THE POWER TO KNOW.

SAS® 9.3 In-Database Products

User's Guide

Fourth Edition

SAS® Documentation

The correct bibliographic citation for this manual is as follows: SAS Institute Inc. 2012. *SAS® 9.3 In-Database Products: User's Guide, Fourth Edition*. Cary, NC: SAS Institute Inc.

SAS® 9.3 In-Database Products: User's Guide, Fourth Edition

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

Electronic book 1, December 2012

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** or call 1-800-727-3228.

Contents

What's New in SAS 9.3 In-Database Products

Overview

Starting in SAS 9.3, the user documentation for format publishing, in-database procedures, and the SAS Scoring Accelerator are combined into this document, *SAS 9.3 In-Database Products: User's Guide*.

Support for Teradata V13, Netezza V6.0, and Aster *n*Cluster V6 has been added.

Some Base SAS procedures have been enhanced for in-database processing inside Aster *n*Cluster, Greenplum, and Netezza.

In the November 2011 release, format publishing is supported for Aster *n*Cluster and Greenplum. In addition, in-database scoring for Teradata has been enhanced by the addition of the SAS Embedded Process. The SAS Embedded Process is a SAS server process that runs within Teradata to read and write data.

In the December 2011 release, in-database scoring for DB2 has been enhanced by the addition of the SAS Embedded Process.

In the April 2012 release, you can use the SAS Scoring Accelerator in conjunction with SAS Model Manager to manage and deploy scoring models in Greenplum.

In the June 2012 release, in-database scoring is supported for Oracle using the SAS Embedded Process.

In the August 2012 release, in-database scoring for Greenplum has been enhanced by the addition of the SAS Embedded Process. Also, SAS Scoring Accelerator and SAS Model Manager now supports importing SAS/STAT linear models and SAS High-Performance Analytics models from a SAS package file (.SPK).

In the December 2012 release, installation and configuration information for the SAS Embedded Process for Hadoop is added to the *SAS In-Database Products: Administrator's Guide*. The SAS Embedded Process must be installed and configured before you can read and write data to a Hadoop Distributed File System (HDFS) in parallel for High-Performance Analytics (HPA).

Documentation Enhancements

Starting in SAS 9.3, the user documentation for these in-database technologies has been combined into this document, *SAS In-Database Products: User's Guide*:

- Format publishing and the SAS_PUT( ) function were previously documented in *SAS/ACCESS for Relational Databases: Reference*.
- In-database procedures were previously documented in *SAS/ACCESS for Relational Databases: Reference*.

  Note: Each in-database procedure has its own specific considerations and limitations. For more information, see the documentation for the procedure.
- Scoring Accelerator was previously documented in the *SAS Scoring Accelerator: User's Guide* for each database.

The in-database installation and configuration documentation can be found in *SAS In-Database Products: Administrator's Guide*.

The configuration instructions for the SAS Model Manager In-Database Scoring Scripts product have been moved to this book from the *SAS Model Manager: User's Guide*.

Compiled Publishing Macros

All publishing macros are compiled now for better security. There is no change in how you run the publishing macros.

Additional Alias for INDCONN Macro Password Argument

You can now use PASS= for the password argument in the INDCONN macro variable.

In-Database Procedures

There are several enhancements to in-database procedures:

- You can use the SAS In-Database technology to run some Base SAS procedures inside Aster *n*Cluster, Greenplum, and Netezza.
- In BY-group processing, the NOTSORTED option is now ignored because the data is always returned in sorted order. Previously, the NOTSORTED option was not supported.

Support for SAS/STAT Linear Models

In the August 2012 release, the SAS Scoring Accelerator now supports importing SAS/STAT linear models and SAS High-Performance Analytics models from a SAS package file (.SPK). Models that have a DATA step score code type can also be scored, published, and included in performance monitoring. SAS Model Manager is required.

Support for Reading and Writing Data to HDFS for High-Performance Analytics

In the December 2012 release, installation and configuration information for the SAS Embedded Process for Hadoop is added to the *SAS In-Database Products: Administrator's Guide*. The SAS Embedded Process must be installed and configured before you can read and write data to a Hadoop Distributed File System (HDFS) in parallel for High-Performance Analytics (HPA).

Aster *n*Cluster Changes

The following changes have been made for Aster *n*Cluster:

- Support for Aster *n*Cluster V6 has been added.
- If you use Aster *n*Cluster V6, you can specify a schema where the scoring model files are published. You specify this schema in the INDCONN macro variable, and you can use the MODEL_SCHEMA parameter in the SAS_SCORE() function when you execute the scoring model.
- In the November 2011 release, format publishing is now supported. Format publishing enables you to execute SAS PUT function calls inside the database. You can reference most of the formats that SAS supplies and the custom formats that you create with PROC FORMAT.
- In the December 2011 release, the default value for the SQLGENERATION system option now includes Aster *n*Cluster. This means that procedures automatically run inside the database.

DB2 Changes

The following changes have been made for DB2:

- Format publishing is now supported. Format publishing enables you to execute SAS PUT function calls inside the database. You can reference most of the formats that SAS supplies and the custom formats that you create with PROC FORMAT.
- In the December 2011 release, in-database scoring for DB2 has been enhanced by the addition of the SAS Embedded Process. The SAS Embedded Process is a SAS server process that runs within DB2 to read and write data. The SAS Embedded Process can be used with the SAS Scoring Accelerator for DB2 under UNIX to run scoring models.
- In the December 2011 release, the DB2IDA utility was added to control the SAS Embedded Process. DB2IDA is a utility that is installed with the DB2 server. The DB2IDA command enables you to manually stop and restart the SAS Embedded Process without shutting down the database.

Greenplum Changes

The following changes have been made for Greenplum:

- In the November 2011 release, format publishing is now supported. Format publishing enables you to execute SAS PUT function calls inside the database. You can reference most of the formats that SAS supplies and the custom formats that you create with PROC FORMAT.
- In the December 2011 release, the default value for the SQLGENERATION system option now includes Greenplum. This means that procedures automatically run inside the database.
- In the April 2012 release, you can use the SAS Scoring Accelerator in conjunction with SAS Model Manager to manage and deploy scoring models in Greenplum.
- In the August 2012 release, in-database scoring for Greenplum has been enhanced by the addition of the SAS Embedded Process. The SAS Embedded Process is a SAS server process that runs within Greenplum to read and write data. The SAS Embedded Process can be used with the SAS Scoring Accelerator for Greenplum to run scoring models.

  Note: Starting with the August 2012 release, SAS is not compatible with Greenplum version 4.0 or older when publishing formats or running scoring models. If you use the second maintenance release of SAS 9.3, you must use Greenplum version 4.2.2 or later.

Netezza Changes

The following changes have been made for Netezza:

- Support for Netezza V6.0 has been added.
- Netezza Performance Server (NPS) is no longer supported.
- You can now run Netezza format and model publishing macros in fenced mode and in unfenced mode. Fenced mode means that the format and scoring functions that are published are isolated in a separate process in the Netezza database when they are invoked. An error does not cause the database to stop. When the format or scoring functions are ready for production, you can run the macro to publish the functions in unfenced mode.

Oracle Changes

In the June 2012 release, in-database scoring for Oracle is supported using the SAS Embedded Process. The SAS Embedded Process is a SAS server process that runs within Oracle to read and write data. The SAS Embedded Process can be used with the SAS Scoring Accelerator for Oracle to run scoring models.

Teradata Changes

The following changes have been made for Teradata:

- V2R6 on Linux is no longer supported.
- In the November 2011 release, in-database scoring for Teradata has been enhanced by the addition of the SAS Embedded Process. The SAS Embedded Process is a SAS server process that runs within Teradata to read and write data. The SAS Embedded Process can be used with the SAS Scoring Accelerator for Teradata to run scoring models. During the installation process, there is an additional RPM file that must be installed. This RPM file contains the SAS Embedded Process. In addition, you must download and install the SAS Embedded Process support functions.

Recommended Reading

Here is the recommended reading list for this title:

- *Base SAS Procedures Guide*
- *Base SAS Procedures Guide: Statistical Procedures*
- *Getting Started with SAS Enterprise Miner*
- *SAS/ACCESS for Relational Databases: Reference*
- *SAS Analytics Accelerator for Teradata: Guide*
- *SAS In-Database Products: Administrator's Guide*
- *SAS Model Manager: User's Guide*
- *SAS/STAT User's Guide*

For a complete list of SAS publications, go to support.sas.com/bookstore. If you have questions about which titles you need, please contact a SAS Publishing Sales Representative:

SAS Publishing Sales
SAS Campus Drive
Cary, NC 27513-2414
Phone: 1-800-727-3228
Fax: 1-919-677-8166
E-mail: sasbook@sas.com
Web address: support.sas.com/bookstore

Part 1

Introduction

Chapter 1

SAS In-Database Processing

Introduction to SAS In-Database Processing

When using conventional processing to access data inside a database management system (DBMS), SAS 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 DBMS. That SELECT statement fetches all the rows in the table, and the SAS/ACCESS engine returns them to SAS. As the number of rows in the table grows over time, network latency grows because the amount of data that is fetched from the DBMS to SAS increases.

SAS In-Database processing integrates SAS solutions, SAS analytic processes, and third-party database management systems. Using SAS In-Database processing, you can run scoring models, some SAS procedures, and formatted SQL queries inside the database. The following table lists the SAS products needed to use these features.

In-Database Feature	Software Required	DBMSs Supported
format publishing and the SAS_PUT( ) function	• Base SAS • SAS/ACCESS Interface to the DBMS	Aster DB2 under UNIX Greenplum Netezza Oracle Teradata

In-Database Feature	Software Required	DBMSs Supported
scoring models	• Base SAS • SAS/ACCESS Interface to the DBMS • SAS Scoring Accelerator • SAS Model Manager (optional)	Aster DB2 under UNIX Greenplum Netezza Oracle Teradata
Base SAS procedures: FREQ RANK REPORT SORT SUMMARY/MEANS TABULATE	• Base SAS • SAS/ACCESS Interface to the DBMS	Aster DB2 under UNIX and PC Hosts Greenplum Oracle Netezza Teradata
SAS/STAT procedures: CORR CANCORR DMDB DMINE DMREG FACTOR PRINCOMP REG SCORE TIMESERIES VARCLUS	• Base SAS (for CORR) • SAS/ACCESS Interface to Teradata • SAS/STAT (for CANCORR, FACTOR,PRINCOMP, REG, SCORE, VARCLUS) • SAS/ETS (for TIMESERIES) • SAS Enterprise Miner (for DMDB, DMINE, DMREG) • SAS Analytics Accelerator	Teradata

Deployed Components for In-Database Processing

Deployed Components for Aster

Components that are deployed to Aster for in-database processing are contained in a self-extracting archive file (tkindbsrv-9.33-*n*_lax.sh). *n*_lax.sh. *n* is a number that indicates the latest version of the file. If this is the initial installation, *n* has a value of 1. Each time you reinstall or upgrade, *n* is incremented by 1.

The archive file is located in the ***SAS-install-directory*/SASTKInDatabaseServer/9.31/AsternClusteronLinuxx64/** directory.

The SAS Embedded Process is the component that is deployed in Aster. The SAS Embedded Process contains run-time libraries, and other software that is installed on

your Aster system. The SAS scoring files created in Aster access the routines within the run-time libraries.

In particular, the SAS System libraries, the SAS_SCORE() SQL/MR function, and the SAS_PUT( ) SQL/MR function are installed. The SAS Scoring Accelerator for Aster uses these libraries and the SAS_SCORE() SQL/MR function to run scoring models inside the database. The SAS_PUT( ) function executes the format files in Aster. The SAS_PUT( ) function is deployed and stored in the NC_INSTALLED_FILES table under either the PUBLIC schema (4.5) or the specified schema (4.6).

For more information about these components, see the installation and configuration instructions in the *SAS In-Database Products: Administrator's Guide*.

Deployed Components for DB2

Components that are deployed to DB2 for in-database processing are contained in two self-extracting archive files (acceldb2fmt-2.1-*n*_*.sh and tkindbsrv-9.33-*n*_*.sh). *n* is a number that indicates the latest version of the file. If this is the initial installation, *n* has a value of 1. Each time you reinstall or upgrade, *n* is incremented by 1.

The first self-extracting archive file is located in the ***SAS-install-directory*/SASFormatsLibraryForDB2/2.1/DB2on<AIX | Linux64>/** directory. The second self-extracting archive file is located in the ***SAS-install-directory*/SASTKInDatabaseServer/9.31/DB2on<AIX | Linuxx64>/** directory.

- The following components are deployed in the acceldb2fmt-2.1-*n*_*.sh file:
  - The SAS formats library. The library contains many formats that are available in Base SAS.

    After you install the SAS formats library, the SAS scoring model functions and the SAS_PUT( ) function created in DB2 can access the routines within its run-time library.
  - The binary files for the SAS_COMPILEUDF function.

    The%INDB2_PUBLISH_COMPILEUDF macro registers the SAS_COMPILEUDF function in the SASLIB schema of the DB2 database. The SAS_COMPILEUDF function compiles the scoring model source files in the DB2 database, links to the SAS formats library, and then copies the new object files to a specified location.
  - The binary files for the SAS_DELETEUDF function.

    The %INDB2_PUBLISH_DELETEUDF macro registers the SAS_DELETEUDF function in the SASLIB schema of the DB2 database. The SAS_DELETEUDF function removes existing object files.
- The SAS Embedded Process is deployed in the tkindbsrv-9.33-*n*_*.sh file. The SAS Embedded Process contains run-time libraries and other software that is installed on your DB2 system. The SAS scoring files created in DB2 access the routines within the run-time libraries.

For more information about these components, see the installation and configuration instructions in the *SAS In-Database Products: Administrator's Guide*.

Deployed Components for Greenplum

Components that are deployed to Greenplum for in-database processing are contained in two self-extracting archive files (accelgplmfmt-2.2-*n*_lax.sh and tkindbsrv-9.33-*n*). *n* is a

number that indicates the latest version of the file. If this is the initial installation, *n* has a value of 1. Each time you reinstall or upgrade, *n* is incremented by 1.

The first self-extracting archive file is located in the ***SAS-install-directory/*** **SASFormatsLibraryforGreenplum/2.3/GreenplumonLinux64/** directory. The second self-extracting archive file is located in the ***SAS-install-directory/*** **SASTKInDatabaseServer/9.33/GreenplumonLinux64/** directory.

- The following components are deployed in the accelgplmfmt-2.2-*n*_*.sh file:
  - The SAS formats library. The library contains many formats that are available in Base SAS.

    After you install the SAS formats library, the SAS scoring model functions and the SAS_PUT( ) function created in Greenplum can access the routines within its run-time library.
  - The binary files for the SAS_COMPILEUDF function and other utility functions.

    The %INDGP_PUBLISH_COMPILEUDF macro registers the SAS_COMPILEUDF function and other utility functions in the database. The utility functions are called by the %INDGP_PUBLISH_MODEL scoring publishing macro.
- The SAS Embedded Process is deployed in the tkindbsrv-9.33-*n*_*.sh file. The SAS Embedded Process contains run-time libraries and other software that is installed on your Greenplum system. The SAS Embedded process accesses the scoring files when a scoring operation is performed.

For more information about these components, see the installation and configuration instructions in the *SAS In-Database Products: Administrator's Guide*.

Deployed Components for Netezza

Components that are deployed to Netezza for in-database processing are contained in a self-extracting archive file (accelnetzfmt-2.1-*n*_lax.sh). *n* is a number that indicates the latest version of the file. If this is the initial installation, *n* has a value of 1. Each time you reinstall or upgrade, *n* is incremented by 1.

The archive file is located in the ***SAS-install-directory/*** **SASFormatsLibraryforNetezza/2.1/Netezza32bitTwinFin/** directory.

The following components are deployed:

- The SAS formats library. The library contains many formats that are available in Base SAS.

  The SAS formats library is published to the database as an object.

  After the %INDNZ_PUBLISH_JAZLIB macro publishes and registers the SAS formats library, the SAS scoring model functions and the SAS_PUT( ) function created in Netezza can access the routines within its run-time library.
- The binary files for SAS_COMPILEUDF and other utility functions.

  The %INDNZ_PUBLISH_COMPILEUDFmacro creates the SAS_COMPILEUDF, SAS_DictionaryUDF, and SAS_HextToText functions that are needed to facilitate the publishing of the scoring models, the SAS_PUT( ) function, and user-defined formats.

The %INDNZ_PUBLISH_JAZLIB and %INDNZ_PUBLISH_COMPILEUDF macros are typically run by your system or database administrator.

For more information, see the *SAS In-Database Products: Administrator's Guide*.

Deployed Components for Oracle

Components that are deployed to Oracle for in-database processing are contained in a self-extracting archive file (tkindbsrv-9.35-*n*_lax.sh). *n* is a number that indicates the latest version of the file. If this is the initial installation, *n* has a value of 1. Each time you reinstall or upgrade, *n* is incremented by 1.

The archive file is located in the ***SAS-install-directory*/SASTKInDatabaseServer/9.35/OracleDatabaseonLinuxx64/** directory.

The SAS Embedded Process is the component that is deployed in Oracle. The SAS Embedded Process contains run-time libraries and other software that is installed on your Oracle system. The SAS scoring files created in Oracle access the routines within the run-time libraries.

For more information about these components, see the installation and configuration instructions in the *SAS In-Database Products: Administrator's Guide*.

Deployed Components for Teradata

Components that are deployed to Teradata for in-database processing are contained in two RPM files (accelterfmt-2.1-*n*.x86_64.rpm and tkindbsrv-9.35-*n*.x86_64.rpm). *n* is a number that indicates the latest version of the file. If this is the initial installation, *n* has a value of 1. Each time you reinstall or upgrade, *n* is incremented by 1.

The first RPM file is located in the ***SAS-install-directory*/SASFormatsLibraryforTeradata/2.1/TeradataonLinux/** directory. The second RPM file is located in the ***SAS-install-directory*/SASTKInDatabaseServer/9.35/TeradataonLinux/** directory.

The components that are deployed are the SAS formats library and the SAS Embedded Process.

The SAS formats library contains many of the formats that are available in Base SAS. After you install the SAS formats library, the SAS scoring model functions and the SAS_PUT( ) function can access the routines within its run-time library.

The SAS Embedded Process contains run-time libraries, and other software that is installed on your Teradata system. The SAS scoring files created in Teradata access the routines within the run-time libraries.

For more information about installing and configuring these components, see the *SAS In-Database Products: Administrator's Guide*.

User-Defined Functions and the SAS Embedded Process

There are two methods by which formats and scoring models are processed inside the database:

- user-defined functions

  Formats and scoring models are converted by the publishing macros into scoring and format functions that are similar to any user-defined functions in the database.

In-database processing of formats and scoring models by means of user-defined functions is supported by Aster, DB2 under UNIX, Greenplum, Netezza, and Teradata.

- SAS Embedded Process

  The SAS Embedded Process is a SAS server process that is installed and runs inside the database to read and write data from the database. The advantage of using the SAS Embedded Process is that a single function or a stored procedure is used instead of multiple, user-defined functions.

  The SAS Embedded Process is supported for Aster format publishing and scoring models, and for DB2, Greenplum, Oracle, and Teradata scoring models.

  The SAS Embedded Process is one of the deployed components for in-database processing. For more information, see the *SAS In-Database Products: Administrator's Guide*.

Where to Go from Here

After the in-database deployment packages have been installed and configured, see the following topics to use in-database processing inside your database:

In-Database Processing Task	Documentation
Run scoring models	Chapter 2, “Introduction to the SAS Scoring Accelerator,” on page 11
Publish user-defined formats and use the SAS_PUT( ) function	Chapter 11, “Deploying and Using SAS Formats inside the Database,” on page 125
Run procedures inside the database	Chapter 17, “Running SAS Procedures inside the Database,” on page 191

Part 2

SAS Scoring Accelerator

Chapter 2

Introduction to the SAS Scoring Accelerator

Overview of the SAS Scoring Accelerator

When using conventional processing to access data inside a DBMS, 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 database. That SELECT statement fetches all the rows in the table, and the SAS/ACCESS engine returns them to SAS Enterprise Miner. As the number of rows in the table grows over time, network latency grows. This happens because the amount of data that is fetched from the database to the SAS scoring process increases.

The SAS Scoring Accelerator embeds the robustness of SAS Enterprise Miner scoring models directly in the highly scalable database. By using the SAS In-Database technology and the SAS Scoring Accelerator, the scoring process is done inside the database and thus does not require the transfer of data.

The SAS Scoring Accelerator takes the models that are developed by SAS Enterprise Miner and translates them into scoring files or functions that can be deployed inside the database. After the scoring functions are published, the functions extend the database's SQL language and can be used in SQL statements like other database functions. After the scoring files are published, they are used by the SAS Embedded Process to run the scoring model.

The SAS Scoring Accelerator consists of two components:

- the Score Code Export node in SAS Enterprise Miner. This extension exports the model scoring logic (including metadata about the required input and output variables) from SAS Enterprise Miner.
- the publishing client that includes a scoring publishing macro. This macro translates the scoring model into files that are used inside the database to run the scoring model. The publishing client then uses the SAS/ACCESS Interface to the database to publish the files to the database.

In the August 2012 release, you can also use the SAS Scoring Accelerator and SAS Model Manager to import SAS/STAT linear models and SAS High-Performance Analytics models from a SAS package file (.SPK). Models that have a DATA step score

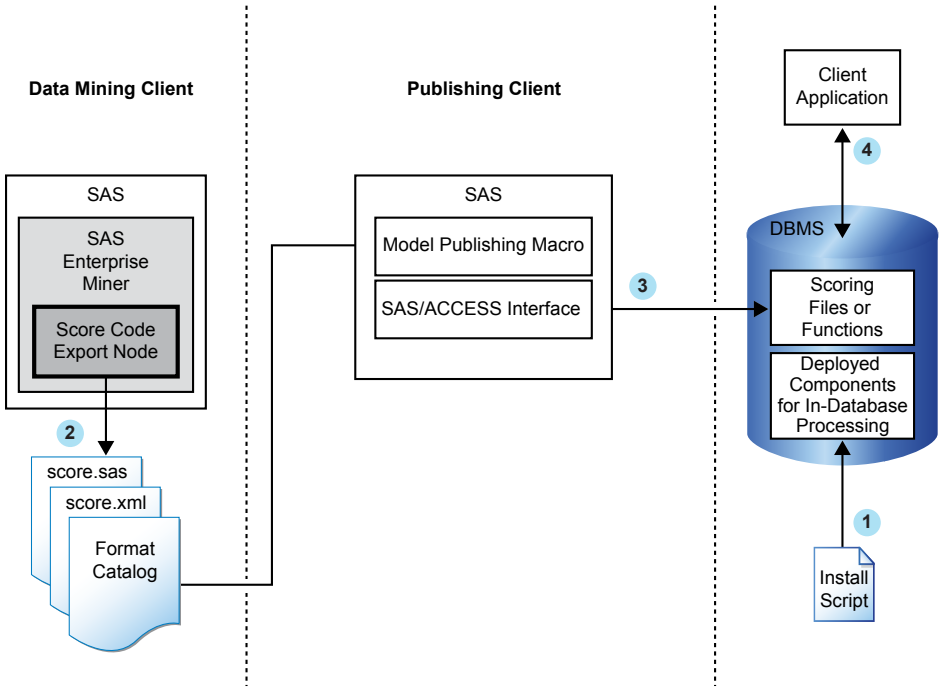
code type can be scored, published, and included in performance monitoring. For more information, see the *SAS Model Manager: User's Guide*.

How It Works

Using SAS Enterprise Miner, you can generate SAS DATA step code that contains scoring functions. The SAS Scoring Accelerator takes the scoring model code, the associated property file that contains model inputs and outputs, and a catalog of user-defined formats. The SAS Scoring Accelerator deploys (or publishes) them to the database. Inside the database, one or more scoring files or functions are created and registered for use in SQL queries.

The following figure illustrates this process.

Figure 2.1 *Process Flow Diagram*



1 Install the components that are necessary for in-database processing.

   The components that are deployed are different for each database. For more information, see the *SAS In-Database Products: Administrator's Guide*.

   Note: This is a one-time installation process.

2 Use SAS Enterprise Miner to create a scoring model. Use the Score Code Export node to export files that are used to create the scoring files or functions to a score output directory.

   For more information, see Chapter 3, "Exporting the Scoring Model Files from SAS Enterprise Miner," on page 15.

3 Start SAS 9.3 and run the SAS publishing macros. This creates the files that are needed to build the scoring files or functions and publish those files to the database.

   For more information, see the section on publishing scoring model files in the Scoring Accelerator chapter for your database.

4 After the scoring files or functions are created, you can run your scoring model.

For more information, see the topic on running the scoring model in the Scoring Accelerator chapter for your database.

Special Characters in Directory Names

If the directory names that are used in the macros contain any of the following special characters, you must mask the characters by using the %STR macro quoting function. For more information, see the %STR function and macro string quoting topic in *SAS Macro Language: Reference*.

Character	How to Represent
blank[1]	%str( )
*[2]	%str(*)
;	%str(;)
,	%str(,)
=	%str(=)
+	%str(+)
-	%str(-)
>	%str(>)
<	%str(<)
^	%str(^)
|	%str(|)
&	%str(&)
#	%str(#)
/	%str(/)
~	%str(~)
%	%str(%%)
'	%str(%')
"	%str(%")
(	%str(%()
)	%str(%))
¬	%str(¬)

Character	How to Represent

[1]Only leading blanks require the %STR function, but you should avoid using leading blanks in directory names.

[2]Asterisks are allowed in UNIX directory names. Asterisks are not allowed in Windows directory names. In general, you should avoid using asterisks in directory names.

Here are some examples of directory names with special characters:

Directory	Code Representation
c:\temp\Sales(part1)	`c:\temp\Sales%str(%()part1%str(%))`
c:\temp\Drug “trial” X	`c:\temp\Drug %str(%")trial(%str(%") X`
c:\temp\Disc's 50% Y	`c:\temp\Disc%str(%')s 50%str(%%) Y`
c:\temp\Pay,Emp=Z	`c:\temp\Pay%str(,)Emp%str(=)Z`

Chapter 3

Exporting the Scoring Model Files from SAS Enterprise Miner

Overview of the Score Code Export Node

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. The model can then be 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 (score.sas).
- a properties file that contains a description of the variables that are used and created by the scoring code (score.xml).
- a format catalog, if the scoring program contains user-defined formats.
- an XML file containing descriptions 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. This data set can be used to test and debug new scoring processes.
- a ten-row sample table of the training data set showing the typical cases of the input attributes used to develop the score code.

For more information about the exported files, see "Output Files" on page 19. For more information about using SAS Enterprise Miner, see the SAS Enterprise Miner Help.

Comparing the Score Code Export Node 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. 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.

Using the Score Code Export Node

Using the Score Code Export Node in a Process Flow Diagram

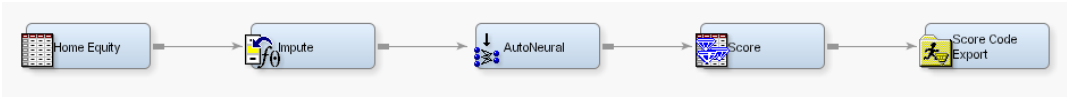
The **Score Code Export node** icon is located on the Utility tab, as shown in Figure 3.1:

Figure 3.1 *The Diagram Toolbar with the SAS Score Code Export Node Icon Highlighted*

To use the Score Code Export node, you need a process flow diagram that contains nodes that produce score code and that flow 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.

This is a valid data mining process for exporting score code:

Figure 3.2 *Data Mining Process Flow Diagram*



Requirement: The Score Code Export node exports score code that contains only one DATA step. For a list of SAS Enterprise Miner nodes that produce score code, see "SAS Enterprise Miner Tools Production of Score Code" on page 22.

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

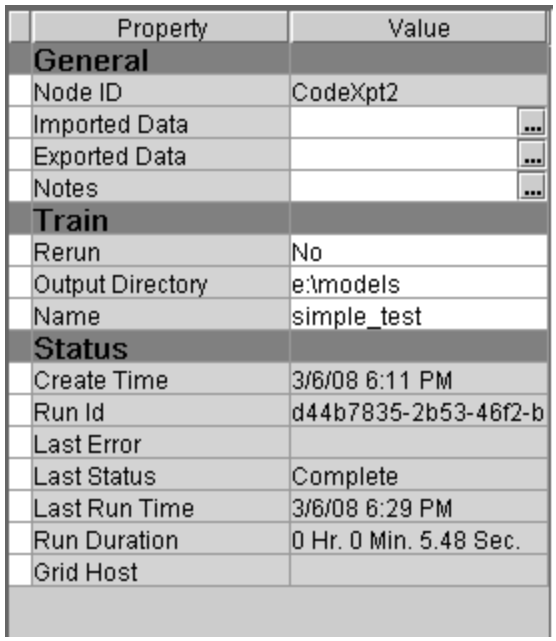
1. Select the **Score** node. Ensure that each of the following properties is set to the default value of Yes:
   - **Use Output Fixed Names**
   - **C Score**
2. Select the **Score Code Export** node and set the properties. The **Output Directory** property specifies the directory to store the export 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" on page 17.

After the properties are set, you are ready to export the score code. Right-click the **Score Code Export** node and select **Run**. When SAS Enterprise Miner completes processing, the Run Status window appears and indicates 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" on page 18.

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 3.3.

Figure 3.3 *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	

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 has 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*.

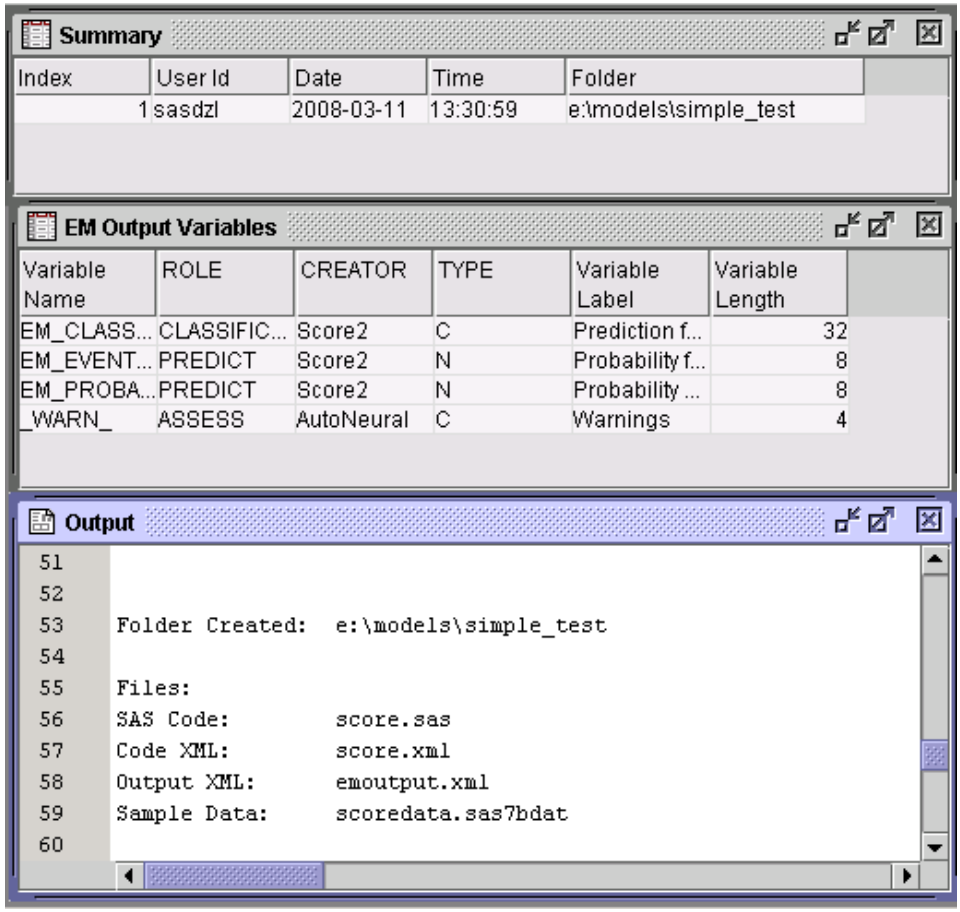
The General and Status properties for the Score Code Export node function just as they do for other nodes.

Output Created by the Score Code Export Node

Results Window

Using the values set in the Properties panel (Figure 3.3), the Score Code Export node creates the following output in the Results window:

Figure 3.4 *Results Using Sample Properties in the Properties Panel*



Output Files

The Score Code Export node writes the following output files, and a format catalog, if applicable, to the location specified by the Output Directory property. These files are used as input to the scoring publishing macro that creates the scoring functions.

Table 3.1 *Score Code Export Node Output Files*

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 3.3 looks like this:
	`data testout ;`
	`  set simpletest.scoredata ;`
	`  %include "c:\models\simpletest\score.sas";`
	`run;`

File or Folder	Description
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 scoring 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" on page 21. *Note:* The emoutput.xml file is not used by the scoring publishing 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:* The scoredata.sas7bdat file is not used by the scoring publishing 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:* The traindata.sas7bdat file is not used by the scoring publishing macro.
Format Catalog	If the training data contains SAS user-defined formats, the Score Code Export node creates a format catalog. The catalog contains the user-defined formats in the form of a lookup 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 output variables for the scoring process follow a naming convention using a prefix, as shown in the following table.

Table 3.2 *Output Variables*

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 cases where 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.

Table 3.3 *Fixed Variable Names*

Role	Type	Fixed Name	Description
Prediction	N	EM_PREDICTION	The prediction value for an interval target.

Role	Type	Fixed Name	Description
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. 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.

Table 3.4 *Types of Score Code Created by Node*

Node	SAS DATA Step	SAS Program	PMML	C	Java	DBMS
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

Node	SAS DATA Step	SAS Program	PMML	C	Java	DBMS
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
Principal Components	Y	N	N	Y	Y	Y
Rules Builder	Y	N	N	Y	Y	Y**
Transform Variables	Y	N	N	Y	Y	Y
Model						

Node	SAS DATA Step	SAS Program	PMML	C	Java	DBMS
Autoneural	Y	N	Y	Y	Y	Y
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
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

Node	SAS DATA Step	SAS Program	PMML	C	Java	DBMS
Metadata	*	*	*	*	*	*
Reporter	*	*	*	*	*	*
SAS Code The user can enter either SAS DATA step code or SAS program code.	Y	Y	N	N	N	N
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.

** There is limited support for user-written code in this node. User-written code could produce errors or unexpected results.

Chapter 4

SAS Scoring Accelerator for Aster *n*Cluster

Overview of Running Scoring Models in Aster

The integration of the SAS Embedded Process and Aster allows scoring code to be running directly using the SAS Embedded Process on Aster through a SQL/MR function.

The SQL/MR function is the framework for enabling execution of user-defined functions within Aster through an SQL interface. A SAS SQL/MR function, SAS_SCORE(), performs the scoring of models published in Aster.

The SAS Embedded Process is a SAS server process that runs inside Aster to read and write data. The model publishing macro creates scoring files that are then used in a stored procedure to run the scoring model.

The %INDAC_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 %INDAC_PUBLISH_MODEL macro performs the following tasks:

- takes the score.sas and score.xml files that are created using the Score Code Export node and produces two files for each scoring model. The following files are produced:
  - sasscore_*modelname*.ds2. This file contains code that is executed by the SAS_SCORE() function.

  - sasscore_*modelname*_io.xml. This file contains the scoring model's input and output variables.
- takes the format catalog, if available, and produces the sasscore_*modelname*_ufmt.xml file. This file contains user-defined formats for the scoring model that is being published.
- uses the SAS/ACCESS Interface to Aster *n*Cluster to insert the three scoring files into a table. For more information, see "Scoring Files Table" on page 35.

After the scoring files are published, you can call the SAS_SCORE() function to execute the scoring model. For more information, see "SAS_SCORE() Function" on page 35.

The SAS Scoring Accelerator for Aster requires a specific version of the Aster client and server environment. For more information, see **http://www.sas.com/technologies/analytics/datamining/scoring_acceleration/#section=5** and *SAS In-Database Products: Administrator's Guide*.

Running the %INDAC_PUBLISH_MODEL Macro

%INDAC_PUBLISH_MODEL Macro Run Process

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

1. Create a scoring model using SAS Enterprise Miner.
2. Use the SAS Enterprise Miner Score Code Export node to create a score output directory. Populate the directory with the score.sas file, the score.xml file, and, if needed, the format catalog.
3. Start SAS 9.3 and submit one of these following sets of commands in the Program Editor or Enhanced Editor:

```
%indacpm;
%let indconn = user=myuserid password=XXXX
dsn=ncluster <schema=myschema>;

%indacpm;
%let indconn = user=myuserid password=XXXX server=myserver
 database=mydatabase <schema=myschema>;
```

   For more information, see the "%INDACPM Macro" on page 28 and "INDCONN Macro Variable" on page 29.
4. Run the %INDAC_PUBLISH_MODEL macro.

   Messages are written to the SAS log that indicate the success or failure of the creation of the .ds2 and .xml scoring files.

   For more information, see "%INDAC_PUBLISH_MODEL Macro Syntax" on page 30.

%INDACPM Macro

The %INDACPM macro searches the autocall library for the indacpm.sas file. The indacpm.sas file contains all the macro definitions that are used in conjunction with the %INDAC_PUBLISH_MODEL macro. The indacpm.sas file should be in one of the directories listed in the SASAUTOS= system option in your configuration file. If the

indacpm.sas file is not present, the %INDACPM macro call (%INDACPM; statement) issues the following message:

```
macro indacpm not defined
```

INDCONN Macro Variable

The INDCONN macro variable is used to provide credentials to connect to Aster. You must specify user, password, and either a DSN name or a server and database name. You must assign the INDCONN macro variable before the %INDAC_PUBLISH_MODEL macro is invoked.

The value of the INDCONN macro variable for the %INDAC_PUBLISH_MODEL macro has one of these formats:

USER=*username* PASSWORD=*password* DSN=*dsnname* <SCHEMA=*schemaname*>

USER=*username* PASSWORD=*password* DATABASE=*databasename* SERVER=*servername* <SCHEMA=*schemaname*>

Arguments

USER=*username*
specifies the Aster user name (also called the user ID) that is used to connect to the database.

PASSWORD=*password*
specifies the password that is associated with your Aster user ID.

Tip Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error.

DSN=*datasourcename*
specifies the configured Aster data source to which you want to connect.

Requirement You must specify either the DSN= argument alone, or the SERVER= and DATABASE= arguments together in the INDCONN macro variable.

DATABASE=*databasename*
specifies the Aster database that contains the tables and views that you want to access.

Requirement You must specify either the DSN= argument alone, or the SERVER= and DATABASE= arguments together in the INDCONN macro variable.

SERVER=*servername*
specifies the Aster server name or the IP address of the server host.

Requirement You must specify either the DSN= argument alone, or the SERVER= and DATABASE= arguments together in the INDCONN macro variable.

SCHEMA=*schemaname*
specifies the schema name for the database.

Default your default schema. To determine your default schema name, use the **show search_path** command from the Aster Client Tool (ACT).

Restriction The SCHEMA argument is valid only for Aster 4.6. For Aster 4.5, the scoring model XML files are published to the PUBLIC schema.

TIP The INDCONN macro variable is not passed as an argument to the %INDAC_PUBLISH_MODEL macro. 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.

%INDAC_PUBLISH_MODEL Macro Syntax

%INDAC_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>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DIR=*input-directory-path*
specifies the directory where the scoring model program, the properties file, and the format 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 format catalog.

Requirement You must use a fully qualified pathname.

Interaction If you do not use the default filenames that are created by SAS Enterprise Miner, you must specify the DATASTEP=, XML=, and (if needed) FMTCAT= arguments.

See "Special Characters in Directory Names" on page 13

MODELNAME=*name*
specifies the name that becomes part of the .ds2 and .xml scoring filenames.

Restriction The names of the .ds2 and .xml scoring files are a combination of the model and type of filenames. A scoring filename cannot exceed 63 characters. For more information, see "Aster Scoring Files" on page 33.

Requirement The name must be a valid SAS name. For more information about valid SAS names, see the topic on rules for words and names in *SAS Language Reference: Concepts*.

Interaction Only the EM_ output variables are published in the sasscore_*modelname*_io.xml file. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21 and "Aster Scoring Files" on page 33.

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.

Interactions 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.

The SAS file that is specified in the DATASTEP= argument is translated by the %INDAC_PUBLISH_MODEL macro into the sasscore_*modelname*.ds2 file. For Aster 4.5, this file is stored in the NC_INSTALLED_FILES table under the PUBLIC schema. For Aster 4.6, this file is stored in the NC_USER_INSTALLED_FILES table under the schema that you specified in the INDCONN macro variable.

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

Restrictions Only XML files that are produced by the SAS Enterprise Miner Score Code Export node can be used.

The maximum number of output variables is 1660.

Interactions 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.

The XML file is renamed to sasscore_*modelname*_io.xml by the %INDAC_PUBLISH_MODEL macro. For Aster 4.5, this file is stored in the NC_INSTALLED_FILES table under the PUBLIC schema. For Aster 4.6, this file is stored in the NC_USER_INSTALLED_FILES table under the schema that you specified in the INDCONN macro variable.

DATABASE=*database-name*
specifies the name of an Aster database to which the scoring functions and formats are published.

Restriction If you specify DSN= in the INDCONN macro variable, do not use the DATABASE argument.

Interaction The database that is specified by the DATABASE argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "%INDAC_PUBLISH_MODEL Macro Run Process" on page 28.

Tip You can publish the scoring files to a shared database where other users can access them.

FMTCAT=*format-catalog-filename*
specifies the name of the format catalog file. The file contains all user-defined 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.

Interactions 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.

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 *Base SAS Procedures Guide*.

ACTION=CREATE | REPLACE | DROP
specifies one of the following actions that the macro performs:

CREATE
creates the sasscore_*modelname*.ds2, sasscore_*modelname*_io.xml, and sasscore_*modelname*_ufmt.xml files.

REPLACE
overwrites the current sasscore_*modelname*.ds2, sasscore_*modelname*_io.xml, and sasscore_*modelname*_ufmt.xml files, if those files by the same name are already registered.

DROP
causes the sasscore_*modelname*.ds2, sasscore_*modelname*_io.xml, and sasscore_*modelname*_ufmt.xml files to be dropped from either the NC_INSTALLED_FILES table (Aster 4.5) or the NC_USER_INSTALLED_FILES table (Aster 4.6) in the database.

Default CREATE

Tip If the scoring files have been previously defined and you specify ACTION=CREATE, you receive warning messages from Aster. If the scoring files have been previously defined and you specify ACTION=REPLACE, no warnings are issued.

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process and sample SQL code (SampleSQL.txt). For more information about the SampleSQL.txt file, see "Aster Scoring Files" on page 33.

Tip This argument is useful to debug a scoring model that fails to be published.

See "Special Characters in Directory Names" on page 13

Model Publishing Macro Example

```
%indacpm;
```

```
%let indconn = server=yoursvr user=user1 password=open1
    database=yourdb schema=yoursch;
%indac_publish_model( dir=C:\SASIN\score, modelname=score);
```

The %INDAC_PUBLISH_MODEL macro produces these three files:

- sasscore_score.ds2. See "Example of a .ds2 Scoring File" on page 209.
- sasscore_score_io.xml. See "Example of an Input and Output Variables Scoring File" on page 229.
- sasscore_score_ufmt.xml. See "Example of a User-Defined Formats Scoring File" on page 236.

After the scoring files are installed, they can be invoked in Aster using the SAS_SCORE() function. For more information, see "SAS_SCORE() Function" on page 35.

Aster Permissions

For Aster 4.5, no permissions are needed by the person who runs the scoring publishing macros, because all functions and files are published to the PUBLIC schema.

For Aster 4.6, the following permissions are needed for the schema by the person who runs the scoring publishing macros, because all functions and files can be published to a specific schema.

- USAGE permission
- INSTALL FILE permission
- CREATE permission

Without these permissions, the publishing of the %INDAC_PUBLISH_MODEL macro fails. To obtain these permissions, contact your database administrator.

For more information about specific permissions, see "Aster Permissions" in Chapter 2 of SAS In-Database Products: Administrator's Guide.

Scoring Files and Functions inside the Aster Database

Aster Scoring Files

The %INDAC_PUBLISH_MODEL macro produces three scoring files for each model:

- sasscore_*modelname*.ds2. This file contains code that is executed by the SAS_SCORE() function.
- sasscore_*modelname*_io.xml. This file contains the scoring model's input and output variables.
- sasscore_*modelname*_ufmt.xml. This file contains user-defined formats for the scoring model that is being published.

For Aster 4.5, these files are stored in the NC_INSTALLED_FILES table under the PUBLIC schema. For Aster *n*Cluster 4.6, these files are stored in the NC_USER_INSTALLED_FILES table under the schema that you specified in the

INDCONN macro variable. See Appendix 1, "Scoring File Examples," on page 209 for an example of each of these files.

Note: When you publish a model using Aster 4.5, you are likely to receive warnings about multiple lengths and unbalanced quotation marks. This warning does not keep the model from being published successfully. The error occurs because the .ds2 scoring file is inserted into an Aster system table as a long quoted string.

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

- Log on to the database using the Aster command line processor and submit an SQL statement. The following example assumes that the model name that you used to create the scoring files is **reg**.

```
>act -h hostname -u username -w password -d databasename
>select name from nc_user_installed_files where name like '%sasscore_reg%';
```

  Three files are listed for each model:

```
    name
-------------------------
 sasscore_reg.ds2
 sasscore_reg_io.xml
 sasscore_reg_ufmt.xml
```

- From SAS, 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 **reg**.

```
proc sql noerrorstop;
  connect to aster (user=username password=password dsn=dsnname);

select *
   from connection to aster
      (select filename, fileowner, uploadtime
         from nc_user_installed_files where
            name like 'sasscore_reg%');
   disconnect from aster;
quit;
```

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

  The SampleSQL.txt file contains basic code that, with modifications, can be used to run your score code inside Aster.

  Note: The function and table names must be fully qualified if the functions and tables are not in the same database.

  For example, the SampleSQL.txt file refers to an ID column in **score_outtab** 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 is **reg**.

```
drop table score_outtab;
create table score_outtab(
 id integer
,"EM_CLASSIFICATION" varchar(256)
,"EM_EVENTPROBABILITY" float
```

```
,"EM_PROBABILITY" float
);
insert into score_outtab(
 id
,"EM_CLASSIFICATION"
,"EM_EVENTPROBABILITY"
,"EM_PROBABILITY"
)
select id,
"EM_CLASSIFICATION",
"EM_EVENTPROBABILITY",
"EM_PROBABILITY"
from sas_score(on score_intab model('reg'));
```

- Look at the SAS log that is created when the %INDAC_PUBLISH_MODEL macro was run. A message that indicates whether the scoring files are successfully or not successfully created is printed to the SAS log.

SAS_SCORE() Function

Overview of the SAS_SCORE() Function

The SAS_SCORE() function is an SQL/MR function that executes the scoring model running on the SAS Embedded Process in Aster. The SAS_SCORE() function is deployed and stored in the PUBLIC schema during the installation and configuration of the in-database deployment for Aster.

For more information about installing and configuring the in-database deployment package for Aster, see the *SAS In-Database Products: Administrator's Guide*.

Scoring Files Table

The NC_INSTALLED_FILES table contains the following columns. The ModelName column is the table key. The table is referenced by the two-level name *model-name*.*model-table-name*.

Column Name	Description	Specification
ModelName	contains the name of the model	VARCHAR(128) CHARACTER SET UNICODE CASESPECIFIC
ModelDS2	contains the sasscore_*modelname*.ds2 file	BLOB(209708800)
ModelFormats	contains the sasscore_*modelname*_ufmt.xml file	BLOB(209708800)
ModelOwner	contains the name of the user who published the model	VARCHAR(128) CHARACTER SET UNICODE CASESPECIFIC
ModelUpdated	contains the date and time that the model was published	TIMESTAMP(6)

Using the SAS_SCORE() Function

You can use the SAS_SCORE() function in the FROM clause in any SQL expression in the same way that Aster SQL/MR functions are used.

The syntax of the SAS_SCORE() function is as follows:

FROM **SAS_SCORE**(ON *input-table* MODEL('*model-name*')
<MODEL_SCHEMA('*schema-name*')>)

Arguments

input-table
specifies the input table that is used by the SAS_SCORE() function.

model-name
specifies the name of the model. The value of this argument is the same as the value of MODELNAME=*name* argument for the %INDAC_PUBLISH_MODEL macro.

schema-name
specifies the name of the schema where the scoring model files are published.

Restriction: This argument is valid only for Aster 4.6. For Aster 4.5, the scoring model files are published to the PUBLIC schema.

Default: your default schema. To determine your default schema name, use the **`show search_path`** command from the Aster Client Tool (ACT).

Here is an example of using the SAS_SCORE function. In this example, the input table is **score_intab** and the model name is **reg**.

```
select id, em_classification, em_eventprobability, em_probability
   from sas_score (on score_intab model('reg') model_schema('mysch'));
```

Chapter 5

SAS Scoring Accelerator for DB2 under UNIX

Overview of Running Scoring Models in DB2

There are two ways to run scoring models in DB2.

- You can create scoring functions for each EM_ output variable. The model publishing macro creates the scoring functions that are published as DB2 user-defined functions. These functions can then be used in any SQL query. For more information, see "Using Scoring Functions to Run Scoring Models" on page 38.
- Starting with the December 2011 release, you can use the SAS Embedded Process. The SAS Embedded Process is a SAS server process that runs inside DB2 to read and write data. The model publishing macro creates scoring files. These scoring files are then used by a DB2 built-in function to run the scoring model. For more information, see "Using the SAS Embedded Process to Run Scoring Models" on page 43.

The SAS Scoring Accelerator for DB2 requires a certain version of the DB2 client and server environment. For more information, see **http://www.sas.com/technologies/analytics/datamining/scoring_acceleration/#section=5** and *SAS In-Database Products: Administrator's Guide*.

Using Scoring Functions to Run Scoring Models

How to Run a Scoring Model Using Scoring Functions

The %INDB2_PUBLISH_MODEL macro creates the files that are needed to build the scoring functions and publishes the scoring functions with those files to a specified database in DB2. Only the EM_ output variables are published as DB2 scoring functions. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21.

Note: Secure File Transfer Protocol (SFTP) is used to transfer the source files to the DB2 server during the publishing process. Certain software products that support SSH-2 or SFTP protocols must be installed before you can use the publishing macros. For more information, see *Configuring SSH Client Software in UNIX and Windows Environments for Use with the SFTP Access Method in SAS 9.2 and SAS 9.3* located at **http://support.sas.com/techsup/technote/ts800.pdf**.

To run the scoring model using scoring functions, follow these steps.

1. Run the %INDB2_PUBLISH_MODEL macro.

   The %INDB2_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 %INDB2_PUBLISH_MODEL macro performs the following tasks:

   - 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 a format catalog is available, processes the format catalog and creates an .h file with C structures. These files are also necessary to build the scoring functions.
   - produces a script of the DB2 commands that are used to register the scoring functions on the DB2 database.
   - transfers the .c and .h files to DB2 using SFTP.
   - calls the SAS_COMPILEUDF function to compile the source files into object files, links to the SAS formats library, and copies the new object files to ***db2path*/sqllib/function/SAS**, where ***db2path*** is the path that was defined during installation. The object filename is *dbname_schemaname_modelname_segnum*, where *segnum* is a sequence number that increments each time the model is replaced or re-created. The object file is renamed to avoid library caching in DB2.
   - calls the SAS_DELETEUDF function to remove existing object files.
   - uses the SAS/ACCESS Interface to DB2 to run the script to create the scoring functions with the object files.

The scoring functions are registered in DB2 with shared object files, which are loaded at run time. These functions are stored in a permanent location. The SAS object files and the SAS formats library are stored in the ***db2path*/sqllib/function/SAS** directory, where ***db2path*** is the path that was defined during installation. This directory is accessible to all database partitions.

DB2 caches the object files after they are loaded. Each time that the updated objects are used, one of the following actions must occur:

- The database must be stopped and restarted to clean up the cache.
- The object files need to be renamed and the functions reregistered with the new object filenames.

The SAS publishing process automatically handles the renaming to avoid stopping and restarting the database.

Note: You can publish scoring model files with the same model name in multiple databases and schemas. Because object files for the SAS scoring function are stored in the ***db2path*/sqllib/function/SAS** directory, the publishing macros use the database, schema, and model name as the object filename to avoid potential naming conflicts.

2. Use the scoring functions in any SQL query.

   For more information, see "Using Scoring Functions to Run a Scoring Model" on page 42.

Scoring Function Names

The names of the scoring functions that are built in DB2 have the following format:

`modelname_EM_outputvarname`

modelname is the name that was specified in the MODELNAME argument of the %INDB2_PUBLISH_MODEL macro. *modelname* is always followed by _EM_ in the scoring function name. For more information about the MODELNAME argument, see "%INDB2_PUBLISH_MODEL Macro Syntax" on page 50.

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 about the score.xml file, see "Fixed Variable Names" on page 21.

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 %INDB2_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".

Note: A scoring function name cannot exceed 128 characters.

CAUTION:

When the scoring function is 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 overwrites the first scoring function.

Viewing the Scoring Functions

The scoring functions are available to use in any SQL expression in the same way that DB2 built-in functions are used. For an example, see "Using Scoring Functions to Run a Scoring Model" on page 42.

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

- From DB2, log on to the database using the DB2 client tool (command line processor) and submit an SQL statement. The following example assumes that the model name that you used to create the scoring functions is **mymodel** and the DB2 installation instance is located in **`/users/db2v9`**. The first line of code executes a db2profile script. The script sets the DB2 environment variables so that the DB2 command line processor (CLP) can execute.

```
>./users/db2v9/sqllib/db2profile
>db2
db2 => connect to database user username using password
db2 => select * from syscat.functions where funcname like '%MYMODEL%'
```

- From SAS, 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 db2 (user=username pw=password db=database);

select *
   from connection to db2
      (select * from syscat.functions where funcname like '%MYMODEL%');
   disconnect from db2;
quit;
```

- Look at the SampleSQL.txt file that is produced when the %INDB2_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 DB2.

  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*. *n* is 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.

  Note: The function and table names must be fully qualified if the function and table are not in the same schema.

  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 ;
```

- You can look at the SAS log that is created when the %INDB2_PUBLISH_MODEL macro was run. A message that indicates whether a scoring function is successfully or not successfully executed is printed to the SAS log.

Using Scoring Functions to Run a Scoring Model

The scoring functions are available to use in any SQL expression in the same way that DB2 built-in functions are used.

The following example code creates the scoring functions.

```
%indb2pm;
%let indconn = server=db2base user=user1 password=open1 database=mydb;
%indb2_publish_model( dir=C:\SASIN\baseball1, modelname=baseball1);
```

The %INDB2_PUBLISH_MODEL macro produces a text file of DB2 CREATE FUNCTION commands as shown in the following example.

Note: This example file is shown for illustrative purposes. The text file that is created by the %INDB2_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 varchar(33)
LANGUAGE C
NO SQL
PARAMETER STYLE SQL
DETERMINISTIC
FENCED THREADSAFE
NO EXTERNAL ACTION
ALLOW PARALLEL
NULL CALL
EXTERNAL NAME '/users/db2v9/sqllib/function/SAS/
   dbname_username_baseball1.so!baseball1_em_ eventprobablility '
```

After the scoring functions are installed, they can be invoked in DB2 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 MLBDB2;
```

Using the SAS Embedded Process to Run Scoring Models

How to Run a Scoring Model with the SAS Embedded Process

The integration of the SAS Embedded Process and DB2 allows scoring code to run directly using the SAS Embedded Process on DB2.

Note: The SAS Embedded Process might require a later release of DB2 than function-based scoring. For more information, see **http://www.sas.com/technologies/analytics/datamining/scoring_acceleration/#section=5**.

To run the scoring model using the SAS Embedded Process, follow these steps.

1. Create a table to hold the scoring files.

   The %INDB2_CREATE_MODELTABLE macro creates a table that holds the scoring files for the model that is being published.

   For more information, see "Creating a Model Table" on page 44.

2. Run the %INDB2_PUBLISH_MODEL to create the scoring files.

   The %INDB2_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 %INDB2_PUBLISH_MODEL macro performs the following tasks:

   - translates the scoring model into the sasscore_*modelname*.ds2 file that is used to run scoring inside the SAS Embedded Process.
   - takes the format catalog, if available, and produces the sasscore_*modelname*_ufmt.xml file. This file contains user-defined formats for the scoring model that is being published.

- uses the SAS/ACCESS Interface to DB2 to insert the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files into the model table that was created using the %INDB2_CREATE_MODELTABLE macro.

For more information, see "Running the %INDB2_PUBLISH_MODEL Macro" on page 48 and "DB2 Scoring Files" on page 47.

3. Use the ANALYZE_TABLE function in the FROM clause in any SQL expression to run the scoring model.

   For more information, see "ANALYZE_TABLE Function" on page 46.

Creating a Model Table

Overview

When using the SAS Embedded Process to publish a scoring model in DB2, you must create a table to hold the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files. You must run the %INDB2_CREATE_MODELTABLE macro to create the table before you run the %INDB2_PUBLISH_MODEL macro.

The model table contains the following columns. The ModelName column is the table key. The table is referenced by the two-level name *schema-name.model-table-name*.

Column Name	Description	Specification
ModelName	contains the name of the model	VARCHAR(128) NOT NULL PRIMARY KEY
ModelDS2	contains the sasscore_*modelname*.ds2 file	BLOB(4M) NOT NULL
ModelFormats	contains the sasscore_*modelname*_ufmt.xml file	BLOB(4M)
ModelMetadata	Reserved by SAS for future use	BLOB(4M)

%INDB2_CREATE_MODELTABLE Run Process

To run the %INDB2_CREATE_MODELTABLE macro, complete the following steps:

1. Start SAS 9.3 and submit the following commands in the Program Editor or Enhanced Editor:

```
%indb2pm;
%let indconn = server=yourserver user=youruserid password=yourpwd
    database=yourdb schema=yourschema;
```

   For more information, see "%INDB2PM Macro" on page 48 and the "INDCONN Macro Variable" on page 48.

2. Run the %INDB2_CREATE_MODELTABLE macro.

   For more information, see "%INDB2_CREATE_MODELTABLE Macro Syntax" on page 45.

%INDB2_CREATE_MODELTABLE Macro Syntax

%INDB2_CREATE_MODELTABLE

(TS_PRIMARYPAR=*tablespace-name*
<DATABASE=*database-name*>
<, MODELTABLE=*model-table-name*>
<, ACTION=CREATE | REPLACE | DROP>
);

Arguments

TS_PRIMARYPAR=*tablespace-name*
specifies the name of the tablespace that resides in the primary partition.

Tip You can get the name of the tablespace from your database administrator.

DATABASE=*database-name*
specifies the name of a DB2 database where the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files are held.

Default The database specified in the INDCONN macro variable or your current database

MODELTABLE=*model-table-name*
specifies the name of the table that holds the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files.

Default sas_model_table

Requirement The maximum table name length is 128 characters and it must be a valid DB2 table name.

See "%INDB2_PUBLISH_MODEL Macro Syntax" on page 50

ACTION = CREATE | REPLACE | DROP
specifies one of the following actions that the macro performs:

CREATE
creates a new table.

Tip If the table has been previously defined and you specify ACTION=CREATE, an error is issued.

REPLACE
overwrites the current table, if a table with the same name is already registered.

Tip If you specify ACTION = REPLACE, and the current table contains sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml files, the files are deleted and an empty table is re-created.

DROP
causes all models in this table to be dropped.

Default CREATE

ANALYZE_TABLE Function

Overview of the ANALYZE_TABLE Function

The ANALYZE_TABLE function is the interface for running the scoring model inside DB2 with the SAS Embedded Process. The ANALYZE_TABLE function uses the information that is stored in the model table. The ANALYZE_TABLE function is a built-in DB2 function.

Using the ANALYZE_TABLE Function

You can use the ANALYZE_TABLE function using explicit pass-through and PROC SQL or you can use other DB2 query tools such as the Command Line Processor. Use the ANALYZE_TABLE function in the FROM clause in any SQL expression to run the scoring model.

TIP Look at the SampleSQL.txt file that is produced when the %INDB2_PUBLISH_MODEL macro is successfully run. This file can be found in the output directory (OUTDIR argument) that you specify in the %INDB2_PUBLISH_MODEL macro. The SampleSQL.txt file contains the basic SQL code that, with modifications, can be used to run your score code inside Greenplum.

Note: Before using the ANALYZE_TABLE function with the SAS Embedded Process, you must create the model table with the %INDB2_CREATE_MODELTABLE macro. Then, you must publish the files to the model table with the %INDB2_PUBLISH_MODEL macro. For more information, see "Creating a Model Table" on page 44 and "Running the %INDB2_PUBLISH_MODEL Macro" on page 48.

Here is an example using PROC SQL.

```
proc sql;
 connect to db2 (user=userid password=xxxx database=mydatabase);
 create table work.sas_score_out1 as select * from connection to db2
    (WITH T1 as (SELECT * from SCORE_INPUT_TABLE where X1 < 1.0)
      SELECT * from T1 ANALYZE_TABLE
         (IMPLEMENTATION 'PROVIDER=SAS;
            ROUTINE_SOURCE_TABLE=myschema.SAS_PUBLISH_MODEL;
            ROUTINE_SOURCE_NAME="Intr_Tree";') );
 disconnect from db2;
quit;
```

ANALYZE_TABLE Function Syntax

The syntax of the ANALYZE_TABLE function is as follows:

FROM *input-table-name* **ANALYZE_TABLE** (IMPLEMENTATION 'PROVDER=SAS';
ROUTINE_SOURCE_TABLE=*schema.model-table-name*;
ROUTINE_SOURCE_NAME="*model-name*"; ')

Arguments

input-table-name
specifies the input table that is used by the ANALYZE_TABLE function.

schema
specifies the name of the schema where the scoring model files are published.

model-table-name
specifies the name of the model table where the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files were published with the %INDB2_CREATE_MODELTABLE macro.

Requirement The table name that you specify for this function must be the same table name that is used in the %INDB2_CREATE_MODELTABLE macro. For more information, see "%INDB2_CREATE_MODELTABLE Macro Syntax" on page 45.

model-name
specifies the name of the model.

DB2 Scoring Files

When using the SAS Embedded Process, the %INDB2_PUBLISH_MODEL macro produces two scoring files for each model:

- sasscore_*modelname*.ds2. This file contains code that is executed by the ANALYZE_TABLE function.
- sasscore_*modelname*_ufmt.xml. This file contains user-defined formats for the scoring model that is being published. This file is used by the ANALYZE_TABLE function.

These files are published to the model table that you specify in the %INDB2_PUBLISH_MODEL macro. See Appendix 1, "Scoring File Examples," on page 209 for an example of each of these files.

A message that indicates whether the scoring files are successfully or not successfully created is printed to the SAS log.

Although you cannot view the scoring files directly, there are two ways to see the models whose files are created:

- Run this query from the DB2 command line processor:

```
db2> connect to databasename user userid using password
db2> select modelname from sasmodeltablename
```

- Run a PROC SQL query from SAS.

```
proc sql;
 connect to db2 (user=userid password=xxxx database=mydatabase);
  select * from connection to db2
 (select modelname from sas_model_table);
 disconnect from db2;
quit;
```

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

Running the %INDB2_PUBLISH_MODEL Macro

%INDB2_PUBLISH_MODEL Macro Run Process

To run the %INDB2_PUBLISH_MODEL macro, complete the following steps:

1. Create a scoring model using SAS Enterprise Miner.
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 9.3 and submit the following commands in the Program Editor or Enhanced Editor:

   ```
   %indb2pm;
   %let indconn = server=yourserver user=youruserid password=yourpwd
       database=yourdb schema=yourschema serveruserid=yourserveruserid;
   ```

   For more information, see the "%INDB2PM Macro" on page 48 and the "INDCONN Macro Variable" on page 48.
4. If you use the SAS Embedded Process, run the %INDB2_CREATE_MODELTABLE macro.

   For more information, see "Creating a Model Table" on page 44.
5. Run the %INDB2_PUBLISH_MODEL macro.

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

   For more information, see "%INDB2_PUBLISH_MODEL Macro Syntax" on page 50.

%INDB2PM Macro

The %INDB2PM macro searches the autocall library for the indb2pm.sas file. The indb2pm.sas file contains all the macro definitions that are used in conjunction with the %INDB2_PUBLISH_MODEL macro. The indb2pm.sas file should be in one of the directories listed in the SASAUTOS= system option in your configuration file. If the indb2pm.sas file is not present, the %INDB2PM macro call (%INDB2PM; statement) issues the following message:

```
macro indb2pm not defined
```

INDCONN Macro Variable

The INDCONN macro variable is used to provide credentials to connect to DB2. You must specify server, user, password, and database information to access the machine on which you have installed the DB2 database. The schema name and the server user ID are optional. You must assign the INDCONN macro variable before the %INDB2_PUBLISH_MODEL macro is invoked.

Here is the syntax for the value of the INDCONN macro variable for the %INDB2_PUBLISH_MODEL macro:

USER=*user* PASSWORD=*password* DATABASE=*database* SERVER=*server* <SCHEMA=*schema*> <SERVERUSERID=*serveruserid*>

Arguments

USER=*userid*
specifies the DB2 user name (also called the user ID) that is used to connect to the database.

PASSWORD=*password*
specifies the password that is associated with your DB2 user ID.

Tip Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error.

DATABASE=*database*
specifies the DB2 database that contains the tables and views that you want to access.

Requirement The scoring model functions are created as Unicode functions. If the database is not a Unicode database, then the alternate collating sequence must be configured to use **`identity_16bit`**.

SERVER=*server*
specifies the DB2 server name or the IP address of the server host.

Restriction This argument is required when using function-based scoring. It is not used if you use the SAS Embedded Process.

Requirement The name must be consistent with how the host name was cached when SFTP server was run from the command window. If the full server name was cached, you must use the full server name in the SERVER argument. If the short server name was cached, you must use the short server name. For example, if the long name, *disk3295.unx.comp.com*, is used when SFTP was run, then *server=disk3295.unx.comp.com* must be specified. If the short name, *disk3295*, was used, then *server=disk3295* must be specified. For more information about running the SFTP command, see “DB2 Installation and Configuration Steps” in the *SAS In-Database Products: Administrator's Guide*.

SCHEMA=*schema*
specifies the schema name for the database.

Default If you do not specify a value for the SCHEMA argument, the value of the USER argument is used as the schema name.

SERVERUSERID=*serveruserid*
specifies the user ID for SAS SFTP and enables you to access the machine on which you have installed the DB2 database.

Default If you do not specify a value for the SERVERUSERID argument, the value of the USER argument is used as the user ID for SAS SFTP.

Restriction This argument is not used if you use the SAS Embedded Process.

Note The person who installed and configured the SSH software can provide the SERVERUSERID (SFTP user ID) and the private key that need to be added to the pageant.exe (Windows) or SSH agent (UNIX). In order for the SFTP process to be successful, Pageant must be running on Windows and the SSH agent must be running on UNIX.

TIP The INDCONN macro variable is not passed as an argument to the %INDB2_PUBLISH_MODEL macro. 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.

%INDB2_PUBLISH_MODEL Macro Syntax

%INDB2_PUBLISH_MODEL

(DIR=*input-directory-path*, MODELNAME=*name*
<, MECHANISM=STATIC | EP>
<, MODELTABLE=*model-table-name*>
<, DATASTEP=*score-program-filename*>
<, XML=*xml-filename*>
<, DATABASE=*database-name*>
<, FMTCAT=*format-catalog-filename*>
<, ACTION=CREATE | REPLACE | DROP>
<, MODE=FENCED | UNFENCED>
<, INITIAL_WAIT=*wait-time*>
<, FTPTIMEOUT=*timeout-time*>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DIR=*input-directory-path*
specifies the directory where the scoring model program, the properties file, and the format 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 format 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.

See "Special Characters in Directory Names" on page 13

MODELNAME=*name*
specifies the name that is prepended to each output function to ensure that each scoring function name is unique on the DB2 database. If you use the SAS Embedded Process, the model name is the primary index field in the model table.

Restriction The scoring function name is a combination of the model and output variable names. A scoring function name cannot exceed 128 characters. For more information, see "Scoring Function Names" on page 39.

Requirement If you use scoring functions, the model name must be a valid SAS name that is 10 characters or fewer. If you use the SAS Embedded Process, the model name can be up to 128 characters. For more information about valid SAS names, see the topic on rules for words and names in *SAS Language Reference: Concepts*.

Interaction Only the EM_ output variables are published as DB2 scoring functions. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21 and "Scoring Function Names" on page 39.

MECHANISM=STATIC | EP

specifies whether scoring functions or scoring files are created. MECHANISM= can have one of the following values:

STATIC

specifies that scoring functions are created.

These scoring functions are used in an SQL query to run the scoring model.

See "Using Scoring Functions to Run Scoring Models" on page 38

EP

specifies that scoring files are created.

These scoring files are used by the SAS Embedded Process to run the scoring model. A single entry in the model table is inserted for each new model. The entry contains both the score.sas and score.xml in separate columns. The scoring process includes reading these entries from the table and transferring them to each instance of the SAS Embedded Process for execution.

Requirement If you specify MECHANISM=EP, you must also specify the MODELTABLE= argument.

Note The SAS Embedded Process might require a later release of DB2 than function-based scoring. For more information, see **http://www.sas.com/technologies/analytics/datamining/scoring_acceleration/#section=5**.

See "Using the SAS Embedded Process to Run Scoring Models" on page 43

Default STATIC

MODELTABLE=*model-table-name*

specifies the name of the model table where the scoring files are published.

Default sas_model_table

Restriction This argument is valid only when using the SAS Embedded Process.

Requirement The name of the model table must be the same as the name specified in the %INDB2_CREATE_MODELTABLE macro. For more information, see the MODELTABLE argument in "%INDB2_CREATE_MODELTABLE Macro Syntax" on page 45.

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

Restrictions Only XML files that are produced by the SAS Enterprise Miner Score Code Export node can be used.

If you use scoring functions to run scoring models, the maximum number of output variables is 128. If you use the SAS Embedded Process, the maximum depends on the page size of the database table space. For a 4K page size database, the limit is 500. If you have it configured for any of the larger page sizes (8K, 16K, 32K), then the limit is 1012.

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 DB2 database to which the scoring functions and formats or the scoring files are published.

Requirement The scoring model functions are created as Unicode functions. If the database is not a Unicode database, then the alternate collating sequence must be configured to use **`identity_16bit`**.

Interaction The database that is specified by the DATABASE argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "%INDB2_PUBLISH_MODEL Macro Run Process" on page 48.

FMTCAT=*format-catalog-filename*
specifies the name of the format catalog file that contains all user-defined 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.

Interactions 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.

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 *Base SAS Procedures Guide*.

ACTION=CREATE | REPLACE | DROP
specifies one of the following actions that the macro performs:

CREATE
creates new functions or files.

REPLACE
overwrites the current functions or files, if functions or files by the same name are already registered.

DROP
causes all functions or files for this model to be dropped from the DB2 database.

Default CREATE

Tip If the function or file has been previously defined and you specify ACTION=CREATE, you receive warning messages from DB2. If the function or file has been previously defined and you specify ACTION=REPLACE, no warnings are issued.

MODE=FENCED | UNFENCED
specifies whether the running code is isolated in a separate process in the DB2 database so that a program fault does not cause the database to stop.

Default FENCED

Restriction This argument is valid only when using the scoring functions. It has no effect if you specify MECHANISM=EP.

Tip After the SAS scoring functions are validated in fenced mode, you can republish them in unfenced mode. You might see a performance advantage when you run in unfenced mode.

See "Modes of Operation" on page 54

INITIAL_WAIT=*wait-time*
specifies the initial wait time in seconds for SAS SFTP to parse the responses and complete the SFTP -batchfile process.

Default 15 seconds

Restriction This argument is valid only when using the scoring functions. It has no effect if you specify MECHANISM=EP.

Interactions The INITIAL_WAIT= argument works in conjunction with the FTPTIMEOUT= argument. Initially, SAS SFTP waits the amount of time specified by the INITIAL_WAIT= argument. If the SFTP -batchfile process is not complete after the initial wait time, retries occur until the wait time is equal to or greater than the time-out value specified by the FTPTIMEOUT= argument. All retries double the previous wait time. SAS SFTP fails after the time-out value is reached or exceeded, and an error message is written to the SAS log.

For example, assume that you use the default values. The initial wait time is 15 seconds. The first retry waits for 30 seconds. The second retry waits for 60 seconds. The third retry waits for 120 seconds. This is the default time-out value. So, the default initial wait time and time-out values enable four possible tries: the initial try and three retries.

See FTPTIMEOUT= argument

FTPTIMEOUT=*time-out-value*
specifies the time-out value in seconds if SAS SFTP fails to transfer the files.

Default 120 seconds

Restriction This argument is valid only when using the scoring functions. It has no effect if you specify MECHANISM=EP.

Interactions The FTPTIMEOUT= argument works in conjunction with the INITIAL_WAIT= argument. Initially, SAS SFTP waits the amount of time specified by the INITIAL_WAIT= argument. If the SFTP -batchfile process is not complete after the initial wait time, retries occur until the wait time is equal to or greater than the time-out value specified by the FTPTIMEOUT= argument. All retries double the previous wait time. SAS SFTP fails after the time-out value is reached or exceeded and an error message is written to the SAS log.

For example, assume that you use the default values. The initial wait time is 15 seconds. The first retry waits for 30 seconds. The second retry waits for 60 seconds. The third retry waits for 120 seconds. This is the default time-out value. So the default initial wait time and time-out values enable four possible tries: the initial try and three retries.

Tip Use this argument to control how long SAS SFTP waits to complete a file transfer before timing out. A time-out failure could indicate a network or key authentication problem.

See INITIAL_WAIT= argument

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process and sample SQL code (SampleSQL.txt). For more information about the SampleSQL.txt file, see "Scoring Function Names" on page 39.

Tip This argument is useful when testing your scoring models.

See "Special Characters in Directory Names" on page 13

Modes of Operation

The %INDB2_PUBLISH_MODEL macro has two modes of operation: fenced and unfenced. You specify the mode by setting the MODE= argument.

The default mode of operation is fenced. Fenced mode means that the scoring function that is published is isolated in a separate process in the DB2 database when it is invoked,

and an error does not cause the database to stop. It is recommended that you publish the scoring functions in fenced mode during acceptance tests.

The SAS Embedded Process always operates in its own process that is equivalent to fenced mode functions. An optimized data transport mechanism allows the SAS Embedded Process to provide fenced mode protection with speed that is as good or better than unfenced functions.

When the scoring function is ready for production, you can run the macro to publish the scoring function in unfenced mode. You could see a performance advantage if the scoring function is published in unfenced mode.

DB2 Permissions

Scoring Function Permissions

You must have DB2 user permissions to execute the SAS publishing macros to publish the scoring functions. Some of these permissions are as follows.

- EXECUTE user permission for functions that were published by another user
- READ user permission to read the SASUDF_COMPILER_PATH and SASUDF_DB2PATH global variables
- CREATE_EXTERNAL_ROUTINE user permission to the database to create functions
- CREATEIN user permission for the schema in which the scoring functions are published if a nondefault schema is used
- CREATE_NOT_FENCED_ROUTINE user permission to create functions that are not fenced

Permissions must be granted for each user that needs to publish a scoring function and for each database that the scoring model publishing uses. Without these permissions, publishing of the scoring functions fails.

The person who can grant the permissions and the order in which permissions are granted is important. For more information about specific permissions, see “DB2 Permissions” in Chapter 3 of SAS In-Database Products: Administrator's Guide.

SAS Embedded Process Permissions

You must have CREATE TABLE user permission to create a model table when using the SAS Embedded Process.

For more information about specific permissions, see “DB2 Permissions” in Chapter 3 of SAS In-Database Products: Administrator's Guide.

Chapter 6

SAS Scoring Accelerator for Greenplum

Overview of Running Scoring Models in Greenplum

There are two ways to run scoring models in Greenplum.

- You can create scoring functions for each EM_ output variable. The model publishing macro creates the scoring functions that are published as Greenplum user-defined functions. These functions can then be used in any SQL query. For more information, see "Using Scoring Functions to Run Scoring Models" on page 58.
- Starting with the August 2012 release, you can use the SAS Embedded Process. The SAS Embedded Process is a SAS server process that runs inside Greenplum to read and write data. The model publishing macro creates scoring files. These scoring files are then used by a Greenplum built-in function to run the scoring model. For more

information, see "Using the SAS Embedded Process to Run Scoring Models" on page 63.

The SAS Scoring Accelerator for Greenplum requires a certain version of the Greenplum client and server environment. For more information, see **http://www.sas.com/technologies/analytics/datamining/scoring_acceleration/#section=5** and *SAS In-Database Products: Administrator's Guide*.

Using Scoring Functions to Run Scoring Models

How to Run a Scoring Model Using Scoring Functions

The %INDGP_PUBLISH_MODEL macro creates the files that are needed to build the scoring functions. The macro then publishes the scoring functions with those files to a specified database in Greenplum. Only the EM_ output variables are published as Greenplum scoring functions. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21.

To run the scoring model using scoring functions, follow these steps.

1. Run the %INDGP_PUBLISH_MODEL macro. The %INDGP_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 %INDGP_PUBLISH_MODEL macro performs the following tasks:

   - 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.
   - processes the format catalog, if a format catalog is available, and creates an .h file with C structures, which are also necessary to build the scoring functions.
   - produces a script of the Greenplum commands that are used to register the scoring functions in the Greenplum database.
   - transfers the .c and .h files to Greenplum.
   - calls the SAS_COMPILEUDF function to compile the source files into object files and links to the SAS formats library.
   - calls the SAS_COPYUDF function to copy the new object files to ***full-path-to-pkglibdir*/SAS** on the whole database array (master and all segments) , where ***full-path-to-pkglibdir*** is the path that was defined during installation.
   - uses the SAS/ACCESS Interface to Greenplum to run the script to create the scoring functions with the object files.

   The scoring functions are registered in Greenplum with shared object files. These shared object files are loaded at run time. These functions are stored in a permanent location. The SAS object files and the SAS formats library are stored in the ***full-path-to-pkglibdir*/SAS** directory on all nodes, where ***full-path-to-pkglibdir*** is the path that was defined during installation.

   Greenplum caches the object files within a session.

Note: You can publish scoring model files with the same model name in multiple databases and schemas. Because all model object files for the SAS scoring function are stored in the ***full-path-to-pkglibdir*/SAS** directory, the publishing macros use the database, schema, and model name as the object filename to avoid potential naming conflicts.

2. Use the scoring functions in any SQL query.

   For more information, see "Using Scoring Functions to Run a Scoring Model" on page 62.

Scoring Function Names

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

```
modelname_EM_outputvarname
```

modelname is the name that was specified in the MODELNAME argument of the %INDGP_PUBLISH_MODEL macro. *modelname* is always followed by _EM_ in the scoring function name. For more information about the MODELNAME argument, see "%INDGP_PUBLISH_MODEL Macro Syntax" on page 71.

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 about the score.xml file, see "Fixed Variable Names" on page 21.

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 scoring function has the name of an output variable. For example, if you set MODELNAME=credit in the %INDGP_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".

Note: A scoring function name cannot exceed 63 characters.

CAUTION:

When the scoring function is 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 overwrites the first scoring function.

Viewing the Scoring Functions

The scoring functions are available to use in any SQL expression in the same way that Greenplum built-in functions are used. For an example, see "Using Scoring Functions to Run a Scoring Model" on page 62.

TIP In Greenplum, character variables have a length of 32K. If you create an output table or data set to hold the scored rows, it is recommended that you create the table and define the variables. Here is an example.

```
proc sql noerrorstop;
connect to greenplm (<connection options>);
execute (create table scoretab (
   ID                    integer
```

```
   , EM_SEGMENT            float
   , EM_EVENTPROBABILITY   float
   , EM_PROBABILITY        float
   , EM_CLASSIFICATION     varchar (32)
   )
   distributed by (id)
) by greenplm;
execute ( insert into scoretab
select id,
function prefix_EM_SEGMENT (
   comma-delimited input column list
   ) as "EM_ SEGMENT",
function prefix_EM_EVENTPROBABILITY (
   comma-delimited input column list
   ) as "EM_EVENTPROBABILITY",
function prefix_EM_PROBABILITY (
   comma-delimited input column list
   ) as "EM_PROBABILITY"
cast(function prefix_EM_CLASSIFICATION (
   comma-delimited input column list
   ) as varchar(32)) as "EM_CLASSIFICATION",
from scoring_input_table
   order by id
) by greenplm;
quit;
```

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

- From Greenplum, start psql to connect to the database and submit an SQL statement. In this example, 'SCHEMA' is the actual schema value.

  ```
  psql -h hostname -d databasename -U userid
  select proname
     from pg_catalog.pg_proc f, pg_catalog.pg_namespace s
     where f.pronamespace=s.oid and upper(s.nspname)='SCHEMA';
  ```

- From SAS, 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 greenplm (user=username pw=password dsn= dsnname);

  select *
     from connection to greenplm
        (select proname
         from pg_catalog.pg_proc f, pg_catalog.pg_namespace s
         where f.pronamespace=s.oid and upper(s.nspname)='SCHEMA');
     disconnect from greenplm;
  quit;
  ```

- Look at the SampleSQL.txt file that is produced when the %INDGP_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 Greenplum.

  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.

Note: The function and table names must be fully qualified if the function and table are not in the same schema.

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 ;
```

- You can look at the SAS log that is created when the %INDGP_PUBLISH_MODEL macro was run. A message that indicates whether a scoring function is successfully or not successfully executed is printed to the SAS log.

Using Scoring Functions to Run a Scoring Model

The scoring functions are available to use in any SQL expression in the same way that Greenplum built-in functions are used.

The following example code creates the scoring functions.

```
%indgppm;
%let indconn = user=user1 password=open1 dsn=green6 schema=myschema;
%indgp_publish_model(dir=C:\SASIN\baseball1, modelname=baseball1, outdir=C:\test);
```

The %INDGP_PUBLISH_MODEL macro produces a text file of Greenplum CREATE FUNCTION commands as shown in the following example.

Note: This example file is shown for illustrative purposes. The text file that is created by the %INDGP_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 varchar(33)
AS '/usr/local/greenplum-db-3.3.4.0/lib/postgresql/SAS/
   sample_dbitest_homeeq_5.so', 'homeeq_5_em_classification'
```

After the scoring functions are installed, they can be invoked in Greenplum 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 MLBGP;
```

Using the SAS Embedded Process to Run Scoring Models

How to Run a Scoring Model with the SAS Embedded Process

The integration of the SAS Embedded Process and Greenplum allows scoring code to run directly using the SAS Embedded Process on Greenplum.

To run the scoring model using the SAS Embedded Process, follow these steps.

1. Create a table to hold the scoring files.

   The %INDGP_CREATE_MODELTABLE macro creates a table that holds the scoring files for the model that is being published.

   For more information, see "Creating a Model Table" on page 64.

2. Run the %INDGP_PUBLISH_MODEL to create the scoring files.

   The %INDGP_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 %INDGP_PUBLISH_MODEL macro performs the following tasks:

   - translates the scoring model into the sasscore_*modelname*.ds2 file that is used to run scoring inside the SAS Embedded Process.

- takes the format catalog, if available, and produces the sasscore_*modelname*_ufmt.xml file. This file contains user-defined formats for the scoring model that is being published.
- uses the SAS/ACCESS Interface to Greenplum to insert the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files into the model table that was created using the %INDGP_CREATE_MODELTABLE macro.

For more information, see "Running the %INDGP_PUBLISH_MODEL Macro" on page 69 and "Greenplum Scoring Files" on page 67.

3. Use the SAS_EP function in the FROM clause in any SQL expression to run the scoring model.

   For more information, see "SAS_EP Function" on page 66.

Creating a Model Table

Overview

When using the SAS Embedded Process to publish a scoring model in Greenplum, you must create a table to hold the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files. You must run the %INDGP_CREATE_MODELTABLE macro to create the table before you run the %INDGP_PUBLISH_MODEL macro.

The model table contains the following columns. The ModelName column is the table key. The table is referenced by the two-level name *schema-name.model-table-name*.

Column Name	Description	Specification
ModelName	contains the name of the model	VARCHAR(128) NOT NULL PRIMARY KEY
ModelDS2	contains the sasscore_*modelname*.ds2 file	BYTEA NOT NULL
ModelFormats	contains the sasscore_*modelname*_ufmt.xml file	BYTEA
ModelMetadata	Reserved by SAS for future use	BYTEA

%INDGP_CREATE_MODELTABLE Run Process

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

1. Start SAS 9.3 and submit the following commands in the Program Editor or Enhanced Editor:

   ```
   %indgppm;
   %let indconn = user=youruserid password=yourpwd
       dsn=yourdsn schema=yourschema;
   ```

   For more information, see "%INDGPPM Macro" on page 69 and the "INDCONN Macro Variable" on page 69.

2. Run the %INDGP_CREATE_MODELTABLE macro.

For more information, see "%INDGP_CREATE_MODELTABLE Macro Syntax" on page 65.

%INDGP_CREATE_MODELTABLE Macro Syntax

%INDGP_CREATE_MODELTABLE

<DATABASE=*database-name*>
<, MODELTABLE=*model-table-name*>
<, ACTION=CREATE | REPLACE | DROP>
);

Arguments

DATABASE=*database-name*
specifies the name of a Greenplum database where the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files are held.

Default The database specified in the INDCONN macro variable or your current database

MODELTABLE=*model-table-name*
specifies the name of the table that holds the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files.

Default sas_model_table

Requirement The maximum table name length is 63 characters and it must be a valid Greenplum table name.

See "%INDGP_PUBLISH_MODEL Macro Syntax" on page 71

ACTION = CREATE | REPLACE | DROP
specifies one of the following actions that the macro performs:

CREATE
creates a new table.

Tip If the table has been previously defined and you specify ACTION=CREATE, an error is issued.

REPLACE
overwrites the current table, if a table with the same name is already registered.

Tip If you specify ACTION = REPLACE, and the current table contains sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml files, the files are deleted and an empty table is re-created.

DROP
causes all models in this table to be dropped.

Default CREATE

SAS_EP Function

Overview of the SAS_EP Function

The SAS_EP function is the interface for running the scoring model inside Greenplum with the SAS Embedded Process. The SAS_EP function uses the information that is stored in the model table. The SAS_EP function is a built-in Greenplum function.

Using the SAS_EP Function

You can use the SAS_EP function using explicit pass-through and PROC SQL or you can use other Greenplum query tools such as psql. Use the SAS_EP function in the FROM clause in any SQL expression to run the scoring model.

TIP Look at the SampleSQL.txt file that is produced when the %INDGP_PUBLISH_MODEL macro is successfully run. This file can be found in the output directory (OUTDIR argument) that you specify in the %INDGP_PUBLISH_MODEL macro. The SampleSQL.txt file contains the basic SQL code that, with modifications, can be used to run your score code inside Greenplum.

Note: Before using the SAS_EP function with the SAS Embedded Process, you must create the model table with the %INDGP_CREATE_MODELTABLE macro. Then, you must publish the files to the model table with the %INDGP_PUBLISH_MODEL macro. For more information, see "Creating a Model Table" on page 64 and "Running the %INDGP_PUBLISH_MODEL Macro" on page 69.

Here is an example using PROC SQL.

```
%indgppm;
%let indconn = user=user1 password=open1
    dsn=dsn6 schema=GPschema;

%indgp_publish_model
  (dir= C:\models,
   modelname= almush02,
   action=create,
   mechanism=ep,
   outdir=C:\test
   );

proc sql noerrorstop;
connect to greenplm (user=user1 password=open1 dsn=dsn6 schema=GPschema);
create table test.dbscore as select * from connection to greenplm
   (select id,
    "EM_CLASSIFICATION" ,
    "EM_EVENTPROBABILITY" ,
     "EM_PROBABILITY" from public.SAS_EP(TABLE(select id
     ,"capcolor"
     ,"capsurf"
     ,"odor"
     ,"ringnumb"
     ,"sporepc"
     ,"stalkcbr"
     ,"stalksbr"
    from model.almush02),
      'select modelds2, modelformats from model.sas_model_table
```

```
        where upper(modelname)=''ALMUSH02''
      ');
    ) ;
quit;
```

SAS_EP Function Syntax

The syntax of the SAS_EP table function is as follows:

FROM <*SAS_EP-schema*.>**SAS_EP**(TABLE (SELECT
***** | *column-1* <, … *column-n*>
, FROM <*input-table-schema*.>*input-table-name*)
'SELECT MODELDS2<, MODELFORMATS> FROM <*schema*.>*model-table-name*
WHERE MODELNAME =' '*model-name*' '
');
);

Arguments

SAS_EP-schema
specifies the name of the schema where the SAS_EP function was created.

Note The SAS_EP function is created in the database by the %INDGP_PUBLISH_COMPILEUDF_EP macro. For more information, see *SAS In-Database Products: Administrator's Guide*.

column
specifies the name of the column or columns that are read from the input table and passed to the SAS_EP function.

input-table-schema
specifies the name of the schema where the input table exists.

input-table-name
specifies the input table that is used by the SAS_EP function.

model-table-name
specifies the name of the model table where the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files were published with the %INDGP_CREATE_MODELTABLE macro.

Requirement The table name that you specify for this function must be the same table name that is used in the %INDGP_CREATE_MODELTABLE macro. For more information, see "%INDGP_CREATE_MODELTABLE Macro Syntax" on page 65.

model-name
specifies the name of the model.

Greenplum Scoring Files

When using the SAS Embedded Process, the %INDGP_PUBLISH_MODEL macro produces two scoring files for each model:

- sasscore_*modelname*.ds2. This file contains code that is executed by the SAS_EP function.
- sasscore_*modelname*_ufmt.xml. This file contains user-defined formats for the scoring model that is being published. This file is used by the SAS_EP function.

These files are published to the model table that you specify in the %INDGP_PUBLISH_MODEL macro. See Appendix 1, "Scoring File Examples," on page 209 for an example of each of these files.

A message that indicates whether the scoring files are successfully or not successfully created is printed to the SAS log.

Although you cannot view the scoring files directly, there are two ways to see the models whose files are created:

- Run this query from psql:

```
select modelname from <schema.>sas-model-table;
```

- Run a PROC SQL query from SAS.

```
proc sql;
 connect to greenplm (user=userid password=xxxx dsn=mydsn schema=myschema);
  select * from connection to greenplm
 (select modelname from schema.sas_model_table);
 disconnect from greenplm;
quit;
```

Starting and Stopping the SAS Embedded Process

The SAS Embedded Process starts when a query is submitted using the SAS_EP function. It continues to run until it is manually stopped or the database is shut down.

Manually starting and stopping the SAS Embedded Process has implications for all scoring model publishers, requires superuser permissions, and must be run from the Greenplum master node. It should not be done without consulting your database administrator. For more information, see "Controlling the SAS Embedded Process" in Chapter 4 of SAS In-Database Products: Administrator's Guide.

SAS Embedded Process Troubleshooting Tips

If you have problems running scoring models with the SAS Embedded Process, these are the most likely areas where a problem could occur:

- GPPC version 1.1 or later must be installed. You can verify that GPPC is installed by running this command.

```
ls $GPHOME/lib/*gppc*
```

- When you use the SAS_EP function in an SQL query, the schema name is either SASLIB or a schema that was specified when the SAS_EP function was registered. SASLIB is the default schema name for the INDCONN macro variable when the %INDGP_PUBLISH_COMPILEUDF_EP macro is run to create the SAS_EP function. For more information, see "Running the %INDGP_PUBLISH_COMPILEUDF_EP Macro" in Chapter 4 of SAS In-Database Products: Administrator's Guide.
- When you refer to the model table in an SQL query, the schema name is either the user ID or a schema that was specified when the model table was created. The user ID is the default schema name for the INDCONN macro variable when the %INDGP_PUBLISH_MODELTABLE macro is run to create the model table. For more information, see "Creating a Model Table" on page 64.
- When you use the SAS_EP function, you must specify the schema where the SAS_EP function was registered.

- $GPHOME can be referenced by a symbolic link or the explicit path. When you update the Greenplum version, it is safer to always use the explicit path. Here is an example.

  ```
  /usr/local/greenplum-db -> /usr/local/greenplum-db-4.2.2.0
  ```

Running the %INDGP_PUBLISH_MODEL Macro

%INDGP_PUBLISH_MODEL Macro Run Process

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

1. Create a scoring model using SAS Enterprise Miner.
2. Use the SAS Enterprise Miner Score Code Export node to create a score output directory. Populate the directory with the score.sas file, the score.xml file, and (if needed) the format catalog.
3. Start SAS 9.3 and submit one of the following sets of commands in the Program Editor or Enhanced Editor:

   ```
   %indgppm;
   %let indconn = user=youruserid password=yourpwd
       dsn=yourdsn schema=yourschema;

   %indgppm;
   %let indconn = user=youruserid password=yourpwd server=yourserver
       database=yourdb schema=yourschema;
   ```

   For more information, see "%INDGPPM Macro" on page 69 and "INDCONN Macro Variable" on page 69.
4. Run the %INDGP_PUBLISH_MODEL macro. For more information, see "%INDGP_PUBLISH_MODEL Macro Syntax" on page 71.

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

%INDGPPM Macro

The %INDGPPM macro searches the autocall library for the indgppm.sas file. The indgppm.sas file contains all the macro definitions that are used in conjunction with the %INDGP_PUBLISH_MODEL macro. The indgppm.sas file should be in one of the directories listed in the SASAUTOS= system option in your configuration file. If the indgppm.sas file is not present, the %INDGPPM macro call (%INDGPPM; statement) issues the following message:

```
macro indgppm not defined
```

INDCONN Macro Variable

The INDCONN macro variable is used to provide credentials to connect to Greenplum. You must specify user, password, either the DSN name or the server and database name. The schema name is optional. You must assign the INDCONN macro variable before the %INDGP_PUBLISH_MODEL macro is invoked.

The value of the INDCONN macro variable for the %INDGP_PUBLISH_MODEL macro has one of these formats:

USER=<'>*username*<'> PASSWORD=<'>*password*<'> DSN=<'>*dsnname*<'> <SCHEMA=<'>*schemaname*<'>>

USER=<'>*username*<'> PASSWORD=<'>*password*<'> SERVER=<'>*servername*<'> DATABASE=<'>*databasename*<'> <SCHEMA=<'>*schemaname*<'>>

Arguments

USER=<'>*username*<'>
specifies the Greenplum user name (also called the user ID) that is used to connect to the database. If the user name contains spaces or nonalphanumeric characters, you must enclose the user name in quotation marks.

PASSWORD=<'>*password*<'>
specifies the password that is associated with your Greenplum user ID. If the password contains spaces or nonalphabetic characters, you must enclose he password in quotation marks.

Tip Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error.

DSN=<'>*datasourcename*<'>
specifies the configured Greenplum ODBC data source to which you want to connect. If the DSN contains spaces or nonalphabetic characters, you must enclose the DSN in quotation marks.

Requirement You must specify either the DSN= argument or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

SERVER=<'>*servername*<'>
specifies the Greenplum server name or the IP address of the server host. If the server name contains spaces or nonalphanumeric characters, you must enclose the server name in quotation marks.

Requirement You must specify either the DSN= argument or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

DATABASE=<'>*databasename*<'>
specifies the Greenplum database that contains the tables and views that you want to access. If the database name contains spaces or nonalphanumeric characters, you must enclose the database name in quotation marks.

Requirement You must specify either the DSN= argument or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

SCHEMA=<'>*schemaname*<'>
specifies the schema name for the database.

Tip If you do not specify a value for the SCHEMA argument, the value of the USER argument is used as the schema name. The schema must be created by your database administrator.

TIP The INDCONN macro variable is not passed as an argument to the %INDGP_PUBLISH_MODEL macro. 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.

%INDGP_PUBLISH_MODEL Macro Syntax

%INDGP_PUBLISH_MODEL

(DIR=*input-directory-path*, MODELNAME=*name*
<, MECHANISM=STATIC | EP>
<, MODELTABLE=*model-table-name*>
<, DATASTEP=*score-program-filename*>
<, XML=*xml-filename*>
<, DATABASE=*database-name*>
<, FMTCAT=*format-catalog-filename*>
<, ACTION=CREATE | REPLACE | DROP>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DIR=*input-directory-path*

specifies the directory where the scoring model program, the properties file, and the format 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 format 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.

See "Special Characters in Directory Names" on page 13

MODELNAME=*name*

specifies the name that is prepended to each output function to ensure that each scoring function name is unique in the Greenplum database.

Restriction The scoring function name is a combination of the model and output variable names. A scoring function name cannot exceed 63 characters. For more information, see "Scoring Function Names" on page 59.

Requirement The model name must be a valid SAS name that is 10 characters or fewer. For more information about valid SAS names, see the topic on rules for words and names in *SAS Language Reference: Concepts*.

Interaction Only the EM_ output variables are published as Greenplum scoring functions. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21 and "Scoring Function Names" on page 59.

MECHANISM=STATIC | EP

specifies whether scoring functions or scoring files are created. MECHANISM= can have one of the following values:

STATIC
specifies that scoring functions are created.

These scoring functions are used in an SQL query to run the scoring model.

See "Using Scoring Functions to Run Scoring Models" on page 58

EP
specifies that scoring files are created.

These scoring files are used by the SAS Embedded Process to run the scoring model. A single entry in the model table is inserted for each new model. The entry contains both the score.sas and score.xml files in separate columns. The scoring process includes reading these entries from the table and transferring them to each instance of the SAS Embedded Process for execution.

Requirement If you specify MECHANISM=EP, you must also specify the MODELTABLE= argument.

See "Using the SAS Embedded Process to Run Scoring Models" on page 63

Default STATIC

MODELTABLE=*model-table-name*
specifies the name of the model table where the scoring files are published.

Default sas_model_table

Restriction This argument is valid only when using the SAS Embedded Process.

Requirement The name of the model table must be the same as the name specified in the %INDGP_CREATE_MODELTABLE macro. For more information, see the MODELTABLE argument in "%INDGP_CREATE_MODELTABLE Macro Syntax" on page 65.

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

Restrictions Only XML files that are produced by the SAS Enterprise Miner Score Code Export node can be used.

If you use scoring functions to run scoring models, the maximum number of output variables is 128. If you use the SAS Embedded Process, the maximum is 1660.

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 Greenplum database to which the scoring functions and formats are published.

Restriction If you specify DSN= in the INDCONN macro variable, do not use the DATABASE argument.

Interaction The database that is specified by the DATABASE= argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "%INDGP_PUBLISH_MODEL Macro Run Process" on page 69.

FMTCAT=*format-catalog-filename*
specifies the name of the format catalog file that contains all user-defined 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.

Interactions 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.

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 *Base 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 Greenplum database.

Default CREATE

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

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process and sample SQL code

(SampleSQL.txt). For more information about the SampleSQL.txt file, see "Scoring Function Names" on page 59.

Tip This argument is useful when testing your scoring models.

See "Special Characters in Directory Names" on page 13

Greenplum Permissions

Scoring Function Permissions

You must have Greenplum superuser permissions to execute the %INDGP_PUBLISH_MODEL macro that publishes the scoring functions. Greenplum requires superuser permissions to create C functions in the database.

Without these permissions, the publishing of the scoring functions fails. To obtain these permissions, contact your database administrator.

For more information about specific permissions, see "Greenplum Permissions" in Chapter 4 of SAS In-Database Products: Administrator's Guide.

SAS Embedded Process Permissions

In addition to Greenplum superuser permissions, you must have CREATE TABLE permission to create a model table when using the SAS Embedded Process.

For more information about specific permissions, see "Greenplum Permissions" in Chapter 4 of SAS In-Database Products: Administrator's Guide.

Chapter 7

SAS Scoring Accelerator for Netezza

Publishing Scoring Model Files in Netezza

The SAS publishing macros are used to publish the user-defined formats and the scoring functions in Netezza.

The %INDNZ_PUBLISH_MODEL macro creates the files that are needed to build the scoring functions and publishes those files to a specified database in the Netezza data warehouse. Only the EM_ output variables are published as Netezza scoring functions. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21.

The %INDNZ_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 %INDNZ_PUBLISH_MODEL macro performs the following tasks:

- takes the score.sas and score.xml files that are created using the Score Code Export node and produces the set of .c, .cpp, and .h files. These 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.
- processes the format catalog (if a format catalog is available) and creates an .h file with C structures, which are also necessary to build the scoring functions.
- produces a script of the Netezza commands that are necessary to register the scoring functions on the Netezza data warehouse.

- transfers the .c, .cpp, and .h files to Netezza using the Netezza External Table interface.
- calls the SAS_COMPILEUDF function to compile the source files into object files and to access the SAS formats library.
- uses the SAS/ACCESS Interface to Netezza to run the script to create the scoring functions with the object files.

The SAS Scoring Accelerator for Netezza requires a certain version of the Netezza client and server environment. For more information, see **http://www.sas.com/technologies/analytics/datamining/scoring_acceleration/#section=5** and *SAS In-Database Products: Administrator's Guide*.

Running the %INDNZ_PUBLISH_MODEL Macro

%INDNZ_PUBLISH_MODEL Macro Run Process

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

1. Create a scoring model using SAS Enterprise Miner.
2. Use the SAS Enterprise Miner Score Code Export node to create a score output directory. Populate the directory with the score.sas file, the score.xml file, and (if needed) the format catalog.
3. Start SAS 9.3 and submit the following commands in the Program Editor or Enhanced Editor:

   ```
   %indnzpm;
   %let indconn = server=myserver user=myuserid password=XXXX database=mydb;
   ```

   For more information, see "%INDNZPM Macro" on page 76 and the "INDCONN Macro Variable" on page 77.
4. Run the %INDNZ_PUBLISH_MODEL macro.

   For more information, see "%INDNZ_PUBLISH_MODEL Macro Syntax" on page 77.

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

Note: The %INDNZ_PUBLISH_JAZLIB macro and the %INDNZ_PUBLISH_COMPILEUDF macro (if needed) must be run before you can publish your scoring models. Otherwise, the %INDNZ_PUBLISH_MODEL macro fails. These macros are typically run by your system or database administrator. For more information about these macros, see the *SAS In-Database Products: Administrator's Guide*.

%INDNZPM Macro

The %INDNZPM macro searches the autocall library for the indnzpm.sas file. The indnzpm.sas file contains all the macro definitions that are used in conjunction with the %INDNZ_PUBLISH_MODEL macro. The indnzpm.sas file should be in one of the directories listed in the SASAUTOS= system option in your configuration file. If the

indnzpm.sas file is not present, the %INDNZPM macro call (%INDNZPM; statement) issues the following message:

```
macro indnzpm not defined
```

INDCONN Macro Variable

The INDCONN macro variable is used to provide credentials to connect to Netezza. You must specify server, user, password, and database information to access the machine on which you have installed the Netezza data warehouse. You must assign the INDCONN macro variable before the %INDNZ_PUBLISH_MODEL macro is invoked.

Here is the syntax for the value of the INDCONN macro variable for the %INDNZ_PUBLISH_MODEL macro:

SERVER=*server*USER=*user* PASSWORD=*password* DATABASE=*database*

Arguments

SERVER=*server*
specifies the Netezza server name or the IP address of the server host.

USER=*user*
specifies the Netezza user name (also called the user ID) that is used to connect to the database.

PASSWORD=*password*
specifies the password that is associated with your Netezza user ID.

Tip Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error to occur.

DATABASE=*database*
specifies the Netezza database that contains the tables and views that you want to access.

TIP The INDCONN macro variable is not passed as an argument to the %INDNZ_PUBLISH_MODEL macro. This information can be concealed in your SAS job. For example, you can place it in an autoexec file and apply permissions to the file so that others cannot access the user credentials.

%INDNZ_PUBLISH_MODEL Macro Syntax

%INDNZ_PUBLISH_MODEL
(DIR=*input-directory-path*, MODELNAME=*name*
<, DATASTEP=*score-program-filename*>
<, XML=*xml-filename* >
<, DATABASE=*database-name* >
<, DBCOMPILE=*database-name*>
<, DBJAZLIB=*database-name*>
<, FMTCAT=*format-catalog-filename*>
<, ACTION=CREATE | REPLACE | DROP >
<, MODE=FENCED | UNFENCED>
<, IDCASE=UPPERCASE | LOWERCASE >
<, OUTDIR=*diagnostic-output-directory*>
);

Note: Do not enclose variable arguments in single or double quotation marks. This causes the %INDNZ_PUBLISH_MODEL macro to fail.

Arguments

DIR=*input-directory-path*
specifies the directory where the scoring model program, the properties file, and the format 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 format 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.

See "Special Characters in Directory Names" on page 13

MODELNAME=*name*
specifies the name that is prepended to each output function to ensure that each scoring function name is unique on the Netezza database.

Restriction The scoring function name is a combination of the model and output variable names. A scoring function name cannot exceed 128 characters. For more information, see "Scoring Function Names" on page 82.

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

Interaction Only the EM_ output variables are published as Netezza scoring functions. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21 and "Scoring Function Names" on page 82.

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

Restrictions Only XML files that are produced by the SAS Enterprise Miner Score Code Export node can be used.

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 Netezza database to which the scoring functions and formats are published.

Interaction The database that is specified by the DATABASE argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "%INDNZ_PUBLISH_MODEL Macro Run Process" on page 76.

Tip You can publish the scoring functions and formats to a shared database where other users can access them.

DBCOMPILE=*database-name*
specifies the name of the database where the SAS_COMPILEUDF function is published.

Default SASLIB

See For more information about publishing the SAS_COMPILEUDF function, see the *SAS In-Database Products: Administrator's Guide*.

DBJAZLIB=*database-name*
specifies the name of the database where the SAS formats library is published.

Default SASLIB

FMTCAT=*format-catalog-filename*
specifies the name of the format catalog file that contains all user-defined 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.

Interactions 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.

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 *Base 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 Netezza database.

Default CREATE

Tip If the function was published previously and you specify ACTION=CREATE, you receive warning messages that the function already exists and you are prompted to use REPLACE. If you specify ACTION=DROP and the function does not exist, an error message is issued.

MODE= FENCED | UNFENCED
specifies whether running the code is isolated in a separate process in the Netezza database so that a program fault does not cause the database to stop.

Default FENCED

Restriction The MODE= argument is supported for Netezza 6.0. The MODE argument is ignored for previous versions of Netezza.

Tip There are limited resources available in Netezza when you run in fenced mode. For example, there is a limit to the number of columns available.

See "Modes of Operation" on page 81

IDCASE= UPPERCASE | LOWERCASE
specifies whether the variable names in the generated sample SQL code (SampleSQL.txt) appear in uppercase or lowercase characters.

Default UPPERCASE

Tip When you specify the IDCASE argument, the %INDNZ_PUBLISH_MODEL macro first determines which release of Netezza is being used. If Netezza release 5.0 or later is being used, the macro then checks to see whether the LOWERCASE or UPPERCASE option is set for the database by using SQL statement SELECT IDENTIFIER_CASE. If the value of the IDCASE argument is different from the case configuration of the database, the macro overwrites the value of the IDCASE option and uses the case configuration of the database. If an earlier release of Netezza is being used, the macro uses the value of the IDCASE argument.

See "Using the Scoring Functions" on page 83 for more information about the SampleSQL.txt file

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process and sample SQL code (SampleSQL.txt). For more information about the SampleSQL.txt file, see "Scoring Function Names" on page 82.

Tip This argument is useful when testing your scoring models.

See "Special Characters in Directory Names" on page 13

Modes of Operation

The %INDNZ_PUBLISH_MODEL macro has two modes of operation: fenced and unfenced. You specify the mode by setting the MODE= argument.

The default mode of operation is fenced. Fenced mode means that the scoring function that is published is isolated in a separate process in the Netezza database when it is invoked. An error does not cause the database to stop. It is recommended that you publish the scoring functions in fenced mode during acceptance tests.

When the scoring function is ready for production, you can run the macro to publish the scoring function in unfenced mode. You could see a performance advantage if the scoring function is published in unfenced mode.

Note: The MODE= argument is supported for Netezza 6.0. The MODE argument is ignored for previous versions of Netezza.

Model Publishing Macro Example

```
%indnzpm;
%let indconn = server=netezbase user=user1 password=open1 database=mydb;
%indnz_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 that is compiled first. The %INDNZ_PUBLISH_MODEL macro also produces a text file of Netezza CREATE FUNCTION commands as shown in the following example.

Note: This example file is shown for illustrative purposes. The text file that is created by the %INDNZ_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 CPP
PARAMETER STYLE npsgeneric
CALLED ON NULL INPUT
EXTERNAL CLASS NAME 'Cbaseball1_em_eventprobability'
EXTERNAL HOST OBJECT '/tmp/tempdir_20090506T113450_316550/baseball1.o_x86'
EXTERNAL NSPU OBJECT '/tmp/tempdir_20090506T113450_316550/baseball1.o_diab_ppc';
DEPENDENCIES dbjazlib..sas_jazlib  /* if TwinFin system */
```

After the scoring functions are installed, they can be invoked in Netezza 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 MLBNetz;
```

Netezza Permissions

You must have permission to create scoring functions and tables in the Netezza database. You must also have permission to execute the SAS_COMPILEUDF, SAS_DIRECTORYUDF, and SAS_HEXTOTEXTUDF functions in either the SASLIB database or the database specified in lieu of SASLIB. In other words, you must have permission to execute functions in the database where these functions are published.

Without these permissions, the publishing of a scoring function fails. To obtain these permissions, contact your database administrator.

For more information about specific permissions, see “Netezza Permissions” in Chapter 6 of SAS In-Database Products: Administrator's Guide.

Scoring Functions inside the Netezza Data Warehouse

Scoring Function Names

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

modelname_EM_outputvarname

modelname is the name that was specified in the MODELNAME argument of the %INDNZ_PUBLISH_MODEL macro. *modelname* is always followed by _EM_ in the scoring function name. For more information about the MODELNAME argument, see "Running the %INDNZ_PUBLISH_MODEL Macro" on page 76.

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 about the score.xml file, see "Fixed Variable Names" on page 21.

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 scoring function has the name of an output variable. For example, if you set MODELNAME=credit in the %INDNZ_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".

Note: Scoring function names cannot exceed 128 characters.

CAUTION:

When the scoring function is 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 overwrites the first scoring function.

Using the Scoring Functions

The scoring functions are available to use in any SQL expression in the same way that Netezza built-in functions are used. For an example, see "Model Publishing Macro Example" on page 81.

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

- From Netezza, log on to the database using a client tool such as NZSQL and submit an SQL statement. The following example assumes that the model name that you used to create the scoring functions is **mymodel**.

```
nzsql database username password

 select function,createdate,functionsignature from _v_function where
   function like '%MYMODEL%'
```

- From SAS, 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 netezza (server=servername database=database
    username=username password=password);
  select *
     from connection to netezza
     (select function,createdate,functionsignature
      from _v_function where
       function like '%MYMODEL%');
   disconnect from netezza;
quit;
```

- Look at the SampleSQL.txt file that is produced when the %INDNZ_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 Netezza.

  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*. *n* is 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.

  Note: The function and table names must be fully qualified if the function and table are not in the same database.

  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 ;
```

- You can look at the SAS log that is created when the %INDNZ_PUBLISH_MODEL macro was run. A message that indicates whether a scoring function is successfully or not successfully created or replaced is printed to the SAS log.

Chapter 8

SAS Scoring Accelerator for Oracle

Overview of Running Scoring Models

The integration of the SAS Embedded Process and Oracle allows scoring code to be run directly using the SAS Embedded Process on Oracle.

The SAS Embedded Process is a SAS server process that runs inside Oracle to read and write data. A model publishing macro creates scoring files and stores them in an Oracle table. These scoring files are then used by an Oracle function to run the scoring model.

The SAS Scoring Accelerator for Oracle requires a certain version of the Oracle client and server environment. For more information, see **http://www.sas.com/technologies/analytics/datamining/scoring_acceleration/#section=5** and *SAS In-Database Products: Administrator's Guide*.

Oracle Permissions

For Oracle, the following permissions are needed by the person who runs the scoring publishing macros.

- The person who runs the %INDOR_CREATE_MODELTABLE needs CREATE permission to create the model table.
- The person who runs the %INDOR_PUBLISH_MODEL macro needs INSERT permission to load data into the model table.

Without these permissions, the %INDOR_CREATE_MODELTABLE macro and the %INDOR_PUBLISH_MODEL macro fails. To obtain these permissions, contact your database administrator.

For more information about specific permissions, see “Oracle Permissions” in Chapter 7 of SAS In-Database Products: Administrator's Guide.

How to Run a Scoring Model in Oracle

To run a scoring model using the SAS Embedded Process, follow these steps.

1. Create a scoring model using SAS Enterprise Miner.
2. Start SAS 9.3 and create a table to hold the scoring files.

   The %INDOR_CREATE_MODELTABLE macro creates a table that holds the scoring files for the model that is being published.

   For more information, see “Creating a Model Table” on page 89.
3. Run the %INDOR_PUBLISH_MODEL macro to create the scoring files.

   The %INDOR_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 %INDOR_PUBLISH_MODEL macro performs the following tasks:

   - translates the scoring model into the sasscore_*modelname*.ds2 file that is used to run scoring inside the SAS Embedded Process.
   - takes the format catalog, if available, and produces the sasscore_*modelname*_ufmt.xml file. This file contains user-defined formats for the scoring model that is being published.
   - uses the SAS/ACCESS Interface to Oracle to insert the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files into the model table that was created using the %INDOR_CREATE_MODELTABLE macro.

   For more information, see “Running the %INDOR_PUBLISH_MODEL Macro” on page 90 and “Oracle Scoring Files” on page 94.
4. Use the SASEPFUNC table function in the FROM clause in any SQL expression to run the scoring model.

   For more information see, “SASEPFUNC Table Function” on page 95.

Creating a Model Table

Overview

When publishing a model in Oracle that has the SAS Embedded Process deployed, you must create a table to hold the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files. You must run the %INDOR_CREATE_MODELTABLE macro to create the table before you run the %INDOR_PUBLISH_MODEL macro.

You have to create the table only one time to hold a model's scoring files.

The model table contains the following columns. The ModelName column is the table key. The table is referenced by the two-level name *schema-name.model-table-name*.

Column Name	Description	Specification
ModelName	contains the name of the model	VARCHAR(128)
ModelDS2	contains the sasscore_*modelname*.ds2 file	BLOB not null
ModelFormats	contains the sasscore_*modelname*_ufmt.xml file	BLOB
ModelMetadata	reserved by SAS for future use	BLOB

%INDOR_CREATE_MODELTABLE Run Process

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

1. Start SAS 9.3 and submit the following commands in the Program Editor or Enhanced Editor:

   ```
   %indorpm;
   %let indconn = user=myuserid password=xxxx path=ortest;
   ```

   For more information, see "%INDORPM Macro" on page 91 and the "INDCONN Macro Variable" on page 91.

2. Run the %INDOR_CREATE_MODELTABLE macro.

   For more information, see "%INDOR_CREATE_MODELTABLE Macro Syntax" on page 89.

%INDOR_CREATE_MODELTABLE Macro Syntax

%INDOR_CREATE_MODELTABLE

(<DATABASE=*database-name*>
<, MODELTABLE=*model-table-name*>
<, ACTION=CREATE | REPLACE | DROP>
);

Arguments

DATABASE=*database-name*
specifies the name of an Oracle database where the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files are held.

Default The database specified in the INDCONN macro variable

MODELTABLE=*model-table-name*
specifies the name of the table that holds the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files.

Default sas_model_table

Requirement The maximum table name length is 30 characters, and it must be a valid Oracle table name.

Interaction The table name that you specify for this macro must be the same table name that is used in the %INDOR_PUBLISH_MODEL macro.

See "%INDOR_PUBLISH_MODEL Macro Syntax" on page 92

ACTION = CREATE | REPLACE | DROP
specifies one of the following actions that the macro performs:

CREATE
creates a new table.

Tip If the table has been previously defined and you specify ACTION=CREATE, an error is issued.

REPLACE
overwrites the current table, if a table with the same name is already registered.

Tip If you specify ACTION = REPLACE, and the current table contains sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml files, the files are deleted and an empty table is re-created.

DROP
causes all models in this table to be dropped.

Default CREATE

Running the %INDOR_PUBLISH_MODEL Macro

%INDOR_PUBLISH_MODEL Run Process

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

1. Create a scoring model using SAS Enterprise Miner.
2. Use the SAS Enterprise Miner Score Code Export node to create a score output directory.

   This directory will contain the score.sas file, the score.xml file, and, if needed, the format catalog.

3. Start SAS 9.3 and submit these commands in the Program Editor or Enhanced Editor:

```
%indorpm;
%let indconn = user=myuserid password=XXXX path=ortest;
```

   For more information, see "%INDORPM Macro" on page 91 and "INDCONN Macro Variable" on page 91.

4. Run the %INDOR_PUBLISH_MODEL macro.

   Messages are written to the SAS log that indicate the success or failure of the creation of the .ds2 and .xml scoring files.

   For more information, see "%INDOR_PUBLISH_MODEL Macro Syntax" on page 92.

%INDORPM Macro

The %INDORPM macro searches for the SAS catalog for the compiled publishing macros. The indorpm.sas file should be in one of the directories listed in the SASAUTOS= system option in your configuration file. If the indorpm.sas file is not present, the %INDORPM macro call (%INDORPM; statement) issues the following message:

```
macro indorpm not defined
```

INDCONN Macro Variable

The INDCONN macro variable is used to provide credentials to connect to Oracle. You must specify user, password, and database information to access the machine on which Oracle is installed. You must assign the INDCONN macro variable before the %INDOR_PUBLISH_MODEL macro is invoked.

Here is the syntax for the value of the INDCONN macro variable for the %INDOR_PUBLISH_MODEL macro:

USER=*user* PASSWORD=*password* PATH=*path*

Arguments

USER=*user*
specifies the Oracle user name (also called the user ID) that is used to connect to the database.

PASSWORD=*password*
specifies the password that is associated with your Oracle user ID.

> **Tip** Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error to occur.

PATH=*path*
specifies the Oracle driver, node, and database that contains the tables and views that you want to access.

TIP The INDCONN macro variable is not passed as an argument to the %INDOR_PUBLISH_MODEL macro. This information can be concealed in your SAS job. For example, you can place it in an autoexec file and apply permissions to the file so that others cannot access the user credentials.

%INDOR_PUBLISH_MODEL Macro Syntax

%INDOR_PUBLISH_MODEL

(DIR=*input-directory-path*, MODELNAME=*name*
<, MODELTABLE=*model-table-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 format 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 format catalog.

Restriction 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.

See "Special Characters in Directory Names" on page 13

MODELNAME=*name*
specifies the name for the published model.

Restriction The model filename cannot exceed 128 characters. For more information, see "Oracle Scoring Files" on page 94.

MODELTABLE=*model-table-name*
specifies the name of the model table where the scoring files are published.

Default sas_model_table

Requirement The name of the model table must be the same as the name specified in the %INDOR_CREATE_MODELTABLE macro. For more information, see the MODELTABLE argument in "%INDOR_CREATE_MODELTABLE Macro Syntax" on page 89.

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

Restrictions Only XML files that are produced by the SAS Enterprise Miner Score Code Export node can be used.

The maximum number of output variables is 1000.

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 an Oracle database to which the scoring files are published.

Default The database specified in the INDCONN macro variable

Requirement The name of the database must be the same as the database specified in the %INDOR_CREATE_MODELTABLE macro. For more information, see the DATABASE argument in "%INDOR_CREATE_MODELTABLE Macro Syntax" on page 89.

Interaction The database that is specified by the DATABASE argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "%INDOR_PUBLISH_MODEL Run Process" on page 90.

FMTCAT=*format-catalog-filename*
specifies the name of the format catalog file that contains all user-defined 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.

Interactions 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.

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 *Base SAS Procedures Guide*.

ACTION=CREATE | REPLACE | DROP
specifies one of the following actions that the macro performs:

CREATE
creates new files.

REPLACE
overwrites the current files, if files with the same name are already registered.

DROP
causes all files for this model to be dropped from the Oracle database.

Default CREATE

Tip If the model has been previously published and you specify ACTION=CREATE, you receive warning messages from Oracle. If the model has been previously published and you specify ACTION=REPLACE, no warnings are issued.

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process and sample SQL code (SampleSQL.txt). For more information about the SampleSQL.txt file, see "Oracle Scoring Files" on page 94.

Tip This argument is useful when testing your scoring models.

See "Special Characters in Directory Names" on page 13

Oracle Scoring Files

When using the SAS Embedded Process, the %INDOR_PUBLISH_MODEL macro produces two scoring files for each model:

- sasscore_*modelname*.ds2. This file contains code that is executed by the SASEPFUNC table function.
- sasscore_*modelname*_ufmt.xml. This file contains user-defined formats for the scoring model that is being published. This file is used by the SASEPFUNC table function.

These files are published to the model table that you specify in the %INDOR_PUBLISH_MODEL macro. See Appendix 1, "Scoring File Examples," on page 209 for an example of each of these files.

A message that indicates whether the scoring files are successfully or not successfully created is printed to the SAS log.

Although you cannot view the scoring files directly, there are two ways to see the models whose files are published:

- Log on to the database using SQLPlus and submit an SQL statement. The following example assumes that the model table where the scoring files were published is **`register`** and the model name is **`reg1`**.

```
sqlplus userid/pwd@address
select modelname, modelDS2 from sas_model_table
   where modelname like '%reg1%';
```

The model name and the model .ds2 filename are listed.

- From SAS, 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 files is **reg**.

```
proc sql noerrorstop;
  connect to oracle (user=username password=xxxx path=mypath);

select * from connection to oracle
      (select modelname, modelDS2
         from sasmodeltablename
            where modelname like '%reg%');
disconnect from oracle;
quit;
```

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

SASEPFUNC Table Function

Overview of the SASEPFUNC Table Function

The SASEPFUNC table function is the interface for running the scoring model inside Oracle with the SAS Embedded Process. The SASEPFUNC table function performs the scoring based on the parameters that are passed to it. It uses the .ds2 and .ufmt XML files that are stored in the model table.

This function is created by the SASADMIN user when the in-database deployment package is installed and configured. For more information, see the *SAS In-Database Products: Administrator's Guide*.

Using the SASEPFUNC Table Function

You can use the SASEPFUNC table function using explicit pass-through and PROC SQL or you can use other Oracle query tools such as SQLPlus. Use the SASEPFUNC function in the FROM clause in any SQL expression to run the scoring model.

TIP Look at the SampleSQL.txt file is produced when the %INDOR_PUBLISH_MODEL macro is successfully run. This file can be found in the output directory (OUTDIR argument) that you specify in the %INDOR_PUBLISH_MODEL macro. The SampleSQL.txt file contains basic SQL code that, with modifications, can be used to run your score code inside Oracle.

TIP The SampleSQL.txt file refers to an ID column in the example table 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.

Note: Before using the SASEPFUNC table function with the SAS Embedded Process, you must create the model table with the %INDOR_CREATE_MODELTABLE macro. Then, you must publish the files to the model table with the %INDOR_PUBLISH_MODEL macro. For more information, see "Creating a Model Table" on page 89 and "Running the %INDOR_PUBLISH_MODEL Macro" on page 90.

Here is an example using PROC SQL.

```
proc sql;
connect to oracle (user=userid password=xxxx path=mydatabase);
create table work.sas_score_out1 as select * from connection to oracle
   (SELECT * from table(SASEPFUNC(CURSOR(select * from intrtree),
      'myschema.SAS_PUBLISH_MODEL', 'INTRREG1', 'null',
      'select * from intrtree'));
disconnect from oracle;quit;
```

SASEPFUNC Table Function Syntax

The syntax of the SASEPFUNC table function is as follows.

FROM TABLE (**SASEPFUNC**(
CURSOR (SELECT /* + PARALLEL(*table-alias*, *dop*) */
* FROM *input-table table-alias*),
'*schema-name.model-table-name*',
'*model-name*', '*null*',
'SELECT * FROM '*input-table*'))

Arguments

CURSOR(SELECT /*PARALLEL (*table-alias*, *dop*) */ * FROM *input-table table-alias*)
specifies the SELECT statement to read from the input table.

Tip You can specify a hint for the degree of parallelism (*dop*) value that is used for reading the input table. For more information, see "Run-Time Guidance for the Oracle Degree of Parallelism (DOP) Setting" on page 97.

table-alias
specifies an alias for the input table name.

Requirement The table alias must be the same in the parallel hint and the FROM clause.

input-table
specifies the name of the input table that is used by the SASEPFUNC table function.

schema-name.model-table-name
specifies the fully qualified model table name.

Requirement The table name that you specify for this function must be the same table name that is used in the %INDOR_CREATE_MODELTABLE macro. For more information, see "Creating a Model Table" on page 89.

model-name
specifies the model name.

Requirement The model name must be the same name that is used in the %INDOR_PUBLISH_MODEL macro. For more information, see "%INDOR_PUBLISH_MODEL Macro Syntax" on page 92.

null
specifies a placeholder value at this time

Tip You can specify either 'null' or an empty string ' '.

SELECT * FROM *input-table*
specifies a simple SELECT statement for the input table.

Requirement The input table name must be the same in the first SELECT statement.

Run-Time Guidance for the Oracle Degree of Parallelism (DOP) Setting

The performance of the Scoring Accelerator for Oracle can be affected by altering the Degree of Parallelism (DOP) setting. In a Real Application Clusters (RAC) environment the parallel processes are distributed among the available database instances when the chosen DOP exceeds the expected capabilities of a single node. In environments with mixed workloads and multi-concurrency, you should rely on the parallelism provided by the Oracle database. However, to achieve maximum throughput for dedicated Scoring Accelerator operations, you might consider adjusting the DOP setting.

Because Oracle and SAS use separate threads during execution, improvements throughput diminish for DOP values that are greater than half the total number of cores available. For example, if you have 128 cores total available for all instances, a DOP greater than 64 is not likely to yield improved performance. Setting the DOP up to this maximum level assumes that the system is solely dedicated to running the SAS Scoring Accelerator. For a mixed load system, a lower DOP value might be more appropriate.

Along with the DOP, adjusting the value of the internal parameter _parallel_load_bal_unit can also be beneficial to distributed performance. This parameter affects the number of threads allocated for a given RAC instance before a parallel query engages additional instances. Similar to DOP, setting _parallel_load_bal_unit parameter beyond half the core total per instance is not likely to be beneficial.

CAUTION:
_parallel_load_bal_unit is an internal Oracle parameter. Do not use this parameter unless instructed to do so by Oracle Support. Modifying this parameter might be harmful.

Chapter 9

SAS Scoring Accelerator for Teradata

Overview of Running Scoring Models in Teradata

There are two ways to run scoring models in Teradata.

- You can create scoring functions for each EM_ output variable. The model publishing macro creates the scoring functions that are published as Teradata user-defined functions. These functions can then be used in any SQL query. For more information, see "Using Scoring Functions to Run Scoring Models" on page 100.
- Starting with the November 2011 release, you can use the SAS Embedded Process. The SAS Embedded Process is a SAS server process that runs inside the Teradata EDW to read and write data. The model publishing macro creates scoring files that are then used in a stored procedure to run the scoring model. For more information, see "Using the SAS Embedded Process to Run Scoring Models" on page 103.

The SAS Scoring Accelerator for Teradata requires a certain version of the Teradata client and server environment. For more information, see `http://www.sas.com/`

technologies/analytics/datamining/scoring_acceleration/#section=5 and *SAS In-Database Products: Administrator's Guide*.

Using Scoring Functions to Run Scoring Models

How to Run a Scoring Model Using Scoring Functions

The %INDTD_PUBLISH_MODEL macro creates the files that are needed to build the scoring functions and publishes these files to a specified database in the Teradata EDW. Only the EM_ output variables are published as Teradata scoring functions. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21.

To run the scoring model using scoring functions, follow these steps.

1. Run the %INDTD_PUBLISH_MODEL macro.

   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 performs the following tasks:

   - 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.
   - processes the format catalog and creates an .h file with C structures if a format catalog is available. This file is also necessary to build the scoring functions.
   - produces a script of the Teradata commands that are used to register the scoring functions on the Teradata EDW.
   - uses SAS/ACCESS Interface to Teradata to run the script and publish the scoring model files to the Teradata EDW.

   For more information, see "Running the %INDTD_PUBLISH_MODEL Macro" on page 113.

   For more information about the scoring functions that are created, see "Scoring Function Names" on page 100 and "Viewing the Scoring Functions" on page 101.

2. Use the scoring functions in any SQL query.

   For more information, see "Using Scoring Functions to Run a Scoring Model" on page 103.

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 about the MODELNAME argument, see "Running the %INDTD_PUBLISH_MODEL Macro" on page 113.

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 about the score.xml file, see "Fixed Variable Names" on page 21.

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 scoring function has 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".

Note: The scoring function name cannot exceed 30 characters.

CAUTION:

When the scoring function is 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 overwrites the first scoring function.

Viewing the Scoring Functions

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

- From Teradata, log on to the database using a client tool such as BTEQ 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, 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');

disconnect from teradata;
quit;
```

- You can look at the SAS log that is created when the %INDTD_PUBLISH_MODEL macro was run. A message is printed to the SAS log that states whether a scoring function is successfully or not successfully created or replaced.
- 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.

  For example, this SampleSQL.txt file refers to an ID column in **`allmush1_intab`** that is populated with a unique integer from 1 to *n*. *n* is the number of rows in the table. The ID column uniquely identifies each row. This SampleSQL.txt file 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 ;
```

Using Scoring Functions to Run a Scoring Model

The scoring functions are available to use in any SQL expression in the same way that Teradata built-in functions are used.

After 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. The SampleSQL.txt file shown in "Viewing the Scoring Functions" on page 101 was modified to create the SELECT statement in this example.

```
select id, allmush1_em_classification
(
"BRUISES"
,"CAPCOLOR"
,"GILLCOLO"
,"GILLSIZE"
,"HABITAT"
,"ODOR"
,"POPULAT"
,"RINGNUMB"
,"RINGTYPE"
,"SPOREPC")
  as "EM_CLASSIFICATION",
 from allmush1_intab ;
```

Note: The function and table names must be fully qualified if the functions and tables are not in the same database.

Using the SAS Embedded Process to Run Scoring Models

How to Run a Scoring Model with the SAS Embedded Process

The integration of the SAS Embedded Process and Teradata allows scoring code to run directly using the SAS Embedded Process on Teradata.

Note: The SAS Embedded Process might require a later release of Teradata than function-based scoring. For more information, see **http://www.sas.com/technologies/analytics/datamining/scoring_acceleration/#section=5** and *SAS In-Database Products: Administrator's Guide*.

To run the scoring model using the SAS Embedded Process, follow these steps.

1. Create a table to hold the scoring files.

The %INDTD_CREATE_MODELTABLE macro creates a table that holds the scoring files for the model that is being published.

For more information, see "Creating a Model Table" on page 104.

2. Run the %INDTD_PUBLISH_MODEL to create the scoring files.

   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 performs the following tasks:

   - translates the scoring model into the sasscore_*modelname*.ds2 file that is used to run scoring inside the SAS Embedded Process.
   - takes the format catalog, if available, and produces the sasscore_*modelname*_ufmt.xml file. This file contains user-defined formats for the scoring model that is being published.
   - uses the SAS/ACCESS Interface to Teradata to insert the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files into the model table that was created using the %INDTD_CREATE_MODELTABLE macro.

   For more information, see "Running the %INDTD_PUBLISH_MODEL Macro" on page 113 and "Teradata Scoring Files" on page 111.

3. Execute the SAS_SCORE_EP stored procedure to run the scoring model.

   For more information, see "SAS_SCORE_EP Stored Procedure" on page 106.

Creating a Model Table

Overview

When using the SAS Embedded Process to publish a scoring model in Teradata, you must create a table to hold the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files. You must run the %INDTD_CREATE_MODELTABLE macro to create the table before you run the %INDTD_PUBLISH_MODEL macro.

You have to create the table only one time to hold a model's scoring files.

The model table contains the following columns. The ModelName column is the table key. The table is referenced by the two-level name *model-name.model-table-name*.

Column Name	Description	Specification
ModelName	contains the name of the model	VARCHAR(128) CHARACTER SET UNICODE CASESPECIFIC
ModelDS2	contains the sasscore_*modelname*.ds2 file	BLOB(209708800)
ModelFormats	contains the sasscore_*modelname*_ufmt.xml file	BLOB(209708800)
ModelMetadata	reserved by SAS for future use	BLOB(4M)

Column Name	Description	Specification
ModelOwner	contains the name of the user who published the model	VARCHAR(128) CHARACTER SET UNICODE CASESPECIFIC
ModelUpdated	contains the date and time that the model was published	TIMESTAMP(6)

%INDTD_CREATE_MODELTABLE Run Process

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

1. Start SAS 9.3 and submit the following commands in the Program Editor or Enhanced Editor:

   ```
   %indtdpm;
   %let indconn = server=myserver user=myuserid password=xxxx database=mydb;
   ```

   For more information, see "%INDTDPM Macro" on page 113 and the "INDCONN Macro Variable" on page 113.

2. Run the %INDTD_CREATE_MODELTABLE macro.

   For more information, see "%INDTD_CREATE_MODELTABLE Macro Syntax" on page 105.

%INDTD_CREATE_MODELTABLE Macro Syntax

%INDTD_CREATE_MODELTABLE

(<DATABASE=*database-name*>
<, MODELTABLE=*model-table-name*>
<, ACTION=CREATE | REPLACE | DROP>
);

Arguments

DATABASE=*database-name*

specifies the name of a Teradata database where the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files are held.

Default The database specified in the INDCONN macro variable or your current database

MODELTABLE=*model-table-name*

specifies the name of the table that holds the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files.

Default sas_model_table

Requirement The maximum table name length is 30 characters, and it must be a valid Teradata table name.

Interaction The table name that you specify for this macro must be the same table name that is used in the %INDTD_PUBLISH_MODEL macro.

See "%INDTD_PUBLISH_MODEL Macro Syntax" on page 114

ACTION = CREATE | REPLACE | DROP
specifies one of the following actions that the macro performs:

CREATE
creates a new table.

Tip If the table has been previously defined and you specify ACTION=CREATE, an error is issued.

REPLACE
overwrites the current table, if a table with the same name is already registered.

Tip If you specify ACTION = REPLACE, and the current table contains sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml files, the files are deleted and an empty table is re-created.

DROP
causes all models in this table to be dropped.

Default CREATE

SAS_SCORE_EP Stored Procedure

Overview of the SAS_SCORE_EP Stored Procedure

The SAS_SCORE_EP stored procedure is the interface for running the scoring model inside Teradata with the SAS Embedded Process. The SAS_SCORE_EP stored procedure uses the files that are stored in the model table. The stored procedure parameters enable you to control the name and location of the output table, how much data is returned, and how it is returned.

The SAS_SCORE_EP stored procedure is installed in the SAS_SYSFNLIB database. To run the stored procedure, you must have the following permissions:

- EXECUTE PROCEDURE permission on the SAS_SYSFNLIB database
- EXECUTE FUNCTION permission on the SAS_SYSFNLIB database
- EXECUTE FUNCTION ON SYSLIB.MonitorVirtualConfig permission on the SYSLIB.MonitorVirtualConfig function

For more information, see "Teradata Permissions" on page 118.

Running the SAS_SCORE_EP Stored Procedure

You can run the SAS_SCORE_EP stored procedure using explicit pass-through and PROC SQL or you can use other Teradata query tools.

TIP 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 %INDTD_PUBLISH_MODEL macro. The SampleSQL.txt file contains basic SQL code that, with modifications, can be used to run your score code inside Teradata.

Note: Before running the SAS_SCORE_EP stored procedure, you must create the model table with the %INDTD_CREATE_MODELTABLE macro and then you must publish the files to the model table with the %INDTD_PUBLISH_MODEL macro.

Here is an example using PROC SQL.

```
proc sql;
   connect to teradata (user=userid password=xxxx server=myserver mode=Teradata);
   execute
      (CALL SAS_SYSFNLIB.SAS_SCORE_EP
         (
            'MODELTABLE="grotto"."sas_publish_model"',
            'MODELNAME=Intr_Tree',
            'INQUERY=SELECT * from "grotto"."score_input_table" WHERE x1 < 1.0',
            'OUTTABLE="grotto"."sas_score_out1"',
            'OUTKEY=id',
            'OPTIONS='  /* can be blank or NULL if no options are needed */
         )
      ) by teradata;
   disconnect from teradata;
quit;
```

Note: You must specify MODE=TERADATA in your connection string.

For more information about the stored procedure parameters, see "SAS_SCORE_EP Stored Procedure Syntax" on page 107.

SAS_SCORE_EP Stored Procedure Syntax

SAS_SYSFNLIB.SAS_SCORE_EP

('MODELTABLE="*database*"."*model-table-name*" ',
'MODELNAME=*model-name*',
'INQUERY=SELECT …',
'OUTTABLE=< "*output-database-name*". >"*output-table-name*" ',
'OUTKEY=*column*<…, *column*,> | NO PRIMARY INDEX,
NULL | 'OPTIONS=' | 'OPTIONS=*option*; <…; *option*;>'
);

Parameters

database
specifies the name of the database that contains the model table.

Default	Database in the current session
Requirement	The database must be the same as the one specified in the %INDTD_PUBLISH_MODEL macro's DATABASE argument.

model-table-name
specifies the name of the model table where the sasscore_*modelname*.ds2 and sasscore_*modelname*_ufmt.xml scoring files were published with the %INDTD_CREATE_MODELTABLE macro.

model-name
specifies the name of the model.

SELECT …
specifies a SELECT statement that defines the inputs to the SAS Embedded Process.

Ranges	The INQUERY= parameter string can be up to 30,000 characters long.
Restrictions	The maximum number of characters in the query is 30,000.
	The maximum number of input and output colums is 1024.

Requirement If the query is greater than 1,000 characters, the INQUERY= parameter must be the first parameter listed in the stored procedure.

Interaction A query can reference tables or views, except if you specify the DIRECT option. If you specify the DIRECT option, the query can reference only tables.

Tip To pass single quotation marks around character literals, use two adjacent single quotation marks. This is an example.

```
'INQUERY=select * from my_input_tbl where name like ''%Jones%'''
```

< "*output-database-name*". >"*output-table-name*"
specifies the location of the scoring model output table.

output-database-name
specifies the database where the table is created or currently exists.

Default Current database

output-table-name
specifies the name of the table to be created or the table that currently exists.

Requirement The output table can already exist. If the output table already exists, scored rows are inserted into the table along with any existing rows. If the output table already exists, the output columns must match the existing table's columns for the insert to succeed.

Interaction The output table can be a temporary table by adding VOLATILE=YES in the OPTIONS parameter. The temporary table can be used only for the duration of the SQL session where it is created.

column
specifies the column or columns that are used as the primary index for the output table.

Requirement The column must exist in the output table.

NO PRIMARY INDEX
specifies that there is no primary index for the output table and that output rows are placed on the same Teradata Access Module Processor (AMP) that ran the scoring code for the corresponding input row.

NULL | 'OPTIONS='
specifies that no options are used.

Tip You can use either 'OPTIONS=' or NULL to indicate that no options are used.

Example These two code lines are identical.

```
call sas_sysfnlib.sas_score_ep ('modeltable=...', modelname=...',
'inquery=...', 'outtable=scored_output1', 'outkey=no primary index',
null);
```

```
call sas_sysfnlib.sas_score_ep ('modeltable=...', modelname=...',
'inquery=...', 'outtable=scored_output1', 'outkey=no primary index',
'options=');
```

option
specifies additional options for the stored procedure. *option* can be any of the following values:

CONTRACT=YES | NO
specifies whether to write the output metadata to the table specified in the OUTTABLE= parameter.

Default NO

Interaction If you specify CONTRACT=YES, the OUTKEY= parameter is ignored.

Tip The output is written to the table in the form of one row per output value with the sequence, name, data type, and length for each output.

DIRECT=YES | NO
specifies whether direct retrieve optimization is enabled.

Default NO

Interaction This option affects the stored procedure SQL generation.

Tip The direct retrieve optimization improves performance in the case where the input to the SAS Embedded Process is a table and the input query is **`SELECT * FROM table`**. When DIRECT=YES, the INQUERY= parameter is only the table name. No SELECT statement is needed.

DS2_KEEP=*column-name*<…*column-name*>
specifies the column or columns that are passed to the SAS_SCORE_EP procedure and are applied as a dynamic KEEP= statement in the sasscore_*modelname*.ds2 file.

Requirement If more than one column is specified, column names must be separated with spaces.

Interaction Specify CONTRACT=YES to preview the available output columns without executing the model.

ENCODING= LATIN | UNICODE
specifies the character data encoding for internationalization.

Default LATIN

See *SAS National Language Support (NLS): Reference Guide*

EPTRACE=YES
specifies that journal messages are written to the journal table.

HASHBY=*column-name*<…, *column-name*>
specifies one or more columns to use for the HASH BY clause.

Requirement If more than one column is specified, column names must be separated with commas.

Interaction This option affects the stored procedure SQL generation.

Note Data is redistributed by hash code to the TERADATA AMPs based on this column or columns although there is no implied ordering to the groups.

JOURNALTABLE=*journal-table-name*
specifies the name of a table that the stored procedure creates. This table holds any journal messages and notes from the SAS journal facility that are produced when executing the store procedure.

Requirement The name must follow Teradata naming conventions for table names.

Note Use a SELECT statement to retrieve the journal messages from the table after the stored procedure call is complete.

LOCALE=*sas-locale*
specifies set of attributes in the SAS session that reflect the language, local conventions, and culture for a geographical region.

Requirement *sas-locale* must be one of the five-character POSIX values, for example fr_FR.

See *SAS National Language Support (NLS): Reference Guide*

ORDERBY=*column-name*<…, *column-name*>
specifies one or more columns to use for the LOCAL ORDER BY (BY groups) clause.

Requirement If more than one column is specified, column names must be separated with commas.

Interaction This option affects the stored procedure SQL generation.

SELECT_LIST=*column-name*<…, *column-name*>
specifies the column or columns that are used in the SQL that is generated by the SAS_SCORE_EP stored procedure.

Default * (asterisk) which indicates all columns

Requirement If more than one column is specified, column names must be separated with commas.

SQLTRACE=*table-name*
specifies the name of a table to hold the generated SQL code.

Tip This table is useful for stored procedure debugging or to reference later if you want to customize the SQL code that is used to call the SAS Embedded Process.

UNIQUE=YES | NO
specifies whether the primary index of the output table is unique.

Default NO

VOLATILE=YES | NO
specifies whether the output table is created as a temporary table.

Default	NO
Interaction	This option affects the stored procedure SQL generation.
Range	The OPTIONS= parameter string can be from 0–20,000 characters long.
Requirement	Each option must end with a semicolon, including the last option in the list.
Note	*option* can be blank or NULL if no options are needed.
Tip	Options that are not recognized as directives to the stored procedure are passed to the SAS Embedded Process as Query Band name-value pairs. If the SAS Embedded Process does not recognize them, they are ignored. Up to ten user-defined Query Band name-value pairs can be specified in addition to the options listed here that are Query Band name-value pairs. The maximum length of the query band is 2048 characters. User-defined Query Band information is logged in Teradata Database Query Log (DBQL) that makes it useful for workload analysis and reporting.

Tips for Using the SAS_SCORE_EP Stored Procedure

- No specific parameter order is required, but if the INQUERY parameter string is greater than 1,000 characters, it must be the first parameter. Similarly, if the OPTIONS parameter string is greater than 1,000 characters, it must be the last parameter.
- Database object names, for example tables and columns, must be enclosed in double quotation marks if they are Teradata reserved words. Otherwise, quotation marks are optional.
- Tables can be qualified with a database name. If a table name is not qualified with a database name, the table name is resolved based on the default database for your session.
- All parameters are passed as strings to the SAS_SCORE_EP stored procedure, so they must be enclosed in single quotation marks. To pass a single quotation mark as part of the SQL within a parameter, use two adjacent single quotation marks as shown in the following example:

```
'INQUERY=select * from my_input_tbl where name like ''%Jones%''',
```

Teradata Scoring Files

When using the SAS Embedded Process, the %INDTD_PUBLISH_MODEL macro produces two scoring files for each model:

- sasscore_*modelname*.ds2. This file contains code that is executed by the SAS_SCORE_EP stored procedure.
- sasscore_*modelname*_ufmt.xml. This file contains user-defined formats for the scoring model that is being published. This file is used by the SAS_SCORE_EP stored procedure.

These files are published to the model table that you specify in the %INDTD_PUBLISH_MODEL macro. See Appendix 1, "Scoring File Examples," on page 209 for an example of each of these files.

A message that indicates whether the scoring files are successfully or not successfully created is printed to the SAS log.

Although you cannot view the scoring files directly, there are two ways to see the models whose files are created:

- Log on to the database using BTEQ and submit an SQL statement. The following example assumes that the model table where the scoring files were published is **register** and the model name is **reg1**.

  ```
  bteq .logon myserver/myuserid,mypassword
  select modelname, modelowner, modelupdated from register
     where modelname like '%reg1%';
  ```

  The model name, user ID, and date and time the model files were published are listed.

- From SAS, 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 files is **reg**.

  ```
  proc sql noerrorstop;
    connect to teradata (user=username password=xxxx server=myserver);

  select * from connection to teradata
        (select modelname,modelowner,modelupdated
           from sasmodeltablename
              where modelname like '%reg%');
  disconnect teradata;
  quit;
  ```

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

Controlling the SAS Embedded Process

The SAS Embedded Process starts when a query is submitted. It continues to run until it is manually stopped or the database is shut down.

You can check the status of the SAS Embedded Process or disable it so that no new queries can be started. Use the following commands to perform those actions.

Command	Action performed
`CALL DBCEXTENSION.SERVERCONTROL ('STATUS', :A);`	Provides the status of the SAS Embedded Process.
`CALL DBCEXTENSION.SERVERCONTROL ('DISABLE', :A);`	Stops new queries from being started. Queries that are currently running continue to run until they are complete.
`CALL DBCEXTENSION.SERVERCONTROL ('ENABLE', :A);`	Enables waiting and new queries to start running.

Running the %INDTD_PUBLISH_MODEL Macro

%INDTD_PUBLISH_MODEL Macro Run Process

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

1. Create a scoring model using SAS Enterprise Miner.
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. Test your connection to Teradata with a local utility such as BTEQ.
4. Start SAS 9.3 and submit the following commands in the Program Editor or Enhanced Editor:

   ```
   %indtdpm;
   %let indconn = server=myserver user=myuserid password=xxxx database=mydb;
   ```

   For more information, see "%INDTDPM Macro" on page 113 and the "INDCONN Macro Variable" on page 113.
5. If you use the SAS Embedded Process, run the %INDTD_CREATE_MODELTABLE macro.

   For more information, see "Creating a Model Table" on page 104.
6. Run the %INDTD_PUBLISH_MODEL macro.

   Messages are written to the SAS log that indicate whether the scoring functions or files were successfully created.

   For more information, see "%INDTD_PUBLISH_MODEL Macro Syntax" on page 114.

%INDTDPM Macro

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 and the %INDTD_CREATE_MODELTABLE macros. 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 the following message:

```
macro indtdpm not defined
```

INDCONN Macro Variable

The INDCONN macro variable is used to provide the credentials to connect to Teradata. You must specify server, user, password, and database to access the machine on which you have installed the Teradata EDW. You must assign the INDCONN macro variable before the %INDTD_PUBLISH_MODEL or the %INDTD_CREATE_MODELTABLE macros are invoked.

Here is the syntax for the value of the INDCONN macro variable:

SERVER=*server* USER=*user* PASSWORD=*password* DATABASE=*database*;

Arguments

SERVER="*server*"
specifies the Teradata server name or the IP address of the server host.

USER="*user*"
specifies the Teradata user name (also called the user ID) that is used to connect to the database.

PASSWORD="*password*"
specifies the password that is associated with your Teradata user ID.

Tip Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error to occur.

DATABASE="*database*"
specifies the Teradata database that contains the tables and views that you want to access.

Default Your current database

Requirement You must specify the DATABASE= argument if you use the SAS Embedded Process.

TIP The INDCONN macro variable is not passed as an argument to the %INDTD_PUBLISH_MODEL macro. This information can be concealed in your SAS job. For example, you can place it in an autoexec file and apply permissions on that file so that others cannot access the user credentials.

%INDTD_PUBLISH_MODEL Macro Syntax

%INDTD_PUBLISH_MODEL
(DIR=*input-directory-path*, MODELNAME=*name*
<, MECHANISM=STATIC | EP>
<, MODELTABLE=*model-table-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 format 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 format catalog.

Restriction 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.

See "Special Characters in Directory Names" on page 13

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. If you use the SAS Embedded Process, the model name is part of the scoring filenames.

Restriction The scoring function name is a combination of the model and the output variable names. The scoring function name cannot exceed 30 characters. For more information, see "Scoring Function Names" on page 100.

Requirement If you use scoring functions, the model name must be a valid SAS name that is ten characters or fewer. If you use the SAS Embedded Process, the model name can be up to 128 characters. For more information about valid SAS names, see the topic on rules for words and names in *SAS Language Reference: Concepts*.

Interaction Only the EM_ output variables are published as Teradata scoring functions. For more information about the EM_ output variables, see "Fixed Variable Names" on page 21 and "Scoring Function Names" on page 100.

MECHANISM=STATIC | EP
specifies whether scoring functions or scoring files are created. MECHANISM= can have one of the following values:

STATIC
specifies that scoring functions are created.

These scoring functions are used in an SQL query to run the scoring model.

See "Using Scoring Functions to Run Scoring Models" on page 100

EP
specifies that scoring files are created.

These scoring files are used by the SAS Embedded Process to run the scoring model. A single entry in the model table is inserted for each new model. The entry contains both the score.sas and score.xml in separate columns. The scoring process includes reading these entries from the table and transferring them to each instance of the SAS Embedded Process for execution.

Requirement If you specify MECHANISM=EP, you must also specify the MODELTABLE= argument.

Note The SAS Embedded Process might require a later release of Teradata than function-based scoring. For more information, see and *SAS In-Database Products: Administrator's Guide*.

See "Using the SAS Embedded Process to Run Scoring Models" on page 103

Default STATIC

MODELTABLE=*model-table-name*
specifies the name of the model table where the scoring files are published.

Default sas_model_table

Restriction This argument is available only when using the SAS Embedded Process.

Requirement The name of the model table must be the same as the name specified in the %INDTD_CREATE_MODELTABLE macro. For more information, see the MODELTABLE argument in "%INDTD_CREATE_MODELTABLE Macro Syntax" on page 105.

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

Restrictions Only XML files that are produced by the SAS Enterprise Miner Score Code Export node can be used.

If you use scoring functions to run scoring models, the maximum number of output variables is 128. If you use the SAS Embedded Process and Teradata version 13.1 or 14.0, the maximum is 1024. If you use the SAS Embedded Process and Teradata version 14.10, the maximum is 2048.

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 or the scoring files are published.

Default The database specified in the INDCONN macro variable or your current database

Requirement If you use the SAS Embedded Process, the name of the database must be the same as the database specified in the %INDTD_CREATE_MODELTABLE macro. For more information, see the DATABASE argument in "%INDTD_CREATE_MODELTABLE Macro Syntax" on page 105.

Interaction The database that is specified by the DATABASE argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "%INDTD_PUBLISH_MODEL Macro Run Process" on page 113.

Tip You can publish the scoring functions and formats or the scoring files to a shared database where other users can access them.

FMTCAT=*format-catalog-filename*
specifies the name of the format catalog file that contains all user-defined 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.

Interactions 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.

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 *Base SAS Procedures Guide*.

ACTION=CREATE | REPLACE | DROP
specifies one of the following actions that the macro performs:

CREATE
creates new functions or files.

REPLACE
overwrites the current functions or files, if functions or files with the same name are already registered.

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

Default CREATE

Tip If the function or file has been previously defined and you specify ACTION=CREATE, you receive warning messages from Teradata. If the function or file 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 does not cause the database to stop.

Default PROTECTED

Restriction This argument is valid only when . It has no effect if you specify MECHANISM=EP.

Tip After 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 that contains detailed information about the success or failure of the publishing process and sample SQL code (SampleSQL.txt). For more information about the SampleSQL.txt file, see "Scoring Function Names" on page 100.

Tip This argument is useful when testing your scoring models.

See "Special Characters in Directory Names" on page 13

Modes of Operation

The %INDTD_PUBLISH_MODEL macro has two modes of operation: 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 any 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. The SAS Embedded Process always operates in its own process, which is equivalent to fenced mode functions. An optimized data transport mechanism allows the SAS Embedded Process to provide fenced mode protection with speed that is as good or better than unfenced functions.

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

Teradata Permissions

Because functions are associated with a database, the functions inherit the access rights of that database. It could be useful to create a separate shared database for scoring functions so that access rights can be customized as needed.

If you use scoring functions to run your scoring model, you must have the following permissions on the database where the functions are published:

CREATE FUNCTION
DROP FUNCTION
EXECUTE FUNCTION
ALTER FUNCTION

If you use the SAS Embedded Process to run your scoring model, you must have these permissions:

SELECT, CREATE TABLE, INSERT ON *database* TO *userid*
EXECUTE FUNCTION ON SAS_SYSFNLIB
EXECUTE FUNCTION ON SYSLIB.MonitorVirtualConfig

EXECUTE PROCEDURE ON SAS_SYSFNLIB

The SAS_SCORE_EP procedure runs with access rights of the calling user.

To obtain database permissions, contact your database administrator.

For more information about specific permissions, see “Teradata Permissions” in Chapter 8 of SAS In-Database Products: Administrator's Guide.

Chapter 10

SAS Scoring Accelerator and SAS Model Manager

Using the SAS Scoring Accelerator with SAS Model Manager

You can use SAS Scoring Accelerator in conjunction with the SAS Model Manager to manage and deploy scoring models in DB2, Greenplum, Netezza, and Teradata.

The **Publish Scoring Function** of SAS Model Manager enables you to publish models that are associated with the DATA Step score code type to a configured database. When you publish a scoring function for a project, SAS Model Manager exports the project's champion model to the SAS Metadata Repository. The SAS Scoring Accelerator then creates scoring functions in the default version that can be deployed inside the database based on the project's champion model score code. The scoring function is validated automatically against a default train table to ensure that the scoring results are correct. A scoring application or SQL code can then execute the scoring functions in the database. The scoring functions extend the database's SQL language and can be used in SQL statements like other database functions.

In the August 2012 release, you can also use the SAS Scoring Accelerator and SAS Model Manager to import SAS/STAT linear models and SAS High-Performance Analytics models from a SAS package file (.SPK). Models that have a DATA step score code type can be scored, published, and included in performance monitoring.

For more information, see the *SAS Model Manager: User's Guide*.

Part 3

Format Publishing and the SAS_PUT( ) Function

Chapter 11

Deploying and Using SAS Formats inside the Database

Using SAS Formats and the SAS_PUT( ) Function

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

SAS supplies many formats. You can also use the SAS FORMAT procedure to define custom formats that replace raw data values with formatted character values. For example, this PROC FORMAT code creates a custom format called $REGION that maps ZIP codes to geographic regions.

```
proc format;
   value $region
   '02129', '03755', '10005' = 'Northeast'
   '27513', '27511', '27705' = 'Southeast'
   '92173', '97214', '94105' = 'Pacific';
run;
```

SAS programs, including in-database procedures, frequently use both user-defined formats and formats that SAS supplies. Although they are referenced in numerous ways, using the PUT function in the SQL procedure is of particular interest for SAS In-Database processing.

The PUT function takes a format reference and a data item as input and returns a formatted value. This SQL procedure query uses the PUT function to summarize sales by region from a table of all customers:

```
select put(zipcode,$region.) as region,
   sum(sales) as sum_sales from sales.customers
   group by region;
```

The SAS SQL processor knows how to process the PUT function. Currently, SAS/ACCESS Interface to the database returns all rows of unformatted data in the SALES.CUSTOMERS table in the database to the SAS System for processing.

The SAS In-Database technology deploys, or publishes, the PUT function implementation to the database as a new function named SAS_PUT( ). Similar to any other programming language function, the SAS_PUT( ) function can take one or more input parameters and return an output value.

The SAS_PUT( ) function supports use of SAS formats. You can specify the SAS_PUT( ) function in SQL queries that SAS submits to the database in one of two ways:

- implicitly by enabling SAS to automatically map PUT function calls to SAS_PUT( ) function calls
- explicitly by using the SAS_PUT( ) function directly in your SAS program

If you used the SAS_PUT( ) function in the previous SELECT statement, the database formats the ZIP code values with the $REGION format. It then processes the GROUP BY clause using the formatted values.

By publishing the PUT function implementation to the database as the SAS_PUT( ) function, you can realize these advantages:

- You can process the entire SQL query inside the database, which minimizes data transfer (I/O).
- The SAS format processing leverages the scalable architecture of the DBMS.
- The results are grouped by the formatted data and are extracted from the database.

Deploying SAS formats to execute inside a database can enhance performance and exploit the database's parallel processing.

Note: SAS formats and the SAS_PUT( ) functionality is available in Aster *n*Cluster, DB2, Greenplum, Netezza, and Teradata.

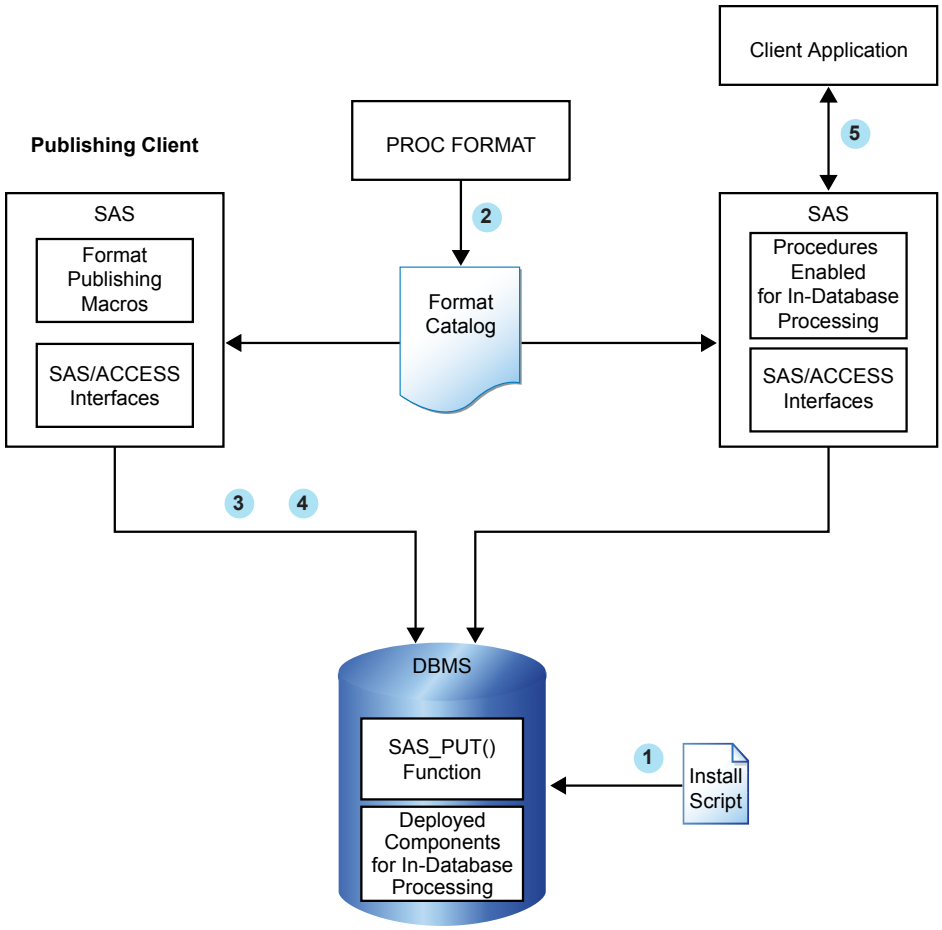
How It Works

By using the SAS formats publishing macro for DB2, Greenplum, Netezza, and Teradata, you can generate a SAS_PUT( ) function that enables you to execute PUT function calls inside the database. You can reference the formats that SAS supplies and most custom formats that you create by using PROC FORMAT.

The SAS formats publishing macro takes a SAS format catalog and publishes it to the database. Inside the database, a SAS_PUT( ) function, which emulates the PUT function, is created and registered for use in SQL queries.

For Aster *n*Cluster, the SAS_PUT( ) function is installed as part of the SAS Embedded Process. For more information, see the *SAS In-Database Products: Administrator's Guide*.

Figure 11.1 *Process Flow Diagram*



Here is the basic process flow.

1 Install the components that are necessary for in-database processing.

   For more information, see "Deployed Components for In-Database Processing" on page 4.

   Note: This is a one-time installation process.

2 If necessary, create your custom formats by using PROC FORMAT and create a permanent catalog by using the LIBRARY= option.

   For more information, see the topic on user-defined formats in the section for your database.

3 Start SAS 9.3 and run the format publishing macro. For DB2, Greenplum, Netezza, and Teradata, this macro creates the files that are needed to build the SAS_PUT( ) function and publishes those files to the database.

   For more information, see the topic on publishing SAS formats in the section for your database.

4 After the format publishing macro creates the script, SAS/ACCESS Interface to your database executes the script and publishes the files to the database.

   For more information, see the topic on publishing SAS formats in the section for your database.

5 The SAS_PUT( ) function is available to use in any SQL expression and to use typically wherever you use your database's built-in functions.

For more information, see the topic on using the SAS_PUT( ) function in the section for your database.

Special Characters in Directory Names

If the directory names that are used in the macros contain any of the following special characters, you must mask the characters by using the %STR macro quoting function. For more information, see the %STR function and macro string quoting topic in *SAS Macro Language: Reference*.

Table 11.1 *Special Characters in Directory Names*

Character	How to Represent
blank*	%str()
**	%str(*)
;	%str(;)
, (comma)	%str(,)
=	%str(=)
+	%str(+)
-	%str(–)
>	%str(>)
<	%str(<)
^	%str(^)
|	%str(|)
&	%str(&)
#	%str(#)
/	%str(/)
~	%str(~)
%	%str(%%)
'	%str(%')
"	%str(%")
(	%str(%()

Character	How to Represent
)	%str(%))
¬	%str(¬)

* Only leading blanks require the %STR function, but you should avoid using leading blanks in directory names.

** Asterisks (*) are allowed in UNIX directory names. Asterisks are not allowed in Windows directory names. In general, avoid using asterisks in directory names.

Here are some examples of directory names with special characters:

Table 11.2 *Examples of Special Characters in Directory Names*

Directory	Code Representation
`c:\temp\Sales(part1)`	`c:\temp\Sales%str(%()part1%str(%))`
`c:\temp\Drug "trial" X`	`c:\temp\Drug %str(%")trial(%str(%") X`
`c:\temp\Disc's 50% Y`	`c:\temp\Disc%str(%')s 50%str(%%) Y`
`c:\temp\Pay,Emp=Z`	`c:\temp\Pay%str(,)Emp%str(=)Z`

Considerations and Limitations with User-Defined Formats

- If you create a local user-defined format with the same name but a different value than a user-defined format that was published previously to the database, a `check sum ERROR` warning occurs and the local format is used. This warning indicates that the local and published formats differ. The query is processed by SAS and not inside the database.

  If you want the query to be processed inside the database, you need to redefine the local format to match the published version and rerun the query.
- Avoid using PICTURE formats with the MULTILABEL option. You cannot successfully create a CNTLOUT= data set when PICTURE formats are present. This is a known problem in PROC FORMAT.
- If you use the MULTILABEL option, only the first label that is found is returned. For more information, see the PROC FORMAT MULTILABEL option in the *Base SAS Procedures Guide*.
- The format publishing macros reject a format unless the LANGUAGE= option is set to English or is not specified.
- Although the format catalog can contain informats, the format publishing macros ignore the informats.
- User-defined formats that include a format that SAS supplies are not supported.

Tips for Using the Format Publishing Macros

- Use the ACTION=CREATE option only the first time you run the format publishing macro. After that, use ACTION=REPLACE or ACTION=DROP.
- The format publishing macro does not require a format catalog. If you do not have any custom formats, only the formats that SAS supplies are published. However, you can use this code to create an empty format catalog in your WORK directory before you publish the PUT function and the formats that SAS supplies:

```
proc format;
run;
```

- If you modify any PROC FORMAT entries in the source catalog, you must republish the entire catalog.
- If the format publishing macro is executed between two procedure calls, the page number of the last query output is increased by two.

Tips for Using the SAS_PUT( ) Function

- When SAS parses the PUT function, SAS checks to make sure that the format is a known format name. SAS looks for the format in the set of formats that are defined in the scope of the current SAS session. If the format name is not defined in the context of the current SAS session, the SAS_PUT( ) is returned to the local SAS session for processing.
- Using both the SQLREDUCEPUT= system option (or the PROC SQL REDUCEPUT= option) and SQLMAPPUTTO= can result in a significant performance boost. First, SQLREDUCEPUT= works to reduce as many PUT functions as possible. Then, using SQLMAPPUTTO= with the format publishing macro changes the remaining PUT functions to SAS_PUT( ) functions.

  For more information, see the "SQLMAPPUTTO= System Option" on page 204 and the "SQLREDUCEPUT= System Option" on page 205.
- To turn off automatic translation of the PUT function to the SAS_PUT( ) function, set the SQLMAPPUTTO= system option to NONE.
- The format of the SAS_PUT( ) function parallels that of the PUT function:

```
SAS_PUT(source, 'format.')
```

Determining Format Publish Dates

You might need to know when user-defined formats or formats that SAS supplies 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 SQL pass-through facility to return the datetime value associated with the INTRINSIC-CRDATE and UFMT-CRDATE formats, as illustrated in this example:

```
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;
   );

disconnect from teradata;
quit;
```

Chapter 12

Deploying and Using SAS Formats in Aster *n*Cluster

User-Defined Formats in the Aster Database

Introduction to User-Defined Formats in Aster

You can use PROC FORMAT to create user-defined formats and store them in a format catalog. You can then use the %INDAC_PUBLISH_FORMATS macro to export the user-defined format definitions as format files to a table inside the Aster database where the SAS_PUT( ) function can reference them.

For more information about the %INDAC_PUBLISH_FORMATS macro, see"Publishing SAS Formats in Aster" on page 134. For more information about the SAS_PUT( ) function, see "Using the SAS_PUT( ) Function in the Aster Database" on page 141.

Aster Limitations and Restrictions When Using the FMTCAT= Option

Formats as labels and the DATATYPE= option cannot be used with formats that are exported to Aster.

Publishing SAS Formats in Aster

Overview of the Publishing Process

The SQL/MR function is the framework for enabling execution of user-defined functions within Aster through an SQL interface. A new SAS SQL/MR function, SAS_PUT( ), supports format publishing in Aster. The SAS_PUT( ) function is installed as part of the in-database deployment package. For more information, see the *SAS In-Database Products: Administrator's Guide*.

The %INDAC_PUBLISH_FORMATS macro creates the user-defined format files that are needed by the SAS_PUT( ) function and publishes those files to the Aster database.

This macro makes many formats that SAS supplies available inside Aster. In addition to formats that SAS supplies, you can also publish the PROC FORMAT definitions that are contained in a single SAS format catalog by using the FMTCAT= option. The process of publishing a PROC FORMAT catalog entry converts the range label pairs into embedded data in Aster.

The %INDAC_PUBLISH_FORMATS macro performs the following tasks:

- takes the format catalog and produces a sasput_*type*_*fmtname*.xml file for each user-defined format that is in the format catalog.
- uses the SAS/ACCESS Interface to Aster to insert the format files into either the NC_INSTALLED_FILES table under the PUBLIC schema (Aster 4.5) or the NC_USER_INSTALLED_FILES table under a specified schema (Aster 4.6).

Note: Files larger than 32k are automatically divided into 32k chunks of data and then are concatenated back together by performing multiple updates.

Note: If there are no user-defined formats, you do not need to run the %INDAC_PUBLISH_FORMATS macro. The formats that SAS supplies are installed in either the NC_INSTALLED_FILES table (Aster 4.5) or the NC_USER_INSTALLED_FILES table (Aster 4.6) when the SAS 9.3 Formats Library for Aster is installed.

When the user accesses a SAS format through the SQL interface, the SAS_PUT( ) function retrieves the specified format's .xml file and activates the SAS Embedded Process to perform the formatting. For more information, see "Using the SAS_PUT( ) Function in the Aster Database" on page 141.

Running the %INDAC_PUBLISH_FORMATS Macro

To run the %INDAC_PUBLISH_FORMATS macro, follow these steps.

1. Start SAS 9.3 and submit these commands in the Program Editor or the Enhanced Editor:

```
%indacpf;
```

```
%let indconn = user=youruserid password=yourpwd
   dsn=yourdsn;
```

For more information, see "%INDACPF Macro" on page 135 and the "INDCONN Macro Variable" on page 135.

2. Run the %INDAC_PUBLISH_FORMATS macro.

   For more information, see "%INDAC_PUBLISH_FORMATS Macro Syntax" on page 136.

Messages are written to the SAS log that indicate the success or failure of the creation of the XML format files.

%INDACPF Macro

The %INDACPF macro is an autocall library that initializes the format publishing software.

INDCONN Macro Variable

The INDCONN macro variable is used to provide credentials to connect to Aster. You must specify user, password, and either a DSN name or a server and database name. You must assign the INDCONN macro variable before the %INDAC_PUBLISH_FORMATS macro is invoked.

The value of the INDCONN macro variable for the %INDAC_PUBLISH_FORMATS macro has one of these formats:

USER=*username* PASSWORD=*password* DSN=*dsnname* <SCHEMA=*schemaname*>

USER=*username* PASSWORD=*password* DATABASE=*databasename* SERVER=*servername* <SCHEMA=*schemaname*>

USER=*username*
specifies the Aster user name (also called the user ID) that is used to connect to the database.

PASSWORD=*password*
specifies the password that is associated with your Aster user ID.

Tip You can use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error.

DSN=*datasourcename*
specifies the configured Aster data source to which you want to connect.

Requirement You must specify either the DSN= argument alone, or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

DATABASE=*databasename*
specifies the Aster database that contains the tables and views that you want to access.

Requirement You must specify either the DSN= argument alone, or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

SERVER=*servername*
specifies the Aster server name or the IP address of the server host.

Requirement You must specify either the DSN= argument alone, or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

SCHEMA=*schemaname*
specifies the schema name for the database.

Default Your default schema. To determine your default schema name, use the **show search_path** command from the Aster Client Tool (ACT).

Restriction The SCHEMA argument is valid only for Aster 4.6. For Aster 4.5, the format XML files are published to the PUBLIC schema.

TIP The INDCONN macro variable is not passed as an argument to the %INDAC_PUBLISH_FORMATS macro. 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.

%INDAC_PUBLISH_FORMATS Macro Syntax

%INDAC_PUBLISH_FORMATS
(<DATABASE=*database–name*>
<, FMTCAT=*format-catalog-filename* | ALL>
<, FMTLIST=*format-name* <…*format-name*> | ALL>
<, ACTION=CREATE | REPLACE | DROP>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DATABASE=*database-name*
specifies the name of an Aster database to which the format files are published to either the NC_INSTALLED_FILES table (Aster 4.5) or the NC_USER_INSTALLED_FILES table (Aster 4.6). This argument lets you publish the sasput_*type_fmtname*.xml format files to a shared database where other users can access them.

Restriction If you specify DSN= in the INDCONN macro variable, do not use the DATABASE argument. For more information, see "Running the %INDAC_PUBLISH_FORMATS Macro" on page 134.

Tip It is not necessary that the format definitions and the SAS_PUT( ) function reside in the same database as the one that contains the data that you want to format. You can use the SQLMAPPUTO= system option to specify the database where the format definitions and the SAS_PUT( ) function have been published.

FMTCAT=*format-catalog-filename* | ALL
specifies the name of the format catalog file that contains all user-defined formats that were created with the FORMAT procedure and are made available in Aster.

Default If you do not specify a value for FMTCAT= and you have created user-defined formats in your SAS session, the default is WORK.FORMATS. If you do not specify a value for FMTCAT= and you have not created any user-defined formats in your SAS session, only the formats that SAS supplies are available in Aster.

Interaction If the format definitions that you want to publish exist in multiple catalogs, you must copy them into a single catalog for publishing. If you specify more than one format catalog using the FMTCAT argument, only the last catalog that you specify is published.

See "Considerations and Limitations with User-Defined Formats" on page 129

FMTLIST=*format-name <…format-name>* | ALL
specifies a list of formats that are created, replaced, or dropped.

Default ALL

Requirement Format names must be separated with a space.

Interaction When ACTION=CREATE or REPLACE, the list of formats that are in the specified format catalog (FMTCAT=) are added to either the NC_INSTALLED_FILES table (Aster 4.5) or the NC_USER_INSTALLED_FILES table (Aster 4.6). When ACTION=DROP and FMTCAT=ALL, all the formats listed in FMTLIST are dropped. If ACTION=DROP and FMTCAT=*format-catalog-filename*, only those listed formats that exist in the format catalog are dropped.

ACTION=CREATE | REPLACE | DROP
specifies that the macro performs one of these actions:

CREATE
creates a sasput_*type_fmtname*.xml file for each user-defined format in the format catalog.

Tip If a format file already exists, an error occurs.

REPLACE
overwrites the current sasput_*type_fmtname*.xml file if it is already registered or creates a new sasput_*type_fmtname*.xml file, if one is not registered.

DROP
causes the sasput_*type_fmtname*.xml files to be dropped from either the NC_INSTALLED_FILES table (Aster 4.5) or the NC_USER_INSTALLED_FILES table (Aster 4.6) in the database.

Interaction If FMTCAT=ALL, all user-defined format files are dropped.

Default CREATE

Tip If the format files was defined previously and you specify ACTION=CREATE, you receive warning messages from Aster. If the format files were defined previously and you specify ACTION=REPLACE, a message is written to the SAS log indicating that the format file has been replaced.

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process.

See "Special Characters in Directory Names" on page 128

Format Publishing Macro Example

```
%indacpf;
%let indconn = server=acbase user=user1 password=open1 dsn=ncluster;
%indac_publish_formats(fmtcat= fmtlib.formats);
```

This sequence of macros generates an .xml file for each format. The format data types that are supported are numeric and character. The naming convention for the .xml file is sasput_*type_fmtname*.xml, where *type* is the format data type (N for numeric formats or C for character formats), and *fmtname* is the format name.

After the format files are installed, you can invoke user-defined formats in Aster *n*Cluster by using the SAS_PUT( ) function. For more information, see "Using the SAS_PUT( ) Function in the Aster Database" on page 141.

Aster Format Files

Overview of Aster Format Files

The %INDAC_PUBLISH_FORMATS macro produces a format file for each user-defined format in the format catalog. These files are inserted into either the NC_INSTALLED_FILES table under the PUBLIC schema (Aster 4.5) or the NC_USER_INSTALLED_FILES table under a specified schema (Aster 4.6). The naming convention for the file is **sasput_*type*_*fmtname*.xml**, where *type* is the format data type (N for numeric formats or C for character formats), and *fmtname* is the format name.

For an example, see "Example of a Format File" on page 139.

There are three ways to see the format files that are created:

- You can log on to the database using the Aster command line processor and submit an SQL statement. The following example assumes that three format files were created in Aster 4.6.

  ```
  >act -h hostname -u username -w password -d databasename -s schemaname
  >select name from schemaname.nc_user_installed_files where name like 'sasput_%';
  ```

  All the format files are listed:

  ```
  name
  -------------------------
  sasput_n_dinar.xml
  sasput_n_ruble.xml
  sasput_c_lowcase.xml
  ```

- From SAS, you can use SQL procedure code that produces output in the LST file.

  ```
  proc sql noerrorstop;
     connect to aster (user=username password=password dsn=dsnname schema=schemaname);
  select *
     from connection to aster
     (select filename, fileowner, uploadtime
     from schemaname.nc_user_installed_files where
  ```

```
   filename like 'sasput_%');
   disconnect from aster;
quit;
```

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

- You can look at the SAS log. A message that indicates whether the format files are successfully or not successfully created is printed to the SAS log.

Example of a Format File

Here is an example of an Aster format file. This is a partial listing.

```
<?xml version="1.0" encoding="UTF-8" ?>
<?xml-stylesheet type="text/xsl" href="SUVformats.xsl"?>
<LIBRARY type="EXPORT" version="SUV">
   <HEADER>
      <Provider>SAS Institute Inc.</Provider>
      <Version>9.2</Version>
      <VersionLong>9.02.02M0P01152009</VersionLong>
      <CreationDateTime>2009-11-13T15:19:55</CreationDateTime>
   </HEADER>

   <TABLE name="N_DIVFMT">
      <TABLE-HEADER>
         <Provider>SAS Institute Inc.</Provider>
         <Version>9.2</Version>
         <VersionLong>9.02.02M0P01152009</VersionLong>
         <CreationDateTime>2009-11-13T15:19:55</CreationDateTime>
         <ModifiedDateTime>2009-11-13T15:19:55</ModifiedDateTime>

         <Protection />
         <DataSetType />
         <DataRepresentation />
         <Encoding>UTF-8</Encoding>
         <ReleaseCreated />
         <HostCreated />
         <FileName>c:\jaseco\tmp\SASWORK\920\_TD22220\#LN00024</FileName>

         <Observations length="187" />
         <Compression compressed="No" number="1" length="252" />
         <Variables number="21" />
      </TABLE-HEADER>

      <COLUMN name="FMTNAME" order="1" label="Format name">
         <TYPE>character</TYPE>
         <DATATYPE>string</DATATYPE>
         <LENGTH>32</LENGTH>
         <Offset>0</Offset>
      </COLUMN>

      <COLUMN name="START" order="2" label="Starting value for format">
         <TYPE>character</TYPE>
         <DATATYPE>string</DATATYPE>
```

```
   <LENGTH>16</LENGTH>
   <Offset>32</Offset>
</COLUMN>

<COLUMN name="END" order="3" label="Ending value for format">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>16</LENGTH>
   <Offset>48</Offset>
</COLUMN>

<COLUMN name="LABEL" order="4" label="Format value label">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>21</LENGTH>
   <Offset>64</Offset>
</COLUMN>

<COLUMN name="MIN" order="5" label="Minimum length">
   <TYPE>numeric</TYPE>
   <DATATYPE>float</DATATYPE>
   <Offset>85</Offset>
</COLUMN>

... <more column definitions> ...

<ROW>
   <DELTA-RECORD key="DIVFMT" />
   <FMTNAME>DIVFMT</FMTNAME>
   <START>1</START>
   <END>1</END>
   <LABEL>New England</LABEL>
   <MIN>1</MIN>
   <MAX>40</MAX>
   <DEFAULT>15</DEFAULT>
   <LENGTH>15</LENGTH>
   <FUZZ>1E-12</FUZZ>
   <PREFIX missing=" " />
   <MULT>0</MULT>
   <FILL missing=" " />
   <NOEDIT>0</NOEDIT>
   <TYPE>N</TYPE>
   <SEXCL>N</SEXCL>
   <EEXCL>N</EEXCL>
   <HLO missing=" " />
   <DECSEP missing=" " />
   <DIG3SEP missing=" " />
   <DATATYPE missing=" " />
   <LANGUAGE missing=" " />
</ROW>

<ROW>
   <FMTNAME>DIVFMT</FMTNAME>
   <START>2</START>
   <END>2</END>
   <LABEL>Middle Atlantic</LABEL>
```

```
            <MIN>1</MIN>
            <MAX>40</MAX>
            <DEFAULT>15</DEFAULT>
            <LENGTH>15</LENGTH>
            <FUZZ>1E-12</FUZZ>
            <PREFIX missing=" " />
            <MULT>0</MULT>
            <FILL missing=" " />
            <NOEDIT>0</NOEDIT>
            <TYPE>N</TYPE>
            <SEXCL>N</SEXCL>
            <EEXCL>N</EEXCL>
            <HLO missing=" " />
            <DECSEP missing=" " />
            <DIG3SEP missing=" " />
            <DATATYPE missing=" " />
            <LANGUAGE missing=" " />
         </ROW>

         ... <more row definitions>...

      </TABLE>
   </LIBRARY>
```

Using the SAS_PUT( ) Function in the Aster Database

Overview of the SAS_PUT( ) Function

The SAS_PUT( ) function executes the format files using the SAS Embedded Process in Aster. The SAS_PUT( ) function is installed in the NC_INSTALLED_FILES table under the PUBLIC schema. For more information, see the *SAS In-Database Products: Administrator's Guide*.

The SAS_PUT( ) function is available to use in the SELECT clause in any SQL expression in the same way that Aster SQL/MR functions are used.

This is the syntax of the SAS_PUT( ) function.

SELECT SAS_PUT(*value* , '*fmtname*') FROM *input-table*;

Arguments

value
specifies the name of the value that the format is applied to.

fmtname
specifies the name of the format.

input-table
specifies the input table that is used by the SAS_PUT( ) function.

Implicit Use of the SAS_PUT( ) Function

After you install the SAS_PUT( ) function and formats that SAS supplies in libraries inside the Aster database, and after you publish any custom format definitions that you created in SAS, you can access the SAS_PUT( ) function with your SQL queries.

If the SQLMAPPUTTO= system option is set to SAS_PUT and you submit your program from a SAS session, the SAS SQL processor maps PUT function calls to SAS_PUT( ) function references that Aster understands.

This example illustrates how the PUT function is mapped to the SAS_PUT( ) function using implicit pass-through.

```
options sqlmapputto=sas_put;

libname dblib aster user="sas" password="sas" server="sl96208"
   database=sas connection=shared;

   /*-- Set SQL debug global options --*/
   /*-----------------------------------*/
   options sastrace=',,,d' sastraceloc=saslog;

   /*-- Execute SQL using Implicit Passthru --*/
   /*-----------------------------------------*/
   proc sql noerrorstop;
      title1 'Test SAS_PUT using Implicit Passthru ';
      select distinct
         PUT(PRICE,Dollar8.2) AS PRICE_C
            from dblib.mailorderdemo;
   quit;
```

These lines are written to the SAS log.

```
libname dblib aster user="sas" password="sas" server="sl96208"
   database=sas connection=shared;

NOTE: Libref DBLIB was successfully assigned, as follows:
      Engine:        ASTER
      Physical Name: sl96208

         /*-- Set SQL debug global options --*/
         /*-----------------------------------*/
         options sastrace=',,,d' sastraceloc=saslog;

         /*-- Execute SQL using Implicit Passthru --*/
         /*-----------------------------------------*/
         proc sql noerrorstop;
           title1 'Test SAS_PUT using Implicit Passthru ';
           select distinct
              PUT(PRICE,Dollar8.2) AS PRICE_C
            from dblib.mailorderdemo
                ;

ASTER_0: Prepared: on connection 0
SELECT * FROM sas."mailorderdemo"
```

```
ASTER_1: Prepared: on connection 0
 select distinct cast(sas_put("sas"."mailorderdemo"."PRICE", 'DOLLAR8.2')
 as char(8)) as "PRICE_C" from "sas"."mailorderdemo"

ASTER: trforc: COMMIT WORK
ACCESS ENGINE:  SQL statement was passed to the DBMS for fetching data.

ASTER_2: Executed: on connection 0
 select distinct cast(sas_put("sas"."mailorderdemo"."PRICE", 'DOLLAR8.2')
 as char(8)) as "PRICE_C" from "sas"."mailorderdemo"

ASTER: trget - rows to fetch: 9
ASTER: trforc: COMMIT WORK

              Test SAS_PUT using Implicit Passthru                        9
                                3:42 Thursday, April 25, 2012

                            PRICE_C
                            _______
                              $8.00
                             $10.00
                             $12.00
                             $13.59
                             $13.99
                             $14.00
                             $27.98
                             $48.99
                             $54.00

        quit;
```

Be aware of these items:

- The SQLMAPPUTTO= system option must be set to SAS_PUT to ensure that the SQL processor maps your PUT functions to the SAS_PUT( ) function and the SAS_PUT( ) reference is passed through to Aster. SAS_PUT is the default value for the SQLMAPPUTTO= system option.
- The SAS SQL processor translates the PUT function in the SQL SELECT statement into a reference to the SAS_PUT( ) function.

  ```
  select distinct cast(sas_put("sas"."mailorderdemo"."PRICE", 'DOLLAR8.2')
     as char(8)) as "PRICE_C" from "sas"."mailorderdemo"
  ```

  A large value, VARCHAR(*n*), is always returned because one function prototype accesses all formats. Use the CAST expression to reduce the width of the returned column to be a character width that is reasonable for the format that is being used.

  The return text cannot contain a binary zero value (hexadecimal 00) because the SAS_PUT( ) function always returns a VARCHAR(*n*) data type and an Aster VARCHAR(*n*) is defined to be a null-terminated string.

The SELECT DISTINCT clause executes inside Aster, and the processing is distributed across all available data nodes. Aster formats the price values with the $DOLLAR8.2 format and processes the SELECT DISTINCT clause using the formatted values.

Explicit Use of the SAS_PUT( ) Function

If you use explicit pass-through (direct connection to Aster), you can use the SAS_PUT( ) function call in your SQL program.

This example shows the same query from "Implicit Use of the SAS_PUT( ) Function" on page 142 and explicitly uses the SAS_PUT( ) function call.

```
proc sql noerrorstop;
   title1 'Test SAS_PUT using Explicit Passthru;
   connect to aster(user=sas password=XXX database=sas server=sl96208);

   select * from connection to aster
      (select distinct cast(sas_put("PRICE",'DOLLAR8.2') as char(8)) as
         "PRICE_C" from mailorderdemo);

disconnect from aster;
quit;
```

The following lines are written to the SAS log.

```
 proc sql noerrorstop;
 title1 'Test SAS_PUT using Explicit Passthru ';
 connect to aster(user=sas password=XXX database=sas server=sl96208);

 select * from connection to aster
    (select distinct cast(sas_put("PRICE",'DOLLAR8.2') as char(8)) as
        "PRICE_C" from mailorderdemo);

            Test SAS_PUT using Explicit Passthru                        10
                                        13:42 Thursday, April 25, 2012

                          PRICE_C
                          _______
                            $8.00
                           $10.00
                           $12.00
                           $13.59
                           $13.99
                           $14.00
                           $27.98
                           $48.99
                           $54.00

disconnect from aster;
quit;
```

Note: If you explicitly use the SAS_PUT( ) function in your code, it is recommended that you use double quotation marks around a column name to avoid any ambiguity with the keywords. For example, if you did not use double quotation marks around the column name, DATE, in this example, all date values would be returned as today's date.

```
select distinct
   cast(sas_put("price", 'dollar8.2') as char(8)) as "price_c",
   cast(sas_put("date", 'date9.1') as char(9)) as "date_d",
   cast(sas_put("inv", 'best8.') as char(8))  as "inv_n",
```

```
   cast(sas_put("name", '$32.') as char(32)) as "name_n"
from mailorderdemo;
```

Aster Permissions

For Aster 4.5, the person who runs the format publishing macros needs no permissions, because all functions and files are published to the PUBLIC schema.

For Aster 4.6, the person who runs the format publishing macros needs the following permissions, because all functions and files can be published to a specific schema.

- USAGE permission
- INSTALL FILE permission
- CREATE permission

Without these permissions, the publishing of the %INDAC_PUBLISH_FORMATS macro fails. To obtain these permissions, contact your database administrator.

For more information about specific permissions, see the *SAS In-Database Products: Administrator's Guide*.

Chapter 13

Deploying and Using SAS Formats in DB2 under UNIX

User-Defined Formats in the DB2 Database

You can use PROC FORMAT to create user-defined formats and store them in a format catalog. You can then use the %INDB2_PUBLISH_FORMATS macro to export the user-defined format definitions to the DB2 database where the SAS_PUT( ) function can reference them.

For more information about the %INDB2_PUBLISH_FORMATS macro, see "Publishing SAS Formats in DB2" on page 147. For more information about the SAS_PUT( ) function, see "Using the SAS_PUT( ) Function in the DB2 Database" on page 154.

Publishing SAS Formats in DB2

Overview of the Publishing Process

The SAS publishing macros are used to publish formats and the SAS_PUT( ) function in DB2.

Note: SFTP is used to transfer the source files to the DB2 server during the publishing process. Certain software products that support SSH-2 or SFTP protocols must be

installed before you can use the publishing macros. For more information, see the *SAS In-Database Products: Administrator's Guide*.

The %INDB2_PUBLISH_FORMATS macro creates the files that are needed to build the SAS_PUT( ) function and publishes those files to the DB2 database.

This macro also makes many formats that SAS supplies available inside DB2. In addition to formats that SAS supplies, you can also publish the PROC FORMAT definitions that are contained in a single SAS format catalog by using the FMTCAT= option. The process of publishing a PROC FORMAT catalog entry converts the range label pairs into embedded data in DB2.

The %INDB2_PUBLISH_FORMATS macro performs the following tasks:

- produces the set of .c and .h files that are necessary to build the SAS_PUT( ) function
- produces a script of the DB2 commands that are necessary to register the SAS_PUT( ) function in the DB2 database
- transfers the .c and .h files to DB2 using SFTP
- calls the SAS_COMPILEUDF function to compile the source files into object files and to link to the SAS Formats Library for DB2
- calls the SAS_DELETEUDF function to remove existing object files and then replaces them with the new object files
- uses the SAS/ACCESS Interface to DB2 to run the script and publish the SAS_PUT( ) function to the DB2 database

The SAS_PUT( ) function is registered in DB2 with shared object files that are loaded at run time. These functions must be stored in a permanent location. The SAS object files and the SAS Formats Library for DB2 are stored in the ***db2path*/SQLLIB/FUNCTION/SAS** directory where you supply the ***db2path***. This directory is accessible to all database partitions.

DB2 caches the object files after they are loaded. Each time the updated objects are used, you must either stop and restart the database to clean up the cache, or you can rename the object files and register the functions with the new object filenames. The SAS publishing process automatically handles the renaming to avoid stopping and restarting the database.

Running the %INDB2_PUBLISH_FORMATS Macro

To run the %INDB2_PUBLISH_FORMATS macro, follow these steps:

1. Start SAS 9.3 and submit these commands in the Program Editor or the Enhanced Editor:

   ```
   %indb2pf;
   %let indconn = server=yourserver user=youruserid password=yourpwd
      database=yourdb schema=yourschema serveruserid=yourserveruserid;
   ```

   For more information, see "%INDB2PF Macro" on page 149 and "INDCONN Macro Variable" on page 149.

2. Run the %INDB2_PUBLISH_FORMATS macro.

   For more information, see "%INDB2_PUBLISH_FORMATS Macro Syntax" on page 150.

   Messages are written to the SAS log that indicate whether the SAS_PUT( ) function was successfully created.

%INDB2PF Macro

The %INDB2PF macro is an autocall library that initializes the format publishing software.

INDCONN Macro Variable

The INDCONN macro variable is used as credentials to connect to DB2. You must specify the server, user, password, and database. The schema name and server user ID are optional. You must assign the INDCONN macro variable before the %INDB2_PUBLISH_FORMATS macro is invoked.

Here is the syntax for the value of the INDCONN macro variable:

SERVER=*server* USER=*userid* PASSWORD=*password*
DATABASE=*database* <SCHEMA=*schemaname*> <SERVERUSERID=*serveruserid*>

Arguments

SERVER=*server*
specifies the DB2 server name or the IP address of the server host. If the server name contains spaces or nonalphanumeric characters, you must enclose it in quotation marks.

Requirement The name must be consistent with how the host name was cached when SFTP *server* was run from the command window. If the full server name was cached, you must use the full server name in the SERVER argument. If the short server name was cached, you must use the short server name. For example, if the long name, *disk3295.unx.comp.com*, is used when SFTP was run, then *server=disk3295.unx.comp.com* must be specified. If the short name, *disk3295*, was used, then *server=disk3295* must be specified. For more information about running the SFTP command, see "DB2 Installation and Configuration Steps" in Chapter 3 of SAS In-Database Products: Administrator's Guide.

USER=*userid*
specifies the DB2 user name (also called the user ID) that is used to connect to the database.

PASSWORD=*password*
specifies the password that is associated with your DB2 user ID.

Tip Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error.

DATABASE=*database*
specifies the DB2 database that contains the tables and views that you want to access.

Requirement The format functions are created as Unicode functions. If the database is not a Unicode database, then the alternate collating sequence must be configured to use `identity_16bit`.

SCHEMA=*schema*
specifies the schema name for the database.

Default If you do not specify a value for the SCHEMA argument, the value of the USER argument is used as the schema name.

SERVERUSERID=*serveruserid*
specifies the user ID for SAS SFTP and enables you to access the machine on which you have installed the DB2 database.

Default If you do not specify a value for the SERVERUSERID argument, the value of the USER argument is used as the user ID for SAS SFTP.

Note The person who installed and configured the SSH software can provide the SERVERUSERID (SFTP user ID) and the private key that need to be added to the pageant.exe (Windows) or SSH agent (UNIX). In order for the SFTP process to be successful, Pageant must be running on Windows, and the SSH agent must be running on UNIX.

TIP The INDCONN macro variable is not passed as an argument to the %INDB2_PUBLISH_FORMATS macro. 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.

%INDB2_PUBLISH_FORMATS Macro Syntax

%INDB2_PUBLISH_FORMATS
(<DATABASE=*database–name*>
<, FMTCAT=*format-catalog-filename*>
<, FMTTABLE=*format-table-name*>
<, ACTION=CREATE | REPLACE | DROP>
<, MODE=FENCED | UNFENCED>
<, INITIAL_WAIT=*wait-time*>
<, FTPTIMEOUT=*timeout-time*>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DATABASE=*database-name*
specifies the name of a DB2 database to which the SAS_PUT( ) function and the formats are published. This argument lets you publish the SAS_PUT( ) function and the formats to a shared database where other users can access them.

Requirement The format functions are created as Unicode functions. If the database is not a Unicode database, then the alternate collating sequence must be configured to use **`identity_16bit`**.

Interaction The database that is specified by the DATABASE= argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "Running the %INDB2_PUBLISH_FORMATS Macro" on page 148.

Tip It is not necessary that the format definitions and the SAS_PUT( ) function reside in the same database as the one that contains the data that you want to format. You can use the SQLMAPPUTO= system option to specify the database where the format definitions and the SAS_PUT( ) function have been published.

FMTCAT=*format-catalog-filename*
specifies the name of the format catalog file that contains all user-defined formats that were created with the FORMAT procedure and are made available in DB2.

Default If you do not specify a value for FMTCAT= and you have created user-defined formats in your SAS session, the default is WORK.FORMATS. If you do not specify a value for FMTCAT= and you have not created any user-defined formats in your SAS session, only the formats that SAS supplies are available in DB2.

Interaction If the format definitions that you want to publish exist in multiple catalogs, you must copy them into a single catalog for publishing. If you specify more than one format catalog using the FMTCAT argument, only the last catalog that you specify is published.

See "Considerations and Limitations with User-Defined Formats" on page 129

FMTTABLE=*format-table-name*
specifies the name of the DB2 table that contains all formats that the %INDB2_PUBLISH_FORMATS macro creates and that the SAS_PUT( ) function supports. The format table contains the columns shown in the following table.

Table 13.1 *Format Table Columns*

Column Name	Description
FMTNAME	specifies the name of the format.
SOURCE	specifies the origin of the format. SOURCE can contain one of these values: SAS supplied by SAS PROCFMT User–defined with PROC FORMAT

Default If FMTTABLE is not specified, no table is created. You can see only the SAS_PUT( ) function. You cannot see the formats that are published by the macro.

Interaction If ACTION=CREATE or ACTION=DROP is specified, messages are written to the SAS log that indicate the success or failure of the table creation or drop.

ACTION=CREATE | REPLACE | DROP
specifies that the macro performs one of these actions:

CREATE
creates a new SAS_PUT( ) function.

REPLACE
overwrites the current SAS_PUT( ) function, if a SAS_PUT( ) function is already registered or creates a new SAS_PUT( ) function if one is not registered.

DROP
causes the SAS_PUT( ) function to be dropped from the DB2 database.

Interaction If FMTTABLE= is specified, both the SAS_PUT( ) function and the format table are dropped. If the table name cannot be found or is incorrect, only the SAS_PUT( ) function is dropped.

Default CREATE

Tip If the SAS_PUT( ) function was defined previously and you specify ACTION=CREATE, you receive warning messages from DB2. If the SAS_PUT( ) function was defined previously and you specify ACTION=REPLACE, a message is written to the SAS log indicating that the SAS_PUT( ) function has been replaced.

MODE=FENCED | UNFENCED
specifies whether the running code is isolated in a separate process in the DB2 database so that a program fault does not cause the database to stop.

Default FENCED

Tip Once the SAS formats are validated in fenced mode, you can republish them in unfenced mode for a significant performance gain.

INITIAL_WAIT=*wait-time*
specifies the initial wait time in seconds for SAS SFTP to parse the responses and complete the SFTP batch-file process.

Default 15 seconds

Interactions The INITIAL_WAIT= argument works in conjunction with the FTPTIMEOUT= argument. Initially, SAS SFTP waits the amount of time specified by the INITIAL_WAIT= argument. If the SFTP batch-file process is not complete after the initial wait time, retries occur until the wait time is equal to or greater than the time-out value specified by the FTPTIMEOUT= argument. All retries double the previous wait time. SAS SFTP fails after the time-out value is reached or exceeded. An error message is written to the SAS log.

For example, assume that you use the default values. The initial wait time is 15 seconds. The first retry waits 30 seconds. The second retry waits 60 seconds. The third retry waits 120 seconds, which is the default time-out value. So the default initial wait time and time-out values enable four possible tries: the initial try, and three retries.

See FTPTIMEOUT= argument

FTPTIMEOUT=*time-out-value*
specifies the time-out value in seconds if SAS SFTP fails to transfer the files.

Default 120 seconds

Interactions The FTPTIMEOUT= argument works in conjunction with the INITIAL_WAIT= argument. Initially, SAS SFTP waits the amount of time specified by the INITIAL_WAIT= argument. If the SFTP batch-file process is not complete after the initial wait time, retries occur until the wait time is equal to or greater than the time-out value specified by the FTPTIMEOUT= argument. All retries double the

previous wait time. SAS SFTP fails after the time-out value is reached or exceeded and an error message is written to the SAS log.

For example, assume you use the default values. The initial wait time is 15 seconds. The first retry waits 30 seconds. The second retry waits 60 seconds. The third retry waits 120 seconds, which is the default time-out value. So the default initial wait time and time-out values enable four possible tries: the initial try, and three retries.

Tip Use this argument to control how long SAS SFTP waits to complete a file transfer before timing out. A time-out failure could indicate a network or key authentication problem.

See INITIAL_WAIT argument

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process.

See "Special Characters in Directory Names" on page 128

Modes of Operation

There are two modes of operation when executing the %INDB2_PUBLISH_FORMATS macro: fenced and unfenced. You specify the mode by setting the MODE= argument.

The default mode of operation is fenced. Fenced mode means that the macro code is isolated in a separate process in the DB2 database, and an error does not cause the database to stop. It is recommended that you run the %INDB2_PUBLISH_FORMATS macro in fenced mode during acceptance tests.

When the %INDB2_PUBLISH_FORMATS macro is ready for production, you can rerun the macro in unfenced mode. Note that you should see a significant performance advantage when you republish the formats in unfenced mode.

Format Publishing Macro Example

```
%indb2pf;
%let indconn = server=db2base user=user1 password=open1
database=mydb schema=myschema;
%indb2_publish_formats(fmtcat= fmtlib.fmtcat);
```

This sequence of macros generates .c and .h files for each data type. The format data types that are supported are numeric (FLOAT, INT), character, date, time, and timestamp (DATETIME). The %INDB2_PUBLISH_FORMATS macro also produces a text file of DB2 CREATE FUNCTION commands that are similar to these:

```
CREATE FUNCTION sas_put(float , varchar(256))
RETURNS VARCHAR(256)
LANGUAGE C
PARAMETER STYLE npsgeneric
CALLED ON NULL INPUT
EXTERNAL CLASS NAME 'Csas_putn'
EXTERNAL HOST OBJECT '/tmp/tempdir_20090528T135753_616784/formal5.o_x86'
EXTERNAL NSPU OBJECT '/tmp/tempdir_20090528T135753_616784/formal5.o_diab_ppc'
```

After it is installed, you can call the SAS_PUT( ) function in DB2 by using SQL. For more information, see "Using the SAS_PUT( ) Function in the DB2 Database" on page 154.

Using the SAS_PUT( ) Function in the DB2 Database

Implicit Use of the SAS_PUT( ) Function

After you install the formats that SAS supplies in libraries inside the DB2 database and publish any custom format definitions that you created in SAS, you can access the SAS_PUT( ) function with your SQL queries.

If the SQLMAPPUTTO= system option is set to SAS_PUT and you submit your program from a SAS session, the SAS SQL processor maps PUT function calls to SAS_PUT( ) function references that DB2 understands.

This example illustrates how the PUT function is mapped to the SAS_PUT( ) function using implicit pass-through.

```
%let mapconn=user=sas1 password=sas31 database=indb;
libname dblib db2 &mapconn;

data dblib.shoes;
set sashelp.shoes;
run;

options sastrace=',,,d' sastraceloc=saslog;

proc sql noerrorstop;
title 'Test SAS_PUT using Implicit PassThru/LIBNAME ';
select distinct
       PUT(SALES, Dollar8.2)AS SALES_C from dblib.SHOES;
quit;
```

These lines are written to the SAS log.

```
1726   options sastrace=',,,d' sastraceloc=saslog;
1727
1728   proc sql noerrorstop;
1729   title 'Test SAS_PUT using Implicit PassThru/LIBNAME ';
1730   select distinct
1731          PUT(SALES, Dollar8.2)AS SALES_C from dblib.SHOES;
DB2: AUTOCOMMIT turned ON for connection id 0 1854 1309265953 setconlo 0 SQL
  1855 1309265953 du_prep 0 SQL
DB2_363: Prepared: on connection 0 1856 1309265953 du_prep 0 SQL
SELECT * FROM SHOES FOR READ ONLY  1857 1309265953 du_prep 0 SQL
  1858 1309265953 du_prep 0 SQL
DB2: COMMIT performed on connection 0. 1859 1309265953 du_comm 0 SQL
  1860 1309265953 du_prep 0 SQL
DB2_364: Prepared: on connection 0 1861 1309265953 du_prep 0 SQL
 select distinct cast(SAS_PUT(TXT_1."SALES", 'DOLLAR8.2') as char(8))
      as SALES_C from SHOES TXT_1
FOR READ ONLY  1862 1309265953 du_prep 0 SQL
  1863 1309265953 du_prep 0 SQL
```

```
DB2: COMMIT performed on connection 0. 1864 1309265953 du_comm 0 SQL
  1865 1309265953 du_exec 0 SQL
DB2_365: Executed: on connection 0 1866 1309265953 du_exec 0 SQL
Prepared statement DB2_364 1867 1309265953 du_exec 0 SQL
  1868 1309265953 du_exec 0 SQL
ACCESS ENGINE:  SQL statement was passed to the DBMS for fetching data.
    1869 1309265953 fetch 0
SQL
1732   quit;
```

Be aware of these items:

- The SQLMAPPUTTO= system option must be set to SAS_PUT to ensure that the SQL processor maps your PUT functions to the SAS_PUT( ) function and the SAS_PUT( ) reference is passed through to DB2.
- The SAS SQL processor translates the PUT function in the SQL SELECT statement into a reference to the SAS_PUT( ) function.

  ```
  select distinct cast(sas_put("dblib"."shoes"."SALES", 'DOLLAR12.2')
     as char(12)) as "SALES_C" from "dblib"."shoes"
  ```

  A large value, VARCHAR(*n*), is always returned because one function prototype accesses all formats. Use the CAST expression to reduce the width of the returned column to be a character width that is reasonable for the format that is being used.

  The return text cannot contain a binary zero value (hexadecimal 00) because the SAS_PUT( ) function always returns a VARCHAR(*n*) data type and a DB2 VARCHAR(*n*) is defined to be a null-terminated string.

The SELECT DISTINCT clause executes inside DB2, and the processing is distributed across all available data nodes. DB2 formats the sales values with the $DOLLAR12.2 format and processes the SELECT DISTINCT clause using the formatted values.

Explicit Use of the SAS_PUT( ) Function

If you use explicit pass-through (direct connection to DB2), you can use the SAS_PUT( ) function call in your SQL program.

This example shows the same query from "Implicit Use of the SAS_PUT( ) Function" on page 154 and explicitly uses the SAS_PUT( ) function call.

```
%let mapconn=user=sasts password=xxxx database=indb;
libname dblib db2 &mapconn;

data dblib.shoes;
set sashelp.shoes;
run;

options sastrace=',,,d' sastraceloc=saslog;

proc sql noerrorstop;
title 'Test SAS_PUT using Explicit Passthru ';
connect to db2 (user=sas3 password=sas31 database=indb);
select * from connection to db2
  (select distinct (sas_put("SALES",'DOLLAR12.2')) as "SALES_C" from SHOES);
disconnect from db2;
quit;
```

The following lines are written to the SAS log.

```
1733
1734   proc sql noerrorstop;
1735   title 'Test SAS_PUT using Explicit Passthru ';
1736   connect to db2 (user=db2 password=XXXXXXXXXXXX database=indb);
DB2: AUTOCOMMIT is YES for connection 4 1870 1309265953 ducon 0 SQL
1737   select * from connection to db2
1738     (select distinct (sas_put("SALES",'DOLLAR12.2')) as "SALES_C" from
SHOES);
  1871 1309265953 du_prep 0 SQL
DB2_366: Prepared: on connection 4 1872 1309265953 du_prep 0 SQL
select distinct (sas_put("SALES",'DOLLAR12.2')) as "SALES_C" from SHOES 1873
1309265953 du_prep 0
SQL
  1874 1309265953 du_prep 0 SQL
DB2: COMMIT performed on connection 4. 1875 1309265953 du_comm 0 SQL
  1876 1309265953 du_exec 0 SQL
DB2_367: Executed: on connection 4 1877 1309265953 du_exec 0 SQL
Prepared statement DB2_366 1878 1309265953 du_exec 0 SQL
  1879 1309265953 du_exec 0 SQL
1739   disconnect from db2;
1740   quit;
```

Note: If you explicitly use the SAS_PUT( ) function in your code, it is recommended that you use double quotation marks around a column name to avoid any ambiguity with the keywords. For example, if you did not use double quotation marks around the column name, DATE, in this example, all date values would be returned as today's date.

```
select distinct
   cast(sas_put("sales", 'dollar12.2') as char(12)) as "sales_c",
   from shoes;
```

DB2 Permissions

You must have DB2 user permissions to execute the SAS publishing macros to publish the SAS_PUT( ) and format functions. Some of these permissions are as follows.

- EXECUTE user permission for functions that were published by another user
- READ user permission to read the SASUDF_COMPILER_PATH and SASUDF_DB2PATH global variables
- CREATE_EXTERNAL_ROUTINE user permission to the database to create functions
- CREATEIN user permission for the schema in which the SAS_PUT( ) and format functions are published if a nondefault schema is used
- CREATE_NOT_FENCED_ROUTINE user permission to create functions that are not fenced

Permissions must be granted for each user that needs to publish the SAS_PUT( ) and format functions and for each database that the format publishing uses. Without these permissions, publishing of the SAS_PUT( ) and format functions fail.

The person who can grant the permissions and the order in which permissions are granted is important. For complete information and examples, see the installation and configuration instructions in the *SAS In-Database Products: Administrator's Guide*.

Chapter 14

Deploying and Using SAS Formats in Greenplum

User-Defined Formats in the Greenplum Database

You can use PROC FORMAT to create user-defined formats and store them in a format catalog. You can then use the %INDGP_PUBLISH_FORMATS macro to export the user-defined format definitions to the Greenplum database where the SAS_PUT( ) function can reference them.

For more information about the %INDGP_PUBLISH_FORMATS macro, see "Publishing SAS Formats in Greenplum" on page 159. For more information about the SAS_PUT( ) function, see "Using the SAS_PUT( ) Function in Greenplum" on page 164.

Publishing SAS Formats in Greenplum

Overview of the Publishing Process

The SAS publishing macros are used to publish formats and the SAS_PUT( ) function in Greenplum.

The %INDGP_PUBLISH_FORMATS macro creates the files that are needed to build the SAS_PUT( ) function and publishes those files to the Greenplum database.

This macro also makes many formats that SAS supplies available inside Greenplum. In addition to formats that SAS supplies, you can publish the PROC FORMAT definitions that are contained in a single SAS format catalog by using the FMTCAT= option. The process of publishing a PROC FORMAT catalog entry converts the range label pairs into embedded data in Greenplum.

The %INDGP_PUBLISH_FORMATS macro performs the following tasks:

- produces the set of .c and .h files that are necessary to build the SAS_PUT( ) function
- produces a script of the Greenplum commands that are necessary to register the SAS_PUT( ) function in the Greenplum database
- transfers the .c and .h files to Greenplum
- calls the SAS_COMPILEUDF function to compile the source files into object files and links to the SAS Formats Library
- calls the SAS_COPYUDF function to copy the new object files to ***full-path-to-pkglibdir/SAS*** on the whole database array (master and all segments) , where ***full-path-to-pkglibdir*** is the path that was defined during installation.
- uses the SAS/ACCESS Interface to Greenplum to run the script to publish the SAS_PUT( ) function to the Greenplum database

The SAS_PUT( ) function is registered in Greenplum with shared object files that are loaded at run time. These functions must be stored in a permanent location. The SAS object files and the SAS Formats Library are stored in the ***full-path-to-pkglibdir/SAS*** directory on all nodes, where ***full-path-to-pkglibdir*** is the path that was defined during installation.

Greenplum caches the object files within a session.

Note: You can publish format functions with the same name in multiple databases and schemas. Because all format object files are stored in the ***full-path-to-pkglibdir/SAS*** directory, the publishing macro uses the database, schema, and model name as the object filename to avoid potential naming conflicts.

Running the %INDGP_PUBLISH_FORMATS Macro

To run the %INDGP_PUBLISH_FORMATS macro, follow these steps:

1. Start SAS 9.3, and submit one of the following sets of commands in the Program Editor or the Enhanced Editor:

```
%indgppf;
%let indconn = user=youruserid password=yourpwd dsn=yourdsn schema=yourschema;
```

```
%indgppf;
%let indconn = user=youruserid password=yourpwd
   database=yourdb server=yourserver schema=yourschema;
```

   For more information, see "%INDGPPF Macro" on page 161 and the "INDCONN Macro Variable" on page 161.

2. Run the %INDGP_PUBLISH_FORMATS macro.

   For more information, see "%INDGP_PUBLISH_FORMATS Macro Syntax" on page 162.

Messages are written to the SAS log that indicate whether the SAS_PUT( ) function and format functions were successfully created.

%INDGPPF Macro

The %INDGPPF macro is an autocall library that initializes the format publishing software.

INDCONN Macro Variable

The INDCONN macro variable is used as credentials to connect to Greenplum. You must specify the user, password, and either a DSN name or a server and database name. The schema name is optional. You must assign the INDCONN macro variable before the %INDGD_PUBLISH_FORMATS macro is invoked.

The value of the INDCONN macro variable for the %INDGP_PUBLISH_FORMATS macro has one of these formats:

USER=*username* PASSWORD=*password* DSN=*dsnname* <SCHEMA=*schemaname*>

USER=*username* PASSWORD=*password* SERVER=*servername* DATABASE=*databasename* <SCHEMA=*schemaname*>

Arguments

USER=*username*
specifies the Greenplum user name (also called the user ID) that is used to connect to the database.

PASSWORD=*password*
specifies the password that is associated with your Greenplum user ID.

Tip Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error.

DSN=*datasourcename*
specifies the configured Greenplum ODBC data source to which you want to connect.

Requirement You must specify either the DSN= argument or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

SERVER=*servername*
specifies the Greenplum server name or the IP address of the server host.

Requirement You must specify either the DSN= argument or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

DATABASE=*databasename*
specifies the Greenplum database that contains the tables and views that you want to access.

Requirement You must specify either the DSN= argument or the SERVER= and DATABASE= arguments in the INDCONN macro variable.

SCHEMA=*schemaname*
specifies the schema name for the database.

Tip If you do not specify a value for the SCHEMA argument, the value of the USER argument is used as the schema name. The schema must be created by your database administrator.

TIP The INDCONN macro variable is not passed as an argument to the %INDGP_PUBLISH_FORMATS macro. 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.

%INDGP_PUBLISH_FORMATS Macro Syntax

%INDGP_PUBLISH_FORMATS
(<DATABASE=*database-name*>
<, FMTCAT=*format-catalog-filename*>
<, FMTTABLE=*format-table-name*>
<, ACTION=CREATE | REPLACE | DROP>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DATABASE=*database-name*
specifies the name of a Greenplum database to which the SAS_PUT( ) function and the format functions are published.

Restriction If you specify DSN= in the INDCONN macro variable, do not use the DATABASE argument.

Interaction The database that is specified by the DATABASE= argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "Running the %INDGP_PUBLISH_FORMATS Macro" on page 160.

FMTCAT=*format-catalog-filename*
specifies the name of the format catalog file that contains all user-defined formats that were created by the FORMAT procedure and are made available in Greenplum.

Defaults If you do not specify a value for FMTCAT= and you have created user-defined formats in your SAS session, the default is WORK.FORMATS.

If you do not specify a value for FMTCAT= and you have not created any user-defined formats in your SAS session, only the formats that SAS supplies are available in Greenplum.

Interactions If the format definitions that you want to publish exist in multiple catalogs, you must copy them into a single catalog for publishing.

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 *Base SAS Procedures Guide*.

FMTTABLE=*format-table-name*
specifies the name of the Greenplum table that contains all formats that the %INDGP_PUBLISH_FORMATS macro creates and that the SAS_PUT( ) function supports. The format table contains the columns shown in following table.

Table 14.1 *Format Table Columns*

Column Name	Description
FMTNAME	specifies the name of the format.
SOURCE	specifies the origin of the format. SOURCE can contain one of these values: SAS supplied by SAS PROCFMT User-defined with PROC FORMAT

Default If FMTTABLE is not specified, no table is created. You can see only the SAS_PUT( ) function. You cannot see the formats that are published by the macro.

Interaction If ACTION=CREATE or ACTION=DROP is specified, messages are written to the SAS log that indicate the success or failure of the table creation or drop.

ACTION=CREATE | REPLACE | DROP
specifies that the macro performs one of these actions:

CREATE
creates the SAS_PUT( ) function.

REPLACE
overwrites the current SAS_PUT( ) function, if a SAS_PUT( ) function is already registered.

DROP
causes the SAS_PUT( ) function to be dropped from the Greenplum database.

Default CREATE

Tip If the SAS_PUT( ) function has been previously defined and you specify ACTION=CREATE, you receive warning messages from Greenplum. If the function has been previously defined and you specify ACTION=REPLACE, no warnings are issued.

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process.

See "Special Characters in Directory Names" on page 128

Format Publishing Macro Example

```
%indgppf;
%let indconn = user=user1 password=xxxx dsn=dsnx34 schema=block;
%indgp_publish_formats(fmtcat=work.formats);
```

This sequence of macros generates a .c and a .h files for each data type. The format data types that are supported are numeric (FLOAT, INT), character, date, time, and timestamp (DATETIME). The %INDGP_PUBLISH_FORMATS macro also produces a text file of Greenplum CREATE FUNCTION commands that are similar to these:

```
CREATE OR REPLACE FUNCTION dbitest.homeeq_5_em_classification
(
float8,
float8,
float8,
float8,
float8,
varchar(32),
float8,
float8,
varchar(32),
float8,
float8
)
RETURNS varchar(33)
AS '/usr/local/greenplum-db-3.3.4.0/lib/postgresql/SAS/sample_dbitest_homeeq_5.so',
   'homeeq_5_em_classification'
```

After it is installed, you can use SQL to call the SAS_PUT( ) function in Greenplum. For more information, see "Using the SAS_PUT( ) Function in Greenplum" on page 164.

Using the SAS_PUT( ) Function in Greenplum

Implicit Use of the SAS_PUT( ) Function

After you install the formats that SAS supplies in libraries inside the Greenplum data warehouse and publish any custom format definitions that you created in SAS, you can access the SAS_PUT( ) function with your SQL queries.

If the SQLMAPPUTTO= system option is set to SAS_PUT (the default) and you submit your program from a SAS session, the SAS SQL processor maps PUT function calls to SAS_PUT( ) function references that Greenplum understands.

This example illustrates how the PUT function is mapped to the SAS_PUT( ) function using implicit pass-through.

```
/* implicit pass-thru query */
options sqlgeneration=dbms sqlreduceput=none;
options sastrace=',,,d' sastraceloc=saslog
        sql_ip_trace=(note,source) msglevel=i;

proc sql noerrorstop reduceput=none details="reduce_put_bench$";
```

```
create table fmt_ipout as
   select distinct id, put(a,ANIMAL.) len=50 as fmtresult
     from dblib.sample ;
quit;
options sastrace=',,,,'
       sql_ip_trace=none msglevel=n;
```

This is a partial listing of the lines that are written to the SAS log.

```
/*
GREENPL_1: Prepared:
SELECT * FROM SAMPLE FOR READ ONLY

NOTE: XOG: Put Ping Query
NOTE: SELECT SAS_PUT('ANIMAL', '$IS-INTRINSIC') AS X, SAS_PUT('ANIMAL',
      '$FMT-META') AS Y FROM (SELECT COUNT(*) AS C FROM  SAMPLE WHERE 0=1)

GREENPL_2: Prepared:
select distinct TXT_1."id", cast(SAS_PUT(TXT_1."a", 'ANIMAL20.0') as char(20))
   as fmtresult from SAMPLE TXT_1

SQL_IP_TRACE: pushdown attempt # 1
SQL_IP_TRACE: passed down query:
select distinct TXT_1."id", cast(SAS_PUT(TXT_1."a", 'ANIMAL20.0') as char(20))
   as fmtresult from SAMPLE TXT_1
SQL_IP_TRACE: The SELECT statement was passed to the DBMS.

GREENPL_3: Executed:
Prepared statement GREENPL_2

ACCESS ENGINE:  SQL statement was passed to the DBMS for fetching data.
*/
```

Be aware of these items:

- The SQLMAPPUTTO= system option must be set to SAS_PUT to ensure that the SQL processor maps your PUT functions to the SAS_PUT( ) function and the SAS_PUT( ) reference is passed through to Greenplum.
- The SAS SQL processor translates the PUT function in the SQL SELECT statement into a reference to the SAS_PUT( ) function.

  ```
  select distinct TXT_1."id",
     cast(SAS_PUT(TXT_1."a", 'ANIMAL20.0') as char(20)) as fmtresult
     from SAMPLE TXT_1
  ```

  A large value, VARCHAR(*n*), is always returned because one function prototype accesses all formats. Use the CAST expression to reduce the width of the returned column to be a character width that is reasonable for the format that is being used.

  The return text cannot contain a binary zero value (hexadecimal 00) because the SAS_PUT( ) function always returns a VARCHAR(*n*) data type and a Greenplum VARCHAR(*n*) is defined to be a null-terminated string.

The SELECT DISTINCT clause executes inside Greenplum, and the processing is distributed across all available data nodes. Greenplum formats the **id** values with the ANIMAL 20.0 format and processes the SELECT DISTINCT clause using the formatted values.

Explicit Use of the SAS_PUT( ) Function

If you use explicit pass-through (direct connection to Greenplum), you can use the SAS_PUT( ) function call in your SQL program.

This example shows the same query from "Implicit Use of the SAS_PUT( ) Function" on page 164 and explicitly uses the SAS_PUT( ) function call.

```
options sastrace=',,,d' sastraceloc=saslog
        sql_ip_trace=(note,source) msglevel=i;

proc sql noerrorstop;
connect to greenplm (&exconn) ;
create table fmt_epout as
select * from connection to greenplm (
select id, sas_put(a,'ANIMAL' ) as FMTRESULT
from sample
);
quit;
options sastrace=',,,,'
        sql_ip_trace=none msglevel=n;
```

This is a partial listing of the lines that are written to the SAS log.

```
/*
GREENPL_4: Prepared:
select id, sas_put(a,'ANIMAL' ) as FMTRESULT from sample

GREENPL_5: Executed:
Prepared statement GREENPL_4
*/
```

Note: If you explicitly use the SAS_PUT( ) function in your code, it is recommended that you use double quotation marks around a column name to avoid any ambiguity with the keywords. For example, if you did not use double quotation marks around the column name, DATE, in this example, all date values would be returned as today's date.

```
select distinct
   cast(sas_put("id", 'animal20.0') as char(20)) as "id",
   from sample;
```

Greenplum Permissions

You must have Greenplum superuser permissions to execute the %INDGP_PUBLISH_FORMATS macro that publishes the SAS_PUT( ) function and the format functions. Greenplum requires superuser permissions to create C functions in the database.

Without these permissions, the publishing of the SAS_PUT( ) function and user-defined formats fails. To obtain these permissions, contact your database administrator.

For more information about specific permissions, see the *SAS In-Database Products: Administrator's Guide*.

Chapter 15

Deploying and Using SAS Formats in Netezza

User-Defined Formats in the Netezza Data Warehouse

Introduction to User-Defined Formats in Netezza

You can use PROC FORMAT to create user-defined formats and store them in a format catalog. You can then use the %INDNZ_PUBLISH_FORMATS macro to export the user-defined format definitions to the Netezza data warehouse where the SAS_PUT( ) function can reference them.

For more information about the %INDNZ_PUBLISH_FORMATS macro, see "Publishing SAS Formats in Netezza" on page 168. For more information about the SAS_PUT( ) function, see "Using the SAS_PUT( ) Function in the Netezza Data Warehouse " on page 173.

Netezza Considerations and Limitations When Using the FMTCAT= Options

If you use the FMTCAT= option to specify a format catalog in the %INDNZ_PUBLISH_FORMATS macro, the following limitations apply if you are using a character set encoding other than Latin 1:

- Picture formats are not supported. The picture format supports only Latin 1 characters.
- If the format value's encoded string is longer than 256 bytes, the string is truncated and a warning is printed to the SAS log.

Publishing SAS Formats in Netezza

Overview of the Publishing Process

The SAS publishing macros are used to publish formats and the SAS_PUT( ) function in Netezza.

The %INDNZ_PUBLISH_FORMATS macro creates the files that are needed to build the SAS_PUT( ) function and publishes those files to the Netezza data warehouse.

This macro also makes many formats that SAS supplies available inside Netezza. In addition to formats that SAS supplies, you can also publish the PROC FORMAT definitions that are contained in a single SAS format catalog by using the FMTCAT= option. The process of publishing a PROC FORMAT catalog entry converts the range label pairs into embedded data in Netezza.

The %INDNZ_PUBLISH_FORMATS macro performs the following tasks:

- produces the set of .c, .cpp, and .h files that are necessary to build the SAS_PUT( ) function
- produces a script of the Netezza commands that are necessary to register the SAS_PUT( ) function on the Netezza data warehouse
- transfers the .c, .cpp, and .h files to Netezza using the Netezza External Table interface
- calls the SAS_COMPILEUDF function to compile the source files into object files and to access the SAS Formats Library for Netezza
- uses SAS/ACCESS Interface to Netezza to run the script to create the SAS_PUT( ) function with the object files

Running the %INDNZ_PUBLISH_FORMATS Macro

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

1. Start SAS 9.3 and submit these commands in the Program or Enhanced Editor:

```
%indn;
%let indconn = server=myserver user=myuserid password=XXXX
   database=mydb <serveruserid=myserveruserid>;
```

For more information, see " %INDNZPF Macro" on page 169 and the "INDCONN Macro Variable" on page 169.

2. Run the %INDNZ_PUBLISH_FORMATS macro.

   For more information, see "%INDNZ_PUBLISH_FORMATS Macro Syntax" on page 169.

   Messages are written to the SAS log that indicate whether the SAS_PUT( ) function was successfully created.

%INDNZPF Macro

The %INDNZPF macro is an autocall library that initializes the format publishing software.

INDCONN Macro Variable

The INDCONN macro variable is used as credentials to connect to Netezza. You must specify the server, user, password, and database information to access the machine on which you have installed the Netezza data warehouse. You must assign the INDCONN macro variable before the %INDNZ_PUBLISH_FORMATS macro is invoked.

Here is the syntax for the value of the INDCONN macro variable:

SERVER=*server* USER=*userid* PASSWORD=*password* DATABASE=*database*

Arguments

SERVER=*server*
specifies the Netezza server name or the IP address of the server host.

USER=*user*
specifies the Netezza user name (also called the user ID) that is used to connect to the database.

PASSWORD=*password*
specifies the password that is associated with your Netezza user ID.

> **Tip** Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error to occur.

DATABASE=*database*
specifies the Netezza database that contains the tables and views that you want to access.

TIP The INDCONN macro variable is not passed as an argument to the %INDNZ_PUBLISH_FORMATS macro. 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.

%INDNZ_PUBLISH_FORMATS Macro Syntax

%INDNZ_PUBLISH_FORMATS

(<DATABASE=*database-name*>
<. DBCOMPILE=*database-name*>
<, DBJAZLIB=*database-name*>
<, FMTCAT=*format-catalog-filename*>
<, FMTTABLE=*format-table-name*>
<, ACTION=CREATE | REPLACE | DROP>
<, MODE=FENCED | UNFENCED>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DATABASE=*database-name*

specifies the name of a Netezza database to which the SAS_PUT( ) function and the formats are published. This argument lets you publish the SAS_PUT( ) function and the formats to a shared database where other users can access them.

Interaction The database that is specified by the DATABASE= argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "Running the %INDNZ_PUBLISH_FORMATS Macro" on page 168.

Tip It is not necessary that the format definitions and the SAS_PUT( ) function reside in the same database as the one that contains the data that you want to format. You can use the SQLMAPPUTO= system option to specify the database where the format definitions and the SAS_PUT( ) function have been published.

DBCOMPILE=*database-name*

specifies the name of the database where the SAS_COMPILEUDF function was published.

Default SASLIB

See For more information about the publishing the SAS_COMPILEUDF function, see the *SAS In-Database Products: Administrator's Guide*.

DBJAZLIB=*database-name*

specifies the name of the database where the SAS Formats Library for Netezza was published.

Default SASLIB

Restriction This argument is supported only on TwinFin systems.

See For more information about publishing the SAS Formats Library for Netezza, see the *SAS In-Database Products: Administrator's Guide*.

FMTCAT=*format-catalog-filename*

specifies the name of the format catalog file that contains all user-defined formats that were created with the FORMAT procedure and are made available in Netezza.

Default If you do not specify a value for FMTCAT= and you have created user-defined formats in your SAS session, the default is WORK.FORMATS. If you do not specify a value for FMTCAT= and you have not created any user-defined formats in your SAS session, only the formats that SAS supplies are available in Netezza.

Interaction If the format definitions that you want to publish exist in multiple catalogs, you must copy them into a single catalog for publishing.

See "Netezza Considerations and Limitations When Using the FMTCAT= Options" on page 168

FMTTABLE=*format-table-name*
specifies the name of the Netezza table that contains all formats that the %INDNZ_PUBLISH_FORMATS macro creates and that the SAS_PUT( ) function supports. The format table contains the columns shown in the following table.

Table 15.1 *Format Table Columns*

Column Name	Description
FMTNAME	specifies the name of the format.
SOURCE	specifies the origin of the format. SOURCE can contain one of these values: SAS supplied by SAS PROCFMT User-defined with PROC FORMAT

Default If FMTTABLE is not specified, no table is created. You can see only the SAS_PUT( ) function. You cannot see the formats that are published by the macro.

Interaction If ACTION=CREATE or ACTION=DROP is specified, messages are written to the SAS log that indicate the success or failure of the table creation or drop.

ACTION=CREATE | REPLACE | DROP
specifies that the macro performs one of these actions:

CREATE
creates a new SAS_PUT( ) function.

REPLACE
overwrites the current SAS_PUT( ) function, if a SAS_PUT( ) function is already registered or creates a new SAS_PUT( ) function if one is not registered.

DROP
causes the SAS_PUT( ) function to be dropped from the Netezza database.

Interaction If FMTTABLE= is specified, both the SAS_PUT( ) function and the format table are dropped. If the table name cannot be found or is incorrect, only the SAS_PUT( ) function is dropped.

Default CREATE

Tip If the SAS_PUT( ) function was published previously and you specify ACTION=CREATE, you receive warning messages that the function already exists and you are prompted to use REPLACE. If you specify

ACTION=DROP and the function does not exist, an error message is issued.

MODE= FENCED | UNFENCED
specifies whether running the code is isolated in a separate process in the Netezza database so that a program fault does not cause the database to stop.

Default FENCED

Restriction The MODE= argument is supported for Netezza 6.0. The MODE argument is ignored for previous versions of Netezza.

Tip There are limited resources available in Netezza when you run in fenced mode. For example, there is a limit to the number of columns available.

See "Modes of Operation" on page 172

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process.

See "Special Characters in Directory Names" on page 128

Modes of Operation

The %INDNZ_PUBLISH_FORMATS macro has two modes of operation: fenced and unfenced. You specify the mode by setting the MODE= argument.

The default mode of operation is fenced. Fenced mode means that the format that is published is isolated in a separate process in the Netezza database when it is invoked. An error does not cause the database to stop. It is recommended that you publish the format in fenced mode during acceptance tests.

When the format is ready for production, you can run the macro to publish the format in unfenced mode. You could see a performance advantage if the format is published in unfenced mode.

Note: The MODE= argument is supported for Netezza 6.0. The MODE argument is ignored for previous versions of Netezza.

Format Publishing Macro Example

```
%indnzpf;
%let indconn = server=netezbase user=user1 password=xxxx
database=mydb;
%indnz_publish_formats(fmtcat= fmtlib.fmtcat);
```

This sequence of macros generates .c, .cpp, and .h files for each data type. The format data types that are supported are numeric (FLOAT, INT), character, date, time, and timestamp (DATETIME). The %INDNZ_PUBLISH_FORMATS macro also produces a text file of Netezza CREATE FUNCTION commands that are similar to these:

```
CREATE FUNCTION sas_put(float , varchar(256))
RETURNS VARCHAR(256)
```

```
LANGUAGE CPP
PARAMETER STYLE npsgeneric
CALLED ON NULL INPUT
EXTERNAL CLASS NAME 'Csas_putn'
EXTERNAL HOST OBJECT '/tmp/tempdir_20090528T135753_616784/formal5.o_x86'
EXTERNAL NSPU OBJECT '/tmp/tempdir_20090528T135753_616784/formal5.o_diab_ppc'
```

After it is installed, you can call the SAS_PUT( ) function in Netezza by using SQL. For more information, see "Using the SAS_PUT( ) Function in the Netezza Data Warehouse " on page 173.

Using the SAS_PUT( ) Function in the Netezza Data Warehouse

Implicit Use of the SAS_PUT( ) Function

After you install the formats that SAS supplies in libraries inside the Netezza data warehouse and publish any custom format definitions that you created in SAS, you can access the SAS_PUT( ) function with your SQL queries.

If the SQLMAPPUTTO= system option is set to SAS_PUT and you submit your program from a SAS session, the SAS SQL processor maps PUT function calls to SAS_PUT( ) function references that Netezza understands.

This example illustrates how the PUT function is mapped to the SAS_PUT( ) function using implicit pass-through.

```
options sqlmapputto=sas_put;

%put &mapconn;

libname dblib netezza &mapconn;

   /*-- Set SQL debug global options --*/
   /*----------------------------------*/
   options sastrace=',,,d' sastraceloc=saslog;

   /*-- Execute SQL using Implicit Passthru --*/
   /*-----------------------------------------*/
   proc sql noerrorstop;
      title1 'Test SAS_PUT using Implicit Passthru ';
      select distinct
         PUT(PRICE,Dollar8.2) AS PRICE_C
            from dblib.mailorderdemo;

   quit;
```

These lines are written to the SAS log.

```
options sqlmapputto=sas_put;

%put &mapconn;
user=dbitext password=xxxx server=spubox database=TESTDB
   sql_functions="EXTERNAL_APPEND=WORK.dbfuncext" sql_functions_copy=saslog;
```

```
libname dblib netezza &mapconn;

NOTE: Libref DBLIB was successfully assigned, as follows:
      Engine:        NETEZZA
      Physical Name: spubox

         /*-- Set SQL debug global options --*/
         /*----------------------------------*/
        options sastrace=',,,d' sastraceloc=saslog;

         /*-- Execute SQL using Implicit Passthru --*/
         /*----------------------------------------*/
         proc sql noerrorstop;
           title1 'Test SAS_PUT using Implicit Passthru ';
           select distinct
              PUT(PRICE,Dollar8.2) AS PRICE_C
            from dblib.mailorderdemo
                ;
NETEZZA: AUTOCOMMIT is NO for connection 1
NETEZZA: AUTOCOMMIT turned ON for connection id 1

NETEZZA_1: Prepared: on connection 1
SELECT * FROM mailorderdemo

NETEZZA: AUTOCOMMIT is NO for connection 2
NETEZZA: AUTOCOMMIT turned ON for connection id 2

NETEZZA_2: Prepared: on connection 2
 select distinct cast(sas_put(mailorderdemo."PRICE", 'DOLLAR8.2') as char(8))
        as PRICE_C from mailorderdemo

NETEZZA_3: Executed: on connection 2
Prepared statement NETEZZA_2

ACCESS ENGINE:  SQL statement was passed to the DBMS for fetching data.

               Test SAS_PUT using Implicit Passthru                    9
                                          13:42 Thursday, May 7, 2012

                            PRICE_C
                            _______
                             $10.00
                             $12.00
                             $13.59
                             $48.99
                             $54.00
                              $8.00
                             $14.00
                             $27.98
                             $13.99

           quit;
```

Be aware of these items:

- The SQLMAPPUTTO= system option must be set to SAS_PUT. This ensures that the SQL processor maps your PUT functions to the SAS_PUT( ) function and that the SAS_PUT( ) reference is passed through to Netezza.
- The SAS SQL processor translates the PUT function in the SQL SELECT statement into a reference to the SAS_PUT( ) function.

```
select distinct cast(sas_put("sas"."mailorderdemo"."PRICE", 'DOLLAR8.2')
   as char(8)) as "PRICE_C" from "sas"."mailorderdemo"
```

  A large value, VARCHAR(*n*), is always returned because one function prototype accesses all formats. Use the CAST expression to reduce the width of the returned column to be a character width that is reasonable for the format that is being used.

  The return text cannot contain a binary zero value (hexadecimal 00) because the SAS_PUT( ) function always returns a VARCHAR(*n*) data type and a Netezza VARCHAR(*n*) is defined to be a null-terminated string.

The SELECT DISTINCT clause executes inside Netezza, and the processing is distributed across all available data nodes. Netezza formats the price values with the $DOLLAR8.2 format and processes the SELECT DISTINCT clause using the formatted values.

Explicit Use of the SAS_PUT( ) Function

If you use explicit pass-through (direct connection to Netezza), you can use the SAS_PUT( ) function call in your SQL program.

This example shows the same query from "Implicit Use of the SAS_PUT( ) Function" on page 173 and explicitly uses the SAS_PUT( ) function call.

```
options sqlmapputto=sas_put sastrace=',,,d' sastraceloc=saslog;

proc sql noerrorstop;
   title1 'Test SAS_PUT using Explicit Passthru';
   connect to netezza (user=dbitest password=XXXXXXX database=testdb
      server=spubox);

   select * from connection to netezza
      (select distinct cast(sas_put("PRICE",'DOLLAR8.2') as char(8)) as
         "PRICE_C" from mailorderdemo);

disconnect from netezza;
quit;
```

The following lines are written to the SAS log.

```
options sqlmapputto=sas_put sastrace=',,,d' sastraceloc=saslog;

proc sql noerrorstop;
 title1 'Test SAS_PUT using Explicit Passthru';
 connect to netezza (user=dbitest password=XXXXXXX database=testdb server=spubox);

 select * from connection to netezza
    (select distinct cast(sas_put("PRICE",'DOLLAR8.2') as char(8)) as
        "PRICE_C" from mailorderdemo);

           Test SAS_PUT using Explicit Passthru           2
                                      17:13 Thursday, May 7, 2012
```

```
PRICE_C
_______
 $27.98
 $10.00
 $12.00
 $13.59
 $48.99
 $54.00
 $13.98
  $8.00
 $14.00
```

```
disconnect from netezza;
quit;
```

Note: If you explicitly use the SAS_PUT( ) function in your code, it is recommended that you use double quotation marks around a column name to avoid any ambiguity with the keywords. For example, if you did not use double quotation marks around the column name, DATE, in this example, all date values would be returned as today's date.

```
select distinct
   cast(sas_put("price", 'dollar8.2') as char(8)) as "price_c",
   cast(sas_put("date", 'date9.1') as char(9)) as "date_d",
   cast(sas_put("inv", 'best8.') as char(8))  as "inv_n",
   cast(sas_put("name", '$32.') as char(32)) as "name_n"
from mailorderdemo;
```

Netezza Permissions

You must have permission to create the SAS_PUT( ) function and formats, and tables in the Netezza database. You must also have permission to execute the SAS_COMPILEUDF, SAS_DIRECTORYUDF, and SAS_HEXTOTEXTUDF functions in either the SASLIB database or the database specified in lieu of SASLIB where these functions are published.

Without these permissions, the publishing of the SAS_PUT( ) function and formats fails. To obtain these permissions, contact your database administrator.

For more information about specific permissions, see the *SAS In-Database Products: Administrator's Guide*.

Chapter 16

Deploying and Using SAS Formats in Teradata

User-Defined Formats in the Teradata EDW

Introduction to User-Defined Formats in Teradata

You can use PROC FORMAT to create user-defined formats and store them in a format catalog. You can then use the %INDTD_PUBLISH_FORMATS macro to export the user-defined format definitions to the Teradata EDW where the SAS_PUT( ) function can reference them.

For more information about %INDTD_PUBLISH_FORMATS, see "Publishing SAS Formats in Teradata" on page 178. For more information about the SAS_PUT( ) function, see "Using the SAS_PUT( ) Function in the Teradata EDW " on page 184.

Teradata Limitations and Restrictions When Using the FMTCAT= Option

If you use the FMTCAT= option to specify a format catalog in the %INDTD_PUBLISH_FORMATS macro and if you use a character set encoding other

than Latin 1, picture formats are not supported. The picture format supports only Latin 1 characters.

Publishing SAS Formats in Teradata

Overview of the Publishing Process

The SAS publishing macros are used to publish formats and the SAS_PUT( ) function in the Teradata EDW.

The %INDTD_PUBLISH_FORMATS macro creates the files that are needed to build the SAS_PUT( ) function and publishes these files to the Teradata EDW.

The %INDTD_PUBLISH_FORMATS macro also publishes the formats that are included in the SAS formats library. This makes many formats that SAS supplies available inside Teradata. For more information about the SAS formats library, see "Deployed Components for Teradata" on page 7.

In addition to formats that SAS supplies, you can also publish the PROC FORMAT definitions that are contained in a single SAS format catalog by using the FMTCAT= option. The process of publishing a PROC FORMAT catalog entry converts the range label pairs into embedded data in Teradata. For more information about value-range-sets, see PROC FORMAT in the *Base SAS Procedures Guide*.

Note: If you specify more than one format catalog using the FMTCAT= option, the last format that you specify is the one that is published. You can have only one formats library active in the Teradata database.

The %INDTD_PUBLISH_FORMATS macro performs the following tasks:

- creates .h and .c files, which are necessary to build the SAS_PUT( ) function
- produces a script of Teradata commands that are necessary to register the SAS_PUT( ) function in the Teradata EDW
- uses SAS/ACCESS Interface to Teradata to execute the script and publish the files to the Teradata EDW

Running the %INDTD_PUBLISH_FORMATS Macro

Follow these steps to run the %INDTD_PUBLISH_FORMATS macro.

1. Start SAS 9.3 and submit these commands in the Program or Enhanced Editor:

```
%indtdpf;
%let indconn = server="myserver" user="myuserid" password="xxxx"
   database="mydb";
```

   For more information, see " %INDTDPF Macro" on page 179 and the "INDCONN Macro Variable" on page 179.

2. Run the %INDTD_PUBLISH_FORMATS macro.

   For more information, see "%INDTD_PUBLISH_FORMATS Macro Syntax" on page 179.

   Messages are written to the SAS log that indicate whether the SAS_PUT( ) function was successfully created.

%INDTDPF Macro

The %INDTDPF macro is an autocall library that initializes the format publishing software.

INDCONN Macro Variable

The INDCONN macro variable is used as credentials to connect to Teradata. You must specify the server, user, password, and database information to access the machine on which you have installed the Teradata EDW. You must assign the INDCONN macro variable before the %INDTD_PUBLISH_FORMATS macro is invoked.

Here is the syntax for the value of the INDCONN macro variable:

SERVER="*server*" USER="*userid*" PASSWORD="*password*" <DATABASE="*database*">

Arguments

SERVER="*server*"
specifies the Teradata server name or the IP address of the server host.

USER="*user*
specifies the Teradata user name (also called the user ID) that is used to connect to the database.

PASSWORD="*password*
specifies the password that is associated with your Teradata user ID.

Tip Use only PASSWORD=, PASS=, or PW= for the password argument. PWD= is not supported and causes an error to occur.

DATABASE="*database*"
specifies the Teradata database that contains the tables and views that you want to access.

Default Your current database

TIP The INDCONN macro variable is not passed as an argument to the %INDTD_PUBLISH_FORMATS 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.

%INDTD_PUBLISH_FORMATS Macro Syntax

%INDTD_PUBLISH_FORMATS
(<DATABASE=*database–name*>
<, FMTCAT=*format-catalog-filename*>
<, FMTTABLE=*format-table-name*>
<, ACTION=CREATE | REPLACE | DROP>
<, MODE=PROTECTED | UNPROTECTED>
<, OUTDIR=*diagnostic-output-directory*>
);

Arguments

DATABASE=*database-name*

specifies the name of a Teradata database to which the SAS_PUT( ) function and the formats are published. This argument lets you publish the SAS_PUT( ) function and the formats to a shared database where other users can access them.

Default The database specified in the INDCONN macro variable or your current database

Interaction The database that is specified by the DATABASE= argument takes precedence over the database that you specify in the INDCONN macro variable. For more information, see "Running the %INDTD_PUBLISH_FORMATS Macro" on page 178.

Tip The format definitions and the SAS_PUT( ) function do not need to reside in the same database as the one that contains the data that you want to format. You can use the SQLMAPPUTTO= system option to specify where the format definitions and the SAS_PUT( ) function are published. For more information, see "SQLMAPPUTTO= System Option" on page 204.

FMTCAT=*format-catalog-filename*

specifies the name of the format catalog file that contains all user-defined formats that were created with the FORMAT procedure and are made available in Teradata.

Default If you do not specify a value for FMTCAT= and you have created user-defined formats in your SAS session, the default is WORK.FORMATS. If you do not specify a value for FMTCAT= and you have not created any user-defined formats in your SAS session, only the formats that SAS supplies are available in Teradata.

Interaction If the format definitions that you want to publish exist in multiple catalogs, you must copy them into a single catalog for publishing.

FMTTABLE=*format–table–name*

specifies the name of the Teradata table that contains all formats that the %INDTD_PUBLISH_FORMATS macro creates and that the SAS_PUT( ) function supports. The table contains the columns in the following table.

Table 16.1 *Teradata Format Table Columns*

Column Name	Description
FMTNAME	specifies the name of the format.
SOURCE	specifies the origin of the format. SOURCE can contain one of these values: SAS supplied by SAS. PROCFMT User-defined with PROC FORMAT.

Column Name	Description
PROTECTED	specifies whether the format is protected. PROTECTED can contain one of these values: YES Format was created with the MODE= option set to PROTECTED. NO Format was created with the MODE= option set to UNPROTECTED.

Default If FMTTABLE is not specified, no table is created. You can see only the SAS_PUT( ) function. You cannot see the formats that are published by the macro.

Interaction If ACTION=CREATE or ACTION=DROP is specified, messages are written to the SAS log that indicate the success or failure of the table creation or drop.

ACTION=CREATE | REPLACE | DROP
specifies that the macro performs one of these actions:

CREATE
creates a new SAS_PUT( ) function.

REPLACE
overwrites the current SAS_PUT( ) function, if a SAS_PUT( ) function is already registered or creates a new SAS_PUT( ) function if one is not registered.

DROP
causes the SAS_PUT( ) function to be dropped from the Teradata database.

Interaction If FMTTABLE= is specified, both the SAS_PUT( ) function and the format table are dropped. If the table name cannot be found or is incorrect, only the SAS_PUT( ) function is dropped.

Default CREATE.

Tip If the SAS_PUT( ) function was defined previously and you specify ACTION=CREATE, you receive warning messages from Teradata. If the SAS_PUT( ) function was defined previously and you specify ACTION=REPLACE, a message is written to the SAS log indicating that the SAS_PUT( ) function has been replaced.

MODE=PROTECTED | UNPROTECTED
specifies whether the running code is isolated in a separate process in the Teradata database so that a program fault does not cause the database to stop.

Default PROTECTED

Tip Once the SAS formats are validated in PROTECTED mode, you can republish them in UNPROTECTED mode for a performance gain.

See "Modes of Operation" on page 182

OUTDIR=*diagnostic-output-directory*
specifies a directory that contains diagnostic files.

Files that are produced include an event log that contains detailed information about the success or failure of the publishing process.

See "Special Characters in Directory Names" on page 128

Modes of Operation

There are two modes of operation when executing the %INDTD_PUBLISH_FORMATS 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_FORMATS macro in protected mode during acceptance tests.

When the %INDTD_PUBLISH_FORMATS macro is ready for production, you can rerun the macro in unprotected mode. Note that you could see a performance advantage when you republish the formats in unprotected mode.

Format Publishing Macro Example

This sequence of macros generates a .c and a .h file for each data type. The format data types that are supported are numeric (FLOAT, INT), character, date, time, and timestamp (DATETIME).

```
%indtdpf;
%let indconn server="terabase" user="user1" password="open1" database="mydb";
%indtd_publish_formats(fmtcat= fmtlib.fmtcat);
```

The %INDTD_PUBLISH_FORMATS macro also produces a text file of Teradata CREATE FUNCTION commands that are similar to these:

```
CREATE FUNCTION sas_put
(d float, f varchar(64))
RETURNS varchar(256)
SPECIFIC sas_putn
LANGUAGE C
NO SQL
PARAMETER STYLE SQL
NOT DETERMINISTIC
CALLED ON NULL INPUT
EXTERNAL NAME
'SL!"jazxfbrs"'
'!CI!ufmt!C:\file-path\'
'!CI!jazz!C:\file-path\'
'!CS!formn!C:\file-path\';
```

After it is installed, you can call the SAS_PUT( ) function in Teradata by using SQL. For more information, see "Using the SAS_PUT( ) Function in the Teradata EDW " on page 184.

Data Types and the SAS_PUT( ) Function

The SAS_PUT( ) function supports direct use of the Teradata data types shown in the following table. In some cases, the Teradata database performs an implicit conversion of the input data to the match the input data type that is defined for the SAS_PUT( ) function. For example, all compatible numeric data types are implicitly converted to FLOAT before they are processed by the SAS_PUT( ) function.

Table 16.2 *Teradata Data Types Supported by the SAS_PUT( ) Function*

Type of Data	Data Type
Numeric	BYTEINT
	SMALLINT
	INTEGER
	BIGINT*
	DECIMAL (ANSI NUMERIC)*
	FLOAT (ANSI REAL or DOUBLE PRECISION)
Date and time	DATE
	TIME
	TIMESTAMP
Character*****	CHARACTER†
	VARCHAR
	LONG VARCHAR

* Numeric precision might be lost when inputs are implicitly converted to FLOAT before they are processed by the SAS_PUT( ) function.

** Only the Latin 1 character set is supported for character data. UNICODE is not supported at this time.

*** When character inputs are larger than 256 characters, the results depend on the session mode associated with the Teradata connection.

† The SAS_PUT( ) function has a VARCHAR data type for its first argument when the value passed has a data type of CHARACTER. Therefore, columns with a data type of CHARACTER have their trailing blanks trimmed when converting to a VARCHAR data type.

The SAS_PUT( ) function does not support direct use of the Teradata data types shown in the following table. In some cases, unsupported data types can be explicitly converted to a supported type by using SAS or SQL language constructs. For information about performing explicit data conversions, see the topic on data types for Teradata in *SAS/ACCESS for Relational Databases: Reference* and your Teradata documentation.

Table 16.3 *Teradata Data Types Not Supported by the SAS_PUT( ) Function*

Type of Data	Data Type
ANSI date and time	INTERVAL
	TIME WITH TIME ZONE
	TIMESTAMP WITH TIME ZONE

Type of Data	Data Type
GRAPHIC server character set	GRAPHIC VARGRAPHIC LONG VARGRAPHIC
Binary and large object	CLOB BYTE VARBYTE BLOB

If an incompatible data type is passed to the SAS_PUT( ) function, various error messages can appear in the SAS log including the following messages:

- **Function SAS_PUT does not exist**
- **Data truncation**
- **SQL syntax error near the location of the first argument in the SAS_PUT( ) function call**

Using the SAS_PUT( ) Function in the Teradata EDW

Implicit Use of the SAS_PUT( ) Function

After you install the formats that SAS supplies in libraries inside the Teradata EDW and publish any custom format definitions that you created in SAS, you can access the SAS_PUT( ) function with your SQL queries.

If the SQLMAPPUTTO= system option is set to SAS_PUT and you submit your program from a SAS session, the SAS SQL processor maps PUT function calls to SAS_PUT( ) function references that Teradata understands.

Note: If you specify SQLMAPPUTTO=*database*.SAS_PUT, *database* must be the same as the database where the SAS_PUT function is mapped.

This example illustrates how the PUT function is mapped to the SAS_PUT( ) function using implicit pass-through.

```
options sqlmapputto=sas_put;

libname dblib teradata user="sas" password="sas" server="sl96208"
   database=sas connection=shared;

   /*-- Set SQL debug global options --*/
   /*----------------------------------*/
   options sastrace=',,,d' sastraceloc=saslog;

   /*-- Execute SQL using Implicit Passthru --*/
   /*----------------------------------------*/
   proc sql noerrorstop;
      title1 'Test SAS_PUT using Implicit Passthru ';
```

```
      select distinct
         PUT(PRICE,Dollar8.2) AS PRICE_C
            from dblib.mailorderdemo;
   quit;
```

These lines are written to the SAS log.

```
libname dblib teradata user="sas" password="sas" server="sl96208"
   database=sas connection=shared;

NOTE: Libref DBLIB was successfully assigned, as follows:
      Engine:        TERADATA
      Physical Name: sl96208

         /*-- Set SQL debug global options --*/
         /*-----------------------------------*/
         options sastrace=',,,d' sastraceloc=saslog;

         /*-- Execute SQL using Implicit Passthru --*/
         /*-----------------------------------------*/
         proc sql noerrorstop;
           title1 'Test SAS_PUT using Implicit Passthru ';
           select distinct
              PUT(PRICE,Dollar8.2) AS PRICE_C
            from dblib.mailorderdemo
                ;

TERADATA_0: Prepared: on connection 0
SELECT * FROM sas."mailorderdemo"


TERADATA_1: Prepared: on connection 0
 select distinct cast(sas_put("sas"."mailorderdemo"."PRICE", 'DOLLAR8.2')
 as char(8)) as "PRICE_C" from "sas"."mailorderdemo"

TERADATA: trforc: COMMIT WORK
ACCESS ENGINE:  SQL statement was passed to the DBMS for fetching data.

TERADATA_2: Executed: on connection 0
 select distinct cast(sas_put("sas"."mailorderdemo"."PRICE", 'DOLLAR8.2')
 as char(8)) as "PRICE_C" from "sas"."mailorderdemo"

TERADATA: trget - rows to fetch: 9
TERADATA: trforc: COMMIT WORK

               Test SAS_PUT using Implicit Passthru                    9
                                    3:42 Thursday, July 25, 2012

                              PRICE_C
                              _______
                                $8.00
                               $10.00
                               $12.00
                               $13.59
                               $13.99
                               $14.00
                               $27.98
```

```
$48.99
$54.00

quit;
```

Be aware of these factors:

- The SQLMAPPUTTO= system option must be set to SAS_PUT to ensure that the SQL processor maps your PUT functions to the SAS_PUT( ) function and the SAS_PUT( ) reference is passed through to Teradata.
- The SAS SQL processor translates the PUT function in the SQL SELECT statement into a reference to the SAS_PUT( ) function.

  ```
  select distinct cast(sas_put("sas"."mailorderdemo"."PRICE", 'DOLLAR8.2')
     as char(8)) as "PRICE_C" from "sas"."mailorderdemo"
  ```

  A large value, VARCHAR(*n*), is always returned because one function prototype accesses all formats. Use the CAST expression to reduce the width of the returned column to be a character width that is reasonable for the format that is being used.

  The return text cannot contain a binary zero value (hexadecimal 00) because the SAS_PUT( ) function always returns a VARCHAR(*n*) data type and a Teradata VARCHAR(*n*) is defined to be a null-terminated string.

The SELECT DISTINCT clause executes inside Teradata, and the processing is distributed across all available data nodes. Teradata formats the price values with the $DOLLAR8.2 format and processes the SELECT DISTINCT clause using the formatted values.

Explicit Use of the SAS_PUT( ) Function

If you use explicit pass-through (a direct connection to Teradata), you can use the SAS_PUT( ) function call in your SQL program.

This example shows the same query from "Implicit Use of the SAS_PUT( ) Function" on page 184 and explicitly uses the SAS_PUT( ) function call.

```
proc sql noerrorstop;
   title1 'Test SAS_PUT using Explicit Passthru';
   connect to teradata (user=sas password=XXX database=sas server=sl96208);

   select * from connection to teradata
      (select distinct cast(sas_put("PRICE",'DOLLAR8.2') as char(8)) as
         "PRICE_C" from mailorderdemo);

disconnect from teradata;
quit;
```

The following lines are written to the SAS log.

```
proc sql noerrorstop;
title1 'Test SAS_PUT using Explicit Passthru ';
connect to teradata (user=sas password=XXX database=sas server=sl96208);

select * from connection to teradata
   (select distinct cast(sas_put("PRICE",'DOLLAR8.2') as char(8)) as
       "PRICE_C" from mailorderdemo);

          Test SAS_PUT using Explicit Passthru                    10
                                    13:42 Thursday, July 25, 2012
```

```
PRICE_C

_______
  $8.00
 $10.00
 $12.00
 $13.59
 $13.99
 $14.00
 $27.98
 $48.99
 $54.00
```

```
disconnect from teradata;
quit;
```

Note: If you explicitly use the SAS_PUT( ) function in your code, it is recommended that you use double quotation marks around a column name to avoid any ambiguity with the keywords. For example, if you did not use double quotation marks around the column name, DATE, in this example, all date values would be returned as today's date.

```
select distinct
   cast(sas_put("price", 'dollar8.2') as char(8)) as "price_c",
   cast(sas_put("date", 'date9.1') as char(9)) as "date_d",
   cast(sas_put("inv", 'best8.') as char(8))  as "inv_n",
   cast(sas_put("name", '$32.') as char(32)) as "name_n"
from mailorderdemo;
```

Tips When Using the SAS_PUT( ) Function in Teradata

- Format widths greater than 256 can cause unexpected or unsuccessful behavior.
- If a variable is associated with a $HEXw. format, SAS/ACCESS creates the DBMS table, and the PUT function is being mapped to the SAS_PUT( ) function, SAS/ACCESS assumes that variable is binary and assigns a data type of BYTE to that column. The SAS_PUT( ) function does not support the BYTE data type. Teradata reports an error that the SAS_PUT( ) function is not found instead of reporting that an incorrect data type was passed to the function. To avoid this error, variables that are processed by the SAS_PUT( ) function implicitly should not have the $HEXw. format associated with them. For more information, see "Data Types and the SAS_PUT( ) Function" on page 183.

  If you use the $HEXw. format in an explicit SAS_PUT( ) function call, this error does not occur.
- If you use the $HEXw. format in an explicit SAS_PUT( ) function call, blanks in the variable are converted to "20" but trailing blanks (blanks that occur when using a format width greater than the variable width) are trimmed. For example, the value "A " ("A" with a single blank) with a $HEX4. format is written as 4120. The value "A" ("A" with no blanks) with a $HEX4. format is written as 41 with no blanks.

Teradata Permissions

Because functions are associated with a database, the functions inherit the access rights of that database. It could be useful to create a separate shared database for the functions so that access rights can be customized as needed. In addition, you must have the following permissions to publish the functions in Teradata:

- CREATE FUNCTION
- DROP FUNCTION
- EXECUTE FUNCTION
- ALTER FUNCTION

Without these permissions, the publishing of the SAS_PUT( ) function and formats fails. To obtain these permissions, contact your database administrator.

For more information about specific permissions, see the *SAS In-Database Products: Administrator's Guide*.

Part 4

In-Database Procedures

Chapter 17

Running SAS Procedures inside the Database

Introduction to In-Database Procedures

Using conventional processing, a SAS procedure (by means of the SAS/ACCESS engine) receives all the rows of the table from the database. All processing is done by the procedure. Large tables mean that a significant amount of data must be transferred.

Using the new in-database technology, the procedures that are enabled for processing inside the database generate more sophisticated queries. These queries allow the aggregations and analytics to be run inside the database. Some of the in-database procedures generate SQL procedure syntax and use implicit pass-through to generate the native SQL. Other in-database procedures generate native SQL and use explicit pass-through. For more information about how a specific procedure works inside the database, see the documentation for that procedure.

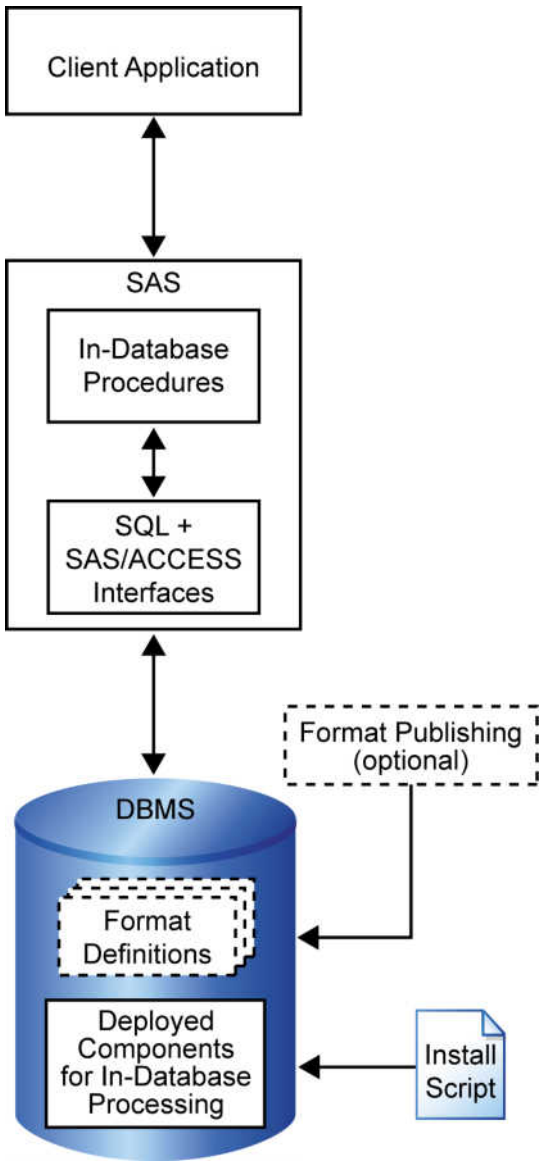
The queries submitted by SAS in-database procedures reference DBMS SQL functions and, in some cases, the special SAS functions that are deployed inside the database. One example of a special SAS function is the SAS_PUT( ) function that enables you to execute PUT function calls inside the database. Other examples are SAS functions for computing sum-of-squares-and-crossproducts (SSCP) matrices.

For most in-database procedures, a much smaller result set is returned for the remaining analysis that is required to produce the final output. As a result of using the in-database

procedures, more work is done inside the database, and less data movement can occur. This could result in significant performance improvements.

This diagram illustrates the in-database procedure process.

Figure 17.1 *Process Flow Diagram*



Running In-Database Procedures

To run in-database procedures, these actions must be taken:

- The SQLGENERATION system option or the SQLGENERATION LIBNAME option must be set to DBMS or DBMS='*database-name*'.

  The SQLGENERATION system option or LIBNAME statement option controls whether and how in-database procedures are run inside the database. By default, the

SQLGENERATION system option is set to NONE DBMS='TERADATA DB2 ORACLE NETEZZA ASTER GREENPLUM'.

Conventional SAS processing is also used when specific procedure statements and options do not support in-database processing. For complete information, see the "SQLGENERATION= System Option" on page 201 or the SQLGENERATION LIBNAME option in *SAS/ACCESS for Relational Databases: Reference*.

- The LIBNAME statement must point to a valid version of the DBMSs:
  - Aster 5.0 or higher
  - DB2 UDB9.5 Fixpack 7 running only on AIX or LINUX x64
  - Greenplum
  - Netezza 5.0 or higher
  - Teradata server running version 12 or higher for Linux
  - Oracle 9i

In-Database Procedures in Aster, DB2 under UNIX and PC Hosts, Greenplum, Netezza, and Oracle

The following Base SAS procedures have been enhanced for in-database processing inside Aster, DB2 under UNIX and PC Hosts, Greenplum, Netezza, and Oracle.

- FREQ
- RANK
- REPORT
- SORT
- SUMMARY/MEANS
- TABULATE

For more information about running a specific procedure inside the database, see the documentation for that procedure.

In-Database Procedures in Teradata

The following Base SAS, SAS Enterprise Miner, SAS/ETS, and SAS/STAT procedures have been enhanced for in-database processing.

- CORR*
- CANCORR*
- DMDB*
- DMINE*
- DMREG*
- FACTOR*
- FREQ

- PRINCOMP*
- RANK
- REG*
- REPORT
- SCORE*
- SORT
- SUMMARY/MEANS
- TABULATE
- TIMESERIES*
- VARCLUS*

*SAS Analytics Accelerator is required to run these procedures inside the database. For more information, see the *SAS Analytics Accelerator for Teradata: Guide*.

For more information about running a specific procedure inside the database, see the documentation for that procedure.

In-Database Procedure Considerations and Limitations

Overview

The considerations and limitations in the following sections apply to both Base SAS and SAS/STAT in-database procedures.

Note: Each in-database procedure has its own specific considerations and limitations. For more information, see the documentation for the procedure.

User-Defined Formats

If you use in-database procedures with user-defined formats that were published in the database, you must have a local copy of the user-defined formats. Without the local copy, the procedure fails.

Note: The local copy of the user-defined format must be identical in both name and function to the format that is published to the database. If they are not identical, the following actions occur.

- A "check sum ERROR" warning is produced. The warning indicates that the local and published formats differ.
- The local format is used, and the query is processed by SAS instead of inside the database.

If this occurs, you can redefine the local format to match the published version and rerun the procedure inside the database.

For more information about publishing user-defined formats, see the section on deploying and using formats for your database in Part 3, "Format Publishing and the SAS_PUT( ) Function."

Note: Format publishing of user-defined formats is not available for Oracle.

Row Order

- DBMS tables have no inherent order for the rows. Therefore, the BY statement with the OBS option and the FIRSTOBS option prevents in-database processing.
- If you specify the ORDER=DATA option for input data, the procedure might produce different results for separate runs of the same analysis.
- The order of rows written to a database table from a SAS procedure is not likely to be preserved. For example, the SORT procedure can output a SAS data set that contains ordered observations. If the results are written to a database table, the order of rows within that table might not be preserved because the DBMS has no obligation to maintain row order.
- You can print a table using the SQL procedure with an ORDER BY clause to get consistent row order. Another option is to use the SORT procedure to create an ordinary SAS data set and use the PRINT procedure on that SAS data set.

BY-Groups

BY-group processing is handled by SAS for Base SAS procedures. Raw results are returned from the DBMS, and SAS BY-group processing applies formats as necessary to create the BY group.

For SAS/STAT procedures, formats can be applied, and BY-group processing can occur inside the DBMS if the SAS_PUT( ) function and formats are published to the DBMS. For more information, see the *SAS Analytics Accelerator for Teradata: Guide*.

These BY statement option settings apply to the in-database procedures:

- The DESCENDING option is supported.
- The NOTSORTED option is ignored because the data is always returned in sorted order.

When SAS/ACCESS creates a database table, SAS/ACCESS by default uses the SAS formats that are assigned to variables to decide which DBMS data types to assign to the DBMS columns. If you specify the DBFMTIGNORE system option for numeric formats, SAS/ACCESS creates DBMS columns with a DOUBLE PRECISION data type. For more information, see the LIBNAME Statement for Relational Databases, "LIBNAME Statement Data Conversions," and the DBFMTIGNORE system option in *SAS/ACCESS for Relational Databases: Reference*.

LIBNAME Statement

- These LIBNAME statement options and settings prevent in-database processing:
  - DBMSTEMP=YES
  - DBCONINIT
  - DBCONTERM
  - DBGEN_NAME=SAS
  - PRESERVE_NAMES=NO
  - MODE=TERADATA

- LIBNAME concatenation prevents in-database processing.

Data Set-related Options

These data set options and settings prevent in-database processing:

- RENAME= on a data set.
- OUT= data set on DBMS and DATA= data set not on DBMS.

  For example, if *data=work.foo* and *out=tera.fooout* where WORK is the Base SAS engine, in-database processing does not occur.
- OBS= and FIRSTOBS= on DATA= data set.

Column Names in Netezza

Column names that start with an underscore are not allowed in Netezza.

An error occurs if you try to create an output table in Netezza that contains a column whose name starts with an underscore. The workaround for this is to send the output table to the SAS Work directory.

Miscellaneous Items

These items prevent in-database processing:

- DBMSs do not support SAS passwords.
- SAS encryption requires passwords that are not supported.
- Teradata does not support generation options that are explicitly specified in the procedure step, and the procedure does not know whether a generation number is explicit or implicit.
- When the database resolves function references. the database searches in this order:

  1. fully qualified object name
  2. current database
  3. SYSLIB

  If you need to reference functions that are published in a nonsystem, nondefault database, you must use one of these methods:

  - Use explicit SQL.
  - Use the DATABASE= LIBNAME option.
  - Map the fully qualified name (*schema*.sas_put) in the external mapping.

Using the MSGLEVEL Option to Control Messaging

The MSGLEVEL system option specifies the level of detail in messages that are written to the SAS log. When the MSGLEVEL option is set to N (the default value), these messages are printed to the SAS log:

- a note that says SQL is used for in-database computations when in-database processing is performed.
- error messages if something goes wrong with the SQL commands that are submitted for in-database computations.
- if there are SQL error messages, a note that says whether SQL is used.

When the MSGLEVEL option is set to I, all the messages that are printed when MSGLEVEL=N are printed to the SAS log.

These messages are also printed to the SAS log:

- a note that explains why SQL was not used for in-database computations, if SQL is not used.

  Note: No note is printed if you specify SQLGENERATION=NONE.

- a note that says that SQL cannot be used because there are no observations in the data source.

  Note: This information is not always available to the procedure.

- a note that says that the TYPE= attribute is not stored in DBMS tables. You see this note if you try to create a special SAS data set as a DBMS table for PROC MEANS or PROC SUMMARY.
- a note that says if the format was or was not found in the database. You see this note if you use a format that SAS supplies or a user-defined format.

Part 5

System Options Reference

Chapter 18

System Options That Affect In-Database Processing

Dictionary

SQLGENERATION= System Option

Specifies whether and when SAS procedures generate SQL for in-database processing of source data.

Valid in: configuration file, SAS invocation, OPTIONS statement, SAS System Options window

Default:Default: NONE DBMS='TERADATA DB2 ORACLE NETEZZA ASTER GREENPLUM'

Restriction: For DBMS= and EXCLUDEDB= values, the maximum length of an engine name is eight characters. For the EXCLUDEPROC= value, the maximum length of a procedure name is 16 characters. An engine can appear only once, and a procedure can appear only once for a given engine.

Data source: Aster *n*Cluster, DB2 under UNIX and PC Hosts, Greenplum, Netezza, Oracle, Teradata

Syntax

SQLGENERATION=<(>NONE | DBMS | NONE DBMS='*engine1... enginen*
<EXCLUDEDB=*engine* | '*engine1... enginen*'>
<EXCLUDEPROC="*engine='proc1... procn' enginen='proc1... procn'* "><)>

SQLGENERATION=" "

Syntax Description

NONE
prevents those SAS procedures that are enabled for in-database processing from generating SQL for in-database processing. This is a primary state.

DBMS
allows SAS procedures that are enabled for in-database processing to generate SQL for in-database processing of DBMS tables through supported SAS/ACCESS engines. This is a primary state.

DBMS='*engine1... enginen*'
specifies one or more SAS/ACCESS engines. It modifies the primary state.

EXCLUDEDB=*engine* | '*engine1... enginen*'
prevents SAS procedures from generating SQL for in-database processing for one or more specified SAS/ACCESS engines.

EXCLUDEPROC="*engine*='*proc1... procn*' *enginen*='*proc1... procn*' "
identifies engine-specific SAS procedures that you do not want to run inside the database.

" "
resets the value to the default that was shipped.

Details

Use this option with such procedures as PROC FREQ to indicate that SQL is generated for in-database processing of DBMS tables through supported SAS/ACCESS engines.

You must specify NONE, DBMS, or both. One or both of these arguments indicates the primary state.

The maximum length of the option value is 4096. Also, parentheses are required when this option value contains multiple keywords.

Not all procedures support SQL generation for in-database processing for every engine type. If you specify a setting that is not supported, an error message indicates the level of SQL generation that is not supported, and the procedure can reset to the default so that source table records can be read and processed within SAS. If this is not possible, the procedure ends and sets SYSERR= as needed.

You can specify different SQLGENERATION= values for the DATA= and OUT= data sets by using different LIBNAME statements for each of these data sets.

Here is how SAS/ACCESS handles precedence.

Table 18.1 *Precedence of Values for SQLGENERATION= LIBNAME and System Options*

LIBNAME Option	PROC EXCLUDE on System Option?	Engine Type	Engine Specified on System Option	Resulting Value	From (option)
not set NONE DBMS	yes	database interface	NONE DBMS	NONE EXCLUDEDB	system
NONE	no			NONE	LIBNAME
DBMS				DBMS	
not set			NONE	NONE	system
NONE DBMS			DBMS	DBMS	LIBNAME
		no SQL generated for this database host or database version	NONE DBMS	NONE	
not set		Base			system
NONE DBMS					LIBNAME

Example

Here is the default that is shipped with the product.

```
options sqlgeneration='';
proc options option=sqlgeneration;
 run;
```

SAS procedures generate SQL for in-database processing for all databases except DB2 in this example.

```
options sqlgeneration='';
options sqlgeneration=(DBMS EXCLUDEDB='DB2');
proc options option=sqlgeneration;
run;
```

In this example, in-database processing occurs only for Teradata. SAS procedures that are run on other databases do not generate SQL for in-database processing.

```
options sqlgeneration='';
options SQLGENERATION = (NONE DBMS='Teradata');
proc options option=sqlgeneration;
run;
```

For this example, SAS procedures generate SQL for Teradata and Oracle in-database processing. However, no SQL is generated for PROC1 and PROC2 in Oracle.

```
options sqlgeneration='';
```

```
Options SQLGENERATION = (NONE DBMS='Teradata Oracle'
   EXCLUDEPROC="oracle='proc1 proc2'");
proc options option=sqlgeneration;
run;
```

See Also

- "Running In-Database Procedures" on page 192

LIBNAME Options:

- SQLGENERATION= LIBNAME option in *SAS/ACCESS for Relational Databases: Reference*

SQLMAPPUTTO= System Option

Specifies whether the PUT function is mapped to the SAS_PUT( ) function for a database. This is also possible where the SAS_PUT( ) function is mapped.

Valid in: configuration file, SAS invocation, OPTIONS statement

Default:Default: SAS_PUT

Data source: Aster, DB2 under UNIX, Greenplum, Netezza, Teradata

Syntax

SQLMAPPUTTO= NONE | SAS_PUT | (*database*.SAS_PUT)

Syntax Description

NONE
specifies to PROC SQL that no PUT mapping is to occur.

SAS_PUT
specifies that the PUT function be mapped to the SAS_PUT( ) function.

***database*.SAS_PUT**
specifies the database name.

Requirement If you specify a database name, you must enclose the entire argument in parentheses.

Tips It is not necessary that the format definitions and the SAS_PUT( ) function reside in the same database as the one that contains the data that you want to format. You can use the *database*.SAS_PUT argument to specify the database where the format definitions and the SAS_PUT( ) function have been published.

The database name can be a multilevel name and it can include blanks.

Details

The format publishing macros deploy, or publish, the PUT function implementation to the database as a new function named SAS_PUT( ). The format publishing macros also

publish both user-defined formats that you create using PROC FORMAT and most formats that SAS supplies. The SAS_PUT( ) function supports the use of SAS formats. You can use the function in SQL queries that SAS submits to the database so that the entire SQL query can be processed inside the database. You can also use it in conjunction with in-database procedures.

You can use this option with the SQLREDUCEPUT=, SQLREDUCEPUTOBS, and SQLREDUCEPUTVALUES= system options. For more information about these options, see the *Base SAS Procedures Guide*.

See Also

- Chapter 12, "Deploying and Using SAS Formats in Aster nCluster," on page 133
- Chapter 13, "Deploying and Using SAS Formats in DB2 under UNIX," on page 147
- Chapter 14, "Deploying and Using SAS Formats in Greenplum," on page 159
- Chapter 15, "Deploying and Using SAS Formats in Netezza," on page 167
- Chapter 16, "Deploying and Using SAS Formats in Teradata," on page 177
- "BY-Groups" on page 195

LIBNAME Options:

- SQLMAPPUTTO= LIBNAME option in *SAS/ACCESS for Relational Databases: Reference*

SQLREDUCEPUT= System Option

For the SQL procedure, specifies the engine type that a query uses for which optimization is performed by replacing a PUT function in a query with a logically equivalent expression.

Valid in: configuration file, SAS invocation, OPTIONS statement, SAS System Options window

Categories: Files: SAS Files
System administration: SQL
System administration: Performance

PROC OPTIONS GROUP= SASFILES
SQL
PERFORMANCE

Note: This option can be restricted by a site administrator. For more information, see the section on restricted options in the *SAS System Options: Reference*.

Syntax

SQLREDUCEPUT= ALL | NONE | DBMS | BASE

Syntax Description

ALL
specifies that optimization is performed on all PUT functions regardless of any engine that is used by the query to access the data.

NONE
specifies that no optimization is to be performed.

DBMS
specifies that optimization is performed on all PUT functions whose query is performed by a SAS/ACCESS engine. This is the default.

Requirement The first argument to the PUT function must be a variable obtained by a table that is accessed using a SAS/ACCESS engine.

BASE
specifies that optimization is performed on all PUT functions whose query is performed by a SAS/ACCESS engine or a Base SAS engine.

Details

If you specify the SQLREDUCEPUT= system option, SAS optimizes the PUT function as much as possible before the query is executed. If the query also contains a WHERE clause, the evaluation of the WHERE clause is simplified. The following SELECT statements are examples of queries that would be reduced if this option was set to any value other than **none**:

```
select x, y from &lib..b where (PUT(x, abc.) in ('yes', 'no'));
select x from &lib..a where (PUT(x, udfmt.) = trim(left('small')));
```

If both the SQLREDUCEPUT= system option and the SQLCONSTDATETIME system option are specified, PROC SQL replaces the DATE, TIME, DATETIME, and TODAY functions with their respective values to determine the PUT function value before the query executes.

The following two SELECT clauses show the original query and the optimized query. This is the original query.

```
select x from &lib..c where (put(bday, date9.) = put(today(), date9.));
```

Here, the SELECT clause is optimized.

```
select x from &lib..c where (x = '17Mar2011'D);
```

If a query does not contain the PUT function, it is not optimized.

Note: The value that is specified in the SQLREDUCEPUT= system option is in effect for all SQL procedure statements, unless the PROC SQL REDUCEPUT= option is set. The value of the REDUCEPUT= option takes precedence over the SQLREDUCEPUT= system option. However, changing the value of the REDUCEPUT= option does not change the value of the SQLREDUCEPUT= system option.

See Also

- “Improving Query Performance” in the *SAS SQL Procedure User’s Guide*

Procedure Statement Options:

- PROC SQL Statement REDUCEPUT= option in the *SAS SQL Procedure User’s Guide*

System Options:

- SQLCONSTDATETIME and SQLREDUCEPUTOBS in the *SAS SQL Procedure User’s Guide*

Part 6

Appendix

Appendix 1

Scoring File Examples

Example of a .ds2 Scoring File

This is an example of a .ds2 scoring file. The filename is sasscore_score.ds2.

```
data &ASTER_OUTPUT;
 #_local _LPMAX;
 #_local _P4;
 #_local _P3;
 #_local _P2;
 #_local _P1;
 #_local _P0;
 #_local _IY;
 #_local _MAXP;
 #_local _LP3;
 #_local _LP2;
 #_local _LP1;
 #_local _LP0;
 #_local _TEMP;
 #_local _7_1;
 #_local _7_0;
 #_local _6_2;
 #_local _6_1;
 #_local _6_0;
 #_local _5_14;
 #_local _5_13;
 #_local _5_12;
 #_local _5_11;
 #_local _5_10;
 #_local _5_9;
 #_local _5_8;
 #_local _5_7;
 #_local _5_6;
 #_local _5_5;
 #_local _5_4;
```

```
 #_local _5_3;
 #_local _5_2;
 #_local _5_1;
 #_local _5_0;
 #_local _3_10;
 #_local _3_9;
 #_local _3_8;
 #_local _3_7;
 #_local _3_6;
 #_local _3_5;
 #_local _3_4;
 #_local _3_3;
 #_local _3_2;
 #_local _3_1;
 #_local _3_0;
 #_local _2_12;
 #_local _2_11;
 #_local _2_10;
 #_local _2_9;
 #_local _2_8;
 #_local _2_7;
 #_local _2_6;
 #_local _2_5;
 #_local _2_4;
 #_local _2_3;
 #_local _2_2;
 #_local _2_1;
 #_local _2_0;
 #_local _DM_FIND;
 #_local _1_14;
 #_local _1_13;
 #_local _1_12;
 #_local _1_11;
 #_local _1_10;
 #_local _1_9;
 #_local _1_8;
 #_local _1_7;
 #_local _1_6;
 #_local _1_5;
 #_local _1_4;
 #_local _1_3;
 #_local _1_2;
 #_local _1_1;
 #_local _1_0;
 #_local _DM_BAD;
dcl char(4) _WARN_;
dcl char(6) I_ATTACK;
dcl char(6) U_ATTACK;
dcl char(32) EM_CLASSIFICATION;
dcl double COUNT;
dcl double DIF_SRVR;
dcl char(32) FLAG;
dcl double HOT;
dcl double SAM_SRAT;
dcl char(32) SERVICE;
dcl double SRV_CNT;
```

```
method run();
 dcl char(8) _NORM8;
 dcl char(8) _NORM8;
 dcl char(12) _DM12;
 dcl char(12) _DM12;
 dcl char(12) _DM12;
 dcl char(12) _DM12;
 dcl char(12) _DM12;
 dcl char(12) _DM12;
 dcl char(6) REGDRU[5];
 dcl char(6) REGDRF[5];
REGDRU:=('u2r   ', 'r2l   ', 'probe ', 'normal', 'dos   ');
REGDRF:=('U2R', 'R2L', 'PROBE', 'NORMAL', 'DOS');
set &ASTER_INPUT;
_WARN_ = ' ';
if (COUNT = .) then AOV16_COUNT = 8.0;
 else if (COUNT <= 31.9375) then AOV16_COUNT = 1.0;
 else if (COUNT <= 63.875) then AOV16_COUNT = 2.0;
 else if (COUNT <= 95.8125) then AOV16_COUNT = 3.0;
 else if (COUNT <= 127.75) then AOV16_COUNT = 4.0;
 else if (COUNT <= 159.6875) then AOV16_COUNT = 5.0;
 else if (COUNT <= 191.625) then AOV16_COUNT = 6.0;
 else if (COUNT <= 223.5625) then AOV16_COUNT = 7.0;
 else if (COUNT <= 255.5) then AOV16_COUNT = 8.0;
 else if (COUNT <= 287.4375) then AOV16_COUNT = 9.0;
 else if (COUNT <= 319.375) then AOV16_COUNT = 10.0;
 else if (COUNT <= 351.3125) then AOV16_COUNT = 11.0;
 else if (COUNT <= 383.25) then AOV16_COUNT = 12.0;
 else if (COUNT <= 415.1875) then AOV16_COUNT = 13.0;
 else if (COUNT <= 447.125) then AOV16_COUNT = 14.0;
 else if (COUNT <= 479.0625) then AOV16_COUNT = 15.0;
 else AOV16_COUNT = 16.0;
if (SRV_CNT = .) then AOV16_SRV_CNT = 7.0;
 else if (SRV_CNT <= 31.9375) then AOV16_SRV_CNT = 1.0;
 else if (SRV_CNT <= 63.875) then AOV16_SRV_CNT = 2.0;
 else if (SRV_CNT <= 95.8125) then AOV16_SRV_CNT = 3.0;
 else if (SRV_CNT <= 127.75) then AOV16_SRV_CNT = 4.0;
 else if (SRV_CNT <= 159.6875) then AOV16_SRV_CNT = 5.0;
 else if (SRV_CNT <= 191.625) then AOV16_SRV_CNT = 6.0;
 else if (SRV_CNT <= 223.5625) then AOV16_SRV_CNT = 7.0;
 else if (SRV_CNT <= 255.5) then AOV16_SRV_CNT = 8.0;
 else if (SRV_CNT <= 287.4375) then AOV16_SRV_CNT = 9.0;
 else if (SRV_CNT <= 319.375) then AOV16_SRV_CNT = 10.0;
 else if (SRV_CNT <= 351.3125) then AOV16_SRV_CNT = 11.0;
 else if (SRV_CNT <= 383.25) then AOV16_SRV_CNT = 12.0;
 else if (SRV_CNT <= 415.1875) then AOV16_SRV_CNT = 13.0;
 else if (SRV_CNT <= 447.125) then AOV16_SRV_CNT = 14.0;
 else if (SRV_CNT <= 479.0625) then AOV16_SRV_CNT = 15.0;
 else AOV16_SRV_CNT = 16.0;
if (SAM_SRAT = .) then AOV16_SAM_SRAT = 14.0;
 else if (SAM_SRAT <= 0.0625) then AOV16_SAM_SRAT = 1.0;
 else if (SAM_SRAT <= 0.125) then AOV16_SAM_SRAT = 2.0;
 else if (SAM_SRAT <= 0.1875) then AOV16_SAM_SRAT = 3.0;
 else if (SAM_SRAT <= 0.25) then AOV16_SAM_SRAT = 4.0;
 else if (SAM_SRAT <= 0.3125) then AOV16_SAM_SRAT = 5.0;
 else if (SAM_SRAT <= 0.375) then AOV16_SAM_SRAT = 6.0;
```

```
 else if (SAM_SRAT <= 0.4375) then AOV16_SAM_SRAT = 7.0;
 else if (SAM_SRAT <= 0.5) then AOV16_SAM_SRAT = 8.0;
 else if (SAM_SRAT <= 0.5625) then AOV16_SAM_SRAT = 9.0;
 else if (SAM_SRAT <= 0.625) then AOV16_SAM_SRAT = 10.0;
 else if (SAM_SRAT <= 0.6875) then AOV16_SAM_SRAT = 11.0;
 else if (SAM_SRAT <= 0.75) then AOV16_SAM_SRAT = 12.0;
 else if (SAM_SRAT <= 0.8125) then AOV16_SAM_SRAT = 13.0;
 else if (SAM_SRAT <= 0.875) then AOV16_SAM_SRAT = 14.0;
 else if (SAM_SRAT <= 0.9375) then AOV16_SAM_SRAT = 15.0;
 else AOV16_SAM_SRAT = 16.0;
if (DIF_SRVR = .) then AOV16_DIF_SRVR = 1.0;
 else if (DIF_SRVR <= 0.0625) then AOV16_DIF_SRVR = 1.0;
 else if (DIF_SRVR <= 0.125) then AOV16_DIF_SRVR = 2.0;
 else if (DIF_SRVR <= 0.1875) then AOV16_DIF_SRVR = 3.0;
 else if (DIF_SRVR <= 0.25) then AOV16_DIF_SRVR = 4.0;
 else if (DIF_SRVR <= 0.3125) then AOV16_DIF_SRVR = 5.0;
 else if (DIF_SRVR <= 0.375) then AOV16_DIF_SRVR = 6.0;
 else if (DIF_SRVR <= 0.4375) then AOV16_DIF_SRVR = 7.0;
 else if (DIF_SRVR <= 0.5) then AOV16_DIF_SRVR = 8.0;
 else if (DIF_SRVR <= 0.5625) then AOV16_DIF_SRVR = 9.0;
 else if (DIF_SRVR <= 0.625) then AOV16_DIF_SRVR = 10.0;
 else if (DIF_SRVR <= 0.6875) then AOV16_DIF_SRVR = 11.0;
 else if (DIF_SRVR <= 0.75) then AOV16_DIF_SRVR = 12.0;
 else if (DIF_SRVR <= 0.8125) then AOV16_DIF_SRVR = 13.0;
 else if (DIF_SRVR <= 0.875) then AOV16_DIF_SRVR = 14.0;
 else if (DIF_SRVR <= 0.9375) then AOV16_DIF_SRVR = 15.0;
 else AOV16_DIF_SRVR = 16.0;
if (HOT = .) then AOV16_HOT = 1.0;
 else if (HOT <= 1.875) then AOV16_HOT = 1.0;
 else if (HOT <= 3.75) then AOV16_HOT = 2.0;
 else if (HOT <= 5.625) then AOV16_HOT = 3.0;
 else if (HOT <= 7.5) then AOV16_HOT = 4.0;
 else if (HOT <= 9.375) then AOV16_HOT = 5.0;
 else if (HOT <= 11.25) then AOV16_HOT = 6.0;
 else if (HOT <= 13.125) then AOV16_HOT = 7.0;
 else if (HOT <= 15.0) then AOV16_HOT = 8.0;
 else if (HOT <= 16.875) then AOV16_HOT = 9.0;
 else if (HOT <= 18.75) then AOV16_HOT = 10.0;
 else if (HOT <= 20.625) then AOV16_HOT = 11.0;
 else if (HOT <= 22.5) then AOV16_HOT = 12.0;
 else if (HOT <= 24.375) then AOV16_HOT = 13.0;
 else if (HOT <= 26.25) then AOV16_HOT = 14.0;
 else if (HOT <= 28.125) then AOV16_HOT = 15.0;
 else AOV16_HOT = 16.0;
_NORM8 = DMNORM(SERVICE, 32.0);
select (_NORM8);
when ('IRC     ') G_SERVICE = 2.0;
when ('X11     ') G_SERVICE = 2.0;
when ('Z39_50  ') G_SERVICE = 1.0;
when ('AUTH    ') G_SERVICE = 2.0;
when ('BGP     ') G_SERVICE = 0.0;
when ('COURIER ') G_SERVICE = 1.0;
when ('CSNET_NS') G_SERVICE = 1.0;
when ('CTF     ') G_SERVICE = 0.0;
when ('DAYTIME ') G_SERVICE = 1.0;
when ('DISCARD ') G_SERVICE = 0.0;
```

```
when ('DOMAIN  ') G_SERVICE = 1.0;
when ('DOMAIN_U') G_SERVICE = 2.0;
when ('ECHO    ') G_SERVICE = 0.0;
when ('ECO_I   ') G_SERVICE = 2.0;
when ('ECR_I   ') G_SERVICE = 0.0;
when ('EFS     ') G_SERVICE = 1.0;
when ('EXEC    ') G_SERVICE = 0.0;
when ('FINGER  ') G_SERVICE = 2.0;
when ('FTP     ') G_SERVICE = 2.0;
when ('FTP_DATA') G_SERVICE = 2.0;
when ('GOPHER  ') G_SERVICE = 1.0;
when ('HOSTNAME') G_SERVICE = 0.0;
when ('HTTP    ') G_SERVICE = 2.0;
when ('HTTP_443') G_SERVICE = 0.0;
when ('IMAP4   ') G_SERVICE = 1.0;
when ('ISO_TSAP') G_SERVICE = 0.0;
when ('KLOGIN  ') G_SERVICE = 0.0;
when ('KSHELL  ') G_SERVICE = 0.0;
when ('LDAP    ') G_SERVICE = 0.0;
when ('LINK    ') G_SERVICE = 1.0;
when ('LOGIN   ') G_SERVICE = 0.0;
when ('MTP     ') G_SERVICE = 1.0;
when ('NAME    ') G_SERVICE = 0.0;
when ('NETBIOS_') G_SERVICE = 0.0;
when ('NETSTAT ') G_SERVICE = 0.0;
when ('NNSP    ') G_SERVICE = 0.0;
when ('NNTP    ') G_SERVICE = 1.0;
when ('NTP_U   ') G_SERVICE = 2.0;
when ('OTHER   ') G_SERVICE = 2.0;
when ('POP_2   ') G_SERVICE = 0.0;
when ('POP_3   ') G_SERVICE = 2.0;
when ('PRINTER ') G_SERVICE = 1.0;
when ('PRIVATE ') G_SERVICE = 1.0;
when ('RED_I   ') G_SERVICE = 2.0;
when ('REMOTE_J') G_SERVICE = 1.0;
when ('RJE     ') G_SERVICE = 1.0;
when ('SHELL   ') G_SERVICE = 0.0;
when ('SMTP    ') G_SERVICE = 2.0;
when ('SQL_NET ') G_SERVICE = 0.0;
when ('SSH     ') G_SERVICE = 1.0;
when ('SUNRPC  ') G_SERVICE = 1.0;
when ('SUPDUP  ') G_SERVICE = 1.0;
when ('SYSTAT  ') G_SERVICE = 1.0;
when ('TELNET  ') G_SERVICE = 2.0;
when ('TFTP_U  ') G_SERVICE = 2.0;
when ('TIM_I   ') G_SERVICE = 1.0;
when ('TIME    ') G_SERVICE = 2.0;
when ('URH_I   ') G_SERVICE = 2.0;
when ('URP_I   ') G_SERVICE = 2.0;
when ('UUCP    ') G_SERVICE = 1.0;
when ('UUCP_PAT') G_SERVICE = 0.0;
when ('VMNET   ') G_SERVICE = 1.0;
when ('WHOIS   ') G_SERVICE = 1.0;
otherwise _WARN_ = 'U';
end;
_NORM8 = DMNORM(FLAG, 32.0);
```

```
select (_NORM8);
when ('OTH     ') G_FLAG = 3.0;
when ('REJ     ') G_FLAG = 2.0;
when ('RSTO    ') G_FLAG = 2.0;
when ('RSTOS0  ') G_FLAG = 3.0;
when ('RSTR    ') G_FLAG = 3.0;
when ('S0      ') G_FLAG = 0.0;
when ('S1      ') G_FLAG = 3.0;
when ('S2      ') G_FLAG = 3.0;
when ('S3      ') G_FLAG = 3.0;
when ('SF      ') G_FLAG = 1.0;
when ('SH      ') G_FLAG = 3.0;
otherwise _WARN_ = 'U';
end;
_DM_BAD = 0.0;
_1_0 = 0.0;
_1_1 = 0.0;
_1_2 = 0.0;
_1_3 = 0.0;
_1_4 = 0.0;
_1_5 = 0.0;
_1_6 = 0.0;
_1_7 = 0.0;
_1_8 = 0.0;
_1_9 = 0.0;
_1_10 = 0.0;
_1_11 = 0.0;
_1_12 = 0.0;
_1_13 = 0.0;
_1_14 = 0.0;
if MISSING(AOV16_COUNT) then do ;
_1_0 = .;
_1_1 = .;
_1_2 = .;
_1_3 = .;
_1_4 = .;
_1_5 = .;
_1_6 = .;
_1_7 = .;
_1_8 = .;
_1_9 = .;
_1_10 = .;
_1_11 = .;
_1_12 = .;
_1_13 = .;
_1_14 = .;
substr(_WARN_, 1.0, 1.0) = 'M';
_DM_BAD = 1.0;
end;
 else do ;
_DM12 = put(AOV16_COUNT, BEST12.);
_DM12 = DMNORM(_DM12, 32.0);
_DM_FIND = 0.0;
if _DM12 <= '16' then do ;
if _DM12 <= '12' then do ;
if _DM12 <= '10' then do ;
```

```
if _DM12 = '1' then do ;
_1_0 = 1.0;
_DM_FIND = 1.0;
end;
 else do ;
if _DM12 = '10' then do ;
_1_9 = 1.0;
_DM_FIND = 1.0;
end;
end;
end;
 else do ;
if _DM12 = '11' then do ;
_1_10 = 1.0;
_DM_FIND = 1.0;
end;
 else do ;
if _DM12 = '12' then do ;
_1_11 = 1.0;
_DM_FIND = 1.0;
end;
end;
end;
end;
 else do ;
if _DM12 <= '14' then do ;
if _DM12 = '13' then do ;
_1_12 = 1.0;
_DM_FIND = 1.0;
end;
 else do ;
if _DM12 = '14' then do ;
_1_13 = 1.0;
_DM_FIND = 1.0;
end;
end;
end;
 else do ;
if _DM12 = '15' then do ;
_1_14 = 1.0;
_DM_FIND = 1.0;
end;
 else do ;
if _DM12 = '16' then do ;
_1_0 = -1.0;
_1_1 = -1.0;
_1_2 = -1.0;
_1_3 = -1.0;
_1_4 = -1.0;
_1_5 = -1.0;
_1_6 = -1.0;
_1_7 = -1.0;
_1_8 = -1.0;
_1_9 = -1.0;
_1_10 = -1.0;
_1_11 = -1.0;
```

```
_1_12 = -1.0;
_1_13 = -1.0;
_1_14 = -1.0;
_DM_FIND = 1.0;
end;
end;
end;
end;
end;
 else do ;
if _DM12 <= '5' then do ;
if _DM12 <= '3' then do ;
if _DM12 = '2' then do ;
_1_1 = 1.0;
_DM_FIND = 1.0;
end;
 else do ;
if _DM12 = '3' then do ;
_1_2 = 1.0;
_DM_FIND = 1.0;
end;
end;
end;
 else do ;
if _DM12 = '4' then do ;
_1_3 = 1.0;
_DM_FIND = 1.0;
end;
 else do ;
if _DM12 = '5' then do ;
_1_4 = 1.0;
_DM_FIND = 1.0;
end;
end;
end;
end;
 else do ;
if _DM12 <= '7' then do ;
if _DM12 = '6' then do ;
_1_5 = 1.0;
_DM_FIND = 1.0;
end;
 else do ;
if _DM12 = '7' then do ;
_1_6 = 1.0;
_DM_FIND = 1.0;
end;
end;
end;
 else do ;
if _DM12 = '8' then do ;
_1_7 = 1.0;
_DM_FIND = 1.0;
end;
 else do ;
if _DM12 = '9' then do ;
```

```
_1_8 = 1.0;
_DM_FIND = 1.0;
end;
end;
end;
end;
end;
if ^_DM_FIND then do ;
_1_0 = .;
_1_1 = .;
_1_2 = .;
_1_3 = .;
_1_4 = .;
_1_5 = .;
_1_6 = .;
_1_7 = .;
_1_8 = .;
_1_9 = .;
_1_10 = .;
_1_11 = .;
_1_12 = .;
_1_13 = .;
_1_14 = .;
substr(_WARN_, 2.0, 1.0) = 'U';
_DM_BAD = 1.0;
end;
end;
_2_0 = 0.0;
_2_1 = 0.0;
_2_2 = 0.0;
_2_3 = 0.0;
_2_4 = 0.0;
_2_5 = 0.0;
_2_6 = 0.0;
_2_7 = 0.0;
_2_8 = 0.0;
_2_9 = 0.0;
_2_10 = 0.0;
_2_11 = 0.0;
_2_12 = 0.0;
if MISSING(AOV16_DIF_SRVR) then do ;
_2_0 = .;
_2_1 = .;
_2_2 = .;
_2_3 = .;
_2_4 = .;
_2_5 = .;
_2_6 = .;
_2_7 = .;
_2_8 = .;
_2_9 = .;
_2_10 = .;
_2_11 = .;
_2_12 = .;
substr(_WARN_, 1.0, 1.0) = 'M';
_DM_BAD = 1.0;
```

```
end;
 else do ;
_DM12 = put(AOV16_DIF_SRVR, BEST12.);
_DM12 = DMNORM(_DM12, 32.0);
if _DM12 = '1' then do ;
_2_0 = 1.0;
end;
 else if _DM12 = '2' then do ;
_2_1 = 1.0;
end;
 else if _DM12 = '16' then do ;
_2_0 = -1.0;
_2_1 = -1.0;
_2_2 = -1.0;
_2_3 = -1.0;
_2_4 = -1.0;
_2_5 = -1.0;
_2_6 = -1.0;
_2_7 = -1.0;
_2_8 = -1.0;
_2_9 = -1.0;
_2_10 = -1.0;
_2_11 = -1.0;
_2_12 = -1.0;
end;
 else if _DM12 = '11' then do ;
_2_10 = 1.0;
end;
 else if _DM12 = '8' then do ;
_2_7 = 1.0;
end;
 else if _DM12 = '10' then do ;
_2_9 = 1.0;
end;
 else if _DM12 = '3' then do ;
_2_2 = 1.0;
end;
 else if _DM12 = '7' then do ;
_2_6 = 1.0;
end;
 else if _DM12 = '4' then do ;
_2_3 = 1.0;
end;
 else if _DM12 = '9' then do ;
_2_8 = 1.0;
end;
 else if _DM12 = '5' then do ;
_2_4 = 1.0;
end;
 else if _DM12 = '12' then do ;
_2_11 = 1.0;
end;
 else if _DM12 = '6' then do ;
_2_5 = 1.0;
end;
 else if _DM12 = '13' then do ;
```

```
_2_12 = 1.0;
end;
 else do ;
_2_0 = .;
_2_1 = .;
_2_2 = .;
_2_3 = .;
_2_4 = .;
_2_5 = .;
_2_6 = .;
_2_7 = .;
_2_8 = .;
_2_9 = .;
_2_10 = .;
_2_11 = .;
_2_12 = .;
substr(_WARN_, 2.0, 1.0) = 'U';
_DM_BAD = 1.0;
end;
end;
_3_0 = 0.0;
_3_1 = 0.0;
_3_2 = 0.0;
_3_3 = 0.0;
_3_4 = 0.0;
_3_5 = 0.0;
_3_6 = 0.0;
_3_7 = 0.0;
_3_8 = 0.0;
_3_9 = 0.0;
_3_10 = 0.0;
if MISSING(AOV16_HOT) then do ;
_3_0 = .;
_3_1 = .;
_3_2 = .;
_3_3 = .;
_3_4 = .;
_3_5 = .;
_3_6 = .;
_3_7 = .;
_3_8 = .;
_3_9 = .;
_3_10 = .;
substr(_WARN_, 1.0, 1.0) = 'M';
_DM_BAD = 1.0;
end;
 else do ;
_DM12 = put(AOV16_HOT, BEST12.);
_DM12 = DMNORM(_DM12, 32.0);
if _DM12 = '1' then do ;
_3_0 = 1.0;
end;
 else if _DM12 = '2' then do ;
_3_1 = 1.0;
end;
 else if _DM12 = '15' then do ;
```

```
_3_10 = 1.0;
end;
 else if _DM12 = '3' then do ;
_3_2 = 1.0;
end;
 else if _DM12 = '4' then do ;
_3_3 = 1.0;
end;
 else if _DM12 = '11' then do ;
_3_7 = 1.0;
end;
 else if _DM12 = '12' then do ;
_3_8 = 1.0;
end;
 else if _DM12 = '10' then do ;
_3_6 = 1.0;
end;
 else if _DM12 = '8' then do ;
_3_5 = 1.0;
end;
 else if _DM12 = '16' then do ;
_3_0 = -1.0;
_3_1 = -1.0;
_3_2 = -1.0;
_3_3 = -1.0;
_3_4 = -1.0;
_3_5 = -1.0;
_3_6 = -1.0;
_3_7 = -1.0;
_3_8 = -1.0;
_3_9 = -1.0;
_3_10 = -1.0;
end;
 else if _DM12 = '13' then do ;
_3_9 = 1.0;
end;
 else if _DM12 = '7' then do ;
_3_4 = 1.0;
end;
 else do ;
_3_0 = .;
_3_1 = .;
_3_2 = .;
_3_3 = .;
_3_4 = .;
_3_5 = .;
_3_6 = .;
_3_7 = .;
_3_8 = .;
_3_9 = .;
_3_10 = .;
substr(_WARN_, 2.0, 1.0) = 'U';
_DM_BAD = 1.0;
end;
end;
_5_0 = 0.0;
```

```
_5_1 = 0.0;
_5_2 = 0.0;
_5_3 = 0.0;
_5_4 = 0.0;
_5_5 = 0.0;
_5_6 = 0.0;
_5_7 = 0.0;
_5_8 = 0.0;
_5_9 = 0.0;
_5_10 = 0.0;
_5_11 = 0.0;
_5_12 = 0.0;
_5_13 = 0.0;
_5_14 = 0.0;
if MISSING(AOV16_SRV_CNT) then do ;
_5_0 = .;
_5_1 = .;
_5_2 = .;
_5_3 = .;
_5_4 = .;
_5_5 = .;
_5_6 = .;
_5_7 = .;
_5_8 = .;
_5_9 = .;
_5_10 = .;
_5_11 = .;
_5_12 = .;
_5_13 = .;
_5_14 = .;
substr(_WARN_, 1.0, 1.0) = 'M';
_DM_BAD = 1.0;
end;
 else do ;
_DM12 = put(AOV16_SRV_CNT, BEST12.);
_DM12 = DMNORM(_DM12, 32.0);
if _DM12 = '1' then do ;
_5_0 = 1.0;
end;
 else if _DM12 = '16' then do ;
_5_0 = -1.0;
_5_1 = -1.0;
_5_2 = -1.0;
_5_3 = -1.0;
_5_4 = -1.0;
_5_5 = -1.0;
_5_6 = -1.0;
_5_7 = -1.0;
_5_8 = -1.0;
_5_9 = -1.0;
_5_10 = -1.0;
_5_11 = -1.0;
_5_12 = -1.0;
_5_13 = -1.0;
_5_14 = -1.0;
end;
```

```
 else if _DM12 = '2' then do ;
_5_1 = 1.0;
end;
 else if _DM12 = '15' then do ;
_5_14 = 1.0;
end;
 else if _DM12 = '14' then do ;
_5_13 = 1.0;
end;
 else if _DM12 = '3' then do ;
_5_2 = 1.0;
end;
 else if _DM12 = '4' then do ;
_5_3 = 1.0;
end;
 else if _DM12 = '5' then do ;
_5_4 = 1.0;
end;
 else if _DM12 = '6' then do ;
_5_5 = 1.0;
end;
 else if _DM12 = '8' then do ;
_5_7 = 1.0;
end;
 else if _DM12 = '7' then do ;
_5_6 = 1.0;
end;
 else if _DM12 = '9' then do ;
_5_8 = 1.0;
end;
 else if _DM12 = '10' then do ;
_5_9 = 1.0;
end;
 else if _DM12 = '12' then do ;
_5_11 = 1.0;
end;
 else if _DM12 = '11' then do ;
_5_10 = 1.0;
end;
 else if _DM12 = '13' then do ;
_5_12 = 1.0;
end;
 else do ;
_5_0 = .;
_5_1 = .;
_5_2 = .;
_5_3 = .;
_5_4 = .;
_5_5 = .;
_5_6 = .;
_5_7 = .;
_5_8 = .;
_5_9 = .;
_5_10 = .;
_5_11 = .;
_5_12 = .;
```

```
_5_13 = .;
_5_14 = .;
substr(_WARN_, 2.0, 1.0) = 'U';
_DM_BAD = 1.0;
end;
end;
if MISSING(G_FLAG) then do ;
_6_0 = .;
_6_1 = .;
_6_2 = .;
substr(_WARN_, 1.0, 1.0) = 'M';
_DM_BAD = 1.0;
end;
 else do ;
_DM12 = put(G_FLAG, BEST12.);
_DM12 = DMNORM(_DM12, 32.0);
if _DM12 = '1' then do ;
_6_0 = 0.0;
_6_1 = 1.0;
_6_2 = 0.0;
end;
 else if _DM12 = '0' then do ;
_6_0 = 1.0;
_6_1 = 0.0;
_6_2 = 0.0;
end;
 else if _DM12 = '2' then do ;
_6_0 = 0.0;
_6_1 = 0.0;
_6_2 = 1.0;
end;
 else if _DM12 = '3' then do ;
_6_0 = -1.0;
_6_1 = -1.0;
_6_2 = -1.0;
end;
 else do ;
_6_0 = .;
_6_1 = .;
_6_2 = .;
substr(_WARN_, 2.0, 1.0) = 'U';
_DM_BAD = 1.0;
end;
end;
if MISSING(G_SERVICE) then do ;
_7_0 = .;
_7_1 = .;
substr(_WARN_, 1.0, 1.0) = 'M';
_DM_BAD = 1.0;
end;
 else do ;
_DM12 = put(G_SERVICE, BEST12.);
_DM12 = DMNORM(_DM12, 32.0);
if _DM12 = '2' then do ;
_7_0 = -1.0;
_7_1 = -1.0;
```

```
end;
 else if _DM12 = '0' then do ;
_7_0 = 1.0;
_7_1 = 0.0;
end;
 else if _DM12 = '1' then do ;
_7_0 = 0.0;
_7_1 = 1.0;
end;
 else do ;
_7_0 = .;
_7_1 = .;
substr(_WARN_, 2.0, 1.0) = 'U';
_DM_BAD = 1.0;
end;
end;
if _DM_BAD > 0.0 then do ;
_P0 = 0.0006798097;
_P1 = 0.0153183775;
_P2 = 0.0558123725;
_P3 = 0.3941083163;
_P4 = 0.534081124;
goto REGDR1;
end;
_LP0 = 0.0;
_LP1 = 0.0;
_LP2 = 0.0;
_LP3 = 0.0;
_TEMP = 1.0;
_LP0 = _LP0 + (8.97309749884509) * _TEMP * _1_0;
_LP1 = _LP1 + (9.475456450304) * _TEMP * _1_0;
_LP2 = _LP2 + (0.08183779939133) * _TEMP * _1_0;
_LP3 = _LP3 + (7.91547642280949) * _TEMP * _1_0;
_LP0 = _LP0 + (-7.09311218652648) * _TEMP * _1_1;
_LP1 = _LP1 + (3.42946756538907) * _TEMP * _1_1;
_LP2 = _LP2 + (-1.63736222687037) * _TEMP * _1_1;
_LP3 = _LP3 + (8.60035492871607) * _TEMP * _1_1;
_LP0 = _LP0 + (16.3315840253036) * _TEMP * _1_2;
_LP1 = _LP1 + (-5.85959164693143) * _TEMP * _1_2;
_LP2 = _LP2 + (-2.53740928241609) * _TEMP * _1_2;
_LP3 = _LP3 + (2.62120809028614) * _TEMP * _1_2;
_LP0 = _LP0 + (-22.5615273556858) * _TEMP * _1_3;
_LP1 = _LP1 + (-5.52330111707437) * _TEMP * _1_3;
_LP2 = _LP2 + (-5.33919133360776) * _TEMP * _1_3;
_LP3 = _LP3 + (0.11884727866076) * _TEMP * _1_3;
_LP0 = _LP0 + (-30.2554906468364) * _TEMP * _1_4;
_LP1 = _LP1 + (0.64526397467362) * _TEMP * _1_4;
_LP2 = _LP2 + (-4.40987507627988) * _TEMP * _1_4;
_LP3 = _LP3 + (-1.46254346452609) * _TEMP * _1_4;
_LP0 = _LP0 + (13.4444067104834) * _TEMP * _1_5;
_LP1 = _LP1 + (-15.4359581659106) * _TEMP * _1_5;
_LP2 = _LP2 + (-3.78315830765155) * _TEMP * _1_5;
_LP3 = _LP3 + (-4.74730533646477) * _TEMP * _1_5;
_LP0 = _LP0 + (5.99426137980241) * _TEMP * _1_6;
_LP1 = _LP1 + (3.34304711000097) * _TEMP * _1_6;
_LP2 = _LP2 + (-4.49993737709991) * _TEMP * _1_6;
```

```
_LP3 = _LP3 + (0.39149662840319) * _TEMP * _1_6;
_LP0 = _LP0 + (8.00404660871621) * _TEMP * _1_7;
_LP1 = _LP1 + (3.87729351931859) * _TEMP * _1_7;
_LP2 = _LP2 + (-5.662863418933) * _TEMP * _1_7;
_LP3 = _LP3 + (0.92431512613497) * _TEMP * _1_7;
_LP0 = _LP0 + (9.73639514490121) * _TEMP * _1_8;
_LP1 = _LP1 + (1.66486268124882) * _TEMP * _1_8;
_LP2 = _LP2 + (-5.34790399310294) * _TEMP * _1_8;
_LP3 = _LP3 + (-0.80452936208339) * _TEMP * _1_8;
_LP0 = _LP0 + (-1.18886754533908) * _TEMP * _1_9;
_LP1 = _LP1 + (0.98108751722337) * _TEMP * _1_9;
_LP2 = _LP2 + (-5.09756573837529) * _TEMP * _1_9;
_LP3 = _LP3 + (0.55035390990751) * _TEMP * _1_9;
_LP0 = _LP0 + (3.33003316374041) * _TEMP * _1_10;
_LP1 = _LP1 + (1.28863079547562) * _TEMP * _1_10;
_LP2 = _LP2 + (4.52005620947533) * _TEMP * _1_10;
_LP3 = _LP3 + (-1.88185495205653) * _TEMP * _1_10;
_LP0 = _LP0 + (-1.23514061750629) * _TEMP * _1_11;
_LP1 = _LP1 + (-0.63165164315095) * _TEMP * _1_11;
_LP2 = _LP2 + (4.47980876228159) * _TEMP * _1_11;
_LP3 = _LP3 + (-2.28762571372038) * _TEMP * _1_11;
_LP0 = _LP0 + (3.45175998109795) * _TEMP * _1_12;
_LP1 = _LP1 + (-0.05911640263949) * _TEMP * _1_12;
_LP2 = _LP2 + (3.7133976012504) * _TEMP * _1_12;
_LP3 = _LP3 + (-3.40533163917284) * _TEMP * _1_12;
_LP0 = _LP0 + (-1.79579379752335) * _TEMP * _1_13;
_LP1 = _LP1 + (-0.66575638518718) * _TEMP * _1_13;
_LP2 = _LP2 + (2.46190197688312) * _TEMP * _1_13;
_LP3 = _LP3 + (-3.86144993561858) * _TEMP * _1_13;
_LP0 = _LP0 + (16.2289623285747) * _TEMP * _1_14;
_LP1 = _LP1 + (3.87844062530087) * _TEMP * _1_14;
_LP2 = _LP2 + (13.5342255495752) * _TEMP * _1_14;
_LP3 = _LP3 + (0.11787447033604) * _TEMP * _1_14;
_TEMP = 1.0;
_LP0 = _LP0 + (4.96178727582277) * _TEMP * _2_0;
_LP1 = _LP1 + (7.19423934264755) * _TEMP * _2_0;
_LP2 = _LP2 + (-2.57814751000107) * _TEMP * _2_0;
_LP3 = _LP3 + (-0.41318251862093) * _TEMP * _2_0;
_LP0 = _LP0 + (2.53606187215301) * _TEMP * _2_1;
_LP1 = _LP1 + (1.02456723195019) * _TEMP * _2_1;
_LP2 = _LP2 + (-3.01518942636817) * _TEMP * _2_1;
_LP3 = _LP3 + (-6.42999803474578) * _TEMP * _2_1;
_LP0 = _LP0 + (-17.0716556901489) * _TEMP * _2_2;
_LP1 = _LP1 + (-2.55836176487159) * _TEMP * _2_2;
_LP2 = _LP2 + (-2.66986765613004) * _TEMP * _2_2;
_LP3 = _LP3 + (-3.77427590976266) * _TEMP * _2_2;
_LP0 = _LP0 + (-11.6228431594003) * _TEMP * _2_3;
_LP1 = _LP1 + (-4.42118648129498) * _TEMP * _2_3;
_LP2 = _LP2 + (-2.41006554535669) * _TEMP * _2_3;
_LP3 = _LP3 + (-2.47998713977501) * _TEMP * _2_3;
_LP0 = _LP0 + (-6.65446334079067) * _TEMP * _2_4;
_LP1 = _LP1 + (-4.21089586391698) * _TEMP * _2_4;
_LP2 = _LP2 + (-2.40850931862971) * _TEMP * _2_4;
_LP3 = _LP3 + (-2.46504190674716) * _TEMP * _2_4;
_LP0 = _LP0 + (-3.17136687316047) * _TEMP * _2_5;
_LP1 = _LP1 + (-1.69998112881134) * _TEMP * _2_5;
```

```
_LP2 = _LP2 + (-2.27711189809608) * _TEMP * _2_5;
_LP3 = _LP3 + (-0.56541361679043) * _TEMP * _2_5;
_LP0 = _LP0 + (0.06485838750697) * _TEMP * _2_6;
_LP1 = _LP1 + (2.083825423476) * _TEMP * _2_6;
_LP2 = _LP2 + (4.31755671819224) * _TEMP * _2_6;
_LP3 = _LP3 + (4.36618153369848) * _TEMP * _2_6;
_LP0 = _LP0 + (-3.15969642288067) * _TEMP * _2_7;
_LP1 = _LP1 + (-3.11663563731206) * _TEMP * _2_7;
_LP2 = _LP2 + (-1.93101189518423) * _TEMP * _2_7;
_LP3 = _LP3 + (-0.66813727595772) * _TEMP * _2_7;
_LP0 = _LP0 + (23.3492198306386) * _TEMP * _2_8;
_LP1 = _LP1 + (15.3692429684277) * _TEMP * _2_8;
_LP2 = _LP2 + (19.6299281653522) * _TEMP * _2_8;
_LP3 = _LP3 + (3.7767067535256) * _TEMP * _2_8;
_LP0 = _LP0 + (0.6888846491937) * _TEMP * _2_9;
_LP1 = _LP1 + (0.26881516596812) * _TEMP * _2_9;
_LP2 = _LP2 + (3.49366097063402) * _TEMP * _2_9;
_LP3 = _LP3 + (4.77521196924485) * _TEMP * _2_9;
_LP0 = _LP0 + (6.93832447370645) * _TEMP * _2_10;
_LP1 = _LP1 + (-14.7995817386477) * _TEMP * _2_10;
_LP2 = _LP2 + (-3.17802481741923) * _TEMP * _2_10;
_LP3 = _LP3 + (-0.75953335528334) * _TEMP * _2_10;
_LP0 = _LP0 + (-5.17421740905568) * _TEMP * _2_11;
_LP1 = _LP1 + (-3.50927803184578) * _TEMP * _2_11;
_LP2 = _LP2 + (-0.93991965967767) * _TEMP * _2_11;
_LP3 = _LP3 + (-0.57578867183536) * _TEMP * _2_11;
_LP0 = _LP0 + (-5.40485675039647) * _TEMP * _2_12;
_LP1 = _LP1 + (-3.43007109867235) * _TEMP * _2_12;
_LP2 = _LP2 + (-11.8686117799293) * _TEMP * _2_12;
_LP3 = _LP3 + (-0.57409656273319) * _TEMP * _2_12;
_TEMP = 1.0;
_LP0 = _LP0 + (42.0263556916437) * _TEMP * _3_0;
_LP1 = _LP1 + (1.55172177304255) * _TEMP * _3_0;
_LP2 = _LP2 + (10.9123737543277) * _TEMP * _3_0;
_LP3 = _LP3 + (2.20643367366059) * _TEMP * _3_0;
_LP0 = _LP0 + (35.8542164366111) * _TEMP * _3_1;
_LP1 = _LP1 + (-7.03832251333459) * _TEMP * _3_1;
_LP2 = _LP2 + (-13.5692536842049) * _TEMP * _3_1;
_LP3 = _LP3 + (-11.6512021486838) * _TEMP * _3_1;
_LP0 = _LP0 + (47.2300160154457) * _TEMP * _3_2;
_LP1 = _LP1 + (5.43079775823532) * _TEMP * _3_2;
_LP2 = _LP2 + (-1.76238042211005) * _TEMP * _3_2;
_LP3 = _LP3 + (2.88051687962657) * _TEMP * _3_2;
_LP0 = _LP0 + (32.2801944616028) * _TEMP * _3_3;
_LP1 = _LP1 + (5.10935792540826) * _TEMP * _3_3;
_LP2 = _LP2 + (2.52744460733309) * _TEMP * _3_3;
_LP3 = _LP3 + (2.95088205442946) * _TEMP * _3_3;
_LP0 = _LP0 + (31.6597113950015) * _TEMP * _3_4;
_LP1 = _LP1 + (-9.07258866978128) * _TEMP * _3_4;
_LP2 = _LP2 + (1.62190948241675) * _TEMP * _3_4;
_LP3 = _LP3 + (2.04551962977074) * _TEMP * _3_4;
_LP0 = _LP0 + (31.6597116255105) * _TEMP * _3_5;
_LP1 = _LP1 + (2.67824698076013) * _TEMP * _3_5;
_LP2 = _LP2 + (1.62190948383178) * _TEMP * _3_5;
_LP3 = _LP3 + (1.19293530007666) * _TEMP * _3_5;
_LP0 = _LP0 + (31.6597116340262) * _TEMP * _3_6;
```

```
_LP1 = _LP1 + (2.54298742758522) * _TEMP * _3_6;
_LP2 = _LP2 + (1.62190948388826) * _TEMP * _3_6;
_LP3 = _LP3 + (1.30825513024406) * _TEMP * _3_6;
_LP0 = _LP0 + (-362.950916427088) * _TEMP * _3_7;
_LP1 = _LP1 + (6.17176825281735) * _TEMP * _3_7;
_LP2 = _LP2 + (2.29729057331607) * _TEMP * _3_7;
_LP3 = _LP3 + (1.72970564346861) * _TEMP * _3_7;
_LP0 = _LP0 + (15.9700734501859) * _TEMP * _3_8;
_LP1 = _LP1 + (-9.54799929498259) * _TEMP * _3_8;
_LP2 = _LP2 + (-9.74287510861865) * _TEMP * _3_8;
_LP3 = _LP3 + (1.95662231341111) * _TEMP * _3_8;
_LP0 = _LP0 + (31.6597115840211) * _TEMP * _3_9;
_LP1 = _LP1 + (-9.0725886711641) * _TEMP * _3_9;
_LP2 = _LP2 + (1.62190948358845) * _TEMP * _3_9;
_LP3 = _LP3 + (2.04551963042141) * _TEMP * _3_9;
_LP0 = _LP0 + (31.291502511214) * _TEMP * _3_10;
_LP1 = _LP1 + (20.319207702854) * _TEMP * _3_10;
_LP2 = _LP2 + (1.22785286240863) * _TEMP * _3_10;
_LP3 = _LP3 + (-8.71070773697709) * _TEMP * _3_10;
_TEMP = 1.0;
_LP0 = _LP0 + (39.0432493014866) * _TEMP * _5_0;
_LP1 = _LP1 + (2.41556930669061) * _TEMP * _5_0;
_LP2 = _LP2 + (10.9819053439207) * _TEMP * _5_0;
_LP3 = _LP3 + (-2.4193090445841) * _TEMP * _5_0;
_LP0 = _LP0 + (26.0525989318919) * _TEMP * _5_1;
_LP1 = _LP1 + (-10.8013995852177) * _TEMP * _5_1;
_LP2 = _LP2 + (7.80802468659326) * _TEMP * _5_1;
_LP3 = _LP3 + (-8.37335359162762) * _TEMP * _5_1;
_LP0 = _LP0 + (-91.7996367657177) * _TEMP * _5_2;
_LP1 = _LP1 + (-7.20941847531768) * _TEMP * _5_2;
_LP2 = _LP2 + (6.37205506985912) * _TEMP * _5_2;
_LP3 = _LP3 + (-4.13523264892108) * _TEMP * _5_2;
_LP0 = _LP0 + (-43.2987854849329) * _TEMP * _5_3;
_LP1 = _LP1 + (9.63628678654799) * _TEMP * _5_3;
_LP2 = _LP2 + (15.2260866612625) * _TEMP * _5_3;
_LP3 = _LP3 + (3.41098536758909) * _TEMP * _5_3;
_LP0 = _LP0 + (-92.5078418147566) * _TEMP * _5_4;
_LP1 = _LP1 + (0.92035946274589) * _TEMP * _5_4;
_LP2 = _LP2 + (14.6028124613418) * _TEMP * _5_4;
_LP3 = _LP3 + (4.74556696940043) * _TEMP * _5_4;
_LP0 = _LP0 + (-169.198537792928) * _TEMP * _5_5;
_LP1 = _LP1 + (17.5135430652249) * _TEMP * _5_5;
_LP2 = _LP2 + (-27.5413368656283) * _TEMP * _5_5;
_LP3 = _LP3 + (5.71011491340335) * _TEMP * _5_5;
_LP0 = _LP0 + (29.0429678675398) * _TEMP * _5_6;
_LP1 = _LP1 + (-4.70698581451379) * _TEMP * _5_6;
_LP2 = _LP2 + (2.19747568966552) * _TEMP * _5_6;
_LP3 = _LP3 + (0.25036394861618) * _TEMP * _5_6;
_LP0 = _LP0 + (27.4220001532713) * _TEMP * _5_7;
_LP1 = _LP1 + (-5.62951270960282) * _TEMP * _5_7;
_LP2 = _LP2 + (2.97946845585617) * _TEMP * _5_7;
_LP3 = _LP3 + (0.07300025078033) * _TEMP * _5_7;
_LP0 = _LP0 + (24.9838671156593) * _TEMP * _5_8;
_LP1 = _LP1 + (-4.23916148505361) * _TEMP * _5_8;
_LP2 = _LP2 + (3.42557523365742) * _TEMP * _5_8;
_LP3 = _LP3 + (1.46388562797025) * _TEMP * _5_8;
```

```
_LP0 = _LP0 + (22.8194752422965) * _TEMP * _5_9;
_LP1 = _LP1 + (-4.25224375283395) * _TEMP * _5_9;
_LP2 = _LP2 + (2.49905210556025) * _TEMP * _5_9;
_LP3 = _LP3 + (-0.01709833699071) * _TEMP * _5_9;
_LP0 = _LP0 + (37.114213383863) * _TEMP * _5_10;
_LP1 = _LP1 + (2.9953971574379) * _TEMP * _5_10;
_LP2 = _LP2 + (-4.63754693643679) * _TEMP * _5_10;
_LP3 = _LP3 + (-4.36468726526216) * _TEMP * _5_10;
_LP0 = _LP0 + (34.2320056651284) * _TEMP * _5_11;
_LP1 = _LP1 + (-2.48152127510367) * _TEMP * _5_11;
_LP2 = _LP2 + (-7.20881969172312) * _TEMP * _5_11;
_LP3 = _LP3 + (2.05199646600986) * _TEMP * _5_11;
_LP0 = _LP0 + (34.1979425371632) * _TEMP * _5_12;
_LP1 = _LP1 + (1.32583179116639) * _TEMP * _5_12;
_LP2 = _LP2 + (-1.94011877303868) * _TEMP * _5_12;
_LP3 = _LP3 + (8.74058490108554) * _TEMP * _5_12;
_LP0 = _LP0 + (39.1512435469843) * _TEMP * _5_13;
_LP1 = _LP1 + (1.88577792759584) * _TEMP * _5_13;
_LP2 = _LP2 + (-1.93386166738385) * _TEMP * _5_13;
_LP3 = _LP3 + (0.84886002004651) * _TEMP * _5_13;
_LP0 = _LP0 + (20.9363766085136) * _TEMP * _5_14;
_LP1 = _LP1 + (-2.0647251475618) * _TEMP * _5_14;
_LP2 = _LP2 + (-13.1892422255085) * _TEMP * _5_14;
_LP3 = _LP3 + (-4.52842188369726) * _TEMP * _5_14;
_TEMP = 1.0;
_LP0 = _LP0 + (1.76663561037174) * _TEMP * _6_0;
_LP1 = _LP1 + (-5.40874215787948) * _TEMP * _6_0;
_LP2 = _LP2 + (-6.87281360284862) * _TEMP * _6_0;
_LP3 = _LP3 + (-6.22229997982126) * _TEMP * _6_0;
_LP0 = _LP0 + (21.8797726373068) * _TEMP * _6_1;
_LP1 = _LP1 + (2.87906958740983) * _TEMP * _6_1;
_LP2 = _LP2 + (1.83666665646742) * _TEMP * _6_1;
_LP3 = _LP3 + (4.13135987011355) * _TEMP * _6_1;
_LP0 = _LP0 + (1.73459041116589) * _TEMP * _6_2;
_LP1 = _LP1 + (-0.75352434519744) * _TEMP * _6_2;
_LP2 = _LP2 + (-0.62400019216188) * _TEMP * _6_2;
_LP3 = _LP3 + (0.53569098310408) * _TEMP * _6_2;
_TEMP = 1.0;
_LP0 = _LP0 + (-3.44927846183227) * _TEMP * _7_0;
_LP1 = _LP1 + (-6.37652016665453) * _TEMP * _7_0;
_LP2 = _LP2 + (-4.25904939215537) * _TEMP * _7_0;
_LP3 = _LP3 + (-4.51685639332432) * _TEMP * _7_0;
_LP0 = _LP0 + (-6.43408008433648) * _TEMP * _7_1;
_LP1 = _LP1 + (-0.80236520705753) * _TEMP * _7_1;
_LP2 = _LP2 + (-0.12922463272966) * _TEMP * _7_1;
_LP3 = _LP3 + (-0.63228249961139) * _TEMP * _7_1;
_LPMAX = 0.0;
_LP0 = -123.067467124716 + _LP0;
if _LPMAX < _LP0 then _LPMAX = _LP0;
_LP1 = -23.6221258810818 + _LP1;
if _LPMAX < _LP1 then _LPMAX = _LP1;
_LP2 = -18.5909979689337 + _LP2;
if _LPMAX < _LP2 then _LPMAX = _LP2;
_LP3 = -6.00322742797283 + _LP3;
if _LPMAX < _LP3 then _LPMAX = _LP3;
_LP0 = EXP(_LP0 - _LPMAX);
```

```
_LP1 = EXP(_LP1 - _LPMAX);
_LP2 = EXP(_LP2 - _LPMAX);
_LP3 = EXP(_LP3 - _LPMAX);
_LPMAX = EXP(-_LPMAX);
_P4 = 1.0 / (_LPMAX + _LP0 + _LP1 + _LP2 + _LP3);
_P0 = _LP0 * _P4;
_P1 = _LP1 * _P4;
_P2 = _LP2 * _P4;
_P3 = _LP3 * _P4;
_P4 = _LPMAX * _P4;
REGDR1: P_ATTACKU2R = _P0;
_MAXP = _P0;
_IY = 1.0;
P_ATTACKR2L = _P1;
if (_P1 - _MAXP > 1E-8) then do ;
_MAXP = _P1;
_IY = 2.0;
end;
P_ATTACKPROBE = _P2;
if (_P2 - _MAXP > 1E-8) then do ;
_MAXP = _P2;
_IY = 3.0;
end;
P_ATTACKNORMAL = _P3;
if (_P3 - _MAXP > 1E-8) then do ;
_MAXP = _P3;
_IY = 4.0;
end;
P_ATTACKDOS = _P4;
if (_P4 - _MAXP > 1E-8) then do ;
_MAXP = _P4;
_IY = 5.0;
end;
I_ATTACK = REGDRF[_IY];
U_ATTACK = REGDRU[_IY];
EM_EVENTPROBABILITY = P_ATTACKU2R;
EM_PROBABILITY = MAX(P_ATTACKU2R, P_ATTACKR2L, P_ATTACKPROBE, P_ATTACKNORMAL,
P_ATTACKDOS);
EM_CLASSIFICATION = I_ATTACK;
_return: ;
end;
 enddata;
```

Example of an Input and Output Variables Scoring File

Here is an example of an input and output variables scoring file. The filename is sasscore_score_io.xml.

```
<?xml version="1.0" encoding="utf-8"?>
<Score>
   <Producer>
      <Name> SAS Enterprise Miner </Name>
```

```
      <Version> 1.0 </Version>
   </Producer>
   <TargetList>
   </TargetList>
   <Input>
      <Variable>
         <Name> COUNT </Name>
         <Type> numeric </Type>
      </Variable>
      <Variable>
         <Name> DIF_SRVR </Name>
         <Type> numeric </Type>
         <Description>
            <![CDATA[diff_srv_rate]]>
         </Description>
      </Variable>
      <Variable>
         <Name> FLAG </Name>
         <Type> character </Type>
      </Variable>
      <Variable>
         <Name> HOT </Name>
         <Type> numeric </Type>
      </Variable>
      <Variable>
         <Name> SAM_SRAT </Name>
         <Type> numeric </Type>
         <Description>
            <![CDATA[same_srv_rate]]>
         </Description>
      </Variable>
      <Variable>
         <Name> SERVICE </Name>
         <Type> character </Type>
      </Variable>
      <Variable>
         <Name> SRV_CNT </Name>
         <Type> numeric </Type>
         <Description>
            <![CDATA[srv_count]]>
         </Description>
      </Variable>
   </Input>
   <Output>
      <Variable>
         <Name> AOV16_COUNT </Name>
         <Type> numeric </Type>
      </Variable>
      <Variable>
         <Name> AOV16_DIF_SRVR </Name>
         <Type> numeric </Type>
      </Variable>
      <Variable>
         <Name> AOV16_HOT </Name>
         <Type> numeric </Type>
      </Variable>
```

```
<Variable>
   <Name> AOV16_SAM_SRAT </Name>
   <Type> numeric </Type>
</Variable>
<Variable>
   <Name> AOV16_SRV_CNT </Name>
   <Type> numeric </Type>
</Variable>
<Variable>
   <Name> EM_CLASSIFICATION </Name>
   <Type> character </Type>
   <Description>
      <![CDATA[Prediction for ATTACK]]>
   </Description>
</Variable>
<Variable>
   <Name> EM_EVENTPROBABILITY </Name>
   <Type> numeric </Type>
   <Description>
      <![CDATA[Probability for level U2R of ATTACK]]>
   </Description>
</Variable>
<Variable>
   <Name> EM_PROBABILITY </Name>
   <Type> numeric </Type>
   <Description>
      <![CDATA[Probability of Classification]]>
   </Description>
</Variable>
<Variable>
   <Name> G_FLAG </Name>
   <Type> numeric </Type>
</Variable>
<Variable>
   <Name> G_SERVICE </Name>
   <Type> numeric </Type>
</Variable>
<Variable>
   <Name> I_ATTACK </Name>
   <Type> character </Type>
   <Description>
      <![CDATA[Into: ATTACK]]>
   </Description>
</Variable>
<Variable>
   <Name> P_ATTACKDOS </Name>
   <Type> numeric </Type>
   <Description>
      <![CDATA[Predicted: ATTACK=dos]]>
   </Description>
</Variable>
<Variable>
   <Name> P_ATTACKNORMAL </Name>
   <Type> numeric </Type>
   <Description>
      <![CDATA[Predicted: ATTACK=normal]]>
```

```
      </Description>
   </Variable>
   <Variable>
      <Name> P_ATTACKPROBE </Name>
      <Type> numeric </Type>
      <Description>
         <![CDATA[Predicted: ATTACK=probe]]>
      </Description>
   </Variable>
   <Variable>
      <Name> P_ATTACKR2L </Name>
      <Type> numeric </Type>
      <Description>
         <![CDATA[Predicted: ATTACK=r2l]]>
      </Description>
   </Variable>
   <Variable>
      <Name> P_ATTACKU2R </Name>
      <Type> numeric </Type>
      <Description>
         <![CDATA[Predicted: ATTACK=u2r]]>
      </Description>
   </Variable>
   <Variable>
      <Name> U_ATTACK </Name>
      <Type> character </Type>
      <Description>
         <![CDATA[Unnormalized Into: ATTACK]]>
      </Description>
   </Variable>
   <Variable>
      <Name> _WARN_ </Name>
      <Type> character </Type>
      <Description>
         <![CDATA[Warnings]]>
      </Description>
   </Variable>
</Output>
<C>
   <Function>
      <Name>
         score
      </Name>
      <ParameterList>
         <Parameter>
            <Array length="7">
               <Type>
                  Parm
               </Type>
               <DataMap>
                  <Element index="0">
                     <Value>
                        <Origin> COUNT </Origin>
                        <Type> double </Type>
                     </Value>
                  </Element>
```

```
            <Element index="1">
               <Value>
                  <Origin> DIF_SRVR </Origin>
                  <Type> double </Type>
               </Value>
            </Element>
            <Element index="2">
               <Value>
                  <Origin> FLAG </Origin>
                  <Array length="33">
                    <Type> char </Type>
                  </Array>
               </Value>
            </Element>
            <Element index="3">
               <Value>
                  <Origin> HOT </Origin>
                  <Type> double </Type>
               </Value>
            </Element>
            <Element index="4">
               <Value>
                  <Origin> SAM_SRAT </Origin>
                  <Type> double </Type>
               </Value>
            </Element>
            <Element index="5">
               <Value>
                  <Origin> SERVICE </Origin>
                  <Array length="33">
                    <Type> char </Type>
                  </Array>
               </Value>
            </Element>
            <Element index="6">
               <Value>
                  <Origin> SRV_CNT </Origin>
                  <Type> double </Type>
               </Value>
            </Element>
         </DataMap>
      </Array>
   </Parameter>

   <Parameter>
      <Array length="18">
         <Type>
            Parm
         </Type>
         <DataMap>
            <Element index="0">
               <Value>
                  <Origin> AOV16_COUNT </Origin>
                  <Type> double </Type>
               </Value>
            </Element>
```

```
<Element index="1">
   <Value>
      <Origin> AOV16_DIF_SRVR </Origin>
      <Type> double </Type>
   </Value>
</Element>
<Element index="2">
   <Value>
      <Origin> AOV16_HOT </Origin>
      <Type> double </Type>
   </Value>
</Element>
<Element index="3">
   <Value>
      <Origin> AOV16_SAM_SRAT </Origin>
      <Type> double </Type>
   </Value>
</Element>
<Element index="4">
   <Value>
      <Origin> AOV16_SRV_CNT </Origin>
      <Type> double </Type>
   </Value>
</Element>
<Element index="5">
   <Value>
      <Origin> EM_CLASSIFICATION </Origin>
      <Array length="33">
        <Type> char </Type>
     </Array>
   </Value>
</Element>
<Element index="6">
   <Value>
      <Origin> EM_EVENTPROBABILITY </Origin>
      <Type> double </Type>
   </Value>
</Element>
<Element index="7">
   <Value>
      <Origin> EM_PROBABILITY </Origin>
      <Type> double </Type>
   </Value>
</Element>
<Element index="8">
   <Value>
      <Origin> G_FLAG </Origin>
      <Type> double </Type>
   </Value>
</Element>
<Element index="9">
   <Value>
      <Origin> G_SERVICE </Origin>
      <Type> double </Type>
   </Value>
</Element>
```

```
      <Element index="10">
         <Value>
            <Origin> I_ATTACK </Origin>
            <Array length="7">
              <Type> char </Type>
           </Array>
         </Value>
      </Element>
      <Element index="11">
         <Value>
            <Origin> P_ATTACKDOS </Origin>
            <Type> double </Type>
         </Value>
      </Element>
      <Element index="12">
         <Value>
            <Origin> P_ATTACKNORMAL </Origin>
            <Type> double </Type>
         </Value>
      </Element>
      <Element index="13">
         <Value>
            <Origin> P_ATTACKPROBE </Origin>
            <Type> double </Type>
         </Value>
      </Element>
      <Element index="14">
         <Value>
            <Origin> P_ATTACKR2L </Origin>
            <Type> double </Type>
         </Value>
      </Element>
      <Element index="15">
         <Value>
            <Origin> P_ATTACKU2R </Origin>
            <Type> double </Type>
         </Value>
      </Element>
      <Element index="16">
         <Value>
            <Origin> U_ATTACK </Origin>
            <Array length="7">
              <Type> char </Type>
           </Array>
         </Value>
      </Element>
      <Element index="17">
         <Value>
            <Origin> _WARN_ </Origin>
            <Array length="5">
              <Type> char </Type>
           </Array>
         </Value>
      </Element>
   </DataMap>
</Array>
```

```
            </Parameter>
         </ParameterList>
      </Function>
   </C>
</Score>
```

Example of a User-Defined Formats Scoring File

Here is an example of a user-defined formats scoring file. The filename is sasscore_score_ufmt.xml.

```
<?xml version="1.0" encoding="utf-8" ?>
<?xml-stylesheet type="text/xsl" href="SUVformats.xsl"?>
<LIBRARY type="EXPORT" version="SUV">
   <HEADER>
      <Provider>SAS Institute Inc.</Provider>
      <Version>9.2</Version>
      <VersionLong>9.02.02M2D09012009</VersionLong>
      <CreationDateTime>2009-12-14T12:47:03</CreationDateTime>
   </HEADER>

   <TABLE name="sasscore_score_ufmt">
      <TABLE-HEADER>
         <Provider>SAS Institute Inc.</Provider>
         <Version>9.2</Version>
         <VersionLong>9.02.02M2D09012009</VersionLong>
         <CreationDateTime>2009-12-14T12:47:03</CreationDateTime>
         <ModifiedDateTime>2009-12-14T12:47:03</ModifiedDateTime>

         <Protection />
         <DataSetType />
         <DataRepresentation />
         <Encoding>utf-8</Encoding>
         <ReleaseCreated />
         <HostCreated />
         <FileName>sasscore_score_ufmt</FileName>

         <Observations />
         <Compression number="1" />
         <Variables number="21" />
      </TABLE-HEADER>

      <COLUMN name="FMTNAME" label="Format name">
         <TYPE>character</TYPE>
         <DATATYPE>string</DATATYPE>
         <LENGTH>32</LENGTH>
         <Offset>32</Offset>
         <SortedBy />
      </COLUMN>

      <COLUMN name="START" label="Starting value for format">
         <TYPE>character</TYPE>
         <DATATYPE>string</DATATYPE>
```

```
   <LENGTH>16</LENGTH>
   <Offset>16</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="END" label="Ending value for format">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>16</LENGTH>
   <Offset>16</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="LABEL" label="Format value label">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>3</LENGTH>
   <Offset>3</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="MIN" label="Minimum length">
   <TYPE>numeric</TYPE>
   <DATATYPE>double</DATATYPE>
   <LENGTH>3</LENGTH>
   <Offset>3</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="MAX" label="Maximum length">
   <TYPE>numeric</TYPE>
   <DATATYPE>double</DATATYPE>
   <LENGTH>3</LENGTH>
   <Offset>3</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="DEFAULT" label="Default length">
   <TYPE>numeric</TYPE>
   <DATATYPE>double</DATATYPE>
   <LENGTH>3</LENGTH>
   <Offset>3</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="LENGTH" label="Format length">
   <TYPE>numeric</TYPE>
   <DATATYPE>double</DATATYPE>
   <LENGTH>3</LENGTH>
   <Offset>3</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="FUZZ" label="Fuzz value">
   <TYPE>numeric</TYPE>
   <DATATYPE>double</DATATYPE>
```

```
   <LENGTH>8</LENGTH>
   <Offset>8</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="PREFIX" label="Prefix characters">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>2</LENGTH>
   <Offset>2</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="MULT" label="Multiplier">
   <TYPE>numeric</TYPE>
   <DATATYPE>double</DATATYPE>
   <LENGTH>8</LENGTH>
   <Offset>8</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="FILL" label="Fill character">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>1</LENGTH>
   <Offset>1</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="NOEDIT" label="Is picture string noedit?">
   <TYPE>numeric</TYPE>
   <DATATYPE>double</DATATYPE>
   <LENGTH>3</LENGTH>
   <Offset>3</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="TYPE" label="Type of format">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>1</LENGTH>
   <Offset>1</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="SEXCL" label="Start exclusion">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>1</LENGTH>
   <Offset>1</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="EEXCL" label="End exclusion">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
```

```
   <LENGTH>1</LENGTH>
   <Offset>1</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="HLO" label="Additional information">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>11</LENGTH>
   <Offset>11</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="DECSEP" label="Decimal separator">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>1</LENGTH>
   <Offset>1</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="DIG3SEP" label="Three-digit separator">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>1</LENGTH>
   <Offset>1</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="DATATYPE" label="Date/time/datetime?">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>8</LENGTH>
   <Offset>8</Offset>
   <SortedBy />
</COLUMN>

<COLUMN name="LANGUAGE" label="Language for date strings">
   <TYPE>character</TYPE>
   <DATATYPE>string</DATATYPE>
   <LENGTH>8</LENGTH>
   <Offset>8</Offset>
   <SortedBy />
</COLUMN>

<ROW>
   <FMTNAME missing=" " />
   <START missing=" " />
   <END missing=" " />
   <LABEL missing=" " />
   <MIN missing=" " />
   <MAX missing=" " />
   <DEFAULT missing=" " />
   <LENGTH missing=" " />
   <FUZZ missing=" " />
   <PREFIX missing=" " />
```

```
      <MULT missing=" " />
      <FILL missing=" " />
      <NOEDIT missing=" " />
      <TYPE missing=" " />
      <SEXCL missing=" " />
      <EEXCL missing=" " />
      <HLO missing=" " />
      <DECSEP missing=" " />
      <DIG3SEP missing=" " />
      <DATATYPE missing=" " />
      <LANGUAGE missing=" " />
   </ROW>

   <ROW>
      <DELTA-RECORD key="ABC" />
      <FMTNAME>ABC</FMTNAME>
      <START>1</START>
      <END>1</END>
      <LABEL>yes</LABEL>
      <MIN>1</MIN>
      <MAX>40</MAX>
      <DEFAULT>3</DEFAULT>
      <LENGTH>3</LENGTH>
      <FUZZ>1E-12</FUZZ>
      <PREFIX missing=" " />
      <MULT>0</MULT>
      <FILL missing=" " />
      <NOEDIT>0</NOEDIT>
      <TYPE>N</TYPE>
      <SEXCL>N</SEXCL>
      <EEXCL>N</EEXCL>
      <HLO missing=" " />
      <DECSEP missing=" " />
      <DIG3SEP missing=" " />
      <DATATYPE missing=" " />
      <LANGUAGE missing=" " />
   </ROW>

   <ROW>
      <DELTA-RECORD key="YESNO" />
      <FMTNAME>YESNO</FMTNAME>
      <START>0</START>
      <END>0</END>
      <LABEL>NO</LABEL>
      <MIN>1</MIN>
      <MAX>40</MAX>
      <DEFAULT>3</DEFAULT>
      <LENGTH>3</LENGTH>
      <FUZZ>0</FUZZ>
      <PREFIX missing=" " />
      <MULT>0</MULT>
      <FILL missing=" " />
      <NOEDIT>0</NOEDIT>
      <TYPE>C</TYPE>
      <SEXCL>N</SEXCL>
      <EEXCL>N</EEXCL>
```

```
            <HLO missing=" " />
            <DECSEP missing=" " />
            <DIG3SEP missing=" " />
            <DATATYPE missing=" " />
            <LANGUAGE missing=" " />
         </ROW>

         <ROW>
            <FMTNAME>YESNO</FMTNAME>
            <START>1</START>
            <END>1</END>
            <LABEL>YES</LABEL>
            <MIN>1</MIN>
            <MAX>40</MAX>
            <DEFAULT>3</DEFAULT>
            <LENGTH>3</LENGTH>
            <FUZZ>0</FUZZ>
            <PREFIX missing=" " />
            <MULT>0</MULT>
            <FILL missing=" " />
            <NOEDIT>0</NOEDIT>
            <TYPE>C</TYPE>
            <SEXCL>N</SEXCL>
            <EEXCL>N</EEXCL>
            <HLO missing=" " />
            <DECSEP missing=" " />
            <DIG3SEP missing=" " />
            <DATATYPE missing=" " />
            <LANGUAGE missing=" " />
         </ROW>
      </TABLE>
   </LIBRARY>
```

Index

M

N

O