

*IBM SPSS Statistics Programmability
Extension Developer's Guide for UNIX*



Note

Before using this information and the product it supports, read the information in "Notices" on page 45.

Product Information

This edition applies to version 23, release 0, modification 0 of IBM SPSS Statistics and to all subsequent releases and modifications until otherwise indicated in new editions.

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Chapter 1. Overview

The *IBM SPSS Statistics Programmability Extension Developer's Guide* provides information about the tools available for working with the IBM® SPSS® Statistics Programmability Extension, which is available with the Core system.

Introduction to IBM SPSS Statistics

Before developing plug-ins and applications with the IBM SPSS Statistics Programmability Extension, it is useful to understand the basics of what IBM SPSS Statistics does and how it works.

Programmability is supported in three applications:

- IBM SPSS Statistics
- IBM SPSS Statistics Server
- IBM SPSS Statistics Batch Facility, a batch processing utility that is included with the IBM SPSS Statistics Server application.

All three applications provide a powerful statistical-analysis and data-management system. The statistics and data management facilities are controlled by the command syntax language.

IBM SPSS Statistics has a graphical user interface (GUI) of menus and dialog boxes that provides point and click access to the same features that are controlled by the command language; however the IBM SPSS Statistics Programmability Extension doesn't use the GUI.

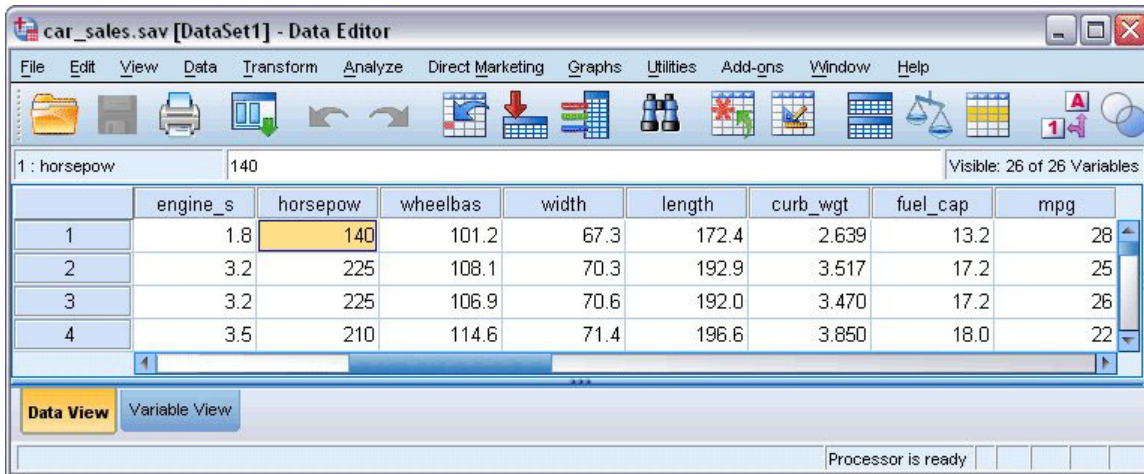
IBM SPSS Statistics Server is a distributed application. It has a client/server architecture. It distributes client requests for resource-intensive operations to powerful analytic server software. Requests are submitted by the IBM SPSS Statistics client and processed by IBM SPSS Statistics Server.

IBM SPSS Statistics Batch Facility is included with IBM SPSS Statistics Server. It is intended for automated data management and production of statistical output. Automated production provides the ability to submit commands without user intervention. The Batch Facility takes as its input a command syntax file with requests for data manipulation and statistics. It has no graphical user interface.

This section provides a quick overview of the basics of IBM SPSS Statistics. If you are not familiar with IBM SPSS Statistics, please refer to the *Command Syntax Reference*, which is installed with IBM SPSS Statistics and can be accessed from the Help menu. The Universals chapter contains information that is particularly useful for the reader interested in programmability. Also see the *Core System User's Guide*, which is on the manuals CD-ROM included with IBM SPSS Statistics.

Data Structure

IBM SPSS Statistics defines data as **variables** (similar to database fields) and **cases** (similar to database records). A variable contains information that you want to analyze—for example, an attribute like horsepower. A case is an observation—for example, a specific car.



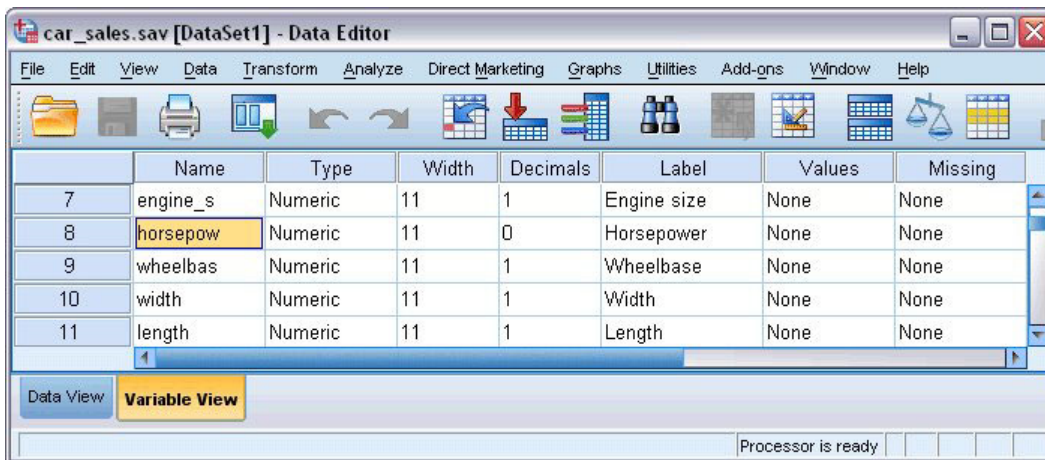
When a data file is open in IBM SPSS Statistics it becomes the **active dataset** and is displayed in the Data View tab of the Data Editor window, which is a spreadsheet-like system for entering and editing data. Variables are displayed in columns and cases are displayed in rows.

Data is saved in a proprietary format, the .sav file. It consists of the data and information about the data.

Metadata

Metadata are data about data, for example, information about the type, labels, and other characteristics. A **dictionary** contains some metadata at two levels—information about the data file and information about the variables.

The file-level dictionary information contains an optional file label, documents, and attributes that you define.



The variable-level dictionary information includes:

- Name
- Type
- Format
- Label
- Measurement level
- Missing values

- Value labels

You can also define your own variable metadata and assign attribute values to variables in the active dataset. Creating your own file-level and variable-level dictionary attributes can be quite useful in conjunction with Programmability because those attributes can then be used to control the flow of a command syntax job.

Syntax Commands

Syntax commands are used to indicate what type of data management and statistical analysis you want to perform. You use syntax commands to:

- Perform data transformations
- Run statistical procedures and produce output
- Create charts and other graphical output
- Display information about settings

For example if you want to calculate descriptive statistics for a variable, you could use the Descriptives statistical procedure. The command syntax could be:

```
DESCRIPTIVES
  VARIABLES=weight
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Although syntax commands indicate what to do and what output to produce, it is difficult to use command syntax for **jobwise flow control**; for instance, to run different procedures for different variables based on each variable's metadata, or to determine which procedure to run next based on the output from the last procedure. This is where programmability can help. You can use programmability to branch or loop syntax commands based on:

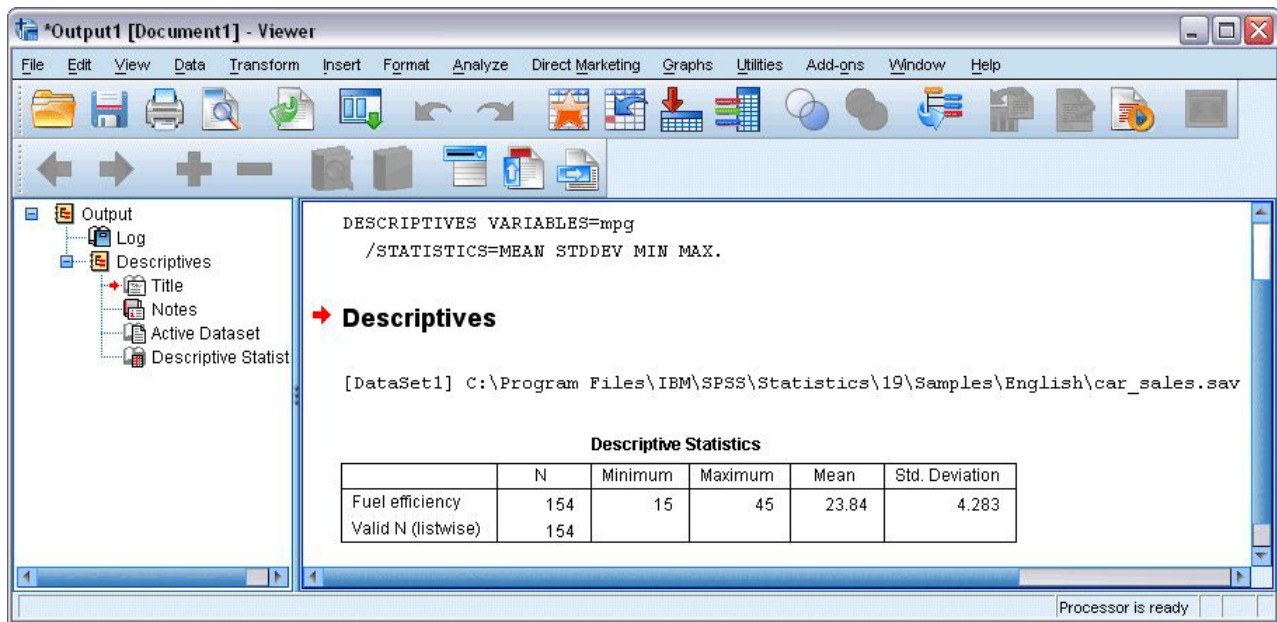
- The state of the active dataset's dictionary
- Values in the IBM SPSS Statistics output
- Case data from the active dataset
- Error level return codes from procedures

The code to control IBM SPSS Statistics is written in an external language, utilizing functions provided with an integration plug-in that are designed to interact with IBM SPSS Statistics.

Output

When you submit commands, IBM SPSS Statistics processes them and produces **output**. Output includes statistical results, tables, charts, trees, text, and other output.

For example, if you look at the Viewer window below you can see that the *Mean*, or average, fuel efficiency (mpg) of all cars in the active dataset is 23.84. This output was produced as a result of a DESCRIPTIVES request.



The **Output Management System (OMS)** provides the ability to automatically write selected categories of output to different destinations and in different formats. The **XML workspace** destination is designed for use with the IBM SPSS Statistics Programmability Extension, allowing values in the output to be accessed programmatically using XPath expressions.

For example, if you look at the XML produced by OMS for a `DESCRIPTIVES` request, you can see that it contains the same information as the Viewer output shown above. With the IBM SPSS Statistics Programmability Extension, this information is available through an API.

```
- <outputTree xsi:schemaLocation="http://xml.spss.com/spss/oms http://xml.spss.com/spss/oms/spss-output-1.6.xsd">
- <command command="Descriptives" displayOutlineValues="label" displayOutlineVariables="label" displayTableValues="label" displayTableVariables="label" lang="en"
text="Descriptives">
- <pivotTable subType="Descriptive Statistics" text="Descriptive Statistics">
- <dimension axis="row" text="Variables">
- <category label="Fuel efficiency" text="Fuel efficiency" varName="mpg" variable="true">
- <dimension axis="column" text="Statistics">
- <category text="N">
<cell number="154" text="154"/>
</category>
- <category text="Minimum">
<cell number="15" text="15"/>
</category>
- <category text="Maximum">
<cell number="45" text="45"/>
</category>
- <category text="Mean">
<cell decimals="2" number="23.843506493506" text="23.84"/>
</category>
- <category text="Std. Deviation">
<cell decimals="3" number="4.2827198816786" text="4.283"/>
</category>
</dimension>
</category>
</dimension>
</category>
</pivotTable>
</command>
</outputTree>
```

Basic Steps for Submitting IBM SPSS Statistics Commands

The basic steps to manipulate and analyze data with commands are:

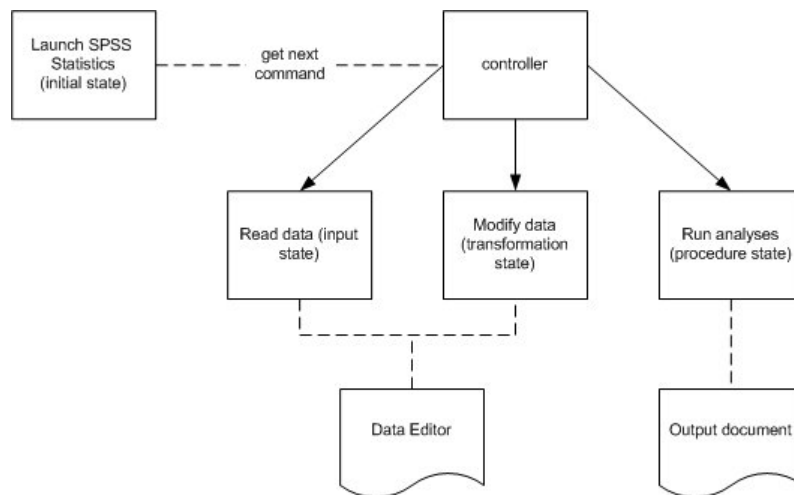
1. **Get data.** You can open a previously saved external IBM SPSS Statistics data file, read a spreadsheet, database, a text data file, and other file formats.
2. **Specify the commands and variables.** You can use syntax commands to transform data, calculate statistics, and to create charts and trees.

3. **Direct the output.** By default output appears in the Viewer window. You may want it there or you may choose to direct it to OMS.
4. **Submit the commands.** IBM SPSS Statistics processes the commands and produces output.
5. **Use the output.** Use the output to control the flow of additional syntax commands or as the final product.

How Commands Are Processed Normally

To process commands:

1. IBM SPSS Statistics gets a command from an input stream—commands from a file or the GUI, or a command typed at a prompt.
2. The command is evaluated. If it is valid for the current state, it is executed. If it is invalid for the current state, it is not executed.
3. Either way, IBM SPSS Statistics does something to the active data set or puts something into the output and gets the next command.



With the IBM SPSS Statistics Programmability Extension, IBM SPSS Statistics breaks out of normal mode and responds to an external processor—that is when your code gets used.

Introduction to the Programmability Extension

The IBM SPSS Statistics Programmability Extension--included with the IBM SPSS Statistics Core system--provides generic support for extending IBM SPSS Statistics to work with external programming languages, each of which requires a separate integration plug-in. Integration with external languages is provided through the following means:

- **libspssxd.so and libspssxd_p.so.** In-process (libspssxd.so) and out-of-process (libspssxd_p.so) implementations of a C API, called the **XD API**, that allow an external processor to control IBM SPSS Statistics. The functions available in the API are detailed in Chapter 4, "Introduction to the XD API," on page 25. Integration plug-ins interact with IBM SPSS Statistics through this library.
- A framework (installed with IBM SPSS Statistics) that enables IBM SPSS Statistics to execute external language code from within `BEGIN PROGRAM <language> - END PROGRAM` blocks in command syntax. Invocation of the processor for the external language is provided by a separate library that forms an optional part of an integration plug-in.

Programmability Integration Plug-in

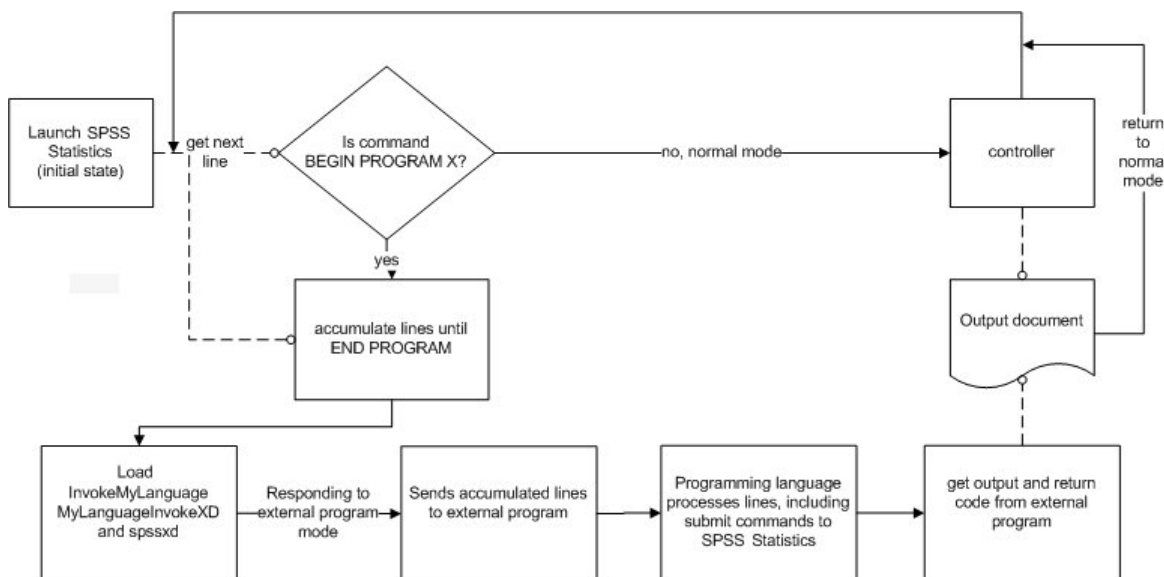
An integration plug-in contains code that can invoke and control IBM SPSS Statistics from an external processor through the XD API (and can optionally invoke an external processor from IBM SPSS Statistics) and support communication between the applications. A plug-in will also typically include a wrapper to the low level XD API functions, written in the language supported by the plug-in. Generically, a plug-in will include the following libraries:

- **MyLanguageInvokeXD.** Loads *libspssxd.so* or *libspssxd_p.so* and makes the XD API available in an external language (the API is implemented in C). This is a required piece of every plug-in.
- **InvokeMyLanguage.** An adapter to invoke an external processor from IBM SPSS Statistics and execute language statements (written in an external language) contained in a BEGIN PROGRAM <language> - END PROGRAM block. This is an optional component of a plug-in.

The IBM SPSS Statistics - Programmability SDK includes the source code for an example plug-in for Python that can be used as a model for creating your own plug-in. Language-specific plug-ins provided by IBM SPSS are available from the SPSS community at <http://www.ibm.com/developerworks/spssdevcentral>.

Operational Modes

The IBM SPSS Statistics Programmability Extension provides two modes for controlling IBM SPSS Statistics from an external language processor, both of which utilize *libspssxd.so* or *libspssxd_p.so*. In the more complex of the two, you invoke an external language processor from IBM SPSS Statistics through an *InvokeMyLanguage* library. The load sequence includes *MyLanguageInvokeXD* and *libspssxd.so* (or *libspssxd_p.so*), which then allows the processor to interact with IBM SPSS Statistics. This mode of operation is designed for end users who want to leverage the power of an external programming language from within a command syntax job. The following flowchart captures how IBM SPSS Statistics processes commands when responding to an external processor in this mode.



In a simpler mode of operation you invoke and control the IBM SPSS Statistics backend in a completely external manner through the use of *MyLanguageInvokeXD* and *libspssxd.so* (or *libspssxd_p.so*). This mode of operation is designed for applications developers who want to create applications that utilize IBM SPSS Statistics functionality, while leveraging the power of an external programming language to build the user interface and drive the program logic.

Example

As an example of the kind of task suited for the IBM SPSS Statistics Programmability Extension, consider running a procedure for just those variables that have a particular property, as defined by the variable's metadata. Specifically, we'll instruct IBM SPSS Statistics to run the Descriptives procedure for the variables whose measurement level is scale. A scale variable is a numeric variable whose values represent ordered categories with a meaningful metric, so that distance comparisons between values are appropriate. Examples of scale variables include age in years and income in thousands of dollars.

Regardless of the operational mode used, the task is accomplished with code written in an external language, like Python, making use of functions in an integration plug-in that provide a wrapper to the low level XD API. Without tying ourselves to a particular language, a block of pseudo-code to accomplish this task might look like:

```
varcount=PlugInFunctionToGetVariableCount()
loop i to varcount:
    if PlugInFunctionToGetVariableMeasurementLevel(i)='scale'
        varname=PlugInFunctionToGetVariableName(i)
        append varname to list of scale variables (ScaleVarList)
PlugInFunctionToSubmitCommands
    ("DESCRIPTIVES VARIABLES= ", ScaleVarList, ".")
```

A comprehensive introduction to working with the example IBM SPSS Statistics - Integration Plug-in for Python provided with the IBM SPSS Statistics - Programmability SDK can be found in *Programming and Data Management for IBM SPSS Statistics*, available in PDF from the SPSS community at <http://www.ibm.com/developerworks/spssdevcentral>.

The Programmability Extension and Other IBM SPSS Statistics Programming Features

IBM SPSS Statistics includes other developer tools. The tools, and their relationship to the IBM SPSS Statistics Programmability Extension, are discussed in this section.

OLE Automation and Scripting. OLE Automation and the IBM SPSS Statistics Basic Script development environment makes it possible to write applications that incorporate, or extend, the functionality of IBM SPSS Statistics on Windows systems. OLE Automation allows an external application to access IBM SPSS Statistics output objects and manipulate them using methods and properties. Use OLE Automation when you need to integrate Viewer output into applications that support OLE automation, such as Microsoft PowerPoint, or when you need to control IBM SPSS Statistics from an application that supports Visual Basic, such as Microsoft Office or Visual Basic itself.

Macro. Program macros, which are blocks of syntax commands enclosed in DEFINE and !ENDDDEFINE commands, can be used to parameterize repetitive tasks. Macros are named definitions. When IBM SPSS Statistics encounters a macro name, it expands the macro according to its definition. The IBM SPSS Statistics macro is a text substitution mechanism, not a scripting language. If you are working in Python, the spss module included in the IBM SPSS Statistics - Programmability SDK contains the function SetMacroValue which defines a macro that can be used just like a macro created with DEFINE and !ENDDDEFINE. Likewise, the (available from the SPSS community at) includes the method in the class, available in the assembly. We suggest that you use SetMacroValue instead of defining macros with DEFINE and !ENDDDEFINE, or use the IBM SPSS Statistics - Programmability SDK to write your own macro definition function.

Matrix. Matrix programs, which are blocks of matrix algebra commands enclosed in MATRIX and END MATRIX commands, can be used to write customized statistical routines. With the IBM SPSS Statistics Programmability Extension you can retrieve case data from the active dataset, allowing you to perform custom calculations on your data or utilize the scientific programming libraries and packages available with external languages like Python or R.

Production Jobs. Production jobs allow you to run command syntax jobs in an automated fashion, producing output from regularly repeated, time-consuming statistical analyses. Consider using the IBM SPSS Statistics Programmability Extension and the Batch Facility, or the Batch Facility alone to meet your production needs.

Overview of Programmability SDK Contents

In addition to this Developer's Guide, the IBM SPSS Statistics - Programmability SDK includes binaries, source, projects, and other documentation to help you create plug-ins and applications for the IBM SPSS Statistics Programmability Extension. All file paths listed are relative to the directory where the IBM SPSS Statistics - Programmability SDK is installed.

Programmability Extension Files and Documentation

- For developers interested in building their own plug-in, the directory `\XD_API` includes the files--`spssxd.h`, `libspssxd.so`, and `libspssxd.p.so` --needed to build an implementation of `MyLanguageInvokeXD`. You can choose to build an implementation that is either in-process (`libspssxd.so`) or out-of-process (`libspssxd.p.so`) with IBM SPSS Statistics. The in-process approach typically has better performance for executing large tasks, however, the out-of-process approach is recommended when using the nesting feature. Sample C++ code for loading `libspssxd.so` or `libspssxd.p.so`, and exercising the functions available in the API can be found in `\XD_API\in_process\examples` and `\XD_API\out_of_process\examples`.
- Documentation for the XD API is accessible from `\documentation\XD_API\index.html`.
- The IBM SPSS Statistics Programmability Extension utilizes the configuration file `spssdxcfg.ini` when invoking an external language processor from IBM SPSS Statistics (an optional feature of an integration plug-in). An example of this file can be found in `\DX_API\config`. In addition, a simple example of invoking the Python language from within IBM SPSS Statistics can be found in `\DX_API\MyInvokePython`.

IBM SPSS Statistics - Integration Plug-in for Python Source

The IBM SPSS Statistics - Programmability SDK includes the source code to build an example plug-in for Python consisting of an extension module that makes the XD API available from Python, a library for invoking Python from IBM SPSS Statistics, a Python module that provides a wrapper for the low level XD API, and other supporting files. The plug-in enables you to drive IBM SPSS Statistics from any separate Python process (such as a Python IDE or the Python interpreter) or to execute Python code contained within a BEGIN PROGRAM-END PROGRAM block in a command syntax job. The IBM SPSS Statistics - Programmability SDK includes the following items:

- **PyInvokeSpss.** A Python extension module which loads `libspssxd.p.so` and makes the XD API available from Python. Source files can be found in `\Statistics_Python\spss\src`.
- **InvokePython.** A Python-specific library that enables IBM SPSS Statistics to invoke Python. Source files and instructions for building this library can be found in `\DX_API\InvokePython`.
- **spssdxcfg.ini.** A configuration file which is used by Python to determine the location of `libspssxd.p.so`. A template can be found in `\Statistics_Python\spss`.

The main application files that constitute the wrapper for the low level XD API are available from `\Statistics_Python\spss`. They are:

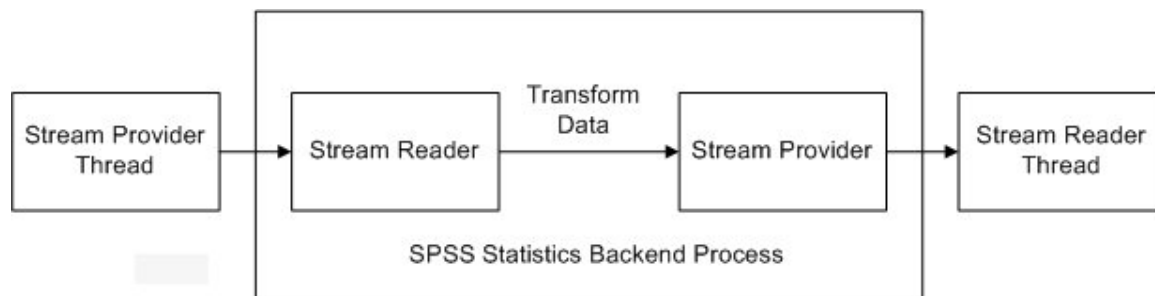
- **__init__.py.** The Python Integration Package for IBM SPSS Statistics initialization code.
- **spss.py.** A Python module that wraps the low level XD API functions exposed to Python by `PyInvokeSpss`. It provides functions that invoke IBM SPSS Statistics and execute command syntax.
- **cursors.py.** A Python module that provides functions for getting case data, adding new variables, and appending cases to the active dataset.
- **dataStep.py.** A Python module that provides functions for creating and managing multiple concurrent datasets.

- **pivotTable.py.** A Python module that provides functions for creating custom pivot tables and text blocks.
- **preaction.py and postaction.py.** Python modules that provide functions for getting Python output into IBM SPSS Statistics.

Chapter 2. Streaming Binary Data in IBM SPSS Statistics

Through command syntax you can instruct the IBM SPSS Statistics backend to read binary data from a pipe or socket, and you can independently instruct the backend to write binary data from the active dataset to a pipe or socket. This allows you to eliminate the time-consuming step of writing data to a disk file when reading data into IBM SPSS Statistics or when passing data from IBM SPSS Statistics to an external program for further processing.

The two independent functions of streaming data into IBM SPSS Statistics and streaming data from IBM SPSS Statistics require separate threads on the parts of the external processes that are involved in providing a stream to IBM SPSS Statistics and/or reading a stream from IBM SPSS Statistics. The IBM SPSS Statistics backend process is single-threaded. For example, you might stream data into IBM SPSS Statistics from an external processor that collects real-time data, and then use IBM SPSS Statistics to analyze the data and produce the results. Or, you might start with an IBM SPSS Statistics dataset, transform it, and stream it to an external processor for further analysis. You can also combine the capabilities of streaming data into and out of IBM SPSS Statistics in the same IBM SPSS Statistics backend process, as shown in the following figure. This illustrates the use of IBM SPSS Statistics as an intermediate data transformation step in a larger analysis which involves one or more external processors (the two external threads shown in the figure may or may not belong to the same processor).



You use the GET DATA command with /TYPE=BINARYSTREAM to read from a stream, and you use the SAVE or XSAVE command with /TYPE=BINARYSTREAM to write to a stream (details of the command syntax are provided in the sections that follow). Remotely instructing IBM SPSS Statistics to read from and/or write to a binary stream is done by submitting command syntax to an instance of the IBM SPSS Statistics backend. This can be done in one of the following ways:

- Use the IBM SPSS Statistics - Integration Plug-in for Python , and pass the necessary command syntax to IBM SPSS Statistics, from an external Python program, using the Submit function (available with all integration plug-ins). The Submit function starts up an instance of the IBM SPSS Statistics backend if there isn't one already. Plug-ins are freely available from the SPSS community at <http://www.ibm.com/developerworks/spssdevcentral>.
- Use the IBM SPSS Statistics Batch Facility (a separate executable provided with IBM SPSS Statistics Server) with a command syntax (.sps) file containing the necessary syntax. The IBM SPSS Statistics Batch Facility starts up an instance of the IBM SPSS Statistics backend.

For help getting started with the IBM SPSS Statistics - Integration Plug-in for Python, see *Python Integration Package for IBM SPSS Statistics.pdf*, available from `\documentation\PythonPackage`. You may also want to consult *Programming and Data Management for IBM SPSS Statistics* available in PDF from the Articles page at <http://www.ibm.com/developerworks/spssdevcentral>.

For information about using the Batch Facility, see the *IBM SPSS Statistics Batch Facility User's Guide*, provided in PDF with the IBM SPSS Statistics Server product DVD/CD.

GET DATA /TYPE=BINARYSTREAM

The following syntax diagram shows all of the subcommands, keywords, and specifications available for the GET DATA command with /TYPE=BINARYSTREAM.

GET DATA /TYPE=BINARYSTREAM

```
{ /PIPE='name' [REWINDABLE='name2' [SEEKABLE] ] }
{ /SOCKET=portnum [HOST={localhost**} ] [REWINDABLE [SEEKABLE] ] }
  { 'hostname' }

/VARIABLES = varname format ...
```

** Default if the keyword is omitted.

Example

```
GET DATA /TYPE=BINARYSTREAM
  /PIPE='\\.\pipe\datapipe'
  /VARIABLES=V1 F3.2 V2 F6.4 V3 DOLLAR9.2 V4 ADATE10 V5 A33.
```

Overview

The GET DATA command with /TYPE=BINARYSTREAM reads records of cases from a pipe or socket, allowing you to stream data into IBM SPSS Statistics from an external processor. In the discussion that follows, the provider of the data is referred to as the **stream provider** and **data source** refers to the data that it provides. You can stream data values from the active dataset in IBM SPSS Statistics to a pipe or socket using the SAVE or XSAVE commands with /TYPE = BINARYSTREAM. See the topic “SAVE, XSAVE /TYPE=BINARYSTREAM” on page 15 for more information.

OptionsBasic Specification

Pipe. The source of case records can be a named pipe. The pipe must be created by an external program prior to executing GET DATA /TYPE=BINARYSTREAM. The pipe option assumes that the stream provider and IBM SPSS Statistics are on the same machine.

Socket. The source of case records can be the port number of a TCP socket. The TCP socket must exist in the listening state and be ready to accept a connection prior to executing GET DATA /TYPE=BINARYSTREAM. The socket option allows for the stream provider and IBM SPSS Statistics to be on different machines.

The basic specification for GET DATA /TYPE=BINARYSTREAM is a named pipe or the port number and hostname of a socket, and the name and format for at least one variable.

- In the absence of the REWINDABLE keyword the data source provides only one pass of the data.

Syntax Rules

- Subcommand names, keywords, and options must be spelled in full.
- Either the PIPE or SOCKET subcommand, but not both, must be specified.
- An error occurs if the SEEKABLE keyword is specified in the absence of the REWINDABLE keyword.

Operations

- GET DATA /TYPE=BINARYSTREAM does not initiate the reading of data from the specified pipe or socket. Data are read as needed by procedures that follow GET DATA /TYPE=BINARYSTREAM, or by a following SAVE command.
- If REWINDABLE is specified, IBM SPSS Statistics will send a rewind command to the stream provider when it requires that the provider rewind to the beginning of the data source. In the absence of REWINDABLE, IBM SPSS Statistics will not send rewind commands to the stream provider and will be unable to rewind the data source; any subsequent data requests to this data source will yield errors.

- If SEEKABLE is specified, IBM SPSS Statistics will send a seek command to the stream provider when it requires data for a specific case number. In the absence of SEEKABLE, IBM SPSS Statistics will not send seek commands to the stream provider.
- An error occurs if the pipe or socket connection cannot be established or cannot provide case records when needed.
- An error occurs if REWINDABLE is specified and the pipe specified for rewind or the full duplex socket connection cannot be established or cannot be maintained through the life of the data source.

Examples

Streaming Data From a Pipe

```
GET DATA /TYPE=BINARYSTREAM
/PIPE='\\.\pipe\datapipe' REWINDABLE='\\.\pipe\rewpipe'
/VARIABLES=V1 F3.2 V2 F6.4 V3 DOLLAR9.2 V4 ADATE10 V5 A33.
```

- The PIPE subcommand specifies that the stream provider will provide cases of data on the pipe named `\\.\pipe\datapipe`.
- REWINDABLE specifies that the stream provider allows the data source to be rewound and is listening for rewind commands on the pipe named `\\.\pipe\rewpipe`.
- The VARIABLES subcommand defines the variables that will be populated by the streamed data.

Streaming Data From a Socket

```
GET DATA /TYPE=BINARYSTREAM
/SOCKET=5764 HOST='myhost.mycompany.com' REWINDABLE SEEKABLE
/VARIABLES=V1 F3.2 V2 F6.4 V3 DOLLAR9.2 V4 ADATE10 V5 A33.
```

- The SOCKET subcommand specifies that the stream provider will provide cases of data on the socket on port 5764 on the host `myhost.mycompany.com`.
- REWINDABLE specifies that the socket is full duplex and that the stream provider allows the data source to be rewound and is listening for rewind commands on the specified socket.
- SEEKABLE specifies that the stream provider will listen for, and honor, a seek command from IBM SPSS Statistics specifying a particular case number.

PIPE Subcommand

The PIPE subcommand specifies a named pipe on which the stream provider will provide case data to IBM SPSS Statistics. Use of a pipe assumes that the stream provider and IBM SPSS Statistics are on the same machine.

- The pipe must be created by an external program prior to executing this command.
- The name of the pipe must be enclosed in quotes. You cannot assign a file handle to a pipe.
- Since, for pipes, IBM SPSS Statistics and the stream provider are on the same machine, they are both assumed to be in the same endian. The binary format of the pipe stream is as described in .

REWINDABLE. *Option to specify that the stream provider supports multiple data passes.* Use of this option requires a second named pipe (enclose the name in quotes) on which the stream provider is ready to listen for, and honor, a rewind command from IBM SPSS Statistics. In the absence of this option, IBM SPSS Statistics will not attempt to rewind the data source; only one pass of the data is provided and the stream provider is free to close the named pipe after the last case.

- The rewind command is the null-terminated character message: "RWND". After receiving a rewind command, the next case that the stream provider provides must be the first case in the data source.
- The stream provider must also listen on the rewind pipe for, and honor, a close command from IBM SPSS Statistics. The close command is the null-terminated character message: "STOP". IBM SPSS Statistics sends the close command when it is finished with the data source.
- The rewind pipe must be created by an external program prior to executing this command.

SEEKABLE. *Option to specify that the stream provider supports the seek operation in conjunction with multiple data passes.* This option specifies that the stream provider will listen for, and honor, a seek command from IBM SPSS Statistics on the rewind pipe. In the absence of this option, IBM SPSS Statistics will not send seek commands to the stream provider.

- To specify SEEKABLE, REWINDABLE must also be specified.
- The seek command is the null-terminated character string message: "SEEK n" and is sent to the stream provider on the rewind pipe. After receiving a seek command, the next case provided must be case number n, where the first case is defined as case number 1.

SOCKET Subcommand

The SOCKET subcommand specifies the port number of a TCP socket on which the stream provider will provide case data to IBM SPSS Statistics.

- The TCP socket must already be in the listening state, ready to accept a connection, prior to executing this command.
- For endian detection by IBM SPSS Statistics, the socket stream provider must write a 32-bit integer value (between 1 and 255) to the socket prior to sending any data, and only send this integer once.
- Upon executing this command, IBM SPSS Statistics will read the first 4 bytes of data from the socket to determine if the host is big or little endian. IBM SPSS Statistics will perform byte swapping, if necessary. The remainder of the stream is as described in .
- You cannot assign a file handle to the port number of a TCP socket.

HOST. *Optional host name of the stream provider.* This option specifies the server machine on which the TCP socket exists. In the absence of the HOST option, the local computer, also referred to as *localhost*, is assumed.

REWINDABLE. *Option to specify that the stream provider supports multiple data passes.* This option specifies that the socket is full duplex and that the stream provider is ready to listen for, and honor, a rewind command from IBM SPSS Statistics. In the absence of this option, IBM SPSS Statistics will not attempt to rewind the data source; only one pass of the data is provided and the stream provider is free to close the socket after the last case.

- The rewind command is the null-terminated character message: "RWND". After receiving a rewind command, the next case that the stream provider provides must be the first case in the data source.
- The stream provider must also listen on the socket for, and honor, a close command from IBM SPSS Statistics. The close command is the null-terminated character message: "STOP". IBM SPSS Statistics sends the close command when it is finished with the data source.

SEEKABLE. *Option to specify that the stream provider supports the seek operation in conjunction with multiple data passes.* This option specifies that the stream provider will listen for, and honor, a seek command from IBM SPSS Statistics. In the absence of this option, IBM SPSS Statistics will not send seek commands to the stream provider.

- To specify SEEKABLE, REWINDABLE must also be specified.
- The seek command is the null-terminated character string message: "SEEK n". After receiving a seek command, the next case provided must be case number n, where the first case is defined as case number 1.

VARIABLES Subcommand

The VARIABLES subcommand is required and specifies the properties of the variables in the active dataset to be created from the streamed data. At least one variable must be specified.

- The order of the variables specified on the VARIABLES subcommand is the order in which they will be populated from the streaming data.
- Each variable specified on the VARIABLES subcommand must have a name and a format (used to specify type of variable, numeric or string, and the input format). Variable names must conform to IBM

SPSS Statistics variable naming rules and must be unique. All IBM SPSS Statistics input formats are supported. Variable naming rules as well as IBM SPSS Statistics variable formats are described in the "Universals" chapter of the *Command Syntax Reference*, available in the Help system or in PDF form from the Help menu.

Common Binary Format of the Stream

Case data is written as a packed stream of 8 byte entities such that each case is represented by the same number of bytes. Cases and variables within cases are written in the order specified by the active data set, honoring the effects of any KEEP and DROP subcommands.

- Each numeric variable is a double, 8 bytes wide, and in the endian of the IBM SPSS Statistics backend. The IBM SPSS Statistics backend does not perform byte swapping. Examples of numeric variables include, but are not limited to, those with formats Fn.d, DATEn, ADATEn, or DOLLARn.d.
- Variables with a date or date and time format, represent the number of seconds from 0 hours, 0 minutes, and 0 seconds on Oct. 14, 1582.
- Missing values for numeric variables are specified by setting the value to the most negative normalized double supported by IEEE double floating point (big endian representation: X'FFEFFFFF FFFFFFFF') or to an invalid IEEE floating point double.
- String variables in IBM SPSS Statistics can have widths from 1 to 32767 characters, however, they are written to the stream in widths that are integer multiples of 8 bytes, large enough to hold the defined length of the string variable, and padded with spaces if needed. For example, the width of the buffer provided for a string variable defined as A7 will be 8 bytes with the last byte set to a space (ASCII code decimal 32), whereas the buffer for a string variable defined as A12 will be 16 bytes with the last 4 bytes set to spaces. The strings are multibyte strings and in the same locale as the IBM SPSS Statistics backend.
- Missing values for string variables are specified by setting all characters in the string to spaces (ASCII code decimal 32).

SAVE, XSAVE /TYPE=BINARYSTREAM

The following syntax diagrams show all of the subcommands, keywords, and specifications available for the SAVE and XSAVE commands with /TYPE=BINARYSTREAM.

SAVE /TYPE = BINARYSTREAM

```
{/PIPE='name' }  
{/SOCKET=portnum}  
  
[/UNSELECTED = [ {RETAIN**} ] ]  
                {DELETE }  
  
[/KEEP = {ALL** } ] [/DROP = varlist]  
                {varlist}
```

XSAVE /TYPE = BINARYSTREAM

```
{/PIPE='name' }  
{/SOCKET=portnum}  
  
[/KEEP = {ALL** } ] [/DROP = varlist]  
                {varlist}
```

** Default if the subcommand is omitted.

Example

```
SAVE /TYPE=BINARYSTREAM  
    /PIPE='\\.\pipe\datapipe'.
```

Overview

The SAVE and XSAVE commands with /TYPE=BINARYSTREAM write cases from the active dataset to a specified pipe or socket. The SAVE command reads the active dataset, causes execution of any pending commands, and causes the data to be written to the specified pipe or socket. The XSAVE command does not read the

active dataset; it is stored, pending execution with the next command that reads the dataset. In the discussion that follows, the consumer of the case data is referred to as the **stream reader**. You can stream data values into IBM SPSS Statistics from a pipe or socket using GET DATA /TYPE = BINARYSTREAM. See the topic “GET DATA /TYPE=BINARYSTREAM” on page 12 for more information.

OptionsBasic Specification

Pipe. The destination for case records can be a named pipe to be created by IBM SPSS Statistics. The pipe option assumes that the stream reader and IBM SPSS Statistics are on the same machine.

Socket. The destination for case records can be the port number of a TCP socket to which IBM SPSS Statistics binds, and waits for a connection. The socket option allows for the stream reader and IBM SPSS Statistics to be on different machines.

The basic specification for SAVE /TYPE=BINARYSTREAM or XSAVE /TYPE=BINARYSTREAM is a pipe name or socket port number.

Syntax Rules

- Subcommand names, keywords, and options must be spelled in full.
- Either the PIPE or SOCKET subcommand, but not both, must be specified.
- XSAVE /TYPE=BINARYSTREAM cannot appear within a DO REPEAT–END REPEAT structure.
- Multiple XSAVE /TYPE=BINARYSTREAM commands writing to the same pipe or socket are not allowed.

Operations

- The PIPE subcommand creates the named pipe, writes all of the specified cases to the pipe, and then closes the pipe.
- The SOCKET subcommand creates one listening socket, waits for one TCP connection, writes all of the specified cases to the socket, and then closes the socket.

Example

```
SAVE /TYPE=BINARYSTREAM
  /PIPE='\\.\pipe\datapipe'
  /DROP=GRADE STORE
  /KEEP=LNAME NAME TENURE JTENURE ALL.
```

- The PIPE subcommand specifies that IBM SPSS Statistics will write cases from the active dataset to the pipe named `\\.\pipe\datapipe`.
- DROP excludes variables *GRADE* and *STORE* from the written stream. KEEP specifies that *LNAME*, *NAME*, *TENURE*, and *JTENURE* are the first four variables written to the stream (for each case), followed by all remaining variables not specified on *DROP*. These remaining variables are written to the stream in the same order as they occur in the active dataset.

PIPE Subcommand

The PIPE subcommand specifies a named pipe to be created by IBM SPSS Statistics and to which IBM SPSS Statistics will write case data. Use of a pipe assumes that IBM SPSS Statistics and the stream reader are on the same machine.

- The name of the pipe must be enclosed in quotes. You cannot assign a file handle to a pipe.
- Both forward slashes and backslashes can be used as path separators in the pipe name.
- Since, for pipes, IBM SPSS Statistics and the stream reader are on the same machine, they are both assumed to be in the same endian. The binary format of the pipe stream created by IBM SPSS Statistics is as described in .

SOCKET Subcommand

The **SOCKET** subcommand specifies the port number for which IBM SPSS Statistics will create a TCP socket in the listening state. IBM SPSS Statistics will wait for a connection, write a 32-bit integer number (between 1 and 255) for endian detection, and then write case data to the socket with no byte swapping. The stream reader is required to detect endian and perform byte-swapping, if necessary.

- You cannot assign a file handle to the port number of a TCP socket.
- Following the initial 32-bit integer used for endian detection, the remainder of the stream created by IBM SPSS Statistics is as described in .

UNSELECTED Subcommand

The **UNSELECTED** subcommand, which applies to **SAVE** but not **XSAVE**, determines whether cases excluded by a previous **FILTER** or **USE** command are to be retained or deleted in the output stream. The default is **RETAIN**.

- The **UNSELECTED** subcommand has no effect when the active dataset does not contain unselected cases.

RETAIN. *Retain the unselected cases.* All cases in the active dataset are written to the stream. This setting is the default when **UNSELECTED** is specified by itself.

DELETE. *Delete the unselected cases.* Only cases that meet the **FILTER** or **USE** criteria currently in effect are written to the stream.

DROP and KEEP Subcommands

DROP and **KEEP** are used to specify a subset of variables to be written to the stream. **DROP** specifies the variables that are not to be included in the output stream. **KEEP** specifies the variables that are to be included in the output stream. When **KEEP** is specified, variables that are not named on **KEEP** are dropped.

- Variables can be specified in any order. The order of variables on **KEEP** determines the order of variables in the output stream. The order on **DROP** does not affect the order of variables in the stream.
- The keyword **ALL** on **KEEP** refers to all remaining variables that were not previously specified on **KEEP**. **ALL** must be the last specification on **KEEP**.
- If a variable is specified twice on the same **DROP** or **KEEP** subcommand, only the first mention is recognized.
- Multiple **DROP** and **KEEP** subcommands are allowed. If a variable is specified that is not in the active dataset or that has been dropped because of a previous **DROP** or **KEEP** subcommand, an error results, and the **SAVE** or **XSAVE** command is not executed.
- The keyword **T0** can be used to specify a group of consecutive variables in the active dataset.

Common Binary Format of the Stream

Case data is written as a packed stream of 8 byte entities such that each case is represented by the same number of bytes. Cases and variables within cases are written in the order specified by the active data set, honoring the effects of any **KEEP** and **DROP** subcommands.

- Each numeric variable is a double, 8 bytes wide, and in the endian of the IBM SPSS Statistics backend. The IBM SPSS Statistics backend does not perform byte swapping. Examples of numeric variables include, but are not limited to, those with formats **Fn.d**, **DATEn**, **ADATEn**, or **DOLLARn.d**.
- Variables with a date or date and time format, represent the number of seconds from 0 hours, 0 minutes, and 0 seconds on Oct. 14, 1582.
- Missing values for numeric variables are specified by setting the value to the most negative normalized double supported by IEEE double floating point (big endian representation: **X'FFFEFFFFFF FFFFFFFF'**) or to an invalid IEEE floating point double.
- String variables in IBM SPSS Statistics can have widths from 1 to 32767 characters, however, they are written to the stream in widths that are integer multiples of 8 bytes, large enough to hold the defined length of the string variable, and padded with spaces if needed. For example, the width of the buffer

provided for a string variable defined as A7 will be 8 bytes with the last byte set to a space (ASCII code decimal 32), whereas the buffer for a string variable defined as A12 will be 16 bytes with the last 4 bytes set to spaces. The strings are multibyte strings and in the same locale as the IBM SPSS Statistics backend.

- Missing values for string variables are specified by setting all characters in the string to spaces (ASCII code decimal 32).

Chapter 3. Creating an Integration Plug-in

An **integration plug-in** is code that you write that:

- Invokes IBM SPSS Statistics from an external processor.
- Supports communication between IBM SPSS Statistics and the external processor.
- Optionally invokes an external processor from IBM SPSS Statistics and passes language statements (written in the external language), contained in a BEGIN PROGRAM <language> - END PROGRAM block of command syntax, to the external processor. For example, if you create a plug-in for the Basic language then you can wrap Basic statements in a BEGIN PROGRAM BASIC - END PROGRAM block in command syntax. When you run the syntax, the Basic statements will be executed by the Basic processor.

We recommend that your plug-ins be at the same release level as the IBM SPSS Statistics application software, although they may work with versions as low as 14.0.

Planning

Before you start writing code, consider:

- **Language type.** You can create plug-ins for the IBM SPSS Statistics Programmability Extension in any language that can call a C API. The optional feature of invoking an external language from IBM SPSS Statistics is designed for interpreted or dynamically compiled languages.
- **Processes and threads.** If you are building a plug-in that will only invoke IBM SPSS Statistics from an external processor and are using the in-process mode, then you should be aware that there is one process with two threads, one for the IBM SPSS Statistics application and one for your external processor. The IBM SPSS Statistics application is single-threaded—only one instance of IBM SPSS Statistics can be running in the process. Because the IBM SPSS Statistics application and your implementation operate in the same process, they may share the runtime library. Be sure that your implementation does not make changes to the state of the runtime that would affect IBM SPSS Statistics. For example, a C `setlocale` call to set the process locale would change the locale in which IBM SPSS Statistics is running, but it would not completely effect this change because IBM SPSS Statistics needs to do additional tasks when the locale changes.
- **Synchronization.** When using the in-process mode, the two threads execute synchronously. Only one thread is executing at a given time. The other thread waits for execution to complete.
- **Resource utilization.** The IBM SPSS Statistics application can have a large footprint. The amount of computing resources (for example RAM, CPU time and disc space) that it requires in order to operate varies according to what it is doing. The XD API has a small footprint.
- **Functions.** Decide which XD API functions you need to use. For an introduction to the available functions, see Chapter 4, “Introduction to the XD API,” on page 25.

Invoking IBM SPSS Statistics from an External Processor

You invoke IBM SPSS Statistics from an external processor through a library that calls the XD API. For example, this can be a C++ interface to the low-level functions that the C API in *libspssxd.so* or *libspssxd_p.so* implements. We generically refer to this library as *MyLanguageInvokeXD*. The sequence of actions for invoking IBM SPSS Statistics in this manner is as follows:

1. *MyLanguageInvokeXD* loads.
2. *MyLanguageInvokeXD* determines the path to *libspssxd.so* or *libspssxd_p.so* and loads the library.

The mechanism for determining the path might involve reading from a configuration file. Ultimately the path must initially be determined when a user installs a plug-in or an application.

The code that you write to launch IBM SPSS Statistics from an external processor needs to include, at a minimum, functions to:

- Load and unload *libspssxd.so* or *libspssxd_p.so*.
- Submit command syntax to IBM SPSS Statistics for processing.
- Get information from your external processor to the IBM SPSS Statistics application.

Building MyLanguageInvokeXD

To build *MyLanguageInvokeXD* you use the *spssxd.h* and *libspssxd.so* (or *libspssxd_p.so*) files which are available from `\XD_API` in the directory where the IBM SPSS Statistics - Programmability SDK is installed. An implementation of *MyLanguageInvokeXD* can only be used with a version of *libspssxd.so* (or *libspssxd_p.so*) that matches the version of IBM SPSS Statistics associated with the IBM SPSS Statistics - Programmability SDK used to build *MyLanguageInvokeXD*. For more information, see the section labeled *Versions* in .

Python Example

The IBM SPSS Statistics - Programmability SDK includes *PyInvokeSpss* as an example implementation of how to invoke IBM SPSS Statistics from Python. The source files and script to build *PyInvokeSpss* are included in the IBM SPSS Statistics - Programmability SDK in `\Statistics_Python`. The readme file in that directory provides further information about building *PyInvokeSpss*.

The Path to *libspssxd.so* or *libspssxd_p.so*

The Python example utilizes the configuration file *spssxdcfg.ini* (a template is available in `\Statistics_Python\spss`) to determine the path to *libspssxd.so* or *libspssxd_p.so*. Specifically, the path is stored as the value of *spssxd_path* in this file. Regardless of the language and implementation of the plug-in, it is the responsibility of the program that installs the plug-in to query the user for the path to the desired installation of IBM SPSS Statistics (*libspssxd.so* and *libspssxd_p.so* are located in the IBM SPSS Statistics application installation directory) and to store that value so that it can be retrieved at run-time.

Invoking an External Processor from IBM SPSS Statistics

To invoke the processor for an external language from IBM SPSS Statistics, you will need to create the following:

- A library that launches and initializes the processor. We generically refer to this library as *InvokeMyLanguage*. An external processor invoked from IBM SPSS Statistics should provide access to all the functionality of the external programming language—in some programming languages this is called **embedding**. Details on creating the library are provided in the topic “Creating an InvokeMyLanguage library.”
- A section in the configuration file *spssxdcfg.ini* (located in the directory where IBM SPSS Statistics is installed) that provides the details needed to invoke the external language processor, such as the name of the library and the path to the home directory for the external processor. Details are provided in the topic “Modifying the DX configuration file” on page 22.

Note: The framework for invoking an external language from IBM SPSS Statistics is designed for interpreted or dynamically compiled languages.

Creating an InvokeMyLanguage library

The *InvokeMyLanguage* library should include a set of functions that are called by the framework that invokes external language processors from IBM SPSS Statistics. Following are the functions:

```
int init_embedded_x (int argc, char **argv)
```


The *init_embedded_x* function initializes the external language. It is only called once during an IBM SPSS Statistics session. The argument *argv* is an array of strings containing the set of values, if any, specified by the ARGV keyword in the *spssdxcfg.ini* configuration file (See the topic “Modifying the DX configuration file” on page 22 for more information.). The argument *argc* is an integer specifying the number of elements in the string array. A return value of 0 indicates success. *init_embedded_x* is a required function.

```
int stop_embedded_x ()
```

The *stop_embedded_x* function stops the external language. It is only called once during an IBM SPSS Statistics session. A return value of 0 indicates success. *stop_embedded_x* is a required function.

```
int pre_action ()
```

The *pre_action* function is called prior to the beginning of each BEGIN PROGRAM <language> - END PROGRAM block and should handle any actions that are required prior to executing the block. For example, if you intend to capture text output from the external processor then you would typically use the *pre_action* function to handle redirecting the output to a temporary file. A return value of 0 indicates success. *pre_action* is a required function.

```
int post_action ()
```

The *post_action* function is called at the completion of each BEGIN PROGRAM <language> - END PROGRAM block and should handle any actions that are required after executing the block. For example, if you intend to capture text output from the external processor then you would typically use the *post_action* function to retrieve any output directed to a temporary file and post it to IBM SPSS Statistics. A return value of 0 indicates success. *post_action* is a required function.

```
int execute_x (char *cmd)
```

The *execute_x* function accepts a string containing the contents of a BEGIN PROGRAM <language> - END PROGRAM block (i.e. statements written in the external language) and passes it to the external processor for execution. The string is null-terminated with multiple lines separated by “\n”. A return value of 0 indicates success. *execute_x* is a required function.

```
void set_post_spss_output (FPPostSpssOutput fpSpssOutput )
```

The *set_post_spss_output* function is called by the framework in order to pass a pointer to the function that should be used to post text output to IBM SPSS Statistics. Output is posted to a log item in the IBM SPSS Statistics Viewer. The argument *fpSpssOutput* is a function pointer and its function prototype is:

```
typedef int (*FPPostSpssOutput)(const char* text, int length);.
```

Note that *set_post_spss_output* is an optional function. You can also post text output to IBM SPSS Statistics with the *PostSpssOutput* function in the XD API.

Source files and instructions for building example implementations of *InvokeMyLanguage* for Python can be found in `\DX_API\InvokePython` and `\DX_API\MyInvokePython`, located in the directory where the IBM SPSS Statistics - Programmability SDK is installed. The example in `\DX_API\MyInvokePython` is very basic and simply illustrates how to invoke an external language processor, execute external language statements from BEGIN PROGRAM <language> - END PROGRAM blocks and post output to IBM SPSS Statistics; but it does not support utilizing the XD API to interact with IBM SPSS Statistics. The example in `\DX_API\InvokePython` supports invoking the Python processor from IBM SPSS Statistics as well as utilizing the XD API to interact with IBM SPSS Statistics.

Modifying the DX configuration file

The configuration file *spssdxcfg.ini* specifies how to invoke the processor for an external language. The file contains an entry for each external processor that can be invoked from IBM SPSS Statistics. *spssdxcfg.ini* is part of the IBM SPSS Statistics Programmability Extension and is located in the IBM SPSS Statistics application installation directory. It is the responsibility of the installation program for a plug-in to populate this file if the plug-in supports invoking the associated language from IBM SPSS Statistics.

To add support for a new external language:

1. Add the name of the language to the existing list in the [SUPPORTED_LANG] section, using a semicolon as a delimiter. The name is case insensitive but cannot contain blank characters. For example, if the existing list is specified as X=PYTHON;R, then you add a language named MYLANGUAGE by updating the list to:

```
X=PYTHON;R;MYLANGUAGE.
```

Note that the name you specify for the language is the name that users will specify when creating BEGIN PROGRAM <language> - END PROGRAM blocks. For the current example, users will create BEGIN PROGRAM MYLANGUAGE - END PROGRAM blocks.

2. Add a section for your language to *spssdxcfg.ini*. A template for the contents of the section is as follows:

```
[MYLANGUAGE]
LIB_NAME=
HOME=
ARGS=
```

[MYLANGUAGE]. The name of the external language enclosed in square brackets.

LIB_NAME. The name of the library that provides the adapter for your external processor--what we have generically called *InvokeMyLanguage*. This is required. For example, if the name of the library is *InvokeMyLanguage* then specify: LIB_NAME=InvokeMyLanguage.

HOME. An absolute path to the external processor. This is required.

ARGS. A blank separated list of arguments, if any, to pass to the *init_embedded_x* function in the *InvokeMyLanguage* library. Values should be specified as unquoted strings, as in: ARGS=arg1 arg2 arg3. The ARGS keyword is optional.

You can also add key/value pairs specifying any environment variables that may be needed by your plug-in. In that regard, note that for UNIX platforms (including MacOS), the process in which the external processor runs only inherits the following environment variables: *SPSS_HOME*, *SPSSDXTEMP*, *SPSS_EXTENSIONS_PATH* and the library path (*LD_LIBRARY_PATH* for Linux and Solaris, *LIBPATH* for AIX, and *DYLD_LIBRARY_PATH* for MacOS).

For example, if your plug-in requires libraries distributed with the external processor and the path to those libraries is not in the current library search path, then you would add a library path environment variable to the [MYLANGUAGE] section, as in the following for Windows:

```
PATH=<library path>;%PATH%
```

Likewise, for Linux or Solaris you would add:

```
LD_LIBRARY_PATH=<library path>:$LD_LIBRARY_PATH
```

Language-specific Wrappers

For ease of use by applications developers and end users, you may want to consider providing a wrapper to the library that loads and exposes the XD API to the external language, i.e. a wrapper to *MyLanguageInvokeXD*. In this regard, the IBM SPSS Statistics - Programmability SDK includes an example module for Python, *spss.py*, that wraps *PyInvokeSpss*. The source files are included in the IBM SPSS Statistics - Programmability SDK in `\Statistics_Python\spss`.

Setting the IBM SPSS Statistics Locale

When writing language-specific wrappers, you should be aware that the `StartSPSS` function at the level of the XD API does not set the IBM SPSS Statistics locale. In the example Python plug-in available from <http://www.ibm.com/developerworks/spssdevcentral>, the locale for IBM SPSS Statistics is set by the `StartSPSS` function at the level of the wrapper to *MyLanguageInvokeXD*--that is, at the level of *spss.py* for Python.

In designing your own plug-ins and optional wrappers, you'll have to decide where best to set the IBM SPSS Statistics locale when starting an IBM SPSS Statistics session. And if you decide to write your own wrapper for *PyInvokeSpss* you'll need to set the IBM SPSS Statistics locale as part of the process of starting an IBM SPSS Statistics session.

Deploying An Integration Plug-in

You can deploy a plug-in that you have developed using the IBM SPSS Statistics - Programmability SDK. Your plug-in can only be used with a licensed IBM SPSS Statistics application. For information about licensing or distribution arrangements, please contact IBM Corp. directly.

In order for your plug-in to run properly on the target computer you must have:

- An IBM SPSS Statistics application
- Your chosen programming language
- Your plug-in files
- Updated configuration files

Programming Language

The programming language that you used to develop your plug-in must be installed on the computer where you will run it. Note that if you are using your plug-in from an IBM SPSS Statistics client which is connected to IBM SPSS Statistics Server, the programming language and plug-in must be installed on the computer on which IBM SPSS Statistics Server is running.

Integration Plug-in

Your plug-in files must be available on the computer where you will run your plug-in.

MyLanguageInvokeXD. The library that loads *libspssxd.so* or *libspssxd_p.so* and makes the XD API available in an external language should be installed in a location where your programming language can find it (for example, `/usr/local/python27/lib/python2.7/site-packages/MyPackage`).

InvokeMyLanguage. The optional library that invokes an external processor from IBM SPSS Statistics must be installed in the IBM SPSS Statistics application's *lib* directory. Note that the IBM SPSS Statistics Programmability Extension files—*libspssxd.so* and *libspssxd_p.so*—are installed in this directory as part of the IBM SPSS Statistics application installation.

Language-specific wrappers. Wrappers to *MyLanguageInvokeXD* should be installed in a location where your programming language can find them (for example, */usr/local/python27/lib/python2.7/site-packages/MyPackage*).

Configuration File Updates

If your plug-in invokes an external language processor from IBM SPSS Statistics, make sure to update the configuration file *spssdxcfg.ini* so that the appropriate libraries can be located by your plug-in. Be sure to update the path settings for the value of *HOME* in *spssdxcfg.ini* to be an absolute path to the external processor. Use forward slashes in the path.

Versions

To build *MyLanguageInvokeXD* you use the *spssxd.h* and *libspssxd.so* (or *libspssxd_p.so*) files which are included in the IBM SPSS Statistics - Programmability SDK. The version of *libspssxd.so* (or *libspssxd_p.so*) on the target machine needs to be the same as the version of *spssxd.h* and *libspssxd.so* (or *libspssxd_p.so*) used to build *MyLanguageInvokeXD*. You can check the version of *libspssxd.so* and *libspssxd_p.so*, on the target machine, from the value of *SpssdxVersion* in *spssdxcfg.ini*, located in the IBM SPSS Statistics application's *bin* directory. The copies of *spssxd.h*, *libspssxd.so*, and *libspssxd_p.so* included with the IBM SPSS Statistics - Programmability SDK are compatible with the version of IBM SPSS Statistics given in the readme file located at the root of the IBM SPSS Statistics - Programmability SDK installation directory.

Documentation

You can deploy IBM SPSS Statistics Programmability Extension documentation with your plug-in, including:

Dictionary schema documentation. The dictionary schema is available from <http://xml.spss.com/spss/data/>. Documentation is included in the IBM SPSS Statistics - Programmability SDK and accessible from `\documentation\DictionarySchema\dictionary_schema_intro.htm`.

Output schema documentation. The output schema is distributed with your IBM SPSS Statistics application, in *spss-output-1.8.xsd*, and is also available from <http://xml.spss.com/spss/oms/>. Documentation is included in the IBM SPSS Statistics - Programmability SDK and accessible from `\documentation\OutputSchema\oms_oxml_schema_intro.htm`.

Plug-in documentation. You may want to write documentation for your plug-in. You can use `\documentation\PythonPackage\Python Integration Package for IBM SPSS Statistics.pdf` as an example.

Programmability SDK documentation. You can distribute this document with your plug-in.

Chapter 4. Introduction to the XD API

An overview of the functions available with the XD API, along with examples of using them to accomplish basic tasks follows. Complete documentation of the XD API is included in the IBM SPSS Statistics - Programmability SDK and accessible from `\documentation\XD API\index.html`.

The XD API in *libspssxd.so* contains low-level functions which you can sequence to:

- Submit requests for actions to IBM SPSS Statistics.
- Submit requests for information to IBM SPSS Statistics.

Typically, the return value from an action request is an error code. Typically, the return value from an information request is the information requested.

Functions operate on IBM SPSS Statistics, the variable dictionary, the XML workspace, and the active dataset.

Controlling IBM SPSS Statistics

With programmability you can use an external programming language to control IBM SPSS Statistics. Functions include:

StartSPSS. Action request that starts the IBM SPSS Statistics backend.

- Note that this function does not set the IBM SPSS Statistics locale. You must set the appropriate locale (after starting the backend) with `set locale` command syntax executed with the `Submit` function. An example of command syntax to set the locale is: `set locale = 'English_United States.1252'`.
- Starting with version 21, IBM SPSS Statistics operates in Unicode mode by default. If you need to work in code page mode, you can use the `Submit` function with `SET UNICODE=NO` syntax.

StopSPSS. Action request that causes the backend to shutdown when it was started from an external application. The function has no effect when IBM SPSS Statistics is the main program.

Submit. Action request that queues a line of syntax command text and executes all of the currently queued lines.

QueueCommandPart. Action request that queues a line of syntax command text but does not execute it.

PostSpssOutput. Action request that adds a line to the IBM SPSS Statistics log.

IsBackendReady. Information request used to determine if IBM SPSS Statistics is ready to receive commands.

IsXDDriven. Information request used to determine whether the backend is being driven by an external processor.

IsUTF8mode. Information request to determine whether IBM SPSS Statistics is running in Unicode mode or code page mode.

GetGraphic. Action request to display an R-style graphic in the IBM SPSS Statistics Viewer.

GetSPSSLocale. Information request to get the current locale of the IBM SPSS Statistics processor.

GetOutputLanguage. Action request to get the output language of the IBM SPSS Statistics processor.

SetOutputLanguage. Action request to set the output language of the IBM SPSS Statistics processor.

GetFileHandles. Action request to get any defined file handles.

GetOMStagList. Information request that returns a list of tags associated with any active OMS requests.

GetSetting. Information request that returns the value of an options setting, as set from the SET command.

EncryptTempFiles. Action request that specifies whether temp files are encrypted. By default, temp files are not encrypted.

Variable Dictionary Information

A variable dictionary describes the contents of a dataset. Two sets of functions are available for retrieving dictionary information; one set for retrieving information from the active dataset, and another set for retrieving information from a cursor. While a cursor is open, both sets of functions return information about the current cursor and give identical results. Functions that only retrieve information from the current cursor have a suffix of *InProcDS*. Cursors are created with the *MakeCaseCursor* function and provide both read and write access to the active dataset.

GetCValueLabels. Information request that returns the value labels for a specified string variable.

GetNValueLabels. Information request that returns the value labels for a specified numeric variable.

GetRowCount (GetRowCountInProcDS). Information request that returns the number of cases in the active dataset (or current cursor).

GetVarAttributeNames (GetVarAttributeNamesInProcDS). Information request that returns the names of all variable attributes for a specified variable.

GetVarAttributes (GetVarAttributesInProcDS). Information request that returns the attribute values for a specified variable and variable attribute.

GetVarCMissingValues (GetVarCMissingValuesInProcDS). Information request that returns the user-missing values for a specified string variable.

GetVarNMissingValues (GetVarNMissingValuesInProcDS). Information request that returns the user-missing values for a specified numeric variable.

GetVariableCount (GetVariableCountInProcDS). Information request that returns the number of variables in the active dataset (or current cursor).

GetVariableFormat (GetVariableFormatInProcDS). Information request that returns the display format of a specified variable.

GetVariableLabel (GetVariableLabelInProcDS). Information request that returns the Label of a specified variable.

GetVariableMeasurementLevel (GetVariableMeasurementLevelInProcDS). Information request that returns the measurement level (nominal, ordinal, scale, or unknown) of a specified variable.

GetVariableName (GetVariableNameInProcDS). Information request that returns the name of a specified variable. Variables are specified by an index value representing position in the active dataset (or current cursor), starting with 0 for the first variable in file order.

GetVariableRole (GetVariableRoleInProcDS). Information request that returns the variable role for a specified variable. Variables are specified by an index value representing position in the active dataset (or current cursor), starting with 0 for the first variable in file order.

GetVariableType (GetVariableTypeInProcDS). Information request that returns the variable type (numeric or string) for a specified variable.

GetWeightVar. Information request that returns the name of the weight variable, if any, in the active dataset.

GetSPSSLowHigh. Information request that returns the values IBM SPSS Statistics uses for LO and HI.

GetSystemMissingValue. Information request that returns the system-missing value.

GetMultiResponseSetNames (GetMultiResponseSetNamesInProcDS). Information request that returns the names of any multiple response sets for the active dataset.

GetMultiResponseSet (GetMultiResponseSetInProcDS). Information request that returns the details of a specified multiple response set.

SetVarRole. Action request that sets the variable role for a specified variable.

XML Workspace

The **XML workspace** is an area in memory where you can store and then retrieve both dictionary information and syntax command output. A variable dictionary describes the contents of a dataset. To get dictionary information into the XML workspace, use the `CreateXPathDictionary` function. Use this when you want access to dictionary information that isn't directly accessible with the dictionary information request functions listed above. IBM SPSS Statistics output includes statistical results, tables, charts, trees, and text. To get output into the XML workspace, use the `OMS` syntax command with the `XMLWORKSPACE` destination. See the topic "Retrieving Output from Syntax Commands" on page 41 for more information.

XML workspace functions include:

CreateXPathDictionary. Action request that creates an XPath DOM from the active dataset's dictionary and adds it to the XML workspace with the given handle.

EvaluateXPath. Information request that evaluates the XPath expression in the given context against a specified XPath DOM—either a dictionary DOM or an output DOM. Dictionary DOM's have a structure that conforms to the dictionary schema published at <http://xml.spss.com/spss/data/>, and output DOM's have a structure that conforms to the output schema published at <http://xml.spss.com/spss/oms/>. Documentation for the dictionary and output schemas is included in the IBM SPSS Statistics - Programmability SDK and accessible from `\documentation\DictionarySchema\dictionary_schema_intro.htm` and `\documentation\OutputSchema\oms_oxml_schema_intro.htm` respectively.

GetStringFromList. Information request that gets a single string from the list returned from `EvaluateXPath`.

GetStringListLength. Information request that returns the length of the list found with `EvaluateXPath`.

GetHandleList. Information request that gets the list of handles of the objects currently in the XML workspace.

RemoveStringList. Action request that deletes the storage associated with the string list found with `EvaluateXPath`.

RemoveXPathHandle. Action request that removes an object from the XML workspace, freeing the storage.

GetXmlUtf16. Information request that gets XML from the XML workspace and returns a Utf16 representation of it.

GetImage. Information request that returns a pointer to an image generated by a syntax command and stored in the XML workspace.

Getting Case Data, Adding New Variables, and Appending Cases to the Active Dataset

The active dataset contains variables (columns) and cases (rows). Case data functions for the active dataset include:

MakeCaseCursor. Action request that creates a data cursor. Cursors have three modes: read, write, and append.

HasCursor. Information request that returns an integer indicating if a cursor is running.

NextCase. Action request that moves the cursor to the next case.

IsEndSplit. Information request that returns an integer indicating if the cursor position has crossed a split boundary.

ResetDataPass. Action request to reset the cursor to the first case.

GetCursorPosition. Information request that gets the row index of the cursor.

GetNumericValue. Information request that gets a numeric data value and missing status for a specific variable and case.

GetStringValue. Information request that gets a string data value and missing status for a specific variable and case.

RemoveCaseCursor. Action request to free the storage for a case.

AllocNewVarsBuffer. Action request to specify the buffer size, in bytes, to use when adding new variables in the context of multiple data passes.

CommitHeader. Action request used in write mode to commit the dictionary information for new variables to the current cursor.

CommitCaseRecord. Action request used in write mode to commit changes to the current case in the current cursor.

CommitNewCase. Action request used in append mode to commit data for a new case to the current cursor.

EndChanges. Action request used in append mode to signal the end of appending new cases.

SetOneVarNameAndType. Action request used in write mode to create a single new variable in the active dataset. This function is intended to be used in conjunction with the AllocNewVarsBuffer function.

SetValueChar. Action request used in write mode or append mode to set the value for the current case for a string variable.

SetValueNumeric. Action request used in write mode or append mode to set the value for the current case for a numeric variable.

SetVarAlignment. Action request used in write mode to set the variable alignment property for a new variable.

SetVarAttributes. Action request used in write mode to set a value in an attribute array for a new variable.

SetVarCMissingValues. Action request used in write mode to specify user-missing values for a new string variable.

SetVarCValueLabel. Action request used in write mode to specify value labels for a new string variable.

SetVarFormat. Action request used in write mode to specify the display format for a new variable.

SetVarLabel. Action request used in write mode to specify the variable label for a new variable.

SetVarMeasureLevel. Action request used in write mode to specify the measurement level (nominal, ordinal, or scale) for a new variable.

SetVarNameAndType. Action request used in write mode to create new variables in the active dataset.

SetVarNMissingValues. Action request used in write mode to specify user-missing values for a new numeric variable.

SetVarNValueLabel. Action request used in write mode to specify value labels for a new numeric variable.

ValidateVarName. Information request used to validate a potential variable name.

Creating and Accessing Multiple Datasets

In addition to accessing the active dataset, you can concurrently access multiple open datasets as well as create new datasets. This allows you to create one or more new datasets from existing datasets, combining the data from the existing datasets in any way you choose. It also allows you to concurrently modify multiple datasets. The environment that allows you to create new datasets and access multiple datasets is initiated with the `StartDataStep` function. Functions for creating and accessing multiple datasets include:

StartDataStep. Action request that initiates a data step.

EndDataStep. Action request that ends a data step.

CreateDataset. Action request that provides access to an open dataset or creates a new empty dataset.

SetDatasetName. Action request to rename a dataset. Acts on a dataset object created by the `CreateDataset` function.

GetNewDatasetName. Information request to get the name of a newly created dataset.

GetActive. Information request to get the name of the active dataset.

SetActive. Action request to set the active dataset.

CopyDataset. Action request to create a deep copy of a dataset.

GetSpssDatasets. Information request to return a list of the names of the currently open datasets.

GetDatastepDatasets. Information request to return a list of the names of the datasets that are available in the current datastep. These are the datasets accessed with the CreateDataset function.

CloseDataset. Action request to close a dataset accessed with the CreateDataset function.

InsertVariable. Action request to insert a new variable into a specified dataset. Acts on a dataset object created by the CreateDataset function.

DeleteVariable. Action request to delete a specified variable from a specified dataset. Acts on a dataset object created by the CreateDataset function.

GetVarCountInDS. Information request to return the number of variables in a specified dataset.

GetVarNameInDS. Information request to return the name of the variable at a specified index position in a specified dataset.

SetVarNameInDS. Action request to set the name of the variable at a specified index position in a specified dataset.

GetVarLabelInDS. Information request to get the label of the variable at a specified index position in a specified dataset.

SetVarLabelInDS. Action request to set the label of the variable at a specified index position in a specified dataset.

GetVarTypeInDS. Information request to get the variable type (numeric or string) of the variable at a specified index position in a specified dataset.

SetVarTypeInDS. Action request to set the variable type of the variable at a specified index position in a specified dataset.

GetVarFormatInDS. Information request to get the display format of the variable at a specified index position in a specified dataset.

SetVarFormatInDS. Action request to set the display format of the variable at a specified index position in a specified dataset.

GetVarAlignmentInDS. Information request to get the alignment (left, right, or center) of the variable at a specified index position in a specified dataset.

SetVarAlignmentInDS. Action request to set the alignment of the variable at a specified index position in a specified dataset.

GetVarMeasurementLevelInDS. Information request to get the measurement level (nominal, ordinal, scale, or unknown) of the variable at a specified index position in a specified dataset.

SetVarMeasurementLevelInDS. Action request to set the measurement level (nominal, ordinal, or scale) of the variable at a specified index position in a specified dataset.

GetVarNMissingValuesInDS. Information request to get the missing values of the numeric variable at a specified index position in a specified dataset.

SetVarNMissingValuesInDS. Action request to set the missing values of the numeric variable at a specified index position in a specified dataset.

GetVarCMissingValuesInDS. Information request to get the missing values of the string variable at a specified index position in a specified dataset.

SetVarCMissingValuesInDS. Action request to set the missing values of the string variable at a specified index position in a specified dataset.

GetVarAttributesNameInDS. Information request to get the names of the custom variable attributes associated with a specified variable in a specified dataset.

GetVarAttributesInDS. Information request to get the values associated with a particular custom variable attribute for a specified variable in a specified dataset.

SetVarAttributesInDS. Action request to set the values associated with a particular custom variable attribute for a specified variable in a specified dataset.

DelVarAttributesInDS. Action request to delete the values associated with a particular custom variable attribute for a specified variable in a specified dataset.

GetVarNValueLabelInDS. Information request to get the value labels associated with the numeric variable at a specified index position in a specified dataset.

SetVarNValueLabelInDS. Action request to set a single value label for the numeric variable at a specified index position in a specified dataset.

GetVarCValueLabelInDS. Information request to get the value labels associated with the string variable at a specified index position in a specified dataset.

SetVarCValueLabelInDS. Action request to set a single value label for the string variable at a specified index position in a specified dataset.

DelVarValueLabelInDS. Action request to delete all value labels associated with a specified variable in a specified dataset.

DelVarNValueLabelInDS. Action request to delete a given value label associated with a specified numeric variable in a specified dataset.

DelVarCValueLabelInDS. Action request to delete a given value label associated with a specified string variable in a specified dataset.

GetVarColumnWidthInDS. Information request to get the column width of the variable at a specified index position in a specified dataset. This is the column width for data values displayed in the Data Editor.

SetVarColumnWidthInDS. Action request to set the column width of the variable at a specified index position in a specified dataset. This is the column width for data values displayed in the Data Editor.

InsertCase. Action request to insert a case at a specified position in a specified dataset.

DeleteCase. Action request to delete the case at a specified position in a specified dataset.

GetCaseCountInDS. Information request to get the number of cases in a specified dataset.

GetNCellValue. Information request to get the value for a specified case for a particular numeric variable in a specified dataset.

SetNCellValue. Action request to set the value for a specified case for a particular numeric variable in a specified dataset.

GetCCellValue. Information request to get the value for a specified case for a particular string variable in a specified dataset.

SetCCellValue. Action request to set the value for a specified case for a particular string variable in a specified dataset.

GetMultiResponseSetNamesInDS. Information request to get the names of any multiple response sets for a specified dataset.

GetMultiResponseSetInDS. Information request to get the details of a specified multiple response set for a specified dataset.

SetMultiResponseSetInDS. Action request to create a multiple response set for a specified dataset.

DelMultiResponseSetInDS. Action request to delete a specified multiple response set from a specified dataset.

GetDataFileAttributeNamesInDS. Information request to get the names of any datafile attributes for a specified dataset.

GetDataFileAttributesInDS. Information request to get the value of a specified datafile attribute in a specified dataset.

SetDataFileAttributesInDS. Action request to create a datafile attribute in a specified dataset.

DelDataFileAttributesInDS. Action request to delete a specified datafile attribute from a specified dataset.

GetVarRoleInDS. Information request that returns the variable role for a specified variable in a specified dataset.

SetVarRoleInDS. Action request to set the variable role for a specified variable in a specified dataset.

Creating Pivot Tables and Text Blocks

Pivot tables and text blocks are generated within the context of user procedures created with the `StartProcedure` function. Functions for working with pivot tables and text blocks include:

StartProcedure. Action request that creates a user procedure and signals the beginning of pivot table or text block output.

EndProcedure. Action request that ends a user procedure and signals the end of pivot table or text block output.

HasProcedure. Information request that returns an integer indicating if a user procedure is running.

SplitChange. Action request to process a split change when creating a pivot table from data that have splits. Split changes are detected with the *IsEndSplit* function.

StartPivotTable. Action request to create a pivot table. Dimensions, categories, and cell values are specified separately.

MinDataColumnWidth. Action request to set the minimum column width for a pivot table.

MaxDataColumnWidth. Action request to set the maximum column width for a pivot table.

PivotTableCaption. Action request to add a caption to a pivot table.

AddCellFootnotes. Action request to add a footnote, associated with a specified cell, to a pivot table.

HidePivotTableTitle. Action request to hide the title of a pivot table.

AddDimension. Action request that adds a row, column, or layer dimension to a pivot table.

AddNumberCategory. Action request that adds a category with a numeric value to a specified dimension in a pivot table.

AddStringCategory. Action request that adds a category with a string value to a specified dimension in a pivot table. The string will not be translated.

AddVarNameCategory. Action request that adds a category representing a variable name to a specified dimension in a pivot table. Display settings for variable names in pivot tables (names, labels, or both) will be honored.

AddVarValueDoubleCategory. Action request that adds a category representing the value of a numeric variable to a specified dimension in a pivot table. Display settings for variable values in pivot tables (values, labels, or both) will be honored.

AddVarValueStringCategory. Action request that adds a category representing the value of a string variable to a specified dimension in a pivot table. Display settings for variable values in pivot tables (values, labels, or both) will be honored.

SetNumberCell. Action request to set a pivot table cell to a numeric value.

SetStringCell. Action request to set a pivot table cell to a string value. The string will not be translated.

SetDateCell. Action request to set a pivot table cell to a date value.

SetVarNameCell. Action request to set a pivot table cell to a variable name. Display settings for variable names in pivot tables (names, labels, or both) will be honored.

SetVarValueDoubleCell. Action request to set a pivot table cell to the value of a numeric variable. Display settings for variable values in pivot tables (values, labels, or both) will be honored.

SetVarValueStringCell. Action request to set a pivot table cell to the value of a string variable. Display settings for variable values in pivot tables (values, labels, or both) will be honored.

SetFormatSpec<format name>. Action request to set the format used for numeric values of cells and categories in a pivot table—for instance, `SetFormatSpecGeneralStat`. Each of the available formats has an associated `Set` function. The default format for numeric values of cells and categories in a pivot table is `Count`, which rounds values to the nearest integer.

AddTextBlock. Action request to create and populate a text block item.

Examples

Running IBM SPSS Statistics Commands

You execute a single IBM SPSS Statistics command by providing a string representation of the command as shown in this example. When submitting a single command in this manner the period (.) at the end of the command is optional.

```
// Open a data file
string filename = "/data/Employee data.sav";
string cmd = "GET FILE='" + filename + "'.";
Submit(cmd.c_str(),(int)cmd.length());

//Queue multiple command parts for a multi-line command
cmd = "OMS /SELECT TABLES";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "/IF COMMANDS = ['Descriptives' 'Frequencies']";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "/DESTINATION FORMAT = HTML";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "IMAGES = NO OUTFILE = '/temp/stats.html'.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());

// Execute a Descriptives command and call OMSEND to write the output
cmd = "DESCRIPTIVES jobcat.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "OMSEND.";
Submit(cmd.c_str(),(int)cmd.length());
```

- The first Submit function executes a GET command to open a data file.
- The QueueCommandPart function is used to queue a set of lines specifying the syntax for an OMS command and a DESCRIPTIVES command. In this example, the OMS command routes output from the DESCRIPTIVES command to an html file.
- The Submit function is called again to execute an OMSEND command as well as the queued commands.

Notes

- You can direct output to the XML workspace and subsequently retrieve it using XPath expressions. See the topic “Retrieving Output from Syntax Commands” on page 41 for more information.
- When submitting syntax that includes a BEGIN PROGRAM-END PROGRAM block, each of the lines in the block (including BEGIN PROGRAM) must be queued using the QueueCommandPart function. The END PROGRAM statement, however, can be submitted with the Submit function. In addition, note that you cannot submit an empty BEGIN PROGRAM-END PROGRAM block. The block must contain at least one statement in the associated language (Python or R).

Getting Variable Dictionary Information

Consider the common scenario of running a particular block of command syntax only if a specific variable exists in the dataset. For example, you are processing many datasets containing employee records and want to split them by gender--if a gender variable exists--to obtain separate statistics for the two gender groups. We will assume that if a gender variable exists, it has the name *gender*, although it may be spelled in upper case or mixed case. The following sample code illustrates the approach:

```
string filename = "/data/Employee data.sav";
string cmd = "GET FILE='" + filename + "'.";
Submit(cmd.c_str(),(int)cmd.length());

int errLevel;
unsigned int varNum = GetVariableCount(errLevel);
for (unsigned int n=0; n < varNum; n++) {
    string varName = GetVariableName(n,errLevel);
    for (unsigned int m=0; m < varName.length(); m++) {
        varName[m] = toupper(varName[m]);
    }
    if (varName == "GENDER")
    {
        string cmd = "SORT CASES BY " + varName + ".";
        QueueCommandPart(cmd.c_str(),(int)cmd.length());

        cmd = "SPLIT FILE LAYERED BY " + varName + ".";
        Submit(cmd.c_str(),(int)cmd.length());
    }
}
```

```

        break;
    }
}

```

The example makes use of the `GetVariableCount` and `GetVariableName` functions for retrieving the number of variables in the active dataset and the name of a specified variable respectively. Variables are specified by their position in the dataset, starting with 0 for the first variable in file order. This is referred to as the **index value** of the variable.

Getting Case Data, Adding New Variables, and Appending Cases to the Active Dataset

You can read case data from the active dataset, create new variables in the active dataset, and append new cases to the active dataset using cursors. Cursors are created with the `MakeCaseCursor` function. The function takes a single argument that specifies the type of cursor: "r" allows you to read cases from the active dataset and is the default; "w" allows you to add new variables (and their case values) to the active dataset; and "a" allows you to append new cases to the active dataset.

The following rules apply to the use of cursors:

- You cannot use the `Submit` function while a cursor is open. You must close the cursor first using the `RemoveCaseCursor` function. In particular, if you need to save changes made to the active dataset to an external file, then use the `Submit` function to submit a `SAVE` command after closing the cursor.
- Only one cursor can be open at any point in an application. To define a new cursor, you must first close the previous one. You can use the `HasCursor` function to determine if a cursor is already open.

Reading Case Data

To read case data you create a cursor in read mode by calling `MakeCaseCursor("r")` (the argument can be omitted for read mode). Cases can only be read sequentially, although variable values within a case can be accessed directly by specifying the index of the variable. Index values represent position in the dataset, starting with 0 for the first variable in file order. When reading case data, the following rules apply to retrieved values:

- String values are right-padded to the defined width of the string variable.
- Data retrieved from a variable representing a date, or a date and a time, is given as the number of seconds from October 14, 1582.

Example

This example demonstrates reading case data from the active dataset.

```

string filename = "/data/mydata.sav";
string cmd = "GET FILE=" + filename + "'.";
Submit(cmd.c_str(),(int)cmd.length());

int errLevel, isMissing;
double dResult;
char *cResult;

int varCount = GetVariableCount(errLevel);
int *varType = new int[varCount];

for(int i = 0; i < varCount; i++) {
    varType[i] = GetVariableType(i,errLevel);
}

errLevel = MakeCaseCursor();
int rowCount = GetRowCount(errLevel);
for(int i = 0; i < rowCount; i++) {
    errLevel = NextCase();
    for(int j = 0; j < varCount; j++) {
        if(varType[j] == 0) {
            errLevel = GetNumericValue(j,dResult,isMissing);
        }
        else {
            cResult = new char[varType[j] + 1];
            memset(cResult,'\0',varType[j] + 1);
        }
    }
}

```



```

        }
        errLevel = GetStringValue(j,cResult,varType[j] + 1,isMissing);
    }
}

errLevel = RemoveCaseCursor();

```

- The GET command is used to get the data to be read.
- The GetVariableType function gets the type of the specified variable: 0 for numeric variables and the length in bytes for string variables. Variables are specified by their index.
- The NextCase function moves the cursor to the next case.
- Values for numeric variables are retrieved using the GetNumericValue function and values for string variables are retrieved using the GetStringValue function. The parameter *isMissing* indicates if the value is missing: 0 if the value is not missing; 1 if the value is user-missing; and 2 if the value is system-missing.
- The RemoveCaseCursor function closes the cursor.

Note: When reading datasets in which split file processing is in effect, you'll need to be aware of the behavior at a split boundary. Detecting split changes is necessary when you're creating custom pivot tables from data with splits and want separate results displayed for each split group (using the SplitChange function). The IsEndSplit function allows you to detect split changes when reading from datasets that have splits.

Creating New Variables in the Active Dataset

To add new variables along with their case values to the active dataset, you create a cursor in write mode by calling MakeCaseCursor("w").

- When adding new variables, the CommitHeader function must be called after the statements defining the new variables and prior to setting case values for those variables. You cannot add new variables to an empty dataset. If you need to create a dataset from scratch, use a data step. See the topic "Creating and Accessing Multiple Datasets" on page 39 for more information.
- When setting case values for new variables, the CommitCaseRecord function must be called for each case that is modified. The NextCase function is used to advance the record pointer by one case.
- Changes to the active dataset do not take effect until the cursor is closed.
- Write mode supports multiple data passes and allows you to add new variables on each pass. In the case of multiple data passes where you need to add variables on a data pass other than the first, you must call the AllocNewVarsBuffer function to allocate the buffer size for the new variables. When used, AllocNewVarsBuffer must be called before reading any data with NextCase.
- The SetVarNameAndType and SetOneVarNameAndType functions are used to add new variables to the active dataset. The SetValueChar and SetValueNumeric functions are used to set case values.

Example

In this example we create a new string variable and a new numeric variable and populate their case values. A sample dataset is first created.

```

string cmd = "DATA LIST FREE /case (A5).";
QueueCommandPart(cmd,c_str(),(int)cmd.length());
cmd = "BEGIN DATA";
QueueCommandPart(cmd,c_str(),(int)cmd.length());
cmd = "case1";
QueueCommandPart(cmd,c_str(),(int)cmd.length());
cmd = "case2";
QueueCommandPart(cmd,c_str(),(int)cmd.length());
cmd = "END DATA.";
Submit(cmd,c_str(),(int)cmd.length());

char *varName[] = {"numvar","strvar"};
int varType[] = {0,8};
unsigned int nVars = 2;
char *varLabel_0 = "Sample numeric variable";
char *varLabel_1 = "Sample string variable";

int errLevel = MakeCaseCursor("w");

```



```

errLevel = SetVarNameAndType(varName,varType,nVars);
errLevel = SetVarLabel(varName[0],varLabel_0);
errLevel = SetVarLabel(varName[1],varLabel_1);
errLevel = CommitHeader();

char *cValue = "cheese";
int rowCount = GetRowCount(errLevel);

for(int i = 0; i < rowCount; i++) {
    errLevel = NextCase();
    errLevel = SetValueNumeric(varName[0],i);
    errLevel = SetValueChar(varName[1],cValue,strlen(cValue));
    errLevel = CommitCaseRecord();
}

errLevel = RemoveCaseCursor();

```

- The first argument to the `SetVarNameAndType` function is an array of strings that specifies the name of each new variable. The second argument is an array of integers specifying the variable type of each variable. Numeric variables are specified by a value of 0 for the variable type. String variables are specified with a type equal to the defined length of the string (maximum of 32767). In this example, we create a numeric variable named *numvar* and a string variable of length 8 named *strvar*.
- After calling `SetVarNameAndType` you have the option of specifying variable properties (in addition to the variable type) such as the measurement level, variable label, and missing values. In this example, variable labels are specified using the `SetVarLabel` function.
- Specifications for new variables must be committed to the cursor's dictionary before case values can be set. This is accomplished by calling the `CommitHeader` function, which takes no arguments. The active dataset's dictionary is updated when the cursor is closed.
- To set case values, you first position the record pointer to the desired case using the `NextCase` function, which advances the record pointer by one case. *Note:* To set the value for the first case in the dataset you must call `NextCase` as shown in this example.
- Case values are set using the `SetValueNumeric` function for numeric variables and the `SetValueChar` function for string variables. For both functions, the first argument is the variable name and the second argument is the value for the current case. A numeric variable whose value is not specified is set to the system-missing value. A string variable whose value is not specified will have a blank value. The value will be valid unless you explicitly define the blank value to be missing for that variable.
- The `CommitCaseRecord` function must be called to commit the values for each modified case. Changes to the active dataset take effect when the cursor is closed.

Note: To save the modified active dataset to an external file, use the `Submit` function (following the `RemoveCaseCursor` function) to submit a `SAVE` command, as in:

```

cmd = "SAVE OUTFILE='/data/mydata.sav'.";
Submit(cmd.c_str(),(int)cmd.length());

```

Example: Multiple Data Passes

Sometimes more than one pass of the data is required, as in the following example involving two data passes. The first data pass is used to read the data and compute a summary statistic. The second data pass is used to add a summary variable to the active dataset.

```

string cmd = "DATA LIST FREE /var (F6).";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "BEGIN DATA";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "57000";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "40200";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "21450";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "21900";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "END DATA.";
Submit(cmd.c_str(),(int)cmd.length());

int isMissing;
double dResult;
double total = 0;

```

```

int errLevel = MakeCaseCursor("w");
errLevel = AllocNewVarsBuffer(8);
int rowCount = GetRowCount(errLevel);

for(int i = 0; i < rowCount; i++) {
    errLevel = NextCase();
    errLevel = GetNumericValue(0,dResult,isMissing);
    total = total + dResult;
}
double meanVal = total/rowCount;

ResetDataPass();
SetOneVarNameAndType("mean",0);
errLevel = CommitHeader();

for(int i = 0; i < rowCount; i++) {
    errLevel = NextCase();
    errLevel = SetValueNumeric("mean",meanVal);
    errLevel = CommitCaseRecord();
}

errLevel = RemoveCaseCursor();

```

- Because we'll be adding a new variable on the second data pass, the `AllocNewVarsBuffer` function is called to allocate the required space. In the current example we're creating a single numeric variable, which requires 8 bytes.
- The first for loop is used to read the data and total the case values.
- After the data pass, the `ResetDataPass` function must be called prior to defining new variables.
- The `SetOneVarNameAndType` function is used to add a single new variable. The first argument is the variable name and the second argument is the variable type. In this example, we create a numeric variable named *mean*. The `CommitHeader` function is called to commit this variable to the cursor.
- The second data pass (second for loop) is used to set the case values of the new variable.

Appending New Cases

To append new cases to the active dataset, you create a cursor in append mode by calling `MakeCaseCursor("a")`. A cursor in append mode cannot be used to add new variables or read case data from the active dataset. A dataset must contain at least one variable in order to append cases to it, but it need not contain any cases. If you need to create a dataset from scratch, use a data step. See the topic “Creating and Accessing Multiple Datasets” on page 39 for more information.

- The `CommitNewCase` function must be called for each case that is added.
- The `EndChanges` function must be called before the cursor is closed.
- Changes to the active dataset do not take effect until the cursor is closed.
- The `SetValueChar` and `SetValueNumeric` functions are used to set variable values for new cases.

Example

In this example two new cases are appended to the active dataset.

```

string cmd = "DATA LIST FREE /case (F) value (A1).";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "BEGIN DATA";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "1 a";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "END DATA.";
Submit(cmd.c_str(),(int)cmd.length());

int errLevel = MakeCaseCursor("a");
errLevel = SetValueNumeric("case",2);
errLevel = SetValueChar("value","b",strlen("b"));
errLevel = CommitNewCase();
errLevel = SetValueNumeric("case",3);
errLevel = SetValueChar("value","c",strlen("c"));
errLevel = CommitNewCase();
errLevel = EndChanges();
errLevel = RemoveCaseCursor();

```

- For both the `SetValueNumeric` and `SetValueChar` functions, the first argument is the variable name, as a string, and the second argument is the value for the current case. A numeric variable whose value is

not specified is set to the system-missing value. A string variable whose value is not specified will have a blank value. The value will be valid unless you explicitly define the blank value to be missing for that variable.

- The `CommitNewCase` function must be called to commit the values for each new case. Changes to the active dataset take effect when the cursor is closed. When working in append mode, the cursor is ready to accept values for a new case (using `SetValueNumeric` and `SetValueChar`) once `CommitNewCase` has been called for the previous case.
- The `EndChanges` function signals the end of appending cases and must be called before the cursor is closed or the new cases will be lost.

Note: To save the modified active dataset to an external file, use the `Submit` function (following the `RemoveCaseCursor` function) to submit a `SAVE` command, as in:

```
cmd = "SAVE OUTFILE='/data/mydata.sav'.";
Submit(cmd.c_str(),(int)cmd.length());
```

Creating and Accessing Multiple Datasets

Using a data step, you can create and work concurrently with multiple datasets. Data steps are initiated with the `StartDataStep` function. Once a data step has been initiated, you access existing datasets and create new datasets with the `CreateDataset` function.

Limitations

- Within a data step you cannot create a cursor, a pivot table, or a text block, and you cannot call the `StartProcedure` function or the `Submit` function.
- You cannot start a data step if there are pending transformations or if a user procedure exists. If you need to access case data in the presence of pending transformations, use a cursor.
- Only one data step can exist at a time.
- A new dataset created with the `CreateDataset` function is not automatically set to be the active dataset, unless explicitly specified as such with `CreateDataset("*,true)`. To make a dataset the active one, use the `SetActive` function.

Example: Creating and Saving a New Dataset

```
StartDataStep();
int errLevel = CreateDataset("newds", true);
errLevel = InsertVariable("newds",0,"numvar",0);
errLevel = InsertVariable("newds",1,"strvar",1);
errLevel = SetVarLabelInDS("newds",0,"Sample Numeric Variable");
errLevel = SetVarLabelInDS("newds",1,"Sample String Variable");
errLevel = InsertCase("newds",0);
errLevel = SetNCellValue("newds",0,0,0);
errLevel = SetCCellValue("newds",0,1,"a");
errLevel = InsertCase("newds",1);
errLevel = SetNCellValue("newds",1,0,1);
errLevel = SetCCellValue("newds",1,1,"b");
errLevel = SetActive("newds");
EndDataStep();
string cmd = "SAVE OUTFILE='/data/mynewdata.sav'.";
Submit(cmd.c_str(),(int)cmd.length());
```

- Once a data step has been initiated, you create a new dataset with the `CreateDataset` function. The first argument specifies the name of the new dataset, and setting the second argument to `true` specifies a new dataset (you can also use the `CreateDataset` function to access existing datasets).
- You add variables to a dataset using the `InsertVariable` function. The arguments are the name of the dataset, the position (0-based) at which to add the variable, the name of the variable, and the variable type (0 for numeric variables, and an integer equal to the defined length for string variables).
- You can set variable properties, such as the variable label and measurement level, using additional functions. For example, you can set the variable label using the `SetVarLabelInDS` function, whose arguments are the name of the dataset, the position of the variable, and the variable label. Functions for setting variable properties are easily identified by the common suffix `InDs`.

- You add cases to a dataset using the InsertCase function. The arguments are the name of the dataset and the position of the case (0-based). The InsertCase function inserts an empty case. To populate the case values you use the SetNCellValue (for numeric values) and SetCCellValue (for string values) functions, which allow you to set the case value for a single variable. The arguments to each of these functions are the same and as follows: the name of the dataset, the position of the case for which a value will be set, the position of the variable within the case, and the value of the variable.
- The SetActive function is used to make the new dataset the active one. This is not necessary, but simplifies the process of saving the dataset--an action which must be performed outside of the data step.
- You end a data step with the EndDataStep function.
- The new dataset is saved by submitting a SAVE command outside of the data step.

Example: Modifying Case Values

```
string cmd = "DATA LIST FREE /cust (F2) amt (F5).";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "BEGIN DATA";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "210 4500";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "242 6900";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "370 32500";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "END DATA.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "DATASET NAME ds1.";
Submit(cmd.c_str(),(int)cmd.length());

StartDataStep();
int err, isMissing;
int errLevel = CreateDataset("ds1");
int rowCount = GetCaseCountInDS("ds1",errLevel);
for(int i = 0; i < rowCount; i++) {
    errLevel = SetNCellValue("ds1",i,1,1.05*GetNCellValue("ds1",i,1,isMissing,err));
}
EndDataStep();
```

- A sample dataset is created and assigned the name *ds1*.
- To modify case values in an existing dataset, you first access the dataset using the CreateDataset function, specifying the name of the dataset as the argument.
- Case values are modified using the SetNCellValue (for numeric values) and SetCCellValue (for string values) functions, which allow you to set the case value for a single variable. The arguments to each of these functions are the same and as follows: the name of the dataset, the position of the case for which a value will be set, the position of the variable within the case, and the value of the variable.

Example: Comparing Datasets

Data steps allow you to concurrently work with the case data from multiple datasets. As a simple example, we'll compare the cases in two datasets and indicate identical cases with a new variable added to one of the datasets.

```
//Create the first dataset
string cmd = "DATA LIST FREE /id (F2) salary (DOLLAR8) jobcat (F1).";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "BEGIN DATA";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "1 57000 3";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "3 40200 1";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "2 21450 1";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "END DATA.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "SORT CASES BY id.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "DATASET NAME ds1.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());

//Create the second dataset
```

```

cmd = "DATA LIST FREE /id (F2) salary (DOLLAR8) jobcat (F1).";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "BEGIN DATA";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "3 41000 1";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "1 59280 3";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "2 21450 1";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "END DATA.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "SORT CASES BY id.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "DATASET NAME ds2.";
Submit(cmd.c_str(),(int)cmd.length());

//Perform the comparison
StartDataStep();
int err, isMissing;
int errLevel = CreateDataset("ds1");
int rowCount = GetCaseCountInDS("ds1",errLevel);
errLevel = CreateDataset("ds2");
int varCount = GetVarCountInDS("ds2",errLevel);
errLevel = InsertVariable("ds2",varCount,"match",0);

for(int i = 0; i < rowCount; i++) {
    errLevel = SetNCellValue("ds2",i,varCount,1);
    for(int j = 0; j < varCount; j++) {
        if (GetNCellValue("ds1",i,j,isMissing,err) != \
            GetNCellValue("ds2",i,j,isMissing,err)){
            errLevel = SetNCellValue("ds2",i,varCount,0);
            break;
        }
    }
}
EndDataStep();

```

- The two sample datasets are sorted by the variable *id* which is common to both datasets.
- The new variable *match*, added to *ds2*, is set to 1 for cases that are identical and 0 otherwise.

Retrieving Output from Syntax Commands

To retrieve command output, you first route it via the Output Management System (OMS) to the **XML workspace** where it is stored as an XPath DOM that conforms to the Output XML Schema (xml.spss.com/spss/oms). Textual output is retrieved from this workspace with functions that employ XPath expressions. Charts generated by syntax commands can be retrieved with the `GetImage` function. See the topic “Retrieving Chart Output” on page 43 for more information.

Constructing the correct XPath expression (IBM SPSS Statistics currently supports XPath 1.0) requires an understanding of the Output XML schema. The output schema `spss-output-1.8.xsd` is distributed with IBM SPSS Statistics and is also available from <http://xml.spss.com/spss/oms/>. Documentation is included in the IBM SPSS Statistics - Programmability SDK and accessible from `\documentation\OutputSchema\oms_oxml_schema_intro.htm`.

Example

In this example, we'll retrieve the mean value of a variable calculated from the Descriptives procedure.

```

string cmd = "GET FILE='/data/Employee data.sav'.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "OMS SELECT TABLES";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "/IF COMMANDS=['Descriptives'] SUBTYPES=['Descriptive Statistics']";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "/DESTINATION FORMAT=OXML XMLWORKSPACE='desc_table'";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "/TAG='desc_out'.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "DESCRIPTIVES VARIABLES=salary, salbegin, jobtime, prevexp ";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "/STATISTICS=MEAN.";
QueueCommandPart(cmd.c_str(),(int)cmd.length());
cmd = "OMSEND TAG='desc_out'.";
Submit(cmd.c_str(),(int)cmd.length());

```

```

int err;
const char* handle = "desc_table";
const char* context = "/outputTree";
const char* xpath = "//pivotTable[@subType='Descriptive Statistics']" \
    "/dimension[@axis='row']" \
    "/category[@varName='salary']" \
    "/dimension[@axis='column']" \
    "/category[@text='Mean']" \
    "/cell/@text";

void* result = EvaluateXPath(handle,context,xpath,err);
int len = GetStringListLength(result);
if(len > 0){
    const char* str = GetStringFromList(result,0);
}
RemoveStringList(result);
RemoveXPathHandle(handle);

```

- The OMS command is used to direct output from a syntax command to the XML workspace. The XMLWORKSPACE keyword on the DESTINATION subcommand, along with FORMAT=OXML, specifies the XML workspace as the output destination. It is a good practice to use the TAG subcommand, as done here, so as not to interfere with any other OMS requests that may be operating. The identifiers used for the COMMANDS and SUBTYPES keywords on the IF subcommand can be found in the OMS Identifiers dialog box, available from the Utilities menu in IBM SPSS Statistics.
- The XMLWORKSPACE keyword is used to associate a name with this XPath DOM in the workspace. In the current example, output from the DESCRIPTIVES command will be identified with the name *desc_table*. You can have many XPath DOM's in the XML workspace, each with its own unique name.
- The OMSEND command terminates active OMS commands, causing the output to be written to the specified destination--in this case, the XML workspace.
- You retrieve values from the XML workspace with the EvaluateXPath function. The function takes an explicit XPath expression, evaluates it against a specified XPath DOM in the XML workspace, and returns the result as a list of string values.
- The first argument to the EvaluateXPath function specifies the XPath DOM to which an XPath expression will be applied. This argument is referred to as the handle name for the XPath DOM and is simply the name given on the XMLWORKSPACE keyword on the associated OMS command. In this case the handle name is *desc_table*.
- The second argument to EvaluateXPath defines the XPath context for the expression and should be set to *"/outputTree"* for items routed to the XML workspace by the OMS command.
- The third argument to EvaluateXPath specifies the remainder of the XPath expression (the context is the first part). For users familiar with XSLT for OXML and accustomed to including a namespace prefix, note that XPath expressions for the EvaluateXPath function should not contain the oms: namespace prefix.
- The XPath expression in this example is specified by the variable *xpath*. It is not the minimal expression needed to select the mean value of interest but is used for illustration purposes and serves to highlight the structure of the XML output.
//pivotTable[@subType='Descriptive Statistics'] selects the Descriptives Statistics table.
/dimension[@axis='row']/category[@varName='salary'] selects the row for the variable *salary*.
/dimension[@axis='column']/category[@text='Mean'] selects the *Mean* column within this row, thus specifying a single cell in the pivot table.
/cell/@text selects the textual representation of the cell contents.
- The RemoveStringList function frees the storage associated with the specified result from EvaluateXPath, and RemoveXPathHandle frees the storage associated with the specified XPath DOM.

If you're familiar with XPath, note that the mean value of *salary* can also be selected with the following simpler XPath expression:

```
//category[@varName='salary']//category[@text='Mean']/cell/@text
```

Notes

To the extent possible, construct your XPath expressions using language-independent attributes, such as the variable name rather than the variable label. That will help reduce the translation effort if you need to deploy your code in multiple languages. Also consider factoring out language-dependent identifiers, such as the name of a statistic, into constants. You can obtain the current language used for pivot table output from the `GetOutputLanguage` function.

You may also consider using `text_eng` attributes in place of `text` attributes in XPath expressions. `text_eng` attributes are English versions of `text` attributes and have the same value regardless of the output language. The `OATTRS` subcommand of the `SET` command specifies whether `text_eng` attributes are included in OXML output.

When writing and debugging XPath expressions, it is often useful to inspect the associated XPath DOM. This is provided by the `GetXmlUtf16` function, as well as by an option on the `OMS` syntax command.

Retrieving Chart Output

Charts generated by syntax commands whose output has been routed to the **XML workspace** can be retrieved with the `GetImage` function.

Example

In this example, we'll retrieve a control chart generated by the `SPCHART` command.

```
int err = 0;
const char* cmd1 = "GET FILE='/data/clothing_defects.sav'.";
const char* cmd2 = "OMS /SELECT CHARTS /IF COMMANDS=['SPchart'] " \
    "/DESTINATION FORMAT=OXML XMLWORKSPACE='spchart' " \
    "IMAGES=YES IMAGEFORMAT=JPG CHARTFORMAT=IMAGE.";
const char* cmd3 = "SPCHART /P=COUNT(defects) N(sampled) BY lot /RULES=All /SIGMAS=3.";
const char* cmd4 = "OMSEND.";
QueueCommandPart(cmd1,strlen(cmd1));
QueueCommandPart(cmd2,strlen(cmd2));
QueueCommandPart(cmd3,strlen(cmd3));
Submit(cmd4,strlen(cmd4));
int real_image_size = 0;
char* imageType = 0;
const char* handle = "spchart";
const char* context = "/outputTree";
const char* xpath = "//command[@command='SPchart']" \
    "/chartTitle[@text='p of defects by lot']/chart/@imageFile";
void* result = EvaluateXPath(handle,context,xpath,err);
const char* image_name = GetStringFromList(result,0);
const char* image = GetImage(handle,image_name,real_image_size,&imageType,err);
assert(err == 0);
fstream ftemp;
string output_image = "/images/";
output_image.append(image_name);
ftemp.open(output_image.c_str(),ios::out|ios::binary);
ftemp.write(image,real_image_size);

ftemp.close();
RemoveStringList(result);
RemoveXPathHandle(handle);
```

- The `OMS` command is used to direct output from the `SPCHART` command to the XML workspace. See the topic “Retrieving Output from Syntax Commands” on page 41 for more information.
- To route images along with the OXML output, the `IMAGES` keyword on the `DESTINATION` subcommand (of the `OMS` command) must be set to `YES`, and the `CHARTFORMAT`, `MODELFORMAT`, or `TREEFORMAT` keyword must be set to `IMAGE`.
- The `EvaluateXPath` function is used to retrieve the name of the image associated with the control chart output from the `SPCHART` command. In the present example, the value returned by `EvaluateXPath` is a list with a single element, whose value is extracted with the `GetStringFromList` function and stored to the variable `image_name`.
- The `GetImage` function returns a pointer to the image.

The first argument to `GetImage` specifies the XPath DOM that contains the output from the command that generated the image.

The second argument to `GetImage` is the filename associated with the image in the OXML output--specifically, the value of the `imageFile` attribute of the `chart`, `modelView` or `treeView` element associated with the image.

On return, the third argument to `GetImage` is set to the amount of memory required for the image.

On return, the fourth argument to `GetImage` is set to a string specifying the image type: "PNG", "JPG", "EMF", "BMP", or "VML".

- In the present example, the retrieved image is written to an external file.

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