THE
POWER
TO KNOW®

SAS® Scoring Accelerator 1.4 for Teradata
User's Guide

SAS® Documentation

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

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CHAPTER

1 Introduction to SAS Scoring Accelerator for Teradata

Background

Using conventional processing, SAS Enterprise Miner communicates with a Teradata database by means of a SAS product called the SAS/ACCESS Interface to Teradata, which is basically a SAS/ACCESS engine that can interface directly with a Teradata Enterprise Data Warehouse (EDW). SAS Enterprise Miner asks the SAS/ACCESS engine for all rows of the table being processed; the SAS/ACCESS engine generates an SQL SELECT * statement that is passed to the Teradata EDW. That SELECT statement fetches all the rows in the table, and the SAS/ACCESS engine returns them to SAS Enterprise Miner.

Scoring is the process of applying the model formula to new data. Once a champion model is developed in SAS Enterprise Miner, the model scoring code, including the preliminary statistical transformations, is encoded as SAS DATA step code. Only Base SAS and SAS/ACCESS Interface to Teradata are required to score the models. As the number of rows in the table grows over time, network latency grows because the amount of data that is fetched from the Teradata EDW to the SAS scoring process increases.

The SAS Scoring Accelerator for Teradata is a new product for embedding the robustness of SAS Enterprise Miner scoring models directly in the highly scalable Teradata database. By using the SAS In-Database technology and the SAS Scoring Accelerator for Teradata, the scoring processing is done inside the data warehouse, and thus does not require the transfer of data.

Scoring models operate on individual rows of data independently, which makes them well suited for “shared nothing” execution in Teradata. SAS Scoring Accelerator for Teradata takes the models that are developed by SAS Enterprise Miner and translates them into scoring functions that can be deployed inside Teradata. After the scoring functions are published, the functions extend the Teradata SQL language and can be used on SQL statements like other Teradata functions. Like any other programming language function, these scoring functions can take one or more input parameters and return an output value.

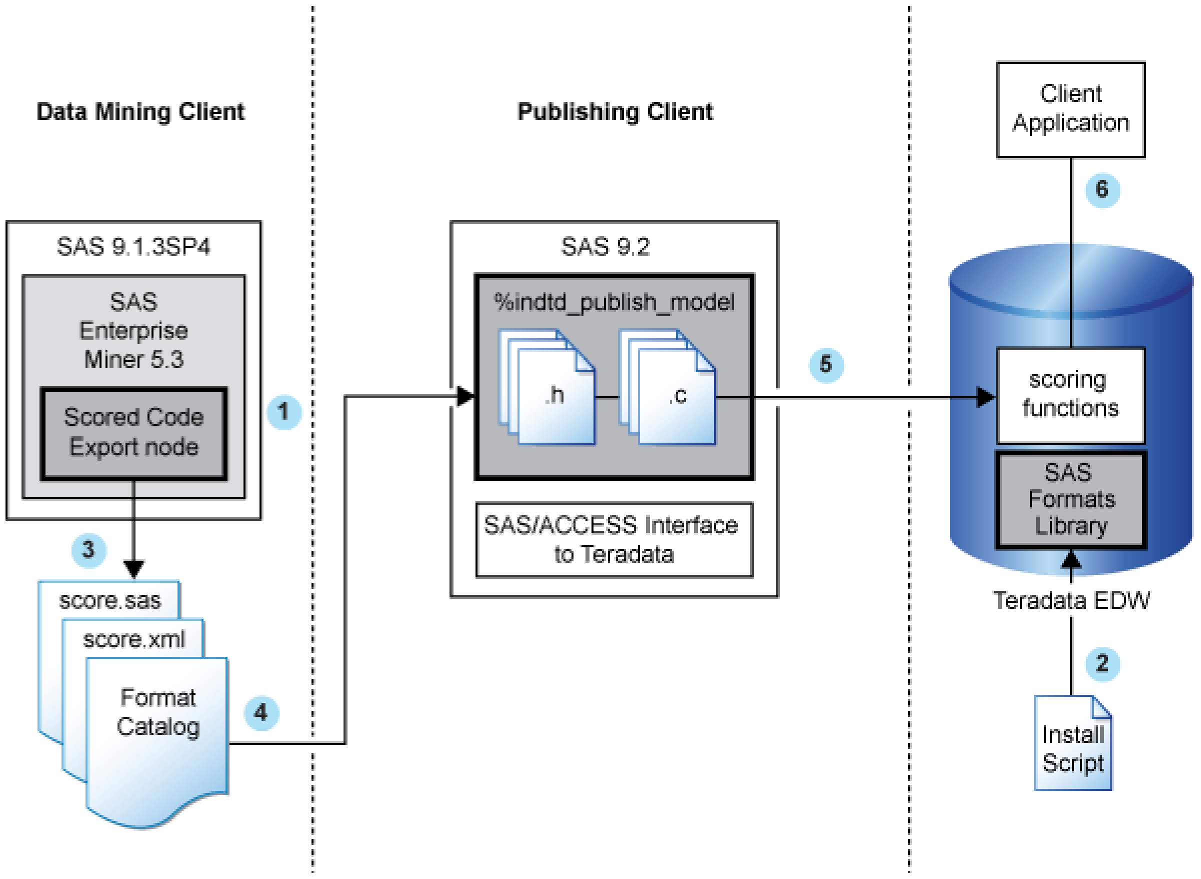
By packaging these scoring models so that they can be deployed as scoring functions inside Teradata, SAS Scoring Accelerator for Teradata processing can take advantage of the inherent scalability of Teradata processing while the controlling model continues to manage the top-level logic inherent in the analytic process being used.

The result of deploying the unique and powerful SAS analytic algorithms to execute inside a Teradata database enhances performance, reduces data movement, and exploits Teradata parallel processing.

SAS Scoring Accelerator for Teradata: How it Works

Using SAS Enterprise Miner 5.3, you can generate SAS DATA step code that contains scoring functions. SAS Scoring Accelerator for Teradata takes the scoring model code, the associated property file that contains model inputs and outputs, and a catalog of user-defined formats, and deploys, or *publishes,* them to the Teradata EDW. Inside the Teradata EDW, one or more scoring functions are created and registered for use in SQL queries. Figure 1 illustrates this process.

Figure 1 – Process Flow Diagram



Here is the basic process flow:

❶ Install the SAS Enterprise Miner Score Code Export Node software.

For more information, see the chapter on post-installation configuration for the SAS Accelerator Publishing Agent software in the *Configuration Guide for SAS 9.2 Foundation for Microsoft Windows*.

❷ Install the SAS 9.2 Formats Library for Teradata in the Teradata EDW. This library contains the formats that are available in Base SAS.

For more information, see Chapter 2, “Formats Supplied by SAS in the Teradata EDW”.

❸ Use SAS Enterprise Miner 5.3 to create a scoring model, and use the Score Code Export node to export files that are used to create the scoring functions to a score output directory. The following exported files are used to create the scoring functions:

- ❑ the scoring model program (score.sas)
- ❑ a properties file that contains a description of the variables that are used and created by the scoring code (score.xml)
- ❑ a formats catalog, if the training data contains SAS user-defined formats

The following are other files that are exported but are not used to create the scoring functions:

- ❑ a file that contains the description of the final variables that are created by the scoring code. This file can be kept for decision-making processes.
- ❑ a ten-row sample of the scored data set showing typical cases of the input attributes, intermediate variables, and final output variables.
- ❑ a ten-row sample table of the training data set showing typical cases of the input attributes used to develop the score code.

For more information, see Chapter 3, “Exporting the Scoring Model Files from SAS Enterprise Miner”.

❹ Start SAS and run the %INDTD_PUBLISH_MODEL macro, which creates the files that are needed to build the scoring functions and publishes those files to the Teradata EDW.

The %INDTD_PUBLISH_MODEL macro performs the following tasks:

- ❑ takes the files that are created using the Score Code Export node and produces the set of .c and .h files that are necessary to build separate scoring functions for each of a fixed set of quantities that can be computed by the scoring model code
- ❑ produces a script of the Teradata commands that are necessary to register the scoring functions on the Teradata EDW

For more information, see Chapter 4, “Publishing the Scoring Model Files”.

❺ After the script is created, the %INDTD_PUBLISH_MODEL macro uses a Teradata client tool to execute the script and publish the files to the Teradata EDW.

For more information, see Chapter 4, “Publishing the Scoring Model Files”.

❻ Teradata compiles the .c and .h files and creates the scoring functions. The scoring functions are available to use in any SQL expression and to use, typically, wherever Teradata built-in functions are used.

For more information, see Chapter 5 , “Scoring Functions Inside the Teradata EDW”.

CHAPTER 2
Formats Supplied by SAS in the Teradata EDW

SAS formats are basically mapping functions. They change an element of data from one format to another. For example, there are SAS formats to change numeric values to various currency formats and date-and-time formats.

SAS supplies many formats, and these formats are made available for use when creating the scoring functions.

You must install the SAS 9.2 Formats Library for Teradata on the same Windows machine where you have installed SAS Foundation. When the SAS format libraries have been installed, you must move them from the Windows machine to the machine on which you have installed Teradata. After the libraries are in the Teradata EDW, they must be configured. This is a one-time installation process.

For information about how to install and configure the SAS 9.2 Formats Library for Teradata, see the chapter on post-installation configuration for the SAS Accelerator Publishing Agent software in the *Configuration Guide for SAS 9.2 Foundation for Microsoft Windows*.

CHAPTER

3 Exporting the Scoring Model Files from SAS Enterprise Miner

Overview of the Score Code Export Node

Note: The Score Code Export node software is included as a .zip file in the SAS Scoring Accelerator for Teradata software package.

Users of SAS Enterprise Miner develop data mining models that use measured attributes to either characterize or predict the value of an event. These models are developed on historical data where an event has been measured or inferred. The models are then applied to new data for which the attributes are known, but the event has not yet occurred. For example, a model can be created based on a credit institution's records of payments that customers made and missed last year and then used to predict which customers will miss payments this year.

SAS Enterprise Miner creates SAS language score code for the purpose of scoring new data. Users run this code in production systems to make business decisions for each record of new data.

The Score Code Export node is an extension for SAS Enterprise Miner that exports files that are necessary for score code deployment. Extensions are programmable add-ins for the SAS Enterprise Miner environment.

The following icon is the Score Code Export node as it appears in a SAS Enterprise Miner process flow diagram.

The following files are exported by the Score Code Export node:

- ❑ the SAS scoring model program.
- ❑ an XML file containing scoring variables and other properties.
- ❑ an XML file containing descriptions of the final variables created by the scoring code. This file can be kept for decision-making processes.
- ❑ a ten-row sample of the scored data set showing typical cases of the input attributes, intermediate variables, and final output variables. This data set can be used to test and debug new scoring processes.
- ❑ a ten-row sample of the training data set showing the typical cases of the input attributes.
- ❑ if the scoring program contains user-defined formats, a format catalog.

For more information about the exported files, see “Output Files”. For more information about using SAS Enterprise Miner, see the SAS Enterprise Miner Help.

Score Code Export Node Compared with Registering Models on the SAS Metadata Server

SAS Enterprise Miner can register models directly in the SAS Metadata Server. Models registered in the SAS Metadata Server are used by SAS Data Integration Studio, SAS Enterprise Guide, and SAS Model Manager for creating, managing, and monitoring production and analytical scoring processes.

The Score Code Export node exports score code created by SAS Enterprise Miner into a format that can be used by the SAS Scoring Accelerator for Teradata. The exported files are stored in a directory, not the SAS Metadata Server.

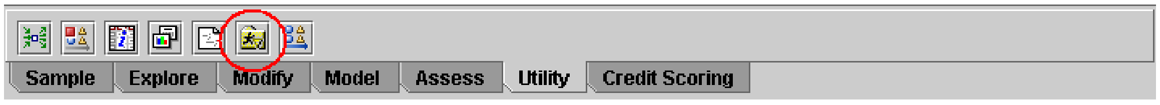
The Score Code Export node does not replace the functionality of registering models in the SAS Metadata Server to be used by SAS Data Integration Studio, SAS Enterprise Guide, and SAS Model Manager.

Using the Score Code Export Node

Using the Score Code Export Node in a Process Flow Diagram

The Score Code Export node is located on the **Utility** tab, as shown in Figure 2:

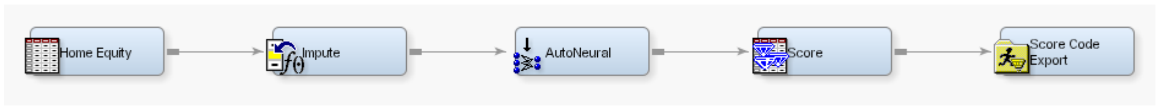
Figure 2 - The Diagram Toolbar with the SAS Score Code Export Node Highlighted



To use the Score Code Export node, you need a process flow diagram that contains nodes that produce score code and that flows to a Score node. The Score node aggregates the score code for the entire analysis path. The Score node must precede the Score Code Export node in the process flow diagram.

Figure 3 shows a valid data mining process for exporting score code:

Figure 3 - Data Mining Process Flow Diagram



Requirement: The Score Code Export node exports score code that contains only one DATA step. For a list of Enterprise Miner nodes that produce score code, see "SAS Enterprise Miner Tools Production of Score Code".

After the process flow diagram is in place, set the properties for the Score node and the Score Code Export node:

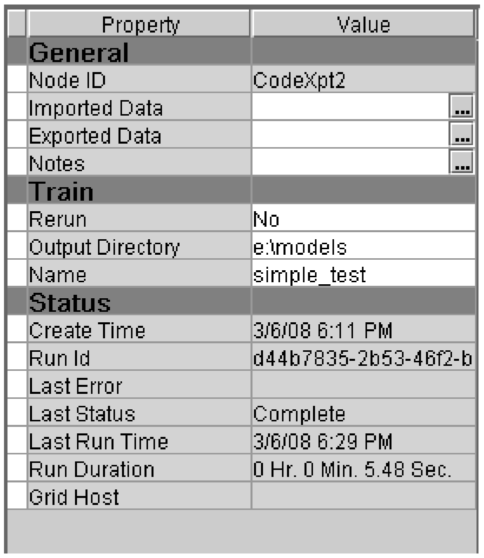
- Select the Score node. Ensure that the following properties are set to their default value of Yes:
    - Use Output Fixed Names
    - C Score
- Select the Score Code Export node and set the properties. The Output Directory property specifies the directory to store the export files. The Name property specifies the folder that contains the output files created by the Score Code Export node. For information about the properties, see "Score Code Export Node Properties".

After the properties are set, you are ready to export the score code. Click the right mouse button over the Score Code Export node and select **Run**. When SAS Enterprise Miner completes processing, the Run Status window opens to indicate that the run completed. Click the **Results** button to view the output variables and the listing output. For information about the output, see "Output Created by the Score Code Export Node".

Score Code Export Node Properties

When the Score Code Export node is selected in the diagram workspace, the Properties panel displays all of the properties that the node uses and their associated values, as shown in Figure 4.

Figure 4 - Properties Panel



Property	Value
General	
Node ID	CodeXpt2
Imported Data	...
Exported Data	...
Notes	...
Train	
Rerun	No
Output Directory	e:\models
Name	simple_test
Status	
Create Time	3/6/08 6:11 PM
Run Id	d44b7835-2b53-46f2-b
Last Error	
Last Status	Complete
Last Run Time	3/6/08 6:29 PM
Run Duration	0 Hr. 0 Min. 5.48 Sec.
Grid Host	

This document explains the Train properties. The General and Status properties function for the Score Code Export node as they function for other nodes.

Score Code Export Node Train Properties

The following Train properties are associated with the Score Code Export node:

- **Rerun** – Use this property to force the node to run again. This property is useful if the macro variable controlling the target directory and folder name have changed.
- **Output Directory** – Enter a fully qualified name for the location of an output directory to contain the score code files. If no directory is entered, a default directory named Score is created in the SAS Enterprise Miner project directory. You can change the value of the default directory by setting the &EM_SCOREDIR=*directory* macro variable in the SAS Enterprise Miner project start-up code or server start-up code.
- **Name** – Enter the name of the model that you are creating. The name is used to create a new subdirectory in the output directory that contains the exported score files. If no name is entered, a default name is generated as a combination of the &SYSUSERID automatic macro variable and an incremental index (for example, userID, userID_2, userID_3).

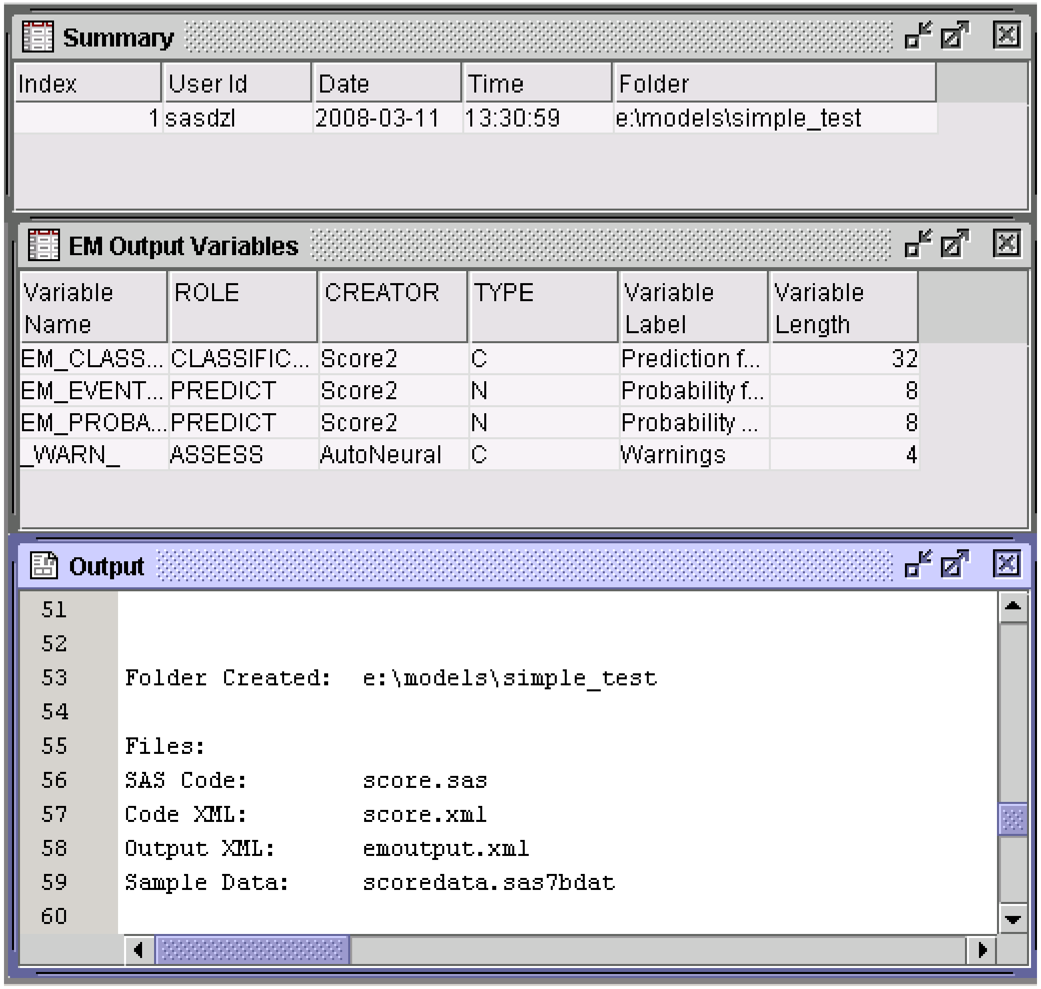
  You can replace the &SYSUSERID automatic macro variable with a custom name by setting the &EM_SCOREFOLDER=*score-folder-name* macro variable in the SAS Enterprise Miner project start-up code or server start-up code. An incremental index preceded by an underscore is added to *score-folder-name*.

Output Created by the Score Code Export Node

Results Window

Using the values set in the Properties panel (Figure 4), the Score Code Export node creates the following output in the Results window:

Figure 5 – Results Using Sample Properties



Index	User Id	Date	Time	Folder
1	sasdzl	2008-03-11	13:30:59	e:\models\simple_test

Variable Name	ROLE	CREATOR	TYPE	Variable Label	Variable Length
EM_CLASS...	CLASSIFIC...	Score2	C	Prediction f...	32
EM_EVENT...	PREDICT	Score2	N	Probability f...	8
EM_PROBA...	PREDICT	Score2	N	Probability ...	8
WARN	ASSESS	AutoNeural	C	Warnings	4

```


Folder Created:  e:\models\simple_test

Files:
SAS Code:        score.sas
Code XML:        score.xml
Output XML:      emoutput.xml
Sample Data:     scoredata.sas7bdat

```

Output Files

The Score Code Export node writes the following output files, and possibly a formats catalog, to the location specified by the **Output Directory** property. These files are used as input to the %INDTD_PUBLISH_MODEL macro that creates the Teradata scoring functions.

File or Folder	Description

score.sas	SAS language score code created by SAS Enterprise Miner. This code can be used directly in a SAS program. A sample program based on the properties shown in Figure 3 looks like this:
	`data testout;`
	`   set simpletest.scoredata;`
	`   %include “c:\models\simpletest\score.sas”;`
	`run;`

score.xml	A description of the variables that are used and created by the scoring code. XML files are created by a machine process for the use of machine processes. Do not edit the XML file. **Restriction:** The maximum number of input variables for a UDF function is 128.
emoutput.xml	A description of the final variables that are created by the scoring code. This file can be kept for decision-making processes. These variables include the primary classification, prediction, probability, segment, profit, and loss variables created by a data mining process. The list does not include intermediate variables created by the analysis. For more information about these variables, see “Fixed Variable Names”. Note that the emoutput.xml file is not used by the %INDTD_PUBLISH_MODEL macro.
scoredata.sas7bdat	A ten-row sample of the scored data set showing typical cases of the input attributes, intermediate variables, and final output variables. Use this data set to test and debug new scoring processes. Note that the scoredata.sas7bdat file is not used by the %INDTD_PUBLISH_MODEL macro.
traindata.sas7bdat	A ten-row sample table of the training data set showing typical cases of the input attributes used to develop the score code. Note that the traindata.sas7bdat file is not used by the %INDTD_PUBLISH_MODEL macro.
Formats catalog	If the training data contains SAS user-defined formats, the Score Code Export node creates a formats catalog. The catalog contains the user-defined formats in the form of a look-up table. This file has an extension of .sas7bcat.

Output Variables

The score code produced by SAS Enterprise Miner creates both intermediate variables, such as imputed values of missing values, transformations, and encodings; and output variables, such as predicted value and probability. Any of these created variables can be used in a scoring process.

Tip: The number of input parameters on a scoring function has a direct impact on performance. The more parameters there are, the more time it takes to score a row. A recommended best practice is to make sure that only variables that are involved in a model score evaluation are exported from SAS Enterprise Miner.

The most important ouptut variables follow a naming convention using a prefix, as shown in the following table.

Role	Type	Prefix	Key	Suffix	Example
Prediction	N	P_	Target variable name		P_amount
Probability	N	P_	Target variable name	Predicted event value	P_purchaseYES P_purchaseNO
Classification	$	I_	Target variable name		I_purchase
Expected Profit	N	EP_	Target variable name		EP_conversion
Expected Loss	N	EL_	Target variable name		EL_conversion
Return on Investment	N	ROI_	Target variable name		ROI_conversion
Decision	$	D_	Target variable name		D_conversion
Decision Tree Leaf	N	_NODE_			_NODE_
Cluster number or SOM cell ID	N	_SEGMENT_			_SEGMENT_

Fixed Variable Names

The Score node of SAS Enterprise Miner maps the output variable names to fixed variable names. This mapping is appropriate in the most common case that there is only one prediction target or one classification target. In other cases, refer to the output variable names described in the previous table.

Using the fixed variable names enables scoring users to build processes that can be reused for different models without changing the code that processes the outputs. These fixed names are listed in the emoutput.xml file and are described in the following table. Most scoring processes return one or more of these variables.

Role	Type	Fixed Name	Description
Prediction	N	EM_PREDICTION	The prediction value for an interval target.
Probability	N	EM_PROBABILITY	The probability of the predicted classification, which can be any one of the target variable values.
Probability	N	EM_EVENTPROBABILITY	The probability of the target event. By default this is the first value in descending order. This is often the event of interest. The user can control the ordering in SAS Enterprise Miner.
Classification	$	EM_CLASSIFICATION	The predicted target class value.
Expected Profit	N	EM_PROFIT	Based on the selected decision.
Expected Loss	N	EM_LOSS	Based on the selected decision.
Return on Investment	N	EM_ROI	Based on the selected decision.
Decision	$	EM_DECISION	Optimal decision based on a function of probability, cost, and profit or loss weights.
Decision Tree Leaf, Cluster number, or SOM cell ID	N	EM_SEGMENT	Analytical customer segmentation.

SAS Enterprise Miner Tools Production of Score Code

The following table shows the types of score code created by each node in SAS Enterprise Miner. In addition, users can develop their own nodes known as *extension nodes,* which can create either SAS DATA step or SAS program score code. However, this code is not converted to PMML, C, or Java.

Node	SAS DATA Step	SAS Program	PMML	C	JAVA	Teradata UDF
Sample						
Input Data	*	*	*	*	*	*
Sample	*	*	*	*	*	*
Partition	*	*	*	*	*	*
Append	N	Y	N	N	N	N
Merge	N	Y	N	N	N	N
Time Series	N	Y	N	N	N	N
Filter	Y When the user keeps the created filter variable.	*	N	Y	Y	Y
Explore						
Association	N	Y	Y	N	N	N
Cluster	Y	N	Y	Y	Y	Y
DMDB	*	*	*	*	*	*
Graph Explore	*	*	*	*	*	*
Market Basket	N	Y	N	N	N	N
Multiplot	*	*	*	*	*	*
Path	N	Y	Y	N	N	N
SOM	Y	N	N	Y	Y	Y
Stat Explore	*	*	*	*	*	*
Text Miner	N	Y	N	N	N	N
Variable Clustering	Y	N	N	Y	Y	Y
Variable Selection	Y	N	N	Y	Y	Y
Modify						
Drop	*	*	*	*	*	*
Impute	Y	N	Y	Y	Y	Y
Interactive Binning	Y	N	N	Y	Y	Y
Replacement	Y	N	N	Y	Y	Y
Principle Components	Y	N	N	Y	Y	Y
Rules Builder	Y	N	N	Y	Y	Y
Transform Variables	Y	N	N	Y	Y	Y
Model						
Autoneural	Y	N	Y	Y	Y	Y

Node	**SAS DATA Step**	**SAS Program**	**PMML**	**C**	**JAVA**	**Teradata UDF**
Decision Tree	Y	N	Y	Y	Y	Y
Dmine Regression	Y	N	Y	Y	Y	Y
Dmine Neural	Y	N	N	Y	Y	Y
Ensemble	Y	N	N	Y	Y	Y
Gradient Boosting	Y	N	N	Y	Y	Y
MBR	N	Y	N	N	N	N
Model Import	*	*	*	*	*	*
Neural Network	Y	N	Y	Y	Y	Y
Partial Least Squares	Y	N	N	Y	Y	Y
Regression (linear, logistic, and multinomial)	Y	N	Y	Y	Y	Y
Rule Induction	Y	N	N	Y	Y	Y
SVM – Linear Kernel	Y	N	Y	Y	Y	Y
SVM – Nonlinear Kernel	N	Y	N	N	N	N
Two Stage	Y	N	N	Y	Y	Y
Assess						
Cutoff	Y	N	N	Y	Y	Y
Decisions	Y	N	N	Y	Y	Y
Model Comparison	Y	N	N	Y	Y	Y
Score	Y	N	N	Y	Y	Y
Segment Profile	*	*	*	*	*	*
Utility						
Control Point	*	*	*	*	*	*
Start Groups	Y	N	N	Y	Y	Y
End Groups	Y	N	N	Y	Y	Y
Metadata	*	*	*	*	*	*
Reporter	*	*	*	*	*	*
SAS Code	Y	Y	N	N	N	N
The user can enter either SAS DATA step code or SAS program code						
Credit Scoring						
Credit Exchange	*	*	*	*	*	*
Interactive Grouping	Y	N	N	Y	Y	Y
Scorecard	Y	N	N	Y	Y	Y
Reject Inference	Y	N	N	Y	Y	Y

*** The node does not produce this type of score code.**

CHAPTER

4 Publishing the Scoring Model Files

Overview of the Publishing Process

A SAS macro, %INDTD_PUBLISH_MODEL, creates the files that are needed to build the scoring functions and publishes these files to the user's default database in the Teradata EDW. Only the EM_ output variables are published as scoring functions. For more information on the EM_ output variables, see "Fixed Variable Names" in Chapter 3.

The %INDTD_PUBLISH_MODEL macro uses some of the files that are created by the SAS Enterprise Miner Score Code Export node: the scoring model program (score.sas file), the properties file (score.xml file), and, if the training data includes SAS user-defined formats, a format catalog.

The %INDTD_PUBLISH_MODEL macro takes the score.sas and score.xml files and produces the set of .c and .h files. These .c and .h files are necessary to build separate scoring functions for each of a fixed set of quantities that can be computed by the scoring model code.

If available, the %INDTD_PUBLISH_MODEL macro processes the format catalog and creates an .h file with C structures, which are also necessary to build the scoring functions.

This macro also produces a script of the Teradata commands that are necessary to register the scoring functions on the Teradata EDW.

After this script is created, the macro uses a Teradata client tool to execute the script and publish scoring model files to the Teradata EDW.

Note: If your model generates a .c file that exceeds 4MB, the %INDTD_PUBLISH_MODEL macro generates a warning that the scoring functions might not build correctly. If you are using the Teradata V2R6 server, you can avoid this problem by installing a patch. For more information, see the *Configuration Guide for SAS 9.2 Foundation for Microsoft Windows*.

Running the %INDTD_PUBLISH_MODEL Macro

To run the %INDTD_PUBLISH_MODEL macro, complete the following steps:

1. Create a scoring model using SAS Enterprise Miner 5.3.
2. Use the SAS Enterprise Miner Score Code Export node to create a score output directory and populate the directory with the score.sas file, the score.xml file, and, if needed, the format catalog.
3. Start SAS 9.2 and submit the following commands in the Program Editor:

   ```
   %indtdpm;
   %let indtdlogon=server/user,password;
   ```

   The %INDTDPM macro searches the autocall library for the indtdpm.sas file. The indtdpm.sas file contains all the macro definitions that are used in conjunction with the %INDTD_PUBLISH_MODEL macro. The indtdpm.sas file should be in one of the directories listed in the SASAUTOS= system option in your configuration file. If the indtdpm.sas file is not present, the %INDTDPM macro call (%INDTDPM; statement) issues a “macro indtdpm not defined” message.

   The INDTDLOGON macro variable is used as credentials to make a connection to Teradata. You must specify *server*, *user*, and *password* to access the machine on which you have installed the Teradata EDW. The INDTDLOGON macro variable must be assigned before the %INDTD_PUBLISH_MODEL macro is invoked.

   Tip: The INDTDLOGON variable is not passed as an argument to the %INDTD_PUBLISH_MODEL macro. Consequently, this information can be concealed in your SAS job. You might want to place it in an autoexec file and set the permissions on the file so that others cannot access the user ID and password.
4. Run the %INDTD_PUBLISH_MODEL macro.

   Messages are written to the SAS log that indicate the success or failure of the creation of the scoring functions.

Modes of Operation

There are two modes of operation when executing the %INDTD_PUBLISH_MODEL macro: protected and unprotected. You specify the mode by setting the MODE= argument.

The default mode of operation is protected. Protected mode means that the macro code is isolated in a separate process in the Teradata database, and an error does not cause the database to stop. It is recommended that you run the %INDTD_PUBLISH_MODEL macro in protected mode during acceptance tests.

When the %INDTD_PUBLISH_MODEL macro is ready for production, you can run the macro in unprotected mode. Note that you will see a significant performance advantage when you run in unprotected mode.

Setting a Timeout Value

When the %INDTD_PUBLISH_MODEL macro invokes the Teradata client tool, it is possible that the client tool process will not complete before SAS resumes control. This might occur for the following reasons:

- ❑ complicated model files
- ❑ machine capacity

If the client tool is still running after ten minutes, SAS resumes control. However, the output file containing the log is still locked by the client tool. SAS is unable to read the output file and issues a "File in use" error.

You can avoid this problem by setting the SAS_UPIPE_PROCESS_TIMEOUT environment variable to a larger value. The SAS_UPIPE_PROCESS_TIMEOUT value is expressed in units of .001 seconds.

For example, if you want to increase the timeout value to 30 minutes, set the SAS_UPIPE_PROCESS_TIMEOUT environment variable to 1800000:

```
options set=sas_upipe_process_timeout 1800000;
```

Syntax

%INDTD_PUBLISH_MODEL
(DIR=input-directory-path, MODELNAME=*name*
<, DATASTEP=*score-program-filename*>
<, XML=*xml-filename*>
<, DATABASE=*database-name*>
<, FMTCAT=*format-catalog-filename*>
<, ACTION=CREATE | REPLACE | DROP>
<, MODE=PROTECTED | UNPROTECTED>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DIR=*input-directory-path*

specifies the directory where the scoring model program, the properties file, and the formats catalog are located.

This is the directory that is created by the SAS Enterprise Miner Score Code Export node. This directory contains the score.sas file, the score.xml file, and, if user-defined formats were used, the formats catalog.

Requirement: You must use a fully qualified pathname.

Interaction: If you do not use the default directory that is created by SAS Enterprise Miner, you must specify the DATASTEP=, XML=, and, if needed, FMTCAT= arguments.

MODELNAME=*name*

specifies the name that is prepended to each output function to ensure that each scoring function name is unique on the Teradata database.

Requirement: The *name* must be a valid SAS name that is less than or equal to ten characters. For more information about valid SAS names, see the topic on rules for words and names in *SAS 9.2 Language Reference: Concepts*.

Interaction: Only the EM_ output variables are published as scoring functions. For more information on the EM_ output variables, see "Fixed Variable Names" in Chapter 3.

See Also: "Scoring Function Names" in Chapter 5.

DATASTEP=*score-program-filename*

specifies the name of the scoring model program file that was created by using the SAS Enterprise Miner Score Code Export node.

Default: score.sas

Restriction: Only DATA step programs that are produced by the SAS Enterprise Miner Score Code Export node can be used.

Interaction: If you use the default score.sas file that is created by the SAS Enterprise Miner Score Code Export node, you do not need to specify the DATASTEP= argument.

XML=*xml-filename*

specifies the name of the properties .xml file that was created by the SAS Enterprise Miner Score Code Export node.

Default: score.xml

Restriction: Only .xml files that are produced by the SAS Enterprise Miner Score Code Export node can be used.

Restriction: The maximum number of output variables is 128.

Interaction: If you use the default score.xml file that is created by the SAS Enterprise Miner Score Code Export node, you do not need to specify the XML= argument.

DATABASE=*database-name*

specifies the name of a Teradata database to which the scoring functions and formats are published. This argument enables you to publish the scoring functions and formats to a shared database where other users can access them.

Default: If DATABASE= is not specified, the scoring functions and formats are published to the default database.

FMTCAT=*format-catalog-filename*

specifies the name of the format catalog file that contains all formats that were created by the FORMAT procedure and that are referenced in the DATA step scoring model program.

Restriction: Only format catalog files that are produced by the SAS Enterprise Miner Score Code Export node can be used.

Interaction: If you use the default format catalog that is created by the SAS Enterprise Miner Score Code Export node, you do not need to specify the FMTCAT= argument.

Interaction: If you do not use the default catalog name (FORMATS) or the default library (WORK or LIBRARY) when you create user-defined formats, you must use the FMTSEARCH system option to specify the location of the format catalog. For more information, see PROC FORMAT in the *SAS Procedures Guide*.

ACTION=CREATE | REPLACE | DROP

specifies one of the following actions that the macro performs:

CREATE

creates a new function.

REPLACE

overwrites the current function, if a function by the same name is already registered.

DROP

causes all functions for this model to be dropped from the Teradata database.

Default: If ACTION= is not specified, the Teradata CREATE FUNCTION command is issued for each scoring function that is generated.

Tip: If the function has been previously defined and you specify ACTION=CREATE, you will receive warning messages from Teradata. If the function has been previously defined and you specify ACTION=REPLACE, no warnings are issued.

MODE=PROTECTED | UNPROTECTED

specifies whether the running code is isolated in a separate process in the Teradata database so that a program fault will not cause the database to stop.

Default: PROTECTED

Tip: Once a function is validated in PROTECTED mode, it can be republished in UNPROTECTED mode. This could result in a significant performance gain.

OUTDIR=*diagnostic-output-directory*

specifies a directory that contains diagnostic files.

Files that are produced include an event log from the the Teradata client tool that contains detailed information about the success or failure of the publishing process and sample SQL code (SampleSQL.txt). For more information on the SampleSQL.txt file, see “Using the Scoring Functions” in Chapter 5.

Example

```
%indtdpm;
%let indtdlogon = terabase/user1,open1;

%indtd_publish_model( dir=C:\SASIN\baseball1, modelname=baseball1);
```

This sequence of macros generates a separate .c file for each output parameter of interest. Each output stub calls into a shared scoring main which is compiled first. The %INDTD_PUBLISH_MODEL macro also produces a text file of Teradata CREATE FUNCTION commands such as the following. Note that this file is shown for illustrative purposes. The text file that is created by the %INDTD_PUBLISH_MODEL macro cannot be viewed and is deleted after the macro is complete.

```
CREATE FUNCTION baseball1_EM_eventprobablility
(
"CR_ATBAT" float,
"CR_BB" float,
"CR_HITS" float,
"CR_HOME" float,
"CR_RBI" float,
"CR_RUNS" float,
"DIVISION" varchar(31),
"LEAGUE" varchar(31),
"NO_ASSTS" float,
"NO_ATBAT" float,
"NO_BB" float,
"NO_ERROR" float,
"NO_HITS" float,
"NO_HOME" float,
"NO_OUTS" float,
"NO_RBI" float,
"NO_RUNS" float,
"YR_MAJOR" float
)
RETURNS float
LANGUAGE C
NO SQL
PARAMETER STYLE SQL
NOT DETERMINISTIC
CALLED ON NULL INPUT
EXTERNAL NAME 'SL!"jazxfbrs"'
'!CI!tkcsparm!c:\SASIN\baseball1\tkcsparm.h'
'!CS!baseball1_EM_eventprobability!c:\SASIN\baseball1\EM_eventprobability
.c';
```

Once the scoring functions are created, they can be invoked in Teradata using SQL, as illustrated in the following example. Each output value is created as a separate function call in the select list.

```
select baseball1_EM_eventprobability
(
"CR_ATBAT",
"CR_BB",
"CR_HITS",
"CR_HOME",
"CR_RBI",
"CR_RUNS",
"DIVISION",
"LEAGUE",
"NO_ASSTS",
"NO_ATBAT",
"NO_BB",
"NO_ERROR",
"NO_HITS",
"NO_HOME",
"NO_OUTS"
) as homeRunProb from MLBTera;
```

Determining Format Publish Dates

You might need to know when the formats supplied by SAS or the user-defined formats were published. SAS supplies two special formats that return a datetime value that indicates when this occurred.

The INTRINSIC–CRDATE format returns a datetime value that indicates when the SAS Formats Library was published.

The UFMT–CRDATE format returns a datetime value that indicates when the user-defined formats were published.

Note: You must use the Pass-Through Facility to return the datetime value associated with the INTRINSIC–CRDATE and UFMT–CRDATE formats. The following example illustrates this.

```
proc sql noerrorstop;
   connect to &tera (&connopt)

title ‘Publish date of SAS Format Library’;
select * from connection to &tera
   (
      select sas_put(1, ‘intrinsic-crdate.’)
         as sas_fmts_datetime;
   );

title ‘Publish date of user-defined formats’;
select * from connection to &tera
   (
      select sas_put(1, ‘ufmt-crdate.’)
         as my_formats_datetime;
   );

quit;
```

CHAPTER

5 Scoring Functions Inside the Teradata EDW

Scoring Function Names

The names of the scoring functions that are built in Teradata have the following format:

*modelname*_EM_*outputvarname*

modelname is the name that was specified in the MODELNAME argument of the %INDTD_PUBLISH_MODEL macro. *modelname* is always followed by _EM_ in the scoring function name. For more information on the MODELNAME argument, see "Running the %INDTD_PUBLISH_MODEL Macro" in Chapter 4.

outputvarname is derived from the names of the EM_ output variables in the score.xml file that is generated from the SAS Enterprise Miner Score Code Export node. For more information on the score.xml file, see "Fixed Variable Names" in Chapter 3.

One scoring function is created for each EM_ output variable in the score.xml file. For example, if the scoring model DATA step program takes ten inputs and creates three new variables, then three scoring functions are defined, each with the name of an output variable. For example, if you set MODELNAME=credit in the %INDTD_PUBLISH_MODEL macro, and the EM_ output variables are "EM_PREDICTION", "EM_PROBABILITY", and "EM_DECISION", then the name of the scoring functions that are created would be "credit_EM_PREDICTION", "credit_EM_PROBABILITY", and "credit_EM_DECISION".

Caution: When the scoring functions are generated, the names are case-insensitive. Consequently, if you have model names "Model01" and "model01", and you create two scoring functions, the second scoring function will overwrite the first scoring function.

Using the Scoring Functions

The scoring functions are available to use in any SQL expression and to use, typically, wherever Teradata built-in functions are used. For an example, see Chapter 4, "Publishing the Scoring Model Files".

There are four ways to see the scoring functions that are created:

- From Teradata, you can log on to the database by using the BTEQ client tool and submit an SQL statement. The following example assumes that the model name that you used to create the scoring functions is **mymodel**.

  ```
  bteq .logon myserver/myuserid,mypassword
  select * from dbc.tables where tablename like '%mymodel%';
  ```

- From SAS, you can use SQL procedure code that produces output in the .lst file. The following example assumes that the model name that you used to create the scoring functions is **mymodel**.

  ```
  proc sql noerrorstop;
    connect to teradata (user=user password=pass server=server);
    select *
       from connection to teradata
       (select tablename,tablekind,databasename,LastALterTimeStamp
        from dbc.tables where
        databasename='sas' and tablename like '%mymodel%'
        and tablekind='F';);
  quit;
  ```

  You can also use the SASTRACE and SASTRACELOC system options to generate tracing information. For more information on these system options, see the *SAS Language Reference: Dictionary*.

- Look at the SampleSQL.txt file that is produced when the %INDTD_PUBLISH_MODEL macro is successfully run. This file can be found in the output directory (OUTDIR argument) that you specify in the macro.

  The SampleSQL.txt file contains basic code that, with modifications, can be used to run your score code inside Teradata. For example, the SampleSQL.txt file refers to an ID column in **allmush1_intab** that is populated with a unique integer from 1 to *n* with *n* being the number of rows in the table. The ID column uniquely identifies each row. You would replace the ID column with your own primary key column.

  The following example assumes that the model name that you used to create the scoring functions is **allmush1**.

  ```
  drop table allmush1_outtab;
  create table allmush1_outtab(
   id integer
  ,"EM_CLASSIFICATION" varchar(33)
  ,"EM_EVENTPROBABILITY" float
  ,"EM_PROBABILITY" float
  );
  insert into allmush1_outtab(
   id
  ,"EM_CLASSIFICATION"
  ,"EM_EVENTPROBABILITY"
  ,"EM_PROBABILITY"
  )
  select id,
   allmush1_em_classification("BRUISES"
  ,"CAPCOLOR"
  ,"GILLCOLO"
  ,"GILLSIZE"
  ,"HABITAT"
  ,"ODOR"
  ,"POPULAT"
  ,"RINGNUMB"
  ```

```
,"RINGTYPE"
,"SPOREPC"
,"STALKCBR"
,"STALKROO"
,"STALKSAR"
,"STALKSHA"
,"VEILCOLO")
  as "EM_CLASSIFICATION",
 allmush1_em_eventprobability("BRUISES"
,"CAPCOLOR"
,"GILLCOLO"
,"GILLSIZE"
,"HABITAT"
,"ODOR"
,"POPULAT"
,"RINGNUMB"
,"RINGTYPE"
,"SPOREPC"
,"STALKCBR"
,"STALKROO"
,"STALKSAR"
,"STALKSHA"
,"VEILCOLO")
  as "EM_EVENTPROBABILITY",
 allmush1_em_probability("BRUISES"
,"CAPCOLOR"
,"GILLCOLO"
,"GILLSIZE"
,"HABITAT"
,"ODOR"
,"POPULAT"
,"RINGNUMB"
,"RINGTYPE"
,"SPOREPC"
,"STALKCBR"
,"STALKROO"
,"STALKSAR"
,"STALKSHA"
,"VEILCOLO")
  as "EM_PROBABILITY"
from allmush1_intab ;
```

❑ Look at the SAS log. A message that indicates whether a scoring function is created or replaced successfully is printed to the SAS log.

Your Turn

We welcome your feedback.

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- If you have comments about the software, please send them to **`suggest@sas.com`**.