicants</i>	<b>104</b>
<i>Task 16. Closing the Diagram</i>	<b>106</b>

---

## Process Flow Diagram Scenario

This section shows you how to arrange various Enterprise Miner nodes into a data mining diagram. Several key components of the Enterprise Miner process flow diagram are covered:

- ☐ input data set
- ☐ target profile for the target
- ☐ partitioned data sets
- ☐ variable transformation
- ☐ supervised modeling, including logistic regression, tree, and neural network models.
- ☐ model comparison and assessment
- ☐ new data scoring.

For more information about the nodes used in this example, see the Enterprise Miner online reference documentation,

[Help](#) ► [EM Reference](#)

or attend one of the data mining courses that the SAS Education Division offers.

In the following scenario, you want to build models that predict the credit status of credit applicants. You will use the champion model, or score card, to determine whether

to extend credit to new applicants. The aim is to anticipate and reduce charge-offs and defaults, which management has deemed are too high.

The input data set that you will use to train the models is named `SAMPSIO.DMAGECR` (the German Credit benchmark data set). This data set is stored in the SAS Sample Library that is included with Enterprise Miner software. It consists of 1,000 past applicants and their resulting credit rating (“GOOD” or “BAD”). The binary target (dependent, response variable) is named `GOOD_BAD`. The other 20 variables in the data set will serve as model inputs (independent, explanatory variables).

VARIABLE	ROLE	LEVEL	DESCRIPTION
CHECKING	input	ordinal	Checking account status
DURATION	input	interval	Duration in months
HISTORY	input	ordinal	Credit history
PURPOSE	input	nominal	Purpose
AMOUNT	input	interval	Credit amount
SAVINGS	input	ordinal	Savings account/bonds
EMPLOYED	input	ordinal	Present employment since
INSTALLP	input	interval	Installment rate as % of disposable income
MARITAL	input	nominal	Personal status and gender
COAPP	input	nominal	Other debtors/guarantors
RESIDENT	input	interval	Present residence since
PROPERTY	input	nominal	Property
AGE	input	interval	Age in years
OTHER	input	nominal	Other installment plans
HOUSING	input	nominal	Housing
EXISTCR	input	interval	Number of existing credits at this bank
JOB	input	ordinal	Job title
DEPENDS	input	interval	Number of dependents
TELEPHON	input	binary	Telephone
FOREIGN	input	binary	Foreign worker
GOOD_BAD	target	binary	Good or bad credit rating

Sixty percent of the data in the `SAMPSIO.DMAGECR` data set will be employed to train the models (the training data). The remainder of the data will be used to adjust the models for overfitting with regard to the training data and to compare the models (the validation data). The models will be judged primarily on their assessed profitability and accuracy and secondarily on their interpretability.

Each of the modeling nodes can make a decision for each case in the data to be scored, based on numerical consequences that you can specify via a decision matrix and cost variables or constant costs. In Enterprise Miner, a decision matrix is defined as part of the target profile for the target. For this example flow, you want to define a loss

matrix that adjusts the models for the expected losses for each decision (accept or reject an applicant). Michie, Spiegelhalter, and Taylor (1994, p. 153) propose the following loss matrix for the SAMPSIO.DMAGECR data set:

Target Values	Decisions:	
	Accept	Reject
Good	\$0	\$1
Bad	\$5	\$0

The rows of the matrix represent the target values, and the columns represent the decisions. For the loss matrix, accepting a bad credit risk is five times worse than rejecting a good credit risk. However, this loss matrix also says that you cannot make any money no matter what you do, so the results may be difficult to interpret. In fact, if you accept a good credit risk, you will make money, that is, you will have a negative loss. And if you reject an applicant (good or bad), there will be no profit or loss aside from the cost of processing the application, which will be ignored. Hence it would be more realistic to subtract one from the first row of the matrix to give a more realistic loss matrix:

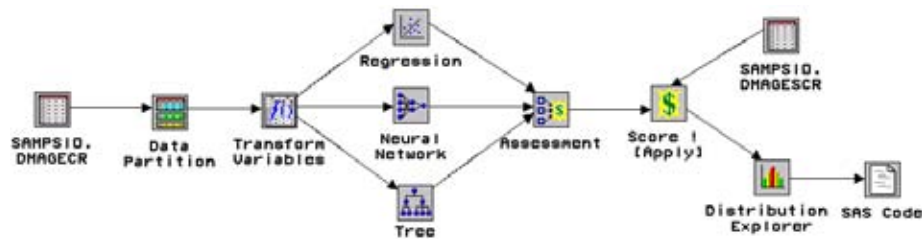
Target Values	Decisions:	
	Accept	Reject
Good	\$-1	0
Bad	\$5	0

This loss matrix will yield the same decisions and the same model selections as the first matrix, but the summary statistics for the second matrix will be easier to interpret.

For a categorical target, such as GOOD\_BAD, each modeling node can estimate posterior probabilities for each class, which are defined as conditional probabilities of the classes, given the input variables. By default, Enterprise Miner computes the posterior probabilities under the assumption that the prior probabilities are proportional to the frequencies of the classes in the training data set. For this example, you need to specify the correct prior probabilities in the decision data set, because the sample proportions of the classes in the training data set differ substantially from the proportions in the operational data set to be scored. The training data set that you will use for modeling contains 70% good credit risk applicants and 30% bad credit risk applicants, respectively. The actual assumed proportion of good-to-bad credit risk applicants in the score data set is 90% and 10%, respectively. If you specify the correct priors in the target profile for GOOD\_BAD, the posterior probabilities will be correctly adjusted no matter what the proportions are in the training data set.

When the most appropriate model for screening bad credit applicants is determined, the scoring code will be deployed to a fictitious score data set that is named SAMPSIO.DMAGESCR. It contains 75 new applicants. This data set is also stored in the SAS Sample Library. Scoring new data that does not contain the target is the end result of most data mining applications.

Follow these steps to create this process flow diagram:

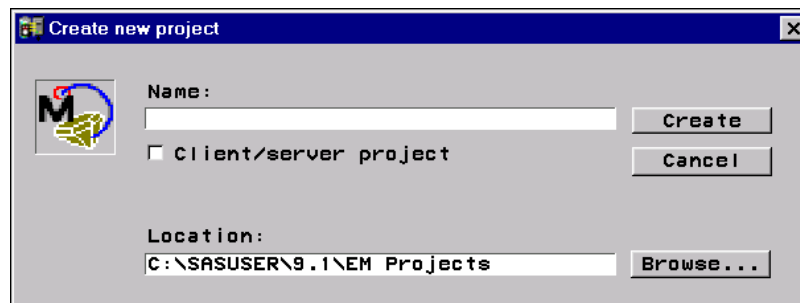


*Note:* Example results may differ. Enterprise Miner nodes and their statistical methods may incrementally change between successive releases. Your process flow diagram results may differ slightly from the results shown in this example. However, the overall scope of the analysis will be the same. △

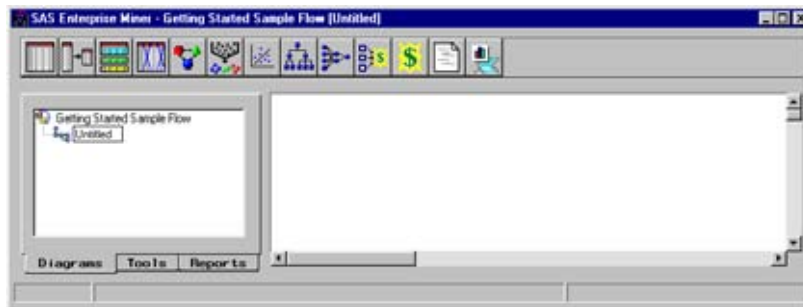
## Task 1. Creating a New Local Project

- 1 To start Enterprise Miner, you must first have a session of SAS running. You open Enterprise Miner from within SAS by typing **miner** in the command bar (found in the upper left corner) in an open SAS session. Enterprise Miner should start and load itself inside the main SAS window.
- 2 Use the **File** pull-down menu from the SAS Enterprise Miner window to select **New** ► **Project**

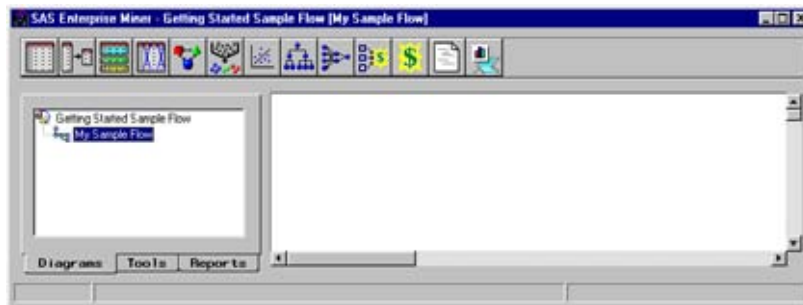
The Create New Project window opens.



- 3 Type the project name in the **Name** text box.
- 4 A project location will be suggested. You can type a different location for storing the project, or use the **Browse** button to search for a location.
- 5 After setting your project location, select **Create**. Enterprise Miner creates the project, which contains a default diagram labeled “Untitled.”

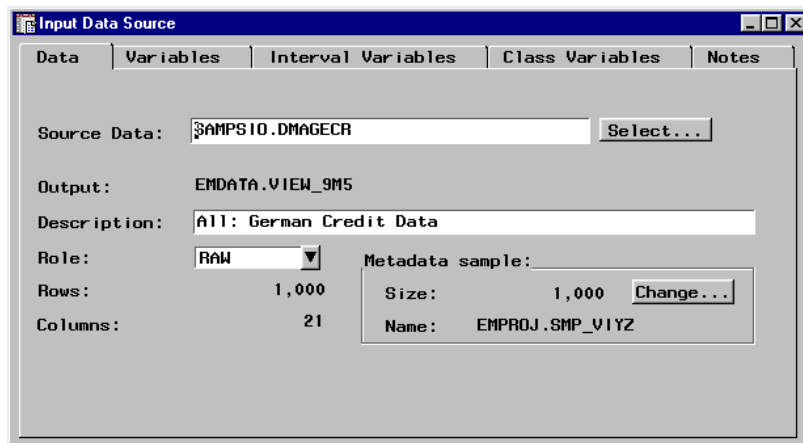


- 6 To rename the diagram, right-click on the diagram icon or label in the Diagrams tab of the Project Navigator and select **Rename**. Type a new diagram name.



## Task 2. Defining the Input Data Set

- 1 Drag an Input Data Source node from the Tools Palette of the Project Navigator or from the toolbox onto the Diagram Workspace.
- 2 Double-click on the Input Data Source node icon in the Diagram Workspace to open the node's configuration interface. The Input Data Source node opens to the Data tab.
- 3 Type SAMPSIO.DMAGECR in the **Source Data** text box, and then press the ENTER key. Alternatively, you can click **Select** to find and set SAMPSIO.DMAGECR as the input data source.



The node automatically creates the metadata sample, which is used in several Enterprise Miner nodes to determine metadata information about the analysis data set.

By default, the metadata sample consists of a random sample of 2,000 cases. Because there are only 1,000 customer cases in this data set, the metadata sample contains all the customer cases in the SAMPSIO.DMAGECR data set. Enterprise Miner assigns a model role and measurement level to each variable that is listed in the Variables tab based on the metadata sample. You can reassign the model role or measurement level for a variable. The summary statistics for interval and class variables are also calculated from the metadata sample.

You can control the size of the metadata sample by selecting **Change** in the Data tab.

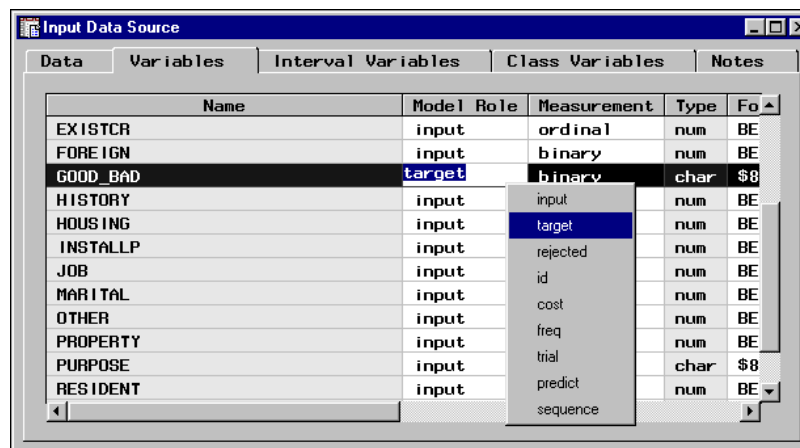
*Note:* The SAMPSIO.DMAGECR credit data set is small relative to many data marts, which often contain gigabytes or even terabytes of data. Therefore, there is no need to sample this data set with a Sampling node prior to creating the partitioned data sets with the Data Partition node.  $\Delta$

## Task 3. Setting the Target Variable

You must assign the target role to the appropriate variables in the input data source. If you have multiple targets, you can use a Group Processing node to generate separate models for each target variable in one run of the process flow diagram. For this example, there is one target variable that is named GOOD\_BAD.

To assign the target model role to GOOD\_BAD, follow these steps:

- 1 Select the Variables tab.
- 2 Scroll down (or page down) the Input Data Source window to display the variable GOOD\_BAD.
- 3 Right-click in the **Model Role** cell of the row that contains the GOOD\_BAD variable and select **Set Model Role**. Another pop-up menu opens.
- 4 Select **target**. Do not close the Input Data Source node.

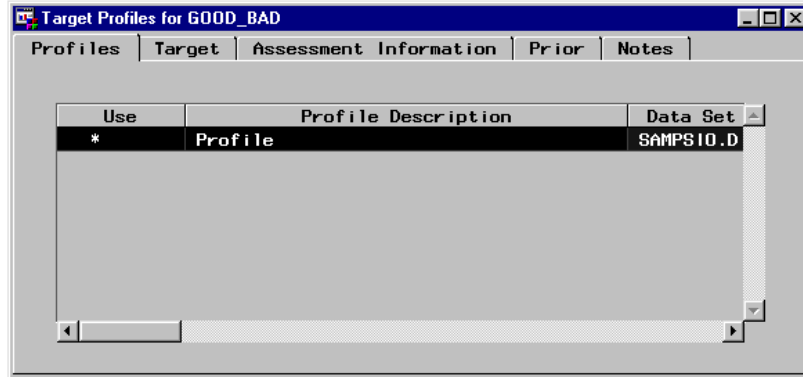


## Task 4. Defining a Target Profile for the GOOD\_BAD Target Variable

A target profile contains information for the target, such as the event level for binary targets, decision matrices, and prior probabilities. The active target profile information is read downstream in the process flow by the modeling nodes and the Assessment node. Although you can define and edit a target profile in any of the modeling nodes, it is often convenient to define this information early in the process flow when you set the target variable in the Input Data Source node.

In this section, you will set the target event level, specify the loss matrix, and define the prior vector for the target GOOD\_BAD. Follow these steps to define the target profile for GOOD\_BAD:

- 1 Open the Target Profiler by right-clicking in any cell of the GOOD\_BAD target variable row of the Variables tab, and select **Edit target profile**. The Target Profiles for the GOOD\_BAD window opens.



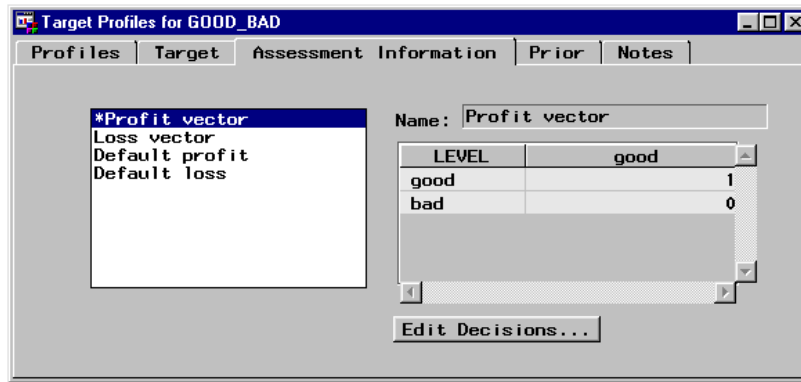
By default, the Target Profiles for the GOOD\_BAD window contains a predefined profile. The asterisk beside the profile name indicates that it is the active target profile. You can create new target profiles, but for this example, you will modify the existing profile.

- 2 Set the Target Event Level:

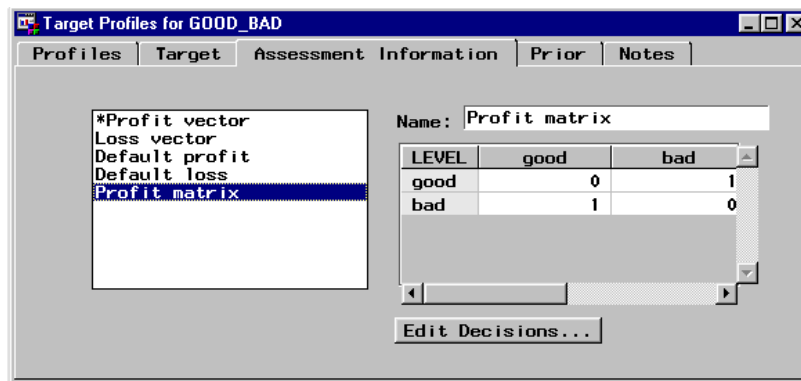
Select the Target tab. By default, the Input Data Source node sets the **Order** value to **Descending** for binary targets. Because the order is set to descending by default, **good** is the target event level. You will model the probability that a customer has good credit. The Assessment node is dependent on the event level when calculating assessment statistics, such as expected profit or loss. If you wanted to model the probability that a customer has bad credit, you would need to set the event level to **bad**. You can accomplish this by setting the **Order** value for GOOD\_BAD to **Ascending** in the Class Variables tab of the Input Data Source window.

- 3 Define the Loss Matrix for the Target GOOD\_BAD:

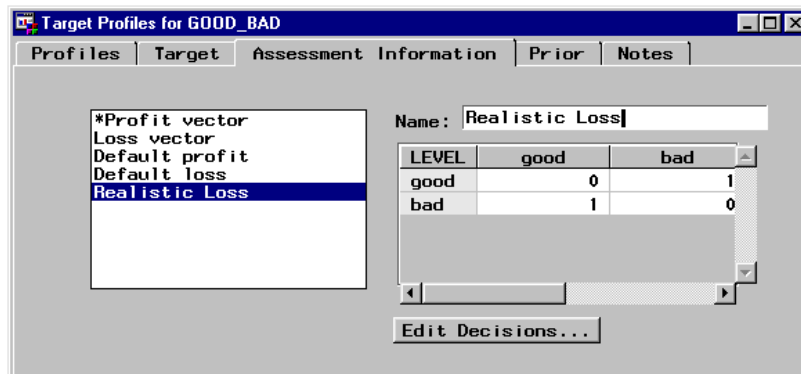
- a Use the Assessment Information tab to define decision matrices, and set the assessment objective for each matrix to either maximize profit, maximize profit with costs (revenue), or minimize loss. For binary targets, the Assessment Information tab contains four predefined decision matrices. These matrices cannot be redefined and are not suitable for this example. Here, you want to define the realistic loss matrix that was described in the overview of the process flow.



- b Add a new loss matrix that you can modify by copying the **Default Loss** matrix (right-click on the **Default Loss** matrix and then select **Copy**). A new decision matrix that is named **Profit matrix** is added to the list box. Alternatively, you can add a new decision matrix by right-clicking an open area of the list box, and selecting **Add**. This matrix will always also be a copy of the **Default profit** matrix.
- c Only one matrix can have a status of **use**. To set the status of the new matrix to **use**, select the **Profit matrix** entry, right-click on the entry, and select the **Set to use** menu item. An asterisk appears besides the matrix name indicating that it is now the active decision matrix that will be read downstream in the process flow by the modeling and Assessment nodes.



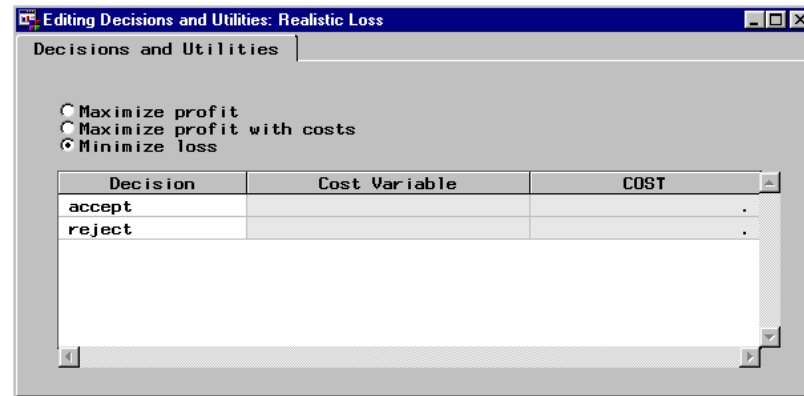
- d To rename the matrix, delete the existing name in the **Name** text box, type a new name, and then press the ENTER key. In this example, the matrix has been renamed **Realistic Loss**.





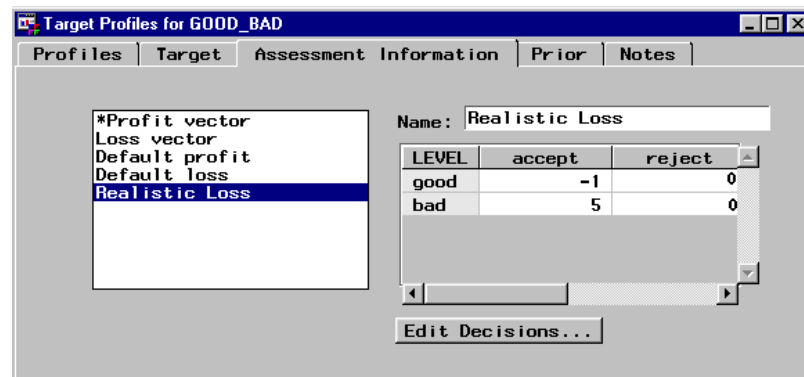
*Note:* The values in the matrix are still the same as the predefined **Default Loss** matrix that you copied. You use this matrix to obtain the correct misclassification rate for the good and bad credit risk applicants. △

- e By default, the decision column names are set to the target levels (good and bad). To rename the decision column names to **accept** and **reject**, click **Edit Decisions**. Then type **accept** in place of the decision that is named **good**, and **reject** in place of the decision that is named **bad**.



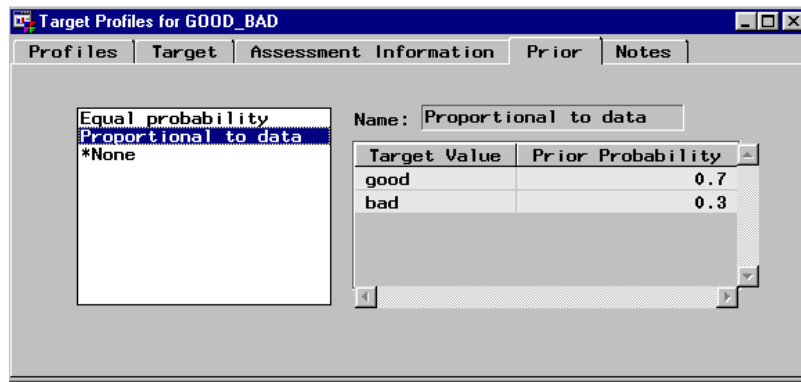
*Note:* You can also use the Decisions and Utilities tab to set the assessment objective for the matrix to either **Maximize profit**, **Maximize profit with costs** (revenue), or **Minimize loss**. Because you copied the predefined **Default loss** matrix, the assessment objective is already correctly set to **Minimize loss**. If you set the assessment objective to **Maximize profit with costs**, you can assign a cost variable or a constant cost to each decision. To assign a cost variable to a decision, the cost model role must have been assigned to the appropriate variables in the Variables tab of the Input Data Source node. △

- f Close the Editing Decisions and Utilities window and follow the prompts to save your changes. Click **Yes** to return to the Assessment Information tab.
- g Type the following values in the loss matrix:



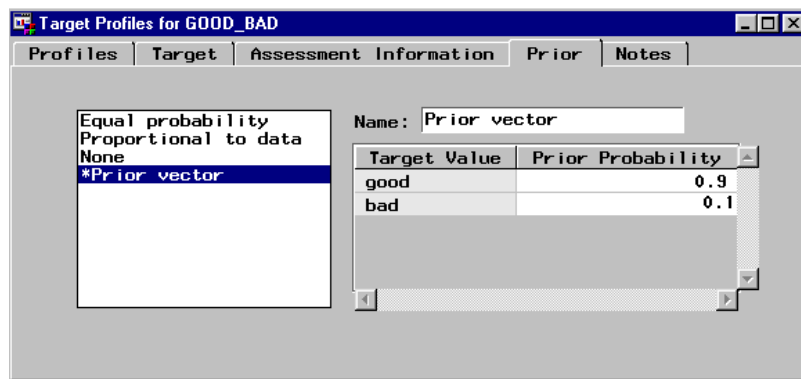
Each of the modeling nodes will use this loss matrix to calculate the expected losses.

- h To specify the true operational priors for the data that you intend to score, select the **Prior** tab.



By default, there are three predefined prior vectors. The **Equal probability** vector contains equal probabilities for the target levels. The **Proportional to data** vector contains priors that are proportional to those in the input data set. Note that the input data set contains 70% good risk applicants and 30% bad risk applicants. The actual probabilities in the score data set are believed to be 90% and 10% for good and bad credit risk applicants, respectively. The active **None** prior vector computes the posterior probabilities under the assumption that the prior probabilities are proportional to the frequencies of the classes in the training data set.

- i To add a new prior vector, right-click in an open area of the list box and select **Add**. A new **Prior vector** is added that contains prior values that are also proportional to those in the input data set.
- j To set the status of the vector to use, right-click on the **Prior vector** and select **Set to Use**.
- k Type the following values in the vector matrix:



The prior probabilities will be used to adjust the relative contribution of each class when computing the total and average loss.

- l Close the window and follow the prompts to save your changes to the target profile. You are returned to the Variables tab of the Input Data Source node. Do not close the Input Data Source node.

## Task 5. Examining Summary Statistics for the Interval and Class Variables

It is advisable to examine the summary statistics for the interval and class variables prior to modeling. Interval variables that are heavily skewed and that have large kurtosis values may need to be filtered or transformed (or both) prior to modeling. It is also important to identify the class and interval variables that have missing values. The entire customer case is excluded from the regression or neural network analysis when a variable attribute for a customer is missing. Although it is usual to collect much information about customers, missing values are common in most data mining data marts. If variables have missing values, you may want to consider imputing these variables with the Replacement node.

- 1 To view summary statistics for the interval variables, select the Interval Variables tab. The variable AMOUNT has the largest skewness statistic. The skewness statistic is 0 for a symmetric distribution. Note that there are no missing values for the interval variables.

Name	Std Dev.	Missing %	Skewness	Kurt
DURATION	12.059	0%	1.0942	****
AMOUNT	2822.7	0%	1.9496	****
AGE	11.375	0%	1.0207	****

- 2 To view summary statistics for the class variables, select the Class Variables tab. Note that also there are no missing values for the class variables.
- 3 Close the Input Data Source node and save all changes when prompted.

*Note:* You can view the distribution of any variable by right-clicking in a cell in the variable row and selecting **View Distribution of <variable name>**. △

## Task 6. Creating Training and Validation Data Sets

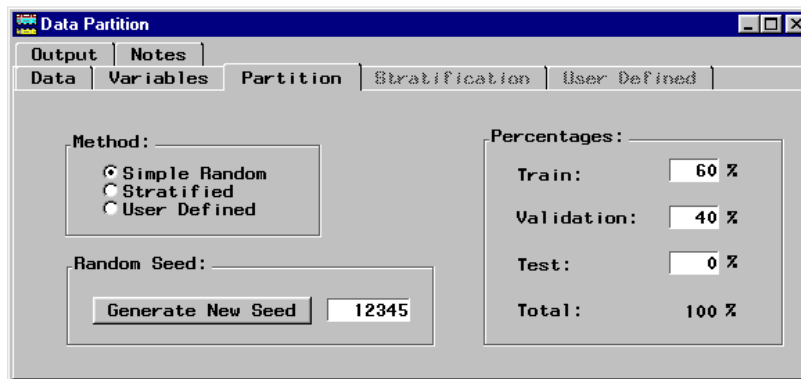
In data mining, one strategy for assessing model generalization is to partition the input data source. A portion of the data, called the training data, is used for model fitting. The rest is held out for empirical validation. The hold-out sample itself is often split into two parts: validation data and test data. The validation data is used to help prevent a modeling node from overfitting the training data (model fine-tuning), and to compare prediction models. The test data set is used for a final assessment of the chosen model.

Because there are only 1,000 customer cases in the input data source, only training and validation data sets will be created. The validation data set will be used to choose the champion model for screening new credit applicants based on the model that

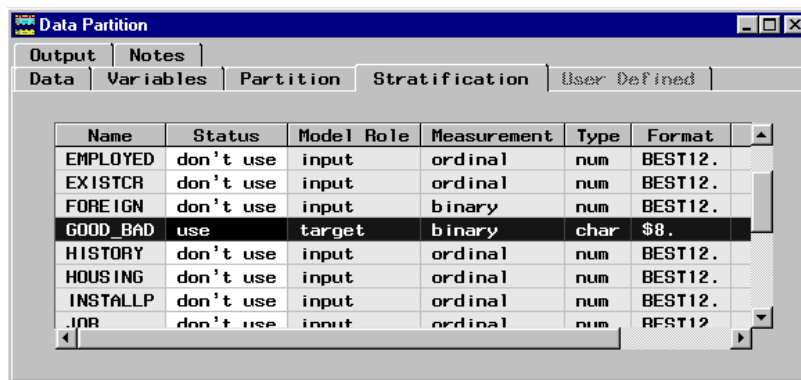
minimizes loss. Ideally, you would want to create a test data set to obtain a final, unbiased estimate of the generalization error of each model.

To create the training and validation data sets:

- 1 Add a Data Partition node to the Diagram Workspace.
- 2 Connect the Input Data Source node to the Data Partition node.
- 3 Open the configuration interface to the Data Partition node. When the node opens, the Partition tab is displayed.
- 4 Allocate 60% of the input data to the training data set and 40% of the input data to the validation data set (type 0 in the **Test** text box). To replicate the results of this example flow, use the default **Random Seed** value of 12345.



- 5 Create the partitioned data sets using a sample that is stratified by the target GOOD\_BAD. A stratified sample helps to preserve the initial ratio of good to bad credit applicants in both the training and validation data sets. Stratification is often important when one of the target event levels is rare.
  - a Select **Stratified** under **Method** in the Partition tab.
  - b Select the Stratification tab.
  - c Scroll down to the bottom of the window to display the GOOD\_BAD variable.
  - d Right-click in the **Status** cell of the GOOD\_BAD variable row and select **Set Status**. Another pop-up menu appears.
  - e Select **use**.

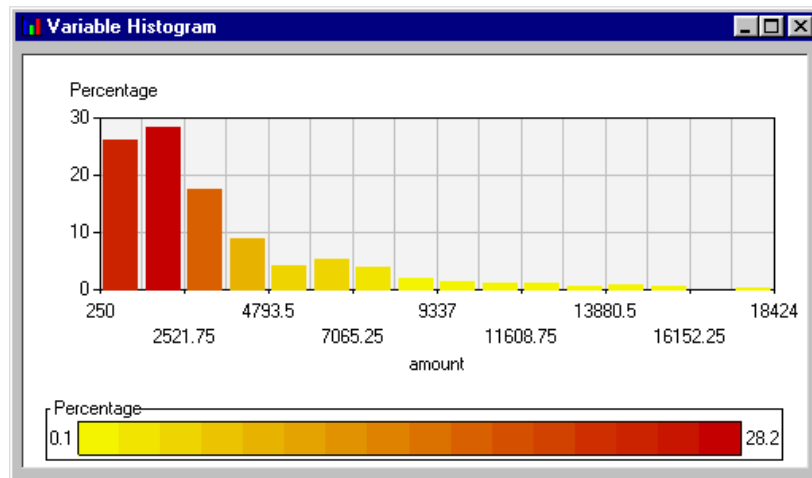


- 6 Close the Data Partition node. Select **Yes** in the Message window to save the node settings.

## Task 7. Creating Variable Transformations

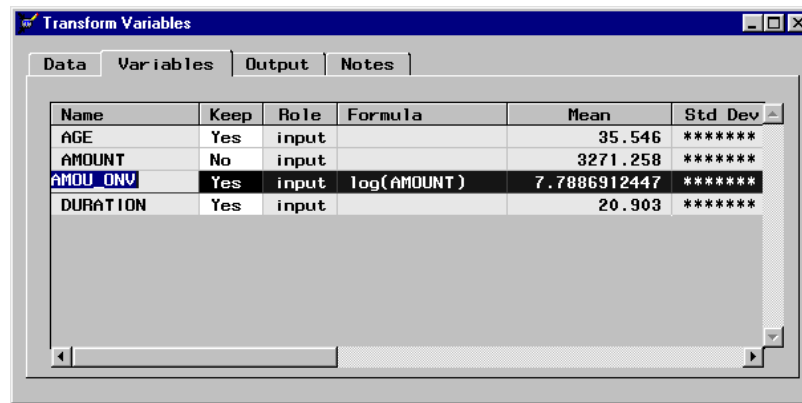
Now that you have partitioned the data, you might want to explore the data with exploratory nodes and perhaps modify the data with modification nodes. For brevity, in this section you will use the Transform Variables node to create transformations of existing variables. The data is often useful in its original form, but transformations may help to maximize the information content that you can retrieve. Transformations are useful when you want to improve the fit of a model to the data. For example, transformations can be used to stabilize variance, remove nonlinearity, improve additivity, and correct nonnormality.

- 1 Add a Transform Variables node to the Diagram Workspace.
- 2 Connect the Data Partition node to the Transform Variables node.
- 3 Open the configuration interface to the Transform Variables node. The Variables tab is displayed.
- 4 View the distribution of AMOUNT:
  - a Right-click in any cell of the AMOUNT variable row and select **View Distribution of AMOUNT**. A histogram of AMOUNT is displayed in the Variable Histogram window.



*Note:* Notice that the distribution for AMOUNT is skewed heavily to one side. The extreme values may cause imprecision in the parameter estimates. △

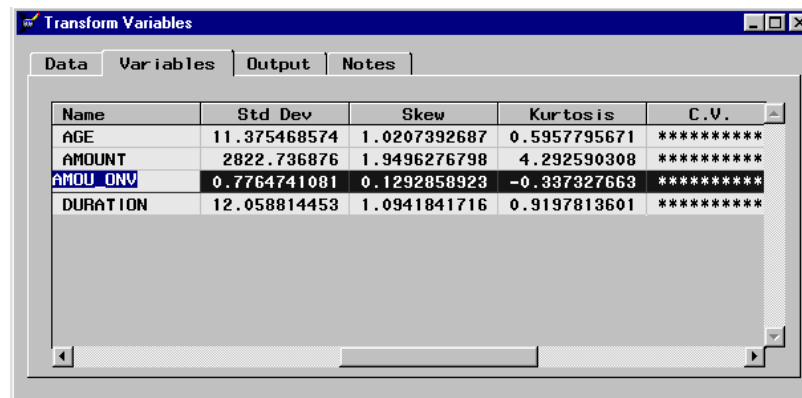
- b Close the window to return to the Variables tab of the Transform Variables window.
- 5 Create a new input variable that maximizes the normality of AMOUNT:
  - a Right-click in any cell of the row that contains the variable AMOUNT and select **Transform**. Another pop-up menu opens.
  - b Select the **Maximize Normality** power transformation to create the transformation and return to the Variables tab of the Transform Variables window. **Maximize Normality** chooses the transformation from a set of best power transformations that yields sample quantiles that are closest to the theoretical quantiles of a normal distribution.



The Transform Variables dialog box shows the 'Variables' tab. It contains a table with columns: Name, Keep, Role, Formula, Mean, and Std Dev. The variables listed are AGE, AMOUNT, AMOU\_ONV, and DURATION. AMOU\_ONV is highlighted in blue, indicating it is the selected variable for transformation.

Name	Keep	Role	Formula	Mean	Std Dev
AGE	Yes	input		35.546	*****
AMOUNT	No	input		3271.258	*****
AMOU_ONV	Yes	input	log(AMOUNT)	7.7886912447	*****
DURATION	Yes	input		20.903	*****

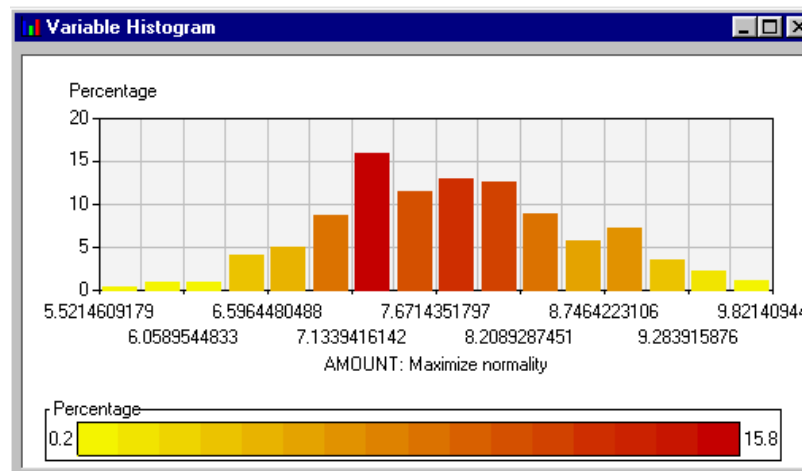
A new variable has been created (for this example, AMOU\_ONV), which is the log of AMOUNT. If you scroll to the right, the **Formula** column lists the formula for the transformation. The skewness statistic has been reduced from 1.95 for AMOUNT to 0.13 for the transformed variable AMOU\_ONV. The **keep** status column identifies variables that will be kept and passed to subsequent modeling nodes (**yes**) and those that will not be (**no**). The keep status for the original input AMOUNT is automatically set to **no** when you apply a transformation.



The Transform Variables dialog box shows the 'Output' tab. It contains a table with columns: Name, Std Dev, Skew, Kurtosis, and C.V. The variables listed are AGE, AMOUNT, AMOU\_ONV, and DURATION. AMOU\_ONV is highlighted in blue, indicating it is the selected variable for transformation.

Name	Std Dev	Skew	Kurtosis	C.V.
AGE	11.375468574	1.0207392687	0.5957795671	*****
AMOUNT	2822.736876	1.9496276798	4.292590308	*****
AMOU_ONV	0.7764741081	0.1292858923	-0.337327663	*****
DURATION	12.058814453	1.0941841716	0.9197813601	*****

- c View the distribution for the log of AMOUNT (for this example, AMOU\_ONV).



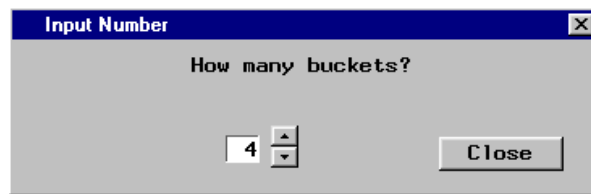
*Note:* Notice that the distribution for the log of AMOUNT is fairly symmetrical. △

- d Close the window to return to the Variables tab of the Transform Variables window.

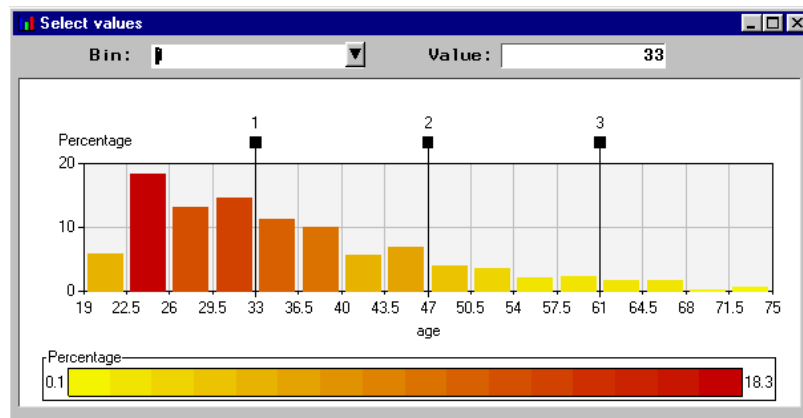
6 Create an ordinal grouping variable from an interval variable:

Using the Transformation node, you can easily transform an interval variable into a group variable. Because you are interested in the credit worthiness of particular age groups, create an ordinal grouping variable from the interval input variable AGE.

- a Right-click in any cell of the AGE variable row and select **Transform**. Another pop-up menu opens.
- b Select **Bucket**. This selection opens the Input Number window, which is used to define the number of buckets (groups) that you want to create. By default, the node creates four buckets.



- c Select **Close** to create the default four buckets. The Select values window opens. It displays the position of each bucket.



To reposition a bin (bucket), drag the slider bar for the bin to a new location. You can also set the bin position by selecting the bin number that you want to modify from the **Bin** drop-down arrow and entering a new bin value in the **Value** text box.

- d For this example, close the Select Values window to use the default bin positions and to return to the Variables tab. The new bucket variable is added as a variable entry in the Variables tab. The keep status of the original input variable AGE is set to **No**.
- 7 Close the Transform Variables node. Click **Yes** in the Message window to save your changes.

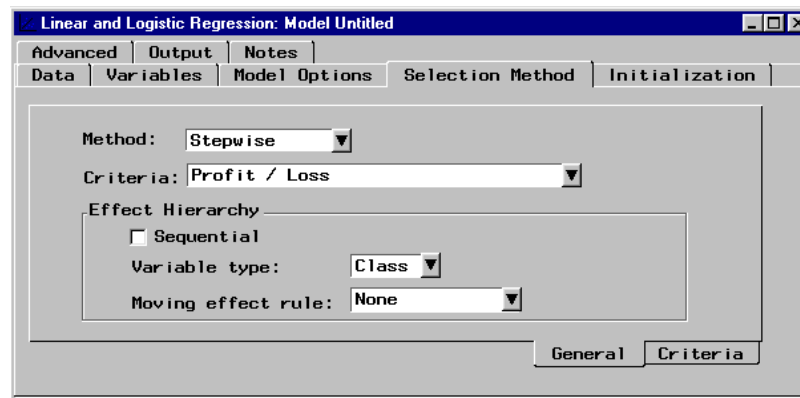
## Task 8. Creating a Stepwise Logistic Regression Model

You can use Enterprise Miner to develop predictive models with the Regression, Neural Network, and Tree nodes. You can also import a model that you developed outside Enterprise Miner with a User Defined Model node, or you can write SAS code in a SAS Code node to create a predictive model. It is also possible to predetermine the important inputs (reduce the data dimension) with the Variable Selection node before modeling with one of the intensive modeling nodes. For more information about predictive modeling, see the Predictive Modeling section in the Enterprise Miner online reference documentation,

[Help](#) ► [EM Reference](#) ► [Predictive Modeling](#)

Many credit organizations use logistic regression to model a binary target, such as GOOD\_BAD. For this reason, a regression model will be the first trained.

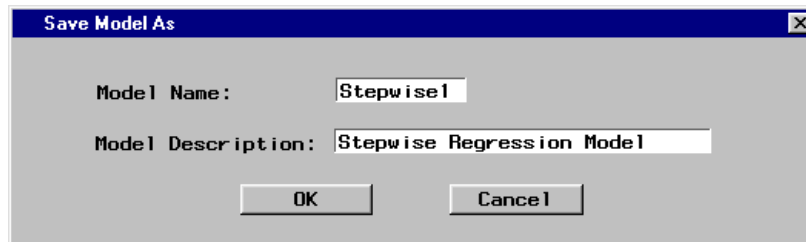
- 1 Add a Regression node to the Diagram Workspace.
- 2 Connect the Transform Variables node to the Regression node.
- 3 Open the configuration interface to the Regression node. The Variables tab lists the input variables and the target. All of the input variables have a status of **use**, indicating they will be used for training. If you know that an input is not important in predicting the target, you might want to set the status of that variable to **don't use** (right-click in the **Status** cell for that input, select **Set Status**, and then select **don't use**). For this example, all variable inputs will be used to train the model.
- 4 For this example, use a stepwise regression to build the model. Stepwise regression systematically adds and deletes variables from the model based on the **Entry** and **Stay** significance levels (defaults of 0.05). Select the Selection Method tab and then click the **Method** drop-down arrow to select **Stepwise**.
- 5 By default, the Regression node chooses the model with the smallest negative log likelihood. For this example, the node should automatically set the value for **Criteria** to **Profit/loss**. **Profit/loss** chooses the model that minimizes the expected loss for each decision using the validation data set. Because the validation data set will be used to fine-tune the model and to assess the model, ideally you would want to withhold a test data set to perform an unbiased assessment of the model.



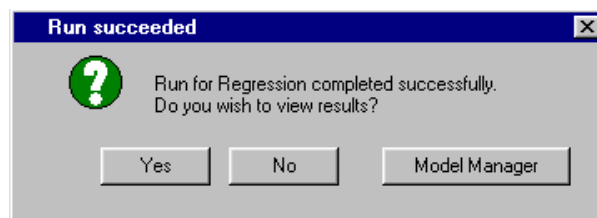
- 6 Select the Model Options tab. Notice that **Type** (of regression) is set to **Logistic** in the Regression subtab. If the target was an interval variable, such as average daily balance, then the type would automatically be set to **Linear**.



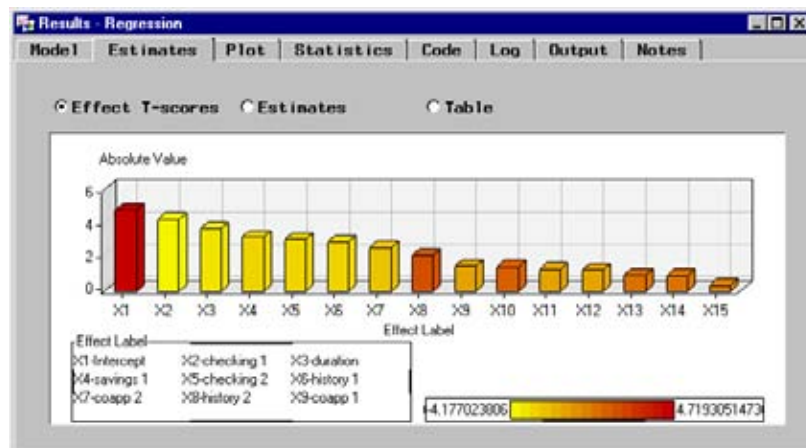
- 7 Select the Target Definition subtab of the Model Options tab. Notice that the event level is set to **GOOD**. If you wanted to model the probability that a customer has bad credit, you would need to reset the event level in the target profile. You can edit the target profile by right-clicking any cell of the target variable row in the Variables tab and selecting **Edit profile**.
- 8 Save the model by using the **File** menu to select **Save Model As**. Type a model name and description in the respective text boxes and then click **OK**. When you run the node, the model is saved as entry in the Model Manager. By default, the model is named "Untitled."



- 9 Close the Regression node.
- 10 Train the model by right-clicking the Regression node icon in the Diagram Workspace and selecting **Run**. Because you did not run the predecessor nodes in the process flow, they execute before the Regression node begins training. In general, when a node is run, all predecessor nodes need to run in order to pass information through the process flow. You can run the Regression node when it is open, but only if you have first run the predecessor nodes in the process flow.
- 11 Click **Yes** in the Message window to view the results.




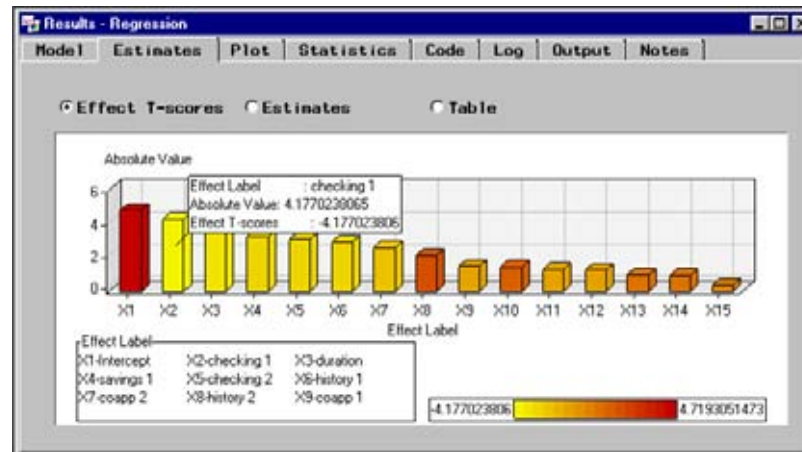
- 12 When the Regression Results Browser opens, the Estimates tab is displayed.



*Note:* The initial bar chart frame may not have room to display all of the bar effects. To view all of the effect estimates, use the **Format** menu and select **Rescale Axes**. △

The scores are ordered by decreasing value in the chart. The color density legend indicates the size of the score for a bar. The legend also displays the minimum and maximum score to the left and right of the legend, respectively. CHECKING, DURATION, and HISTORY are the most important model predictors.

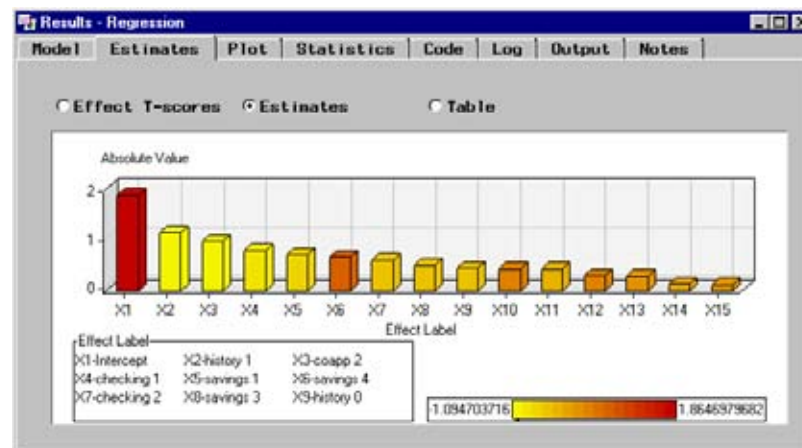
To display a text box that contains summary statistics for a bar, select the View Info tool (  ), then select the bar that you want to investigate, and hold the mouse button down to see the statistics.



You can use the Move and Resize Legend tool icon (  ) on the toolbox to reposition and increase the size of the legend.

To see a chart of the raw parameter estimates, click **Estimates** to display the parameter estimates plot. An advantage of effect T-scores over the raw parameter estimates is that their size can be compared directly to show the relative strengths of several explanatory variables for the same target. This eliminates the effect of differences in measurement scale for the different explanatory variables.

None of the transformations that you created in the Transform Variables node have large absolute effect T-scores. You should work on the exploratory and modification phases of the SEMMA methodology before training models. You can also try different Regression node settings to obtain a better fitting model.

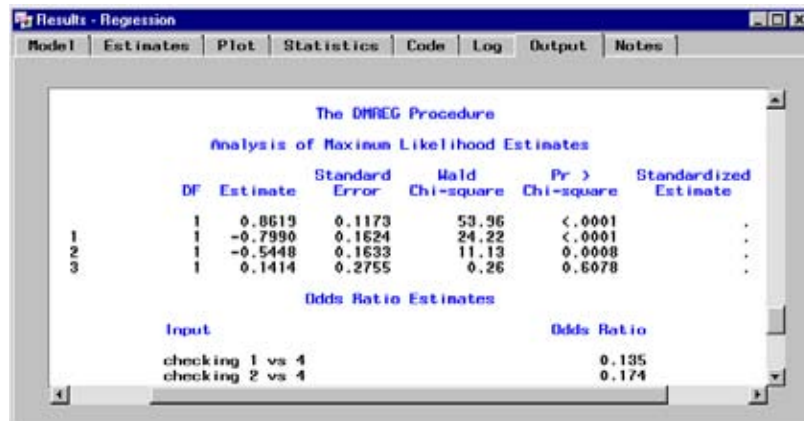


- 13 Select the Statistics tab to display statistics, such as Akaike's Information Criterion, the average squared error, and the average expected loss for the training and validation data sets. The average loss for the cases in the validation data set is about -54 cents (a 54-cent profit), adjusted for the prior probabilities that you specified in the prior vector of the target profile.



Fit Statistic	Label	Training	Validation	Test
_VERR_	Error Function	410.00029579		
_VMAX_	Maximum Absolute Error	0.9400918704		
_VMSE_	Mean Square Error	0.1646321238		
_VNOBS_	Sum of Frequencies	419		
_VRASE_	Root Average Squared Error	0.4057488433		
_VRMSE_	Root Mean Square Error	0.4057488433		
_VSSE_	Sum of Square Errors	137.96171970		
_VSUMW_	Sum of Case Weights Times Freq	838		
_VMISC_	Misclassification Rate	0.2016229117		
_VDISF_	Frequency of Classified Cases	419		
_VUNCF_	Frequency of Unclassified Cases	0		
_VLOSS_	Total Loss for GOOD_BAD	-225.393061		
_VALOSS_	Average Loss for GOOD_BAD	-0.537931996		

- 14 Select the Output tab to view the DMREG procedure output. PROC DMREG is the underlying Enterprise Miner procedure that is used to generate the results. The Output tab lists background information about the fitting of the logistic model, a response profile table, and a summary of the stepwise selection process. At each step, odd ratio estimates are provided. Odd ratios are often used to make summary statements about standard logistic regression models. By subtracting one from the odds ratio and multiplying by 100, you can state the percentage in odds for the response for each unit change in a model input. For nominal and binary inputs, odds ratios are presented versus the last level of the input.



The DMREG Procedure  
analysis of Maximum Likelihood Estimates

	DF	Estimate	Standard Error	Wald Chi-square	Pr > Chi-square	Standardized Estimate
1	1	0.0619	0.1173	53.96	<.0001	.
1	1	-0.7990	0.1624	24.22	<.0001	.
2	1	-0.5448	0.1633	11.13	0.0008	.
3	1	0.1414	0.2755	0.26	0.6078	.

Odds Ratio Estimates

Input	Odds Ratio
checking 1 vs 4	0.135
checking 2 vs 4	0.174

- 15 Close the Results Browser.

## Task 9. Creating a Multilayer Perceptron Neural Network Model

The attraction of a standard regression model is its simplicity. Unfortunately, the structure of the standard model does not allow for nonlinear associations between the

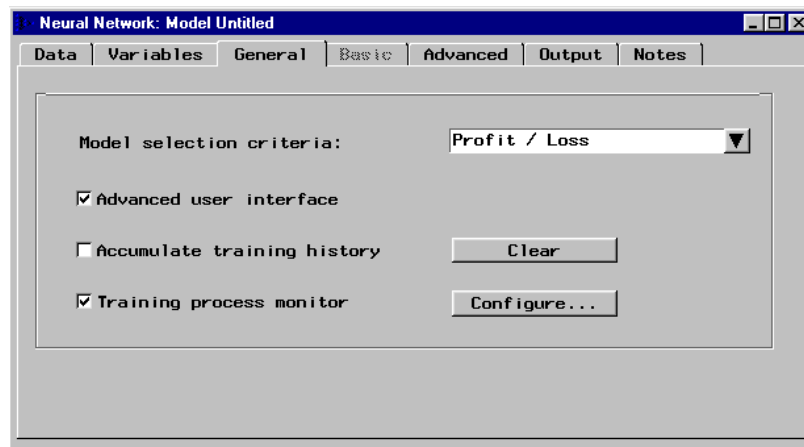
inputs and the target. If such associations exist, both the predicted response probabilities and any interpretations of the modeling results will be inaccurate.

By adding polynomial and interaction terms to the standard model, nonlinear associations can be incorporated into the logistic regression. For more information about this task, see the Regression node section in the Enterpriser Miner online reference documentation.

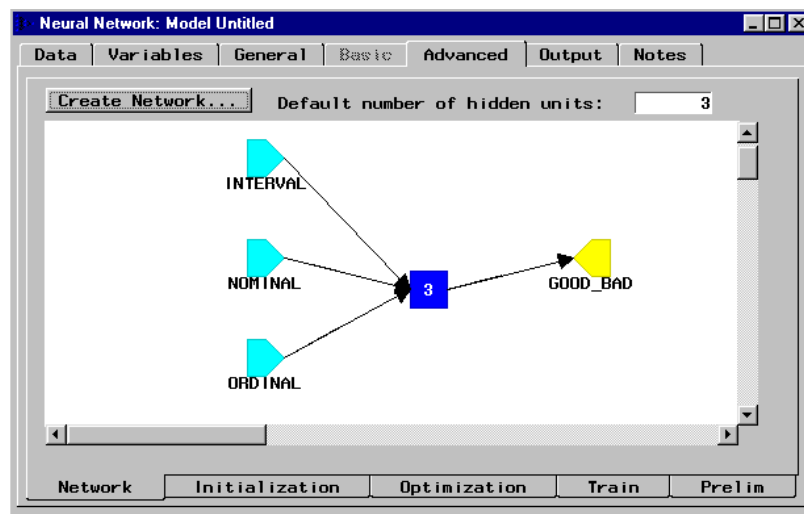
[Help](#) ► [EM Reference](#) ► [Regression Node](#)

You can also use a different modeling tool, such as the Neural Network node. You can use the Neural Network node to fit nonlinear models like a multilayer perceptron (MLP). Neural networks are flexible classification methods that, when carefully tuned, often provide optimal performance in classification problems such as this one. Unfortunately, it is difficult to assess the importance of individual inputs on the classification. For this reason, MLPs have come to be known as “black box” predictive modeling tools. To create an MLP model:

- 1 Add a Neural Network node to the Diagram Workspace.
- 2 Connect the Transform Variables node to the Neural Network node. (Now, both the Neural Network node and the Regression node should be connected to the Transform Variables node.)
- 3 Open the configuration interface to the Neural Network node. The Variables tab lists the input variables and the target. All of the input variables have a status of **use**, indicating that they will be used to train the network. If you know that an input is not important in predicting the target, you might want to set the status of that variable to **don't use** (right-click in the **Status** cell for that variable input, select **Set Status**, and then select **don't use**). For this example, all variable inputs will be used to train the network.
- 4 The Neural Network node provides a basic (default) and an advanced user interface for configuring the network. The basic interface contains a set of easy-to-use templates for configuring the network. The advanced user interface enables you to have more control over configuring the network. For example, you can change the objective function in the advance interface, but not in the basic interface. If you are not familiar with neural networks, you might want to first experiment with different basic network configurations. To configure the network in the advanced interface, you must first select the **Advanced user interface** check box in the General tab. For this example, you will use the advanced interface to see a schematic representation of the network.
- 5 Because you defined a loss matrix for the GOOD\_BAD target, the node automatically sets the model selection criteria to **Profit/Loss**. The node will select the model that minimizes the expected loss for the cases in the validation data set.
- 6 Select the **Advance user interface** check box. The Advanced tab becomes active and the Basic tab becomes dimmed and unavailable when you select this check box.

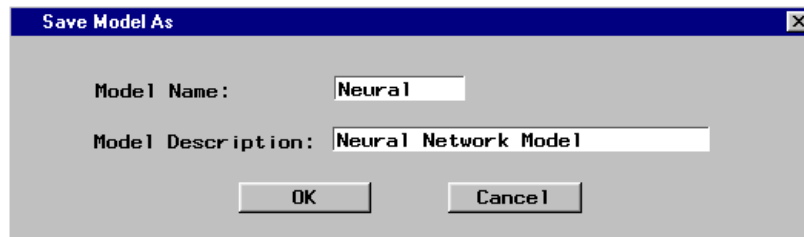


- 7 To display a schematic representation of the network, select the Advanced tab.



The layer on the left represents the input layer that consists of all the interval, nominal, and ordinal inputs. The middle layer is the hidden layer, which has three hidden units (neurons). The layer on the right is the output layer, which corresponds to the target (GOOD\_BAD). When you train the Neural Network node, linear combinations of the inputs are transformed by the hidden units and are recombined to form an estimate of the predicted probability of having bad credit.

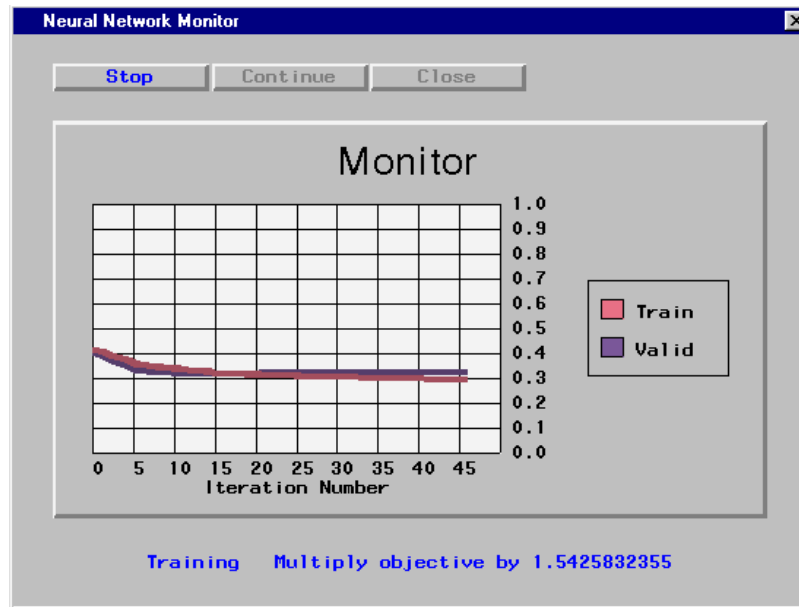
- 8 Save the model by using the **File** menu to select **Save New Model**. Type a model name and description and then click **OK**. The model is added as an entry in the Model Manager. By default, the model is saved as "Untitled."



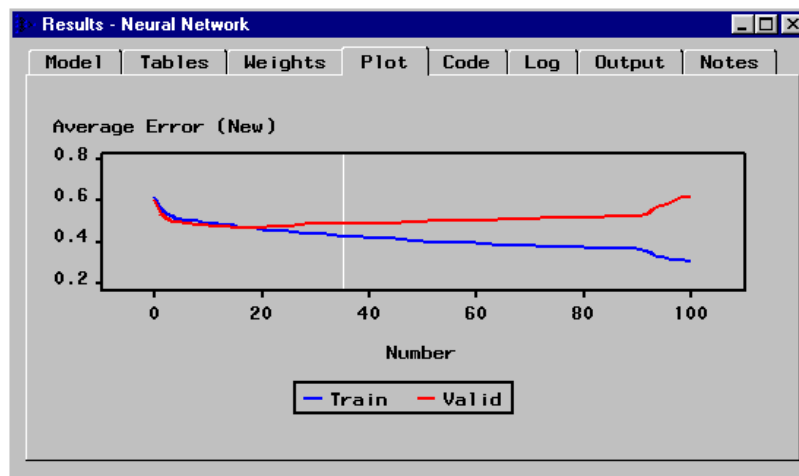
- 9 Train the model by clicking the Run tool icon at the top of the application.

*Note:* Because you have already run the predecessor nodes in the process flow, you can run the Neural Network node while it is open.  $\Delta$

- 10 When the node is running, the Neural Network Monitor window displays the error evolution for the training and validation data sets during optimization.



- 11 After the node finishes training, click **Yes** in the message window to view the results. By default, the node will complete 100 iterations. You can stop training at any time by clicking **Stop**. Click **Continue** to continue training. Click **Close** to stop training altogether and close the monitor.
- 12 When the node has completed training, click **Yes** in the message window to open the Results Browser.
- 13 Select the Plot tab of the Neural Network Results Browser. By default, the plot shows the average squared error for each iteration of the training and validation data sets.

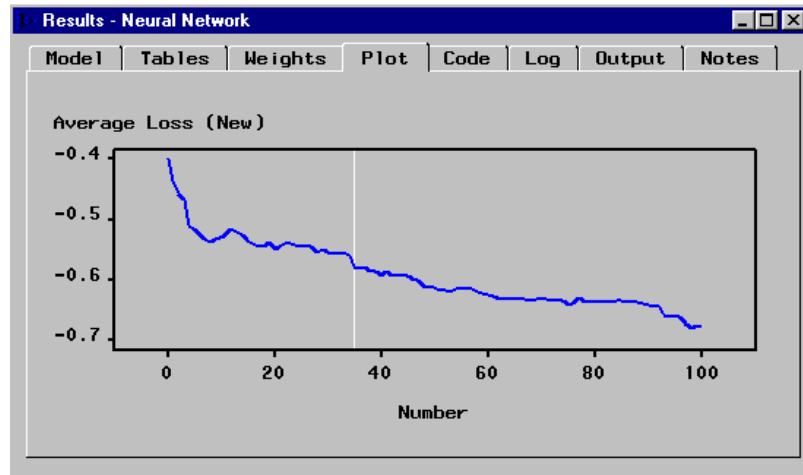


For this example, the optimal average error was achieved at the 35th iteration. Beyond the 35th iteration, overtraining occurs with respect to the validation data

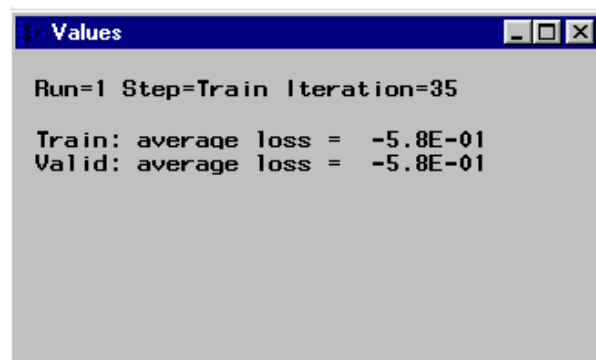
set. The network is being trained to the noise in the training data set instead of the underlying patterns in the data. Note how the training and validation lines diverge beyond the 35th iteration. The message indicator panel at the bottom of the window lists the optimal run, step, iteration, and the average square error for the training and validation data sets.

*Note:* Each time that you open the Neural Network node, a new random seed is created and used to generate starting values for training the network. Therefore, your results may differ slightly from the results that are displayed in this document. △

14 To view the average loss for each iteration, right-click on the plot and select **Loss**.



The average expected loss is minimized at the 35th iteration. To access a dialog box that displays the average loss for this iteration, right-click on the plot, select **Enable pop-up info**, and then select the vertical, white reference line.



The average profit for the cases in the validation data set is 58 cents. Note that the expected loss of -58 cents is adjusted for the prior probabilities that you specified in the prior vector of the target profile for GOOD\_BAD.

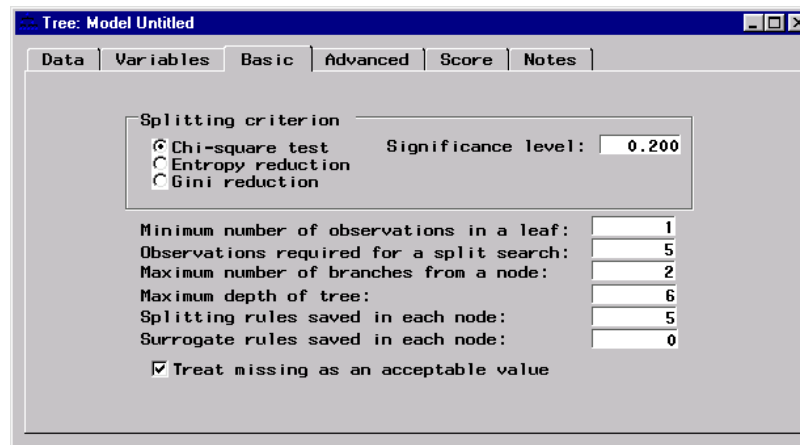
15 Close the Neural Network Results Browser and the Neural Network node.

## Task 10. Creating a Tree Model

An empirical tree represents segmentation of the data that is created by applying a series of simple rules. Each rule assigns an observation to a segment based on the value of one input. One rule is applied after another rule, resulting in a hierarchy of segments within segments. The hierarchy is called a *tree*, and each segment is called a *node*. The original segment contains the entire data set and is called the *root node* of the tree. A node and all its successors form a branch of the node that created it. The final nodes are called *leaves*. For each leaf, a decision is made and applied to all observations in the leaf. The type of decision depends on the context. In predictive modeling, as in this example, the decision is simply the predicted value.

Tree models readily accommodate nonlinear associations between the input variables and the target. They offer easy interpretability, and they handle missing values without using imputation.

- 1 Add a Tree node to the Diagram Workspace.
- 2 Connect the Transform Variables node to the Tree node.
- 3 Open the Tree node. For binary targets, the node uses a chi-square test that has a significance level of 0.200 as the default splitting criterion for binary targets.



For brevity, use the default Basic tab settings of the Tree node to fit the model.

- 4 Select the Advanced tab. Because the Tree node recognizes that an active loss matrix has been defined, it automatically sets the model assessment measure to **Average loss**. The best tree will be created, based on minimizing the expected loss for the cases in the validation data set.



Tree: Model Untitled

Model assessment measure: Average loss

Sub-tree: Best assessment value leaves: 1

Observations sufficient for split search: 581

Maximum tries in an exhaustive split search: 5000

☐ Use prior probability in split search

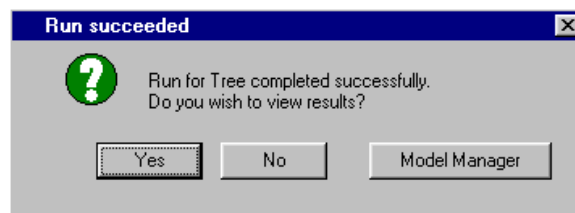
P-value adjustment

☒ Kass ☒ Apply Kass before choosing number of branches  
☐ Apply Kass after choosing number of branches

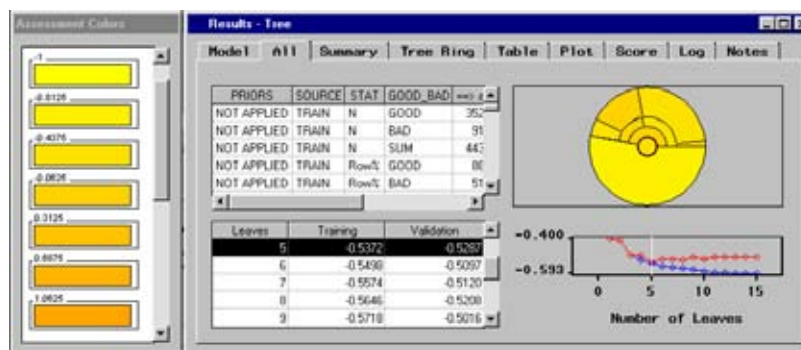
☒ Depth

☐ Effective number of inputs: 20

- 5 Save the model using the **Save** tool icon from the toolbox. The Save Model As window opens. Type a model name and description in the respective entry fields and then click **OK**. By default, the model is saved as "Untitled."
- 6 Train the node by using the **Run** icon in the Toolbox.
- 7 After the node finishes training, click **Yes** in the Message window to view the Tree node Results Browser.



The All tab of the Tree Results Browser is displayed:



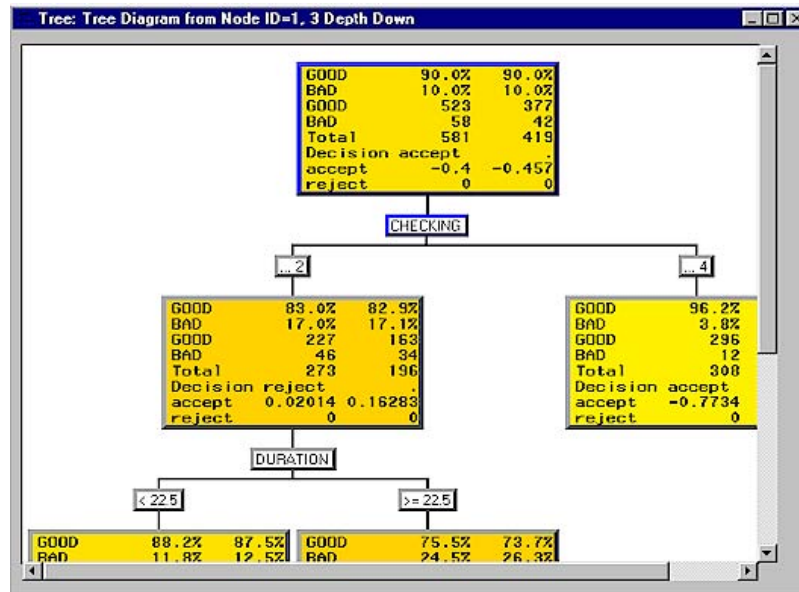
The table in the upper-left corner summarizes the overall classification process. Below this is another table that lists the training and validation expected loss values for increasing tree complexity. The plot at the bottom-right corner represents this same information graphically.

The tree that has only two leaves provides the smallest expected loss for the validation data. The average expected loss for the cases in the validation data set is about -12 cents (a 12-cent profit).

The tree ring provides a quick overview of the tree complexity, split balance, and discriminatory power. The center of the ring corresponds to the root node of

the tree: the farther from the center, the deeper the tree. A split in the ring corresponds to a split in the tree. The arc length of the regions within each ring corresponds to the sample sizes of the nodes. Darker colors represent node purity (“pure” nodes have minimal expected loss values). The Assessment Colors window displays the segment color hues that correspond to the expected loss values in the tree ring.

- 8 To view the more traditional tree diagram, click the **View** menu and select **Tree**.



The tree diagram contains the following items:

- ☐ Root node — the top node in the tree that contains all cases.
- ☐ Internal nodes — nonterminal nodes (also includes the root node) that contain the splitting rule.
- ☐ Leaf nodes — terminal nodes that contain the final classification for a set of observations.

You can use the scroll bars to display additional nodes. The expected loss values are used to recursively partition the data in homogeneous groups. The method is recursive because each subgroup results from splitting a subgroup from a previous split.

The numeric labels that are directly above each node indicate at which point the Tree node found significant splits. The character labels that are in the center of each split are the variable names. For the credit data, the only input variable that resulted in a split was CHECKING.

When you use the loss assessment criterion to build the tree, each row of a node contains the following statistics:

	Target Values	Training Statistics	Validation Statistics	
	GOOD	96.2%	96.2%	Percentages
	BAD	3.8%	3.8%	
	GOOD	296	214	Counts
	BAD	12	8	
	Total	308	223	Total Counts
Decision Alternative (accept or reject)	Decision accept			Expected Loss for Training and Validation sets
	accept	-0.7734	-0.7743	
	reject	0	0	

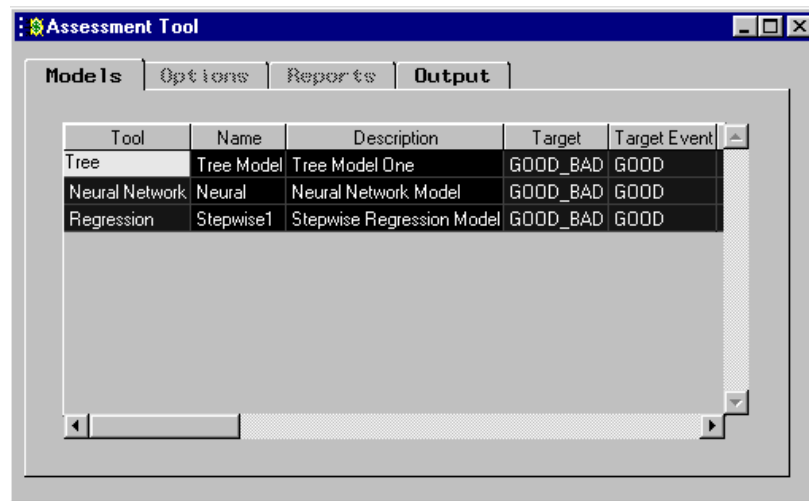
- The first row lists the percentage of good values in the training and validation data sets.
- The second row lists the percentage of bad values in the training and validation data sets.
- The third row lists the number of good values in the training and validation data sets.
- The fourth row lists the number of bad values in the training and validation data sets.
- The fifth row lists the total number of observations in the training and validation data sets.
- The sixth row lists the decision alternative that is assigned to the node (**accept** or **reject**).
- The seventh row lists the expected loss for the **accept** decision in the training and validation data sets.
- The eighth row lists the expected loss for the **reject** decision in the training and validation data sets.

9 Close the Tree Results Browser and then close the Tree node.

## Task 11. Assessing the Models

You use the Assessment node to judge the generalization properties of each predictive model based on characteristics such as their predictive power, lift, sensitivity, profit or loss.

- 1 Add an Assessment node to the Diagram Workspace.
- 2 Connect each modeling node to the Assessment node. Assessment statistics are automatically calculated by each modeling node during training. The Assessment node assembles these statistics, thus enabling you to compare the models with assessment charts.
- 3 Open the configuration interface to the Assessment node. The Models tab of the Assessment Tool window is displayed.
- 4 Select all three models by dragging your mouse pointer across each model row entry.





- 5 To create a lift chart (gains chart) for the models, use the **Tools** pull-down menu to select **Lift Chart**. Alternatively, you can create a lift chart by selecting the Draw Lift Chart tool (the second tool on the Toolbox). By default, the validation data set is used to create the assessment charts. For a binary target, the lift chart does not adjust for the expected loss, it considers only the event posterior probabilities.

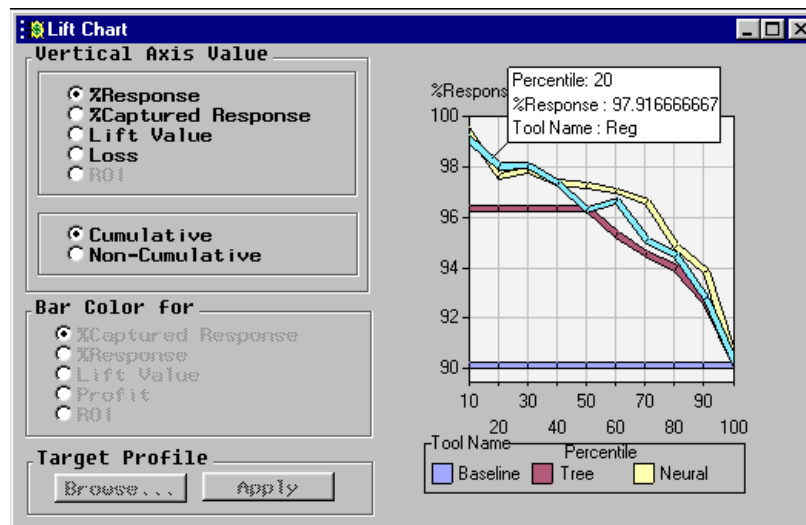


By default, the Assessment node displays a cumulative **%Response** lift chart. For this example chart, the customer cases are sorted from left to right by individuals who are most likely to have good credit as predicted by each model. The sorted group is then divided into ten deciles along the X axis. The left-most decile represents the 10% of the customers who are most likely to have good credit. The vertical axis represents the actual cumulative response rate in each decile.

The lift chart displays the cumulative % response values for a baseline model and for the three predictive models. The legend at the bottom of the display corresponds to each of the models in the chart. Note that the default legend might not have enough room to display all models.

To resize the legend, select the Move and Resize Legend tool icon () , click and hold the mouse pointer on the legend resize handles, and then drag the legend to obtain the desired size.

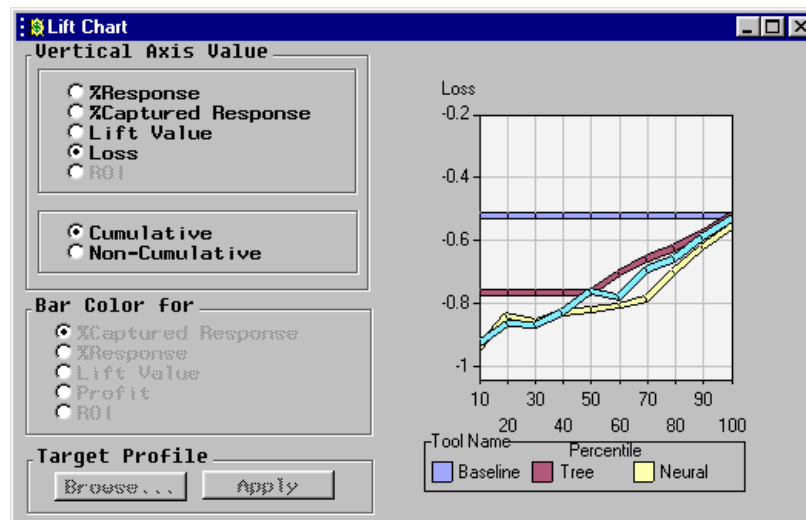
You measure the performance of each model by determining how well the models capture the good credit risk applicants across the various deciles. To display a text box that shows the % response for a point, select the View Info tool () , and then click and hold on a point. For the regression model, the second decile contains 97.92% good credit risk applicants.



The regression model captures a few more good applicants in the second decile than the neural network model. For the other deciles, the performance of the neural network model is as good as or better than the regression model.

For this data, the tree model does not perform quite as well as the regression and neural network models. Note that since a different random seed is used to generate the starting values for training the neural network, your results may differ slightly from the neural network results that are displayed in this lift chart.

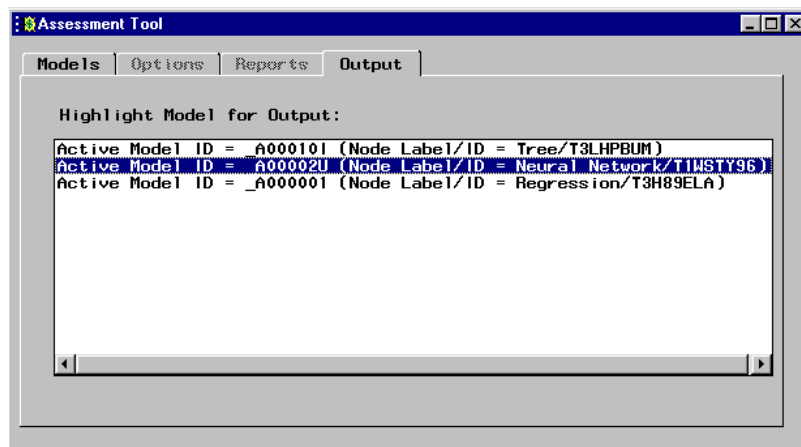
- 6 To create a loss chart, select **Loss**.



The loss chart shows the expected loss across all deciles for each model and for the baseline model. In the first and second deciles, the regression model provides minimal expected loss values of about –70 and –64 cents, respectively (remember that you can use the View Info tool to probe a point on the loss chart). In the remaining deciles, the neural network model provides smaller expected loss values than does the regression model. The performance of the tree model is not as good as the neural model or the regression model in the earlier deciles. The regression model becomes the poorest performing model beyond the fifth decile. In fact, beyond the seventh decile, the regression model yields positive loss values.

There does not seem to be a clear-cut champion model to use for subsequent scoring. Actually, the German credit data set is a highly random data set, which makes it difficult to develop a really good model. This is typical of data mining problems. The selection of the champion model for scoring ultimately depends on how many applicants you intend to target. For this example, you will use the neural network model to score the SAMPSIO.DMAGESCR data set.

- 7 Select the model for subsequent scoring. To export the neural network model to subsequent nodes in the process flow (for example, to the Score node), follow these steps:
  - a Select the Output tab.
  - b Click on the Neural Network entry in the **Highlight Model for Output** list box.



- 8 Close the Assessment node.

## Task 12. Defining the Score Data Set

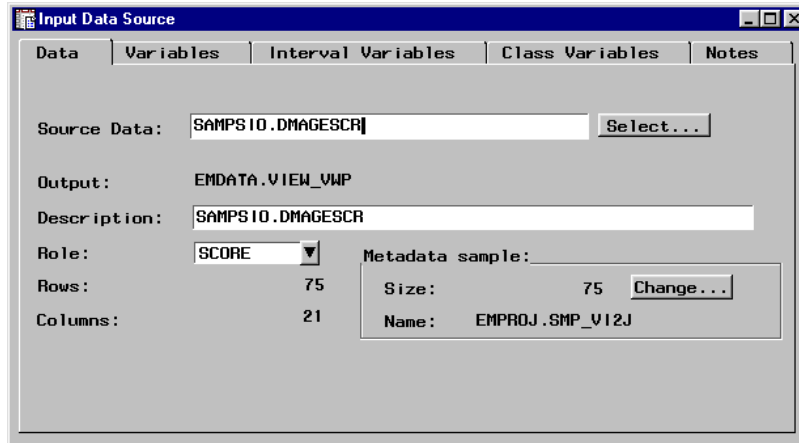
The purpose of predictive modeling is to apply the model to new data. If you are satisfied with the performance of the neural network model, then you can use this model to screen (score) the credit applicants. If you are not satisfied with this model, review the desired components of the sample, explore, modify, model, and assess methodology to try to obtain a better predictive model.

For this example, SAMPSIO.DMAGESCR is the name of the score data set. It is also stored in the sample library.

Follow these steps to set SAMPSIO.DMAGESCR as the score data set:

- 1 Add a second Input Data Source node to the data mining workspace.
- 2 Open the configuration interface to the Input Data Source node.

- 3 Click the down arrow beside **Role** and select **Score**.
- 4 Type **SAMPSIO.DMAGESCR** in the **Source Data** text box and press the ENTER key.

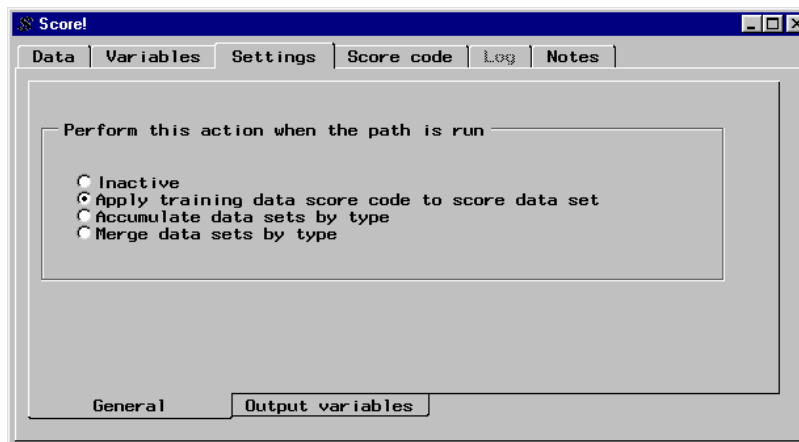


- 5 Select the Variables tab. Notice that the target variable **GOOD\_BAD** does not appear in this data set. You want to estimate the expected loss for the applicants by applying the scoring formula from the neural network model to this data set.
- 6 Close the Input Data Source node and save changes.

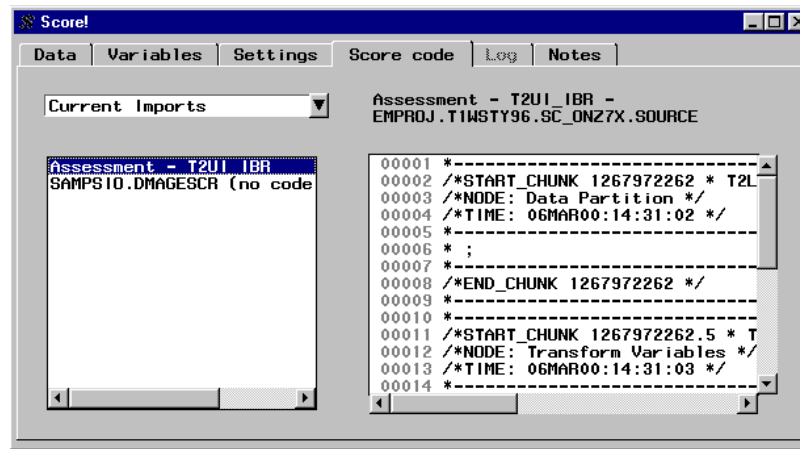
## Task 13. Scoring the Score Data Set

The Score node generates and manages scoring code that is generated by the nodes in the process flow diagram. The code is encapsulated in the form of a single SAS DATA step, which can be used in most SAS environments even without the presence of Enterprise Miner.

- 1 Connect the Assessment node to the Score node.
- 2 Connect the Input Data Source node that contains the score data set to the Score node.
- 3 Open the configuration interface to the Score node. The Settings tab is displayed. Set the action to **Apply training data score code to score data set**.



- 4 Select the Score Code tab to see the current imports. Because you explicitly selected the neural network model in the Output tab of the Assessment node, the **Assessment** import contains the scoring code for the neural network model. To view the scoring code, double-click the **Assessment** current import entry. The code is displayed in the list box to the right.



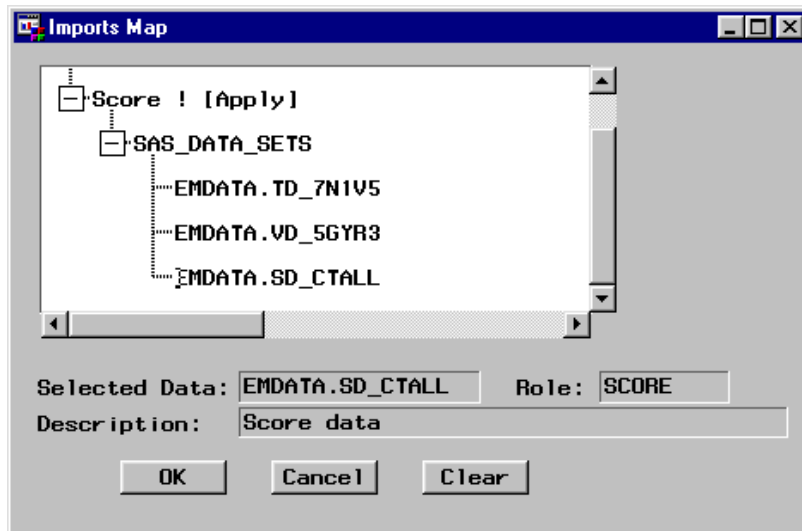
*Note:* The score data set is often much larger than the data set from this example, making it more difficult to score within Enterprise Miner. For this reason, many companies often store the score data set (applicant database) on a mainframe computer. You could save and transport this scoring formula to the target mainframe and score the applicant database on the more powerful mainframe. The code contains the entire instructions for scoring. Only base SAS software is required to run the code. △

- 5 Close the Score node. Click **Yes** in the message window to save your changes.
- 6 To score the SAMP5IO.DMAGESCR data set, right-click the node icon and then select **Run**. When scoring is completed, click **Yes** in the message window.

## Task 14. Viewing the Expected Losses in the Score Data Set

- 1 Add a Distribution Explorer node to the Diagram Workspace.
- 2 Connect the Score node to the Distribution Explorer node.
- 3 Open the configuration interface to the Distribution Explorer node and select the Data tab. The Score node exports the training, validation, and score data sets to the Distribution Explorer node. By default, the Distribution Explorer node selects the training data set as the active data set. To view the distribution of the expected loss values, you must first set the score data set as the active data set. In the Data tab, click **Select**, and then find and select the score data set in the Imports Map window. The score data set name contains the prefix "SD\_". Click **OK**.



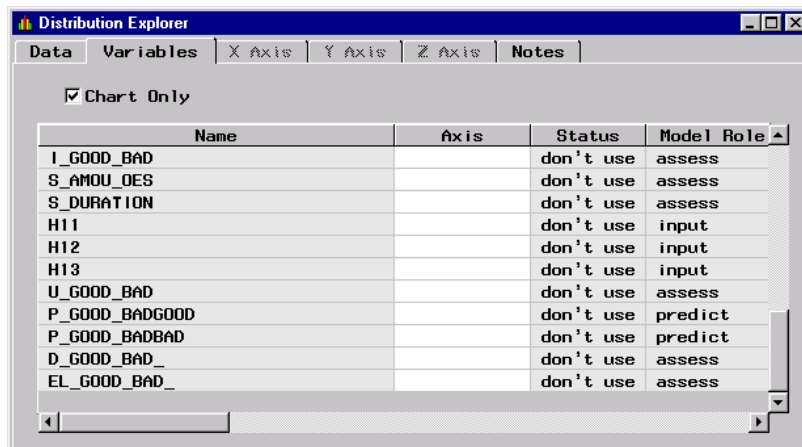


- 4 Select the Variables tab. When you scored SAMPSIO.DMAGESCR, Enterprise Miner automatically created several score variables, such as predicted values, residuals, and classifications. Two important variables that you will plot are
  - EL\_GOOD\_BAD\_ — contains the expected loss values for making the good decision.
  - D\_GOOD\_BAD\_ — assigns either the **accept** or **reject** decision status to an applicant in the score data set.

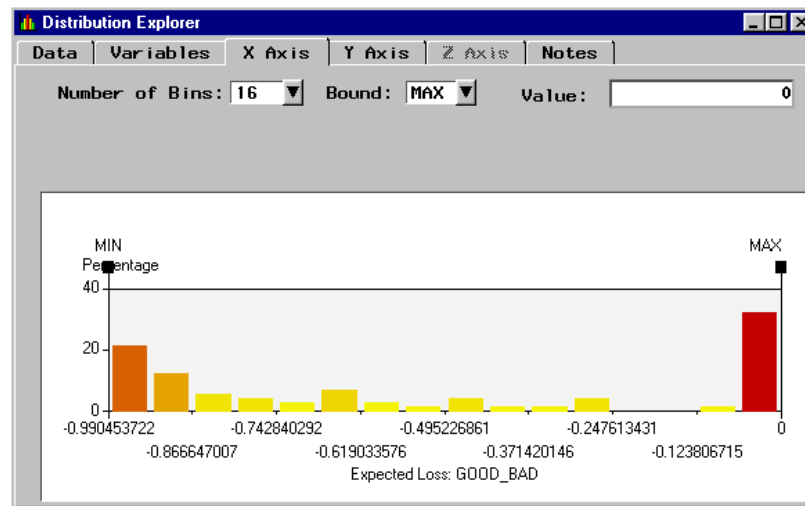
*Note:* For a complete listing of the variable names that are written to the scored data sets see the Predictive Modeling section in the Enterprise Miner online reference documentation. △

Help ► EM Reference ► Predictive Modeling

- 5 To assign EL\_GOOD\_BAD\_ as the X-axis variable, right-click in the Axis cell for this variable, select **Set Axis**, and then select **x**. Repeat these steps to assign D\_GOOD\_BAD\_ as the Y-axis variable. You will use the D\_GOOD\_BAD\_ variable in code that you write in the SAS Code node. Write down the name of this variable for future reference.



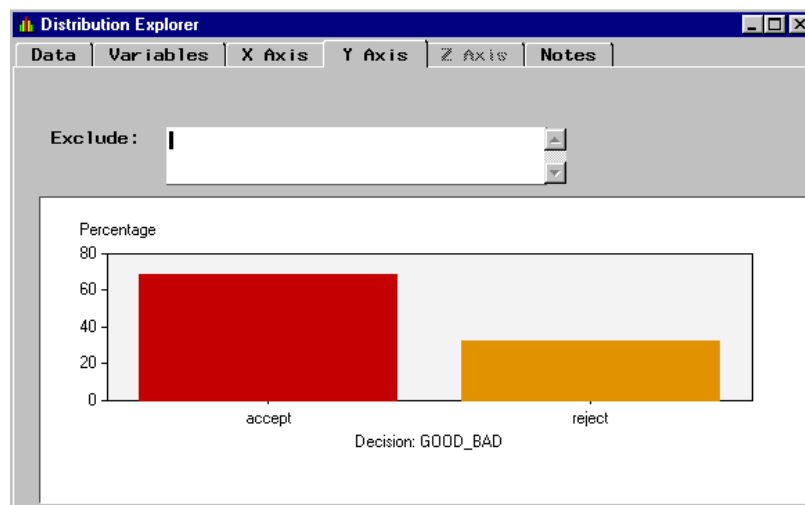
- 6 To view a histogram of the expected losses for making the good decision, select the X Axis tab.



*Note:* The metadata sample is used to create the histogram in the X axis tab and the bar chart in the Y axis tab. For this example, there are only 75 applicants in the score data set. If the scored data set contains more observations than the metadata sample, then you should examine the histogram that is created when you run the node. The node uses all of the observations in the score data set to generate the graphs that are shown in the Results Browser. △

Applicants who have negative expected loss values (the yellow bars) represent the customers who pose a good credit risk. All of these customers are assigned to the accept decision (D\_GOOD\_BAD\_=accept). The orange and red bars represent the applicants that pose a bad credit risk. Because these applicants have positive expected loss values, they are assigned to the **reject** decision (D\_GOOD\_BAD\_=reject).

- 7 To view a bar chart of the accepted and rejected customers in the score data set, select the Y Axis tab.



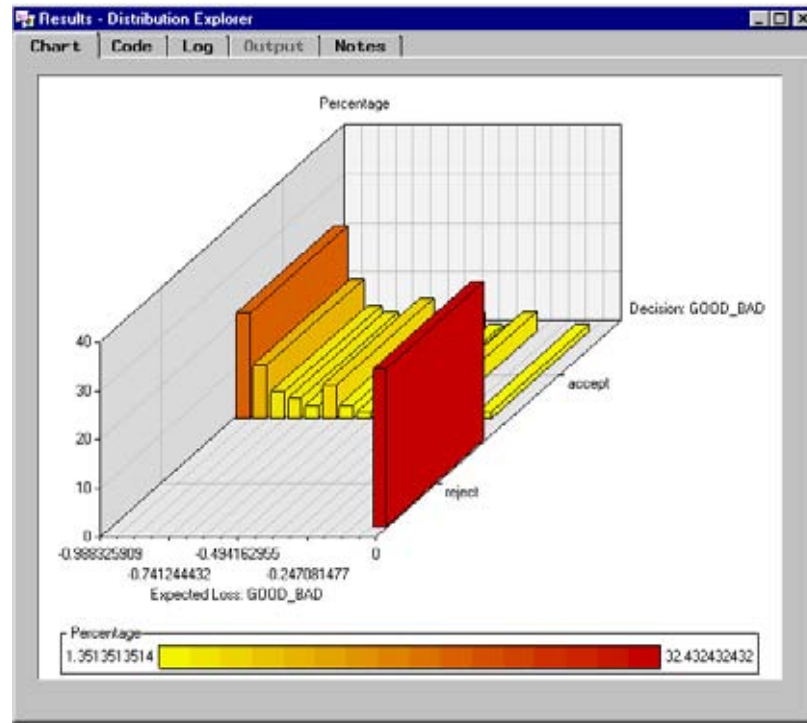
*Note:* The data in both charts is based on the metadata sample. △

To determine the percentage of accepted and rejected customers in the score data set, use the Probe tool icon and click on a bar: the screen shows that 68% of

the applicants were assigned to the **accept** decision, and 32% of the applicants were assigned to the **reject** decision.

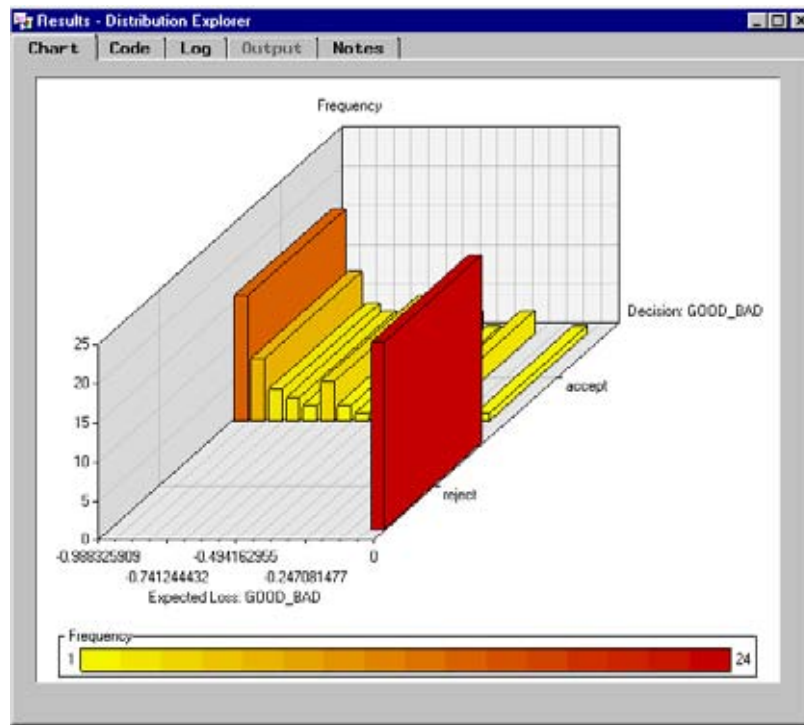
You can use the SAS Code node to create a data set that contains only those customers who pose a good credit risk (accept status). Alternatively, you could use the Filter Outliers node to create a data set that contains only the good credit applicants.

- 8 To create a three-dimensional histogram of the expected losses for the accepted and rejected applicants, use the **Tools** menu to select **Run Distribution Explorer**.



- 9 After the node runs, click **Yes** in the message window to display the histogram. To display frequencies on the vertical axis, use the **View** menu to select

**Axes Statistics** ► **Response Axis** ► **Frequency**

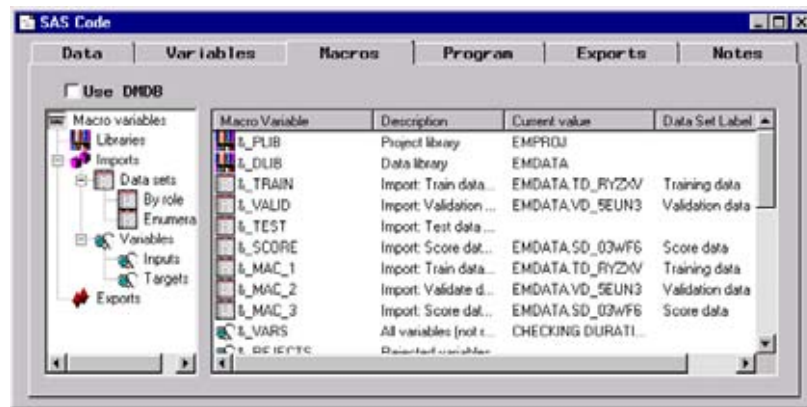


10 Close the Results Browser and then close the Distribution Explorer node.

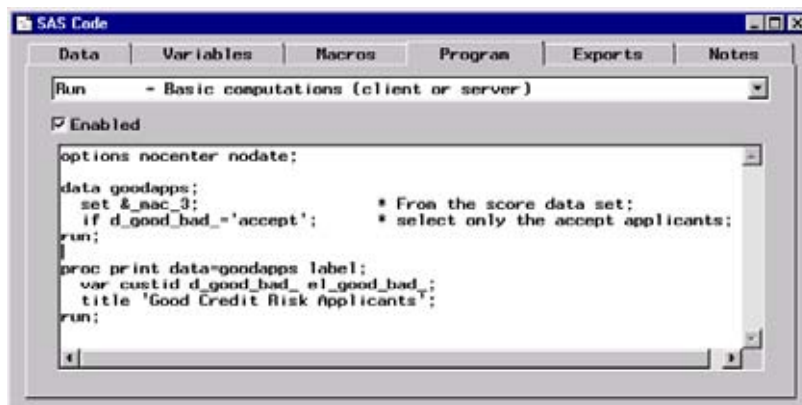
## Task 15. Creating a Score Card of the Good Credit Risk Applicants

You can use a SAS Code node to create a score card of the good credit risk applicants. The SAS Code node enables you to incorporate new or existing SAS code into process flows.

- 1 Add a SAS Code node to the data mining workspace.
- 2 Connect the Distribution Explorer node to the SAS Code node.
- 3 Open the configuration interface to the SAS Code node.
- 4 The SAS Code node provides a macro facility to dynamically reference the data sets and variables. Before you write code to screen for (score) the bad credit applicants, determine the name of the macro variable that references the score data set:
  - a Select the Macros tab.
  - b Notice that the name of the macro variable that references the score data set is `&_MAC_3`.



- 5 Select the Program tab and type the following SAS code:

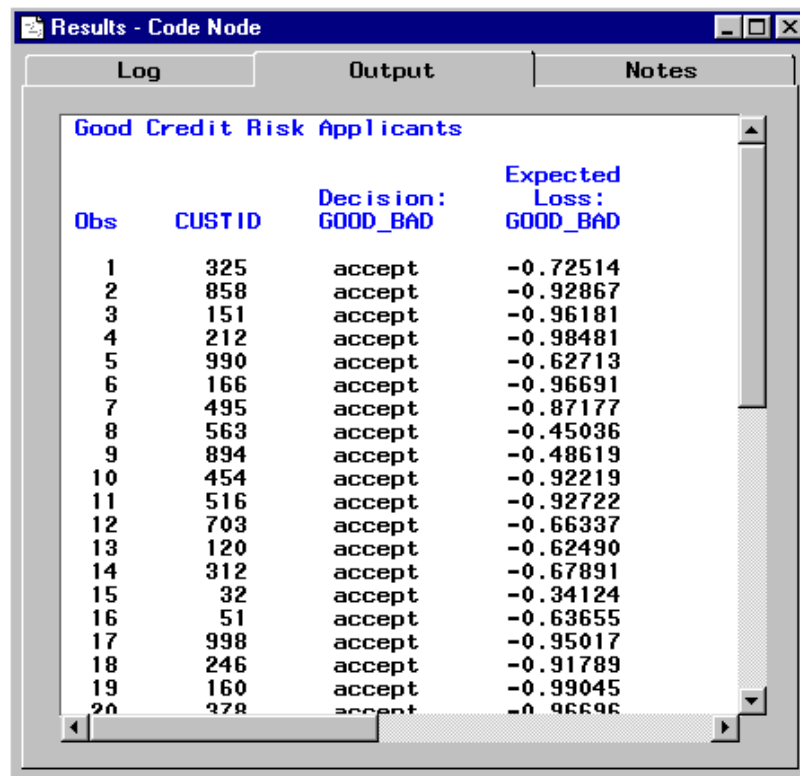


The name of the D\_GOOD\_BAD\_ variable is assigned when the score data set is processed. Make sure you use the correct variable name.

The SAS DATA step reads the observations (customer applicants) from the score data set. The applicants who were assigned to the **accept** decision are written to the output data set GOODAPPS. These applicants are deemed to be credit-worthy.

The PROC PRINT step produces a list report of the good credit risk applicants. The variable CUSTID identifies the good applicants.

- 6 To run the code, click the Run tool icon (  ).
- 7 After the code runs, click **Yes** in the Message window. Select the Output tab to view the list of good credit risk applicants.



The screenshot shows a SAS window titled "Results - Code Node" with three tabs: "Log", "Output", and "Notes". The "Output" tab is active, displaying a table titled "Good Credit Risk Applicants". The table has four columns: "Obs", "CUSTID", "Decision: GOOD\_BAD", and "Expected Loss: GOOD\_BAD". It contains 20 rows of data, all with a decision of "accept".

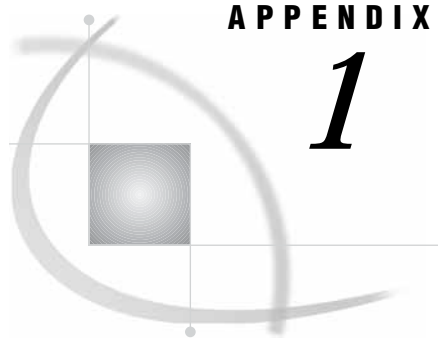
Obs	CUSTID	Decision: GOOD_BAD	Expected Loss: GOOD_BAD
1	325	accept	-0.72514
2	858	accept	-0.92867
3	151	accept	-0.96181
4	212	accept	-0.98481
5	990	accept	-0.62713
6	166	accept	-0.96691
7	495	accept	-0.87177
8	563	accept	-0.45036
9	894	accept	-0.48619
10	454	accept	-0.92219
11	516	accept	-0.92722
12	703	accept	-0.66337
13	120	accept	-0.62490
14	312	accept	-0.67891
15	32	accept	-0.34124
16	51	accept	-0.63655
17	998	accept	-0.95017
18	246	accept	-0.91789
19	160	accept	-0.99045
20	378	accept	-0.96696

8 Close the SAS Code node.

## Task 16. Closing the Diagram

When you close the Diagram Workspace, the diagram is automatically saved to the project. You can reopen the diagram and make revisions.

As you apply the production model, you should record and track the results of the model. (Each node contains a Notes tab where you can type and store notes.) At some point, as you track the model results, you might decide that you need to use additional data and recalibrate the model to improve its predictive ability.



## APPENDIX

## 1

## References

References 107

## References

- Adriaans, P., and D. Zantinge. 1996. *Data Mining*. Edinburgh Gate, England: Addison Wesley Longman.
- Berry, M. J. A., and G. Linoff. 1997. *Data Mining Techniques for Marketing, Sales, and Customer Support*. New York: John Wiley & Sons, Inc.
- Bigus, J. P. 1996. *Data Mining with Neural Networks: Solving Business Problems from Application Development to Decision Support*. New York: McGraw-Hill Companies.
- Bishop, C. M. 1995. *Neural Networks for Pattern Recognition*. New York: Oxford University Press.
- Breiman, L., et al. 1984. *Classification and Regression Trees*. Belmont, CA: Wadsworth International Group.
- CART: Tree-Structured Non-Parametric Data Analysis. Salford Systems, San Diego, CA.
- Hand, D. J. 1997. *Construction and Assessment of Classification Rules*. New York: John Wiley & Sons, Inc.
- Hoaglin, D. C., F. Mosteller, and J. W. Tukey. 1983. *Understanding Robust and Exploratory Data Analysis*. New York: John Wiley & Sons, Inc.
- Little, R. J. A. 1992. "Regression with Missing X's: A Review," *Journal of the American Statistical Association* 87: 1227–1237.
- Little, R. J. A., and D. B. Rubin. 1987. *Statistical Analysis with Missing Data*. New York: John Wiley & Sons, Inc.
- Michie, D., D. J. Spiegelhalter, and C. C. Taylor. 1994. *Machine Learning, Neural and Statistical Classification*. New York: Ellis Horwood.
- Ripley, B. D., and N. L. Hjort. 1996. *Pattern Recognition and Neural Networks*. New York: Cambridge University Press.
- Sarle, W. S. 1994a, "Neural Network Implementation in SAS Software." *Proceedings of the Nineteenth Annual SAS Users Group International Conference*, Dallas, TX, 1550–1573.
- Sarle, W. S. 1994b. "Neural Networks and Statistical Models." *Proceedings of the Nineteenth Annual SAS Users Group International Conference*, Dallas, TX, 1538–1550.

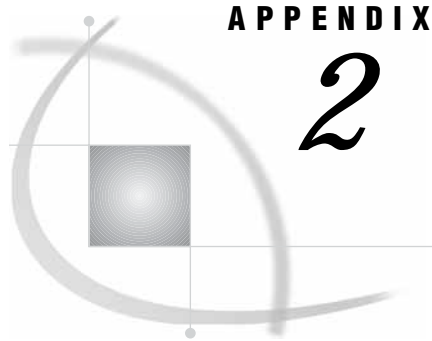
- Sarle, W. S. 1995. "Stopped Training and Other Remedies for Overfitting." *Proceedings of the 27th Symposium on the Interface. Statistics and Manufacturing with Subthemes in Environmental Statistics, Graphics, and Imaging*, Pittsburgh, PA, 352–60.
- SAS Institute Inc. *Data Mining Using Enterprise Miner Software: A Case Study Approach*. Cary, NC: SAS Institute Inc.
- SAS Institute Inc. *Logistic Regression Examples Using the SAS System*. Cary, NC: SAS Institute Inc.
- SAS Institute Inc. *SAS Language Reference: Concepts*. Cary, NC: SAS Institute Inc.
- SAS Institute Inc. *SAS Language Reference: Dictionary*. Cary, NC: SAS Institute Inc.
- SAS Institute Inc. *SAS Procedures Guide*. Cary, NC: SAS Institute Inc.
- SAS Institute Inc. *SAS/INSIGHT User's Guide*. Cary, NC: SAS Institute Inc.
- SAS Institute Inc. *SAS/STAT User's Guide*. Cary, NC: SAS Institute Inc.
- Small, R. D. "Debunking Data Mining Myths." *Information Week*, January 20, 1997: <http://www.twocrows.com/iwk9701.htm>.
- Smith, M. 1993. *Neural Networks for Statistical Modeling*. New York: Van Nostrand Reinhold.
- Weiss, S. M., and N. Indurkha. 1997. *Predictive Data Mining: A Practical Guide*. San Francisco, CA: Morgan Kaufmann.
- Weiss, S. M., and C. A. Kulikowski. 1992. *Computer Systems That Learn: Classification and Prediction Methods from Statistics, Neural Nets, Machine Learning, and Expert Systems*. San Mateo, CA: Morgan Kaufmann.

*Note:* White papers about related topics are often available on the Web at [support.sas.com/documentation](http://support.sas.com/documentation). △

SAS Publishing provides a complete selection of books and electronic products to help customers use SAS software to its fullest potential. For more information about our e-books, e-learning products, CDs, and hard-copy books, visit the SAS Publishing Web site at [support.sas.com/publishing](http://support.sas.com/publishing) or call 1-800-727-3228.

Customers outside the U.S. should contact their local SAS office.





## APPENDIX

## 2

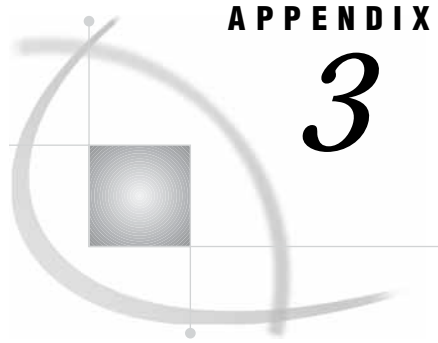
## Variable Layout for SAMPSIO.DMAGECR (German Credit Data Set)

*SAMPSIO.DMAGECR (German Credit Data Set)* 109

### SAMPSIO.DMAGECR (German Credit Data Set)

- ☐ CHECKING: Status of existing checking account
  - ☐ 1: < 0 DM
  - ☐ 2: 0 to <200 DM
  - ☐ 3: >=200 DM/ salary assignments for at least 1 year
  - ☐ 4: no checking account
- ☐ DURATION: Duration in months
- ☐ HISTORY: Credit history
  - ☐ 0: no credits taken/all credits paid back duly
  - ☐ 1: all credits at this bank paid back duly
  - ☐ 2: existing credits paid back duly till now
  - ☐ 3: delay in paying off in the past
  - ☐ 4: critical account/other credits existing (not at this bank)
- ☐ PURPOSE: Purpose
  - ☐ 0: car (new)
  - ☐ 1: car (used)
  - ☐ 2: furniture/equipment
  - ☐ 3: radio/television
  - ☐ 4: domestic appliances
  - ☐ 5: repairs
  - ☐ 6: education
  - ☐ 7: vacation
  - ☐ 8: retraining
  - ☐ 9: business
  - ☐ X: others
- ☐ AMOUNT: Credit amount
- ☐ SAVINGS: Savings account/bonds
  - ☐ 1: < 100 DM
  - ☐ 2: 100 to < 500 DM
  - ☐ 3: 500 to < 1000 DM

- ☐ 4:  $\geq 1000$  DM
- ☐ 5: unknown/no savings account
- ☐ EMPLOYED: Present employment since
  - ☐ 1: unemployed
  - ☐ 2:  $< 1$  year
  - ☐ 3: 1 to  $< 4$  years
  - ☐ 4: 4 to  $< 7$  years
  - ☐ 5:  $\geq 7$  years
- ☐ INSTALLP: Installment rate in percentage of disposable income
- ☐ MARITAL: Personal status and gender
  - ☐ 1: male: divorced/separated
  - ☐ 2: female: divorced/separated/married
  - ☐ 3: male: single
  - ☐ 4: male: married/widowed
  - ☐ 5: female: single
- ☐ COAPP: Other debtors/guarantors
  - ☐ 1: none
  - ☐ 2: co-applicant
  - ☐ 3: guarantor
- ☐ RESIDENT: Date beginning permanent residence
- ☐ PROPERTY: Property
  - ☐ 1: real estate
  - ☐ 2: if not 1: building society savings agreement/life insurance
  - ☐ 3: if not 1/2: car or other, not in attribute 6
  - ☐ 4: unknown/no property
- ☐ AGE: Age in years
- ☐ OTHER: Other installment plans
  - ☐ 1: bank
  - ☐ 2: stores
  - ☐ 3: none
- ☐ HOUSING: Housing
  - ☐ 1: rent
  - ☐ 2: own
  - ☐ 3: for free
- ☐ EXISTCR: Number of existing credits at this bank
- ☐ JOB: Job
  - ☐ 1: unemployed/unskilled - nonresident
  - ☐ 2: unskilled - resident
  - ☐ 3: skilled employee/official
  - ☐ 4: management/self-employed/highly qualified employee/officer
- ☐ DEPENDS: Number of dependents
- ☐ TELEPHON: Telephone
  - ☐ 1: none
  - ☐ 2: yes, registered under the customer's name
- ☐ FOREIGN: foreign worker
  - ☐ 1: yes
  - ☐ 2: no



## APPENDIX

## 3

## Recommended Reading

---

*Recommended Reading* 111

---

## Recommended Reading

Here is the recommended reading list for this title:

- *Data Mining Using SAS Enterprise Miner: A Case Study Approach*
- *SAS/CONNECT User's Guide*
- *SAS/ETS User's Guide*
- *SAS/STAT User's Guide*

For a complete list of SAS publications, see the current *SAS Publishing Catalog*. To order the most current publications or to receive a free copy of the catalog, contact a SAS representative at

SAS Publishing Sales  
SAS Campus Drive  
Cary, NC 27513  
Telephone: (800) 727-3228\*  
Fax: (919) 677-8166  
E-mail: [sasbook@sas.com](mailto:sasbook@sas.com)

Web address: [support.sas.com/pubs](http://support.sas.com/pubs)

\* For other SAS Institute business, call (919) 677-8000.

Customers outside the United States should contact their local SAS office.



# Glossary

---

**activation**

a mathematical transformation of a neuron's net input to yield the neuron's output.

**activation function**

in a neural network, a mathematical transformation of the net input that will yield the output of a neuron.

**assessment**

the process of determining how well a model computes good outputs from input data that is not used during training. Assessment statistics are automatically computed when you train a model with a modeling node. By default, assessment statistics are calculated from the validation data set.

**association analysis**

the identification of items that occur together in a particular event or record. Association analysis rules are based on frequency counts of the number of times items occur alone and in combination in a database. See also association discovery.

**association analysis rule**

in association analyses, an association between two or more items. An association analysis rule should not be interpreted as a direct causation. An association analysis rule is expressed as follows: If item A is part of an event, then item B is also part of the event X percent of the time.

**association discovery**

the process of identifying items that occur together in a particular event or record. This technique is also known as market basket analysis. Association discovery rules are based on frequency counts of the number of times items occur alone and in combination in the database.

**back propagation**

the computation of derivatives for a multilayer perceptron. See also multilayer perceptron (MLP).

**binary variable**

a variable that contains two discrete values (for example, PURCHASE: Yes and No).

**branch**

a subtree that is rooted in one of the initial divisions of a segment of a tree. For example, if a rule splits a segment into seven subsets, then seven branches grow from the segment.

**case**

a collection of information about one of many entities that are represented in a data set. A case is an observation in the data set.

**character variable**

a variable whose values can consist of alphabetic characters and special characters as well as numeric characters.

**cluster sampling**

the process of selecting a sample of groups or clusters from a population. The sample contains all of the members of each selected group or cluster.

**clustering**

the process of dividing a data set into mutually exclusive groups such that the observations for each group are as close as possible to one another, and different groups are as far as possible from one another.

**combination function**

a function that is applied both to inputs and to hidden layers and which computes the net input to a hidden neuron or to an output neuron.

**competitive network**

a two-layer neural network that is trained over time by tracking and predicting input-output responses. Over time, output nodes become associated with input vector patterns from the input data set. The weight vector for an output node can be approximated. The approximated weight vector is the average of the input data vectors that are in the vector pattern that is associated with an output node.

**confidence**

in association analyses, a measure of the strength of the association. In the rule  $A \rightarrow B$ , confidence is the percentage of times that event B occurs after event A occurs. See also association analysis rule.

**cost variable**

a variable that is used to track cost in a data mining analysis.

**data mining database (DMDB)**

a SAS data set that is designed to optimize the performance of the modeling nodes. DMDBs enhance performance by reducing the number of passes that the analytical engine needs to make through the data. Each DMDB contains a meta catalog, which includes summary statistics for numeric variables and factor-level information for categorical variables.

**data subdirectory**

a subdirectory within the Enterprise Miner project location. The data subdirectory contains files that are created when you run process flow diagrams in an Enterprise Miner project.

**DataSources folder**

a folder in the project subdirectory for an Enterprise Miner project. The DataSources folder contains all of the data sources that have been created, configured, and associated with a data mining project. See also project subdirectory.

**decile**

any of the nine points that divide the values of a variable into ten groups of equal frequency, or any of those groups.

**dependent variable**

a variable whose value is determined by the value of another variable or by the values of a set of variables.

**depth**

the number of successive hierarchical partitions of the data in a tree. The initial, undivided segment has a depth of 0.

**diagram lock file**

a temporary lock (.lck) file that is created when an Enterprise Miner process flow diagram is opened and that is deleted when the diagram is closed. The lock file prevents more than one user from modifying an Enterprise Miner process flow diagram at one time. Diagram lock files are created in the Workspaces folder, one level beneath the project subdirectory. See also project subdirectory.

**error function**

a function that measures how well a neural network or other model fits the training data. The error function is also called a Lyapunov function or an estimation criterion.

**estimation criterion**

another term for error function. See error function.

**expected confidence**

in association analyses, the number of consequent transactions divided by the total number of transactions. For example, suppose that 100 transactions of item B were made, and that the data set includes a total of 10,000 transactions. Given the rule  $A \rightarrow B$ , the expected confidence for item B is 100 divided by 10,000, or one percent.

**format**

a pattern or set of instructions that SAS uses to determine how the values of a variable (or column) should be written or displayed. SAS provides a set of standard formats and also enables you to define your own formats.

**frequency variable (freq variable)**

a variable that represents the frequency of occurrence for other values in each observation in a data mining analysis. Unlike some variables that are used by SAS procedures, a frequency variable can contain noninteger values and can be used for weighting observations.

**generalization**

the computation of accurate outputs, using input data that was not used during training.

**Gini index**

a measure of the total leaf impurity in a decision tree.

**hidden layer**

in a neural network, a layer between input and output to which one or more activation functions are applied. Hidden layers are typically used to introduce nonlinearity.

**hidden neuron**

in a feed-forward, multilayer neural network, a neuron that is in one or more of the hidden layers that exist between the input and output neuron layers. The size of a neural network depends largely on the number of layers and on the number of hidden units per layer. See also hidden layer.

**imputation**

the computation of replacement values for missing input values.

**informat**

a pattern or set of instructions that SAS uses to determine how data values in an input file should be interpreted. SAS provides a set of standard informats and also enables you to define your own informats.

**input variable**

a variable that is used in a data mining process to predict the value of one or more target variables.

**internal node**

in a tree, a segment that has been further segmented. See also node.

**interval variable**

a continuous variable that contains values across a range. For example, a continuous variable called Temperature could have values such as 0, 32, 34, 36, 43.5, 44, 56, 80, 99, 99.9, and 100.

**Kass adjustment**

a p-value adjustment that multiplies the p-value by a Bonferroni factor that depends on the number of branches and chi-square target values, and sometimes on the number of distinct input values. The Kass adjustment is used in the Tree node.

**Kohonen network**

any of several types of competitive networks that were invented by Teuvo Kohonen. Kohonen vector quantization networks and self-organizing maps (SOMs) are two types of Kohonen network that are commonly used in data mining. See also Kohonen vector quantization network, SOM (self-organizing map).

**Kohonen vector quantization network**

a type of competitive network that can be viewed either as an unsupervised density estimator or as an autoassociator. The Kohonen vector quantization algorithm is closely related to the k-means cluster analysis algorithm. See also Kohonen network.

**leaf**

in a tree diagram, any segment that is not further segmented. The final leaves in a tree are called terminal nodes.

**level**

a successive hierarchical partition of data in a tree. The first level represents the entire unpartitioned data set. The second level represents the first partition of the data into segments, and so on.

**libref (library reference)**

a name that is temporarily associated with a SAS library. The complete name of a SAS file consists of two words, separated by a period. The libref, which is the first word, indicates the library. The second word is the name of the specific SAS file. For example, in VLIB.NEWBDAY, the libref VLIB tells SAS which library contains the file NEWBDAY. You assign a libref with a LIBNAME statement or with an operating system command.

**lift**

in association analyses and sequence analyses, a calculation that is equal to the confidence factor divided by the expected confidence. See also confidence, expected confidence.

**logistic regression**

a form of regression analysis in which the target variable (response variable) represents a binary-level or ordinal-level response.

**Lyapunov function**

another term for error function. See error function.

**macro variable**

a variable that is part of the SAS macro programming language. The value of a macro variable is a string that remains constant until you change it. Macro variables are sometimes referred to as symbolic variables.



**measurement**

the process of assigning numbers to an object in order to quantify, rank, or scale an attribute of the object.

**measurement level**

a classification that describes the type of data that a variable contains. The most common measurement levels for variables are nominal, ordinal, interval, log-interval, ratio, and absolute. See also interval variable, nominal variable, ordinal variable.

**metadata**

a description or definition of data or information.

**metadata sample**

a sample of the input data source that is downloaded to the client and that is used throughout SAS Enterprise Miner to determine meta information about the data, such as number of variables, variable roles, variable status, variable level, variable type, and variable label.

**model**

a formula or algorithm that computes outputs from inputs. A data mining model includes information about the conditional distribution of the target variables, given the input variables.

**multilayer perceptron (MLP)**

a neural network that has one or more hidden layers, each of which has a linear combination function and executes a nonlinear activation function on the input to that layer. See also hidden layer.

**neural networks**

a class of flexible nonlinear regression models, discriminant models, data reduction models, and nonlinear dynamic systems that often consist of a large number of neurons. These neurons are usually interconnected in complex ways and are often organized into layers. See also neuron.

**neuron**

a linear or nonlinear computing element in a neural network. Neurons accept one or more inputs. They apply functions to the inputs, and they can send the results to one or more other neurons. Neurons are also called nodes or units.

**node**

(1) in the SAS Enterprise Miner user interface, a graphical object that represents a data mining task in a process flow diagram. The statistical tools that perform the data mining tasks are called nodes when they are placed on a data mining process flow diagram. Each node performs a mathematical or graphical operation as a component of an analytical and predictive data model. (2) in a neural network, a linear or nonlinear computing element that accepts one or more inputs, computes a function of the inputs, and optionally directs the result to one or more other neurons. Nodes are also known as neurons or units. (3) a leaf in a tree diagram. The terms leaf, node, and segment are closely related and sometimes refer to the same part of a tree. See also process flow diagram, internal node.

**nominal variable**

a variable that contains discrete values that do not have a logical order. For example, a nominal variable called Vehicle could have values such as car, truck, bus, and train.

**numeric variable**

a variable that contains only numeric values and related symbols, such as decimal points, plus signs, and minus signs.

**observation**

a row in a SAS data set. All of the data values in an observation are associated with a single entity such as a customer or a state. Each observation contains one data value for each variable.

**ordinal variable**

a variable that contains discrete values that have a logical order. For example, a variable called Rank could have values such as 1, 2, 3, 4, and 5.

**output variable**

in a data mining process, a variable that is computed from the input variables as a prediction of the value of a target variable.

**overfit**

to train a model to the random variation in the sample data. Overfit models contain too many parameters (weights), and they do not generalize well. See also underfit.

**partition**

to divide available data into training, validation, and test data sets.

**perceptron**

a linear or nonlinear neural network with or without one or more hidden layers.

**predicted value**

in a regression model, the value of a dependent variable that is calculated by evaluating the estimated regression equation for a specified set of values of the explanatory variables.

**prediction variable**

a variable that contains predicted values (outputs) for a target variable.

**process flow diagram**

a graphical representation of the various data mining tasks that are performed by individual Enterprise Miner nodes during a data mining analysis. A process flow diagram consists of two or more individual nodes that are connected in the order in which the data miner wants the corresponding statistical operations to be performed.

**profit matrix**

a table of expected revenues and expected costs for each decision alternative for each level of a target variable.

**project**

a collection of Enterprise Miner process flow diagrams. See also process flow diagram.

**project subdirectory**

a subdirectory that is used for storing Enterprise Miner project files. The project subdirectory contains folders for data sources, process flow diagram workspaces, target profiles, and statistical results that are associated with a project. The project subdirectory also contains the temporary diagram lock (.lck) files that are created whenever a process flow diagram is opened. See also diagram lock file, DataSources folder, Workspaces folder, Results folder.

**rejected variable**

a variable that is excluded from a data mining analysis. Variables can be rejected manually during data configuration, or data mining nodes can reject a variable that does not meet some specified criterion.

**Reports subdirectory**

a subdirectory that is used for storing HTML reports that are generated by the Reporter node. Each report has its own subdirectory. The name of the subdirectory is the same as the name of the corresponding report.

**Results folder**

a folder in the project subdirectory of an Enterprise Miner project. The Results folder contains the result files that are generated by process flow diagrams in the project. See also project subdirectory.

**root node**

the initial segment of a tree. The root node represents the entire data set that is submitted to the tree, before any splits are made.

**rule**

See association analysis rule, sequence analysis rule, tree splitting rule.

**sampling**

the process of subsetting a population into  $n$  cases. The reason for sampling is to decrease the time required for fitting a model.

**SAS data set**

a file whose contents are in one of the native SAS file formats. There are two types of SAS data sets: SAS data files and SAS data views. SAS data files contain data values in addition to descriptor information that is associated with the data. SAS data views contain only the descriptor information plus other information that is required for retrieving data values from other SAS data sets or from files whose contents are in other software vendors' file formats.

**SAS data view**

a type of SAS data set that retrieves data values from other files. A SAS data view contains only descriptor information such as the data types and lengths of the variables (columns), plus other information that is required for retrieving data values from other SAS data sets or from files that are stored in other software vendors' file formats. SAS data views can be created by the ACCESS and SQL procedures, as well as by the SAS DATA step.

**scoring**

the process of applying a model to new data in order to compute outputs. Scoring is the last process that is performed in data mining.

**seed**

an initial value from which a random number function or CALL routine calculates a random value.

**segmentation**

the process of dividing a population into sub-populations of similar individuals. Segmentation can be done in a supervisory mode (using a target variable and various techniques, including decision trees) or without supervision (using clustering or a Kohonen network). See also Kohonen network.

**self-organizing map**

See SOM (self-organizing map).

**SEMMA**

the data mining process that is used by Enterprise Miner. SEMMA stands for Sample, Explore, Modify, Model, and Assess.

**sequence analysis rule**

in sequence discovery, an association between two or more items, taking a time element into account. For example, the sequence analysis rule  $A \rightarrow B$  implies that event B occurs after event A occurs.

**sequence variable**

a variable whose value is a time stamp that is used to determine the sequence in which two or more events occurred.

**simple random sample**

a sample in which each item in the population has an equal chance of being selected.

**SOM (self-organizing map)**

a competitive learning neural network that is used for clustering, visualization, and abstraction. A SOM classifies the parameter space into multiple clusters, while at the same time organizing the clusters into a map that is based on the relative distances between clusters. See also Kohonen network.

**standard deviation**

a statistical measure of the variability of a group of data values. This measure, which is the most widely used measure of the dispersion of a frequency distribution, is equal to the positive square root of the variance.

**stratified random sample**

a sample obtained by dividing a population into nonoverlapping parts, called strata, and randomly selecting items from each stratum.

**subdiagram**

in a process flow diagram, a collection of nodes that are compressed into a single node. The use of subdiagrams can improve your control of the information flow in the diagram.

**target variable**

a variable whose values are known in one or more data sets that are available (in training data, for example) but whose values are unknown in one or more future data sets (in a score data set, for example). Data mining models use data from known variables to predict the values of target variables.

**test data**

currently available data that contains input values and target values that are not used during training, but which instead are used for generalization and to compare models.

**training**

the process of computing good values for the weights in a model.

**training data**

currently available data that contains input values and target values that are used for model training.

**transformation**

the process of applying a function to a variable in order to adjust the variable's range, variability, or both.

**tree**

the complete set of rules that are used to split data into a hierarchy of successive segments. A tree consists of branches and leaves, in which each set of leaves represents an optimal segmentation of the branches above them according to a statistical measure.

**tree diagram**

a graphical representation of part or all of a tree. The tree diagram can include segment statistics, the names of the variables that were used to split the segments, and the values of the variables.

**tree splitting rule**

in decision trees, a conditional mathematical statement that specifies how to split segments of a tree's data into subsegments.

**trial variable**

a variable that contains count data for a binomial target. For example, the number of individuals who responded to a mailing would be a trial variable. Some of the trials are classified as events, and the others are classified as non-events.

**unary variable**

a variable that contains a single, discrete value.

**underfit**

to train a model to only part of the actual patterns in the sample data. Underfit models contain too few parameters (weights), and they do not generalize well. See also overfit.

**validation data**

data that is used to validate the suitability of a data model that was developed using training data. Both training data sets and validation data sets contain target variable values. Target variable values in the training data are used to train the model. Target variable values in the validation data set are used to compare the training model's predictions to the known target values, assessing the model's fit before using the model to score new data.

**variable**

a column in a SAS data set or in a SAS data view. The data values for each variable describe a single characteristic for all observations. Each SAS variable can have the following attributes: name, data type (character or numeric), length, format, informat, and label. See also SAS data set, SAS data view, macro variable.

**variable attributes**

the name, label, format, informat, data type, and length that are associated with a particular variable.

**weight**

a constant that is used in a model for which the constant values are unknown or unspecified prior to the analysis.

**Workspaces folder**

a folder in the project subdirectory for an Enterprise Miner project. One workspace named *Emwsnn* is created in the Workspaces folder for every process flow diagram that is created in the data mining project, where *nn* is the ordinal for the diagram's creation. The Workspaces folder contains a process flow diagram, a subfolder for each node in the diagram, and target profile descriptor tables, as well as Reports and Results subfolders that are associated with the diagram. See also project subdirectory.



# Index

---

## A

Actions menu 6  
 additive nonlinear models 47  
 application menus 3  
 Assessing nodes 48  
   Assessment node 48, 55, 95  
   Reporter node 27, 48, 55, 60  
 Assessment node 48, 55, 95  
 association discovery data 63, 66  
 Association node 45, 67

## B

bar charts 45  
 basket analysis data 63, 66  
 batch  
   data mining databases for batch processing 49  
   graphs in batch environment 45  
   server profile in batch mode 25  
 bucketed principal components 47  
 building process flow diagrams 33  
 BY processing  
   for class variables 49

## C

C language 48  
 categorizing observations 48  
 charts 45, 48  
 class targets  
   predicting 48  
 class variables  
   group BY processing for 49  
   summary statistics for 79  
 client/server projects 11  
   creating 17, 22  
   defining server profile 18  
   deleting 29  
   server data directory 13  
   server profile in batch mode 25  
   storing the server profile 12  
 cloning nodes 40  
 cluster samples 45  
 cluster scores 46  
 Clustering node 46  
 CONID 24

connecting nodes 37  
   cutting connections 38  
   reducing number of connections 50  
 Connection Status Indicator 3  
 Control Point node 50  
 copying nodes 40  
 credit risk applicants 104

## D

data mining 1  
 Data Mining Database node 49  
 Data Partition node 45  
 Data Set Attributes node 46, 54, 55  
 data sets  
   attributes 46  
   input data set 73  
   partitioning 45, 79  
   test data set 45  
   training data set 45, 79  
   validation data set 45, 79  
 data sources  
   reading and processing 44  
 data structures 63  
   association discovery data 63, 66  
   regression data 63, 64  
   time series cross-sectional (panel) data analysis 64  
   time series data analysis 63  
 Data tab 57  
 decision tree models 47, 92  
 deleting  
   client/server projects 29  
   nodes 39  
   project diagrams 28  
   projects 28  
 diagram lock files 13, 29  
 Diagram menu 5  
 Diagram tab 2  
 Diagram Workspace 3  
   adding nodes to 35  
   connecting nodes in 37  
   pop-up menu 35  
 diagrams  
   *See* process flow diagrams  
   *See* project diagrams  
 dimmed menu items 9  
 directory structure 12  
   EMDATA directory 13

EMPROJ directory 13  
   project location 12  
   REPORTS directory 13  
 Distribution Explorer node 45, 100  
 DMDBs  
   for batch processing 49  
 DMREG procedure 87  
 documentation 9

## E

Edit menu 3  
 EMDATA directory 13  
 EMDATA library 30  
 EMPROJ directory 13  
 EMPROJ library 30  
 endpoints 53  
 Ensemble node 47, 55  
 Enter node 53  
 Enterprise Miner 1  
   documentation 9  
   exporting Release 4.3 projects 30  
   Release 4.2 and earlier projects 30  
   starting 2  
 Enterprise Miner window  
   layout 2  
   menus 3  
 Event Chain Handler 45  
 exit code 14  
 Exit node 53  
 explanatory models 45  
 Exploring nodes 45  
   Association node 45, 67  
   Distribution Explorer node 45, 100  
   Insight node 45  
   Link Analysis node 46  
   Multiplot node 45  
   Variable Selection node 45  
 exporting Release 4.3 projects 30

## F

File menu 3  
 Filter Outliers node 46

**G**

generalized linear models 45  
 graphs 45, 48  
   in batch 45  
 group BY processing  
   for class variables 49  
 Group Processing node 49, 55  
   running project diagrams 27  
   setting a target variable 74  
 grouping variables interactively 47

**H**

halts 29  
 Help menu 7  
 histograms, multidimensional 45  
 HTML reports 13, 48, 55

**I**

initialization 14  
 input data set  
   defining 73  
 Input Data Source node 44, 54  
   example 73  
     Variables tab 59  
 input variables 45  
 Insight node 45  
 Interactive Grouping node 47  
 interface 2  
 interval targets  
   predicting 48  
 interval variables  
   summary statistics for 79

**J**

Java language 48

**K**

k-nearest neighbor algorithm 48  
 kill file 29  
 Kohonen networks 46

**L**

large files 13  
 .lck files 13, 29  
 legacy projects and files 30  
 libraries not assigned 30  
 linear regression models 47  
 Link Analysis node 46  
 local projects 11  
   creating 16  
   example 72  
 lock files 13, 29  
 logistic regression models 47  
   stepwise 84

**M**

maps, self-organizing 46  
 Memory-Based Reasoning node 48  
 menus  
   Actions menu 6  
   application menus 3  
   Diagram menu 5  
   Diagram Workspace pop-up 35  
   dimmed items 9  
   Edit menu 3  
   Enterprise Miner window 3  
   File menu 3  
   Help menu 7  
   node pop-up menu 36  
   Options menu 4  
   pop-up 8, 35, 36  
   pull-down 3  
   View menu 4  
 Message Panel 3  
 messages  
   about nodes 57  
 Messages window 34  
 metadata sample 44, 46  
 missing values  
   replacing 46  
 MLPs (multilayer perceptrons) 87  
 Model Manager 48  
 Modeling nodes 47  
   comparing models and predictions 48  
   Ensemble node 47, 55  
   Memory-Based Reasoning node 48  
   Model Manager 48  
   Neural Network node 47, 87  
   Princomp/Dmneural node 47  
   Regression node 47  
   Tree node 47, 92  
   Two Stage Model node 48  
   User Defined Model node 47  
 models  
   additive nonlinear models 47  
   assessing 48, 95  
   comparing 48  
   decision tree models 47, 92  
   explanatory models 45  
   generalized linear models 45  
   linear regression models 47  
   logistic regression models 47  
   Model Manager 48  
   predictive modeling 84  
   stepwise logistic regression model 84  
   storing 48  
   user-defined 47  
 Modifying nodes 46  
   Clustering node 46  
   Data Set Attributes node 46, 54, 55  
   Filter Outliers node 46  
   Interactive Grouping node 47  
   Replacement node 46  
   SOM/Kohonen node 46  
   Time Series node 47  
   Transform Variables node 46, 81  
 moving nodes 40  
 multidimensional histograms 45  
 multilayer perceptrons (MLPs) 87  
 Multiplot node 45  
 multivariate distributions 45

**N**

Neural Network node 47  
   multilayer perceptrons 87  
 node pop-up menu 36  
 nodes 2  
   adding to process flow diagrams 35  
   Assessing nodes 48  
   Assessment node 48, 55, 95  
   Association node 45, 67  
   changes to 57  
   cloning 40  
   Clustering node 46  
   connecting 37  
   connections, cutting 38  
   connections, reducing number of 50  
   Control Point node 50  
   copying 40  
   Data Mining Database node 49  
   Data Partition node 45  
   Data Set Attributes node 46, 54, 55  
   Data tab 57  
   default settings 60  
   deleting 39  
   Distribution Explorer node 45, 100  
   endpoints 53  
   Ensemble node 47, 55  
   Enter node 53  
   Exit node 53  
   Exploring nodes 45  
   Filter Outliers node 46  
   functionalities 57  
   Group Processing node 27, 49, 55, 74  
   Input Data Source node 44, 54, 59, 73  
   Insight node 45  
   Interactive Grouping node 47  
   Link Analysis node 46  
   Memory-Based Reasoning node 48  
   messages about 57  
   Modeling nodes 47  
   Modifying nodes 46  
   moving 40  
   Multiplot node 45  
   Neural Network node 47, 87  
   Notes tab 60  
   organization of 43  
   pasting 40  
   placement in process flow diagrams 54  
   Princomp/Dmneural node 47  
   properties 60  
   properties, viewing 34  
   Regression node 47  
   Replacement node 46  
   Reporter node 27, 48, 55, 60  
   Results Browser 57, 60  
   running project diagrams and 27  
   Sampling node 45  
   Sampling nodes 44  
   SAS Code node 49, 54, 104  
   Score Converter node 48  
   Score node 48, 55, 99  
   Scoring nodes 48  
   SOM/Kohonen node 46  
   Subdiagram node 50  
   Time Series node 47  
   Transform Variables node 46, 81  
   Tree node 47, 92



- Two Stage Model node 48
- undeleting 39
- usage rules for 54
- User Defined Model node 47
- Utility nodes 49
- Variable Selection node 45
- Variables tab 58
- Notes tab 60

## O

- observations
  - categorizing 48
  - predicting 48
- OLTPs (online transaction processing systems) 63
- Options menu 4
- outliers 46

## P

- panel data analysis 64
- partitioning data sets 45, 79
- pasting nodes 40
- plots 45
- pop-up menus 8
  - Diagram Workspace 35
  - node pop-up 36
- posterior probabilities
  - averaging 47
- predicted values
  - averaging 47
  - from a trained model 48
- predictions
  - class targets 48
  - comparing 48
  - interval targets 48
  - observations 48
- predictive modeling 84
- principal components analysis 47
- Princomp/Dmneural node 47
- process flow diagrams 1
  - See also* project diagrams
  - adding nodes to 35
  - building 33
  - cloning nodes 40
  - closing 106
  - connecting nodes 37
  - copying nodes 40
  - cutting node connections 38
  - deleting nodes 39
  - Diagram Workspace 3, 35
  - example 69
  - generating results from 27
  - Messages window 34
  - moving nodes 40
  - node placement in 54
  - node pop-up menu 36
  - opening 25
  - pasting nodes 40
  - reducing number of connections 50
  - SAS code in 49
  - subdiagrams 50
  - Tools Bar 3, 34

- Tools Palette 2, 34
- profiles
  - See* server profile
  - See* target profiles
- Progress Indicator 3
- project diagrams 27
  - See also* process flow diagrams
  - closing 28
  - creating 28
  - deleting 28
  - running 27
  - saving 27
- project files
  - viewing 12
- project location directory 12
- Project Navigator 2
  - Diagram tab 2
  - Reports tab 2
  - Tools Palette 2, 34
  - Tools tab 2, 43
- projects 11
  - See also* client/server projects
  - See also* local projects
  - closing 28
  - deleting 28
  - directory structure 12
  - exporting Release 4.3 projects 30
  - input data set 73
  - libraries not assigned 30
  - location directory 12
  - opening 26
  - opening Release 4.2 and earlier projects 30
  - properties 13
  - shareable projects 11, 30
  - troubleshooting 29
  - updating settings 12
  - viewing project files 12
- properties
  - nodes 34, 60
  - projects 13
- Properties window 13
- pull-down menus 3

## R

- R-Square criterion 45
- random samples 45
- regression data 63, 64
- Regression node 47
- rejected variables 45
- Release 4.2 and earlier projects
  - opening 30
- Release 4.3 projects
  - exporting 30
- Replacement node 46
- Reporter node 48, 55
  - notes 60
  - running project diagrams 27
- REPORTS directory 13
- Reports tab 2
- Results Browser 57, 60
- running project diagrams 27

## S

- Sampling node 45
- Sampling nodes 44
  - Data Partition node 45
  - Input Data Source node 44, 54, 59, 73
  - Sampling node 45
- SAS Code node 49, 54
  - creating score cards 104
- SAS/CONNECT software 17
- SAS/ETS software 63, 64
- SAS/INSIGHT software 45
- SAS/STAT software 64
- saving project diagrams 27
- scatter plots 45
- score cards 47, 104
- Score Converter node 48
- Score node 48, 55, 99
- scoring 47, 98, 99
- scoring formulas 48
- Scoring nodes 48
  - Score Converter node 48
  - Score node 48, 55, 99
- script files 20
- seasonal and trend analysis 47
- seed values 45
- segmenting data 46
- self-organizing maps 46
- SEMMA data mining process 1, 43
- sequence discovery 45, 67
- server data dictionary 13
- server profile 15
  - batch mode 25
  - defining 18
  - storing 12
- shareable projects 11, 30
- sign-on time 15
- SOM/Kohonen node 46
- spawners 19
- start-up code 14, 20
- starting Enterprise Miner 2
- statistical settings
  - configuring 9
- statistics
  - summary statistics 79
- stepwise logistic regression model 84
- stratification 80
- Subdiagram node 50
- subdiagrams 50
  - endpoints 53
  - examples 50, 52
- summary statistics 79

## T

- target profiles 46
  - example 74
  - for target variables 48
- target variables 45
  - setting 74
  - target profiles for 48
- test data set 45
- time series cross-sectional (panel) data analysis 64
- time series data
  - converting transactional data to 47

- time series data analysis 63
- Time Series node 47
- toolbox 8
- Tools Bar 3, 34
- Tools Palette 2, 34
- Tools tab 2, 43
- training data set 45
  - creating 79
- transactional data
  - converting to time series data 47
- Transform Variables node 46, 81
- transforming variables 46, 81
- Tree node 47, 92
- trend analysis 47
- troubleshooting projects 29
- Two Stage Model node 48

## U

- undeleting nodes 39

- univariate distributions 45
- updating project settings 12
- User Defined Model node 47
- userid and sign-on time 15
- Utility nodes 49
  - Control Point node 50
  - Data Mining Database node 49
  - Group Processing node 27, 49, 55, 74
  - SAS Code node 49, 54, 104
  - Subdiagram node 50

## V

- validation data set 45
  - creating 79
- Variable Selection node 45
- variable transformations 46, 81

- variables
  - class variables 49, 79
  - grouping interactively 47
  - input variables 45
  - interval variables 79
  - rejected variables 45
  - target variables 45, 48, 74
  - transforming 46, 81
- Variables tab 58
- vector quantization networks 46
- View menu 4
- viewing project files 12
- visualization tools 45

## W

- warehouse path 15

# Your Turn

---

If you have comments or suggestions about *Getting Started with SAS® Enterprise Miner™ 4.3*, please send them to us on a photocopy of this page, or send us electronic mail.

For comments about this book, please return the photocopy to

SAS Publishing  
SAS Campus Drive  
Cary, NC 27513  
**email:** [yourturn@sas.com](mailto:yourturn@sas.com)

For suggestions about the software, please return the photocopy to

SAS Institute, Inc.  
Technical Support Division  
SAS Campus Drive  
Cary, NC 27513  
**email:** [suggest@sas.com](mailto:suggest@sas.com)



# SAS® Publishing Delivers!

Whether you are new to the work force or an experienced professional, you need to distinguish yourself in this rapidly changing and competitive job market. SAS® Publishing provides you with a wide range of resources to help you set yourself apart. Visit us online at [support.sas.com/bookstore](http://support.sas.com/bookstore).

## SAS® Press

Need to learn the basics? Struggling with a programming problem? You'll find the expert answers that you need in example-rich books from SAS Press. Written by experienced SAS professionals from around the world, SAS Press books deliver real-world insights on a broad range of topics for all skill levels.

**[support.sas.com/saspress](http://support.sas.com/saspress)**

## SAS® Documentation

To successfully implement applications using SAS software, companies in every industry and on every continent all turn to the one source for accurate, timely, and reliable information: SAS documentation. We currently produce the following types of reference documentation to improve your work experience:

- Online help that is built into the software.
- Tutorials that are integrated into the product.
- Reference documentation delivered in HTML and PDF – **free** on the Web.
- Hard-copy books.

**[support.sas.com/publishing](http://support.sas.com/publishing)**

## SAS® Publishing News

Subscribe to SAS Publishing News to receive up-to-date information about all new SAS titles, author podcasts, and new Web site features via e-mail. Complete instructions on how to subscribe, as well as access to past issues, are available at our Web site.

**[support.sas.com/spn](http://support.sas.com/spn)**



**THE  
POWER  
TO KNOW®**