Step-by-Step Programming with Base SAS® 9.4, Second Edition

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Step-by-Step Programming with Base SAS® 9.4, Second Edition

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Contents

PART 4 Combining SAS Data Sets 255

PART 6 Producing Reports 447

PART 7 Producing Plots and Charts 551

About This Book

Syntax Conventions for the SAS Language

Overview of Syntax Conventions for the SAS Language

Overview of Syntax Conventions for the SAS Language

SAS uses standard conventions in the documentation of syntax for SAS language elements. These conventions enable you to easily identify the components of SAS syntax. The conventions can be divided into these parts:

- syntax components
- style conventions
- special characters
- references to SAS libraries and external files

Syntax Components

Syntax Components

The components of the syntax for most language elements include a keyword and arguments. For some language elements, only a keyword is necessary. For other language elements, the keyword is followed by an equal sign (=). The syntax for arguments has multiple forms in order to demonstrate the syntax of multiple arguments, with and without punctuation.

keyword

specifies the name of the SAS language element that you use when you write your program. Keyword is a literal that is usually the first word in the syntax. In a CALL routine, the first two words are keywords.

In these examples of SAS syntax, the keywords are bold:

CHAR (*string, position*)

CALL RANBIN (*seed, n, p, x*);

ALTER (*alter-password*)

BEST *w*.

REMOVE <*data-set-name*>

In this example, the first two words of the CALL routine are the keywords:

CALL RANBIN(*seed*, *n*, *p*, *x*)

The syntax of some SAS statements consists of a single keyword without arguments:

DO;
... *SAS code* ...
END;

Some system options require that one of two keyword values be specified:

DUPLEX | NODUPLEX

Some procedure statements have multiple keywords throughout the statement syntax:

CREATE <UNIQUE> **INDEX** *index-name* **ON** *table-name* (*column-1* <, *column-2*, …>)

argument

specifies a numeric or character constant, variable, or expression. Arguments follow the keyword or an equal sign after the keyword. The arguments are used by SAS to process the language element. Arguments can be required or optional. In the syntax, optional arguments are enclosed in angle brackets (< >).

In this example, *string* and *position* follow the keyword CHAR. These arguments are required arguments for the CHAR function:

CHAR (*string, position*)

Each argument has a value. In this example of SAS code, the argument *string* has a value of 'summer', and the argument *position* has a value of 4:

```
x=char('summer', 4);
```

In this example, *string* and *substring* are required arguments, whereas *modifiers* and *startpos* are optional.

FIND(*string, substring* <, *modifiers*> <, *startpos*>

argument(s)

specifies that one argument is required and that multiple arguments are allowed. Separate arguments with a space. Punctuation, such as a comma (,) is not required between arguments.

The MISSING statement is an example of this form of multiple arguments:

MISSING *character(s)*;

<LITERAL_ARGUMENT> *argument-1* <<LITERAL_ARGUMENT> *argument-2* ... >

specifies that one argument is required and that a literal argument can be associated with the argument. You can specify multiple literals and argument pairs. No punctuation is required between the literal and argument pairs. The ellipsis (...) indicates that additional literals and arguments are allowed.

The BY statement is an example of this argument:

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* …>;

argument-1 <*options*> <*argument-2* <*options*> ...>
: specifies that one argument is required and that one or more options can be associated with the argument. You can specify multiple arguments and associated options. No punctuation is required between the argument and the option. The ellipsis (...) indicates that additional arguments with an associated option are allowed.

  The FORMAT procedure PICTURE statement is an example of this form of multiple arguments:

  PICTURE name <(*format-options*)>
  <*value-range-set-1* <(*picture-1-options*)>
  <*value-range-set-2* <(*picture-2-options*)> …>>;

argument-1=value-1 <*argument-2=value-2* ...>
: specifies that the argument must be assigned a value and that you can specify multiple arguments. The ellipsis (...) indicates that additional arguments are allowed. No punctuation is required between arguments.

  The LABEL statement is an example of this form of multiple arguments:

  LABEL *variable-1=label-1* <*variable-2=label-2* …>;

argument-1 <, *argument-2*, ...>
: specifies that one argument is required and that you can specify multiple arguments that are separated by a comma or other punctuation. The ellipsis (...) indicates a continuation of the arguments, separated by a comma. Both forms are used in the SAS documentation.

  Here are examples of this form of multiple arguments:

  AUTHPROVIDERDOMAIN (*provider-1:domain-1* <, *provider-2:domain-2*, …>

  INTO :*macro-variable-specification-1* <, :*macro-variable-specification-2*, …>

Note: In most cases, example code in SAS documentation is written in lowercase with a monospace font. You can use uppercase, lowercase, or mixed case in the code that you write.

Style Conventions

Style Conventions

The style conventions that are used in documenting SAS syntax include uppercase bold, uppercase, and italic:

UPPERCASE BOLD
: identifies SAS keywords such as the names of functions or statements. In this example, the keyword ERROR is written in uppercase bold:

  ERROR <*message*>;

UPPERCASE
: identifies arguments that are literals.

  In this example of the CMPMODEL= system option, the literals include BOTH, CATALOG, and XML:

CMPMODEL=BOTH | CATALOG | XML |

italic

identifies arguments or values that you supply. Items in italic represent user-supplied values that are either one of the following:

- nonliteral arguments. In this example of the LINK statement, the argument *label* is a user-supplied value and therefore appears in italic:

  LINK *label*;

- nonliteral values that are assigned to an argument.

  In this example of the FORMAT statement, the argument DEFAULT is assigned the variable *default-format*:

  FORMAT *variable(s)* <*format* > <DEFAULT = *default-format*>;

Special Characters

Special Characters

The syntax of SAS language elements can contain the following special characters:

=

an equal sign identifies a value for a literal in some language elements such as system options.

In this example of the MAPS system option, the equal sign sets the value of MAPS:

MAPS=*location-of-maps*

< >

angle brackets identify optional arguments. A required argument is not enclosed in angle brackets.

In this example of the CAT function, at least one item is required:

CAT (*item-1* <, *item-2*, …>)

|

a vertical bar indicates that you can choose one value from a group of values. Values that are separated by the vertical bar are mutually exclusive.

In this example of the CMPMODEL= system option, you can choose only one of the arguments:

CMPMODEL=BOTH | CATALOG | XML

...

an ellipsis indicates that the argument can be repeated. If an argument and the ellipsis are enclosed in angle brackets, then the argument is optional. The repeated argument must contain punctuation if it appears before or after the argument.

In this example of the CAT function, multiple *item* arguments are allowed, and they must be separated by a comma:

CAT (*item-1* <*, item-2*, …>)

'*value*' or "*value*"

indicates that an argument that is enclosed in single or double quotation marks must have a value that is also enclosed in single or double quotation marks.

In this example of the FOOTNOTE statement, the argument *text* is enclosed in quotation marks:

FOOTNOTE <*n*> <*ods-format-options* '*text*' | "*text*">;

;

a semicolon indicates the end of a statement or CALL routine.

In this example, each statement ends with a semicolon:

```
data namegame;
   length color name $8;
   color = 'black';
   name = 'jack';
   game = trim(color) || name;
run;
```

References to SAS Libraries and External Files

References to SAS Libraries and External Files

Many SAS statements and other language elements refer to SAS libraries and external files. You can choose whether to make the reference through a logical name (a libref or fileref) or use the physical filename enclosed in quotation marks.

If you use a logical name, you typically have a choice of using a SAS statement (LIBNAME or FILENAME) or the operating environment's control language to make the reference. Several methods of referring to SAS libraries and external files are available, and some of these methods depend on your operating environment.

In the examples that use external files, SAS documentation uses the italicized phrase *file-specification*. In the examples that use SAS libraries, SAS documentation uses the italicized phrase *SAS-library* enclosed in quotation marks:

```
infile file-specification obs = 100;
libname libref 'SAS-library';
```

What's New in Step-by-Step Programming with Base SAS 9.4

Overview

Step-by-Step Programming with Base SAS 9.4 shows you how to create SAS programs step by step. You are provided with conceptual information and examples that illustrate the SAS concepts. You can execute the programs in this document and view the results. This document contains the basic information that you need to begin writing and debugging your SAS code.

The following enhancements have been made to the documentation:

- additional information about debugging SAS programs
- new method of concatenating SAS variables
- updated sections on Output Delivery System (ODS)

In the third maintenance release for SAS 9.4, the following enhancements have been made to the documentation:

- discussion of the DSD option was added to the documentation about list input
- directions for viewing ODS style templates were updated (see "Customizing ODS Output at the Level of a SAS Job" on page 695)
- discussion of the IN= data set option was added to the documentation about merging data sets

Debugging SAS Programs

Additional information and examples of SAS log output have been added. Items in the SAS log are explained so that you can more easily debug your own SAS programs.

Documentation for the DATA step debugger has been added. The DATA step debugger is a tool that enables you to find logic errors in your program. A description of the tool and examples are provided. A list of commands that you use with the debugger is also provided.

Concatenating SAS Variables

A preferred method of concatenating SAS variables has been introduced. You use the CAT function to return a concatenated character string.

Output Delivery System (ODS)

The sections about the Output Delivery System (ODS) have been updated, and new information has been added. ODS gives you greater flexibility in generating, storing, and reproducing SAS procedure and DATA step output along with a wide range of formatting options. ODS provides formatting functionality that is not available when using individual procedures or the DATA step without ODS.

Beginning with SAS 9.3, the default destination in the SAS windowing environment is HTML, and ODS Graphics is enabled by default. These new defaults have several advantages. Graphs are integrated with tables, and all output is displayed in the same HTML file using a new style. This new style, HTMLBlue, is an all-color style that is designed to integrate tables and modern statistical graphics. The examples in this document now show HTML output.

PART 1

Introduction to the SAS System

1

What is the SAS System?

Introduction to the SAS System

SAS is an integrated system of software solutions that enables you to perform the following tasks:

- data entry, retrieval, and management
- report writing and graphics design
- statistical and mathematical analysis
- business forecasting and decision support
- operations research and project management
- applications development

How you use SAS depends on what you want to accomplish. Some people use many of the capabilities of the SAS System, and others use only a few.

At the core of the SAS System is Base SAS software, which is the software product that you will learn to use in this documentation. This section presents an overview of Base SAS. It introduces the capabilities of Base SAS, addresses methods of running SAS, and outlines various types of output.

Components of Base SAS Software

Overview of Base SAS Software

Base SAS software contains the following:

- a data management facility
- a programming language
- data analysis and reporting utilities

Learning to use Base SAS enables you to work with these features of SAS. It also prepares you to learn other SAS products, because all SAS products follow the same basic rules.

Data Management Facility

SAS organizes data into a table that is called a SAS data set. The following figure shows a SAS data set. The data describes participants in a 16-week weight program at a health and fitness club. The data for each participant includes an identification number, name, team name, and weight (in U.S. pounds) at the beginning and end of the program.

Figure 1.1 *A SAS Data Set*

variable

	IdNumber	Name	Team	StartWeight	EndWeight	
1	1023	David Shaw	red	189	165	
2	1049	Amelia Serrano	yellow	145	124	observation
3	1219	Alan Nance	red	210	192	
4	1246	Ravi Sinha	yellow	194	177	data value
5	1078	Ashley McKnight	red	127	118	

data value

In a SAS data set, each row represents information about an individual entity and is called an observation. Each column represents the same type of information and is called a variable. Each separate piece of information is a data value. In a SAS data set, an observation contains all the data values for an entity; a variable contains the same type of data value for all entities.

To build a SAS data set with Base SAS, you write a program that uses statements in the SAS programming language. A SAS program that begins with a DATA statement and typically creates a SAS data set or a report is called a DATA step.

The following SAS program creates a SAS data set named WEIGHT_CLUB from the health club data:

```
data weight_club; 1
   input IdNumber 1-4 Name $ 6-24 Team $ StartWeight EndWeight;2
   Loss=StartWeight-EndWeight; 3
   datalines; 4
1023 David Shaw          red 189 165  5
1049 Amelia Serrano      yellow 145 124  5
1219 Alan Nance          red 210 192  5
1246 Ravi Sinha          yellow 194 177  5
1078 Ashley McKnight     red 127 118  5
;6
```

The following list corresponds to the numbered items in the preceding program:

1 The DATA statement tells SAS to begin building a SAS data set named WEIGHT_CLUB.

2 The INPUT statement identifies the fields to be read from the input data and names the SAS variables to be created from them (IdNumber, Name, Team, StartWeight, and EndWeight).

3 The third statement is an assignment statement. It calculates the weight each person lost and assigns the result to a new variable, Loss.

4 The DATALINES statement indicates that data lines follow.

5 The data lines follow the DATALINES statement. This approach to processing raw data is useful when you have only a few lines of data. (Later sections show ways to access larger amounts of data that are stored in files.)

6 The semicolon signals the end of the raw data, and is a step boundary. It tells SAS that the preceding statements are ready for execution.

Note: By default, the data set WEIGHT_CLUB is temporary. It exists only for the current job or session. For information about how to create a permanent SAS data set, see Chapter 3, "Introduction to DATA Step Processing," on page 25.

Programming Language

Elements of the SAS Language

The statements that created the data set WEIGHT_CLUB are part of the SAS programming language. The SAS language contains statements, expressions, functions and CALL routines, options, formats, and informats – elements that many programming languages share. However, the way you use the elements of the SAS language depends on certain programming rules. The most important rules are listed in the next two sections.

Rules for SAS Statements

The conventions that are shown in the programs in this documentation, such as indenting of subordinate statements, extra spacing, and blank lines, are for the purpose of clarity and ease of use. They are not required by SAS. There are only a few rules for writing SAS statements:

- SAS statements end with a semicolon.
- You can enter SAS statements in lowercase, uppercase, or a mixture of the two.
- You can begin SAS statements in any column of a line and write several statements on the same line.
- You can begin a statement on one line and continue it on another line, but you cannot split a word between two lines.
- Words in SAS statements are separated by blanks or by special characters (such as the equal sign and the minus sign in the calculation of the Loss variable in the WEIGHT_CLUB example).

Rules for Most SAS Names

SAS names are used for SAS data set names, variable names, and other items. The following rules apply:

- A SAS name can contain from one to 32 characters.
- The first character must be a letter or an underscore (_).
- Subsequent characters must be letters, numbers, or underscores.
- Blank spaces cannot appear in SAS names.

Special Rules for Variable Names

For variable names only, SAS remembers the combination of uppercase and lowercase letters that you use when you create the variable name. Internally, the case of letters does not matter. “CAT,” “cat,” and “Cat” all represent the same variable. But for presentation purposes, SAS remembers the initial case of each letter and uses it to represent the variable name when printing it.

Data Analysis and Reporting Utilities

The SAS programming language is both powerful and flexible. You can program any number of analyses and reports with it. SAS can also simplify programming for you with its library of built-in programs known as SAS procedures. SAS procedures use data values from SAS data sets to produce preprogrammed reports, requiring minimal effort from you.

For example, the following SAS program produces a report that displays the values of the variables in the SAS data set WEIGHT_CLUB. Weight values are presented in U.S. pounds.

```
proc print data=weight_club;
   title 'Health Club Data';
run;
```

This procedure, known as the PRINT procedure, displays the variables in a simple, organized form. The following output displays the results:

Figure 1.2 Displaying the Values in a SAS Data Set

Health Club Data

Obs	IdNumber	Name	Team	StartWeight	EndWeight	Loss
1	1023	David Shaw	red	189	165	24
2	1049	Amelia Serrano	yellow	145	124	21
3	1219	Alan Nance	red	210	192	18
4	1246	Ravi Sinha	yellow	194	177	17
5	1078	Ashley McKnight	red	127	118	9

To produce a table showing mean starting weight, ending weight, and weight loss for each team, use the TABULATE procedure.

```
proc tabulate data=weight_club;
   class team;
   var StartWeight EndWeight Loss;
   table team, mean*(StartWeight EndWeight Loss);
   title 'Mean Starting Weight, Ending Weight,';
   title2 'and Weight Loss';
run;
```

The following output displays the results:

Figure 1.3 Table of Mean Values for Each Team

Mean Starting Weight, Ending Weight, and Weight Loss

	Mean		
	StartWeight	EndWeight	Loss
Team			
red	175.33	158.33	17.00
yellow	169.50	150.50	19.00

A portion of a SAS program that begins with a PROC (procedure) statement and ends with a RUN statement (or is ended by another PROC or DATA statement) is called a PROC step. Both of the PROC steps that create the previous two outputs comprise the following elements:

- a PROC statement, which includes the word PROC, the name of the procedure that you want to use, and the name of the SAS data set that contains the values. (If you omit the DATA= option and data set name, the procedure uses the SAS data set that was most recently created in the program.)
- additional statements that give SAS more information about what you want to do, for example, the CLASS, VAR, TABLE, and TITLE statements.

- a RUN statement, which indicates that the preceding group of statements is ready to be executed.

Output Produced by the SAS System

Traditional Output

A SAS program can produce some or all of the following types of output:

a SAS data set
: contains data values that are stored as a table of observations and variables. It also stores descriptive information about the data set, such as the names and arrangement of variables, the number of observations, and the creation date of the data set. A SAS data set can be temporary or permanent. The examples in this section create the temporary data set WEIGHT_CLUB.

the SAS log
: is a record of the SAS statements that you entered and of messages from SAS about the execution of your program. It can appear as a file on disk, a display on your monitor, or a hard-copy listing. The exact appearance of the SAS log varies according to your operating environment and your site. The output in "Traditional Output: A SAS Log" on page 9 displays a typical SAS log for the program in this section.

a report or simple listing
: ranges from a simple listing of data values to a subset of a large data set or a complex summary report that groups and summarizes data and displays statistics. The appearance of procedure output varies according to your site and the options that you specify in the program, but the output in Figure 1.2 on page 7 and Figure 1.3 on page 7 illustrate typical procedure output. You can also use a DATA step to produce a completely customized report. For more information, see "Creating Customized Reports" on page 475.

other SAS files such as catalogs
: contain information that cannot be represented as tables of data values. Examples of items that can be stored in SAS catalogs include function key settings, letters that are produced by SAS/FSP software, and displays that are produced by SAS/GRAPH software.

external files or entries in other databases
: can be created and updated by SAS programs. SAS/ACCESS software enables you to create and update files that are stored in databases such as Oracle.

Example Code 1.1 *Traditional Output: A SAS Log*

```
NOTE: Additional host information:

 W32_7PRO DNTHOST 6.1.7601 Service Pack 1 Workstation

NOTE: SAS initialization used:
      real time           1.15 seconds
      cpu time            0.87 seconds

1    data weight_club;
2       input IdNumber 1-4 Name $ 6-24 Team $ StartWeight EndWeight;
3       Loss=StartWeight-EndWeight;
4       datalines;

NOTE: The data set WORK.WEIGHT_CLUB has 5 observations and 6 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds


10   ;
11   proc tabulate data=weight_club;
NOTE: Writing HTML Body file: sashtml.htm
12      class team;
13      var StartWeight EndWeight Loss;
14      table team, mean*(StartWeight EndWeight Loss);
15      title 'Mean Starting Weight, Ending Weight,';
16      title2 'and Weight Loss';
17   run;

NOTE: There were 5 observations read from the data set WORK.WEIGHT_CLUB.
NOTE: PROCEDURE TABULATE used (Total process time):
      real time           0.93 seconds
      cpu time            0.64 seconds
```

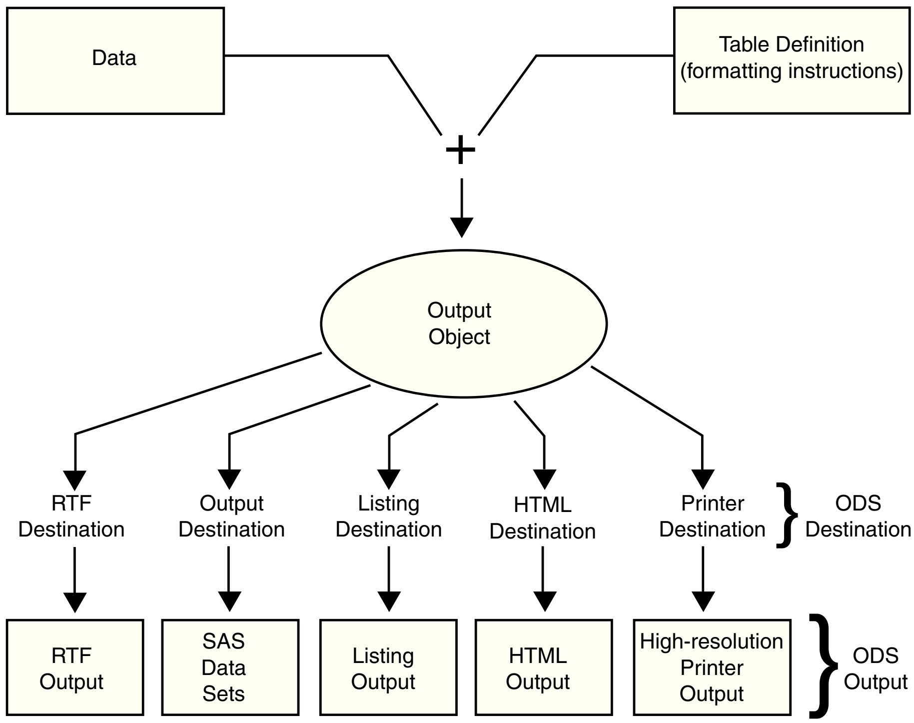
Output from the Output Delivery System (ODS)

The Output Delivery System (ODS) enables you to produce output in a variety of formats, such as the following:

- an HTML file
- a traditional SAS Listing (monospace)
- a PostScript file
- an RTF file (for use with Microsoft Word)
- an output data set

The following figure illustrates the concept of output for SAS.

Figure 1.4 Model of the Production of ODS Output



The following definitions describe the terms in the preceding figure:

data
: Each procedure that supports ODS and each DATA step produces data, which contains the results (numbers and characters) of the step in a form similar to a SAS data set.

table definition
: The table definition is a set of instructions that describes how to format the data. This description includes but is not limited to:

- the order of the columns
- text and order of column headings
- formats for data
- font sizes and font faces

output object
: ODS combines formatting instructions with the data to produce an output object. The output object, therefore, contains both the results of the procedure or DATA step and information about how to format the results. An output object has a name, a label, and a path.

Note: Although many output objects include formatting instructions, not all do. In some cases the output object consists of only the data.

ODS destinations
: An ODS destination specifies a specific type of output. ODS supports a number of destinations, which include the following:

RTF
produces output that is formatted for use with Microsoft Word.

Output
produces a SAS data set.

Listing
produces traditional SAS output (monospace format).

HTML
produces output that is formatted in Hyper Text Markup Language (HTML). You can access the output on the web with your browser.

Printer
produces output that is formatted for a high-resolution printer. An example of this type of output is a PostScript file.

ODS output
ODS output consists of formatted output from any of the ODS destinations.

For more information about ODS output, see Chapter 24, “Directing SAS Output and the SAS Log,” on page 403 and Chapter 34, “Understanding and Customizing SAS Output: The Output Delivery System (ODS),” on page 669.

For complete information about ODS, see *SAS Output Delivery System: User’s Guide*.

Ways to Run SAS Programs

Selecting an Approach

There are several ways to run SAS programs. They differ in the speed with which they run, the amount of computer resources that are required, and the amount of interaction that you have with the program (that is, the types of changes that you can make while the program is running).

The examples in this documentation produce the same results, regardless of how you run the programs. However, in a few cases, the way that you run a program determines the appearance of output. The following sections briefly introduce different ways to run SAS programs.

SAS Windowing Environment

The SAS windowing environment enables you to interact with SAS directly through a series of windows. You can use these windows to perform common tasks, such as locating and organizing files, entering and editing programs, reviewing log information, viewing procedure output, setting options, and more. If needed, you can issue operating system commands from within this environment. Or, you can suspend the current SAS windowing environment session, enter operating system commands, and then resume the SAS windowing environment session at a later time.

Using the SAS windowing environment is a quick and convenient way to program in SAS. It is especially useful for learning SAS and developing programs on small test files. Although it uses more computer resources than other techniques, using the SAS windowing environment can save a lot of program development time.

For more information about the SAS windowing environment, see Chapter 41, “Using the SAS Windowing Environment,” on page 783.

SAS/ASSIST Software

One important feature of SAS is the availability of SAS/ASSIST software. SAS/ASSIST provides a point-and-click interface that enables you to select the tasks that you want to perform. SAS then submits the SAS statements to accomplish those tasks. You do not need to know how to program in the SAS language in order to use SAS/ASSIST.

SAS/ASSIST works by submitting SAS statements just like the ones shown earlier in this section. In that way, it provides a number of features, but it does not represent the total functionality of SAS software. If you want to perform tasks other than those that are available in SAS/ASSIST, you need to learn to program in SAS as described in this documentation.

Noninteractive Mode

In noninteractive mode, you prepare a file that contains SAS statements and any system statements that are required by your operating environment, and submit the program. The program runs immediately and occupies your current workstation session. You cannot continue to work in that session while the program is running,[1] and you usually cannot interact with the program.[2] The log and procedure output go to prespecified destinations, and you usually do not see them until the program ends. To modify the program or correct errors, you must edit and resubmit the program.

Noninteractive execution can be faster than batch execution because the computer system runs the program immediately rather than waiting to schedule your program among other programs.

Batch Mode

To run a program in batch mode, you prepare a file that contains SAS statements and any system statements that are required by your operating environment, and then you submit the program.

You can then work on another task at your workstation. While you are working, the operating environment schedules your job for execution (along with jobs submitted by other people) and runs it. When execution is complete, you can look at the log and the procedure output.

The central feature of batch execution is that it is completely separate from other activities at your workstation. You do not see the program while it is running, and you cannot correct errors when they occur. The log and procedure output go to

1. In a workstation environment, you can switch to another window and continue working.
2. Limited ways of interaction are available. You can, for example, use the asterisk (*) option in a %INCLUDE statement in your program.

prespecified destinations; you can look at them only after the program has finished running. To modify the SAS program, you edit the program with the editor that is supported by your operating environment and submit a new batch job.

When sites charge for computer resources, batch processing is a relatively inexpensive way to execute programs. It is particularly useful for large programs or when you need to use your workstation for other tasks while the program is executing. However, for learning SAS or developing and testing new programs, using batch mode might not be efficient.

Interactive Line Mode

In an interactive line-mode session, you enter one line of a SAS program at a time, and SAS executes each DATA or PROC step automatically as soon as it recognizes the end of the step. You usually see procedure output immediately on your display monitor. Depending on your site's computer system and on your workstation, you might be able to scroll backward and forward to see different parts of your log and procedure output, or you might lose them when they scroll off the top of your screen. There are limited facilities for modifying programs and correcting errors.

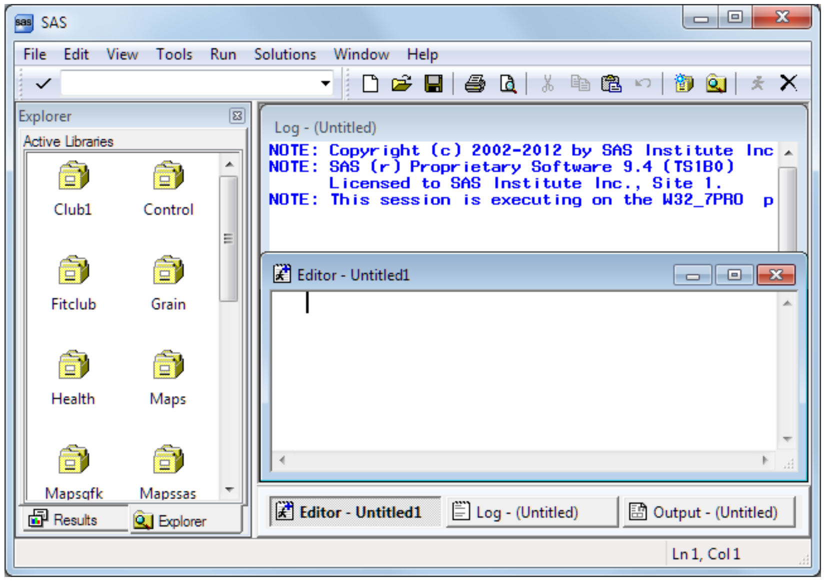
Interactive line-mode sessions use fewer computer resources than a windowing environment. If you use line mode, you should familiarize yourself with the %INCLUDE, %LIST, and RUN statements in *SAS DATA Step Statements: Reference*.

Running Programs in the SAS Windowing Environment

You can run most programs in this documentation by using any of the methods that are described in the previous sections. This documentation uses the SAS windowing environment (as it appears on Windows and UNIX operating environments) when it is necessary to show programming within a SAS session. The SAS windowing environment appears differently depending on the operating environment that you use. For more information about the SAS windowing environment, see Chapter 41, “Using the SAS Windowing Environment,” on page 783.

The following example gives a brief overview of a SAS session that uses the SAS windowing environment. When you invoke SAS, the following windows appear.

Figure 1.5 SAS Windowing Environment

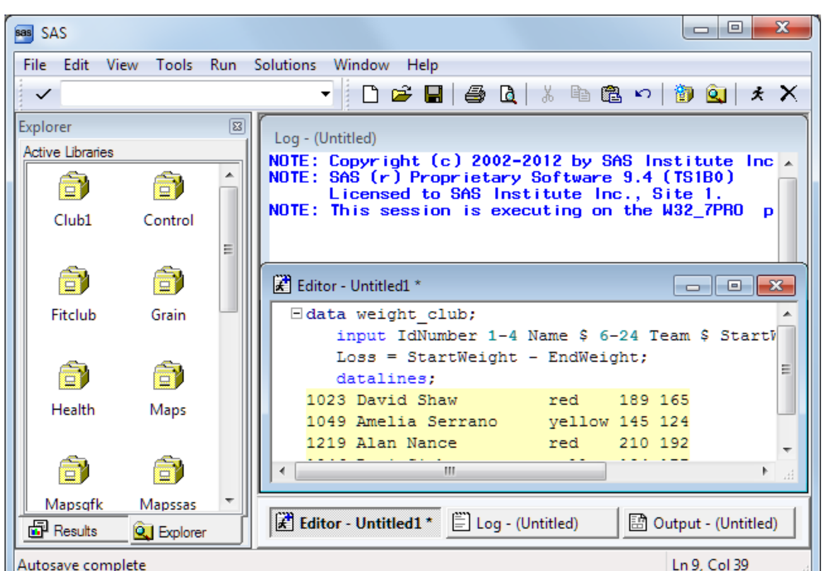


The specific window placement, display colors, messages, and some other details vary according to your site, your monitor, and your operating environment. The window on the left side of the display is the SAS Explorer window, which you can use to assign and locate SAS libraries, files, and other items. The window at the top right is the Log window; it contains the SAS log for the session. The window at the bottom right is the Program Editor window. This window provides an editor in which you edit your SAS programs.

To create the program for the health and fitness club, enter the statements in the Program Editor window. You can turn line numbers on or off to facilitate program creation.

The following display shows the beginning of the program.

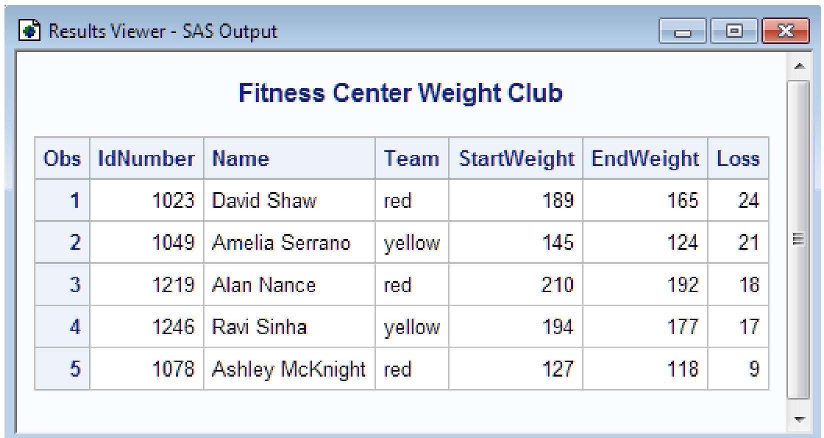
Figure 1.6 Editing a Program in the Program Editor Window



When you fill the Program Editor window, scroll down to continue entering the program. When you finish editing the program, submit it to SAS and view the output. (If SAS does not create output, check the SAS log for error messages.)

The following displays show the first and second pages of the Results Viewer window.

Figure 1.7 *The First Page of Output in the Results Viewer Window*


Results Viewer - SAS Output

Fitness Center Weight Club

Obs	IdNumber	Name	Team	StartWeight	EndWeight	Loss
1	1023	David Shaw	red	189	165	24
2	1049	Amelia Serrano	yellow	145	124	21
3	1219	Alan Nance	red	210	192	18
4	1246	Ravi Sinha	yellow	194	177	17
5	1078	Ashley McKnight	red	127	118	9

Figure 1.8 *The Second Page of Output in the Results Viewer Window*


Results Viewer - SAS Output

Mean Starting Weight, Ending Weight,
and Weight Loss

	Mean		
	StartWeight	EndWeight	Loss
Team			
red	175.33	158.33	17.00
yellow	169.50	150.50	19.00

After you finish viewing the output, you can return to the Program Editor window to begin creating a new program.

By default, the output from all submissions remains in the Output window or the Results Viewer window, and all statements that you submit remain in memory until the end of your session. You can view the output at any time, and you can recall previously submitted statements for editing and resubmitting. You can also clear a window of its contents.

All the commands that you use to move through the SAS windowing environment can be executed as words or as function keys. You can also customize the SAS windowing environment by determining which windows appear, as well as by assigning commands to function keys. For more information about customizing the SAS windowing environment, see Chapter 42, “Customizing the SAS Environment,” on page 829.

Summary

Statements

DATA *SAS-data-set*;
: begins a DATA step and tells SAS to begin creating a SAS data set. *SAS-data-set* names the data set that is being created.

%INCLUDE *source(s)* </<SOURCE2> <S2=*length*> <*host-options*>>;
: brings SAS programming statements, data lines, or both into a current SAS program.

RUN;
: tells SAS to begin executing the preceding group of SAS statements.

For more information, see *SAS Global Statements: Reference* or *SAS DATA Step Statements: Reference*.

Procedures

PROC *procedure* <DATA=*SAS-data-set*>;
: begins a PROC step and tells SAS to invoke a particular SAS procedure to process the SAS data set that is specified in the DATA= option. If you omit the DATA= option, then the procedure processes the most recently created SAS data set in the program.

For more information about using procedures, see the *Base SAS Procedures Guide*.

Learning More

Basic SAS usage
: For an entry-level introduction to basic SAS programming language, see *The Little SAS® Book: A Primer, Fifth Edition*.

DATA step
: For more information about how to create SAS data sets, see Chapter 3, “Introduction to DATA Step Processing,” on page 25.

DATA step processing
: For more information about DATA step processing, see Chapter 7, “Understanding DATA Step Processing,” on page 109.

For information about using the SAS environment, see *Getting Started with SAS*.

2

Working with Output Defaults

Working with Output Defaults

Overview of Working with Output Defaults

Output in the SAS windowing environment is created by default in HTML. In addition, ODS Graphics is enabled by default. The following sections explain the advantages of these defaults:

- ODS Graphics is enabled at SAS start-up.
- The LISTING destination is closed, and the HTML destination is open.
- The default style for the HTML destination is HTMLBlue.
- The default HTML style for z/OS has changed from Default to Htmlblue.
- The default style for the PRINTER destination is Pearl.

LISTING output is the default in releases prior to SAS 9.3 and when you run SAS in batch mode. HTML output in the SAS windowing environment is the default for Microsoft Windows and UNIX, but not for other operating systems. Your actual defaults might be different because of your registry or configuration file settings.

The Default Destination

By default, in the SAS windowing environment with the Windows and UNIX operating systems, the LISTING destination is closed and the HTML destination is open. You do not have to submit an ODS HTML statement to generate HTML output, and you do not have to use the ODS HTML CLOSE statement to be able to view your output. However, to create LISTING output, you must either submit the ODS LISTING statement.

The HTML destination does the following:

- generates HTML 4.0 embedded style sheets
- writes output files to the Work directory
- does not require you to specify an ODS HTML CLOSE statement to view your output

These behaviors persist until you explicitly close the ODS HTML destination by specifying the ODS HTML CLOSE statement, and then reopen the HTML destination. After you have closed the HTML statement and issued a new ODS HTML statement, the HTML destination does the following:

- writes output files to the current directory
- does require you to specify an ODS HTML CLOSE statement to view your output

These behaviors persist until you close your SAS session and open a new one.

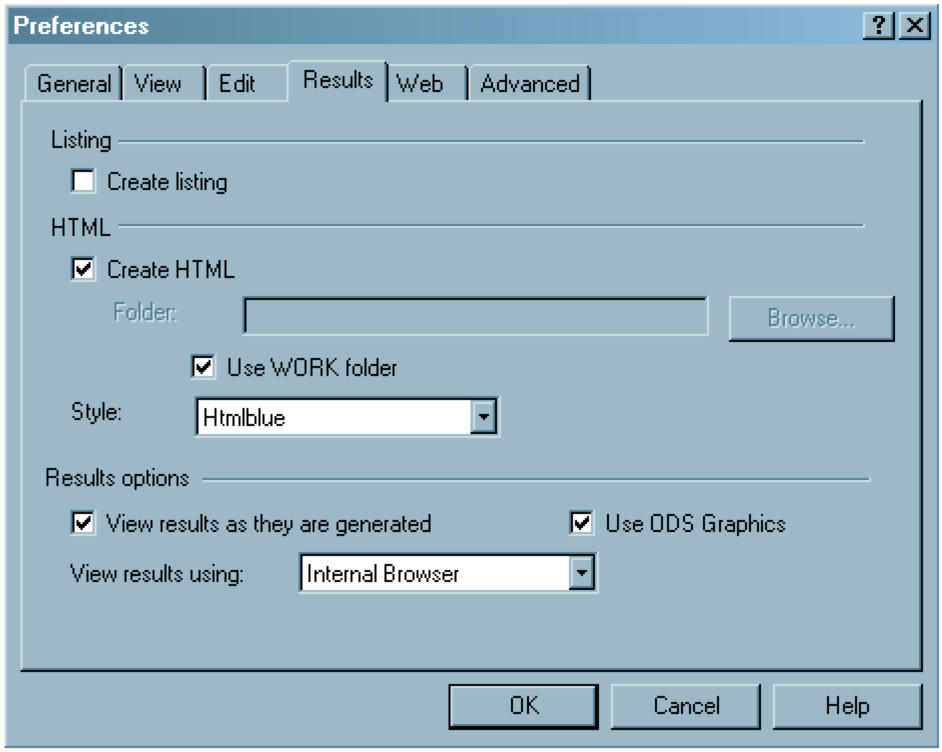
When you run SAS in batch mode or on other operating systems, the LISTING destination is open and is the default, ODS Graphics is not enabled by default, and the default style for HTML output is Styles.Default. Your actual defaults might be different because of your registry or configuration file settings.

HTML Output in the SAS Windowing Environment

The default destination in the SAS windowing environment is HTML, and ODS Graphics is enabled by default. These new defaults have several advantages. Graphs are integrated with tables, and all output is displayed in the same HTML file using a new style. This new style, HTMLBlue, is an all-color style that is designed to integrate tables and modern statistical graphics.

You can view and modify the default settings by selecting **Tools** ⇨ **Options** ⇨ **Preferences** from the menu at the top of the main SAS window. Then open the Results tab. You can remember this sequence using the mnemonic TOPR (pronounced “topper”). The following display shows the SAS **Results** tab with the new default settings specified:

Figure 2.1 *SAS Results Tab with the New Default Settings*



The default settings in the **Results** tab are as follows:

- The **Create listing** check box is not selected, so LISTING output is not created.
- The **Create HTML** check box is selected, so HTML output is created.
- The **Use WORK folder** check box is selected, so both HTML and graph image files are saved in the WORK folder (and not your current directory).
- The default style, HTMLBlue, is selected from the **Style** menu.
- The **Use ODS Graphics** check box is selected, so ODS Graphics is enabled.
- **Internal Browser** is selected from the **View results using:** menu, so results are viewed in an internal SAS browser.

In many cases, graphs are an integral part of a data analysis. However, when you run large computational programs (such as when you use procedures with many BY groups) you might not want to create graphs. In those cases, disabling ODS Graphics improves the performance of your program. You can disable and re-enable ODS Graphics in your SAS programs with the ODS GRAPHICS OFF and ODS GRAPHICS ON statements. You can also change the ODS Graphics default in the **Results** tab.

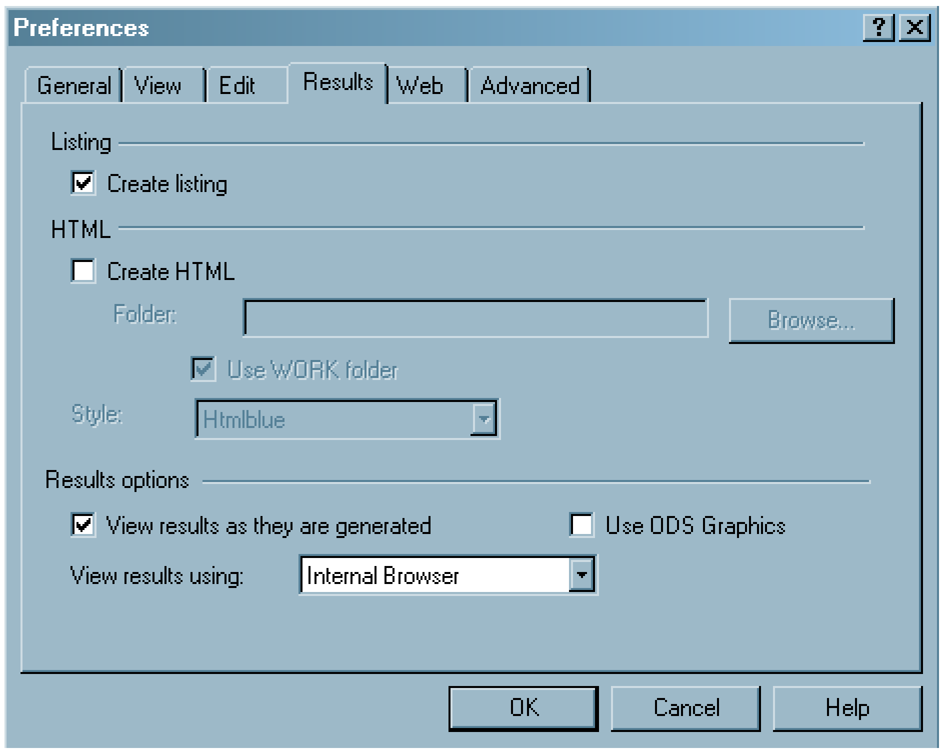
LISTING Output in the SAS Windowing Environment

Prior to SAS 9.3, SAS output in the SAS windowing environment was created by default in the LISTING destination. In the LISTING destination, tables are displayed in monospace, and graphs are not integrated with tables.

You can create LISTING output by selecting **Tools** ⇨ **Options** ⇨ **Preferences** from the menu at the top of the main SAS window. Then open the **Results** tab. Select the **Create listing** check box, and do not select the **Create HTML** check box.

Prior to SAS 9.3, ODS Graphics was disabled by default. You can enable or disable ODS Graphics by default by using the check box, and you can use the ODS GRAPHICS ON and ODS GRAPHICS OFF statements to enable and disable ODS Graphics in your SAS programs. The following display shows the SAS **Results** tab with the old default settings specified:

Figure 2.2 SAS Results Tab with the Old Default Settings



ODS Graphics

Template-based graphics (frequently referred to as ODS Graphics) are created by default. ODS Graphics includes all graphical output where a compiled ODS template of type STATGRAPH is used to produce graphical output. Supplied templates are stored in Sashelp.Tmplmst. For ODS Graphics, you must use the ODS GRAPHICS statement to control the graphical environment. You do not have to specify the ODS GRAPHICS ON statement to enable ODS Graphics in the SAS Windowing environment in the Windows and UNIX operating systems.

Note: The SGSCATTER, SGRENDER, SGPLOT, and SGPANEL procedures always generate graphs, even when ODS Graphics is not enabled.

Learning More

- For information about the ODS GRAPHICS statement, see "ODS GRAPHICS Statement" in *SAS Output Delivery System: Procedures Guide*.
- For information about creating an ODS Graphics template, see "TEMPLATE Procedure: Creating ODS Graphics" in *SAS Output Delivery System: Procedures Guide*.
- *SAS ODS Graphics: Procedures Guide*
- *SAS Graph Template Language: User's Guide*
- *SAS Graph Template Language: Reference*
- *SAS ODS Graphics Designer: User's Guide*
- *SAS ODS Graphics Editor: User's Guide*

PART 2

Getting Your Data into Shape

3

Introduction to DATA Step Processing

Introduction to DATA Step Processing

Purpose

The DATA step is one of the basic building blocks of SAS programming. It creates the data sets that are used in a SAS program's analysis and reporting procedures. Understanding the basic structure, functioning, and components of the DATA step is fundamental to learning how to create your own SAS data sets. In this section, you will learn the following:

- what a SAS data set is and why it is needed
- how the DATA step works
- what information you have to supply to SAS so that it can construct a SAS data set for you

Prerequisites

You should understand the concepts introduced in Chapter 1, "What is the SAS System?," on page 3 before continuing.

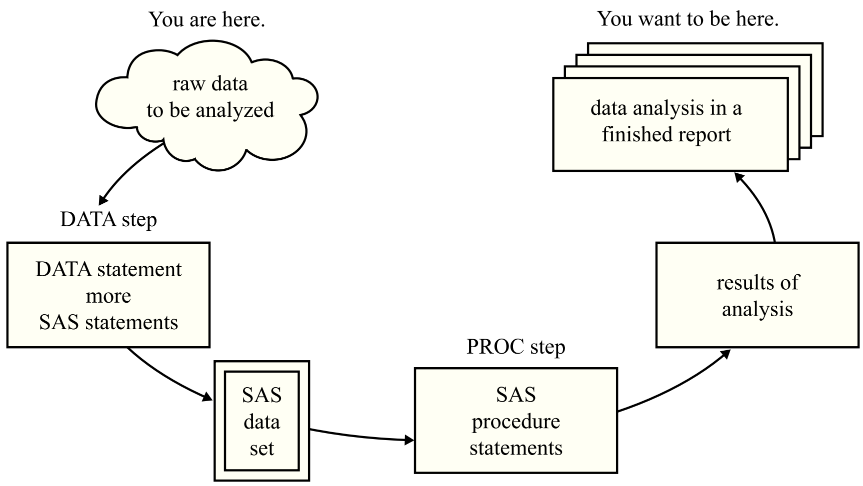
The SAS Data Set: Your Key to the SAS System

Understanding the Function of the SAS Data Set

SAS enables you to solve problems by providing methods to analyze or to process your data in some way. You need to first get the data into a form that SAS can recognize and process. After the data is in that form, you can analyze it and generate reports.

The following figure shows this process in the simplest case.

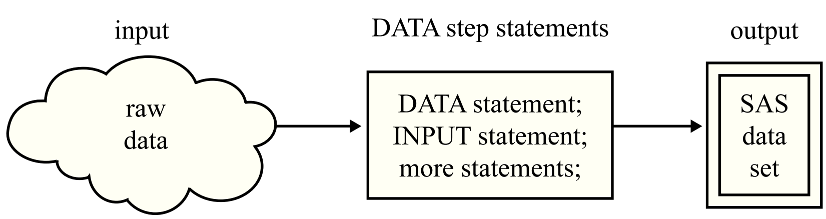
Figure 3.1 From Raw Data to Final Analysis



You begin with raw data, that is, a collection of data that has not yet been processed by SAS. You use a set of statements known as a DATA step to get your data into a SAS data set. Then you can further process your data with additional DATA step programming or with SAS procedures.

In its simplest form, the DATA step can be represented by the three components that are shown in the following figure.

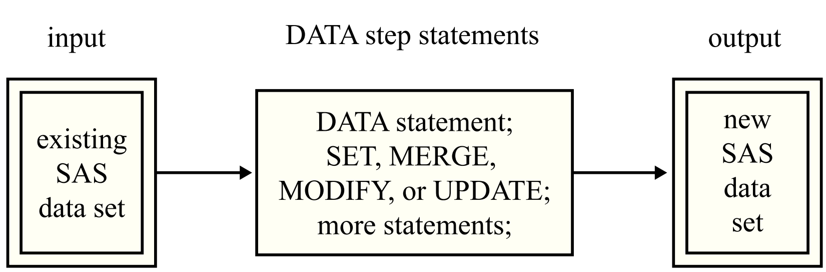
Figure 3.2 From Raw Data to a SAS Data Set



SAS processes input in the form of raw data and creates a SAS data set. When you have a SAS data set, you can use it as input to other DATA steps.

The following figure shows the SAS statements that you can use to create a new SAS data set.

Figure 3.3 Using One SAS Data Set to Create Another



Understanding the Structure of the SAS Data Set

Think of a SAS data set as a rectangular structure that identifies and stores data. When your data is in a SAS data set, you can use additional DATA steps for further processing, or perform many types of analyses with SAS procedures.

The rectangular structure of a SAS data set consists of rows and columns in which data values are stored. The rows in a SAS data set are called observations, and the columns are called variables. In a raw data file, the rows are called records and the columns are called fields. Variables contain the data values for all of the items in an observation.

For example, the following figure shows a collection of raw data about participants in a health and fitness club. Each record contains information about one participant.

Figure 3.4 *Raw Data from the Health and Fitness Club*

data fields

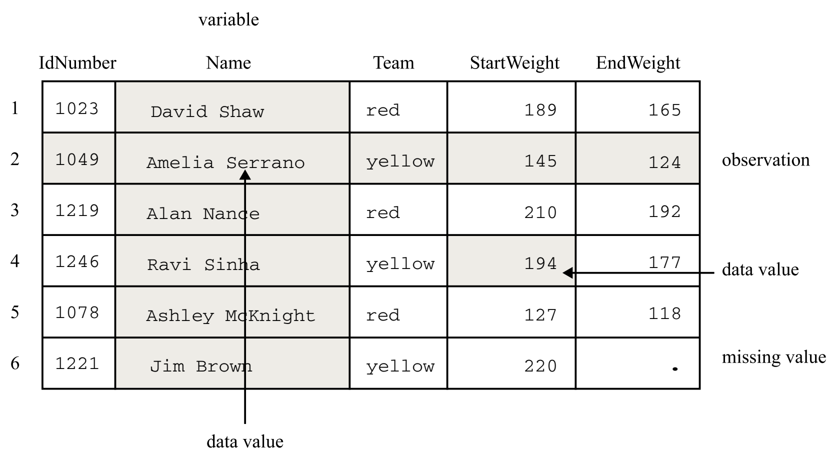
raw data

Health and Fitness Club Data

Id	Name	Team	Starting Weight	Ending Weight
1023	David Shaw	red	189	165
1049	Amelia Serrano	yellow	145	124
1219	Alan Nance	red	210	192
1246	Ravi Sinha	yellow	194	177
1078	Ashley McKnight	red	127	118
1221	Jim Brown	yellow	220	-

The following figure shows how easily the health club records can be translated into parts of a SAS data set. Each record becomes an observation. In this case, each observation represents a participant in the program. Each field in the record becomes a variable. The variables represent each participant's identification number, name, team name, and weight at the beginning and end of a 16-week program.

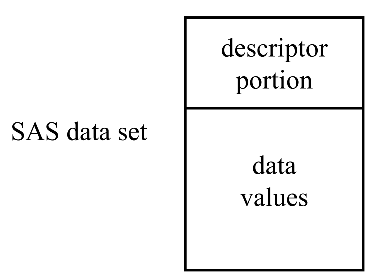
Figure 3.5 How Data Fits into a SAS Data Set



In a SAS data set, every variable exists for every observation. What if you do not have all the data for each observation? If the raw data is incomplete because a value for the numeric variable EndWeight was not recorded for one observation, then this missing value is represented by a period that serves as a placeholder, as shown in observation 6 in the previous figure. (Missing values for character variables are represented by blanks. Character and numeric variables are discussed later in this section.) By coding a value as missing, you can add an observation to the data set for which the data is incomplete and still retain the rectangular shape necessary for a SAS data set.

Along with data values, each SAS data set contains a descriptor portion, as illustrated in the following figure:

Figure 3.6 Parts of a SAS Data Set



The descriptor portion consists of details that SAS records about a data set, such as the names and attributes of all the variables, the number of observations in the data set, and the date and time that the data set was created and updated.

Operating Environment Information: Depending on your operating environment and the engine used to write the SAS data set, SAS can store additional information about a SAS data set in its descriptor portion. For more information, refer to the SAS documentation for your operating environment.

Using FILENAME and LIBNAME Statements

The FILENAME Statement

The FILENAME statement assigns a fileref to an external file. The association between a fileref and an external file lasts only for the duration of a SAS session or until you change the fileref by using another FILENAME statement.

A FILENAME statement uses the following format:

FILENAME *fileref* '*your-input-or-output-file*';

The following FILENAME example assigns the fileref MyWeight to the file named myweight.dat:

```
FILENAME MyWeight 'C:\sasuser\MyWeight\myweight.dat';
```

For more information, see “FILENAME Statement” in *SAS Global Statements: Reference*.

The LIBNAME Statement

The LIBNAME statement assigns a libref to a SAS data set or to a DBMS file that can be accessed like a SAS data set. The association between a libref and a SAS library lasts only for the duration of the SAS session or until you change the libref by using another LIBNAME statement.

A LIBNAME statement uses the following format:

LIBNAME *libref* '*your-SAS-library*';

The following LIBNAME example assigns the libref Weight to the SAS Library named MyWeight:

```
LIBNAME Weight 'C:\sasuser\MyWeight';
```

For more information, see “LIBNAME Statement” in *SAS Global Statements: Reference*.

Temporary versus Permanent SAS Data Sets

Creating and Using Temporary SAS Data Sets

When you use a DATA step to create a SAS data set with a one-level name, you normally create a temporary SAS data set, one that exists only for the duration of your current session. SAS places this data set in a SAS library referred to as WORK. In most operating environments, all files that SAS stores in the WORK library are deleted at the end of a session.

The following is an example of a DATA step that creates the temporary data set WEIGHT_CLUB.

```
data weight_club;
   input IdNumber Name $ 6-20 Team $ 22-27 StartWeight EndWeight;
```

```
   datalines;
1023 David Shaw      red    189 165
1049 Amelia Serrano  yellow 145 124
1219 Alan Nance      red    210 192
1246 Ravi Sinha      yellow 194 177
1078 Ashley McKnight red    127 118
1221 Jim Brown       yellow 220 .
;
```

The preceding program code refers to the temporary data set as WEIGHT_CLUB. SAS. However, it assigns the first-level name WORK to all temporary data sets, and refers to the WEIGHT_CLUB data set with its two-level name, WORK.WEIGHT_CLUB.

The following output from the SAS log displays the name of the temporary data set.

Example Code 3.1 *SAS Log: The WORK.WEIGHT_CLUB Temporary Data Set*

```
data weight_club;
   input IdNumber 1-4 Name $ 6-24 Team $ StartWeight EndWeight;
   Loss=StartWeight-EndWeight;
   datalines;
```

Because SAS assigns the first-level name WORK to all SAS data sets that have only a one-level name, you do not need to use WORK. You can refer to these temporary data sets with a one-level name, such as WEIGHT_CLUB.

To reference this SAS data set in a later DATA step or in a PROC step, you can use a one-level name:

```
proc print data = weight_club;
run;
```

Creating and Using Permanent SAS Data Sets

To create a permanent SAS data set, you must indicate a SAS library other than WORK. (WORK is a reserved libref that SAS automatically assigns to a temporary SAS library.) Use a LIBNAME statement to assign a libref to a SAS library on your operating environment's file system. The libref functions as a shorthand way of referring to a SAS library. Here is the form of the LIBNAME statement:

LIBNAME *libref* '*your-data-library*';

libref
: is a shortcut name to where your SAS files are stored. *libref* must be a valid SAS name. It must begin with a letter or an underscore, and it can contain uppercase and lowercase letters, numbers, or underscores. A libref has a maximum length of 8 characters.

'*your-data-library*'
: must be the physical name for your SAS library. The physical name is the name that is recognized by the operating environment.

Additional restrictions can apply to librefs and physical filenames under some operating environments. For more information, refer to the SAS documentation for your operating environment.

The following is an example of the LIBNAME statement that is used with a DATA step:

```
libname saveit 'your-data-library';  1
```

```
data saveit.weight_club; 2
   ...more SAS statements...
;

proc print data = saveit.weight_club; 3
run;
```

The following list corresponds to the numbered items:

1 The LIBNAME statement associates the libref SAVEIT with *your-data-library*, where *your-data-library* is your operating environment's name for a SAS library.

2 To create a new permanent SAS data set and store it in this SAS library, you must use the two-level name SAVEIT.WEIGHT_CLUB in the DATA statement.

3 To reference this SAS data set in a later DATA step or in a PROC step, you must use the two-level name SAVEIT.WEIGHT_CLUB in the PROC step.

For more information, see Chapter 35, “Understanding SAS Libraries,” on page 715.

Conventions That Are Used in This Documentation

Data sets that are used in examples are usually shown as temporary data sets specified with a one-level name:

```
data fitness;
```

In rare cases in this documentation, data sets are created as permanent SAS data sets. These data sets are specified with a two-level name, and a LIBNAME statement precedes each DATA step in which a permanent SAS data set is created:

```
libname saveit 'your-data-library';
data saveit.weight_club;
```

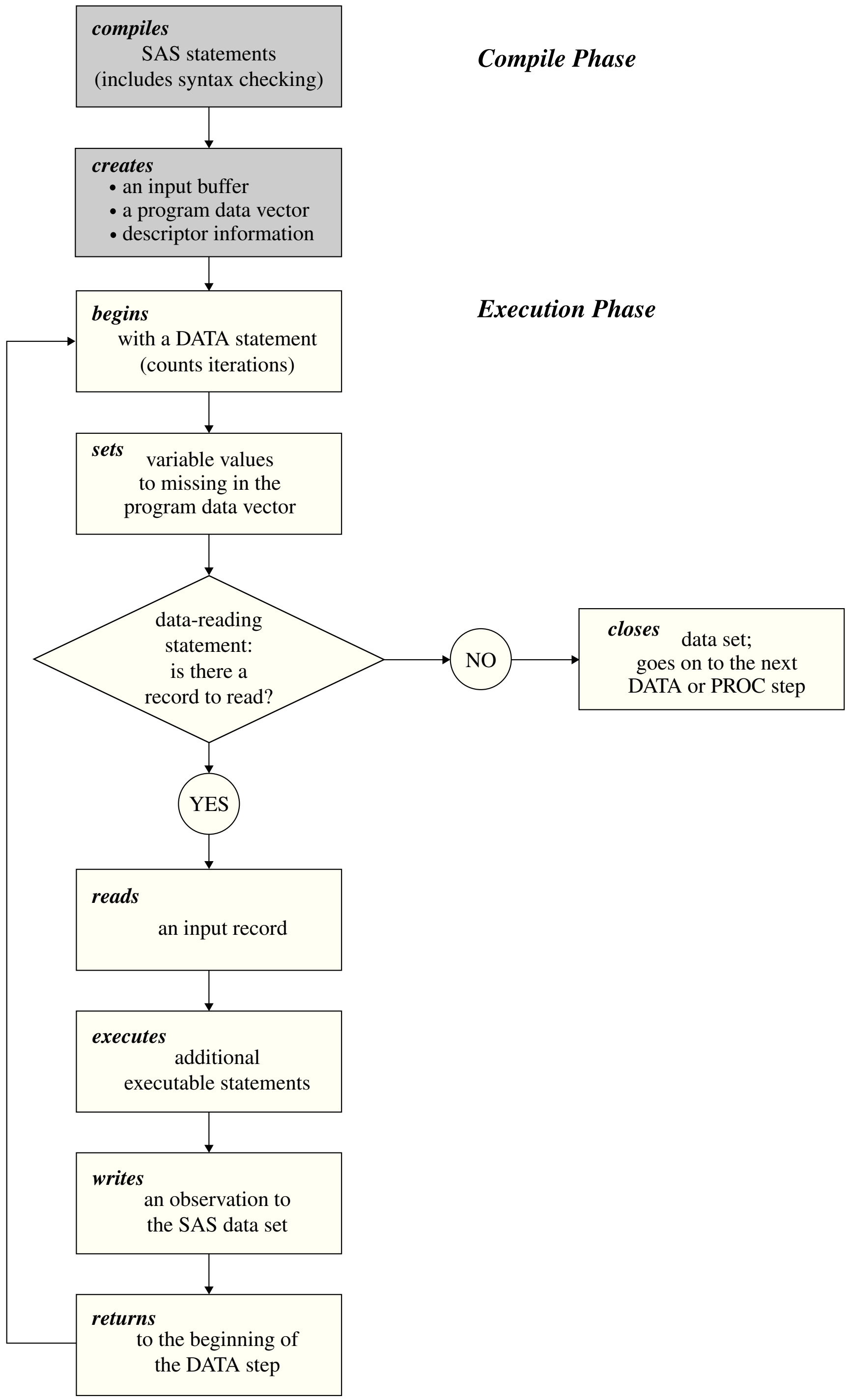
How the DATA Step Works: A Basic Introduction

Overview of the DATA Step

The DATA step consists of a group of SAS statements that begins with a DATA statement. The DATA statement begins the process of building a SAS data set and names the data set. The statements that make up the DATA step are compiled, and the syntax is checked. If the syntax is correct, then the statements are executed. In its simplest form, the DATA step is a loop with an automatic output and return action.

The following figure illustrates the flow of action in a simple DATA step.

Figure 3.7 Flow of Action in a Typical DATA Step



During the Compilation Phase

When you submit a DATA step for execution, SAS checks the syntax of the SAS statements and compiles them, that is, automatically translates the statements into machine code. SAS further processes the code, and creates the following three items:

input buffer
: is a logical area in memory into which SAS reads each record of data from a raw data file when the program executes. (When SAS reads from a SAS data set, however, the data is written directly to the program data vector.)

program data vector
: is a logical area of memory where SAS builds a data set, one observation at a time. When a program executes, SAS reads data values from the input buffer or creates them by executing SAS language statements. SAS assigns the values to the appropriate variables in the program data vector. From here, SAS writes the values to a SAS data set as a single observation.

  The program data vector also contains two automatic variables, _N_ and _ERROR_. The _N_ variable counts the number of times the DATA step begins to iterate. The _ERROR_ variable signals the occurrence of an error caused by the data during execution. These automatic variables are not written to the output data set.

descriptor information
: is information about each SAS data set, including data set attributes and variable attributes. SAS creates and maintains the descriptor information.

During the Execution Phase

All executable statements in the DATA step are executed once for each iteration. If your input file contains raw data, then SAS reads a record into the input buffer. SAS then reads the values in the input buffer and assigns the values to the appropriate variables in the program data vector. SAS also calculates values for variables created by program statements, and writes these values to the program data vector. When the program reaches the end of the DATA step, three actions occur by default that make using the SAS language different from using most other programming languages:

1 SAS writes the current observation from the program data vector to the data set.

2 The program loops back to the top of the DATA step.

3 Variables in the program data vector are reset to missing values.

Note: The following exceptions apply:

- Variables that you specify in a RETAIN statement are not reset to missing values.
- The automatic variables _N_ and _ERROR_ are not reset to missing.

For information about the RETAIN statement, see "Using a Value in a Later Observation" on page 217.

If there is another record to read, then the program executes again. SAS builds the second observation, and continues until there are no more records to read. The data set is then closed, and SAS goes on to the next DATA or PROC step.

Example of a DATA Step

The DATA Step

The following simple DATA step produces a SAS data set from the data collected for a health and fitness club. As discussed earlier, the input data contains each participant's identification number, name, team name, and weight at the beginning and end of a 16-week weight program:

```
data weight_club; 1
   input IdNumber 1-4 Name $ 6-24 Team $ StartWeight EndWeight; 2
   Loss = StartWeight - EndWeight; 3

   datalines; 4
1023 David Shaw         red    189 165
1049 Amelia Serrano     yellow 145 124
1219 Alan Nance         red    210 192
1246 Ravi Sinha         yellow 194 177
1078 Ashley McKnight    red    127 118
1221 Jim Brown          yellow 220   .
1095 Susan Stewart      blue   135 127
1157 Rosa Gomez         green  155 141
1331 Jason Schock       blue   187 172
1067 Kanoko Nagasaka    green  135 122
1251 Richard Rose       blue   181 166
1333 Li-Hwa Lee         green  141 129
1192 Charlene Armstrong yellow 152 139
1352 Bette Long         green  156 137
1262 Yao Chen           blue   196 180
1087 Kim Sikorski       red    148 135
1124 Adrienne Fink      green  156 142
1197 Lynne Overby       red    138 125
1133 John VanMeter      blue   180 167
1036 Becky Redding      green  135 123
1057 Margie Vanhoy      yellow 146 132
1328 Hisashi Ito        red    155 142
1243 Deanna Hicks       blue   134 122
1177 Holly Choate       red    141 130
1259 Raoul Sanchez      green  189 172
1017 Jennifer Brooks    blue   138 127
1099 Asha Garg          yellow 148 132
1329 Larry Goss         yellow 188 174
;  4
```

The following list corresponds to the numbered items in the preceding program:

1 The DATA statement begins the DATA step and names the data set that is being created.

2 The INPUT statement creates five variables, indicates how SAS reads the values from the input buffer, and assigns the values to variables in the program data vector.

3 The assignment statement creates an additional variable called Loss, calculates the value of Loss during each iteration of the DATA step, and writes the value to the program data vector.

4 The DATALINES statement marks the beginning of the input data. The single semicolon marks the end of the input data and the DATA step.

Note: A DATA step that does not contain a DATALINES statement must end with a RUN statement.

The Process

When you submit a DATA step for execution, SAS automatically compiles the DATA step and then executes it. At compile time, SAS creates the input buffer, program data vector, and descriptor information for the data set WEIGHT_CLUB. As the following figure shows, the program data vector contains the variables that are named in the INPUT statement, as well as the variable Loss. The values of the _N_ and the _ERROR_ variables are automatically generated for every DATA step. The _N_ automatic variable represents the number of times that the DATA step has iterated. The _ERROR_ automatic variable acts like a binary switch whose value is 0 if no errors exist in the DATA step, or 1 if one or more errors exist. These automatic variables are not written to the output data set.

All variable values, except _N_ and _ERROR_, are initially set to missing. Note that missing numeric values are represented by a period, and missing character values are represented by a blank.

Figure 3.8 Variable Values Initially Set to Missing

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7
```

Program Data Vector

IdNumber	Name	Team	StartWeight	EndWeight	Loss
.			.	.	.

The syntax is correct, so the DATA step executes. As the following figure illustrates, the INPUT statement causes SAS to read the first record of raw data into the input buffer. Then, according to the instructions in the INPUT statement, SAS reads the data values in the input buffer and assigns them to variables in the program data vector.

Figure 3.9 Values Assigned to Variables by the INPUT Statement

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7
1023 David Shaw         red    189 165
```

Program Data Vector

IdNumber	Name	Team	StartWeight	EndWeight	Loss
1023	David Shaw	red	189	165	.

When SAS assigns values to all variables that are listed in the INPUT statement, SAS executes the next statement in the program:

```
Loss = StartWeight - EndWeight;
```

This assignment statement calculates the value for the variable Loss and writes that value to the program data vector, as the following figure shows.

Figure 3.10 Value Computed and Assigned to the Variable Loss

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7
1023 David Shaw         red    189 165
```

Program Data Vector

IdNumber	Name	Team	StartWeight	EndWeight	Loss
1023	David Shaw	red	189	165	24

SAS has now reached the end of the DATA step, and the program automatically does the following:

- writes the first observation to the data set
- loops back to the top of the DATA step to begin the next iteration
- increments the _N_ automatic variable by 1
- resets the _ERROR_ automatic variable to 0
- except for _N_ and _ERROR_, sets variable values in the program data vector to missing values, as the following figure shows

Figure 3.11 *Values Set to Missing*

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7
1023 David Shaw         red    189 165
```

Program Data Vector

IdNumber	Name	Team	StartWeight	EndWeight	Loss
.			.	.	.

Execution continues. The INPUT statement looks for another record to read. If there are no more records, then SAS closes the data set and the system goes on to the next DATA or PROC step.

In this example, however, more records exist and the INPUT statement reads the second record into the input buffer, as the following figure shows.

Figure 3.12 *Second Record Is Read into the Input Buffer*

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7
1049 Amelia Serrano     yellow 145 124
```

Program Data Vector

IdNumber	Name	Team	StartWeight	EndWeight	Loss
.			.	.	.

The following figure shows that SAS assigned values to the variables in the program data vector and calculated the value for the variable Loss. SAS then built the second observation just as it did the first one.

Figure 3.13 *Results of Second Iteration of the DATA Step*

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7
1049 Amelia Serrano     yellow 145 124
```

Program Data Vector

IdNumber	Name	Team	StartWeight	EndWeight	Loss
1049	Amelia Serrano	yellow	145	124	21

This entire process continues until SAS detects the end of the file. The DATA step iterates as many times as there are records to read. Then SAS closes the data set WEIGHT_CLUB, and SAS looks for the beginning of the next DATA or PROC step.

Now that SAS has transformed the collected data from raw data into a SAS data set, it can be processed by a SAS procedure.

```
proc print data=weight_club;
   title 'Fitness Center Weight Club';
run;
```

The following output, produced with the PRINT procedure, displays the data set that has just been created.

Figure 3.14 *PROC PRINT Output of the WEIGHT_CLUB Data Set*

Fitness Center Weight Club

Obs	IdNumber	Name	Team	StartWeight	EndWeight	Loss
1	1023	David Shaw	red	189	165	24
2	1049	Amelia Serrano	yellow	145	124	21
3	1219	Alan Nance	red	210	192	18
4	1246	Ravi Sinha	yellow	194	177	17
5	1078	Ashley McKnight	red	127	118	9
6	1221	Jim Brown	yellow	220	.	.
7	1095	Susan Stewart	blue	135	127	8
8	1157	Rosa Gomez	green	155	141	14
9	1331	Jason Schock	blue	187	172	15
10	1067	Kanoko Nagasaka	green	135	122	13
11	1251	Richard Rose	blue	181	166	15
12	1333	Li-Hwa Lee	green	141	129	12
13	1192	Charlene Armstrong	yellow	152	139	13
14	1352	Bette Long	green	156	137	19
15	1262	Yao Chen	blue	196	180	16
16	1087	Kim Sikorski	red	148	135	13
17	1124	Adrienne Fink	green	156	142	14
18	1197	Lynne Overby	red	138	125	13
19	1133	John VanMeter	blue	180	167	13
20	1036	Becky Redding	green	135	123	12
21	1057	Margie Vanhoy	yellow	146	132	14
22	1328	Hisashi Ito	red	155	142	13
23	1243	Deanna Hicks	blue	134	122	12
24	1177	Holly Choate	red	141	130	11
25	1259	Raoul Sanchez	green	189	172	17
26	1017	Jennifer Brooks	blue	138	127	11
27	1099	Asha Garg	yellow	148	132	16
28	1329	Larry Goss	yellow	188	174	14

Supplying Information to Create a SAS Data Set

Overview of Creating a SAS Data Set

You supply SAS with specific information for reading raw data so that you can create a SAS data set from the raw data. You can use the data set for further processing, data analysis, or report writing. To process raw data in a DATA step, you must:

- use an INPUT statement to tell SAS how to read the data
- define the variables and indicate whether they are character or numeric
- specify the location of the raw data

Telling SAS How to Read the Data: Styles of Input

SAS provides many tools for reading raw data into a SAS data set. These tools include three basic input styles as well as various format modifiers and pointer controls.

List input is used when each field in the raw data is separated by at least one space and does not contain embedded spaces. The INPUT statement simply contains a list of the variable names. List input, however, places numerous restrictions on your data. These restrictions are discussed in detail in Chapter 4, "Starting with Raw Data: The Basics," on page 51. The following example shows list input. Note that there is at least one blank space between each data value.

```
data scores;
   input Name $ Test_1 Test_2 Test_3;
   datalines;
Bill 187 97 103
Carlos 156 76 74
Monique 99 102 129
;
```

Column input enables you to read the same data if it is located in fixed columns:

```
data scores;
   input Name $ 1-7 Test_1 9-11 Test_2 13-15 Test_3 17-19;
   datalines;
Bill    187  97 103
Carlos  156  76  74
Monique  99 102 129
;
```

Formatted input enables you to supply special instructions in the INPUT statement for reading data. For example, to read numeric data that contains special symbols, you need to supply SAS with special instructions so that it can read the data correctly. These instructions, called informats, are discussed in more detail in

Chapter 4, “Starting with Raw Data: The Basics,” on page 51. In the INPUT statement, you can specify an informat to be used to read a data value, as in the example that follows:

```
data total_sales;
   input Date mmddyy10. +2 Amount comma5.;
   datalines;
09/05/2013  1,382
10/19/2013  1,235
11/30/2013  2,391
;
```

In this example, the MMDDYY10. informat for the variable Date tells SAS to interpret the raw data as a month, day, and year, ignoring the slashes. The COMMA5. informat for the variable Amount tells SAS to interpret the raw data as a number, ignoring the comma. The +2 is a pointer control that tells SAS where to look for the next item. For more information about pointer controls, see Chapter 4, “Starting with Raw Data: The Basics,” on page 51.

SAS also enables you to mix these styles of input as required by how values are arranged in the data records. Chapter 4, “Starting with Raw Data: The Basics,” on page 51 discusses in detail input styles (including their rules and restrictions), as well as additional data-reading tools.

Reading Dates with Two-Digit and Four-Digit Year Values

In the previous example, the year values in the dates in the raw data had four digits:

```
09/05/2013
10/19/2013
11/30/2013
```

However, SAS is also capable of reading two-digit year values (for example, 09/05/99). In this example, use the MMDDYY8. informat for the variable Date.

How does SAS know to which century a two-digit year belongs? SAS uses the value of the YEARCUTOFF= SAS system option. In Version 7 and later of SAS, the default value of the YEARCUTOFF= option is 1926. This means that two-digit years from 00 to 19 are assumed to be in the twenty-first century, that is, 2000 to 2019. Two-digit years from 20 to 99 are assumed to be in the twentieth century, that is, 1920 to 1999.

Note: The YEARCUTOFF= option and the default setting might be different at your site.

To avoid confusion, you should use four-digit year values in your raw data wherever possible. For more information, see the Dates, Times, and Intervals section of *SAS Language Reference: Concepts*.

Defining Variables in SAS

So far you have seen that the INPUT statement instructs SAS on how to read raw data lines. At the same time that the INPUT statement provides instructions for reading data, it defines the variables for the data set that come from the raw data.

By assuming default values for variable attributes, the INPUT statement does much of the work for you. Later in this documentation that you will learn other statements that enable you to define variables and assign attributes to variables. This section and Chapter 4, “Starting with Raw Data: The Basics,” on page 51 concentrate on the use of the INPUT statement.

SAS variables can have these attributes:

- name
- type
- length
- informat
- format
- label
- position in observation
- index type

See the SAS Variables section of *SAS Language Reference: Concepts* for more information about variable attributes.

In an INPUT statement, you must supply each variable name. Unless you also supply an informat, the type is assumed to be numeric, and its length is assumed to be eight bytes. The following INPUT statement creates four numeric variables, each with a length of eight bytes, without requiring you to specify either type or length.

```
input IdNumber Test_1 Test_2 Test_3;
```

The following table summarizes this information.

Variable Name	Type	Length
IdNumber	numeric	8
Test_1	numeric	8
Test_2	numeric	8
Test_3	numeric	8

The values of numeric variables can contain only numbers. To store values that contain alphabetic or special characters, you must create a character variable. By following a variable name in an INPUT statement with a dollar sign ($), you create a character variable. The default length of a character variable is also eight bytes. The following statement creates a data set that contains one character variable and four numeric variables, all with a default length of eight bytes.

```
input IdNumber Name $ Test_1 Test_2 Test_3;
```

The following table summarizes this information.

Variable Name	Type	Length
IdNumber	numeric	8

Variable Name	Type	Length
Name	character	8
Test_1	numeric	8
Test_2	numeric	8
Test_3	numeric	8

In addition to specifying the types of variables in the INPUT statement, you can also specify the lengths of character variables. Character variables can be up to 32,767 bytes in length. To specify the length of a character variable in an INPUT statement, you need to supply an informat or use column numbers. For example, following a variable name in the INPUT statement with the informat $20., or with column specifications such as 1-20, creates a character variable that is 20 bytes long.

Note that the length of numeric variables is not affected by informats or column specifications in an INPUT statement. For more information, see *SAS Language Reference: Concepts* for more information about numeric variables and lengths.

Two other variable attributes, format and label, affect how variable values and names are represented when they are printed or displayed. These attributes are assigned with different statements that you will learn about later.

Indicating the Location of Your Data

Data Locations

To create a SAS data set, you can read data from one of four locations:

- raw data in the data (job) stream, that is, following a DATALINES statement
- raw data in a file that you specify with an INFILE statement
- data from an existing SAS data set
- data in a database management system (DBMS) file

Raw Data in the Job Stream

You can place data directly in the job stream with the programming statements that make up the DATA step. The DATALINES statement tells SAS that raw data follows. The single semicolon that follows the last line of data marks the end of the data. The DATALINES statement and data lines must occur last in the DATA step statements:

```
data weight_club;
   input IdNumber 1-4 Name $ 6-24 Team $ StartWeight EndWeight;
   Loss = StartWeight - EndWeight;
   datalines;
1023 David Shaw         red    189 165
1049 Amelia Serrano     yellow 145 124
1219 Alan Nance         red    210 192
```

```
1246 Ravi Sinha         yellow 194 177
1078 Ashley McKnight    red    127 118
;
```

Data in an External File

If your raw data is already stored in a file, then you do not have to bring that file into the data stream. Use an INFILE statement to specify the file containing the raw data. For more information about the INFILE, FILE, and FILENAME statements, see “Using External Files in Your SAS Job” on page 45. The statements in the code that follows demonstrate the same example, this time showing that the raw data is stored in an external file:

```
data weight_club;
   infile 'your-input-file';
   input IdNumber $ 1-4 Name $ 6-23 StartWeight 24-26
         EndWeight 28-30;
   Loss=StartWeight-EndWeight;
run;
```

Data in a SAS Data Set

You can also use data that is already stored in a SAS data set as input to a new data set. To read data from an existing SAS data set, you must specify the existing data set's name in one of these statements:

- SET statement
- MERGE statement
- MODIFY statement
- UPDATE statement

For example, the statements that follow create a new SAS data set named RED that adds the variable LossPercent:

```
data red;
   set weight_club;
   LossPercent = Loss / StartWeight * 100;
run;
```

The SET statement indicates that the input data is already in the structure of a SAS data set and gives the name of the SAS data set to be read. In this example, the SET statement tells SAS to read the WEIGHT_CLUB data set in the WORK library.

Data in a DBMS File

If you have data that is stored in another vendor's database management system (DBMS) files, then you can use SAS/ACCESS software to bring this data into a SAS data set. SAS/ACCESS software enables you to assign a libref to a library containing the DBMS file. In this example, a libref is declared, and points to a library containing Oracle data. SAS reads data from an Oracle file into a SAS data set:

```
libname dblib oracle user=scott password=tiger path='hrdept_002';
data employees;
   set dblib.employees;
run;
```

See *SAS/ACCESS for Relational Databases: Reference* for more information about using SAS/ACCESS software to access DBMS files.

Using External Files in Your SAS Job

Your SAS programs often need to read raw data from a file, or write data or reports to a file that is not a SAS data set. To use a file that is not a SAS data set in a SAS program, you need to tell SAS where to find it. You can do the following:

- Identify the file directly in the INFILE, FILE, or other SAS statement that uses the file.
- Set up a fileref for the file by using the FILENAME statement, and then use the fileref in the INFILE, FILE, or other SAS statement.
- Use operating environment commands to set up a fileref, and then use the fileref in the INFILE, FILE, or other SAS statement.

The first two methods are described here. The third method depends on the operating environment that you use.

For more information, refer to the SAS documentation for your operating environment.

Identifying an External File Directly

The simplest method for referring to an external file is to use the name of the file in the INFILE, FILE, or other SAS statement that needs to refer to the file. For example, if your raw data is stored in a file in your operating environment, and you want to read the data using a SAS DATA step, then you can tell SAS where to find the raw data by putting the name of the file in the INFILE statement:

```
data temp;
   infile 'your-input-file';
   input IdNumber $ 1-4 Name $ 6-23 StartWeight 24-26
         EndWeight 28-30;
run;
```

The INFILE statement for this example can appear as follows for various operating environments:

Table 3.1 Example INFILE Statements for Various Operating Environments

Operating Environment	INFILE Statement Example
z/OS	`infile 'fitness.weight.rawdata(club1)';`
UNIX	`infile '/usr/local/fitness/club1.dat';`
Windows	`infile 'c:\fitness\club1.dat';`

For more information, refer to the SAS documentation for your operating environment.

Referencing an External File with a Fileref

An alternate method for referencing an external file is to use the FILENAME statement to set up a fileref for a file. The fileref functions as a shorthand way of referring to an external file. You then use the fileref in later SAS statements that reference the file, such as the FILE or INFILE statement. The advantage of this method is that if the program contains many references to the same external file and the external filename changes, then the program needs to be modified in only one place, rather than in every place where the file is referenced.

Here is the form of the FILENAME statement:

FILENAME *fileref* '*your-input-or-output-file*';

The *fileref* must be a valid SAS name, that is, it must

- begin with a letter or an underscore
- contain only letters, numbers, or underscores
- have no more than 8 characters.

Additional restrictions can apply under some operating environments. For more information, refer to the SAS documentation for your operating environment.

For example, you can reference the raw data that is stored in a file in your operating environment by first using the FILENAME statement to specify the name of the file and its fileref, and then using the INFILE statement with the same fileref to reference the file.

```
filename fitclub 'your-input-file';

data temp;
   infile fitclub;
   input IdNumber $ 1-4 Name $ 6-23 StartWeight 24-26 EndWeight 28-30;
run;
```

In this example, the INFILE statement stays the same for all operating environments. The FILENAME statement, however, can appear differently in different operating environments.

The following table shows examples of FILENAME statements for different operating environments.

Table 3.2 *Example FILENAME Statements for Various Operating Environments*

Operating Environment	FILENAME Statement Example
z/OS	`filename fitclub 'fitness.weight.rawdata(club1)';`
UNIX	`filename fitclub '/usr/local/fitness/club1.dat';`
Windows	`filename fitclub 'c:\fitness\club1.dat';`

If you need to use several files or members from the same directory, partitioned data set (PDS), or MACLIB, then you can use the FILENAME statement to create a fileref that identifies the name of the directory, PDS, or MACLIB. Then you can use the fileref in the INFILE statement and enclose the name of the file, PDS member, or MACLIB member in parentheses immediately after the fileref, as in this example:

```
filename fitclub 'directory-or-PDS-or-MACLIB';

data temp;
   infile fitclub(club1);
   input IdNumber $ 1-4 Name $ 6-23 StartWeight 24-26 EndWeight 28-30;
run;

data temp2;
   infile fitclub(club2);
   input IdNumber $ 1-4 Name $ 6-23 StartWeight 24-26 EndWeight 28-30;
run;
```

In this case, the INFILE statements stay the same for all operating environments. The FILENAME statement, however, can appear differently for different operating environments, as the following table shows:

The following table shows examples of FILENAME statements for different operating environments.

Table 3.3 Referencing Directories, PDSs, and MACLIBs in Various Operating Environments

Operating Environment	FILENAME Statement Example
z/OS	`filename fitclub 'fitness.weight.rawdata';`[1]
UNIX	`filename fitclub '/usr/local/fitness';`
Windows	`filename fitclub 'c:\fitness';`

1 Under z/OS, the external file must be a PDS or a UFS file.

Summary

Statements

DATA *<libref.>SAS-data-set;*

tells SAS to begin creating a SAS data set. If you omit the libref, then SAS creates a temporary SAS data set. (SAS attaches the libref WORK for its internal processing.) If you give a previously defined libref as the first level of the name, then SAS stores the data set permanently in the library referenced by the libref. A SAS program or a portion of a program that begins with a DATA statement and ends with a RUN statement, another DATA statement, or a PROC statement is called a DATA step.

FILENAME *fileref 'your-input-or-output-file'*;
: associates a fileref with an external file. Enclose the name of the external file in quotation marks.

INFILE *fileref* | *'your-input-file'*;
: identifies an external file to be read by an INPUT statement. Specify a fileref that has been assigned with a FILENAME statement or with an appropriate operating environment command, or specify the actual name of the external file.

INPUT *variable* <*$*>;
: reads raw data using list input. At least one blank must occur between any two data values. The $ denotes a character variable.

INPUT *variable* <*$*>*column-range*;
: reads raw data that is aligned in columns. The $ denotes a character variable.

INPUT *variable informat*;
: reads raw data using formatted input. An informat supplies special instructions for reading the data.

LIBNAME *libref* '*your-SAS-data-library*';
: associates a libref with a SAS library. Enclose the name of the library in quotation marks. SAS locates a permanent SAS data set by matching the libref in a two-level SAS data set name with the library associated with that libref in a LIBNAME statement. The rules for creating a SAS library depend on your operating environment.

Learning More

ATTRIB statement
: For information about how the ATTRIB statement enables you to assign attributes to variables, see "ATTRIB Statement" in *SAS DATA Step Statements: Reference*.

DBMS access
: This documentation explains how to use SAS for reading files of raw data and SAS data sets and writing to SAS data sets. However, SAS documentation for SAS/ACCESS provides complete information about using SAS to read and write information stored in several types of database management system (DBMS) files.

Informats
: For a discussion about informats that you use with dates, see Chapter 15, "Working with Dates in the SAS System," on page 233.

Length of variables
: For more information about how a variable's length affects the values that you can store in the variable, see Chapter 8, "Working with Numeric Variables," on page 121 and Chapter 9, "Working with Character Variables," on page 135.

LINESIZE= *option*
: For information about how to use the LINESIZE= option in an INPUT statement to limit how much of each data line the INPUT statement reads, see "INPUT Statement" in *SAS DATA Step Statements: Reference*.

MERGE, MODIFY, or UPDATE statements

In addition to the SET statement, you can read a SAS data set with the MERGE, MODIFY, or UPDATE statements. For more information, see Chapter 19, “Merging SAS Data Sets,” on page 299Chapter 20, “Updating SAS Data Sets,” on page 329.

SET statement

For information about the SET statement, see Chapter 6, “Starting with SAS Data Sets,” on page 93.

USER= *SAS system option*

You can specify the USER= SAS system option to use one-level names to point to permanent SAS files. (If you specify USER=WORK, then SAS assumes that files referenced with one-level names refer to temporary work files.) For more information, see the *SAS System Options: Reference*.

4

Starting with Raw Data: The Basics

Introduction to Raw Data

Purpose

To create a SAS data set from raw data, you must examine the data records first to determine how the data values that you want to read are arranged. Then you can look at the styles of reading input that are available in the INPUT statement. SAS provides three basic input styles:

- list
- column
- formatted

You can use these styles individually, in combination with each other, or in conjunction with various line-hold specifiers, line-pointer controls, and column-pointer controls. This section demonstrates various ways of using the INPUT statement to turn your raw data into SAS data sets.

You can enter the data directly in a DATA step or use an existing file of raw data. If your data is machine readable, then you need to learn how to use those tools that enable SAS to read them. If your data is not yet entered, then you can choose the input style that enables you to enter the data most easily.

Prerequisites

Before continuing, you should understand the concepts presented in the following sections:

- Chapter 1, “What is the SAS System?,” on page 3
- Chapter 3, “Introduction to DATA Step Processing,” on page 25

Examine the Structure of the Raw Data: Factors to Consider

Before you can select the appropriate style of input, examine the structure of the raw data that you want to read. Consider some of the following factors:

- how the data is arranged in the input records. For example, are data fields aligned in columns or unaligned? Are they separated by blanks or by other characters?
- whether character values contain embedded blanks

- whether numeric values contain nonnumeric characters such as commas
- whether the data contains time or date values
- whether each input record contains data for more than one observation
- whether data for a single observation is spread over multiple input records

Reading Unaligned Data

Understanding List Input

The simplest form of the INPUT statement uses list input. List input is used to read data values that are separated by a delimiter character (by default, a blank space). With list input, SAS reads a data value until it encounters a blank space. SAS assumes that the value has ended and assigns the data to the appropriate variable in the program data vector. SAS continues to scan the record until it reaches a non-blank character again. SAS reads a data value until it encounters a blank space or the end of the input record.

Program: Basic List Input

This program uses the health and fitness club data from Chapter 3, "Introduction to DATA Step Processing," on page 25 to illustrate a DATA step that uses list input in an INPUT statement.

```
data club1;
   input IdNumber Name $ Team $ StartWeight EndWeight; 1
   datalines; 2
1023 David red 189 165 3
1049 Amelia yellow 145 124
1219 Alan red 210 192
1246 Ravi yellow 194 177
1078 Ashley red 127 118
1221 Jim yellow 220 . 3
; 2

proc print data=club1;
   title 'Weight of Club Members';
run;
```

The following list corresponds to the numbered items in the preceding program:

1. The variable names in the INPUT statement are specified in exactly the same order as the fields in the raw data records.
2. The DATALINES statement marks the beginning of the data lines. The semicolon that follows the data lines marks the end of the data lines and the end of the DATA step.

3 Each data value in the raw data record is separated from the next by at least one blank space. The last record contains a missing value, represented by a period, for the value of EndWeight.

The following output displays the resulting data set. The PROC PRINT statement that follows the DATA step produces this listing.

Figure 4.1 *Data Set Created with List Input*

Weight of Club Members

Obs	IdNumber	Name	Team	StartWeight	EndWeight
1	1023	David	red	189	165
2	1049	Amelia	yellow	145	124
3	1219	Alan	red	210	192
4	1246	Ravi	yellow	194	177
5	1078	Ashley	red	127	118
6	1221	Jim	yellow	220	.

Program: When the Data Is Delimited by Characters, Not Blanks

This program also uses the health and fitness club data but notice that here the data is delimited by a comma instead of a blank space, the default delimiter.

```
data club1;
   infile datalines dlm=','; 1

   input IdNumber Name $ Team $ StartWeight EndWeight;
   datalines;
1023,David,red,189,165 2
1049,Amelia,yellow,145,124
1219,Alan,red,210,192
1246,Ravi,yellow,194,177
1078,Ashley,red,127,118
1221,Jim,yellow,220,.
;
proc print data=club1;
   title 'Weight of Club Members';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 List input, by default, scans the input records, looking for blank spaces to delimit each data value. The DLM= option enables list input to recognize a character, here a comma, as the delimiter.

2 These data values are separated by commas instead of blanks.

Note: This example requires the DLM= option, which is available only in the INFILE statement. Usually, this statement is used only when the input data resides in an external file. The DATALINES specification, however, enables you to take advantage of INFILE statement options, when you are reading data records from the job stream.

Figure 4.2 Reading Data Delimited by Commas

Weight of Club Members

Obs	IdNumber	Name	Team	StartWeight	EndWeight
1	1023	David	red	189	165
2	1049	Amelia	yellow	145	124
3	1219	Alan	red	210	192
4	1246	Ravi	yellow	194	177
5	1078	Ashley	red	127	118
6	1221	Jim	yellow	220	.

Program: When Consecutive Delimiters Indicate Missing Values

This program also uses the health and fitness club data. Notice that here the data is delimited by a colon (:), and there is a missing value for Alan that is indicated by two consecutive delimiters.

```
data club1;
   infile datalines dsd dlm=':';
   input IdNumber Name $ Team $ StartWeight EndWeight;
   datalines;
1023:David:red:189:165
1049:Amelia:yellow:145:124
1219:Alan::210:192
1246:Ravi:yellow:194:177
1078:Ashley:red:127:118
1221:Jim:yellow:220:.
;
proc print data=club1;
   title 'Weight of Club Members';
run;
```

This example requires the DSD option, which is available only in the INFILE statement. Like the previous example, the DATALINES specification enables you to specify the INFILE statement with the DSD and DLM= options. The DSD option treats two consecutive delimiters as a missing value. (The DSD option also sets the default delimiter to a comma and ignores delimiters that occur within quoted strings.)

If you did not specify the DSD option in this example, then data values would become mismatched and the remaining data would not be read correctly. The following listing shows how the data would have been read if the DSD option were omitted. Notice that the values after Alan's name are incorrect, and the observation for Ravi is omitted. Ravi's IdNumber is read as Alan's EndWeight value and the remainder of that record is ignored.

Figure 4.3 DSD Option Incorrectly Omitted

INCORRECT: Weight of Club Members

Obs	IdNumber	Name	Team	StartWeight	EndWeight
1	1023	David	red	189	165
2	1049	Amelia	yellow	145	124
3	1219	Alan	210	192	1246
4	1078	Ashley	red	127	118
5	1221	Jim	yellow	220	.

When you include the DSD option in the INFILE statement, the consecutive delimiters indicate a missing value, and the data is read correctly. The following listing shows the resulting data set. You can see that now the missing Team value for Alan appears as a blank value, and the remaining data set is now read as expected.

Figure 4.4 Missing Values Are Read Correctly with the DSD Option

CORRECT: Weight of Club Members

Obs	IdNumber	Name	Team	StartWeight	EndWeight
1	1023	David	red	189	165
2	1049	Amelia	yellow	145	124
3	1219	Alan		210	192
4	1246	Ravi	yellow	194	177
5	1078	Ashley	red	127	118
6	1221	Jim	yellow	220	.

List Input: Points to Remember

These are the points to remember when you use list input:

- Use list input when each field is separated by at least one blank space or delimiter. Use the DLM= option in an INFILE statement to indicate delimiters other than spaces. For list input, you must also specify DATALINES in the INFILE statement.
- Specify each field in the order in which they appear in the records of raw data.
- Represent missing values by a placeholder such as a period.

Under the default behavior, a blank field causes the variable names and values to become mismatched. However, if you use the DSD option with comma delimiters, multiple commas indicate a missing value. To specify a delimiter other than a comma with the DSD option, use the DLM= option.

Note: Specify the DSD and DLM= options in an INFILE statement. For list input, you must also specify DATALINES in the INFILE statement.

- Character values cannot contain embedded blanks, unless you also specify the DSD and DLM= options in an INFILE statement.
- The default length of character variables is eight bytes. SAS truncates a longer value when it writes the value to the program data vector. (To read a character variable that contains more than eight characters with list input, use a LENGTH statement. See “Defining Enough Storage Space for Variables” on page 116.)
- Data must be in standard character or numeric format (that is, it can be read without an informat).

Note: List input requires the fewest specifications in the INPUT statement. However, the restrictions that are placed on the data might require that you learn to use other styles of input to read your data. For example, column input, which is discussed in the next section, is less restrictive. This section has introduced only simple list input. See “Understanding How to Make List Input More Flexible” on page 64 to learn about modified list input.

Reading Data That Is Aligned in Columns

Understanding Column Input

With column input, data values occupy the same fields within each data record. When you use column input in the INPUT statement, list the variable names and specify column positions that identify the location of the corresponding data fields. You can use column input when your raw data is in fixed columns and does not require the use of informats to be read.

Program: Reading Data Aligned in Columns

The following program also uses the health and fitness club data, but now two more data values are missing. The data is aligned in columns and SAS reads the data with column input:

```
data club1;
   input IdNumber 1-4 Name $ 6-11 Team $ 13-18 StartWeight 20-22
         EndWeight 24-26;
   datalines;
```

```
1023 David  red    189 165
1049 Amelia yellow 145
1219 Alan   red    210 192
1246 Ravi   yellow     177
1078 Ashley red    127 118
1221 Jim    yellow 220
;

proc print data=club1;
   title 'Weight Club Members';
run;
```

The specification that follows each variable name indicates the beginning and ending columns in which the variable value will be found. Note that with column input that you are not required to indicate missing values with a placeholder such as a period.

The following output displays the resulting data set. Missing numeric values occur three times in the data set, and are indicated by periods.

Figure 4.5 *Data Set Created with Column Input*

Weight Club Members

Obs	IdNumber	Name	Team	StartWeight	EndWeight
1	1023	David	red	189	165
2	1049	Amelia	yellow	145	.
3	1219	Alan	red	210	192
4	1246	Ravi	yellow	.	177
5	1078	Ashley	red	127	118
6	1221	Jim	yellow	220	.

Understanding Some Advantages of Column Input over Simple List Input

Here are several advantages of using column input:

- With column input, character variables can contain embedded blanks.
- Column input also enables the creation of variables that are longer than eight bytes. In the preceding example, the variable Name in the data set CLUB1 contains only the members' first names. By using column input, you can read the first and last names as a single value. These differences between input styles are possible for two reasons:
  - Column input uses the columns that you specify to determine the length of character variables.
  - Column input, unlike list input, reads data until it reaches the last specified column, not until it reaches a blank space.

- Column input enables you to skip some data fields when reading records of raw data. It also enables you to read the data fields in any order and reread some fields or parts of fields.

Reading Embedded Blanks and Creating Longer Variables

This DATA step uses column input to create a new data set named CLUB2. The program still uses the health and fitness club weight data. However, the data has been modified to include members' first and last names. Now the second data field in each record or raw data contains an embedded blank and is 18 bytes long.

```
data club2;
   input IdNumber 1-4 Name $ 6-23 Team $ 25-30 StartWeight 32-34
         EndWeight 36-38;
   datalines;
1023 David Shaw         red    189 165
1049 Amelia Serrano     yellow 145 124
1219 Alan Nance         red    210 192
1246 Ravi Sinha         yellow 194 177
1078 Ashley McKnight    red    127 118
1221 Jim Brown          yellow 220
;

proc print data=club2;
   title 'Weight Club Members';
run;
```

The following output displays the resulting data set:

Figure 4.6 Data Set Created with Column Input (Embedded Blanks)

Weight Club Members

Obs	IdNumber	Name	Team	StartWeight	EndWeight
1	1023	David Shaw	red	189	165
2	1049	Amelia Serrano	yellow	145	124
3	1219	Alan Nance	red	210	192
4	1246	Ravi Sinha	yellow	194	177
5	1078	Ashley McKnight	red	127	118
6	1221	Jim Brown	yellow	220	.

Program: Skipping Fields When Reading Data Records

Column input also enables you to skip over fields or to read the fields in any order. This example uses column input to read the same health and fitness club data, but it reads the value for the variable Team first and omits the variable IdNumber altogether.

You can read or reread part of a value when using column input. For example, because the team names begin with different letters, this program saves storage space by reading only the first character in the field that contains the team name. Note the INPUT statement:

```
data club2;
   input Team $ 25 Name $ 6-23 StartWeight 32-34 EndWeight 36-38;
   datalines;
1023 David Shaw         red    189 165
1049 Amelia Serrano     yellow 145 124
1219 Alan Nance         red    210 192
1246 Ravi Sinha         yellow 194 177
1078 Ashley McKnight    red    127 118
1221 Jim Brown          yellow 220
;

proc print data=club2;
   title 'Weight Club Members';
run;
```

The following output displays the resulting data set. The variable that contains the identification number is no longer in the data set. Instead, Team is the first variable in the new data set, and it contains only one character to represent the team value.

Figure 4.7 Data Set Created with Column Input (Skipping Fields)

Weight Club Members

Obs	Team	Name	StartWeight	EndWeight
1	r	David Shaw	189	165
2	y	Amelia Serrano	145	124
3	r	Alan Nance	210	192
4	y	Ravi Sinha	194	177
5	r	Ashley McKnight	127	118
6	y	Jim Brown	220	.

Column Input: Points to Remember

Remember the following rules when you use column input:

- Character variables can be up to 32,767 bytes (32KB) in length and are not limited to the default length of eight bytes.
- Character variables can contain embedded blanks.
- You can read fields in any order.
- A placeholder is not required to indicate a missing data value. A blank field is read as missing and does not cause other values to be read incorrectly.
- You can skip over part of the data in the data record.

- You can reread fields or parts of fields.
- You can read standard character and numeric data only. Informats are ignored.

Reading Data That Requires Special Instructions

Understanding Formatted Input

Sometimes the INPUT statement requires special instructions to read the data correctly. For example, SAS can read numeric data that is in special formats such as binary, packed decimal, or date/time. SAS can also read numeric values that contain special characters such as commas and currency symbols. In these situations, use formatted input. Formatted input combines the features of column input with the ability to read nonstandard numeric or character values. The following data shows formatted input:

- 1,262
- $55.64
- 02JAN2013

Program: Reading Data That Requires Special Instructions

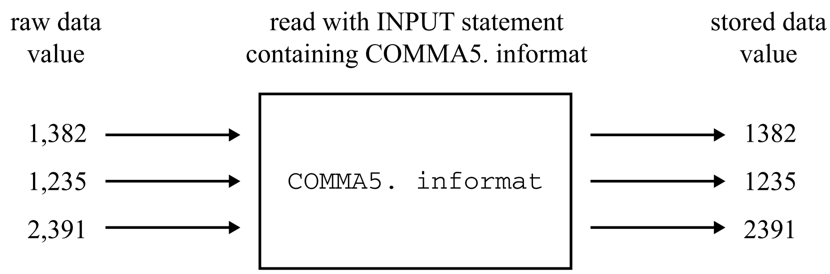
The data in this program includes numeric values that contain a comma, which is an invalid character for a numeric variable:

```
data january_sales;
   input Item $ 1-16 Amount comma5.;
   datalines;
trucks          1,382
vans            1,235
sedans          2,391
;

proc print data=january_sales;
   title 'January Sales in Thousands';
run;
```

The INPUT statement cannot read the values for the variable Amount as valid numeric values without the additional instructions provided by an informat. The informat COMMA5. enables the INPUT statement to read and store this data as a valid numeric value.

The following figure shows that the informat COMMA5. instructs the program to read five characters of data (the comma counts as part of the length of the data), to remove the comma from the data, and to write the resulting numeric value to the program data vector. Note that the name of an informat always ends in a period (.).

Figure 4.8 Reading a Value with an Informat



The following figure shows that the data values are read into the input buffer exactly as they occur in the raw data records. However, they are written to the program data vector (and then to the data set as an observation) as valid numeric values without any special characters.

Figure 4.9 Input Value Compared to Variable Value

Input Buffer

```
----+----1----+----2----+----3
trucks          1,382
```

Program Data Vector

Item	Amount
trucks	1382

The following output displays the resulting data set. The values for Amount contain only numbers. Note that the commas are removed.

Figure 4.10 Data Set Created with Column and Formatted Input

January Sales in Thousands

Obs	Item	Amount
1	trucks	1382
2	vans	1235
3	sedans	2391

In a report, you might want to include the comma in numeric values to improve readability. Just as the informat gives instructions on how to read a value and to remove the comma, a format gives instructions to add characters to variable values in the output. For an example, see "Writing Output without Creating a Data Set" on page 620.

Understanding How to Control the Position of the Pointer

As the INPUT statement reads data values, it uses an input pointer to keep track of the position of the data in the input buffer. Column-pointer controls provide additional control over pointer movement and are especially useful with formatted input. Column-pointer controls tell how far to advance the pointer before SAS reads the next value. In this example, SAS reads data lines with a combination of column and formatted input:

```
data january_sales;
   input Item $ 1-16 Amount comma5.;
   datalines;
trucks          1,382
vans            1,235
sedans          2,391
;
```

In the next example, SAS reads data lines by using formatted input with a column-pointer control:

```
data january_sales;
   input Item $10. @17 Amount comma5.;
   datalines;
trucks          1,382
vans            1,235
sedans          2,391
;
```

After SAS reads the first value for the variable Item, the pointer is left in the next position, column 11. Then the absolute column-pointer control, @17, directs the pointer to move to column 17 in the input buffer. Now, it is in the correct position to read a value for the variable Amount.

In the following program, the relative column-pointer control, +6, instructs the pointer to move six columns to the right before SAS reads the next data value.

```
data january_sales;
   input Item $10. +6 Amount comma5.;
   datalines;
trucks          1,382
vans            1,235
sedans          2,391
;
```

The data in these two programs is aligned in columns. As with column input, you instruct the pointer to move from field to field. You use column specifications with column input. However, with formatted input that you use the length that is specified in the informat together with pointer controls.

Formatted Input: Points to Remember

Remember the following rules when you use formatted input:

- SAS reads formatted input data until it has read the number of columns that the informat indicates. This method of reading the data is different from list input, which reads until a blank space (or other defined delimiter character) is reached.
- You can position the pointer to read the next value by using pointer controls.
- You can read data stored in nonstandard form such as packed decimal, or data that contains commas.

- You have the flexibility of using informats with all the features of column input, as described in “Column Input: Points to Remember” on page 60.

Reading Unaligned Data with More Flexibility

Understanding How to Make List Input More Flexible

While list input is the simplest to code, remember that it places restrictions on your data. By using format modifiers, you can take advantage of the simplicity of list input without the inconvenience of the usual restrictions. For example, you can use modified list input to do the following:

- Create character variables that are longer than the default length of eight bytes.
- Read numeric data with special characters like commas, hyphens, and currency symbols.
- Read character data that contains embedded blanks.
- Read data values that can be stored as SAS date variables.

Creating Longer Variables and Reading Numeric Data That Contains Special Characters

By simply modifying list input with the colon format modifier (:) you can read the following types of data:

- character data that contains more than eight characters
- numeric data that contains special characters

To use the colon format modifier with list input, place the colon between the variable name and the informat. As in simple list input, at least one blank (or other defined delimiter character) must separate each value from the next, and character values cannot contain embedded blanks (or other defined delimiter characters). Consider this DATA step:

```
data january_sales;

   input Item : $12. Amount : comma5.;
   datalines;
Trucks 1,382
Vans 1,235
Sedans 2,391
SportUtility 987
;

proc print data=january_sales;
   title 'January Sales in Thousands';
```

```
run;
```

The variable Item has a length of 12, and the variable Amount requires an informat (in this case, COMMA5.) that removes commas from numbers so that they are read as valid numeric values. The data values are not aligned in columns as was required in the last example, which used formatted input to read the data.

The following output displays the resulting data set:

Figure 4.11 Data Set Created with Modified List Input (: comma5.)

January Sales in Thousands

Obs	Item	Amount
1	trucks	1382
2	vans	1235
3	sedans	2391

Reading Character Data That Contains Embedded Blanks

Because list input uses a blank space to determine where one value ends and the next one begins, values normally cannot contain blanks. However, with the ampersand format modifier (&) you can use list input to read data that contains single embedded blanks. The only restriction is that at least two blanks must divide each value from the next data value in the record.

To use the ampersand format modifier with list input, place the ampersand between the variable name and the informat. The following DATA step uses the ampersand format modifier with list input to create the data set CLUB2. Note that the data is not in fixed columns. Therefore, column input is not appropriate.

```
data club2;
   input IdNumber Name & $18. Team $ StartWeight EndWeight;
   datalines;
1023 David Shaw   red 189 165
1049 Amelia Serrano  yellow 145 124
1219 Alan Nance  red 210 192
1246 Ravi Sinha  yellow 194 177
1078 Ashley McKnight  red 127 118
1221 Jim Brown  yellow 220 .
;

proc print data=club2;
   title 'Weight Club Members';
run;
```

The character variable Name, with a length of 18, contains members' first and last names separated by one blank space. The data lines must have two blank spaces between the values for the variable Name and the variable Team for the INPUT statement to correctly read the data.

The following output displays the resulting data set:

Figure 4.12 Data Set Created with Modified List Input (& $18.)

Weight Club Members

Obs	IdNumber	Name	Team	StartWeight	EndWeight
1	1023	David Shaw	red	189	165
2	1049	Amelia Serrano	yellow	145	124
3	1219	Alan Nance	red	210	192
4	1246	Ravi Sinha	yellow	194	177
5	1078	Ashley McKnight	red	127	118
6	1221	Jim Brown	yellow	220	.

Mixing Styles of Input

An Example of Mixed Input

When you begin an INPUT statement in a particular style (list, column, or formatted), you are not restricted to using that style alone. You can mix input styles in a single INPUT statement as long as you mix them in a way that appropriately describes the raw data records. For example, this DATA step uses all three input styles:

```
data club1;
   input IdNumber 1
         Name $18. 2
         Team $ 25-30 3
         StartWeight EndWeight;

   datalines;1
1023 David Shaw         red    189 165
1049 Amelia Serrano     yellow 145 124
1219 Alan Nance         red    210 192
1246 Ravi Sinha         yellow 194 177
1078 Ashley McKnight    red    127 118
1221 Jim Brown          yellow 220   .
;

proc print data=club1;
   title 'Weight Club Members';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 The variables IdNumber, StartWeight, and EndWeight are read with list input.

2 The variable Name is read with formatted input.

3 The variable Team is read with column input.

The following output demonstrates that the data is read correctly.

Figure 4.13 Data Set Created with Mixed Styles of Input

Weight Club Members

Obs	IdNumber	Name	Team	StartWeight	EndWeight
1	1023	David Shaw	red	189	165
2	1049	Amelia Serrano	yellow	145	124
3	1219	Alan Nance	red	210	192
4	1246	Ravi Sinha	yellow	194	177
5	1078	Ashley McKnight	red	127	118
6	1221	Jim Brown	yellow	220	.

Understanding the Effect of Input Style on Pointer Location

Why You Can Get into Trouble By Mixing Input Styles

CAUTION
When you mix styles of input in a single INPUT statement, you can get unexpected results if you do not understand where the input pointer is positioned after SAS reads a value in the input buffer. As the INPUT statement reads data values from the record in the input buffer, it uses a pointer to keep track of its position. Read the following sections so that you understand how the pointer movement differs between input styles before mixing multiple input styles in a single INPUT statement

Pointer Location with Column and Formatted Input

With column and formatted input, you supply the instructions that determine the exact pointer location. With column input, SAS reads the columns that you specify in the INPUT statement. With formatted input, SAS reads the exact length that you specify with the informat. In both cases, the pointer moves as far as you instruct it and stops. The pointer is left in the column that immediately follows the last column that is read.

Here are two examples of input followed by an explanation of the pointer location. The first DATA step shows column input:

```
data scores;
   input Team $ 1-6 Score 12-13;
   datalines;
red        59
blue       95
yellow     63
green      76
```

```
;
```

The second DATA step uses the same data to show formatted input:

```
data scores;
   input Team $6. +5 Score 2.;
   datalines;
red        59
blue       95
yellow     63
green      76
;
```

The following figure shows that the pointer is located in column 7 after the first value is read with either of the two previous INPUT statements.

Figure 4.14 *Pointer Position: Column and Formatted Input*

```
----+----1----+----2

red         59
```

Unlike list input, column and formatted input rely totally on your instructions to move the pointer and read the value for the second variable, Score. Column input uses column specifications to move the pointer to each data field. Formatted input uses informats and pointer controls to control the position of the pointer.

This INPUT statement uses column input with the column specifications 12-13 to move the pointer to column 12 and read the value for the variable Score:

```
input Team $ 1-6 Score 12-13;
```

This INPUT statement uses formatted input with the +5 column-pointer control to move the pointer to column 12. Then the value for the variable Score is read with the 2. numeric informat.

```
input Team $6. +5 Score 2.;
```

Without the use of a pointer control, which moves the pointer to the column where the value begins, this INPUT statement would attempt to read the value for Score in columns 7 and 8, which are blank.

Pointer Location with List Input

List input, on the other hand, uses a scanning method to determine the pointer location. With list input, the pointer reads until a blank is reached and then stops in the next column. To read the next variable value, the pointer moves automatically to the first nonblank column, discarding any leading blanks that it encounters. Here is the same data that is read with list input:

```
data scores;
   input Team $ Score;
   datalines;
red        59
blue       95
yellow     63
green      76
;
```

The following figure shows that the pointer is located in column 5 after the value `red` is read. Because Score, the next variable, is read with list input, the pointer scans for the next nonblank space before it begins to read a value for Score. Unlike column and formatted input, you do not have to explicitly move the pointer to the beginning of the next field in list input.

Figure 4.15 Pointer Position: List Input

```
----+----1----+----2

red        59
```

Summary

Statements

DATALINES;
: indicates that data lines immediately follow the DATALINES statement. A semicolon in the line that immediately follows the last data line indicates the end of the data and causes the DATA step to compile and execute.

INFILE DATALINES DLM='*character*';
: identifies the source of the input records as data lines in the job stream rather than as an external file. When your program contains the input data, the data lines directly follow the DATALINES statement. Because you can specify DATALINES in the INFILE statement, you can take advantage of many data-reading options that are available only through the INFILE statement.

  The DLM= option specifies the character that is used to separate data values in the input records. By default, a blank space denotes the end of a data value. This option is useful when you want to use list input to read data records in which a character other than a blank separates data values.

INPUT *variable* <&><$>;
: reads the input data record using list input. The & (ampersand format modifier) enables character values to contain embedded blanks. When you use the ampersand format modifier, two blanks are required to signal the end of a data value. The $ indicates a character variable.

INPUT *variable start-column* <– *end-column*>;
: reads the input data record using column input. You can omit end-column if the data is only 1 byte long. This style of input enables you to skip columns of data that you want to omit.

INPUT *variable* : *informat*;
INPUT *variable* & *informat*;
: reads the input data record using modified list input. The : (colon format modifier) instructs SAS to use the informat that follows to read the data value. The &

(ampersand format modifier) instructs SAS to use the informat that follows to read the data value. When you use the ampersand format modifier, two blanks are required to signal the end of a data value.

INPUT <*pointer-control*> *variable informat*;
reads raw data using formatted input. The informat supplies special instructions to read the data. You can also use a pointer-control to direct SAS to start reading at a particular column.

The syntax given above for the three styles of input shows only one variable. Subsequent variables in the INPUT statement might be described in the same input style as the first one. You can use any of the three styles of input (list, column, and formatted) in a single INPUT statement.

Column-Pointer Controls

@n
moves the pointer to the nth column in the input buffer.

+n
moves the pointer forward n columns in the input buffer.

/
moves the pointer to the next line in the input buffer.

#n
moves the pointer to the nth line in the input buffer.

Learning More

Advanced features
For some more advanced data-reading features, see Chapter 5, “Starting with Raw Data: Beyond the Basics,” on page 71.

Character-delimited data
For more information about reading data that is delimited by a character other than a blank space, see the DELIMITER= option in “INFILE Statement” in *SAS DATA Step Statements: Reference*.

Pointer controls
For a complete discussion and listing of column-pointer controls, line-pointer controls, and line-hold specifiers, see *SAS DATA Step Statements: Reference*.

Types of input
For more information about the INPUT statement, see “INPUT Statement” in *SAS DATA Step Statements: Reference*.

5

Starting with Raw Data: Beyond the Basics

Introduction to Beyond the Basics with Raw Data

Purpose

To create a SAS data set from raw data, you often need more than the most basic features. In this section, you will learn advanced features for reading raw data that include the following:

- how to understand and then control what happens when a value is unexpectedly missing in an input record
- how to read a record more than once so that you can test a condition before taking action on the current record
- how to create multiple observations from a single input record
- how to read multiple observations to create a single record

Prerequisites

Before continuing, you should understand the concepts presented in the following sections:

- Chapter 1, “What is the SAS System?,” on page 3
- Chapter 3, “Introduction to DATA Step Processing,” on page 25

Testing a Condition Before Creating an Observation

Sometimes you need to read a record, and hold that record in the input buffer while you test for a specified condition before a decision can be made about further processing. For example, the ability to hold a record so that you can read from it again, if necessary, is useful when you need to test for a condition before SAS creates an observation from a data record. To do this, you can use the trailing at-sign (@).

For example, to create a SAS data set that is a subset of a larger group of records, you might need to test for a condition to decide whether a particular record will be used to create an observation. The trailing at-sign placed before the semicolon at the end of an INPUT statement instructs SAS to hold the current data line in the input buffer. This makes the data line available for a subsequent INPUT statement. Otherwise, the next INPUT statement causes SAS to read a new record into the input buffer.

You can set up the process to read each record twice by following these steps:

1. Use an INPUT statement to read a portion of the record.
2. Use a trailing @ at the end of the INPUT statement to hold the record in the input buffer for the execution of the next INPUT statement.
3. Use an IF statement on the portion that is read in to test for a condition.
4. If the condition is met, use another INPUT statement to read the remainder of the record to create an observation.
5. If the condition is not met, the record is released and control passes back to the top of the DATA step.

To read from a record twice, you must prevent SAS from automatically placing a new record into the input buffer when the next INPUT statement executes. Use of a trailing @ in the first INPUT statement serves this purpose. The trailing @ is one of two line-hold specifiers that enable you to hold a record in the input buffer for further processing.

For example, the health and fitness club data contains information about all members. This DATA step creates a SAS data set that contains only members of the red team:

```
data red_team;
   input Team $ 13-18 @;   1
   if Team='red';   2
   input IdNumber 1-4 StartWeight 20-22 EndWeight 24-26; 3
   datalines;
1023 David  red    189 165
1049 Amelia yellow 145 124
1219 Alan   red    210 192
1246 Ravi   yellow 194 177
1078 Ashley red    127 118
1221 Jim    yellow 220   .
;  4

proc print data=red_team;
   title 'Red Team';
run;
```

In this DATA step, these actions occur:

1. The INPUT statement reads a record into the input buffer, reads a data value from columns 13 through 18, and assigns that value to the variable Team in the program data vector. The single trailing @ holds the record in the input buffer.
2. The IF statement enables the current iteration of the DATA step to continue only when the value for Team is `red`. When the value is not red, the current iteration stops and SAS returns to the top of the DATA step, resets values in the program data vector to missing, and releases the held record from the input buffer.
3. The INPUT statement executes only when the value of Team is `red`. It reads the remaining data values from the record held in the input buffer and assigns values to the variables IdNumber, StartWeight, and EndWeight.

4 The record is released from the input buffer when the program returns to the top of the DATA step.

The following output displays the resulting data set:

Figure 5.1 *Subset Data Set Created with Trailing @*

Red Team

Obs	Team	IdNumber	StartWeight	EndWeight
1	red	1023	189	165
2	red	1219	210	192
3	red	1078	127	118

Creating Multiple Observations from a Single Record

Using the Double Trailing @ Line-Hold Specifier

Sometimes you might need to create multiple observations from a single record of raw data. One way to tell SAS how to read such a record is to use the other line-hold specifier, the double trailing at-sign (@@ or "double trailing @"). The double trailing @ not only prevents SAS from reading a new record into the input buffer when a new INPUT statement is encountered. It also prevents the record from being released when the program returns to the top of the DATA step. (Remember that the trailing @ does not hold a record in the input buffer across iterations of the DATA step.)

For example, this DATA step uses the double trailing @ in the INPUT statement:

```
data body_fat;
   input Gender $ PercentFat @@;
   datalines;
m 13.3 f 22
m 22   f 23.2
m 16   m 12
;

proc print data=body_fat;
    title 'Results of Body Fat Testing';
run;
```

The following output displays the resulting data set.

Figure 5.2 Data Set Created with Double Trailing @

Results of Body Fat Testing

Obs	Gender	PercentFat
1	m	13.3
2	f	22.0
3	m	22.0
4	f	23.2
5	m	16.0
6	m	12.0

Understanding How the Double Trailing @ Affects DATA Step Execution

To understand how the data records in the previous example were read, look at the data lines that were used in the previous DATA step:

```
m 13.3 f 22
m 22   f 23.2
m 16   m 12
```

Each record contains the raw data for two observations instead of one. Consider this example in terms of the flow of the DATA step, as explained in Chapter 3, “Introduction to DATA Step Processing,” on page 25.

When SAS reaches the end of the DATA step, it returns to the top of the program and begins the next iteration, executing until there are no more records to read. Each time it returns to the top of the DATA step and executes the INPUT statement, it automatically reads a new record into the input buffer. The second set of data values in each record, therefore, would never be read:

```
m 13.3 f 22
m 22   f 23.2
m 16   m 12
```

To allow the second set of data values in each record to be read, the double trailing @ tells SAS to hold the record in the input buffer. Each record is held in the input buffer until the end of the record is reached. The program does not automatically place the next record into the input buffer each time the INPUT statement is executed. The current record is not automatically released when it returns to the top of the DATA step. As a result, the pointer location is maintained on the current record, which enables the program to read each value in that record. Each time the DATA step completes an iteration, an observation is written to the data set.

The next five figures demonstrate what happens in the input buffer when a double trailing @ appears in the INPUT statement, as in this example:

```
input Gender $ PercentFat @@;
```

The first figure shows that all values in the program data vector are set to missing. The INPUT statement reads the first record into the input buffer. The program begins to read values from the current pointer location, which is the beginning of the input buffer.

Figure 5.3 *First Iteration: First Record Is Read*

Input Buffer

```
----+----1----+----2
m 13.3 f 22
```

Program Data Vector

Gender	PercentFat
	.

The following figure shows that the value `m` is written to the program data vector. When the pointer reaches the blank space that follows 13.3, the complete value for the variable PercentFat has been read. The pointer stops in the next column, and the value 13.3 is written to the program data vector.

Figure 5.4 *First Observation Is Created*

Input Buffer

```
----+----1----+----2
m 13.3 f 22
```

Program Data Vector

Gender	PercentFat
m	13.3

There are no other variables in the INPUT statement and no more statements in the DATA step, so three actions take place:

1 The first observation is written to the data set.

2 The DATA step begins its next iteration.

3 The values in the program data vector are set to missing.

The following figure shows the current position of the pointer. SAS is ready to read the next piece of data in the same record.

Figure 5.5 Second Iteration: First Record Remains in the Input Buffer

Input Buffer

```
----+----1----+----2
m 13.3 f 22
```

Program Data Vector

Gender	PercentFat
	.

The following figure shows that the INPUT statement reads the next two values from the input buffer and writes them to the program data vector.

Figure 5.6 Second Observation Is Created

Input Buffer

```
----+----1----+----2
m 13.3 f 22
```

Program Data Vector

Gender	PercentFat
f	22

When the DATA step completes the second iteration, the values in the program data vector are written to the data set as the second observation. Then the DATA step begins its third iteration. Values in the program data vector are set to missing, and the INPUT statement executes. The pointer, which is now at column 13 (two columns to the right of the last data value that was read), continues reading. Because this is list input, the pointer scans for the next nonblank character to begin reading the next value. When the pointer reaches the end of the input buffer and fails to find a nonblank character, SAS reads a new record into the input buffer.

The final figure shows that values for the third observation are read from the beginning of the second record.

Figure 5.7 Third Iteration: Second Record Is Read into the Input Buffer

Input Buffer

```
----+----1----+----2
m 22   f 23.2
```

Program Data Vector

Gender	PercentFat
	.

The process continues until SAS reads all the records. The resulting SAS data set contains six observations instead of three.

Note: Although this program successfully reads all of the data in the input records, SAS writes a message to the log noting that the program had to go to a new line.

Reading Multiple Records to Create a Single Observation

How the Data Records Are Structured

An earlier example (see “Reading Character Data That Contains Embedded Blanks” on page 65) shows data for several observations that are contained in a single record of raw data:

```
1023 David Shaw       red 189 165
```

This INPUT statement reads all the data values arranged across a single record:

```
input IdNumber 1-4 Name $ 6-23 Team $ StartWeight EndWeight;
```

Now, consider the opposite situation: when information for a single observation is not contained in a single record of raw data but is scattered across several records. For example, the health and fitness club data could be constructed in such a way that the information about a single member is spread across several records instead of in a single record:

```
1023 David Shaw
red
189 165
```

Method 1: Using Multiple Input Statements

Multiple INPUT statements, one for each record, can read each record into a single observation, as in this example:

```
   input IdNumber 1-4 Name $ 6-23;
   input Team $ 1-6;
   input StartWeight 1-3 EndWeight 5-7;
```

To understand how to use multiple INPUT statements, consider what happens as a DATA step executes. Remember that one record is read into the INPUT buffer automatically as each INPUT statement is encountered during each iteration. SAS reads the data values from the input buffer and writes them to the program data vector as variable values. At the end of the DATA step, all the variable values in the program data vector are written automatically as a single observation.

This example uses multiple INPUT statements in a DATA step to read only selected data fields and create a data set containing only the variables IdNumber, StartWeight, and EndWeight.

```
data club2;
   input IdNumber 1-4;   1
   input;   2
   input StartWeight 1-3 EndWeight 5-7;  3
   datalines;
1023 David Shaw
red
189 165
1049 Amelia Serrano
yellow
145 124
1219 Alan Nance
red
210 192
1246 Ravi Sinha
yellow
194 177
1078 Ashley McKnight
red
127 118
1221 Jim Brown
yellow
220  .
;

proc print data=club2;
   title 'Weight Club Members';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 The first INPUT statement reads only one data field in the first record and assigns a value to the variable IdNumber.

2 The second INPUT statement, without arguments, is a null INPUT statement that reads the second record into the input buffer. However, it does not assign a value to a variable.

3 The third INPUT statement reads the third record into the input buffer and assigns values to the variables StartWeight and EndWeight.

The following output displays the resulting data set.

Figure 5.8 Data Set Created with Multiple INPUT Statements

Weight Club Members

Obs	IdNumber	StartWeight	EndWeight
1	1023	189	165
2	1049	145	124
3	1219	210	192
4	1246	194	177
5	1078	127	118
6	1221	220	.

Method 2: Using the / Line-Pointer Control

Writing a separate INPUT statement for each record is not the only way to create a single observation. You can write a single INPUT statement and use the slash (/) line-pointer control. The slash line-pointer control forces a new record into the input buffer and positions the pointer at the beginning of that record.

This example uses only one INPUT statement to read multiple records:

```
data club2;
   input IdNumber 1-4 / / StartWeight 1-3 EndWeight 5-7;
   datalines;
1023 David Shaw
red
189 165
1049 Amelia Serrano
yellow
145 124
1219 Alan Nance
red
210 192
1246 Ravi Sinha
yellow
194 177
1078 Ashley McKnight
red
127 118
1221 Jim Brown
yellow
220   .
;

proc print data=club2;
   title 'Weight Club Members';
run;
```

The / line-pointer control appears exactly where a new INPUT statement begins in the previous example. See "Method 1: Using Multiple Input Statements" on page 78. The sequence of events in the input buffer and the program data vector as this DATA step executes is identical to the previous example in method 1. The / is the signal to read a new record into the input buffer, which happens automatically when the DATA step encounters a new INPUT statement. The preceding example shows two slashes (/ /), indicating that SAS skips a record. SAS reads the first record, skips the second record, and reads the third record.

The following output displays the resulting data set.

Figure 5.9 *Data Set Created with the / Line-Pointer Control*

Weight Club Members

Obs	IdNumber	StartWeight	EndWeight
1	1023	189	165
2	1049	145	124
3	1219	210	192
4	1246	194	177
5	1078	127	118
6	1221	220	.

Reading Variables from Multiple Records in Any Order

You can also read multiple records to create a single observation by pointing to a specific record in a set of input records with the #*n* line-pointer control. As you saw in the last section, the advantage of using the / line-pointer control over multiple INPUT statements is that it requires fewer statements. However, using the #*n* line-pointer control enables you to read the variables in any order, no matter which record contains the data values. It is also useful if you want to skip data lines.

This example uses one INPUT statement to read multiple data lines in a different order:

```
data club2;
   input #2 Team $ 1-6 #1 Name $ 6-23 IdNumber 1-4
         #3 StartWeight 1-3 EndWeight 5-7;
   datalines;
1023 David Shaw
red
189 165
1049 Amelia Serrano
yellow
145 124
1219 Alan Nance
red
210 192
1246 Ravi Sinha
```

```
yellow
194 177
1078 Ashley McKnight
red
127 118
1221 Jim Brown
yellow
220   .
;

proc print data=club2;
   title 'Weight Club Members';
run;
```

The following output displays the resulting data set.

Figure 5.10 Data Set Created with the #n Line-Pointer Control

Weight Club Members

Obs	Team	Name	IdNumber	StartWeight	EndWeight
1	red	David Shaw	1023	189	165
2	yellow	Amelia Serrano	1049	145	124
3	red	Alan Nance	1219	210	192
4	yellow	Ravi Sinha	1246	194	177
5	red	Ashley McKnight	1078	127	118
6	yellow	Jim Brown	1221	220	.

The order of the observations is the same as in the raw records (shown in the section "Reading Variables from Multiple Records in Any Order" on page 81). However, the order of the variables in the data set differs from the order of the variables in the raw input data records. This occurs because the order of the variables in the INPUT statements corresponds with their order in the resulting data sets.

Understanding How the #n Line-Pointer Control Affects DATA Step Execution

To understand the importance of the #*n* line-pointer control, remember the sequence of events in the DATA steps that demonstrate the / line-pointer control and multiple INPUT statements. Each record is read into the input buffer sequentially. The data is read, and then a / or a new INPUT statement causes the program to read the next record into the input buffer. It is impossible for the program to read a value from the first record after a value from the second record is read because the data in the first record is no longer available in the input buffer.

To solve this problem, use the #*n* line-pointer control. The #*n* line-pointer control signals the program to create a multiple-line input buffer so that all the data for a single observation is available while the observation is being built in the program data vector. The #*n* line-pointer control also identifies the record in which data for each variable appears. To use the #*n* line-pointer control, the raw data must have the same number of records for each observation; for example, it cannot have three records for one observation and two for the next.

When the program compiles and builds the input buffer, it looks at the INPUT statement and creates an input buffer with as many lines as are necessary to contain the number of records that it needs to read for a single observation. In this example, the highest number of records specified is three, so the input buffer is built to contain three records at one time. The following figures demonstrate the flow of the DATA step in this example.

The following figure shows that the values are set to missing in the program data vector and that the INPUT statement reads the first three records into the input buffer.

Figure 5.11 *Three Records Are Read into the Input Buffer as a Single Observation*

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6
1023 David Shaw

----+----1----+----2----+----3----+----4----+----5----+----6
red

----+----1----+----2----+----3----+----4----+----5----+----6
189 165
```

Program Data Vector

Team	Name	IdNumber	StartWeight	EndWeight
		.	.	.

The INPUT statement for this example is as follows:

```
input #2 Team $ 1-6
      #1 Name $ 6-23 IdNumber 1-4
      #3 StartWeight 1-3 EndWeight 5-7;
```

The first variable is preceded by #2 to indicate that the value in the second record is assigned to the variable Team.

The following figure shows that the pointer advances to the second line in the input buffer, reads the value, and writes it to the program data vector.

Figure 5.12 Reading from the Second Record First

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6
1023 David Shaw

----+----1----+----2----+----3----+----4----+----5----+----6
red

----+----1----+----2----+----3----+----4----+----5----+----6
189 165
```

Program Data Vector

Team	Name	IdNumber	StartWeight	EndWeight
red		.	.	.

The following figure shows that the pointer then moves to the sixth column in the first record, reads a value, and assigns it to the variable Name in the program data vector. It then moves to the first column to read the ID number, and assigns it to the variable IdNumber.

Figure 5.13 Reading from the First Record

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6
1023 David Shaw

----+----1----+----2----+----3----+----4----+----5----+----6
red

----+----1----+----2----+----3----+----4----+----5----+----6
189 165
```

Program Data Vector

Team	Name	IdNumber	StartWeight	EndWeight
red	David Shaw	1023	.	.

The following figure shows that the process continues with the pointer moving to the third record in the first observation. Values are read and assigned to StartWeight and EndWeight, the last variable that is listed.

Figure 5.14 Reading from the Third Record

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6
1023 David Shaw

----+----1----+----2----+----3----+----4----+----5----+----6
red

----+----1----+----2----+----3----+----4----+----5----+----6
189 165
↑
```

Program Data Vector

Team	Name	IdNumber	StartWeight	EndWeight
red	David Shaw	1023	189	165

When the bottom of the DATA step is reached, variable values in the program data vector are written as an observation to the data set. The DATA step returns to the top, and values in the program data vector are set to missing. The INPUT statement executes again.

The final figure shows that the next three records are read into the input buffer, ready to create the second observation.

Figure 5.15 Reading the Next Three Records into the Input Buffer

Input Buffer

```
----+----1----+----2----+----3----+----4----+----5----+----6
1049 Amelia Serrano

----+----1----+----2----+----3----+----4----+----5----+----6
yellow

----+----1----+----2----+----3----+----4----+----5----+----6
145 124
```

Program Data Vector

Team	Name	IdNumber	StartWeight	EndWeight
		.	.	.

Problem Solving: When an Input Record Unexpectedly Does Not Have Enough Values

Understanding the Default Behavior

When a DATA step reads raw data from an external file, problems can occur when SAS encounters the end of an input line before reading in data for all variables specified in the input statement. This problem can occur when reading variable-length records, records containing missing values, or both.

The following is an example of an external file that contains variable-length records:

```
----+----1----+----2

22
333
4444
55555
```

This DATA step uses the numeric informat 5. to read a single field in each record of raw data and to assign values to the variable TestNumber:

```
data numbers;
   infile 'your-external-file';
  input TestNumber 5.;
run;

proc print data=numbers;
   title 'Test DATA Step';
run;
```

The DATA step reads the first value (22). Because the value is shorter than the 5 characters expected by the informat, the DATA step attempts to finish filling the value with the next record (333). This value is entered into the PDV and becomes the value of the TestNumber variable for the first observation. The DATA step then goes to the next record, but encounters the same problem because the value (4444) is shorter than the value that is expected by the informat. Again, the DATA step goes to the next record, reads the value (55555), and assigns that value to the TestNumber variable for the second observation.

The following output displays the results. After this program runs, the SAS log contains a note to indicate the places where SAS went to the next record to search for data values.

Figure 5.16 Reading Raw Data Past the End of a Line: Default Behavior

Test DATA Step

Obs	TestNumber
1	333
2	55555

Methods of Control: Your Options

Four Options: FLOWOVER, STOPOVER, MISSOVER, and TRUNCOVER

To control how SAS behaves after it attempts to read past the end of a data line, you can use the following options in the INFILE statement:

`infile 'your-external-file' flowover;`
: is the default behavior. The DATA step simply reads the next record into the input buffer, attempting to find values to assign to the rest of the variable names in the INPUT statement.

`infile 'your-external-file' stopover;`
: causes the DATA step to stop processing if an INPUT statement reaches the end of the current record without finding values for all variables in the statement. Use this option if you expect all of the data in the external file to conform to a given standard, and if you want the DATA step to stop when it encounters a data record that does not conform to the standard.

`infile 'your-external-file' missover;`
: prevents the DATA step from going to the next line if it does not find values in the current record for all of the variables in the INPUT statement. Instead, the DATA step assigns a missing value for all variables that do not have values.

`infile 'your-external-file' truncover;`
: causes the DATA step to assign the raw data value to the variable even if the value is shorter than expected by the INPUT statement. If, when the DATA step encounters the end of an input record, there are variables without values, the variables are assigned missing values for that observation.

You can also use these options even when your data lines are in the program itself, that is, when they follow the DATALINES statement. Simply use `datalines` instead of a reference to an external file to indicate that the data records are in the DATA step itself:

- `infile datalines flowover;`
- `infile datalines stopover;`
- `infile datalines missover;`
- `infile datalines truncover;`

Note: The examples in this section show the use of the MISSOVER and TRUNCOVER options with formatted input. You can also use these options with list input and column input.

Understanding the MISSOVER Option

The MISSOVER option prevents the DATA step from going to the next line if it does not find values in the current record for all of the variables in the INPUT statement. Instead, the DATA step assigns a missing value for all variables that do not have complete values according to any specified informats. The input file contains the following raw data:

```
----+----1----+----2

22
333
4444
55555
```

The following example uses the MISSOVER option:

```
data numbers;
   infile 'your-external-file' missover;
   input TestNumber 5.;
run;

proc print data=numbers;
   title 'Test DATA Step';
run;
```

Figure 5.17 Output from the MISSOVER Option

Test DATA Step

Obs	TestNumber
1	.
2	.
3	.
4	55555

Because the fourth record is the only one whose value matches the informat, it is the only record whose value is assigned to the TestNumber variable. The other observations receive missing values. This result is probably not the desired outcome for this example, but the MISSOVER option can sometimes be valuable. For an example, see "Updating a Data Set" on page 331.

Note: If there is a blank line at the end of the last record, the DATA step attempts to load another record into the input buffer. Because there are no more records, the MISSOVER option instructs the DATA step to assign missing values to all variables, and an extra observation is added to the data set. To prevent this situation from occurring, make sure that your input data does not have a blank line at the end of the last record.

Understanding the TRUNCOVER Option

The TRUNCOVER option causes the DATA step to assign the raw data value to the variable even if the value is shorter that the length that is expected by the INPUT statement. If, when the DATA step encounters the end of an input record, there are variables without values, the variables are assigned missing values for that observation. The following example demonstrated the use of the TRUNCOVER option:

```
data numbers;
   infile 'your-external-file' truncover;
   input TestNumber 5.;
run;

proc print data=numbers;
   title 'Test DATA Step';
run;
```

Figure 5.18 *Output from the TRUNCOVER Option*

Test DATA Step

Obs	TestNumber
1	22
2	333
3	4444
4	55555

This result shows that all of the values were assigned to the TestNumber variable, despite the fact that three of them did not match the informat. For another example using the TRUNCOVER option, see "Input SAS Data Set for Examples" on page 154.

Summary

Column-Pointer Controls

@ *n*
: moves the pointer to the *n* column in the input buffer.

+*n*
: moves the pointer forward *n* columns in the input buffer.

/
: moves the pointer to the next line in the input buffer.

#*n*
: moves the pointer to the *n*th line in the input buffer.

Line-Hold Specifiers

@
: (trailing @) prevents SAS from automatically reading a new data record into the input buffer when a new INPUT statement is executed within the same iteration of the DATA step. When used, the trailing @ must be the last item in the INPUT statement.

@@
: (double trailing @) prevents SAS from automatically reading a new data record into the input buffer when the next INPUT statement is executed, even if the DATA step returns to the top for another iteration. When used, the double trailing @ must be the last item in the INPUT statement.

Statements

DATALINES;
: indicates that data lines immediately follow. A semicolon in the line that immediately follows the last data line indicates the end of the data and causes the DATA step to compile and execute.

INFILE fileref< FLOWOVER | STOPOVER | MISSOVER | TRUNCOVER>;
INFILE '*external-file*' <FLOWOVER | STOPOVER | MISSOVER | TRUNCOVER>;
: identifies an external file to be read by an INPUT statement. Specify a fileref that has been assigned with a FILENAME statement or with an appropriate operating environment command. Or you can specify the actual name of the external file.

These options give you control over how SAS behaves if the end of a data record is encountered before all of the variables are assigned values. You can use these options with list, modified list, formatted, and column input.

FLOWOVER
is the default behavior. It causes the DATA step to look in the next record if the end of the current record is encountered before all of the variables are assigned values

MISSOVER
causes the DATA step to assign missing values to any variables that do not have values when the end of a data record is encountered. The DATA step continues processing.

STOPOVER
causes the DATA step to stop execution immediately and write a note to the SAS log.

TRUNCOVER
: causes the DATA step to assign values to variables, even if the values are shorter than expected by the INPUT statement, and to assign missing values to any variables that do not have values when the end of a record is encountered.

INPUT *variable* <&> <$>;
: reads the input data record using list input. The & (ampersand format modifier) allows character values to contain embedded blanks. When you use the ampersand format modifier, two blanks are required to signal the end of a data value. The $ indicates a character variable.

INPUT variable *start-column* <*end-column*>;
: reads the input data record using column input. You can omit end-column if the data is only 1 byte long. This style of input enables you to skip columns of data that you want to omit.

INPUT *variable* : *informat*;
INPUT *variable* & *informat*;
: reads the input data record using modified list input. The : (colon format modifier) instructs SAS to use the informat that follows to read the data value. The & (ampersand format modifier) instructs SAS to use the informat that follows to read the data value. When you use the ampersand format modifier, two blanks are required to signal the end of a data value.

INPUT <*pointer-control*>*variable informat*;
: reads raw data using formatted input. The *informat* supplies special instructions to read the data. You can also use a *pointer-control* to direct SAS to start reading at a particular column.

The syntax given above for the three styles of input shows only one *variable*. Subsequent variables in the INPUT statement might be described in the same input style as the first one. You can use any of the three styles of input (list, column, and formatted) in a single INPUT statement.

Learning More

Handling missing data values
: For complete details about the FLOWOVER, STOPOVER, MISSOVER, and TRUNCOVER options in the INFILE statement, see "INFILE Statement" in *SAS DATA Step Statements: Reference*.

Testing a condition

- For more information about performing conditional processing with the IF statement, see Chapter 10, "Acting on Selected Observations," on page 153 and Chapter 11, "Creating Subsets of Observations," on page 175.
- For a complete discussion and listing of line-pointer controls and line-hold specifiers, see "PUT Statement" in *SAS DATA Step Statements: Reference*.

6

Starting with SAS Data Sets

Introduction to Starting with SAS Data Sets

Purpose

In this section, you will learn how to do the following:

- display information about a SAS data set
- create a new SAS data set from an existing SAS data set rather than creating it from raw data records

Reading a SAS data set in a DATA step is simpler than reading raw data because the work of describing the data to SAS has already been done.

Prerequisites

Before continuing, you should understand the concepts presented in the following sections:

- Chapter 1, “What is the SAS System?,” on page 3
- Chapter 3, “Introduction to DATA Step Processing,” on page 25

Understanding the Basics

When you use a SAS data set as input into a DATA step, the description of the data set is available to SAS. In your DATA step, use a SET, MERGE, MODIFY, or UPDATE statement to read the SAS data set. Use SAS programming statements to process the data and create an output SAS data set.

In a DATA step, you can create a new data set that is a subset of the original data set. For example, if you have a large data set of personnel data, you might want to look at a subset of observations that meet certain conditions, such as observations for employees hired after a certain date. Alternatively, you might want to see all observations but only a few variables, such as the number of years of education or years of service to the company.

When you use existing SAS data sets, as well as with subsets created from SAS data sets, you can make more efficient use of computer resources than if you use raw data or if you are working with large data sets. Reading fewer variables means that SAS creates a smaller program data vector, and reading fewer observations means that fewer iterations of the DATA step occur. Reading data directly from a SAS data set is more efficient than reading the raw data again, because the work of describing and converting the data has already been done.

One way of looking at a SAS data set is to produce a listing of the data in a SAS data set by using the PRINT procedure. Another way to look at a SAS data set is to display information that describes its structure rather than its data values. To display information about the structure of a data set, use the DATASETS procedure with the CONTENTS statement. If you need to work with a SAS data set that is unfamiliar to you, the CONTENTS statement in the DATASETS procedure displays information such as the name, type, and length of all the variables in the data set. An example that shows the CONTENTS statement in the DATASETS procedure is shown in “Input SAS Data Set for Examples” on page 94.

Input SAS Data Set for Examples

The examples in this section use a SAS data set named CITY, which contains information about expenditures for a small city. It reports total city expenditures for the years 1980 through 2000 and divides the expenses into two major categories: services and administration.

The following example uses the DATASETS procedure with the NOLIST option to display the CITY data set. The NOLIST option prevents the DATASETS procedure from listing other data sets that are also located in the WORK library:

```
data city;
   input Year 4. @7 ServicesPolice comma6.
         @15 ServicesFire comma6. @22 ServicesWater_Sewer comma6.
         @30 AdminLabor comma6. @39 AdminSupplies comma6.
         @45 AdminUtilities comma6.;
   ServicesTotal=ServicesPolice+ServicesFire+ServicesWater_Sewer;
   AdminTotal=AdminLabor+AdminSupplies+AdminUtilities;
   Total=ServicesTotal+AdminTotal;
   label               Total='Total Outlays'
                ServicesTotal='Services: Total'
               ServicesPolice='Services: Police'
                 ServicesFire='Services: Fire'
         ServicesWater_Sewer='Services: Water & Sewer'
                   AdminTotal='Administration: Total'
                   AdminLabor='Administration: Labor'
                AdminSupplies='Administration: Supplies'
               AdminUtilities='Administration: Utilities';
   datalines;
1993  2,819   1,120    422   391      63     98
1994  2,477   1,160    500   172      47     70
1995  2,028   1,061    510   269      29     79
1996  2,754     893    540   227      21     67
1997  2,195     963    541   214      21     59
1998  1,877     926    535   198      16     80
1999  1,727   1,111    535   213      27     70
2000  1,532   1,220    519   195      11     69
2001  1,448   1,156    577   225      12     58
2002  1,500   1,076    606   235      19     62
2003  1,934     969    646   266      11     63
2004  2,195   1,002    643   256      24     55
2005  2,204     964    692   256      28     70
2006  2,175   1,144    735   241      19     83
2007  2,556   1,341    813   238      25     97
2008  2,026   1,380    868   226      24     97
2009  2,526   1,454    946   317      13     89
2010  2,027   1,486  1,043   226       .     82
2011  2,037   1,667  1,152   244      20     88
2012  2,852   1,834  1,318   270      23     74
2013  2,787   1,701  1,317   307      26     66
;
proc datasets library=work nolist;
   contents data=city;
run;
```

The following outputs display the contents of the CITY data set, as well as information about the data set.

Figure 6.1 *Part 1: The Structure of CITY as Shown by PROC DATASETS*

The SAS System

The DATASETS Procedure

Data Set Name	WORK.CITY	**Observations**	21
Member Type	DATA	**Variables**	10
Engine	V9	**Indexes**	0
Created	04/30/2013 15:29:12	**Observation Length**	80
Last Modified	04/30/2013 15:29:12	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Figure 6.2 *Part 2: The Structure of CITY as Shown by PROC DATASETS*

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	817
Obs in First Data Page	21
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	C:\Users\userid\AppData\Local\Temp\SAS Temporary Files_TD1234_D56789_\city.sas7bdat
Release Created	9.0401B0
Host Created	W32_7PRO

Figure 6.3 *Part 3: The Structure of CITY as Shown by PROC DATASETS*

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Label
5	AdminLabor	Num	8	Administration: Labor
6	AdminSupplies	Num	8	Administration: Supplies
9	AdminTotal	Num	8	Administration: Total
7	AdminUtilities	Num	8	Administration: Utilities
3	ServicesFire	Num	8	Services: Fire
2	ServicesPolice	Num	8	Services: Police
8	ServicesTotal	Num	8	Services: Total
4	ServicesWater_Sewer	Num	8	Services: Water & Sewer
10	Total	Num	8	Total Outlays
1	Year	Num	8	

The following list corresponds to items in the three SAS outputs shown above:

1 The Observations and the Variables fields in Figure 6.1 on page 96 identify the number of observations and the number of variables.

2 The Engine/Host Dependent Information section in Figure 6.2 on page 96 lists detailed information about the data set. This information is generated by the engine, which is the mechanism for reading from and writing to files.

3 The Alphabetic List of Variables and Attributes in Figure 6.3 on page 96 lists the name, type, length, and position of each variable.

4 The Label in Figure 6.3 on page 96 lists the format, informat, and label for each variable, if they exist.

Operating Environment Information: The output in the Engine/Host Dependent Information section might differ, depending on your operating environment. For more information, see the SAS documentation for your operating environment.

Reading Selected Observations

If you are interested in only part of a large data set, you can use data set options to create a subset of your data. Data set options specify which observations you want the new data set to include. In Chapter 11, “Creating Subsets of Observations,” on page 175 you learn how to use the subsetting IF statement to create a subset of a large SAS data set. In this section, you learn how to use the FIRSTOBS= and OBS= data set options to create subsets of a larger data set.

For example, you might not want to read the observations at the beginning of the data set. You can use the FIRSTOBS= data set option to define which observation should be the first one that is processed. For the data set CITY, this example creates a data set that excludes observations that contain data prior to 1991 by specifying FIRSTOBS=12. As a result, SAS does not read the first 11 observations, which contain data prior to 1991. (To see the program that creates the CITY data set, see “DATA Step to Create the CITY Data Set” on page 852.)

The following program creates the data set CITY2, which contains the same number of variables but fewer observations than CITY.

```
data city2;
   set city(firstobs=12);
run;

proc print;
   title 'City Expenditures';
   title2 '1991 - 2000';
run;
```

The following output displays the results:

Figure 6.4 *Subsetting a Data Set by Observations*

City Expenditures
2004 - 2013

Obs	Year	ServicesPolice	ServicesFire	ServicesWater_Sewer	AdminLabor	AdminSupplies	AdminUtilities	ServicesTotal	AdminTotal	Total
1	2004	2195	1002	643	256	24	55	3840	335	4175
2	2005	2204	964	692	256	28	70	3860	354	4214
3	2006	2175	1144	735	241	19	83	4054	343	4397
4	2007	2556	1341	813	238	25	97	4710	360	5070
5	2008	2026	1380	868	226	24	97	4274	347	4621
6	2009	2526	1454	946	317	13	89	4926	419	5345
7	2010	2027	1486	1043	226	.	82	4556	.	.
8	2011	2037	1667	1152	244	20	88	4856	352	5208
9	2012	2852	1834	1318	270	23	74	6004	367	6371
10	2013	2787	1701	1317	307	26	66	5805	399	6204

You can also specify the last observation that you want to include in a new data set with the OBS= data set option. For example, the next program creates a SAS data set containing only the observations for 1989 (the 10th observation) through 1994 (the 15th observation).

```
data city3;
   set city (firstobs=10 obs=15);
run;
```

Reading Selected Variables

Overview of Reading Selected Variables

You can create a subset of a larger data set not only by excluding observations but also by specifying which variables you want the new data set to contain. In a DATA step, you can use the SET statement and the KEEP= or DROP= data set options (or the DROP and KEEP statements) to create a subset from a larger data set by specifying which variables you want the new data set to include.

Keeping Selected Variables

This example uses the KEEP= data set option in the SET statement to read only the variables that represent the services-related expenditures of the data set CITY.

```
data services;
   set city (keep=Year ServicesTotal ServicesPolice ServicesFire
            ServicesWater_Sewer);
run;

proc print data=services;
   title 'City Services-Related Expenditures';
run;
```

The following output displays the resulting data set. Note that the data set SERVICES contains only those variables that are specified in the KEEP= option.

Figure 6.5 Selecting Variables with the KEEP= Option

City Services-Related Expenditures

Obs	Year	ServicesPolice	ServicesFire	ServicesWater_Sewer	ServicesTotal
1	2004	2195	1002	643	3840
2	2005	2204	964	692	3860
3	2006	2175	1144	735	4054
4	2007	2556	1341	813	4710
5	2008	2026	1380	868	4274
6	2009	2526	1454	946	4926
7	2010	2027	1486	1043	4556
8	2011	2037	1667	1152	4856
9	2012	2852	1834	1318	6004
10	2013	2787	1701	1317	5805

The following example uses the KEEP statement instead of the KEEP= data set option to read all of the variables from the CITY data set. The KEEP statement creates a new data set (SERVICES) that contains only the variables listed in the KEEP statement. The following program gives results that are identical to those in the previous example:

```
data services;
   set city;
   keep Year ServicesTotal ServicesPolice ServicesFire
        ServicesWater_Sewer;
run;
```

The following example has the same effect as using the KEEP= data set option in the DATA statement. All of the variables are read into the program data vector, but only the specified variables are written to the SERVICES data set:

```
data services (keep=Year ServicesTotal ServicesPolice ServicesFire
               ServicesWater_Sewer);
   set city;
run;
```

Dropping Selected Variables

Use the DROP= option to create a subset of a larger data set when you want to specify which variables are being excluded rather than which ones are being included. The following DATA step reads all of the variables from the data set CITY except for those that are specified with the DROP= option. It then creates a data set named SERVICES2:

```
data services2;
   set city (drop=Total AdminTotal AdminLabor AdminSupplies
             AdminUtilities);
run;

proc print data=services2;
   title 'City Services-Related Expenditures';
run;
```

The following output displays the resulting data set:

Figure 6.6 Excluding Variables with the DROP= Option

City Services-Related Expenditures

Obs	Year	ServicesPolice	ServicesFire	ServicesWater_Sewer	ServicesTotal
1	2004	2195	1002	643	3840
2	2005	2204	964	692	3860
3	2006	2175	1144	735	4054
4	2007	2556	1341	813	4710
5	2008	2026	1380	868	4274
6	2009	2526	1454	946	4926
7	2010	2027	1486	1043	4556
8	2011	2037	1667	1152	4856
9	2012	2852	1834	1318	6004
10	2013	2787	1701	1317	5805

The following example uses the DROP statement instead of the DROP= data set option to read all of the variables from the CITY data set. It also excludes the variables that are listed in the DROP statement from being written to the new data set. The results are identical to those in the previous example:

```
data services2;
   set city;
   drop Total AdminTotal AdminLabor AdminSupplies AdminUtilities;
run;
proc print data=services2;
run;
```

Choosing between Data Set Options and Statements

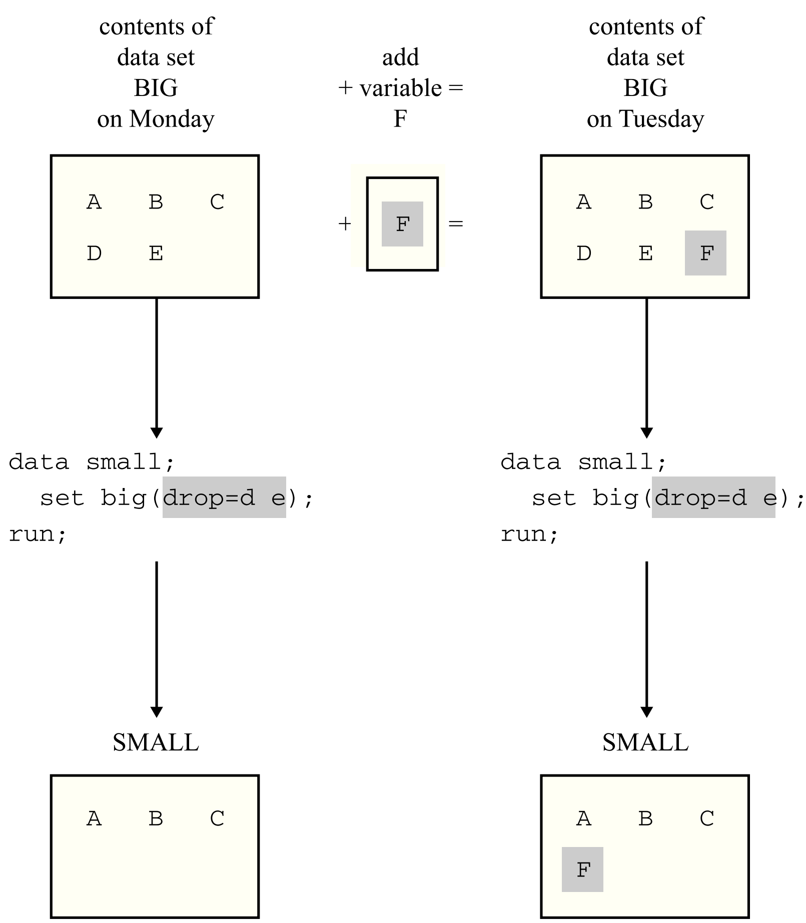
When you create only one data set in the DATA step, the data set options to drop and keep variables have the same effect on the output data set as the statements to drop and keep variables. When you want to control which variables are read into the program data vector, use the data set options in the statement (such as a SET statement) that reads the SAS data set. The options are generally more efficient than using the statements. Later topics in this section show you how to use the data set options in some cases where the statements will not work.

Choosing between the DROP= and KEEP= Data Set Option

In a simple case, you might decide to use the DROP= or KEEP= option, depending on which method enables you to specify fewer variables. If you work with large jobs that read data sets, and you expect that variables might be added between the times your batch jobs run, then you might want to use the KEEP= option to specify which variables are included in the subset data set.

The following figure shows two data sets named SMALL. They have different contents because the new variable F was added to data set BIG before the DATA step ran on Tuesday. The DATA step uses the DROP= option to keep variables D and E from being written to the output data set. The result is that the data sets contain different contents: the second SMALL data set has an extra variable, F. If the DATA step used the KEEP= option to specify A, B, and C, then both of the SMALL data sets would have the same variables (A, B, and C). The addition of variable F to the original data set BIG would have no effect on the creation of the SMALL data set.

Figure 6.7 *Using the DROP= Option*



Creating More Than One Data Set in a Single DATA Step

You can use a single DATA step to create more than one data set at a time. You can create data sets with different contents by using the KEEP= or DROP= data set options. For example, the following DATA step creates two SAS data sets: SERVICES contains variables that show services-related expenditures, and ADMIN contains variables that represent the administration-related expenditures. Use the KEEP= option after each data set name in the DATA statement to determine which variables are written to each SAS data set being created.

```
data services(keep=ServicesTotal ServicesPolice ServicesFire
```

```
                  ServicesWater_Sewer)
         admin(keep=AdminTotal AdminLabor AdminSupplies
               AdminUtilities);
   set city;
run;

proc print data=services;
   title 'City Expenditures: Services';
run;

proc print data=admin;
   title 'City Expenditures: Administration';
run;
```

The following two output display both data sets. Note that each data set contains only the variables that are specified with the KEEP= option after its name in the DATA statement.

Figure 6.8 *Creating Two Data Sets in One DATA Step, Services*

City Expenditures: Services

Obs	ServicesPolice	ServicesFire	ServicesWater_Sewer	ServicesTotal
1	2819	1120	422	4361
2	2477	1160	500	4137
3	2028	1061	510	3599
4	2754	893	540	4187
5	2195	963	541	3699
6	1877	926	535	3338
7	1727	1111	535	3373
8	1532	1220	519	3271
9	1448	1156	577	3181
10	1500	1076	606	3182
11	1934	969	646	3549
12	2195	1002	643	3840
13	2204	964	692	3860
14	2175	1144	735	4054
15	2556	1341	813	4710
16	2026	1380	868	4274
17	2526	1454	946	4926
18	2027	1486	1043	4556
19	2037	1667	1152	4856
20	2852	1834	1318	6004
21	2787	1701	1317	5805

Figure 6.9 Creating Two Data Sets in One DATA Step, Administration

City Expenditures: Administration

Obs	AdminLabor	AdminSupplies	AdminUtilities	AdminTotal
1	391	63	98	552
2	172	47	70	289
3	269	29	79	377
4	227	21	67	315
5	214	21	59	294
6	198	16	80	294
7	213	27	70	310
8	195	11	69	275
9	225	12	58	295
10	235	19	62	316
11	266	11	63	340
12	256	24	55	335
13	256	28	70	354
14	241	19	83	343
15	238	25	97	360
16	226	24	97	347
17	317	13	89	419
18	226	.	82	.
19	244	20	88	352
20	270	23	74	367
21	307	26	66	399

Note: In this case, using the KEEP= data set option is necessary, because when you use the KEEP statement, all data sets that are created in the DATA step contain the same variables.

Using the DROP= and KEEP= Data Set Options for Efficiency

The DROP= and KEEP= data set options are valid in both the DATA statement and the SET statement. However, you can write a more efficient DATA step if you understand the consequences of using these options in the DATA statement rather than the SET statement.

In the DATA statement, these options affect which variables SAS writes from the program data vector to the resulting SAS data set. In the SET statement, these options determine which variables SAS reads from the input SAS data set. Therefore, they determine how the program data vector is built.

When you specify the DROP= or KEEP= option in the SET statement, SAS does not read the excluded variables into the program data vector. If you work with a large data set (perhaps one containing thousands or millions of observations), then you can construct a more efficient DATA step by not reading unneeded variables from the input data set.

Note also that if you use a variable from the input data set to perform a calculation, the variable must be read into the program data vector. If you do not want that variable to appear in the new data set, however, use the DROP= option in the DATA statement to exclude it.

The following DATA step creates the same two data sets as the DATA step in the previous example. It does not read the variable Total into the program data vector. Compare the SET statement here to the one in "Creating More Than One Data Set in a Single DATA Step" on page 101.

```
data services (keep=ServicesTotal ServicesPolice ServicesFire
               ServicesWater_Sewer)
     admin (keep=AdminTotal AdminLabor AdminSupplies
            AdminUtilities);
   set city(drop=Total);
run;

proc print data=services;
   title 'City Expenditures: Services';
run;

proc print data=admin;
   title 'City Expenditures: Administration';
run;
```

In contrast with previous examples, the data set options in this example appear in both the DATA and SET statements. In the SET statement, the DROP= option determines which variables are omitted from the program data vector. In the DATA statement, the KEEP= option controls which variables are written from the program data vector to each data set being created.

Note: Using a DROP or KEEP statement is comparable to using a DROP= or KEEP= option in the DATA statement. All variables are included in the program data vector; they are excluded when the observation is written from the program data vector to the new data set. When you create more than one data set in a single DATA step, use the data set options to drop or keep different variables in each of the new data sets. A DROP or KEEP statement, on the other hand, affects all of the data sets that are created.

Summary

Data Set Options

DROP=*variable(s)*
: specifies the variables to be excluded.

Used in the SET statement, DROP= specifies the variables that are not to be read from the existing SAS data set into the program data vector. Used in the DATA statement, DROP= specifies the variables to be excluded from the data set that is being created.

FIRSTOBS=*n*
: specifies the first observation to be read from the SAS data set that you specify in the SET statement.

KEEP=*variable(s)*
: specifies the variables to be included.

Used in the SET statement, KEEP= specifies the variables to be read from the existing SAS data set into the program data vector. Used in the DATA statement, KEEP= specifies which variables in the program data vector are to be written to the data set being created.

OBS=*n*
: specifies the last observation to be read from the SAS data set that you specify in the SET statement.

Procedures

PROC DATASETS <LIBRARY=*SAS-data-library*>;CONTENTS <DATA=*SAS-data set*>;
: describes the structure of a SAS data set, including the name, type, and length of all variables in the data set.

Statements

DATA *SAS-data-set*<(*data-set-options*)>;
: begins a DATA step and names the SAS data set or data sets that are being created. You can specify the DROP= or KEEP= data set options in parentheses after each data set name to control which variables are written to the output data set from the program data vector.

DROP *variable(s)*;
: specifies the variables to be excluded from the data set that is being created. For more information, see "DROP Statement" in *SAS DATA Step Statements: Reference*.

KEEP *variable(s)*
: specifies the variables to be written to the data set that is being created. For more information, see "KEEP Statement" in *SAS DATA Step Statements: Reference*.

SET SAS-*data-set*(*data-set-options*);
: reads observations from a SAS data set rather than records of raw data. You can specify the DROP= or KEEP= data set options in parentheses after a data set name to control which variables are read into the program data vector from the input data set.

Learning More

Creating SAS data sets
: For a general discussion about creating SAS data sets from other SAS data sets by merging, concatenating, interleaving, and updating, see Chapter 16, "Methods of Combining SAS Data Sets," on page 257.

Data set options
: See the "Data Set Options" section of *SAS Data Set Options: Reference*, and the SAS documentation for your operating environment.

DROP and KEEP statements
: For more information, see "DROP Statement" in *SAS DATA Step Statements: Reference* and "KEEP Statement" in *SAS DATA Step Statements: Reference*.

Engines
: *SAS Language Reference: Concepts*.

Subsetting IF statement
: You can use the subsetting IF statement and conditional (IF-THEN) logic when creating a new SAS data set from an existing one. For more information, see Chapter 10, "Acting on Selected Observations," on page 153 and Chapter 11, "Creating Subsets of Observations," on page 175.

PART 3

Basic Programming

7

Understanding DATA Step Processing

Overview of DATA Step Processing

Purpose

To add, modify, and delete information in a SAS data set, you use a DATA step. In this section, you will learn how the DATA step works, the general form of the statements, and some programming techniques.

Prerequisites

Before continuing, you should understand the concepts presented in the following sections:

- Chapter 3, “Introduction to DATA Step Processing,” on page 25
- Chapter 4, “Starting with Raw Data: The Basics,” on page 51

Input SAS Data Set for Examples

Tradewinds Travel Inc. has an external file that they use to manipulate and store data about their tours. The external file contains the following information:

```
1       2   3   4   5
----------------------------
France  8   793 575 Major
Spain  10   805 510 Hispania
India  10     . 489 Royal
Peru    7   722 590 Mundial
```

The columns in the above example contain the following information:

1 the name of the country toured

2 the number of nights on the tour

3 the airfare in US dollars

4 the cost of the land package in US dollars

5 the name of the company that offers the tour

Notice that the cost of the airfare for the tour to India has a missing value, which is indicated by a period.

The following DATA step creates a permanent SAS data set named MYLIB.INTERNATIONALTOURS:

```
libname mylib 'permanent-data-library';

data mylib.internationaltours;
    infile 'input-file';
    input Country $ Nights AirCost LandCost Vendor $;

proc print data = mylib.internationaltours;
   title 'Data Set MYLIB.INTERNATIONALTOURS';
run;
```

The PROC PRINT statement that follows the DATA step produces this display of the MYLIB.INTERNATIONALTOURS data set:

Figure 7.1 Creating a Permanent SAS Data Set

Data Set MYLIB.INTERNATIONALTOURS

Obs	Country	Nights	AirCost	LandCost	Vendor
1	France	8	793	575	Major
2	Spain	10	805	510	Hispania
3	India	10	.	489	Royal
4	Peru	7	722	590	Mundial

Adding Information to a SAS Data Set

Understanding the Assignment Statement

One of the most common reasons for using program statements in the DATA step is to produce new information from the original information or to change the information read by the INPUT or SET/MERGE/MODIFY/UPDATE statement. How do you add information to observations with a DATA step?

The basic method of adding information to a SAS data set is to create a new variable in a DATA step with an assignment statement. An assignment statement has the form:

variable=*expression*;

The variable receives the new information; the expression creates the new information. You specify the calculation necessary to produce the information and write the calculation as the expression. When the expression contains character data, you must enclose the data in quotation marks. SAS evaluates the expression and stores the new information in the variable that you name. It is important to remember that if you need to add the information to only one or two observations out of many, SAS creates that variable for all observations. The SAS data set that is being created must have information in every observation and every variable.

Making Uniform Changes to Data By Creating a Variable

Sometimes you want to make a particular change to every observation. For example, at Tradewinds Travel the airfare must be increased for every tour by $10 because of a new tax. One way to do this is to write an assignment statement that creates a new variable that calculates the new airfare:

```
NewAirCost = AirCost+10;
```

This statement directs SAS to read the value of AirCost, add 10 to it, and assign the result to the new variable, NewAirCost.

When this assignment statement is included in a DATA step, the DATA step looks like this:

```
data newair;
   set mylib.internationaltours;
   NewAirCost = AirCost + 10;

proc print data=newair;
   var Country AirCost NewAirCost;
   title 'Increasing the Air Fare by $10 for All Tours';
run;
```

Note: In this example, the VAR statement in the PROC PRINT step determines which variables are displayed in the output.

The following output shows the resulting SAS data set, NEWAIR.

Figure 7.2 Adding Information to All Observations By Using a New Variable

Increasing the Air Fare by $10 for All Tours

Obs	Country	AirCost	NewAirCost	
				1
1	France	793	803	
2	Spain	805	815	
3	India	.	.	2
4	Peru	722	732	

Notice the following in this data set:

1 Because SAS carries out each statement in the DATA step for every observation, NewAirCost is calculated during each iteration of the DATA step.

2 The observation for India contains a missing value for AirCost; SAS therefore assigns a missing value to NewAirCost for that observation.

The SAS data set has information in every observation and every variable.

Adding Information to Some Observations but Not Others

Often you need to add information to some observations but not to others. For example, some tour operators award bonus points to travel agencies for scheduling particular tours. Two companies, Hispania and Mundial, are offering bonus points this year.

IF-THEN/ELSE statements can cause assignment statements to be carried out only when a condition is met. In the following DATA step, the IF statements check the value of the variable Vendor. If the value is either Hispania or Mundial, information about the bonus points is added to those observations.

```
data bonus;
   set mylib.internationaltours;
```

```
   if Vendor = 'Hispania' then BonusPoints = 'For 10+ people';
   else if Vendor = 'Mundial' then BonusPoints = 'Yes';
run;

proc print data=bonus;
   var Country Vendor BonusPoints;
   title1 'Adding Information to Observations for';
   title2 'Vendors Who Award Bonus Points';
run;
```

The following output displays the results:

Figure 7.3 *Specifying Values for Specific Observations By Using a New Variable*

Adding Information to Observations for Vendors Who Award Bonus Points

Obs	Country	Vendor	BonusPoints
1	France	Major	❶
2	Spain	Hispania	For 10+ people ❷
3	India	Royal	❶
4	Peru	Mundial	Yes

The new variable BonusPoints has the following information:

1 In the two observations that are not assigned a value for BonusPoints, SAS assigns a missing value, represented by a blank in this case, to indicate the absence of a character value.

2 The first value that SAS encounters for BonusPoints contains 14 characters; therefore, SAS sets aside 14 bytes of storage in each observation for BonusPoints, regardless of the length of the value for that observation.

Making Uniform Changes to Data without Creating Variables

Sometimes you want to change the value of existing variables without adding new variables. For example, in one DATA step a new variable, NewAirCost, was created to contain the value of the airfare plus the new $10 tax:

```
NewAirCost = AirCost + 10;
```

You can also decide to change the value of an existing variable rather than create a new variable. Following the example, AirCost is changed as follows:

```
AirCost = AirCost + 10;
```

SAS processes this statement just as it does other assignment statements. It evaluates the expression on the right side of the equal sign and assigns the result to the variable on the left side of the equal sign. The fact that the same variable appears on the right and left sides of the equal sign does not matter. SAS evaluates the expression on the right side of the equal sign before looking at the variable on the left side.

The following program contains the new assignment statement:

```
data newair2;
   set mylib.internationaltours;
   AirCost = AirCost + 10;

proc print data=newair2;
   var Country AirCost;
   title 'Adding Tax to the Air Cost Without Adding a New Variable';
run;
```

The following output displays the results:

Figure 7.4 *Changing the Information in a Variable*

Adding Tax to the Air Cost Without Adding a New Variable

Obs	Country	AirCost
1	France	803
2	Spain	815
3	India	.
4	Peru	732

When you change the type of information that a variable contains, you change the meaning of that variable. In this case, you are changing the meaning of AirCost from *airfare without tax* to *airfare with tax*. If you remember the current meaning and if you know that you do not need the original information, then changing a variable's values is useful. However, for many programmers, having separate variables is easier than recalling one variable whose definition changes.

Using Variables Efficiently

Variables that contain information that applies to only one or two observations use more storage space than necessary. When possible, create fewer variables that apply to more observations in the data set, and allow the different values in different observations to supply the information.

For example, the Major company offers discounts, not bonus points, for groups of 30 or more people. An inefficient program would create separate variables for bonus points and discounts, as follows:

```
/* inefficient use of variables */
options pagesize=60 linesize=80 pageno=1 nodate;
data tourinfo;
   set mylib.internationaltours;
   if Vendor = 'Hispania' then BonusPoints = 'For 10+ people';
   else if Vendor = 'Mundial' then BonusPoints = 'Yes';
        else if Vendor = 'Major' then Discount = 'For 30+ people';
run;

proc print data=tourinfo;
   var Country Vendor BonusPoints Discount;
   title 'Information About Vendors';
```

```
run;
```

The following output displays the results:

Figure 7.5 Inefficient: Using Variables That Scatter Information across Multiple Variables

Information About Vendors

Obs	Country	Vendor	BonusPoints	Discount
1	France	Major		For 30+ people
2	Spain	Hispania	For 10+ people	
3	India	Royal		
4	Peru	Mundial	Yes	

As you can see, storage space is used inefficiently. Both BonusPoints and Discount have a significant number of missing values.

With a little planning, you can make the SAS data set much more efficient. In the following DATA step, the variable Remarks contains information about bonus points, discounts, and any other special features of any tour.

```
/* efficient use of variables */
data newinfo;
   set mylib.internationaltours;
   if Vendor = 'Hispania' then Remarks = 'Bonus for 10+ people';
   else if Vendor = 'Mundial' then Remarks = 'Bonus points';
        else if Vendor = 'Major' then Remarks = 'Discount: 30+ people';
run;

proc print data=newinfo;
   var Country Vendor Remarks;
   title 'Information About Vendors';
run;
```

The following output displays a more efficient use of variables:

Figure 7.6 Efficient: Using Variables to Contain Maximum Information

Information About Vendors

Obs	Country	Vendor	Remarks
1	France	Major	Discount: 30+ people
2	Spain	Hispania	Bonus for 10+ people
3	India	Royal	
4	Peru	Mundial	Bonus points

Remarks has fewer missing values and contains all the information that is used by BonusPoints and Discount in the inefficient example. Using variables efficiently can save storage space and optimize your SAS data set.

Defining Enough Storage Space for Variables

The first time that a value is assigned to a variable, SAS enables as many bytes of storage space for the variable as there are characters in the first value assigned to it. At times, you might need to specify the amount of storage space that a variable requires.

For example, as shown in the preceding example, the variable Remarks contains miscellaneous information about tours:

```
if Vendor = 'Hispania' then Remarks = 'Bonus for 10+ people';
```

In this assignment statement, SAS enables 20 bytes of storage space for Remarks as there are 20 characters in the first value assigned to it. The longest value might not be the first one assigned, so you specify a more appropriate length for the variable before the first value is assigned to it:

```
length Remarks $ 30;
```

This statement, called a LENGTH statement, applies to the entire data set. It defines the number of bytes of storage that is used for the variable Remarks in every observation. SAS uses the LENGTH statement during compilation, not when it is processing statements on individual observations. The following DATA step shows the use of the LENGTH statement:

```
data newlength;
   set mylib.internationaltours;
   length Remarks $ 30;
   if Vendor = 'Hispania' then Remarks = 'Bonus for 10+ people';
   else if Vendor = 'Mundial' then Remarks = 'Bonus points';
        else if Vendor = 'Major' then Remarks = 'Discount for 30+ people';
run;

proc print data=newlength;
   var Country Vendor Remarks;
   title 'Information About Vendors';
run;
```

The following output displays the NEWLENGTH data set.

Figure 7.7 Using a LENGTH Statement

Information About Vendors

Obs	Country	Vendor	Remarks
1	France	Major	Discount for 30+ people
2	Spain	Hispania	Bonus for 10+ people
3	India	Royal	
4	Peru	Mundial	Bonus points

Because the LENGTH statement affects variable storage, not the spacing of columns in printed output, the Remarks variable appears the same in Figure 7.7 on page 116 and Figure 7.6 on page 115. To show the effect of the LENGTH statement on variable storage using the DATASETS procedures, see Chapter 37, "Getting Information about Your SAS Data Sets," on page 731.

Conditionally Deleting an Observation

If you do not want the program data vector to write to a data set based on a condition, use the DELETE statement in the DATA step. For example, if the tour to Peru has been discontinued, it is no longer necessary to include the observation for Peru in the data set that is being created. The following example uses the DELETE statement to prevent SAS from writing that observation to the output data set:

```
data subset;
   set mylib.internationaltours;
   if Country = 'Peru' then delete;
run;

proc print data=subset;
   title 'Omitting a Discontinued Tour';
run;
```

The following output displays the results.

Figure 7.8 *Deleting an Observation*

Omitting a Discontinued Tour

Obs	Country	Nights	AirCost	LandCost	Vendor
1	France	8	793	575	Major
2	Spain	10	805	510	Hispania
3	India	10	.	489	Royal

The observation for Peru has been deleted from the data set.

Summary

Statements

DELETE;
: prevents SAS from writing a particular observation to the output data set. It usually appears as part of an IF-THEN/ELSE statement.

IF *condition* THEN *action* ELSE *action*;
: tests whether the condition is true. When the condition is true, the THEN statement specifies the action to take. When the condition is false, the ELSE statement provides an alternative action. The action can be one or more statements, including assignment statements.

LENGTH *variable* <$> *length*;
: assigns the number of bytes of storage (length) for a variable. Include a dollar sign ($) if the variable is character. The LENGTH statement must appear before the first use of the variable.

variable = *expression*
: is an assignment statement. It causes SAS to evaluate the *expression* on the right side of the equal sign and assign the result to the *variable* on the left. You must select the name of the variable and create the proper expression for calculating its value. The same variable name can appear on the left and right sides of the equal sign because SAS evaluates the right side before assigning the result to the variable on the left side.

Learning More

Character variables
: For information about expressions involving alphabetic and special characters as well as numbers, see Chapter 9, “Working with Character Variables,” on page 135.

DATA step
: For general DATA step information, see Chapter 3, “Introduction to DATA Step Processing,” on page 25. Complete information about the DATA step can be found in the “DATA Step Concepts” section of *SAS Language Reference: Concepts*.

IF-THEN/ELSE statements
: The IF-THEN/ELSE statements are discussed in Chapter 10, “Acting on Selected Observations,” on page 153.

LENGTH statement
: Additional information about the LENGTH statement can be found in Chapter 8, “Working with Numeric Variables,” on page 121 and Chapter 9, “Working with

Character Variables," on page 135. To show the effect of the LENGTH statement on variable storage using the DATASETS procedures, see Chapter 37, "Getting Information about Your SAS Data Sets," on page 731.

Missing values
: For more information about missing values, see Chapter 8, "Working with Numeric Variables," on page 121 and Chapter 9, "Working with Character Variables," on page 135.

Numeric variables
: Information about working with numeric variables and expressions can be found in Chapter 8, "Working with Numeric Variables," on page 121.

SAS statements
: For complete reference information about the IF-THEN/ELSE, LENGTH, DELETE, assignment, and comment statements, see *SAS DATA Step Statements: Reference*.

8

Working with Numeric Variables

Introduction to Working with Numeric Variables

Purpose

The following concepts are discussed in this section:

- how to perform arithmetic calculations in SAS using arithmetic operators and the SAS functions ROUND and SUM
- how to compare numeric variables using logical operators
- how to store numeric variables efficiently when disk space is limited

Prerequisites

Before proceeding with this section, you should understand the concepts presented in the following sections:

- Part 1, "Introduction to the SAS System"
- Part 2, "Getting Your Data into Shape"
- Chapter 7, "Understanding DATA Step Processing," on page 109

About Numeric Variables in SAS

A numeric variable is a variable whose values are numbers.

Note: SAS uses double-precision floating-point representation for calculations and, by default, for storing numeric variables in SAS data sets.

SAS accepts numbers in many forms, such as scientific notation, and hexadecimal. For more information, see the discussion on the types of numbers that SAS can read from data lines in *SAS Language Reference: Concepts*. For simplicity, this documentation concentrates on numbers in standard representation, as shown here:

```
1254
 336.05
-243
```

You can use SAS to perform all types of mathematical operations. To perform a calculation in a DATA step, you can write an assignment statement in which the expression contains arithmetic operators, SAS functions, or a combination of the two. To compare numeric variables, you can write an IF-THEN/ELSE statement using logical operators. For more information about numeric functions, see the discussion in the "Functions and CALL Routines" section in *SAS Functions and CALL Routines: Reference*.

Input SAS Data Set for Examples

Tradewinds Travel Inc. has an external file that contains information about their most popular tours:

```
1              2  3    4    5
-----------------------------------
Japan          8  982 1020 Express
Greece        12    .   748 Express
```

```
New Zealand  16 1368 1539 Southsea
Ireland       7  787  628 Express
Venezuela     9  426  505 Mundial
Italy         8  852  598 Express
Russia       14 1106 1024 A-B-C
Switzerland   9  816  834 Tour2000
Australia    12 1299 1169 Southsea
Brazil        8  682  610 Almeida
```

The numbered fields represent

1 the name of the country toured

2 the number of nights on the tour

3 the airfare in US dollars

4 the cost of the land package in US dollars

5 the name of the company that offers the tour

The following program creates a permanent SAS data set named MYLIB.POPULARTOURS:

```
libname mylib 'permanent-data-library';

data mylib.populartours;
   infile 'input-file';
   input Country $ 1-11 Nights AirCost LandCost Vendor $;
run;

proc print data=mylib.populartours;
   title 'Data Set MYLIB.POPULARTOURS';
run;
```

The following output displays the data set.

Figure 8.1 *Data Set MYLIB.POPULARTOURS*

Data Set MYLIB.POPULARTOURS

Obs	Country	Nights	AirCost	LandCost	Vendor
1	Japan	8	982	1020	Express
2	Greece	12	.	748	Express
3	New Zealand	16	1368	1539	Southsea
4	Ireland	7	787	628	Express
5	Venezuela	9	426	505	Mundial
6	Italy	8	852	598	Express
7	Russia	14	1106	1024	A-B-C
8	Switzerland	9	816	834	Tour2000
9	Australia	12	1299	1169	Southsea
10	Brazil	8	682	610	Almeida

In MYLIB.POPULARTOURS, the variables Nights, AirCost, and LandCost contain numbers and are stored as numeric variables. For comparison, variables Country and Vendor contain alphabetic and special characters as well as numbers; they are stored as character variables.

Calculating with Numeric Variables

Using Arithmetic Operators in Assignment Statements

One way to perform calculations on numeric variables is to write an assignment statement using arithmetic operators. Arithmetic operators indicate addition, subtraction, multiplication, division, and exponentiation (raising to a power). For more information about arithmetic expressions, see the discussion in *SAS Language Reference: Concepts*.

The following table shows operators that you can use in arithmetic expressions.

Table 8.1 *Operators in Arithmetic Expressions*

Operation	**Symbol**	**Example**
addition	+	x = y + z;
subtraction	–	x = y - z;
multiplication	*	x = y * z
division	/	x = y / z
exponentiation	**	x = y ** z

The following examples show some typical calculations using the Tradewinds Travel sample data.

Table 8.2 *Examples of Using Arithmetic Operators*

Action	SAS Statement
Add the airfare and land cost to produce the total cost.	`TotalCost = AirCost + Landcost;`
Calculate the peak season airfares by increasing the basic fare by 10% and adding an $8 departure tax.	`PeakAir = (AirCost * 1.10) + 8;`

Show the cost per night of each land package.	`NightCost = LandCost / Nights;`

In each case, the variable on the left side of the equal sign receives the calculated value from the numeric expression on the right side of the equal sign. Including these statements in the following DATA step produces data set NEWTOUR:

```
data newtour;
   set mylib.populartours;
   TotalCost = AirCost + LandCost;
   PeakAir = (AirCost * 1.10) + 8;
   NightCost = LandCost / Nights;
run;

proc print data=newtour;
   var Country Nights AirCost LandCost TotalCost PeakAir NightCost;
   title 'Costs for Tours';
run;
```

The VAR statement in the PROC PRINT step causes only the variables listed in the statement to be displayed in the output.

Figure 8.2 *Creating New Variables By Using Arithmetic Expressions*

Costs for Tours

Obs	Country	Nights	AirCost	LandCost	TotalCost	PeakAir	NightCost
1	Japan	8	982	1020	2002	1088.2	127.500
2	Greece	12	.	748	.	.	62.333
3	New Zealand	16	1368	1539	2907	1512.8	96.188
4	Ireland	7	787	628	1415	873.7	89.714
5	Venezuela	9	426	505	931	476.6	56.111
6	Italy	8	852	598	1450	945.2	74.750
7	Russia	14	1106	1024	2130	1224.6	73.143
8	Switzerland	9	816	834	1650	905.6	92.667
9	Australia	12	1299	1169	2468	1436.9	97.417
10	Brazil	8	682	610	1292	758.2	76.250

Understanding Numeric Expressions and Assignment Statements

Numeric expressions in SAS share some features with mathematical expressions:

- When an expression contains more than one operator, the operations have the same order of precedence as in a mathematical expression: exponentiation is done first, then multiplication and division, and finally addition and subtraction.
- When operators of equal precedence appear, the operations are performed from left to right (except exponentiation, which is performed right to left).

- Parentheses are used to group parts of an expression; as in mathematical expressions, operations in parentheses are performed first.

Note: The equal sign in an assignment statement does not perform the same function as the equal sign in a mathematical equation. The sequence *variable*= in an assignment statement defines the statement, and the variable must appear on the left side of the equal sign. You cannot switch the positions of the result variable and the expression as you can in a mathematical equation.

Understanding How SAS Handles Missing Values

Why SAS Assigns Missing Values

What if an observation lacks a value for a particular numeric variable? For example, in the data set MYLIB.POPULARTOURS, as shown in Figure 8.2 on page 125, the observation for Greece has no value for the variable AirCost. To maintain the rectangular structure of a SAS data set, SAS assigns a missing value to the variable in that observation. A missing value indicates that no information is present for the variable in that observation.

Rules for Missing Values

The following rules describe missing values in several situations:

- In data lines, a missing numeric value is represented by a period, for example,

  ```
  Greece       8 12   .   748 Express
  ```

  By default, SAS interprets a single period in a numeric field as a missing value. If the INPUT statement reads the value from particular columns, as in column input, a field that contains only blanks also produces a missing value.

- In an expression, a missing numeric value is represented by a period, for example,

  ```
  if AirCost= . then Status = 'Need air cost';
  ```

- In a comparison and in sorting, a missing numeric value is a lower value than any other numeric value.
- In procedure output, SAS by default represents a missing numeric value with a period.
- Some procedures eliminate missing values from their analyses; others do not. Documentation for individual procedures describes how each procedure handles missing values.

Propagating Missing Values

When you use a missing value in an arithmetic expression, SAS sets the result of the expression to missing. If you use that result in another expression, the next result is also missing. In SAS, this method of treating missing values is called propagation of missing values. For example, Figure 8.2 on page 125 shows that in the data set NEWTOUR, the values for TOTALCOST and PEAKAIR are also missing in the observation for Greece.

Note: SAS enables you to distinguish between various types of numeric missing values. See “Missing Values” section of *SAS Language Reference: Concepts*. The SAS language contains 27 special missing values based on the letters A–Z and the underscore (_).

Calculating Numbers Using SAS Functions

Rounding Values

In the example data that lists costs of the different tours (Figure 8.1 on page 123), some of the tours have odd prices: $748 instead of $750, $1299 instead of $1300, and so on. Rounded numbers, created by rounding the tour prices to the nearest $10, would be easier to work with.

Programming a rounding calculation with only the arithmetic operators is a lengthy process. However, SAS contains built-in numeric expressions called functions. You can use these functions in expressions just as you do the arithmetic operators. For example, the following assignment statement rounds the value of AirCost to the nearest $50:

```
RoundAir = round(AirCost,50);
```

The following statement calculates the total cost of each tour, rounded to the nearest $100:

```
TotalCostR = round(AirCost + LandCost,100);
```

Calculating a Cost When There Are Missing Values

As another example, the travel agent can calculate a total cost for the tours based on all nonmissing costs. Therefore, when the airfare is missing (as it is for Greece) the total cost represents the land cost, not a missing value. (Of course, you must decide whether skipping missing values in a particular calculation is a good idea.) The SUM function calculates the sum of its arguments, ignoring missing values. This example illustrates the SUM function:

```
SumCost = sum(AirCost,LandCost);
```

Combining Functions

It is possible for you to combine functions. The ROUND function rounds the quantity given in the first argument to the nearest unit given in the second argument. The SUM function adds any number of arguments, ignoring missing values. The calculation in the following assignment statement rounds the sum of all nonmissing airfares and land costs to the nearest $100 and assigns the value to RoundSum:

```
RoundSum = round(sum(AirCost,LandCost),100);
```

Using the ROUND and SUM functions in the following DATA step creates the data set MORETOUR:

```
data moretour;
   set mylib.populartours;
   RoundAir = round(AirCost,50);
   TotalCostR = round(AirCost + LandCost,100);
   CostSum = sum(AirCost,LandCost);
   RoundSum = round(sum(AirCost,LandCost),100);
run;

proc print data=moretour;
   var Country AirCost LandCost RoundAir TotalCostR CostSum RoundSum;
   title 'Rounding and Summing Values';
run;
```

The following output displays the results.

Figure 8.3 Creating New Variables with ROUND and SUM Functions

Rounding and Summing Values

Obs	Country	AirCost	LandCost	RoundAir	TotalCostR	CostSum	RoundSum
1	Japan	982	1020	1000	2000	2002	2000
2	Greece	.	748	.	.	748	700
3	New Zealand	1368	1539	1350	2900	2907	2900
4	Ireland	787	628	800	1400	1415	1400
5	Venezuela	426	505	450	900	931	900
6	Italy	852	598	850	1500	1450	1500
7	Russia	1106	1024	1100	2100	2130	2100
8	Switzerland	816	834	800	1700	1650	1700
9	Australia	1299	1169	1300	2500	2468	2500
10	Brazil	682	610	700	1300	1292	1300

Comparing Numeric Variables

Often in a program, you need to know whether variables are equal to each other, or whether they are greater than or less than each other. To compare two numeric variables, you can write an IF-THEN/ELSE statement using logical operators.

The following table lists some of the logical operators that you can use for variable comparisons.

Table 8.3 Logical Operators

Symbol	Mnemonic Equivalent	Logical Operation
=	eq	equal

¬=, ^=, ~=	ne	not equal to (the ¬=, ^=, or ~= symbol, depending on your keyboard)
>	gt	greater than
>=	ge	greater than or equal to
<	lt	less than
<=	le	less than or equal to

In this example, the total cost of each tour in the POPULARTOURS data set is compared to 2000 using the greater-than logical operator (gt). If the total cost of the tour is greater than 2000, the tour is excluded from the data set. The resulting data set TOURSUNDER2K contains tours that are $2000 or less.

```
data toursunder2K;
   set mylib.populartours;
   TotalCost = AirCost + LandCost;
 if TotalCost gt 2000 then delete;
run;
proc print data=toursunder2K;
   var Country Nights AirCost Landcost TotalCost Vendor;
   title 'Tours $2000 or Less';
run;
```

The following output displays the tours that are less than $2000 in total cost.

Figure 8.4 Comparing Numeric Variables

Tours $2000 or Less

Obs	Country	Nights	AirCost	LandCost	TotalCost	Vendor
1	Greece	12	.	748	.	Express
2	Ireland	7	787	628	1415	Express
3	Venezuela	9	426	505	931	Mundial
4	Italy	8	852	598	1450	Express
5	Switzerland	9	816	834	1650	Tour2000
6	Brazil	8	682	610	1292	Almeida

The TotalCost value for Greece is a missing value because any calculation that includes a missing value results in a missing value. In a comparison, missing numeric values are lower than any other numeric value.

If you need to compare a variable to more than one value, you can include multiple comparisons in a condition. To eliminate tours with missing values, a second comparison is added:

```
data toursunder2K2;
   set mylib.populartours;
   TotalCost = AirCost + LandCost;
   if TotalCost gt 2000 or Totalcost = . then delete;
```

```
run;

proc print data=toursunder2K2;
   var Country Nights TotalCost Vendor;
   title 'Tours $2000 or Less';
run;
```

The following output displays the results:

Figure 8.5 Multiple Comparisons in a Condition

Tours $2000 or Less

Obs	Country	Nights	TotalCost	Vendor
1	Ireland	7	1415	Express
2	Venezuela	9	931	Mundial
3	Italy	8	1450	Express
4	Switzerland	9	1650	Tour2000
5	Brazil	8	1292	Almeida

Notice that Greece is no longer included in the tours for under $2000.

Storing Numeric Variables Efficiently

The data sets shown in this section are very small, but data sets are often very large. If you have a large data set, you might need to think about the storage space that your data set occupies. There are ways to save space when you store numeric variables in SAS data sets.

Note: The SAS documentation for your operating environment provides information about storing numeric variables whose values are limited to 1 or 0 in the minimum number of bytes used by SAS (either 2 or 3 bytes, depending on your operating environment).

By default, SAS uses 8 bytes of storage in a data set for each numeric variable. Therefore, storing the variables for each observation in the earlier data set MORETOUR requires 75 bytes:

```
56 bytes for numeric variables
   (8 bytes per variable * 7 numeric variables)
11 bytes for Country
 8 bytes for Vendor
__________________________
75 bytes for all variables
```

When numeric variables contain only integers (whole numbers), you can often shorten them in the data set that is being created. For example, a length of 4 bytes accurately stores all integers up to at least 2,000,000.

Note: Under some operating environments, the maximum number of bytes is much greater. For more information, see the documentation for your operating environment.

To change the number of bytes used for each variable, use a LENGTH statement.

A LENGTH statement contains the names of the variables followed by the number of bytes to be used for their storage. For numeric variables, the LENGTH statement affects only the data set that is being created; it does not affect the program data vector. The following program changes the storage space for all numeric variables that are in the data set SHORTER:

```
data shorter;
   set mylib.populartours;
   length Nights AirCost LandCost RoundAir TotalCostR
          Costsum RoundSum 4;
   RoundAir = round(AirCost,50);
   TotalCostR = round(AirCost + LandCost,100);
   CostSum = sum(AirCost,LandCost);
   RoundSum = round(sum(AirCost,LandCost),100);
run;
```

By calculating the storage space that is needed for the variables in each observation of SHORTER, you can see how the LENGTH statement changes the amount of storage space that is used:

```
28 bytes for numeric variables
   (4 bytes per variable in the LENGTH statement X 7 numeric variables)
11 bytes for Country
 8 bytes for Vendor
_________________________
47 bytes for all variables
```

Because the 7 variables in SHORTER are shortened by the LENGTH statement, the storage space for the variables in each observation is reduced by almost half.

CAUTION

Be careful in shortening the length of numeric variables if your variable values are not integers. Fractional numbers lose precision permanently if they are truncated. In general, use the LENGTH statement to truncate values only when disk space is limited. Use the default length of 8 bytes to store variables containing fractions.

Summary

Functions

ROUND (*expression*, *round-off-unit*)
: rounds the quantity in *expression* to the figure given in *round-off-unit*. The `expression` can be a numeric variable name, a numeric constant, or an arithmetic expression. Separate *round-off-unit* from *expression* with a comma.

SUM (*expression-1*<, *expression-2*>, . . .)
: produces the sum of all expressions that you specify in the parentheses. The SUM function ignores missing values as it calculates the sum of the expressions. Each expression can be a numeric variable, a numeric constant, another arithmetic expression, or another numeric function.

Statements

LENGTH *variable-listnumber-of-bytes*;
: indicates that the variables in the *variable-list* are to be stored in the data set according to the *number-of-bytes* that you specify. Numeric variables are not affected while they are in the program data vector. The default length for a numeric variable is 8 bytes. In general, the minimum that you should use is 4 bytes for variables that contain integers and 8 bytes for variables that contain fractions. You can assign lengths to both numeric and character variables (discussed in the next section) in a single LENGTH statement.

variable=expression;
: is an assignment statement. It causes SAS to calculate the value of the expression on the right side of the equal sign and assign the result to the *variable* on the left. When *variable* is numeric, the expression can be an arithmetic calculation, a numeric constant, or a numeric function.

Learning More

Abbreviating lists of variables
: Ways to abbreviate lists of variables in function arguments are documented in *SAS Language Reference: Concepts*. Many functions, including the SUM function, accept abbreviated lists of variables as arguments.

DEFAULT= option
: Information about using the DEFAULT= option in the LENGTH statement to assign a default storage length to all newly created numeric variables can be found in *SAS DATA Step Statements: Reference*.

Logical expressions
: Additional information about the use of logical expressions can be found in *SAS Language Reference: Concepts*.

Numeric precision
: For a discussion about numeric precision, see *SAS Language Reference: Concepts*. Because the computer's hardware determines how a computer stores numbers, the precision with which SAS can store numbers depends on the hardware of the computer system on which it is installed. Specific limits for hardware are discussed in the SAS documentation for each operating environment.

Saving space
: For information about how you can save space by treating some numeric values as character values see Chapter 9, “Working with Character Variables,” on page 135.

9

Working with Character Variables

Introduction to Working with Character Variables

Purpose

In this section, you will learn how to do the following:

- identify character variables
- set the length of character variables
- align character values within character variables
- handle missing values of character variables

- work with character variables, character constants, and character expressions in SAS program statements
- instruct SAS to read fields that contain numbers as character variables in order to save space

Prerequisites

Before proceeding with this section, you should understand the concepts presented in the following topics:

- Part 1, “Introduction to SAS”
- Part 2, “Getting Your Data into Shape”
- Chapter 7, “Understanding DATA Step Processing,” on page 109

Character Variables in SAS

A character variable is a variable whose value contains letters, numbers, and special characters, and whose length can be from 1 to 32,767 characters long. Character variables can be used in declarative statements, comparison statements, or assignment statements where they can be manipulated to create new character variables.

Input SAS Data Set for Examples

Tradewinds Travel has an external file with data on flight schedules for tours.

The following DATA step reads the information and stores it in a data set named AIR.DEPARTURES:

```
libname mylib 'permanent-data-library';

data mylib.departures;
   input Country $ 1-9 CitiesInTour 11-12 USGate $ 14-26
         ArrivalDepartureGates $ 28-48;
   datalines;

1          2 3                      4
------------------------------------------------
Japan      5 San Francisco          Tokyo, Osaka
Italy      8 New York               Rome, Naples
Australia 12 Honolulu           Sydney, Brisbane
Venezuela  4 Miami            Caracas, Maracaibo
Brazil     4               Rio de Janeiro, Belem
;
proc print data=mylib.departures;
   title 'Data Set AIR.DEPARTURES';
```

```
run;
```

The numbered fields represent

1 the name of the country toured

2 the number of cities in the tour

3 the city from which the tour leaves the United States (the gateway city)

4 the cities of arrival and departure in the destination country

The PROC PRINT statement that follows the DATA step produces this display of the AIR.DEPARTURES data set.

Figure 9.1 *Data Set AIR.DEPARTURES*

Data Set AIR.DEPARTURES

Obs	Country	CitiesInTour	USGate	ArrivalDepartureGates
1	Japan	5	San Francisco	Tokyo, Osaka
2	Italy	8	New York	Rome, Naples
3	Australia	12	Honolulu	Sydney, Brisbane
4	Venezuela	4	Miami	Caracas, Maracaibo
5	Brazil	4		Rio de Janeiro, Belem

In AIR.DEPARTURES, the variables Country, USGate, and ArrivalDepartureGates contain information other than numbers, so they must be stored as character variables. The variable CitiesInTour contains only numbers. Therefore, it can be created and stored as either a character or numeric variable.

Identifying Character Variables and Expressing Character Values

To store character values in a SAS data set, you need to create a character value. One way to create a character variable is to define it in an input statement. Simply place a dollar sign after the variable name in the INPUT statement, as shown in the DATA step that created AIR.DEPARTURES:

```
input Country $ 1-9 CitiesInTour 11-12 USGate $ 14-26
      ArrivalDepartureGates $ 28-48;
```

You can also create a character variable and assign a value to it in an assignment statement. Simply enclose the value in quotation marks:

```
Schedule = '3-4 tours per season';
```

Either single quotation marks (apostrophes) or double quotation marks are acceptable. If the value itself contains a single quotation mark, then enclose the value in double quotation marks, as in

```
Remarks = "See last year's schedule";
```

Note: Matching quotation marks properly is important. Missing or extraneous quotation marks cause SAS to misread both the erroneous statement and the statements following it.

When you specify a character value in an expression, you must also enclose the value in quotation marks. For example, the following statement compares the value of USGate to San Francisco and, when a match occurs, assigns the airport code SFO to the variable Airport:

```
if USGate = 'San Francisco' then Airport =
'SFO';
```

In character values, SAS distinguishes uppercase letters from lowercase letters. For example, in the data set AIR.DEPARTURES, the value of USGate in the observation for Australia is `Honolulu`. The following IF condition is true; therefore, SAS assigns to Airport the value HNL:

```
else if USGate = 'Honolulu' then Airport = 'HNL';
```

However, the following condition is false:

```
if USGate = 'HONOLULU' then Airport = 'HNL';
```

SAS does not select that observation because the characters in Honolulu and HONOLULU are not equivalent.

The following program places these shaded statements in a DATA step:

```
data charvars;
   set mylib.departures;
   Schedule = '3-4 tours per season';
   Remarks = "See last year's schedule";
   if USGate = 'San Francisco' then Airport = 'SFO';
    else if USGate = 'Honolulu' then Airport = 'HNL';
run;

proc print data=charvars noobs; 1
   var Country Schedule Remarks USGate Airport;
   title 'Tours By City of Departure';
run;
```

1 The NOOBS option in the PROC PRINT statement suppresses the display of observation numbers in the output.

The following output displays the character variables in the data set CHARVARS:

Figure 9.2 Examples of Character Variables

Tours By City of Departure

Country	Schedule	Remarks	USGate	Airport
Japan	3-4 tours per season	See last year's schedule	San Francisco	SFO
Italy	3-4 tours per season	See last year's schedule	New York	
Australia	3-4 tours per season	See last year's schedule	Honolulu	HNL
Venezuela	3-4 tours per season	See last year's schedule	Miami	
Brazil	3-4 tours per season	See last year's schedule		

Setting the Length of Character Variables

This example illustrates why you might want to specify a length for a character variable, rather than let the first assigned value determine the length. Because New York City has two airports, both the abbreviations for John F. Kennedy International Airport and La Guardia Airport can be assigned to the Airport variable as in the DATA step.

Note: When you create character variables, SAS determines the length of the variable from its first occurrence in the DATA step. Therefore, you must allow for the longest possible value in the first statement that mentions the variable. If you do not assign the longest value the first time the variable is assigned, then data can be truncated.

```
/* first attempt */
data aircode;
   set mylib.departures;
   if USGate = 'San Francisco' then Airport = 'SFO';
   else if USGate = 'Honolulu' then Airport = 'HNL';
        else if USGate = 'New York' then Airport = 'JFK or LGA';
run;

proc print data=aircode;
   var Country USGate Airport;
   title 'Country by US Point of Departure';
run;
```

The following output displays the results.

Figure 9.3 Truncation of Character Values

Country by US Point of Departure

Obs	Country	USGate	Airport
1	Japan	San Francisco	SFO
2	Italy	New York	JFK
3	Australia	Honolulu	HNL
4	Venezuela	Miami	
5	Brazil		

Only the characters JFK appear in the observation for New York. SAS first encounters Airport in the statement that assigns the value SFO. Therefore, SAS creates Airport with a length of three bytes and uses only the first three characters in the New York observation.

To allow space to write JFK or LGA, use a LENGTH statement as the first reference to Airport. The LENGTH statement is a declarative statement and has the form

LENGTH *variable-list* $ *number-of-bytes*;

variable-list
: specifies the variable or variables to which you are assigning the length *number-of-bytes*. The dollar sign ($) indicates that the variable is a character variable. The LENGTH statement determines the length of a character variable in both the program data vector and the data set that are being created. (In contrast, a LENGTH statement determines the length of a numeric variable only in the data set that is being created.) The maximum length of any character value in SAS is 32,767 bytes.

This LENGTH statement assigns a length of 10 to the character variable Airport:

```
length Airport $ 10;
```

Note: If you use a LENGTH statement to assign a length to a character variable, then it must be the first reference to the character variables in the DATA step. Therefore, the best position in the DATA step for a LENGTH statement is immediately after the DATA statement.

The following DATA step includes the LENGTH statement for Airport. Remember that you can use the DATASETS procedure to display the length of variables in a SAS data set.

```
/* correct method */
data aircode2;
   length Airport $ 10;
   set mylib.departures;
   if USGate = 'San Francisco' then Airport = 'SFO';
   else if USGate = 'Honolulu' then Airport = 'HNL';
        else if USGate = 'New York' then Airport = 'JFK or LGA';
             else if USGate = 'Miami' then Airport = 'MIA';
run;

proc print data=aircode2;
   var Country USGate Airport;
   title 'Country by US Point of Departure';
run;
```

The following output displays the results:

Figure 9.4 Using a LENGTH Statement to Capture Complete Variable Information

Country by US Point of Departure

Obs	Country	USGate	Airport
1	Japan	San Francisco	SFO
2	Italy	New York	JFK or LGA
3	Australia	Honolulu	HNL
4	Venezuela	Miami	MIA
5	Brazil		

Handling Missing Values

Reading Missing Values

SAS uses a blank to represent a missing value of a character variable. For example, the data line for Brazil lacks the departure city from the United States:

```
Japan      5 San Francisco         Tokyo, Osaka
Italy      8 New York              Rome, Naples
Australia 12 Honolulu          Sydney, Brisbane
Venezuela  4 Miami           Caracas, Maracaibo
Brazil     4               Rio de Janeiro, Belem
```

As Figure 9.1 on page 137 shows, when the INPUT statement reads the data line for Brazil and determines that the value for USGate in columns 14-26 is missing, SAS assigns a missing value to USGate for that observation. The missing value is represented by a blank when printing.

One special case occurs when you read character data values with list input. In that case, you must use a period to represent a missing value in data lines. (Blanks in list input separate values. Therefore, SAS interprets blanks as a signal to keep searching for the value, not as a missing value.) In the following DATA step, the TourGuide information for Venezuela is missing and is represented with a period:

```
data missingval;
   length Country $ 10 TourGuide $ 10;
   input Country TourGuide;
   datalines;
Japan Yamada
Italy Militello
Australia Edney
Venezuela .
Brazil Cardoso
;

proc print data=missingval;
   title 'Missing Values for Character List Input Data';
run;
```

The following output displays the results:

Figure 9.5 Using a Period in List Input for Missing Character Data

Missing Values for Character List Input Data

Obs	Country	TourGuide
1	Japan	Yamada
2	Italy	Militello
3	Australia	Edney
4	Venezuela	
5	Brazil	Cardoso

SAS recognized the period as a missing value in the fourth data line. Therefore, it recorded a missing value for the character variable TourGuide in the resulting data set.

Checking for Missing Character Values

When you want to check for missing character values, compare the character variable to a blank enclosed in quotation marks:

```
if USGate = ' ' then GateInformation = 'Missing';
```

The following DATA step includes this statement to check USGate for missing information. The results are recorded in GateInformation:

```
data checkgate;
   length GateInformation $ 15;
   set mylib.departures;
   if USGate = ' ' then GateInformation = 'Missing';
   else GateInformation = 'Available';
run;
proc print data=checkgate;
   var Country CitiesIntour USGate ArrivalDepartureGates GateInformation;
   title 'Checking For Missing Gate Information';
run;
```

The following output displays the results.

Figure 9.6 Checking for Missing Character Values

Checking For Missing Gate Information

Obs	Country	CitiesInTour	USGate	ArrivalDepartureGates	GateInformation
1	Japan	5	San Francisco	Tokyo, Osaka	Available
2	Italy	8	New York	Rome, Naples	Available
3	Australia	12	Honolulu	Sydney, Brisbane	Available
4	Venezuela	4	Miami	Caracas, Maracaibo	Available
5	Brazil	4		Rio de Janeiro, Belem	Missing

Setting a Character Variable Value to Missing

You can assign missing character values in assignment statements by setting the character variable to a blank enclosed in quotation marks. For example, the following statement sets the day of departure based on the number of days in the tour. If the number of cities in the tour is a week or less, then the day of departure is a Sunday. Otherwise, the day of departure is not known and is set to a missing value.

```
if Cities <=7 then DayOfDeparture = 'Sunday';
else DayOfDeparture = ' ';
```

The following DATA step includes these statements:

```
data departuredays;
   set mylib.departures;
   length DayOfDeparture $ 8;
   if CitiesInTour <=7 then DayOfDeparture = 'Sunday';
   else DayOfDeparture = ' ';
run;

proc print data=departuredays;
   var Country CitiesInTour DayOfDeparture;
   title 'Departure Day is Sunday or Missing';
run;
```

The following output displays the results.

Figure 9.7 Assigning Missing Character Values

Departure Day is Sunday or Missing

Obs	Country	CitiesInTour	DayOfDeparture
1	Japan	5	Sunday
2	Italy	8	
3	Australia	12	
4	Venezuela	4	Sunday
5	Brazil	4	Sunday

Creating New Character Values

Extracting a Portion of a Character Value

Understanding the SCAN Function

Some character values might contain multiple pieces of information that need to be isolated and assigned to separate character variables. For example, the value of ArrivalDepartureGates contains two cities: the city of arrival and the city of departure. How can the individual values be isolated so that separate variables can be created for the two cities?

The SCAN function returns a character string when it is given the source string, the position of the desired character string, and a character delimiter:

SCAN (*source*, *n*<,*list-of-delimiters*>)

source is the value that you want to examine. It can be any type of character expression, including character variables, character constants, and so on. *n* is the position of the term to be selected from *source*. *list-of-delimiters* can list one, multiple, or no delimiters. If you specify more than one delimiter, then SAS uses any of them. If you omit the delimiter, then SAS divides words according to a default list of delimiters (including the blank and some special characters).

For example, to select the first term in the value of ArrivalDepartureGates and assign it to a new variable named ArrivalGate, write

```
ArrivalGate = scan(ArrivalDepartureGates,1,',');
```

The SCAN function examines the value of ArrivalDepartureGates and selects the first string as identified by a comma.

Although default values can be used for the delimiter, it is a good idea to specify the delimiter to be used. If the default delimiter is used in the SCAN function when the observation for Brazil is processed, then SAS recognizes a blank space as the delimiter and selects `Rio` rather than `Rio de Janeiro` as the first term. Specifying the delimiter enables you to control where the division of the term occurs.

To select the second term from ArrivalDepartureGates and assign it to a new variable term named DEPARTUREGATE, specify the following:

```
DepartureGate = scan(ArrivalDepartureGates,2,',');
```

Note: Within a DATA step, the default length of a target variable where the expression contains the SCAN function is the same as the length of the first SCAN argument. In the SQL procedure or in any WHERE clause, the maximum length of a string that is returned by the SCAN function is 200 characters. For more information about the SCAN function, see *SAS Functions and CALL Routines: Reference*.

Aligning New Values

Remember that SAS maintains the existing alignment of a character value used in an expression; it does not perform any automatic realignment. This example creates the values for a new variable DepartureGate from the values of ArrivalDepartureGates. The value of ArrivalDepartureGates contains a comma and a blank between the two city names as shown in the following output:

Figure 9.8 *Dividing Values into Separate Words Using the SCAN Function*

Data Set Air.Departure

Obs	Country	CitiesInTour	USGate	ArrivalDepartureGates
1	Japan	5	San Francisco	Tokyo, Osaka
2	Italy	8	New York	Rome, Naples
3	Australia	12	Honolulu	Sydney, Brisbane
4	Venezuela	4	Miami	Caracas, Maracaibo
5	Brazil	4		Rio de Janeiro, Belem

When the SCAN function divides the names at the comma, the second term begins with a blank. Therefore, all the values that are assigned to DepartureGate begin with a blank.

To left-align the values, use the LEFT function:

LEFT (*source*)

The LEFT function produces a value that has all leading blanks in *source* moved to the right side of the value. Therefore, the result is left aligned. *source* can be any type of character expression, including a character variable, a character constant enclosed in quotation marks, or another character function.

This example uses the LEFT function in the second assignment statement:

```
DepartureGate = scan(ArrivalDepartureGates,2,',');
DepartureGate = left(DepartureGate);
```

You can also nest the two functions:

```
DepartureGate = left(scan(ArrivalDepartureGates,2,','));
```

When you nest functions, SAS performs the action in the innermost function first. It uses the result of that function as the argument of the next function, and so on.

The following DATA step creates separate variables for the arrival gates and the departure gates:

```
data gates;
   set mylib.departures;
   ArrivalGate = scan(ArrivalDepartureGates,1,',');
   DepartureGate = left(scan(ArrivalDepartureGates,2,','));
run;

proc print data=gates;
   var Country ArrivalDepartureGates ArrivalGate DepartureGate;
   title 'Arrival and Departure Gates';
```

```
run;
```

The following output displays the results.

Figure 9.9 Dividing Values into Separate Words with the SCAN Function

Arrival and Departure Gates

Obs	Country	ArrivalDepartureGates	ArrivalGate	DepartureGate
1	Japan	Tokyo, Osaka	Tokyo	Osaka
2	Italy	Rome, Naples	Rome	Naples
3	Australia	Sydney, Brisbane	Sydney	Brisbane
4	Venezuela	Caracas, Maracaibo	Caracas	Maracaibo
5	Brazil	Rio de Janeiro, Belem	Rio de Janeiro	Belem

Saving Storage Space When Using the SCAN Function

In a DATA step, the SCAN function assigns the length of the first argument to the target variable in an assignment statement, if the length of the target variable is not already assigned. In the SQL procedure or in a WHERE clause in any procedure, the maximum length of a word that is returned by the SCAN function is 200 characters. If you use the SCAN function in an expression that contains operators or other functions, the maximum length of a word returned by the SCAN function is 32,767 characters.

Setting the lengths of ArrivalGate and DepartureGate to the needed values rather than to the default lengths might save storage space. Because SAS sets the length of a character variable the first time SAS encounters it, the LENGTH statement must appear before the assignment statements that create values for the variables:

```
data gatelength;
   length ArrivalGate $ 14 DepartureGate $ 9;
   set mylib.departures;
   ArrivalGate = scan(ArrivalDepartureGate,1,',');
   DepartureGate = left(scan(ArrivalDepartureGate,2,','));
run;
```

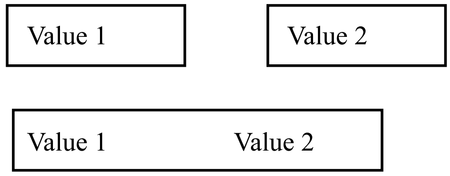
Combining Character Values: Using Concatenation

Understanding Concatenation of Variable Values

SAS enables you to combine character values into longer ones using an operation known as concatenation. Concatenation combines character values by placing them one after the other and assigning them to a variable. In SAS programming, the concatenation operator is a pair of vertical bars (||). If your keyboard does not have a solid vertical bar, use two broken vertical bars (¦¦) or two exclamation points (!!). The length of the new variable is the sum of the lengths of each variable or number of characters that is specified in a LENGTH statement for the new variable.

The following figure illustrates concatenation:

Figure 9.10 *Concatenation of Two Values*



Performing a Simple Concatenation

The following statement uses the CAT function to combine all the cities named as gateways into a single variable named AllGates:

```
AllGates = cat(USGate,ArrivalDepartureGates);
```

Note: The CAT function does not use the || concatenation operator that is described in "Understanding Concatenation of Variable Values" on page 146.

SAS attaches the beginning of each value of ArrivalDepartureGates to the end of each value of USGate and assigns the results to AllGates. The following DATA step includes this statement:

```
data all;
   set mylib.departures;
   AllGates = cat(USGate,ArrivalDepartureGates);
run;

proc print data=all;
   var Country USGate ArrivalDepartureGates AllGates;
   title 'All Tour Gates';
run;
```

The following output displays the results.

Figure 9.11 *Simple Concatenation*

All Tour Gates

Obs	Country	USGate	ArrivalDepartureGates	AllGates
1	Japan	San Francisco	Tokyo, Osaka	San FranciscoTokyo, Osaka
2	Italy	New York	Rome, Naples	New York Rome, Naples
3	Australia	Honolulu	Sydney, Brisbane	Honolulu Sydney, Brisbane
4	Venezuela	Miami	Caracas, Maracaibo	Miami Caracas, Maracaibo
5	Brazil		Rio de Janeiro, Belem	Rio de Janeiro, Belem

The length of USGate in the above output is 13 bytes, but only San Francisco uses all of them. Therefore, the other values contain blanks at the end, and the value for Brazil is entirely blank.

When a character value that is to be concatenated is shorter than the length of the variable to which it belongs, SAS pads the value with trailing blanks during concatenation. However, HTML is the default output style for SAS, and it ignores the trailing blanks in the variable values when it displays the concatenated output. Instead, HTML places one blank between the concatenated values. Therefore, the values for AllGates in the above output contain one blank between the concatenated values of USGate and ArrivalDepartureGates. For example, the value in AllGates for the fourth observation contains one blank between Miami and Caracas. HTML output ignores the eight trailing blanks that follow the value of Miami in the USGATE variable when it displays the concatenated variables.

Note: You can use the NOBREAKSPACE style attribute to keep the trailing blanks between the concatenated variables. For information about the NOBREAKSPACE style attribute, see "Style Attributes" in *SAS Output Delivery System: Procedures Guide*.

Adding Additional Characters

The TRIM function enables you to remove blanks between concatenated variables. It also enables you to add delimiters such as commas, colons, or blanks between concatenated variables.

Note: The TRIM function uses the || concatenation operator that is described in "Understanding Concatenation of Variable Values" on page 146.

If you use the TRIM function to delete the blanks between concatenated variables, then the results might be difficult to read. To make the result easier to read, you can concatenate a comma and blank between the trimmed value of USGate and the value of ArrivalDepartureGates. Also, to align the AllGates2 value for Brazil with all other values of AllGates2, use an IF-THEN statement to equate the value of AllGates2 with the value of ArrivalDepartureGates in that observation.

```
AllGates2 = trim(USGate)||', '||ArrivalDepartureGates;
if Country = 'Brazil' then AllGates2 = ArrivalDepartureGates;
```

This DATA step includes these statements:

```
data all2;
   set mylib.departures;
   AllGates2 = trim(USGate)||', '||ArrivalDepartureGates;
   if Country = 'Brazil' then AllGates2 = ArrivalDepartureGates;
run;

proc print data=all2;
   var Country USGate ArrivalDepartureGates AllGates2;
   title 'All Tour Gates';
run;
```

Note: In the ALLGATES2 statement, `', '` is a literal value. SAS adds the size of the two variables and the length of the literal to calculate the size of the concatenated variable. HTML ignores any additional trailing blanks and inserts only the specified comma and one blank.

The following output displays the results.

Figure 9.12 Concatenating Additional Characters for Readability

All Tour Gates

Obs	Country	USGate	ArrivalDepartureGates	AllGates2
1	Japan	San Francisco	Tokyo, Osaka	San Francisco, Tokyo, Osaka
2	Italy	New York	Rome, Naples	New York, Rome, Naples
3	Australia	Honolulu	Sydney, Brisbane	Honolulu, Sydney, Brisbane
4	Venezuela	Miami	Caracas, Maracaibo	Miami, Caracas, Maracaibo
5	Brazil		Rio de Janeiro, Belem	Rio de Janeiro, Belem

For more information about removing trailing blanks or adding delimiters between concatenated variables, see "TRIM Function" in *SAS Functions and CALL Routines: Reference*.

Saving Storage Space by Treating Numbers as Characters

Remember that SAS uses eight bytes of storage for every numeric value in the DATA step. By default, SAS also uses eight bytes of storage for each numeric value in an output data set. However, a character value can contain a minimum of one character. In that case, SAS uses one byte for the character variable, both in the program data vector and in the output data set. In addition, SAS treats the digits 0 through 9 in a character value like any other character. When you are not going to perform calculations on a variable, you can save storage space by treating a value that contains digits as a character value.

For example, some tours offer various prices, depending on the quality of the hotel room. The brochures rank the rooms as two stars, three stars, and so on. In this case the values 2, 3, and 4 are really the names of categories, and arithmetic operations are not expected to be performed on them. Therefore, the values can be read into a character variable. The following DATA step reads HotelRank as a character variable and assigns it a length of one byte:

```
data hotels;
   input Country $ 1-9 HotelRank $ 11 LandCost;
   datalines;
Italy     2  498
Italy     4  698
Australia 2  915
Australia 3 1169
Australia 4 1399
;

proc print data=hotels;
   title 'Hotel Rankings';
run;
```

In the previous example, the INPUT statement assigns HotelRank a length of one byte because the INPUT statement reads one column to find the value (shown by the use of column input). If you are using list input, then place a LENGTH statement before the INPUT statement to set the length to one byte.

If you read a number as a character value and then discover that you need to use it in a numeric expression, then you can do so without making changes in your program. SAS automatically produces a numeric value from the character value for use in the expression; it also issues a note in the log that the conversion occurred. (Of course, the conversion causes the DATA step to use slightly more computer resources.) The original variable remains unchanged.

The following output displays the results:

Figure 9.13 *Saving Storage Space By Creating a Character Variable*

Hotel Rankings

Obs	Country	HotelRank	LandCost
1	Italy	2	498
2	Italy	4	698
3	Australia	2	915
4	Australia	3	1169
5	Australia	4	1399

Note: Note that the width of the column is not the default width of eight.

Summary

Functions

LEFT (*source*)
: left-aligns *source* by moving any leading blanks to the end of the value. *source* can be any type of character expression, including a character variable, a character constant enclosed in quotation marks, or another character function. Because any blanks removed from the left are added to the right, the length of the result matches the length of *source*. For more information, see “LEFT Function” in *SAS Functions and CALL Routines: Reference*.

SCAN (*source*, n <,*list-of-delimiters*>)
: selects the nth term from *source*. *source* can be any type of character expression, including a character variable, a character constant enclosed in quotation marks, or another character function. To choose the character that divides the terms, use a delimiter. If you omit the delimiter, then SAS divides the terms using a default list of delimiters (the blank and some special characters). For more information, see “SCAN Function” in *SAS Functions and CALL Routines: Reference*.

TRIM (*source*)
: trims trailing blanks from *source*. *source* can be any type of character expression, including a character variable, a character constant enclosed in quotation marks, or another character function. The TRIM function does not affect how a variable is stored. If you use the TRIM function to remove trailing blanks and assign the trimmed value to a variable that is longer than that value, then SAS pads the value with new trailing blanks to make the value match the length of the new variable. For more information, see "TRIM Function" in *SAS Functions and CALL Routines: Reference*.

Statements

LENGTH *variable-list$number-of-bytes*;
: assigns a length that you specify in *number-of-bytes* to the character variable or variables in *variable-list*. You can assign any number of lengths in a single LENGTH statement, and you can assign lengths to both character and numeric variables in the same statement. Place a dollar sign ($) before the length of any character variable. For more information, see "LENGTH Statement" in *SAS DATA Step Statements: Reference*.

Learning More

Character values
: This section illustrates the flexibility that SAS provides for manipulating character values. In addition to the functions that are described in this section, the following character functions are also frequently used:

COMPBL
removes multiple blanks from a character string.

COMPRESS
removes specified character(s) from the source.

INDEX
searches the source data for a pattern of characters.

LOWCASE
converts all letters in an argument to lowercase.

RIGHT
right-aligns the source.

SUBSTR
extracts a group of characters.

TRANSLATE
replaces specific characters in a character expression.

UPCASE
returns the source data in uppercase.

The INDEX and UPCASE functions are discussed in Chapter 10, “Acting on Selected Observations,” on page 153. Complete descriptions of all character functions appear in *SAS Functions and CALL Routines: Reference*.

Character variables
: Detailed information about character variables is found in *SAS Language Reference: Concepts*.

  Additional information about aligning character variables is explained in the TEMPLATE procedure in *SAS Output Delivery System: User’s Guide*, and in the REPORT procedure in *Base SAS Procedures Guide*.

Comparing uppercase and lowercase characters
: How to compare uppercase and lowercase characters is shown in Chapter 10, “Acting on Selected Observations,” on page 153.

Concatenation operator
: Information about the concatenation operator can be found in *SAS Language Reference: Concepts*.

DATASETS procedure
: Using the DATASETS procedure to display the length of variables in a SAS data set is explained in Chapter 37, “Getting Information about Your SAS Data Sets,” on page 731.

IF-THEN statements
: A detailed explanation of the IF-THEN statements can be found in Chapter 10, “Acting on Selected Observations,” on page 153.

Informats and formats
: Complete information about the numerous SAS informats and formats for reading and writing character variables is found in *SAS Formats and Informats: Reference*.

Missing values
: Detailed information about missing values is found in *SAS Language Reference: Concepts*.

VLENGTH function
: The VLENGTH function is explained in detail in *SAS Functions and CALL Routines: Reference*.

10

Acting on Selected Observations

Introduction to Acting on Selected Observations

Purpose

One of the most useful features of SAS is its ability to perform an action on only the observations that you select. The following concepts are discussed in this section:

- how the selection process works
- how to write statements that select observations based on a condition

- some special points about selecting numeric and character variables

Prerequisites

You should understand the concepts presented in all previous sections before proceeding with this section.

Input SAS Data Set for Examples

Tradewinds Travel offers tours to art museums and galleries in various cities. The company decided that in order to make its process more efficient, additional information is needed. For example, if the tour covers too many museums and galleries within a time period, then the number of museums visited must be decreased or the number of days for the tour needs to change. If the guide who is assigned to the tour is not available, then another guide must be assigned. Most of the process involves selecting observations that meet or that do not meet various criteria and then taking the required action.

The Tradewinds Travel tour data is stored in an external file that contains the following information:

```
1         2 3    4   5               6        7
------------------------------------------------------
Rome      3 1550 7 4 M, 3 G          D'Amico  Torres
Brasilia  8 3360 6 5 M, 1 other      Lucas    Lucas
London    6 2460 5 3 M, 2 G          Wilson   Lucas
Warsaw    6    . 8 5 M, 1 G, 2 other Lucas    D'Amico
Madrid    3  740 5 3 M, 2 other      Torres   D'Amico
Amsterdam 4 1160 6 3 M, 3 G                   Vandever
```

The following list explains the numbered items in the preceding file:

1 identifies the name of the destination city

2 specifies the number of nights in the city

3 specifies the cost of the land package in U.S. dollars

4 specifies the number of events the trip offers (such as visits to museums and galleries)

5 provides a brief description of events. **M** indicates a museum, **G** indicates a gallery, and **other** indicates another type of event

6 provides the name of the tour guide

7 provides the name of the backup tour guide

The following DATA step creates MYLIB.ARTTOURS:

```
libname mylib 'SAS-library';

data mylib.arttours;
   infile 'input-file' truncover;
```

```
   input City $ 1-9 Nights 11 LandCost 13-16 NumberOfEvents 18
         EventDescription $ 20-36 TourGuide $ 38-45
         BackUpGuide $ 47-54;
run;

proc print data=mylib.arttours;
   title 'Data Set MYLIB.ARTTOURS';
run;
```

Note: When the TRUNCOVER option is specified in the INFILE statement, and when the record is shorter than what the INPUT statement expects, SAS reads a variable length record.

The PROC PRINT statement that follows the DATA step produces this display of the MYLIB.ARTTOURS data set:

Figure 10.1 *Data Set MYLIB.ARTTOURS*

Data Set MYLIB.ARTTOURS

Obs	City	Nights	LandCost	NumberOfEvents	EventDescription	TourGuide	BackUpGuide
1	Rome	3	1550	7	4 M, 3 G	D'Amico	Torres
2	Brasilia	8	3360	6	5 M, 1 other	Lucas	Lucas
3	London	6	2460	5	3 M, 2 G	Wilson	Lucas
4	Warsaw	6	.	8	5 M, 1 G, 2 other	Lucas	D'Amico
5	Madrid	3	740	5	3 M, 2 other	Torres	D'Amico
6	Amsterdam	4	1160	6	3 M, 3 G		Vandever

The following list describes several of the fields in the output:

- NumberOfEvents contains the number of attractions that were visited during the tour.
- EventDescription lists the number of museums (`M`), art galleries (`G`), and other attractions (`other`) that were visited.
- TourGuide lists the name of the tour guide that is assigned to the tour.
- BackUpGuide lists the alternate tour guide in case the original tour guide is unavailable.

Selecting Observations

Understanding the Selection Process

The most common way that SAS selects observations for action in a DATA step is through the IF-THEN statement:

IF *condition* **THEN** *action*;

The condition is one or more comparisons, for example:

- `City = 'Rome'`
- `NumberOfEvents > Nights`
- `TourGuide = 'Lucas' and Nights > 7`

The symbol > means greater than. How to use symbols as comparison operators is explained in "Understanding Construct Conditions" on page 160.

For a given observation, a comparison is either true or false. In the first example, the value of City is either **`Rome`** or it is not. In the second example, the value of NumberOfEvents in the current observation is either greater than the value of Nights in the same observation or it is not. If the condition contains more than one comparison, as in the third example, then SAS evaluates all of the conditions according to its rules (discussed later) and declares the entire condition to be true or false.

When the condition is true, SAS takes the action in the THEN clause. The action must be expressed as a SAS statement that can be executed in an individual iteration of the DATA step. Such statements are called executable statements. The most common executable statements are assignment statements, as shown in the following examples:

- `LandCost=LandCost + 30;`
- `Calendar='Check schedule';`
- `TourGuide='Torres';`

This section concentrates on assignment statements in the THEN clause, but examples in other sections show other types of statements that are used with the THEN clause.

Statements that provide information about a data set are not executable. Such statements are called declarative statements. For example, the LENGTH statement affects a variable as a whole, and not how the variable is treated in a particular observation. Therefore, you cannot use a LENGTH statement in a THEN clause.

When the condition is false, SAS ignores the THEN clause and proceeds to the next statement in the DATA step.

Selecting Observations Based on a Simple Condition

The following DATA step uses the previous example conditions and actions in IF-THEN statements:

```
data revise;
   set mylib.arttours;
   if City='Rome' then LandCost=LandCost + 30;
   if NumberOfEvents > Nights then Calendar='Check schedule';
   if TourGuide='Lucas' and Nights > 7 then TourGuide='Torres';
run;

proc print data=revise;
   var City Nights LandCost NumberOfEvents TourGuide Calendar;
   title 'Tour Information';
run;
```

The following output displays the results.

Figure 10.2 *Selecting Observations with IF-THEN Statements*

Tour Information

Obs	City	Nights	LandCost	NumberOfEvents	TourGuide	Calendar
1	Rome	3	1580	7	D'Amico	Check schedule
2	Brasilia	8	3360	6	Torres	
3	London	6	2460	5	Wilson	
4	Warsaw	6	.	8	Lucas	Check schedule
5	Madrid	3	740	5	Torres	Check schedule
6	Amsterdam	4	1160	6		Check schedule

In the output, you can see several changes:

- The land cost was increased by $30 in the observation for Rome.
- Four observations have a greater number of events than the number of days in the tour.
- The tour guide for Brasilia is replaced by Torres because the original tour guide is Lucas, and the number of nights in the tour is greater than 7.

Providing an Alternative Action

Remember that SAS creates a variable in all observations, even if you do not assign the variable a value in all observations. In the previous output, the value of Calendar is blank in two observations. A second IF-THEN statement can assign a different value, as in these examples:

```
if NumberOfEvents > Nights then Calendar='Check schedule';
if NumberOfEvents <= Nights then Calendar='No problems';
```

The symbol <= means less than or equal to. In this case, SAS compares the values of Events and Nights twice, once in each IF condition. A more efficient way to provide an alternative action is to use an ELSE statement:

ELSE *action*;

An ELSE statement names an alternative action to be taken when the IF condition is false. It must immediately follow the corresponding IF-THEN statement, as shown here:

```
if NumberOfEvents > Nights then Calendar='Check schedule';
else Calendar='No problems';
```

The REVISE2 DATA step adds the preceding ELSE statement to the previous DATA step:

```
data revise2;
   set mylib.arttours;
   if City='Rome' then LandCost=LandCost + 30;
   if NumberOfEvents > Nights then Calendar='Check schedule';
   else Calendar='No problems';
   if TourGuide='Lucas' and Nights > 7 then TourGuide='Torres';
run;

proc print data=revise2;
   var City Nights LandCost NumberOfEvents TourGuide Calendar;
   title 'Tour Information';
run;
```

The following output displays the results.

Figure 10.3 Providing an Alternative Action with the ELSE Statement

Tour Information

Obs	City	Nights	LandCost	NumberOfEvents	TourGuide	Calendar
1	Rome	3	1580	7	D'Amico	Check schedule
2	Brasilia	8	3360	6	Torres	No problems
3	London	6	2460	5	Wilson	No problems
4	Warsaw	6	.	8	Lucas	Check schedule
5	Madrid	3	740	5	Torres	Check schedule
6	Amsterdam	4	1160	6		Check schedule

Creating a Series of Mutually Exclusive Conditions

Using an ELSE statement after an IF-THEN statement provides one alternative action when the IF condition is false. However, many cases involve a series of mutually exclusive conditions, each of which requires a separate action. In this example, tour prices can be classified as high, medium, or low. A series of IF-THEN and ELSE statements classifies the tour prices appropriately:

```
if LandCost >= 2500 then Price='High';
else if LandCost >= 1500 then Price='Medium';
     else Price='Low';
```

The symbol >= means greater than or equal to. To see how SAS executes this series of statements, consider two observations: Amsterdam, whose value of LandCost is 1160, and Brasilia, whose value is 3360.

When the value of LandCost is 1160, SAS processes the program in the following way:

1 SAS tests whether 1160 is equal to or greater than 2500, determines that the comparison is false, ignores the THEN clause, and proceeds to the ELSE statement.

2 The action in the ELSE statement is to evaluate another condition. SAS tests whether 1160 is equal to or greater than 1500, determines that the comparison is false, ignores the THEN clause, and proceeds to the accompanying ELSE statement.

3 SAS executes the action in the ELSE statement and assigns Price the value Low.

When the value of LandCost is 3360, SAS processes the program in the following way:

1 SAS tests whether 3360 is greater than or equal to 2500, determines that the comparison is true, and executes the action in the THEN clause. The value of Price becomes High.

2 SAS ignores the ELSE statement. Because the entire remaining series is part of the first ELSE statement, SAS skips all remaining actions in the series.

A simple way to think of these actions is to remember that when an observation satisfies one condition in a series of mutually exclusive IF-THEN/ELSE statements, SAS processes the THEN action and skips the rest of the statements. Therefore, you can increase the efficiency of a program by ordering the IF-THEN/ELSE statements so that the most common conditions appear first.

The following DATA step includes the preceding series of statements:

```
data prices;
   set mylib.arttours;
   if LandCost >= 2500 then Price='High  ';
   else if LandCost >= 1500 then Price='Medium';
          else Price='Low';
run;

proc print data=prices;
   var City LandCost Price;
   title 'Tour Prices';
run;
```

The following output displays the results.

Figure 10.4 Assigning Mutually Exclusive Values with IF-THEN/ELSE Statements

Tour Prices

Obs	City	LandCost	Price
1	Rome	1550	Medium
2	Brasilia	3360	High
3	London	2460	Medium
4	Warsaw	.	Low
5	Madrid	740	Low
6	Amsterdam	1160	Low

Note the value of Price in the fourth observation. The Price value is Low because the LandCost value for the Warsaw trip is a missing value. Remember that a missing value is the lowest possible numeric value.

Constructing Conditions

Understanding Construct Conditions

When you use an IF-THEN statement, you ask SAS to make a comparison. SAS must determine whether a value is equal to another value, greater than another value, and so on.

SAS has the following six main comparison operators:

Table 10.1 Comparison Operators

Symbol	Mnemonic Operator	Meaning
=	EQ	equal to
¬=, ^= , ~=	NE	not equal to (the ¬, ^, or ~ symbol, depending on your keyboard)
>	GT	greater than
<	LT	less than
>=	GE	greater than or equal to

Symbol	Mnemonic Operator	Meaning
<=	LE	less than or equal to

The symbols in the table are based on mathematical symbols. The letter abbreviations, known as mnemonic operators, have the same effect as the symbols. Use the form that you prefer, but remember that you can use the mnemonic operators only in comparisons. For example, the equal sign in an assignment statement must be represented by the symbol =, not the mnemonic operator. Both of the following statements compare the number of nights in the tour to six:

- `if Nights >= 6 then Stay='Week+';`
- `if Nights ge 6 then Stay='Week+';`

The terms on each side of the comparison operator can be variables, expressions, or constants. The side a particular term appears on does not matter, as long as you use the correct operator. All of the following comparisons are constructed correctly for use in SAS statements:

- `Guide=' '`
- `LandCost ne .`
- `LandCost lt 1200`
- `600 ge LandCost`
- `NumberOfEvents / Nights > 2`
- `2 <= NumberOfEvents / Nights`

Selecting an Observation Based on Simple Conditions

The following DATA step illustrates some of these conditions:

```
data changes;
   set mylib.arttours;
   if Nights >= 6 then Stay='Week+';
   else Stay = 'Days';
   if LandCost ne . then Remarks='OK  ';
   else Remarks = 'Redo';
   if LandCost lt 1200 then Budget='Low   ';
   else Budget = 'Medium';
   if NumberOfEvents / Nights > 2 then Pace='Too fast';
   else Pace='OK';
run;

proc print data=changes;
   var City Nights LandCost NumberOfEvents Stay Remarks Budget Pace;
   title 'Tour Information';
run;
```

The following output displays the results.

Figure 10.5 Assigning Values to Variables According to Specific Conditions

Tour Information

Obs	City	Nights	LandCost	NumberOfEvents	Stay	Remarks	Budget	Pace
1	Rome	3	1550	7	Days	OK	Medium	Too fast
2	Brasilia	8	3360	6	Week+	OK	Medium	OK
3	London	6	2460	5	Week+	OK	Medium	OK
4	Warsaw	6	.	8	Week+	Redo	Low	OK
5	Madrid	3	740	5	Days	OK	Low	OK
6	Amsterdam	4	1160	6	Days	OK	Low	OK

Using More Than One Comparison in a Condition

Specifying Multiple Comparisons

You can specify more than one comparison in a condition with these operators:

- `&` or `AND`
- `|` or `OR`

A condition can contain any number of AND operators, OR operators, or both.

Making Comparisons When All of the Conditions Must Be True

When comparisons are connected by AND, all of the comparisons must be true for the condition to be true. Consider this example:

```
if City='Brasilia' and TourGuide='Lucas' then Remarks='Bilingual';
```

The comparison is true for observations in which the value of City is **`Brasilia`** and the value of TourGuide is **`Lucas`**.

A common comparison is to determine whether a value is between two quantities, greater than one quantity and less than another quantity. For example, to select observations in which the value of LandCost is greater than or equal to 2000, and less than or equal to 2500, you can write a comparison with AND:

```
if LandCost >= 2000 and LandCost <= 2500 then Price = '2000-2500';
```

This is a simpler way to write this comparison:

```
if 2000 <= LandCost <= 2500 then Price = '2000-2500';
```

This comparison has the same meaning as the previous one. You can use any of the operators <, <=, >, >=, or their mnemonic equivalents in this way.

The following DATA step includes these multiple comparison statements:

```
data showand;
   set mylib.arttours;
   if City='Brasilia' and TourGuide='Lucas' then Remarks='Bilingual';
   if 2000 <= LandCost <= 2500 then Price='2000-2500';
run;

proc print data=showand;
   var City LandCost TourGuide Remarks Price;
   title 'Tour Information';
run;
```

The following output displays the results.

Figure 10.6 Using AND When Making Multiple Comparisons

Tour Information

Obs	City	LandCost	TourGuide	Remarks	Price
1	Rome	1550	D'Amico		
2	Brasilia	3360	Lucas	Bilingual	
3	London	2460	Wilson		2000-2500
4	Warsaw	.	Lucas		
5	Madrid	740	Torres		
6	Amsterdam	1160			

When Only One Condition Must Be True

When comparisons are connected by OR, only one of the comparisons needs to be true for the condition to be true. Consider the following example:

```
if LandCost gt 1500 or LandCost / Nights gt 400 then Level='Deluxe';
```

Any observation in which the land cost is over $1500, the cost per night is over $200, or both, satisfies the condition. The following DATA step shows this condition:

```
data showor;
   set mylib.arttours;
   if LandCost gt 1500 or LandCost / Nights gt 400 then Level='Deluxe';
run;
proc print data=showor;
   var City LandCost Nights Level;
   title 'Tour Information';
run;
```

The following output displays the results.

Figure 10.7 Using OR When Making Multiple Comparisons

Tour Information

Obs	City	LandCost	Nights	Level
1	Rome	1550	3	Deluxe
2	Brasilia	3360	8	Deluxe
3	London	2460	6	Deluxe
4	Warsaw	.	6	
5	Madrid	740	3	
6	Amsterdam	1160	4	

Using Negative Operators with AND or OR

Be careful when you combine negative operators with OR. Often, the operator that you really need is AND. For example, the variable TourGuide contains some problems with the data. In the observation for Brasilia, the tour guide and the backup tour guide are both `Lucas`. In the observation for Amsterdam, the name of the tour guide is missing. You want to label the observations that have no problems with TourGuide as OK. Should you write the IF condition with OR or with AND?

The following DATA step shows both conditions:

```
data showorand;
   set mylib.arttours;
   if TourGuide ne BackUpGuide or TourGuide ne ' ' then GuideCheckUsingOR='OK';
   else GuideCheckUsingOR='No';
   if TourGuide ne BackUpGuide and TourGuide ne ' ' then GuideCheckUsingAND='OK';
   else GuideCheckUsingAND='No';
run;

proc print data = showorand;
   var City TourGuide BackUpGuide GuideCheckUsingOR GuideCheckUsingAND;
   title 'Negative Operators with OR and AND';
run;
```

The following output displays the results.

Figure 10.8 Using Negative Operators When Making Comparisons

Negative Operators with OR and AND

Obs	City	TourGuide	BackUpGuide	GuideCheckUsingOR	GuideCheckUsingAND
1	Rome	D'Amico	Torres	OK	OK
2	Brasilia	Lucas	Lucas	OK	No
3	London	Wilson	Lucas	OK	OK
4	Warsaw	Lucas	D'Amico	OK	OK
5	Madrid	Torres	D'Amico	OK	OK
6	Amsterdam		Vandever	OK	No

In the IF-THEN/ELSE statements that create GuideCheckUsingOR, only one comparison needs to be true to make the condition true. Note that the following conditions are true for the Brasilia and Amsterdam observations in the data set MYLIB.ARTTOURS:

- In the observation for Brasilia, TourGuide does not have a missing value and the comparison `TourGuide NE ' '` is true.
- For Amsterdam, the comparison `TourGuide NE BackUpGuide` is true.

Because one OR comparison is true in each observation, GuideCheckUsingOR is labeled OK for all observations. The IF-THEN/ELSE statements that create GuideCheckUsingAND achieve better results. That is, the AND operator selects the observations in which the value of TourGuide is not the same as BackUpGuide and is not missing.

Using Complex Comparisons That Require AND and OR

A condition can contain both AND operators and OR operators. When it does, SAS evaluates the AND operators before the OR operators. The following example specifies a list of cities and a list of guides:

```
   /* first attempt */
if City='Brasilia' or City='Rome' and TourGuide='Lucas' or
   TourGuide="D'Amico" then Topic= 'Art history';
```

SAS first joins the items that are connected by AND:

```
City='Rome' and TourGuide='Lucas'
```

Then SAS makes the following OR comparisons:

```
City='Brasilia'
    or
City='Rome' and TourGuide='Lucas'
    or
TourGuide="D'Amico"
```

To group the City comparisons and the TourGuide comparisons, use parentheses:

```
   /* correct method */
if (City='Brasilia' or City='Rome') and
   (TourGuide='Lucas' or TourGuide="D'Amico") then
```

```
Topic='Art history';
```

SAS evaluates the comparisons within parentheses first and uses the results as the terms of the larger comparison. You can use parentheses in any condition to control the grouping of comparisons or to make the condition easier to read.

The following DATA step illustrates these conditions:

```
data combine;
   set mylib.arttours;
   if (City='Brasilia' or City='Rome') and
      (TourGuide='Lucas' or TourGuide="D'Amico") then
      Topic='Art history';
run;

proc print data=combine;
   var City TourGuide Topic;
   title 'Tour Information';
run;
```

The following output displays the results.

Figure 10.9 Using Parentheses to Combine Comparisons with AND and OR

Tour Information

Obs	City	TourGuide	Topic
1	Rome	D'Amico	Art history
2	Brasilia	Lucas	Art history
3	London	Wilson	
4	Warsaw	Lucas	
5	Madrid	Torres	
6	Amsterdam		

Abbreviating Numeric Comparisons

Two considerations about numeric comparisons are especially helpful to know:

- An abbreviated form of comparison is possible.
- Abbreviated comparisons with OR require you to use caution.

In computing terms, a value of TRUE is 1 and a value of FALSE is 0. In SAS, the following rules apply:

- Any numeric value other than 0 is true.
- A value of 0 or missing is false.

Therefore, a numeric variable or expression can stand alone in a condition. If its value is a number other than 0, then the condition is true. If its value is 0 or missing, then the condition is false.

The following example assigns a value to the variable Remarks only if the value of LandCost is present for a given observation:

```
if LandCost then Remarks='Ready to budget';
```

This statement is equivalent to

```
if LandCost ne . and LandCost ne 0 then Remarks='Ready to budget';
```

Be careful when you abbreviate comparisons with OR. It is easy to produce unexpected results. For example, this IF-THEN statement selects tours that last six or eight nights:

```
   /* first try */
if Nights=6 or 8 then Stay='Medium';
```

SAS treats the condition as the following comparisons:

```
Nights=6
   or
   8
```

The second comparison does not use the values of Nights. The comparison uses the number 8 standing alone. Because the number 8 is neither 0 nor a missing value, it always has the value TRUE. Because only one comparison in a series of OR comparisons needs to be true to make the condition true, this condition is true for all observations.

The following comparisons correctly select observations that have six or eight nights:

```
   /* correct way */
if Nights=6 or Nights=8 then Stay='Medium';
```

The following DATA step includes these IF-THEN statements:

```
data morecomp;
   set mylib.arttours;
   if LandCost then Remarks='Ready to budget';
   else Remarks='Need land cost';
   if Nights=6 or Nights=8 then Stay='Medium';
   else Stay='Short';
run;

proc print data=morecomp;
   var City Nights LandCost Remarks Stay;
   title 'Tour Information';
run;
```

The following output displays the results.

Figure 10.10 Abbreviating Numeric Comparisons

Tour Information

Obs	City	Nights	LandCost	Remarks	Stay
1	Rome	3	1550	Ready to budget	Short
2	Brasilia	8	3360	Ready to budget	Medium
3	London	6	2460	Ready to budget	Medium
4	Warsaw	6	.	Need land cost	Medium
5	Madrid	3	740	Ready to budget	Short
6	Amsterdam	4	1160	Ready to budget	Short

Comparing Characters

Types of Character Comparisons

Some special situations occur when you make character comparisons. You might need to perform the following tasks:

- compare uppercase and lowercase characters
- select all values that begin with a particular group of characters
- select all values that begin with a particular range of characters
- find a particular value anywhere within another character value

Comparing Uppercase and Lowercase Characters

SAS distinguishes between uppercase and lowercase letters in comparisons. For example, the values **`Madrid`** and **`MADRID`** are not equivalent. To compare values that might occur in different cases, use the UPCASE function to produce an uppercase value. Then make the comparison between two uppercase values, as shown here:

```
data newguide;
   set mylib.arttours;
   if upcase(City)='MADRID' then TourGuide='Balarezo';
run;

proc print data=newguide;
   var City TourGuide;
   title 'Tour Guides';
```

```
run;
```

Within the comparison, SAS produces an uppercase version of the value of City and compares it to the uppercase constant MADRID. The value of City in the observation remains in its original case.

The following output displays the results.

Figure 10.11 Data Set Produced by an Uppercase Comparison

Tour Guides

Obs	City	TourGuide
1	Rome	D'Amico
2	Brasilia	Lucas
3	London	Wilson
4	Warsaw	Lucas
5	Madrid	Balarezo
6	Amsterdam	

Now **`Balarezo`** is assigned as the tour guide for **`Madrid`** because the UPCASE function compares the uppercase value of **`Madrid`** with the value **`MADRID`**. The UPCASE function enables SAS to read the two values as equal.

Selecting All Values That Begin with the Same Group of Characters

Sometimes you need to select a group of character values, such as all tour guides whose names begin with the letter D.

By default, SAS compares values of different lengths by adding blanks to the end of the shorter value and testing the result against the longer value. Here is an example:

```
   /* first attempt */
if Tourguide='D' then Chosen='Yes';
else Chosen='No';
```

SAS interprets the comparison as

```
TourGuide='D       '
```

`D` is followed by seven blanks because TourGuide, a character variable created by column input, has a length of eight bytes. Because the value of TourGuide never consists of the single letter D, the comparison is never true.

To compare a long value to a shorter standard, put a colon (:) after the operator, as in this example:

```
   /* correct method */
if TourGuide=:'D' then Chosen='Yes';
else Chosen='No';
```

The colon causes SAS to compare the same number of characters in the shorter value and the longer value. In this case, the shorter string contains one character. Therefore, SAS tests only the first character from the longer value. All names that begin with a D make the comparison true. (If you are not sure that all the values of TourGuide begin with a capital letter, then use the UPCASE function.) The following DATA step selects names that begin with D:

```
data dguide;
   set mylib.arttours;
   if TourGuide=:'D' then Chosen='Yes';
   else Chosen='No';
run;

proc print data=dguide;
   var City TourGuide Chosen;
   title 'Guides Whose Names Begin with D';
run;
```

The following output displays the results.

Figure 10.12 *Selecting All Values Beginning with a Particular String*

Guides Whose Names Begin with D

Obs	City	TourGuide	Chosen
1	Rome	D'Amico	Yes
2	Brasilia	Lucas	No
3	London	Wilson	No
4	Warsaw	Lucas	No
5	Madrid	Torres	No
6	Amsterdam		No

Selecting a Range of Character Values

You might want to select values that begin with a range of characters, such as all names that begin with A through L or M through Z. To select a range of character values, you need to understand the following points:

- In computer processing, letters have magnitude. A is the smallest letter in the alphabet and Z is the largest. Therefore, the comparison A<B is true; so is the comparison D>C.[1]
- A blank is smaller than any letter.

1. The magnitude of letters in the alphabet is true for all operating environments under which SAS runs. Other points, such as whether uppercase or lowercase letters are larger and how to treat numbers in character values, depend on your operating environment. For more information about how character values are sorted under various operating environments, see Chapter 12, “Working with Grouped or Sorted Observations,” on page 191.

The following statements divide the names of the guides into two groups, A-L and M-Z, by combining the comparison operator with the colon:

```
if TourGuide <=: 'L' then TourGuideGroup='A-L';
   else TourGuideGroup='M-Z';
```

The following DATA step creates the groups:

```
data guidegrp;
   set mylib.arttours;
   if TourGuide <=: 'L' then TourGuideGroup'A-L';
   else TourGuideGroup='M-Z';
run;

proc print data=guidegrp;
   var City TourGuide TourGuideGroup;
   title 'Tour Guide Groups';
run;
```

The following output displays the results.

Figure 10.13 Selecting All Values Beginning with a Range of Characters

Tour Guide Groups

Obs	City	TourGuide	TourGuideGroup
1	Rome	D'Amico	A-L
2	Brasilia	Lucas	A-L
3	London	Wilson	M-Z
4	Warsaw	Lucas	A-L
5	Madrid	Torres	M-Z
6	Amsterdam		A-L

All names that begin with A through L, as well as the missing value, go into group A-L. The missing value goes into that group because a blank is smaller than any letter.

Finding a Value Anywhere within Another Character Value

A data set is needed that lists tours that visit other attractions in addition to museums and galleries. In the data set MYLIB.ARTTOURS, the variable EventDescription refers to those events as `other`. However, the position of the word `other` varies in different observations. How can it be determined that `other` exists anywhere in the value of EventDescription for a given observation?

The INDEX function determines whether a specified character string (the excerpt) is present within a particular character value (the source):

INDEX (*source*, *excerpt*)

Both *source* and *excerpt* can be any type of character expression, including character strings that are enclosed in quotation marks, character variables, and other character functions. If *excerpt* does occur within *source*, then the function returns the position of the first character of *excerpt*, which is a positive number. If it does not, then the function returns a 0. By testing for a value greater than 0, you can determine whether a particular character string is present in another character value.

The following statements select observations containing the string `other`:

```
if index(EventDescription,'other') > 0 then OtherEvents='Yes';
else OtherEvents='No';
```

You can also write the condition in the following way:

```
if index(EventDescription,'other') then OtherEvents='Yes';
else OtherEvents='No';
```

The second example uses the fact that any value other than 0 or missing makes the condition true. This statement is included in the following DATA step:

```
data otherevent;
   set mylib.arttours;
   if index(EventDescription,'other') then OtherEvents='Yes';
   else OtherEvents='No';
run;

proc print data=otherevent;
   var City EventDescription OtherEvents;
   title 'Tour Events';
run;
```

The following output displays the results.

Figure 10.14 *Finding a Character String within Another Value*

Tour Events

Obs	City	EventDescription	OtherEvents
1	Rome	4 M, 3 G	No
2	Brasilia	5 M, 1 other	Yes
3	London	3 M, 2 G	No
4	Warsaw	5 M, 1 G, 2 other	Yes
5	Madrid	3 M, 2 other	Yes
6	Amsterdam	3 M, 3 G	No

In the observations for Brasilia and Madrid, the INDEX function returns the value 8 because the string **`other`** is found beginning in position eight of the variable (**`5 M, 1 other`** for Brasilia and **`3 M, 2 other`** for Madrid). For New York, it returns the value 13 because the string **`other`** is found beginning in position thirteen of the variable (**`5 M, 1 G, 2 other`**). In the remaining observations, the function does not find the string **`other`** and returns a 0.

Summary

Statements

IF *condition* THEN *action*;
<ELSE *action*>;

tests whether *condition* is true. If the condition is true, the action in the THEN clause is carried out. If *condition* is false and an ELSE statement is present, then the ELSE action is carried out. If *condition* is false and no ELSE statement is present, then the next statement in the DATA step is processed. *Condition* specifies one or more numeric or character comparisons. *action* must be an executable statement. That is, one that can be processed in an individual iteration of the DATA step. (Statements that affect the entire DATA step, such as LENGTH, are not executable.)

In SAS processing, any numeric value other than 0 or missing is true. The values 0 and missing are false. Therefore, a numeric value can stand alone in a comparison. If its value is 0 or missing, then the comparison is false. Otherwise, the comparison is true.

Functions

INDEX(*source*, *excerpt*)

searches *source* for the string given in *excerpt*. Both *source* and *excerpt* can be any type of character expressions, such as character variables, character strings that are enclosed in quotation marks, other character functions, and so on. When *excerpt* is present in *source*, the function returns the position of the first character of *excerpt* (a positive number). When *excerpt* is not present, the function returns a 0.

UPCASE(*argument*)

produces an uppercase value of *argument*, which can be any type of character expression, such as a character variable, character string enclosed in quotation marks, other character functions, and so on.

Learning More

Base SAS functions

Base SAS functions are documented in *SAS Functions and CALL Routines: Reference*.

Comparison and logical operators
: For more information, see "SAS Operators in Expressions" in *SAS Language Reference: Concepts*.

Executable statements
: You can issue only executable statements in IF-THEN/ELSE statements. For a complete list of executable and nonexecutable statements, see "DATA Step Statements" in *SAS DATA Step Statements: Reference*.

IF-THEN/ELSE statement and clauses
: For more information, see "IF-THEN/ELSE Statement" in *SAS DATA Step Statements: Reference*.

IN operator
: You can use the IN operator to shorten a comparison when you are comparing a value to a series of numeric or character constants (not variables or expressions). For more information, see "The IN Operator in Character Comparisons" in *SAS Language Reference: Concepts* and "The IN Operator in Numeric Comparisons" in *SAS Language Reference: Concepts*.

SELECT statement
: The SELECT statement, which selects observations based on a condition, is equivalent to a series of IF-THEN/ELSE statements. If you have a long series of conditions and actions, then the DATA step can be easier to read if you write the conditions in a SELECT group. For more information, see "SELECT Statement" in *SAS DATA Step Statements: Reference*.

TRUNCOVER option
: The TRUNCOVER option in the INFILE statement is described in the note in "Input SAS Data Set for Examples" on page 154. For more information, see "INFILE Statement" in *SAS DATA Step Statements: Reference*.

11

Creating Subsets of Observations

Introduction to Creating Subsets of Observations

Purpose

In this section, you will learn to select specific observations from existing SAS data sets to create new data sets. Specifically, you will learn about the following concepts:

- how to create a new SAS data set that includes only some of the observations from the input data source
- how to create several new SAS data sets by writing observations from an input data source, using a single DATA step

Prerequisites

Before proceeding with this section, you should understand the concepts presented in the following sections:

- Chapter 3, “Introduction to DATA Step Processing,” on page 25
- Chapter 4, “Starting with Raw Data: The Basics,” on page 51
- Chapter 5, “Starting with Raw Data: Beyond the Basics,” on page 71
- Chapter 6, “Starting with SAS Data Sets,” on page 93
- Chapter 10, “Acting on Selected Observations,” on page 153
- Chapter 7, “Understanding DATA Step Processing,” on page 109

Input SAS Data Set for Examples

Tradewinds Travel has a schedule for tours to various art museums and galleries. It would be convenient to keep different SAS data sets that contain different information about the tours. The tour data is stored in an external file that contains the following information:

```
1         2 3    4      5
-------------------------------
Rome      3 1550 Medium D'Amico
Brasilia  8 3360 High   Lucas
London    6 2460 Medium Wilson
Warsaw    6    .        Lucas
Madrid    3  740 Low    Torres
Amsterdam 4 1160 Low
```

The following list describes the fields in the input file:

1 provides the name of the destination city

2 specifies the number of nights on the tour

3 specifies the cost of the land package in U.S. dollars

4 specifies a rating for the budget

5 provides the name of the tour guide

The following program creates a permanent SAS data set named MYLIB.ARTS:

```
libname mylib 'SAS-library';

data mylib.arts;
   infile 'input-file' truncover;
   input City $ 1-9 Nights 11 LandCost 13-16 Budget $ 18-23
         TourGuide $ 25-32;
run;
```

```
proc print data=mylib.arts;
   title 'Data Set MYLIB.ARTS';
run;
```

The following output displays the results.

Figure 11.1 *Data Set MYLIB.ARTS*

Data Set MYLIB.ARTS

Obs	City	Nights	LandCost	Budget	TourGuide
1	Rome	3	1550	Medium	D'Amico
2	Brasilia	8	3360	High	Lucas
3	London	6	2460	Medium	Wilson
4	Warsaw	6	.		Lucas
5	Madrid	3	740	Low	Torres
6	Amsterdam	4	1160	Low	

Selecting Observations for a New SAS Data Set

Deleting Observations Based on a Condition

There are two ways to select specific observations in a SAS data set when you create a new SAS data set:

1. Delete the observations that do not meet a condition, keeping only the ones that you want.
2. Accept only the observations that meet a condition.

To delete an observation, first identify it with an IF condition, and then use a DELETE statement in the THEN clause:

IF *condition* **THEN DELETE**;

Processing the DELETE statement for an observation causes SAS to return immediately to the beginning of the DATA step for a new observation without writing the current observation to the output DATA set. The DELETE statement does not include the observation in the output data set, but it does not delete the observation from the input data set. For example, the following statement deletes observations that contain a missing value for LandCost:

```
if LandCost=. then delete;
```

The following DATA step includes this statement:

```
data remove;
   set mylib.arts;
   if LandCost=. then delete;
run;

proc print data=remove;
   title 'Tours With Complete Land Costs';
run;
```

The following output displays the results.

Figure 11.2 *Deleting Observations That Have a Particular Value*

Tours With Complete Land Costs

Obs	City	Nights	LandCost	Budget	TourGuide
1	Rome	3	1550	Medium	D'Amico
2	Brasilia	8	3360	High	Lucas
3	London	6	2460	Medium	Wilson
4	Madrid	3	740	Low	Torres
5	Amsterdam	4	1160	Low	

Warsaw, the observation that is missing a value for LandCost, is not included in the resulting data set, REMOVE.

You can also delete observations as you enter data from an external file. The following DATA step produces the same SAS data set as the REMOVE data set.

```
data remove2;
   infile 'input-file' truncover;
   input City $ 1-9 Nights 11 LandCost 13-16 Budget $ 18-23
         TourGuide $ 25-32;
   if LandCost=. then delete;
run;

proc print data=remove2;
   title 'Tours With Complete Land Costs';
run;
```

The following output displays the results.

Figure 11.3 Deleting Observations While Reading from an External File

Tours With Complete Land Costs

Obs	City	Nights	LandCost	Budget	TourGuide
1	Rome	3	1550	Medium	D'Amico
2	Brasilia	8	3360	High	Lucas
3	London	6	2460	Medium	Wilson
4	Madrid	3	740	Low	Torres
5	Amsterdam	4	1160	Low	

Accepting Observations Based on a Condition

One data set that is needed by the travel agency contains observations for tours that last only six nights. One way to make the selection is to delete observations in which the value of Nights is not equal to 6:

```
if Nights ne 6 then delete;
```

A more straightforward way is to select only observations meeting the criterion. The subsetting IF statement selects the observations that you specify. It contains only a condition:

IF *condition*;

The implicit action in a subsetting IF statement is always the same: if the condition is true, then continue processing the observation. If it is false, then stop processing the observation and return to the top of the DATA step for a new observation. The statement is called subsetting because the result is a subset of the original observations. For example, if you want to select only observations in which the value of Nights is equal to 6, then you specify the following statement:

```
if Nights = 6;
```

The following DATA step includes the subsetting IF statement:

```
data subset6;
   set mylib.arts;
   if nights=6;
run;

proc print data=subset6;
   title 'Six-Night Tours';
run;
```

The following output displays the results.

Figure 11.4 Selecting Observations with a Subsetting IF Statement

Six-Night Tours

Obs	City	Nights	LandCost	Budget	TourGuide
1	London	6	2460	Medium	Wilson
2	Warsaw	6	.		Lucas

Two observations met the criteria for a six-night tour.

Comparing the DELETE and Subsetting IF Statements

These are the main reasons to consider when choosing between a DELETE statement and a subsetting IF statement:

- It is usually easier to choose the statement that requires the fewest comparisons to identify the condition.
- It is usually easier to think in positive terms than negative ones (this favors the subsetting IF).

One additional situation favors the subsetting IF: it is the safer method to use if your data has missing or misspelled values. Consider the following situation.

Tradewinds Travel needs a SAS data set of low-priced to medium-priced tours. Knowing that the values of Budget are **`Low`**, **`Medium`**, and **`High`**, a first thought would be to delete observations with a value of **`High`**. The following program creates a SAS data set by deleting observations that have a Budget value of **`HIGH`**:

```
   /* first attempt */
data lowmed;
   set mylib.arts;
   if upcase(Budget)='HIGH' then delete;
run;

proc print data=lowmed;
   title 'Medium and Low Priced Tours';
run;
```

The following output displays the results.

Figure 11.5 Producing a Subset by Deletion

Medium and Low Priced Tours

Obs	City	Nights	LandCost	Budget	TourGuide
1	Rome	3	1550	Medium	D'Amico
2	London	6	2460	Medium	Wilson
3	Warsaw	6	.		Lucas
4	Madrid	3	740	Low	Torres
5	Amsterdam	4	1160	Low	

The data set LOWMED contains both the tours that you want and the tour to Warsaw. The inclusion of the tour to Warsaw is erroneous because the value of Budget for the Warsaw observation is missing. Using a subsetting IF statement ensures that the data set contains exactly the observations that you want. This DATA step creates the subset with a subsetting IF statement:

```
   /* a safer method */
data lowmed2;
   set mylib.arts;
   if upcase(Budget)='MEDIUM' or upcase(Budget)='LOW';
run;

proc print data=lowmed2;
   title 'Medium and Low Priced Tours';
run;
```

The following output displays the results.

Figure 11.6 Producing an Exact Subset with the Subsetting IF Statement

Medium and Low Priced Tours

Obs	City	Nights	LandCost	Budget	TourGuide
1	Rome	3	1550	Medium	D'Amico
2	London	6	2460	Medium	Wilson
3	Madrid	3	740	Low	Torres
4	Amsterdam	4	1160	Low	

The result is a SAS data set with no missing values for Budget.

Conditionally Writing Observations to One or More SAS Data Sets

Understanding the OUTPUT Statement

SAS enables you to create multiple SAS data sets in a single DATA step using an OUTPUT statement:

OUTPUT <*SAS-data-set(s)*>;

When you use an OUTPUT statement without specifying a data set name, SAS writes the current observation to all data sets that are named in the DATA statement. If you want to write observations to a selected data set, then you specify that data set name directly in the OUTPUT statement. Any data set name appearing in the OUTPUT statement must also appear in the DATA statement.

Example for Conditionally Writing Observations to Multiple Data Sets

One of the SAS data sets contains tours that are guided by the tour guide Lucas and the other contains tours led by other guides. Writing to multiple data sets is accomplished by performing the following tasks:

- naming both data sets in the DATA statement
- selecting the observations using an IF condition
- using an OUTPUT statement in the THEN and ELSE clauses to output the observations to the appropriate data sets

The following DATA step shows how to write to multiple data sets:

```
data lucastour othertours;
   set mylib.arts;
   if TourGuide='Lucas' then output lucastour;
   else output othertours;
run;

proc print data=lucastour;
   title "Data Set with TourGuide='Lucas'";
run;

proc print data=othertours;
   title "Data Set with Other Guides";
run;
```

The following output displays the results.

Figure 11.7 Creating Two Data Sets with One DATA Step

Data Set with TourGuide = 'Lucas'

Obs	City	Nights	LandCost	Budget	TourGuide
1	Brasilia	8	3360	High	Lucas
2	Warsaw	6	.		Lucas

Data Set with Other Guides

Obs	City	Nights	LandCost	Budget	TourGuide
1	Rome	3	1550	Medium	D'Amico
2	London	6	2460	Medium	Wilson
3	Madrid	3	740	Low	Torres
4	Amsterdam	4	1160	Low	

Avoiding a Common Mistake When Writing to Multiple Data Sets

If you use an OUTPUT statement, then you suppress the automatic output of observations at the end of the DATA step. Therefore, if you plan to use any OUTPUT statements in a DATA step, then you must program all output for that step with OUTPUT statements. For example, in the previous DATA step you sent output to both LUCASTOUR and OTHERTOURS. For comparison, the following program shows what would happen if you omit the ELSE statement in the DATA step:

```
data lucastour2 othertour2;
   set mylib.arts;
   if TourGuide='Lucas' then output lucastour2;
run;

proc print data=lucastour2;
   title "Data Set with Guide='Lucas'";
run;

proc print data=othertour2;
   title "Data Set with Other Guides";
run;
```

The following output displays the results.

Figure 11.8 Failing to Direct Output to a Second Data Set

Data Set with Guide = 'Lucas'

Obs	City	Nights	LandCost	Budget	TourGuide
1	Brasilia	8	3360	High	Lucas
2	Warsaw	6	.		Lucas

No observations are written to OTHERTOUR2 because output was not directed to it.

Understanding Why the Placement of the OUTPUT Statement Is Important

By default SAS writes an observation to the output data set at the end of each iteration. When you use an OUTPUT statement, you override the automatic output feature. Where you place the OUTPUT statement, therefore, is very important. For example, if a variable value is calculated after the OUTPUT statement executes, then that value is not available when the observation is written to the output data set.

For example, in the following DATA step, an assignment statement is placed after the IF-THEN/ELSE group:

```
   /* first attempt to combine assignment and OUTPUT statements */
data lucasdays otherdays;
   set mylib.arts;
   if TourGuide='Lucas' then output lucasdays;
   else output otherdays;
   Days=Nights+1;
run;

proc print data=lucasdays;
   title "Number of Days in Lucas's Tours";
run;

proc print data=otherdays;
   title "Number of Days in Other Guides' Tours";
run;
```

The following output displays the results.

Figure 11.9 Unintended Results: Writing Observations Before Assigning Values

Number of Days in Lucas's Tours

Obs	City	Nights	LandCost	Budget	TourGuide	Days
1	Brasilia	8	3360	High	Lucas	.
2	Warsaw	6	.		Lucas	.

Number of Days in Other Guides' Tours

Obs	City	Nights	LandCost	Budget	TourGuide	Days
1	Rome	3	1550	Medium	D'Amico	.
2	London	6	2460	Medium	Wilson	.
3	Madrid	3	740	Low	Torres	.
4	Amsterdam	4	1160	Low		.

The value of Days is missing in all observations because the OUTPUT statement writes the observation to the SAS data sets before the assignment statement is processed. If you want the value of Day to appear in the data sets, then use the assignment statement before you use the OUTPUT statement. The following program shows the correct position:

```
   /* correct position of assignment statement */
data lucasdays2 otherdays2;
   set mylib.arts;
   Days=Nights + 1;
   if TourGuide='Lucas' then output lucasdays2;
   else output otherdays2;
run;

proc print data=lucasdays2;
   title "Number of Days in Lucas's Tours";
run;
proc print data=otherdays2;
   title "Number of Days in Other Guides' Tours";
run;
```

The following output displays the results.

Figure 11.10 Intended Results: Assigning Values After Writing Observations

Number of Days in Lucas's Tours

Obs	City	Nights	LandCost	Budget	TourGuide	Days
1	Brasilia	8	3360	High	Lucas	9
2	Warsaw	6	.		Lucas	7

Number of Days in Other Guides' Tours

Obs	City	Nights	LandCost	Budget	TourGuide	Days
1	Rome	3	1550	Medium	D'Amico	4
2	London	6	2460	Medium	Wilson	7
3	Madrid	3	740	Low	Torres	4
4	Amsterdam	4	1160	Low		5

Writing an Observation Multiple Times to One or More Data Sets

After SAS processes an OUTPUT statement, the observation remains in the program data vector and you can continue programming with it. You can even write it again to the same SAS data set or to a different one. The following example creates two pairs of data sets, one pair based on the name of the tour guide and one pair based on the number of nights.

```
data lucastour othertour weektour daytour;
   set mylib.arts;
   if TourGuide='Lucas' then output lucastour;
   else output othertour;
   if nights >= 6 then output weektour;
   else output daytour;
run;

proc print data=lucastour;
   title "Lucas's Tours";
run;

proc print data=othertour;
   title "Other Guides' Tours";
run;
proc print data=weektour;
   title 'Tours Lasting a Week or More';
run;

proc print data=daytour;
   title 'Tours Lasting Less Than a Week';
run;
```

The following output displays the results.

Figure 11.11 Assigning Observations to More Than One Data Set

Lucas's Tours

Obs	City	Nights	LandCost	Budget	TourGuide
1	Brasilia	8	3360	High	Lucas
2	Warsaw	6	.		Lucas

Other Guides' Tours

Obs	City	Nights	LandCost	Budget	TourGuide
1	Rome	3	1550	Medium	D'Amico
2	London	6	2460	Medium	Wilson
3	Madrid	3	740	Low	Torres
4	Amsterdam	4	1160	Low	

Tours Lasting a Week or More

Obs	City	Nights	LandCost	Budget	TourGuide
1	Brasilia	8	3360	High	Lucas
2	London	6	2460	Medium	Wilson
3	Warsaw	6	.		Lucas

Tours Lasting Less Than a Week

Obs	City	Nights	LandCost	Budget	TourGuide
1	Rome	3	1550	Medium	D'Amico
2	Madrid	3	740	Low	Torres
3	Amsterdam	4	1160	Low	

The first IF-THEN/ELSE group writes all observations to either data set LUCASTOUR or OTHERTOUR. The second IF-THEN/ELSE group writes the same observations to a different pair of data sets, WEEKTOUR and DAYTOUR. This repetition is possible because each observation remains in the program data vector after the first OUTPUT statement is processed and can be written again.

Summary

Statements

DATA <*libref-1*> *SAS-data-set-1*< . . .<*libref-n*> *SAS-data-set-n*>;
: names the SAS data sets to be created in the DATA step.

DELETE;
: deletes the current observation. The DELETE statement is usually used as part of an IF-THEN/ELSE group.

IF *condition*;
: tests whether *condition* is true. If it is true, then SAS continues to process the current observation. If it is not true, then SAS stops processing the observation, does not add it to the SAS data set, and returns to the top of the DATA step. The conditions that are used are the same as in the IF-THEN/ELSE statements. This type of IF statement is called a subsetting IF statement because it produces a subset of the original observations.

OUTPUT <*SAS-data-set*>;
: immediately writes the current observation to *SAS-data-set*. The observation remains in the program data vector. You can continue programming with observation, including writing it again to a SAS data set. When an OUTPUT statement appears in a DATA step, SAS does not automatically output observations to the SAS data set. You must specify the destination for all output in the DATA step with OUTPUT statements. Any SAS data set that you specify in an OUTPUT statement must also appear in the DATA statement.

Learning More

Comparison and logical operators
: For more information, see "SAS Operators in Expressions" in *SAS Language Reference: Concepts* and Chapter 10, "Acting on Selected Observations," on page 153.

DROP= and KEEP= data set options
: Using the DROP= and KEEP= data set options to output a subset of variables to a SAS data set are discussed in Chapter 6, "Starting with SAS Data Sets," on page 93. For more information, see "DROP= Data Set Option" in *SAS Data Set Options: Reference* and "KEEP= Data Set Option" in *SAS Data Set Options: Reference*.

FIRSTOBS= and OBS= data set options
: Using these data set options to select observations from the beginning, middle, or end of a SAS data set are discussed in Chapter 6, "Starting with SAS Data Sets," on page 93. For more information, see "FIRSTOBS= Data Set Option" in

SAS Data Set Options: Reference and "OBS= Data Set Option" in *SAS Data Set Options: Reference*.

IF-THEN/ELSE statement

For more information, see "IF-THEN/ELSE Statement" in *SAS DATA Step Statements: Reference*.

DELETE and OUTPUT statements

For more information, see "DELETE Statement" in *SAS DATA Step Statements: Reference* and "OUTPUT Statement" in *SAS DATA Step Statements: Reference*.

WHERE statement

The WHERE statement selects observations based on a condition. Its action is similar to that of a subsetting IF statement. The WHERE statement is extremely useful in PROC steps, and it can also be useful in some DATA steps. The WHERE statement selects observations before they enter the program data vector. In contrast, the subsetting IF statement selects observations already in the program data vector.

For more information, see "Selecting Observations" on page 460. See also "WHERE Statement" in *SAS DATA Step Statements: Reference*.

Note: In some cases, the same condition in a WHERE statement in the DATA step and in a subsetting IF statement produces different subsets. The difference is described in the discussion of the WHERE statement in "WHERE Statement" in *SAS DATA Step Statements: Reference*. Be sure you understand the difference before you use the WHERE statement in the DATA step. With that caution in mind, a WHERE statement can increase the efficiency of the DATA step considerably.

12

Working with Grouped or Sorted Observations

Introduction to Working with Grouped or Sorted Observations

Purpose

Sometimes you need to create reports where observations are grouped according to the values of a particular variable, or where observations are sorted alphabetically. The following concepts are discussed in this section:

- how to group observations by variables and how to work with grouped observations
- how to sort the observations and how to work with sorted observations

Prerequisites

Before proceeding with this section, you should understand the concepts presented in the following sections:

- Chapter 1, "What is the SAS System?," on page 3
- "Overview of DATA Step Processing" on page 109
- Chapter 4, "Starting with Raw Data: The Basics," on page 51
- Chapter 5, "Starting with Raw Data: Beyond the Basics," on page 71
- Chapter 6, "Starting with SAS Data Sets," on page 93
- Chapter 7, "Understanding DATA Step Processing," on page 109

Input SAS Data Set for Examples

Tradewinds Travel has an external file that contains data about tours that emphasize either architecture or scenery. After the data is created in a SAS data set and the observations for those tours are grouped together, SAS can produce reports for each group separately. In addition, if the observations need to be alphabetized by country, SAS can sort them. The external file looks like this:

```
1           2             3  4    5
------------------------------------------
Spain       architecture  10 1020 World
Japan       architecture   8 1440 Express
Switzerland scenery        9 1468 World
Brazil      architecture   8 1150 World
Ireland     scenery        7 1116 Express
New Zealand scenery       16 2978 Southsea
Italy       architecture   8  936 Express
Greece      scenery       12 1396 Express
```

The following list describes the fields in the input file:

1 provides the name of the destination country

2 identifies the tour's area of emphasis

3 specifies the number of nights on the tour

4 specifies the cost of the land package in U.S. dollars

5 lists the name of the tour vendor

The following DATA step creates the permanent SAS data set MYLIB.ARCH_OR_SCEN.

```
libname mylib 'SAS-library';

data mylib.arch_or_scen;
   infile 'input-file' truncover;
   input Country $ 1-11 TourType $ 13-24 Nights LandCost Vendor $;
run;

proc print data=mylib.arch_or_scen;
   title 'Data Set MYLIB.ARCH_OR_SCEN';
run;
```

The PROC PRINT statement that follows the DATA step produces this display of the MYLIB.ARCH_OR_SCEN data set.

Figure 12.1 *Data Set MYLIB.ARCH_OR_SCEN*

Data Set MYLIB.ARCH_OR_SCEN

Obs	Country	TourType	Nights	LandCost	Vendor
1	Spain	architecture	10	1020	World
2	Japan	architecture	8	1440	Express
3	Switzerland	scenery	9	1468	World
4	Brazil	architecture	8	1150	World
5	Ireland	scenery	7	1116	Express
6	New Zealand	scenery	16	2978	Southsea
7	Italy	architecture	8	936	Express
8	Greece	scenery	12	1396	Express

Working with Grouped Data

Understanding the Basics of Grouping Data

The basic method for grouping data is to use a BY statement:

BY *list-of-variables*;

The BY statement can be used in a DATA step with a SET, MERGE, MODIFY, or UPDATE statement, or it can be used in SAS procedures.

To work with grouped data using the SET, MERGE, MODIFY, or UPDATE statements, the data must meet these conditions:

- The observations must be in a SAS data set, not an external file.
- The variables that define the groups must appear in the BY statement.

- All observations in the input data set must be in ascending or descending numeric or character order, or grouped in some way, such as by calendar month or by a formatted value, according to the variables that are specified in the BY statement.

  Note: If you use the MODIFY statement, the input data does not need to be in any order. However, ordering the data can improve performance.

If the third condition is not met, the data is stored in a SAS data set but is not arranged in the groups that you want. You can order the data using the SORT procedure (discussed in the next section).

After the SAS data set is arranged in some order, you can use the BY statement to group values of one or more common variables.

Grouping Observations with the SORT Procedure

All observations in the input data set must be in a particular order. To meet this condition, the observations in MYLIB.ARCH_OR_SCEN can be ordered by the values of TourType, which are **`architecture`** or **`scenery`**. Use the SORT procedure to sort the observations by TourType:

```
proc sort data=mylib.arch_or_scen out=tourorder;
   by TourType;
run;
```

The SORT procedure sorts the data set MYLIB.ARCH_OR_SCEN alphabetically according to the values of TourType. The sorted observations go into a new data set specified by the OUT= option. In this example, TOURORDER is the sorted data set. If the OUT= option is omitted, the sorted version of the data set replaces the data set MYLIB.ARCH_OR_SCEN.

The SORT procedure does not produce output other than the sorted data set. A message in the SAS log says that the SORT procedure was executed:

Example Code 12.1 *Message That the SORT Procedure Has Executed Successfully*

```
880  proc sort data=mylib.arch_or_scen out=tourorder;
881     by TourType;
882  run;

NOTE: There were 8 observations read from the data set MYLIB.ARCH_OR_SCEN.
NOTE: The data set WORK.TOURORDER has 8 observations and 5 variables.
NOTE: PROCEDURE SORT used (Total process time):
      real time           0.20 seconds
      cpu time            0.04 seconds
```

To see the sorted data set, add a PROC PRINT step to the program:

```
proc sort data=mylib.arch_or_scen out=tourorder;
   by TourType;
run;

proc print data=tourorder;
   var TourType Country Nights LandCost Vendor;
   title 'Tours Sorted by Architecture or Scenery';
```

```
run;
```

The following output displays the results.

Figure 12.2 Displaying the Sorted Output

Tours Sorted by Architecture or Scenery

Obs	TourType	Country	Nights	LandCost	Vendor
1	architecture	Spain	10	1020	World
2	architecture	Japan	8	1440	Express
3	architecture	Brazil	8	1150	World
4	architecture	Italy	8	936	Express
5	scenery	Switzerland	9	1468	World
6	scenery	Ireland	7	1116	Express
7	scenery	New Zealand	16	2978	Southsea
8	scenery	Greece	12	1396	Express

By default, SAS arranges groups in ascending order of the BY values, smallest to largest. Sorting a data set does not change the order of the variables within it. However, most examples in this section use a VAR statement in the PRINT procedure to display the BY variable in the first column. (The PRINT procedure and other procedures used in this documentation can also produce a separate report for each BY group.)

Grouping by More Than One Variable

You can group observations by as many variables as you want. This example groups observations by TourType, Vendor, and LandCost:

```
proc sort data=mylib.arch_or_scen out=tourorder2;
   by TourType Vendor LandCost;
run;

proc print data=tourorder2;
   var TourType Vendor LandCost Country Nights;
   title 'Tours Grouped by Type of Tour, Vendor, and Price';
run;
```

The following output displays the results.

Figure 12.3 Grouping by Several Variables

Tours Grouped by Type of Tour, Vendor, and Price

Obs	TourType	Vendor	LandCost	Country	Nights
1	architecture	Express	936	Italy	8
2	architecture	Express	1440	Japan	8
3	architecture	World	1020	Spain	10
4	architecture	World	1150	Brazil	8
5	scenery	Express	1116	Ireland	7
6	scenery	Express	1396	Greece	12
7	scenery	Southsea	2978	New Zealand	16
8	scenery	World	1468	Switzerland	9

As this example shows, SAS groups the observations by the first variable that is named within those groups, by the second variable named, and so on. The groups defined by all variables contain only one observation each. In this example, no two variables have the same values for all observations. In other words, this example does not have any duplicate entries.

Arranging Groups in Descending Order

In the data sets that are grouped by TourType, the group for **`architecture`** comes before the group for **`scenery`** because **`architecture`** begins with an “a”, and “a” is smaller than “s” in computer processing. (The order of characters, known as their collating sequence, is discussed later in this section.) To produce a descending order for a particular variable, place the DESCENDING option before the name of the variable in the BY statement of the SORT procedure. In the next example, the observations are grouped in descending order by TourType, but in ascending order by Vendor and LandCost:

```
proc sort data=mylib.arch_or_scen out=tourorder3;
   by descending TourType Vendor LandCost;
run;

proc print data=tourorder3;
   var TourType Vendor LandCost Country Nights;
   title 'Descending Order of TourType';
run;
```

The following output displays the results.

Figure 12.4 Combining Descending and Ascending Sorted Observations

Descending Order of TourType

Obs	TourType	Vendor	LandCost	Country	Nights
1	scenery	Express	1116	Ireland	7
2	scenery	Express	1396	Greece	12
3	scenery	Southsea	2978	New Zealand	16
4	scenery	World	1468	Switzerland	9
5	architecture	Express	936	Italy	8
6	architecture	Express	1440	Japan	8
7	architecture	World	1020	Spain	10
8	architecture	World	1150	Brazil	8

Finding the First or Last Observation in a Group

If you do not want to display the entire data set, you can create a data set that contains only the least expensive tour that features architecture, and the least expensive tour that features scenery:

First, sort the data set by TourType and LandCost:

```
proc sort data=mylib.arch_or_scen out=tourorder4;
   by TourType LandCost;
run;

proc print data=tourorder4;
   var TourType LandCost Country Nights Vendor;
   title 'Tours Arranged by TourType and LandCost';
run;
```

The following output displays the results.

Figure 12.5 Sorting to Find the Least Expensive Tours

Tours Arranged by TourType and LandCost

Obs	TourType	LandCost	Country	Nights	Vendor
1	architecture	936	Italy	8	Express
2	architecture	1020	Spain	10	World
3	architecture	1150	Brazil	8	World
4	architecture	1440	Japan	8	Express
5	scenery	1116	Ireland	7	Express
6	scenery	1396	Greece	12	Express
7	scenery	1468	Switzerland	9	World
8	scenery	2978	New Zealand	16	Southsea

You sorted LandCost in ascending order, so the first observation in each value of TourType has the lowest value of LandCost. If you can locate the first observation in each BY group in a DATA step, you can use a subsetting IF statement to select that observation. SAS provides a way to locate the first observation with each value of TourType.

When you use a BY statement in a DATA step, SAS automatically creates two additional variables for each variable in the BY statement. One variable is named FIRST.*variable*, where *variable* is the name of the BY variable. The other variable is named LAST.*variable*. Their values are either 1 or 0. They exist in the program data vector and are available for DATA step programming, but SAS does not add them to the SAS data set that is being created. For example, the DATA step begins with these statements:

```
data lowcost;
   set tourorder4;
   by TourType;
   ...more SAS statements...
run;
```

The BY statement causes SAS to create one variable called FIRST.TOURTYPE and another variable called LAST.TOURTYPE. When SAS processes the first observation with the value **architecture**, the value of FIRST.TOURTYPE is 1. In other observations with the value **architecture**, it is 0. Similarly, when SAS processes the last observation with the value **architecture**, the value of LAST.TOURTYPE is 1. In other observations with the value **architecture**, it is 0. The same result occurs in the scenery group with the observations.

SAS does not write FIRST. and LAST. variables to the output data set, so you cannot display their values with the PRINT procedure. Therefore, the simplest method of displaying the values of FIRST. and LAST. variables is to assign their values to other variables. This example assigns the value of FIRST.TOURTYPE to a variable named FirstTour and the value of LAST.TOURTYPE to a variable named LastTour:

```
data temp;
   set tourorder4;
   by TourType;
```

```
      FirstTour=first.TourType;
      LastTour=last.TourType;
   run;
   proc print data=temp;
      var Country Tourtype FirstTour LastTour;
      title 'Specifying FIRST.TOURTYPE and LAST.TOURTYPE';
   run;
```

The following output displays the results.

Figure 12.6 Demonstrating FIRST. and LAST. Values

Specifying FIRST.TOURTYPE and LAST.TOURTYPE

Obs	Country	TourType	FirstTour	LastTour
1	Italy	architecture	1	0
2	Spain	architecture	0	0
3	Brazil	architecture	0	0
4	Japan	architecture	0	1
5	Ireland	scenery	1	0
6	Greece	scenery	0	0
7	Switzerland	scenery	0	0
8	New Zealand	scenery	0	1

In this data set, Italy is the first observation with the value **architecture**. For that observation, the value of FIRST.TOURTYPE is 1. Italy is not the last observation with the value **architecture**, so the value of LAST.TOURTYPE is 0. The observations for Spain and Brazil are neither the first nor the last with the value **architecture**. Both FIRST.TOURTYPE and LAST.TOURTYPE are 0 for them. Japan is the last observation with the value **architecture**. The value of LAST.TOURTYPE is 1. The same rules apply to observations in the **scenery** group.

Now you are ready to use FIRST.TOURTYPE in a subsetting IF statement. When the data is sorted by TourType and LandCost, selecting the first observation in each type of tour gives you the lowest price of any tour in that category:

```
   proc sort data=mylib.arch_or_scen out=tourorder4;
      by TourType LandCost;
   run;

   data lowcost;
      set tourorder4;
      by TourType;
      if first.TourType;
   run;

   proc print data=lowcost;
      title 'Least Expensive Tour for Each Type of Tour';
   run;
```

The following output displays the results.

Figure 12.7 Selecting One Observation from Each BY Group

Least Expensive Tour for Each Type of Tour

Obs	Country	TourType	Nights	LandCost	Vendor
1	Italy	architecture	8	936	Express
2	Ireland	scenery	7	1116	Express

Working with Sorted Data

Understanding Sorted Data

By default, groups appear in ascending order of the BY values. In some cases you want to emphasize the order in which the observations are sorted, not the fact that they can be grouped. For example, you might want to alphabetize the tours by country.

To sort your data in a particular order, use the SORT procedure just as you do for grouped data. When the sorted order is more important than the grouping, you usually want only one observation with a given BY value in the resulting data set. Therefore, you might need to remove duplicate observations.

Operating Environment Information: The SORT procedure accesses either a sorting utility that is supplied as part of SAS, or a sorting utility that is supplied by the host operating environment. All examples in this documentation use the SAS sorting utility. Some operating environment utilities do not accept particular options, including the NODUPRECS option described later in this section. The default sorting utility is set by your site. For more information about the utilities available to you, see the documentation for your operating environment.

Sorting Data

The following example sorts data set MYLIB.ARCH_OR_SCEN by Country:

```
proc sort data=mylib.arch_or_scen out=bycountry;
   by Country;
run;

proc print data=bycountry;
   title 'Tours in Alphabetical Order by Country';
run;
```

The following output displays the results.

Figure 12.8 Sorting Data

Tours in Alphabetical Order by Country

Obs	Country	TourType	Nights	LandCost	Vendor
1	Brazil	architecture	8	1150	World
2	Greece	scenery	12	1396	Express
3	Ireland	scenery	7	1116	Express
4	Italy	architecture	8	936	Express
5	Japan	architecture	8	1440	Express
6	New Zealand	scenery	16	2978	Southsea
7	Spain	architecture	10	1020	World
8	Switzerland	scenery	9	1468	World

Deleting Duplicate Observations

You can eliminate duplicate observations in a SAS data set by using the NODUPRECS option with the SORT procedure. The following programs show you how to create a SAS data set and then remove duplicate observations.

The external file shown below contains a duplicate observation for Switzerland:

```
Spain       architecture  10 1020 World
Japan       architecture   8 1440 Express
Switzerland scenery        9 1468 World
Brazil      architecture   8 1150 World
Switzerland scenery        9 1468 World
Ireland     scenery        7 1116 Express
New Zealand scenery       16 2978 Southsea
Italy       architecture   8  936 Express
Greece      scenery       12 1396 Express
```

The following DATA step creates a permanent SAS data set named MYLIB.ARCH_OR_SCEN2.

```
libname mylib 'SAS-library';

data mylib.arch_or_scen2;
   infile 'input-file';
   input Country $ 1-11 TourType $ 13-24 Nights LandCost Vendor $;
run;

proc print data=mylib.arch_or_scen2;
   title 'Data Set MYLIB.ARCH_OR_SCEN2';
run;
```

The following output shows that this data set contains a duplicate observation for Switzerland.

Figure 12.9 *Data Set MYLIB.ARCH_OR_SCEN2*

Data Set MYLIB.ARCH_OR_SCEN2

Obs	Country	TourType	Nights	LandCost	Vendor
1	Spain	architecture	10	1020	World
2	Japan	architecture	8	1440	Express
3	Switzerland	scenery	9	1468	World
4	Brazil	architecture	8	1150	World
5	Switzerland	scenery	9	1468	World
6	Ireland	scenery	7	1116	Express
7	New Zealand	scenery	16	2978	Southsea
8	Italy	architecture	8	936	Express
9	Greece	scenery	12	1396	Express

The following program uses the NODUPRECS option in the SORT procedure to delete duplicate observations. The program creates a new data set called FIXED:

```
proc sort data=mylib.arch_or_scen2 out=fixed noduprecs;
    by Country;
run;

proc print data=fixed;
   title 'Data Set FIXED: MYLIB.ARCH_OR_SCEN2 With Duplicates Removed';
run;
```

The following output displays messages that appear in the SAS log.

Example Code 12.2 *SAS Log Indicating Deleted Duplicate Observations*

```
697  proc sort data=mylib.arch_or_scen2 out=fixed noduprecs;
698      by Country;
699  run;

NOTE: There were 9 observations read from the data set MYLIB.ARCH_OR_SCEN2.
NOTE: 1 duplicate observations were deleted.
NOTE: The data set WORK.FIXED has 8 observations and 5 variables.
NOTE: PROCEDURE SORT used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds


700
701  proc print data=fixed;
702     title 'Data Set FIXED: MYLIB.ARCH_OR_SCEN2 With Duplicates Removed';
703  run;

NOTE: There were 8 observations read from the data set WORK.FIXED.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds
```

The following output shows the results of the NODUPRECS option.

Figure 12.10 Data Set FIXED with No Duplicate Observations

Data Set FIXED: MYLIB.ARCH_OR_SCEN2 With Duplicates Removed

Obs	Country	TourType	Nights	LandCost	Vendor
1	Brazil	architecture	8	1150	World
2	Greece	scenery	12	1396	Express
3	Ireland	scenery	7	1116	Express
4	Italy	architecture	8	936	Express
5	Japan	architecture	8	1440	Express
6	New Zealand	scenery	16	2978	Southsea
7	Spain	architecture	10	1020	World
8	Switzerland	scenery	9	1468	World

Understanding Collating Sequences

Both numeric and character variables can be sorted into ascending or descending order. For numeric variables, ascending or descending order is easy to understand. For character variables, ascending or descending order is more complex. Character values include uppercase and lowercase letters, special characters, and the digits 0 through 9 when they are treated as characters rather than as numbers.

The order in which character values are sorted is called a collating sequence. By default, SAS sorts characters in one of two sequences: EBCDIC or ASCII, depending on the operating environment under which SAS is running. For reference, both sequences are displayed here.

As long as you work under a single operating environment, you seldom need to think about the details of collating sequences. However, when you transfer files from an operating environment that uses EBCDIC to an operating environment that uses ASCII or vice versa, character values that are sorted in one operating environment are not necessarily in the correct order for the other operating environment. The simplest solution to the problem is to sort the character data (not numeric data) again in the destination operating environment. For detailed information about collating sequences, see the documentation for your operating environment.

ASCII Collating Sequence

The following operating systems use the ASCII collating sequence:

- UNIX and its derivatives
- Windows

Here is the English-language ASCII sequence from the smallest to the largest character that you can display:

- blank!"#$%&'()*+,− ./0123456789:;<=>?@
- ABCDEFGHIJKLMNOPQRSTUVWXYZ [\ ] ∘_
- abcdefghijklmnopqrstuvwxyz{}~

The main features of the ASCII sequence are that digits are smaller than uppercase letters and uppercase letters are smaller than lowercase letters. The blank is the smallest character that you can display, followed by the other types of characters:

blank < digits < uppercase letters < lowercase letters

EBCDIC Collating Sequence

The z/OS operating system uses the EBCDIC collating sequence.

Here is the English-language EBCDIC sequence from the smallest to largest character that you can display:

- blank.<(+|&!$*);¬ − /,%_>?:#@'="
- abcdefghijklmnopqr~stuvwxyz
- {ABCDEFGHI}JKLMNOPQR\ STUVWXYZ
- 0123456789

The main features of the EBCDIC sequence are that lowercase letters are smaller than uppercase letters and uppercase letters are smaller than digits. The blank is the smallest character that you can display, followed by the other types of characters:

blank < lowercase letters < uppercase letters < digits

Summary

Procedures

PROC SORT <DATA=*SAS-data-set*> <OUT=*SAS-data-set*> <NODUPRECS>;
: sorts a SAS data set by the values of variables that are listed in the BY statement. If you specify the OUT= option, the sorted data is stored in a different SAS data set than the input data. The NODUPRECS option tells PROC SORT to eliminate identical observations.

Statements

BY <DESCENDING> *variable-1* < . . . <DESCENDING> *variable-n*>;
: in a DATA step, causes SAS to create FIRST. and LAST. variables for each variable named in the BY statement. The value of FIRST.*variable-1* is 1 for the first observation with a given BY value, and 0 for other observations. Similarly,

the value of LAST.*variable-1* is 1 for the last observation for a given BY value, and 0 for other observations. The BY statement can follow a SET, MERGE, MODIFY, or UPDATE statement in the DATA step. It cannot be used with an INPUT statement. By default, SAS assumes that the data that is being read with a BY statement is in ascending order of the BY values. The DESCENDING option indicates that values of the variable that follow are in the opposite order, that is, largest to smallest.

Learning More

Alternative to sorting observations
: You can use an alternative method to sort observations by creating an index that identifies the observations with particular values of a variable. For more information, see "SAS Data Files" in *SAS Language Reference: Concepts*.

BY statement and BY-group processing
: For more information, see "BY Statement" in *SAS DATA Step Statements: Reference* and "BY-Group Processing in the DATA Step" in *SAS Language Reference: Concepts*.

Interleaving, merging, and updating SAS data sets
: For more information, see Chapter 18, "Interleaving SAS Data Sets," on page 291, Chapter 19, "Merging SAS Data Sets," on page 299, and Chapter 20, "Updating SAS Data Sets," on page 329.

These operations depend on the BY statement in the DATA step. Interleaving combines data sets in sorted order. Match-merging joins observations that are identified by the value of a BY variable. Updating uses a data set that contains transactions to change values in a master file.

For more information about SAS statements, see "MERGE Statement" in *SAS DATA Step Statements: Reference* and "UPDATE Statement" in *SAS DATA Step Statements: Reference*.

NOTSORTED option
: The NOTSORTED option can be used in both DATA and PROC steps, except for the SORT procedure. The NOTSORTED option is useful when data is grouped according to the values of a variable, but the groups are not in ascending or descending order. Using the NOTSORTED option in the BY statement enables SAS to process them. For more information, see Chapter 32, "Writing Lines to the SAS Log or to an Output File," on page 619.

SORT procedure
: For more information about the SORT procedure and the role of the BY statement, see "SORT Procedure" in *Base SAS Procedures Guide*. For information about the NOTSORTED option in the BY statement, see "BY Statement" in *SAS DATA Step Statements: Reference*.

The following items refer to sorting SAS data sets:

- When you work with large data sets, plan your work so that you sort the data set as few times as possible. For example, if you need to sort a data set by State at the beginning of a program, and by City within State later, then sort the data set by State and City at the beginning of the program.

- To eliminate observations whose BY values duplicate BY values in other observations (but not necessarily values of other variables), use the NODUPKEY option in the SORT procedure.
- SAS can sort data in sequences other than English-language EBCDIC or ASCII. Examples include the Danish-Norwegian and Finnish or Swedish sequences.

The SAS documentation for your operating environment presents operating-environment-specific information about the SORT procedure. In general, many considerations about sorting data depend on the operating environment and other local conditions at your site, such as whether various operating environment utilities are available.

13

Using More Than One Observation in a Calculation

Introduction to Using More Than One Observation in a Calculation

Purpose

In this section, you will learn about calculations that require more than one observation. The following types of examples are included in this section:

- accumulating a total across a data set or a BY group
- saving a value from one observation in order to compare it to a value in a later observation

Prerequisites

Before proceeding with this section, you should understand the concepts presented in the following sections:

- Chapter 7, “Understanding DATA Step Processing,” on page 109
- Chapter 12, “Working with Grouped or Sorted Observations,” on page 191

Input File and SAS Data Set for Examples

Tradewinds Travel needs to know how much business the company did with various tour vendors during the peak season. The data that the company wants to look at is the total number of people that are scheduled on tours with various vendors. It also wants to look at the total value of the tours that are scheduled.

The following external file contains data about Tradewinds Travel tours:

```
1           2    3        4
----------------------------
Germany     1150 Express  10
Spain       1020 World    12
Brazil      1080 World     6
India        978 Express   .
Japan       1440 Express  10
Greece      1396 Express  20
New Zealand 2978 Southsea  6
Venezuela    850 World     8
Italy        936 Express   9
Russia      1848 World     6
Switzerland 1468 World    20
Australia   2158 Southsea 10
Ireland     1116 Express   9
```

The following list describes the fields in the input file:

1 provides the name of the destination country for the tour

2 specifies the cost of the land package in U.S. dollars

3 specifies the name of the trip vendor

4 specifies the number of people that were booked on that tour

The first step is to create a permanent SAS data set. The following program creates the data set MYLIB.TOURREVENUE:

```
libname mylib 'SAS-library';

data mylib.tourrevenue;
   infile 'input-file' truncover;
   input Country $ 1-11 LandCost Vendor $ NumberOfBookings;
```

```
run;

proc print data=mylib.tourrevenue;
   title 'SAS Data Set MYLIB.TOURREVENUE';
run;
```

The PROC PRINT statement that follows the DATA step produces this display of the MYLIB.TOURREVENUE data set.

Figure 13.1 Data Set MYLIB.TOURREVENUE

SAS Data Set MYLIB.TOURREVENUE

Obs	Country	LandCost	Vendor	NumberOfBookings
1	Germany	1150	Express	10
2	Spain	1020	World	12
3	Brazil	1080	World	6
4	India	978	Express	.
5	Japan	1440	Express	10
6	Greece	1396	Express	20
7	New Zealand	2978	Southsea	6
8	Venezuela	850	World	8
9	Italy	936	Express	9
10	Russia	1848	World	6
11	Switzerland	1468	World	20
12	Australia	2158	Southsea	10
13	Ireland	1116	Express	9

Each observation in the data set MYLIB.TOURREVENUE contains the cost of a tour and the number of people who booked that tour. The tasks of Tradewinds Travel are as follows:

- to determine how much money was spent with each vendor and with all vendors together
- to store the totals in a SAS data set that is separate from the individual vendors' records
- to find the tour that produced the most revenue, which is determined by the land cost times the number of people who booked the tour

Accumulating a Total for an Entire Data Set

Creating a Running Total

The first task in performing calculations on the data set MYLIB.TOURREVENUE is to find the total number of people who booked tours with Tradewinds Travel. Therefore, a variable is needed whose value starts at 0 and increases by the number of bookings in each observation. The Sum statement gives you that capability:

variable + *expression*

In a Sum statement, the value of *variable* on the left side of the plus sign is 0 before the statement is processed for the first time. Processing the statement adds the value of *expression* on the right side of the plus sign to the initial value. The Sum variable retains the new value until the next processing of the statement. The Sum statement ignores a missing value for the expression. The previous total remains unchanged.

The following statement creates the total number of bookings:

```
TotalBookings + NumberOfBookings;
```

The following DATA step includes the Sum statement shown above:

```
data total;
   set mylib.tourrevenue;
   TotalBookings + NumberOfBookings;
run;

proc print data=total;
   var Country NumberOfBookings TotalBookings;
   title 'Total Tours Booked';
run;
```

The following output displays the results.

Figure 13.2 Accumulating a Total for a Data Set

Total Tours Booked

Obs	Country	NumberOfBookings	TotalBookings
1	Germany	10	10
2	Spain	12	22
3	Brazil	6	28
4	India	.	28
5	Japan	10	38
6	Greece	20	58
7	New Zealand	6	64
8	Venezuela	8	72
9	Italy	9	81
10	Russia	6	87
11	Switzerland	20	107
12	Australia	10	117
13	Ireland	9	126

The TotalBookings variable in the last observation of the TOTAL data set contains the total number of bookings for the year.

Writing Only the Total

If the total is the only information that is needed from the data set, a data set that contains only one observation and one variable (the TotalBookings variable) can be created by writing a DATA step that performs all of the following functions:

- specifies the END= option in the SET statement to determine whether the current observation is the last observation
- uses a subsetting IF statement to write only the last observation to the SAS data set
- specifies the KEEP= option in the DATA step to keep only the variable that totals the bookings

When the END= option in the SET statement is specified, the variable that is named in the END= option is set to 1 when the DATA step is processing the last observation. The variable that is named in the END= option is set to 0 for other observations:

SET *SAS-data-set* <END=*variable*>;

SAS does not add the END= variable to the data set that is being created. By testing the value of the END= variable, you can determine which observation is the last observation.

The following program selects the last observation with a subsetting IF statement and uses a KEEP= data set option to keep only the variable TotalBookings in the data set:

```
data total2(keep=TotalBookings);
   set mylib.tourrevenue end=Lastobs;
   TotalBookings + NumberOfBookings;
   if Lastobs;
run;

proc print data=total2;
   title 'Total Number of Tours Booked';
run;
```

The following output displays the results.

Figure 13.3 *Selecting the Last Observation in a Data Set*

Total Number of Tours Booked

Obs	TotalBookings
1	126

The condition in the subsetting IF statement is true when Lastobs has a value of 1. When SAS is processing the last observation from MYLIB.TOURREVENUE, it assigns to Lastobs the value 1. Therefore, the subsetting IF statement accepts only the last observation from MYLIB.TOURREVENUE, and SAS writes the last observation to the data set TOTAL2.

Obtaining a Total for Each BY Group

An additional requirement of Tradewinds Travel is to determine the number of tours that are booked with each vendor. In order to accomplish this task, a program must group the data by a variable. That is, the program must organize the data set into groups of observations, with one group for each vendor. In this case, the program must group the data by the Vendor variable. Each group is known generically as a BY- group. The variable that is used to determine the groupings is called a BY variable.

In order to group the data by the Vendor variable:

- include a PROC SORT step to group the observations by the Vendor variable
- use a BY statement in the DATA step
- use a Sum statement to total the bookings
- reset the Sum variable to 0 at the beginning of each group of observations

The following program sorts the data set by Vendor and sums the total bookings for each vendor.

```
proc sort data=mylib.tourrevenue out=mylib.sorttour;
    by Vendor;
```

```
run;

data totalby;
   set mylib.sorttour;
   by Vendor;
   if First.Vendor then VendorBookings=0;
   VendorBookings + NumberOfBookings;
run;

proc print data=totalby;
   title 'Summary of Bookings by Vendor';
run;
```

In the preceding program, the FIRST.Vendor variable is used in an IF-THEN statement to set the Sum variable (VendorBookings) to 0 in the first observation of each BY group. (For more information about the FIRST.*variable* and LAST.*variable* temporary variables, see “Finding the First or Last Observation in a Group” on page 197.)

The following output displays the results.

Figure 13.4 Creating Totals for BY Groups

Summary of Bookings by Vendor

Obs	Country	LandCost	Vendor	NumberOfBookings	VendorBookings
1	Germany	1150	Express	10	10
2	India	978	Express	.	10
3	Japan	1440	Express	10	20
4	Greece	1396	Express	20	40
5	Italy	936	Express	9	49
6	Ireland	1116	Express	9	58
7	New Zealand	2978	Southsea	6	6
8	Australia	2158	Southsea	10	16
9	Spain	1020	World	12	12
10	Brazil	1080	World	6	18
11	Venezuela	850	World	8	26
12	Russia	1848	World	6	32
13	Switzerland	1468	World	20	52

Notice that while this output does in fact include the total number of bookings for each vendor, it also includes a great deal of extraneous information. Reporting the total bookings for each vendor requires only the variables Vendor and VendorBookings from the last observation for each vendor. Therefore, the program can use the following elements:

- the DROP= or KEEP= data set options to eliminate the variables Country, LandCost, and NumberOfBookings from the output data set

- the LAST.Vendor variable in a subsetting IF statement to write only the last observation in each group to the data set TOTALBY

The following program creates data set TOTALBY:

```
proc sort data=mylib.tourrevenue out=mylib.sorttour;
   by Vendor;
run;

data totalby(drop=country landcost NumberOfBookings);
   set mylib.sorttour;
   by Vendor;
   if First.Vendor then VendorBookings=0;
   VendorBookings + NumberOfBookings;
   if Last.Vendor;
run;

proc print data=totalby;
   title 'Total Bookings by Vendor';
run;
```

The following output displays the results.

Figure 13.5 Putting Totals for Each BY Group in a New Data Set

Total Bookings by Vendor

Obs	Vendor	VendorBookings
1	Express	58
2	Southsea	16
3	World	52

Writing to Separate Data Sets

Writing Observations to Separate Data Sets

Tradewinds Travel wants overall information about the tours that were conducted this year. One SAS data set is needed to contain detailed information about each tour, including the total amount that was spent on that tour. Another SAS data set is needed to contain the total number of bookings with each vendor and the total amount spent with that vendor. Both of these data sets can be created using the techniques that you have learned so far.

Begin the program by creating two SAS data sets from the SAS data set MYLIB.SORTTOUR using the following DATA and SET statements:

```
data tourdetails vendordetails;
```

```
set mylib.sorttour;
```

The data set TOURDETAILS will contain the individual records, and VENDORDETAILS will contain the information about vendors. The observations do not need to be grouped for TOURDETAILS, but they need to be grouped by Vendor for VENDORDETAILS.

If the data is not already grouped by Vendor, first use the SORT procedure. Add a BY statement to the DATA step for use with VENDORDETAILS.

```
proc sort data=mylib.tourrevenue out=mylib.sorttour;
   by Vendor;
run;

data tourdetails vendordetails;
   set mylib.sorttour;
   by Vendor;
run;
```

The only calculation that is needed for the individual tours is the amount of money that was spent on each tour. Therefore, calculate the amount in an assignment statement and write the observation to TOURDETAILS.

```
Money=LandCost * NumberOfBookings;
output tourdetails;
```

The portion of the DATA step that builds TOURDETAILS is now complete.

Writing Totals to Separate Data Sets

Because observations remain in the program data vector after an OUTPUT statement executes, you can continue using the observations in programming statements. The rest of the DATA step creates information for the VENDORDETAILS data set.

Use the FIRST.Vendor variable to determine when SAS is processing the first observation in each group.

Then set the Sum variables VendorBookings and VendorMoney to 0 in that observation. VendorBookings accumulates the total number the bookings for each vendor, and VendorMoney accumulates the total costs. Add the following statements to the DATA step:

```
if First.Vendor then
   do;
      VendorBookings=0;
      VendorMoney=0;
   end;
 VendorBookings + NumberOfBookings;
 VendorMoney + Money;
```

Note: The program uses a DO group. Using DO groups enables the program to evaluate a condition once and take more than one action as a result. For more information about DO groups, see "Performing More Than One Action in an IF-THEN Statement" on page 225.

The last observation in each BY–group contains the totals for that vendor. Therefore, use the following statement to output the last observation to the data set VENDORDETAILS:

```
if Last.Vendor then output vendordetails;
```

As a final step, use KEEP= and DROP= data set options to remove extraneous variables from the two data sets so that each data set has just the variables that are wanted.

```
data tourdetails(drop=VendorBookings VendorMoney)
     vendordetails(keep=Vendor VendorBookings VendorMoney);
```

The Program

The following is the complete program that creates the VENDORDETAILS and TOURDETAILS data sets:

```
proc sort data=mylib.tourrevenue out=mylib.sorttour;
   by Vendor;
run;

data tourdetails(drop=VendorBookings VendorMoney)
     vendordetails(keep=Vendor VendorBookings VendorMoney);
   set mylib.sorttour;
   by Vendor;
   Money=LandCost * NumberOfBookings;
   output tourdetails;
   if First.Vendor then
      do;
         VendorBookings=0;
         VendorMoney=0;
      end;
   VendorBookings + NumberOfBookings;
   VendorMoney + Money;
   if Last.Vendor then output vendordetails;
run;

proc print data=tourdetails;
   title 'Detail Records: Dollars Spent on Individual Tours';
run;

proc print data=vendordetails;
   title 'Vendor Totals: Dollars Spent and Bookings by Vendor';
run;
```

The following output displays detail tour records in one SAS data set and vendor totals in another.

Figure 13.6 Detail Tour Records in the TOURDETAILS Data Set

Detail Records: Dollars Spent on Individual Tours

Obs	Country	LandCost	Vendor	NumberOfBookings	Money
1	Germany	1150	Express	10	11500
2	India	978	Express	.	.
3	Japan	1440	Express	10	14400
4	Greece	1396	Express	20	27920
5	Italy	936	Express	9	8424
6	Ireland	1116	Express	9	10044
7	New Zealand	2978	Southsea	6	17868
8	Australia	2158	Southsea	10	21580
9	Spain	1020	World	12	12240
10	Brazil	1080	World	6	6480
11	Venezuela	850	World	8	6800
12	Russia	1848	World	6	11088
13	Switzerland	1468	World	20	29360

Figure 13.7 Vendor Totals in the VENDORDETAILS Data Set

Vendor Totals: Dollars Spent and Bookings by Vendor

Obs	Vendor	VendorBookings	VendorMoney
1	Express	58	72288
2	Southsea	16	39448
3	World	52	65968

Using a Value in a Later Observation

A further requirement of Tradewinds Travel is a separate SAS data set that contains the tour that generated the most revenue. (The revenue total equals the price of the tour multiplied by the number of bookings.) One method of creating the new data set might be to follow these three steps:

1 Calculate the revenue in a DATA step.

2. Sort the data set in descending order by the revenue.
3. Use another DATA step with the OBS= data set option to write that observation.

A more efficient method compares the revenue from all observations in a single DATA step. SAS can retain a value from the current observation to use in future observations. When the processing of the DATA step reaches the next observation, the held value represents information from the previous observation.

The RETAIN statement causes a variable that is created in the DATA step to retain its value from the current observation into the next observation. The variable is not set to missing at the beginning of each iteration of the DATA step. RETAIN is a declarative statement, not an executable statement. This statement has the following form:

RETAIN *variable-1* < . . . *variable-n*>;

To compare the Revenue value in one observation to the Revenue value in the next observation, create a retained variable named HoldRevenue and assign the value of the current Revenue variable to it. In the next observation, the HoldRevenue variable contains the Revenue value from the previous observation, and its value can be compared to that of Revenue in the current observation.

To see how the RETAIN statement works, look at the next example. The following DATA step writes observations to data set TEMP before SAS assigns the current revenue to HoldRevenue:

```
data temp;
   set mylib.tourrevenue;
   retain HoldRevenue;
   Revenue=LandCost * NumberOfBookings;
   output;
   HoldRevenue=Revenue;
run;

proc print data=temp;
   var Country LandCost NumberOfBookings Revenue HoldRevenue;
   title 'Tour Revenue';
run;
```

The following output displays the results.

Figure 13.8 Retaining a Value By Using the Retain Statement

Tour Revenue

Obs	Country	LandCost	NumberOfBookings	Revenue	HoldRevenue
1	Germany	1150	10	11500	.
2	Spain	1020	12	12240	11500
3	Brazil	1080	6	6480	12240
4	India	978	.	.	6480
5	Japan	1440	10	14400	.
6	Greece	1396	20	27920	14400
7	New Zealand	2978	6	17868	27920
8	Venezuela	850	8	6800	17868
9	Italy	936	9	8424	6800
10	Russia	1848	6	11088	8424
11	Switzerland	1468	20	29360	11088
12	Australia	2158	10	21580	29360
13	Ireland	1116	9	10044	21580

The value of HoldRevenue is missing at the beginning of the first observation. It is still missing when the OUTPUT statement writes the first observation to TEMP. After the OUTPUT statement, an assignment statement assigns the value of Revenue to HoldRevenue. Because HoldRevenue is retained, that value is present at the beginning of the next iteration of the DATA step. When the OUTPUT statement executes again, the value of HoldRevenue still contains that value.

To find the largest value of Revenue, assign the value of Revenue to HoldRevenue only when Revenue is larger than HoldRevenue, as shown in the following program:

```
data mostrevenue;
   set mylib.tourrevenue;
   retain HoldRevenue;
   Revenue=LandCost * NumberOfBookings;
   if Revenue > HoldRevenue then HoldRevenue=Revenue;
run;

proc print data=mostrevenue;
   var Country LandCost NumberOfBookings Revenue HoldRevenue;
   title 'Tour Revenue';
run;
```

The following output displays the results.

Figure 13.9 Holding the Largest Value in a Retained Variable

Tour Revenue

Obs	Country	LandCost	NumberOfBookings	Revenue	HoldRevenue
1	Germany	1150	10	11500	11500
2	Spain	1020	12	12240	12240
3	Brazil	1080	6	6480	12240
4	India	978	.	.	12240
5	Japan	1440	10	14400	14400
6	Greece	1396	20	27920	27920
7	New Zealand	2978	6	17868	27920
8	Venezuela	850	8	6800	27920
9	Italy	936	9	8424	27920
10	Russia	1848	6	11088	27920
11	Switzerland	1468	20	29360	29360
12	Australia	2158	10	21580	29360
13	Ireland	1116	9	10044	29360

The value of HoldRevenue in the last observation represents the largest revenue that is generated by any tour. To determine which observation the value came from, create a variable named HoldCountry to hold the name of the country from the observation with the largest revenue. Include HoldCountry in the RETAIN statement to retain its value until explicitly changed. Then use the END= data set option to select the last observation, and use the KEEP= data set option to keep only HoldRevenue and HoldCountry in MOSTREVENUE:

```
data mostrevenue (keep=HoldCountry HoldRevenue);
   set mylib.tourrevenue  end=LastOne;
   retain HoldRevenue HoldCountry;
   Revenue=LandCost * NumberOfBookings;
   if Revenue > HoldRevenue then
      do;
         HoldRevenue=Revenue;
         HoldCountry=Country;
      end;
   if LastOne;
run;
proc print data=mostrevenue;
   title 'Country with the Largest Value of Revenue';
run;
```

Note: The program uses a DO group. Using DO groups enables the program to evaluate a condition once and take more than one action as a result. For more information about DO groups, see "Performing More Than One Action in an IF-THEN Statement" on page 225.

The following output displays the results.

Figure 13.10 *Using the RETAIN and Subsetting IF Statements to Find the Most Revenue*

Country with the Largest Value of Revenue

Obs	HoldRevenue	HoldCountry
1	29360	Switzerland

Summary

Statements

RETAIN *variable-1* < . . . *variable-n*>;

retains the value of *variable* for use in a subsequent observation. The RETAIN statement prevents the value of the variable from being reinitialized to missing when control returns to the top of the DATA step.

The RETAIN statement affects variables that are created in the current DATA step (for example, variables that are created with an INPUT or assignment statement). Variables that are read with a SET, MERGE, or UPDATE statement are retained automatically. Naming them in a RETAIN statement has no effect.

The RETAIN statement can assign an initial value to a variable. If a variable needs to have the same value in all observations of a DATA step, then it is more efficient to put the value in a RETAIN statement rather than in an assignment statement. SAS assigns the value in the RETAIN statement when it is compiling the DATA step, but it executes the assignment statement during each execution of the DATA step.

SET *SAS-data-set* <END=*variable*>;

reads from the specified *SAS-data-set*. The *variable* that is specified in the END= option has the value 0 until SAS is processing the last observation in the data set. Then the variable has the value 1. SAS does not include the END= variable in the data set that is being created.

variable + *expression*;

is called a Sum statement. It adds the result of *expression* on the right side of the plus sign to *variable* on the left side of the plus sign, and holds the new value of *variable* for use in subsequent observations. The expression can be a numeric variable or expression. The value of *variable* is retained. If the expression is a missing value, *variable* maintains its previous value. Before the Sum statement is executed for the first time, the default value of *variable* is 0.

The plus sign is required in the Sum statement. To subtract successive values from a starting value, add negative values to the Sum variable.

Learning More

Automatic variable _N_
: provides a way to count the number of times SAS executes a DATA step. For more information, see Chapter 32, "Writing Lines to the SAS Log or to an Output File," on page 619.

  SAS creates _N_ in each DATA step. The first time SAS begins to execute the DATA step, the value of _N_ is 1. The second time SAS begins to execute, the value is 2, and so on. SAS does not add _N_ to the output data set. Using _N_ is more efficient than using a Sum statement.

DO groups
: specifies a group of statements that are executed as a unit. For information about DO group processing, see Chapter 14, "Finding Shortcuts in Programming," on page 223. For more information about the DO statement, see "DO Statement" in *SAS DATA Step Statements: Reference*.

END= option
: can be used in a SET statement. For an example, see Chapter 22, "Conditionally Processing Observations from Multiple SAS Data Sets," on page 361.

KEEP= and DROP= data set options
: specify which observations should be kept or dropped from a data set. These options can be used on an input or output data set. For more information, see Chapter 6, "Starting with SAS Data Sets," on page 93. See also "DROP= Data Set Option" in *SAS Data Set Options: Reference*, and "KEEP= Data Set Option" in *SAS Data Set Options: Reference*.

LAG family of functions
: provide another way to retain a value from one observation for use in a subsequent observation. LAG functions can retain a value for up to 100 observations. For more information, see "LAG Function" in *SAS Functions and CALL Routines: Reference*.

RETAIN, Sum, and SET statements
: For more information, see "RETAIN Statement" in *SAS DATA Step Statements: Reference*, "Sum Statement" in *SAS DATA Step Statements: Reference*, and "SET Statement" in *SAS DATA Step Statements: Reference*.

Sum and SUMBY statements
: can be used in the PRINT procedure if the only purpose in getting a total is to display it in a report. The Sum and SUMBY statements in the PRINT procedure are discussed in Chapter 27, "Producing Detail Reports with the PRINT Procedure," on page 449.

SUMMARY and MEANS procedures
: can also be used to compute totals. For more information, see "SUMMARY Procedure" in *Base SAS Procedures Guide* and "MEANS Procedure" in *Base SAS Procedures Guide*.

14

Finding Shortcuts in Programming

Introduction to Shortcuts

Purpose

In this section you will learn two DATA step programming techniques that make the code easier to write and read:

- using a DO group to perform more than one action after evaluating an IF condition
- using arrays to perform the same action on more than one variable with a single group of statements

Prerequisites

Before proceeding with this section, you should understand the topics presented in the following sections:

- Chapter 7, “Understanding DATA Step Processing,” on page 109

■ Chapter 10, “Acting on Selected Observations,” on page 153

Input File and SAS Data Set

In the following example, Tradewinds Travel is making adjustments to their data about tours to art museums and galleries. The data for the tours is as follows:

```
1          2 3 4 5        6
--------------------------
Rome       4 3 . D'Amico  2
Paris      5 . 1 Lucas    5
London     3 2 . Wilson   3
New York   5 1 2 Lucas    5
Madrid     . . 5 Torres   4
Amsterdam  3 3 .          .
```

The following list explains the numbered items in the preceding file:

1 This column provides the name of the destination country.

2 This column provides the number of museums to be visited.

3 This column provides the number of art galleries in the tour.

4 This column provides the number of other attractions to be toured.

5 This column lists the last name of the tour guide.

6 This column lists the number of years of experience for the tour guide.

The following program creates the permanent SAS data set MYLIB.ATTRACTIONS:

```
libname mylib 'permanent-data-library';

data mylib.attractions;
   infile 'input-file';
   input City $ 1-9 Museums 11 Galleries 13
         Other 15 TourGuide $ 17-24 YearsExperience 26;
run;

proc print data=mylib.attractions;
   title 'Data Set MYLIB.ATTRACTIONS';
run;
```

The following output shows the results.

Figure 14.1 Data Set MYLIB.ATTRACTIONS

Data Set MYLIB.ATTRACTIONS

Obs	City	Museums	Galleries	Other	TourGuide	YearsExperience
1	Rome	4	3	.	D'Amico	2
2	Paris	5	.	1	Lucas	5
3	London	3	2	.	Wilson	3
4	New York	5	1	2	Lucas	5
5	Madrid	.	.	5	Torres	4
6	Amsterdam	3	3	.		.

Performing More Than One Action in an IF-THEN Statement

Several changes are needed in the observations for Madrid and Amsterdam. One way to select those observations is to evaluate an IF condition in a series of IF-THEN statements, as follows:

```
/* multiple actions based on the same condition */
data updatedattractions;
   set mylib.attractions;
   if City = 'Madrid' then Museums = 3;
   if City = 'Madrid' then Other = 2;
   if City = 'Amsterdam' then TourGuide = 'Vandever';
   if City = 'Amsterdam' then YearsExperience = 4;
run;
```

To avoid writing the IF condition twice for each city, use a DO group in the THEN clause, for example:

IF *condition* THEN
  DO;
    ...more SAS statements...
  END;

The DO statement causes all statements following it to be treated as a unit until a matching END statement appears. A group of SAS statements that begin with DO and end with END is called a DO group.

The following DATA step replaces the multiple IF-THEN statements with DO groups:

```
/* a more efficient method */
data updatedattractions2;
   set mylib.attractions;
   if City = 'Madrid' then
```

```
         do;
            Museums = 3;
            Other = 2;
         end;
      else if City = 'Amsterdam' then
         do;
            TourGuide = 'Vandever';
            YearsExperience = 4;
         end;
run;

proc print data=updatedattractions2;
   title 'Data Set MYLIB.UPDATEDATTRACTIONS';
run;
```

The following output displays the results.

Figure 14.2 Using DO Groups to Produce a Data Set

Data Set MYLIB.UPDATEDATTRACTIONS

Obs	City	Museums	Galleries	Other	TourGuide	YearsExperience
1	Rome	4	3	.	D'Amico	2
2	Paris	5	.	1	Lucas	5
3	London	3	2	.	Wilson	3
4	New York	5	1	2	Lucas	5
5	Madrid	3	.	2	Torres	4
6	Amsterdam	3	3	.	Vandever	4

Using DO groups makes the program faster to write and easier to read. It also makes the program more efficient for SAS in two ways:

1 The IF condition is evaluated fewer times. (Although there are more statements in this DATA step than in the preceding one, the DO, and END statements require very few computer resources.)

2 The conditions `City = 'Madrid'` and `City = 'Amsterdam'` are mutually exclusive, as condensing the multiple IF-THEN statements into two statements shows. You can make the second IF-THEN statement part of an ELSE statement. Therefore, the second IF condition is not evaluated when the first IF condition is true.

Performing the Same Action for a Series of Variables

Using a Series of IF-THEN Statements

In the data set MYLIB.ATTRACTIONS, the variables Museums, Galleries, and Other contain missing values when the tour does not feature that type of attraction. To change the missing values to 0, you can write a series of IF-THEN statements with assignment statements, as the following program illustrates:

```
/* same action for different variables */
data changes;
   set mylib.attractions;
   if Museums = . then Museums = 0;
   if Galleries = . then Galleries = 0;
   if Other = . then Other = 0;
run;
```

The pattern of action is the same in the three IF-THEN statements. Only the variable name is different. To make the program easier to read, you can write SAS statements that perform the same action several times, changing only the variable that is affected. This technique is called array processing, and consists of the following three steps:

1 grouping variables into arrays

2 repeating the action

3 selecting the current variable to be acted upon

Grouping Variables into Arrays

In DATA step programming, you can put variables into a temporary group called an array. To define an array, use an ARRAY statement. A simple ARRAY statement has the following form:

ARRAY *array-name*{*number-of-variables*} *variable-1* < . . . *variable-n*>;

Array-name is a SAS name that you choose to identify the group of variables. *Number-of-variables*, enclosed in braces, tells SAS how many variables you are grouping, and *variable-1*< . . . *variable-n*> lists their names.

Note: If you have worked with arrays in other programming languages, note that arrays in SAS are different from those in many other languages. In SAS, an array is simply a convenient way of temporarily identifying a group of variables by assigning an alias to them. It is not a permanent data structure. It exists only for the duration of the DATA step. The *array-name* identifies the array and distinguishes it from any other arrays in the same DATA step. It is not a variable.

The following ARRAY statement lists the three variables Museums, Galleries, and Other:

```
array changelist{3} Museums Galleries Other;
```

This statement tells SAS to do the following:

- make a group named CHANGLIST for the duration of this DATA step
- put three variable names in CHANGELIST: Museums, Galleries, and Other

In addition, by listing a variable in an ARRAY statement, you assign the variable an extra name with the form *array-name {position}*, where *position* is the position of the variable in the list (1, 2, or 3 in this case). The position can be a number, or the name of a variable whose value is the number. This additional name is called an array reference, and the position is called the subscript. The previous ARRAY statement assigns CHANGELIST{1} to Museums, CHANGELIST{2} to Galleries, and CHANGELIST{3} to Other. From that point in the DATA step, you can refer to the variable by either its original name or by its array reference. For example, the names Museums and CHANGELIST{1} are equivalent.

Repeating the Action

To tell SAS to perform the same action several times, use an iterative DO loop of the following form:

DO *index-variable*=1 TO *number-of-variables-in-array*;

...SAS statements...

END;

An iterative DO loop begins with an iterative DO statement, contains other SAS statements, and ends with an END statement. The loop is processed repeatedly (iterated) according to the directions in the iterative DO statement. The iterative DO statement contains an *index-variable* whose name you choose and whose value changes in each iteration of the loop. In array processing, you usually want the loop to execute as many times as there are variables in the array. Therefore, you specify that the values of *index-variable* are 1 to *number-of-variables-in-array*. By default, SAS increases the value of *index-variable* by 1 before each new iteration of the loop. When the value becomes greater than *number-of-variables-in-array*, SAS stops processing the loop. By default, SAS adds the index variable to the data set that is being created.

An iterative DO loop that processes three times and has an index variable named Count looks like this:

```
do Count = 1 to 3;
   ...SAS statements...
end;
```

The first time the loop is processed, the value of Count is 1; the second time, the value is 2; and the third time, the value is 3. At the beginning of the fourth execution, the value of Count is 4, exceeding the specified range of 1 to 3. SAS stops processing the loop.

Selecting the Current Variable

Now that you have grouped the variables and you know how many times the loop is processed, you must tell SAS which variable in the array to use in each iteration of the loop. Recall that variables in an array can be identified by their array references, and that the subscript of the reference can be a variable name as well as a number. Therefore, you can write programming statements in which the index variable of the DO loop is the subscript of the array reference:

array-name {*index-variable*}

When the value of the index variable changes, the subscript of the array reference (and, therefore, the variable that is referenced) also changes.

The following statement uses the index variable Count as the subscript of array references:

```
if changelist{Count} = . then changelist{Count} = 0;
```

You can place this statement inside an iterative DO loop. When the value of Count is 1, SAS reads the array reference as CHANGELIST{1} and processes the IF-THEN statement on CHANGELIST{1}, that is, Museums. When Count has the value 2 or 3, SAS processes the statement on CHANGELIST{2}, Galleries, or CHANGELIST{3}, Other. The complete iterative DO loop with array references looks like this:

```
do Count = 1 to 3;
   if changelist{Count} = . then changelist{Count} = 0;
end;
```

These statements tell SAS to do the following processing:

- perform the actions in the loop three times
- replace the array subscript Count with the current value of Count for each iteration of the IF-THEN statement
- locate the variable with that array reference and process the IF-THEN statement on that variable

The following DATA step uses the ARRAY statement and iterative DO loop:

```
libname mylib 'permanent-data-library';

data changes;
   set mylib.attractions;
   array changelist{3} Museums Galleries Other;
   do Count = 1 to 3;
      if changelist{Count} = . then changelist{Count} = 0;
   end;
run;

proc print data=changes;
   title 'Tour Attractions';
run;
```

The following output displays the results.

Figure 14.3 Using an Array and an Iterative DO Loop to Produce a Data Set

Tour Attractions

Obs	City	Museums	Galleries	Other	TourGuide	YearsExperience	Count
1	Rome	4	3	0	D'Amico	2	4
2	Paris	5	0	1	Lucas	5	4
3	London	3	2	0	Wilson	3	4
4	New York	5	1	2	Lucas	5	4
5	Madrid	0	0	5	Torres	4	4
6	Amsterdam	3	3	0		.	4

The data set CHANGES shows that the missing values for the variables Museums, Galleries, and Other are now zero. In addition, the data set contains the variable Count with the value 4 (the value that caused processing of the loop to cease in each observation).

To exclude Count from the data set, use a DROP= data set option:

```
data changes2 (drop=Count);
   set mylib.attractions;
   array changelist{3} Museums Galleries Other;
   do Count = 1 to 3;
      if changelist{Count} = . then changelist{count} = 0;
   end;
run;

proc print data=changes2;
   title 'Tour Attractions';
run;
```

The following output displays the results.

Figure 14.4 Dropping the Index Variable from a Data Set

Tour Attractions

Obs	City	Museums	Galleries	Other	TourGuide	YearsExperience
1	Rome	4	3	0	D'Amico	2
2	Paris	5	0	1	Lucas	5
3	London	3	2	0	Wilson	3
4	New York	5	1	2	Lucas	5
5	Madrid	0	0	5	Torres	4
6	Amsterdam	3	3	0		.

Summary

Statements

ARRAY *array-name*{*number-of-variables*} *variable-1* < . . . *variable-n*>;

creates a named, ordered, list of variables that exists for processing of the current DATA step. *Array-name* must be a valid SAS name. Each variable is the name of a variable to be included in the array. *Number-of-variables* is the number of variables listed.

When you place a variable in an array, the variable can also be accessed by *array-name* {*position*}, where *position* is the position of the variable in the list (from 1 to *number-of-variables*). In this way of accessing the variable is called an array reference, and the position is known as the subscript of the array reference. After you list a variable in an ARRAY statement, programming statements in the same DATA step can use either the original name of the variable or the array reference.

This documentation uses braces around the subscript. Parentheses ( ) are also acceptable, and square brackets [ ] are acceptable in operating environments that support those characters. Refer to the documentation for your operating environment to determine the supported characters.

DO;
... SAS statements ...
END;

treats the enclosed *SAS statements* as a unit. A group of statements beginning with DO and ending with END is called a DO group. DO groups usually appear in THEN clauses or ELSE statements.

DO *index-variable*=1 TO *number-of-variables-in-array*;
... SAS statements ...
END;

is known as an iterative DO loop. In each execution of the DATA step, an iterative DO loop is processed repeatedly (is iterated) based on the value of *index-variable*. To create an index variable, use a SAS variable name in an iterative DO statement.

When you use iterative DO loops for array processing, the value of *index-variable* usually starts at 1 and increases by 1 before each iteration of the loop. When the value becomes greater than the *number-of-variables-in-array* (usually the number of variables in the array being processed), SAS stops processing the loop and proceeds to the next statement in the DATA step.

In array processing, the SAS statements in an iterative DO loop usually contain array references whose subscript is the name of the index variable (as in *array-name* {*index-variable*}). In each iteration of the loop, SAS replaces the subscript in the reference with the index variable's current value. Therefore, successive iterations of the loop cause SAS to process the statements on the first variable in the array, then on the second variable, and so on.

Learning More

Arrays
: Arrays can be single or multidimensional. For more information, see "Array Processing" in *SAS Language Reference: Concepts*, "ARRAY Statement" in *SAS DATA Step Statements: Reference*, and "Array Reference Statement" in *SAS DATA Step Statements: Reference*.

DO groups
: Iterative DO statements are flexible and powerful. They are useful in many situations other than array processing. The range of the index variable can start and stop with any number, and the increment can be any positive or negative number. The range of the index variable can be given as starting and stopping values, the values of the DIM, LBOUND, and HBOUND functions, a list of values separated by commas, or a combination of these. A range can also contain a WHILE or UNTIL clause. The index variable can also be a character variable (in that case, the range must be given as a list of character values). For more information, see:

- "DO Statement" in *SAS DATA Step Statements: Reference*
- "DO Statement: Iterative" in *SAS DATA Step Statements: Reference*
- "DIM Function" in *SAS Functions and CALL Routines: Reference*
- "HBOUND Function" in *SAS Functions and CALL Routines: Reference*
- "LBOUND Function" in *SAS Functions and CALL Routines: Reference*

DO UNTIL and DO WHILE statements
: A DO WHILE statement processes a loop as long as a condition is true. A DO UNTIL statement processes a loop until a condition is true. (A DO UNTIL loop always processes at least once. A DO WHILE loop is not processed at all if the condition is initially false.) For more information, see "DO UNTIL Statement" in *SAS DATA Step Statements: Reference* and "DO WHILE Statement" in *SAS DATA Step Statements: Reference*.

15

Working with Dates in the SAS System

Introduction to Working with Dates

Purpose

SAS stores dates as single, unique numbers so that they can be used in programs like any other numeric variable. In this section, you will learn how to do the following:

- make SAS read dates in raw data files and store them as SAS date values
- indicate which calendar form SAS should use to display SAS date values
- calculate with dates, that is, determine the number of days between dates, find the day of the week on which a date falls, and use today's date in calculations

Prerequisites

You should understand the following topics before proceeding with this section:

- Chapter 7, “Understanding DATA Step Processing,” on page 109
- Chapter 11, “Creating Subsets of Observations,” on page 175
- Chapter 12, “Working with Grouped or Sorted Observations,” on page 191

Understanding How SAS Handles Dates

How SAS Stores Date Values

Dates are written in many different ways. Some dates contain only numbers. Others contain various combinations of numbers, letters, and characters. For example, all the following forms represent the date July 26, 2013:

Table 15.1 *How Dates Are Formatted*

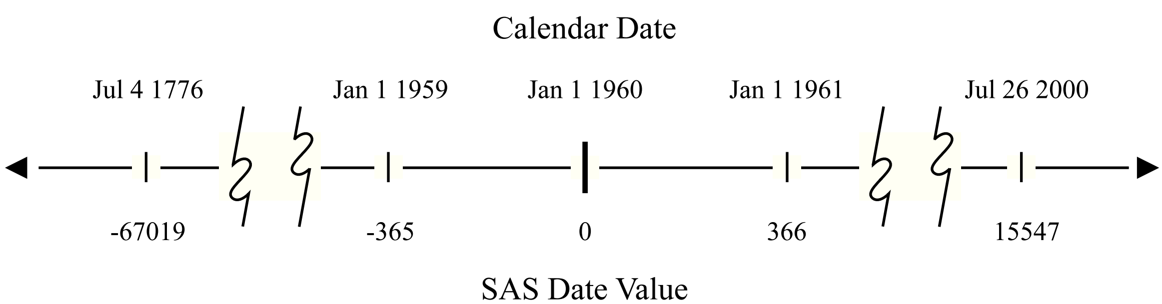
072613	26JUL13	132607
7/26/13	26JUL2013	July 26, 2013

With so many different forms of dates, there must be a way to store dates and use them in calculations, regardless of how dates are entered or displayed.

The common ground that SAS uses to represent dates is called a SAS data value. No matter which form you use to write a date, SAS can convert and store that date as the number of days between January 1, 1960, and the date that you enter.

The following figure shows some dates written in calendar form and as SAS date values:

Figure 15.1 Comparing Calendar Dates to SAS Date Values



In SAS, every date is a unique number on a number line. Dates before January 1, 1960, are negative numbers; those after January 1, 1960, are positive. Because SAS date values are numeric variables, you can sort them easily, determine time intervals, and use dates as constants, as arguments in SAS functions, or in calculations.

Note: SAS date values are valid for dates based on the Gregorian calendar from A.D. 1582 through A.D. 19,900. Use caution when working with historical dates. Although the Gregorian calendar was used throughout most of Europe from 1582, Great Britain and the American colonies did not adopt the calendar until 1752.

Determining the Century for Dates with Two-Digit Years

If dates in your external data sources or SAS program statements contain two-digit years, then you can determine which century prefix should be assigned to them by using the YEARCUTOFF= system option. The YEARCUTOFF= system option specifies the first year of the 100-year span that is used to determine the century of a two-digit year. For example, YEARCUTOFF=1950 means that two-digit years 50 through 99 correspond to 1950 through 1999. Two-digit years 00 through 49 correspond to 2000 through 2049. The default value of the YEARCUTOFF= system option is 1926, but you can change the YEARCUTOFF= value in an OPTIONS statement to accommodate the range of date values that you are working with.

Before you use the YEARCUTOFF= system option, examine the dates in your data:

- If the dates in your data fall within a 100-year span, then you can use the YEARCUTOFF= system option.
- If the dates in your data do not fall within a 100-year span, then you must either convert the two-digit years to four-digit years or use a DATA step with conditional logic to assign the proper century prefix.

After you determine that the YEARCUTOFF= system option is appropriate for your range of data, you can determine the setting to use. The best setting for YEARCUTOFF= is the year before the lowest year in your data. For example, if you have data in a range from 2013 to 2112, then set YEARCUTOFF= to 2013. This is the result of setting YEARCUTOFF= to 2013:

- SAS interprets all two-digit dates in the range of 13 through 99 as 2013 through 2099.
- SAS interprets all two-digit dates in the range of 00 through 12 as 2100 through 2112.

With YEARCUTOFF= set to 2013, a two-digit year of 13 would be interpreted as 2013 and a two-digit year of 05 would be interpreted as 2105.

Input File and SAS Data Set for Examples

In the travel industry, some of the most important data about a tour includes dates such as:

- when the tour leaves and returns
- when payments are due
- when refunds are allowed, and so on

Tradewinds Travel has data that contains dates of past and upcoming popular tours as well as the number of nights spent on the tour. The raw data is stored in an external file that looks like this:

```
Japan       13may2000  8
Greece      17oct99   12
New Zealand 03feb2001 16
Brazil      28feb2001  8
Venezuela   10nov00    9
Italy       25apr2001  8
Russia      03jun1997 14
Switzerland 14jan2001  9
Australia   24oct98   12
Ireland     27aug2000  7
```

The first column lists the name of the country that was toured. The second column lists the departure date. The third column lists the number of nights on the tour.

Entering Dates

Understanding Informats for Date Values

In order for SAS to read a value as a SAS date value, you must give it a set of directions called an informat. By default, SAS reads numeric variables with a standard numeric informat that does not include letters or special characters. When a field that contains data does not match the standard patterns, you specify the appropriate informat in the INPUT statement.

SAS provides many informats. Four informats that are commonly used to read date values are:

MMDDYY8.
: reads dates written as mm/dd/yy.

MMDDYY10.
: reads dates written as mm/dd/yyyy.

DATE7.
: reads dates in the form ddMMMyy.

DATE9.
: reads dates in the form ddMMMyyyy.

Note that each informat name ends with a period and contains a width specification that tells SAS how many columns to read.

Reading a Date Value

To create a SAS data set for the Tradewinds Travel data, the DATE9. informat is used in the INPUT statement to read the variable DepartureDate.

```
input Country $ 1-11 @13 DepartureDate date9. Nights;
```

Using an informat in the INPUT statement is called formatted input. The formatted input in this example contains the following items:

- a pointer to indicate the column in which the value begins (@13)
- the name of the variable to be read (DepartureDate)
- the name of the informat to use (DATE9.)

The following DATA step creates MYLIB.TOURDATES using the DATE9. informat to create SAS date values:

```
options yearcutoff=1920;
libname mylib 'permanent-data-library';

data mylib.tourdates;
   infile 'input-file';
   input Country $ 1-11 @13 DepartureDate date9. Nights;
run;

proc print data=mylib.tourdates;
   title 'Tour Departure Dates as SAS Date Values';
run;
```

The following output displays the results.

Figure 15.2 Creating SAS Date Values from Calendar Dates

Tour Departure Dates as SAS Date Values

Obs	Country	DepartureDate	Nights
1	Japan	14743	8
2	Greece	14534	12
3	New Zealand	15009	16
4	Brazil	15034	8
5	Venezuela	14924	9
6	Italy	15090	8
7	Russia	13668	14
8	Switzerland	14989	9
9	Australia	14176	12
10	Ireland	14849	7

Compare the SAS values of the variable DepartureDate with the values of the raw data shown in the previous section. The data set MYLIB.TOURDATES shows that SAS read the departure dates and created SAS date values. Now you need a way to display the dates in a recognizable form.

Using Good Programming Practices to Read Dates

When reading dates, it is good programming practice to always use the DATE9. or MMDDYY10. informats to make sure that the data is read correctly. If you use the DATE7. or MMDDYY8. informat, then SAS reads only the first two digits of the year. If the data contains four-digit years, then SAS reads the century and not the year.

In the example, the PRINT procedure uses the FORMAT option to format the dates.

Consider the Tradewinds Travel external file with both two-digit years and four-digit years:

```
Japan       13may2000  8
Greece      17oct99   12
New Zealand 03feb2001 16
Brazil      28feb2001  8
Venezuela   10nov00    9
Italy       25apr2001  8
France      03jun1997 14
Switzerland 14jan2001  9
Australia   24oct98   12
Ireland     27aug2000  7
```

The following DATA step creates a SAS data set MYLIB.TOURDATES7 by using the DATE7. informat:

```
options yearcutoff=1920;

data mylib.tourdates7;
   infile 'input-file';
   input Country $ 1-11 @13 DepartureDate date7. Nights;
run;

proc print data=mylib.tourdates7;
   title 'Tour Departure Dates Using the DATE7. Informat';
   title2 'Displayed as Two-Digit Calendar Dates';
   format DepartureDate date7.;
run;

proc print data=mylib.tourdates7;
   title 'Tour Departure Dates Using the DATE7. Informat';
   title2 'Displayed as Four-Digit Calendar Dates';
   format DepartureDate date9.;
run;
```

The PRINT procedures format DepartureDate using two-digit year (DATE7.) and four-digit year (DATE9.) calendar dates. The following output shows how using the wrong date informat can produce invalid SAS data sets. Here is the output from the program.

Figure 15.3 Using the Wrong Date Informat

Tour Departure Dates Using the DATE7. Informat
Displayed as Two-Digit Calendar Dates

Obs	Country	DepartureDate	Nights
1	Japan	13MAY20	0
2	Greece	17OCT99	12
3	New Zealand	03FEB20	1
4	Brazil	28FEB20	1
5	Venezuela	10NOV00	9
6	Italy	25APR20	1
7	Russia	03JUN19	97
8	Switzerland	14JAN20	1
9	Australia	24OCT98	12
10	Ireland	27AUG20	0

Figure 15.4 Using the Wrong Informat Can Produce Invalid SAS Data Sets

**Tour Departure Dates Using the DATE7. Informat
Displayed as Four-Digit Calendar Dates**

Obs	Country	DepartureDate	Nights
1	Japan	13MAY1920	0
2	Greece	17OCT1999	12
3	New Zealand	03FEB1920	1
4	Brazil	28FEB1920	1
5	Venezuela	10NOV2000	9
6	Italy	25APR1920	1
7	Russia	03JUN2019	97
8	Switzerland	14JAN1920	1
9	Australia	24OCT1998	12
10	Ireland	27AUG1920	0

Notice that the four-digit years in the input file do not match the years in MYLIB.TOURDATES7 for observations 1, 3, 4, 6, 7, 8, and 10:

- SAS stopped reading the date after seven characters. It read the first two digits, the century, and not the complete four-digit year.
- To read the data for the next variable, SAS moved the pointer one column and read the next two numeric characters (the years 00, 01, and 97) as the value for the variable Nights. The data for Nights in the input file was ignored.
- When the dates were formatted for four-digit calendar dates, SAS used the YEARCUTOFF= 1920 system option to determine the century for the two-digit year. What was originally 1997 in observation 7 became 2019, and what was originally 2000 and 2001 in observations 1, 3, 4, 6, 8, and 10 became 1920.

Using Dates as Constants

If the tour of Switzerland leaves on January 21, 2001 instead of January 14, then you can use the following assignment statement to make the update:

```
if Country = 'Switzerland' then DepartureDate = '21jan2001'd;
```

The value '21jan2001'D is a SAS date constant. To write a SAS date constant, enclose a date in quotation marks in the standard SAS form ddMMMyyyy and immediately follow the final quotation mark with the letter D. The D suffix tells SAS to convert the calendar date to a SAS date value. The following DATA step includes the use of the SAS date constant. The FORMAT option in the PRINT procedure writes the date with the DATE9. format:

```
   data correctdates;
```

```
   set mylib.tourdates;
   if Country = 'Switzerland' then DepartureDate = '21jan2001'd;
run;

proc print data=correctdates;
   title 'Corrected Departure Date for Switzerland';
   format DepartureDate date9.;
run;
```

The following output displays the results.

Figure 15.5 *Changing a Date By Using a SAS Date Constant*

Corrected Departure Date for Switzerland

Obs	Country	DepartureDate	Nights
1	Japan	13MAY2000	8
2	Greece	17OCT1999	12
3	New Zealand	03FEB2001	16
4	Brazil	28FEB2001	8
5	Venezuela	10NOV2000	9
6	Italy	25APR2001	8
7	Russia	03JUN1997	14
8	Switzerland	21JAN2001	9
9	Australia	24OCT1998	12
10	Ireland	27AUG2000	7

Displaying Dates

Understanding How SAS Displays Values

To understand how to display the departure dates, you need to understand how SAS displays values in general. SAS displays all data values with a set of directions called a format. By default, SAS uses a standard numeric format with no commas, letters, or other special notation to display the values of numeric variables. Figure 15.2 on page 238 shows that writing SAS date values with the standard numeric format produces numbers that are difficult to recognize. To display these numbers as calendar dates, you need to specify a SAS date format for the variable.

SAS date formats are available for the most common ways of writing calendar dates. The DATE9. format represents dates in the form ddMMMyyyy. If you want the month, day, and year to be spelled out, then use the WORDDATE18. format. The WEEKDATE29. format includes the day of the week. There are also formats available for number representations such as the format MMDDYY8., which displays the calendar date in the form mm/dd/yy, or the format MMDDYY10., which displays the calendar date in the form mm/dd/yyyy. Like informat names, each format name ends with a period and contains a width specification that tells SAS how many columns to use when displaying the date value.

Formatting a Date Value

You tell SAS which format to use by specifying the variable and the format name in a FORMAT statement. The following FORMAT statement assigns the MMDDYY10. format to the variable DepartureDate:

```
format DepartureDate mmddyy10.;
```

In this example, the FORMAT statement contains the following items:

- the name of the variable (DepartureDate)
- the name of the format to be used (MMDDYY10.)

The following PRINT procedures format the variable DepartureDate in both the two-digit year calendar format and the four-digit year calendar format:

```
proc print data=mylib.tourdates;
   title 'Departure Dates in Two-Digit Calendar Format';
   format DepartureDate mmddyy8.;
run;

proc print data=mylib.tourdates;
   title 'Departure Dates in Four-Digit Calendar Format';
   format DepartureDate mmddyy10.;
run;
```

The following output displays the results.

Figure 15.6 Displaying a Formatted Date Value: Two-Digit Calendar Format

Departure Dates in Two-Digit Calendar Format

Obs	Country	DepartureDate	Nights
1	Japan	05/13/00	8
2	Greece	10/17/99	12
3	New Zealand	02/03/01	16
4	Brazil	02/28/01	8
5	Venezuela	11/10/00	9
6	Italy	04/25/01	8
7	Russia	06/03/97	14
8	Switzerland	01/14/01	9
9	Australia	10/24/98	12
10	Ireland	08/27/00	7

Figure 15.7 Displaying a Formatted Date Value: Four-Digit Calendar Format

Departure Dates in Four-Digit Calendar Format

Obs	Country	DepartureDate	Nights
1	Japan	05/13/2000	8
2	Greece	10/17/1999	12
3	New Zealand	02/03/2001	16
4	Brazil	02/28/2001	8
5	Venezuela	11/10/2000	9
6	Italy	04/25/2001	8
7	Russia	06/03/1997	14
8	Switzerland	01/14/2001	9
9	Australia	10/24/1998	12
10	Ireland	08/27/2000	7

Placing a FORMAT statement in a PROC step associates the format with the variable only for that step. To associate a format with a variable permanently, use the FORMAT statement in a DATA step.

Assigning Permanent Date Formats to Variables

The next example creates a new permanent SAS data set and assigns the DATE9. format in the DATA step. Now all subsequent procedures and DATA steps that use the variable DepartureDate will use the DATE9. format by default. The PROC CONTENTS step displays the characteristics of the data set MYLIB.TOURDATE.

```
options yearcutoff=1920;

data mylib.fmttourdate;
   set mylib.tourdates;
   format DepartureDate date9.;
run;

proc contents data=mylib.fmttourdate nodetails;
run;
```

The following output displays that the DATE9. format is permanently associated with DepartureDate.

Figure 15.8 Assigning a Format in a DATA Step

The CONTENTS Procedure

Data Set Name	MYLIB.FMTTOURDATE	Observations	10
Member Type	DATA	Variables	3
Engine	V9	Indexes	0
Created	04/30/2013 10:14:06	Observation Length	32
Last Modified	04/30/2013 10:14:06	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	2039
Obs in First Data Page	10
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\Users\lirezn\mylib\fmttourdate.sas7bdat
Release Created	9.0401B0
Host Created	W32_7PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format
1	Country	Char	11	
2	DepartureDate	Num	8	DATE9.
3	Nights	Num	8	

Changing Formats Temporarily

If you are preparing a report that requires the date in a different format, then you can override the permanent format by using a FORMAT statement in a PROC step. For example, to display the value for DepartureDate in the data set MYLIB.TOURDATES in the form of month-name dd, yyyy, you can issue a FORMAT statement in a PROC PRINT step. The following program specifies the WORDDATE18. format for the variable DepartureDate:

```
proc print data=mylib.tourdates;
   title 'Tour Departure Dates';
   format DepartureDate worddate18.;
run;
```

The following output displays the results.

Figure 15.9 Overriding a Previously Specified Format

Tour Departure Dates

Obs	Country	DepartureDate	Nights
1	Japan	May 13, 2000	8
2	Greece	October 17, 1999	12
3	New Zealand	February 3, 2001	16
4	Brazil	February 28, 2001	8
5	Venezuela	November 10, 2000	9
6	Italy	April 25, 2001	8
7	Russia	June 3, 1997	14
8	Switzerland	January 14, 2001	9
9	Australia	October 24, 1998	12
10	Ireland	August 27, 2000	7

The format DATE9. is still permanently assigned to DepartureDate. Calendar dates in the remaining examples are in the form ddMMMyyyy unless a FORMAT statement is included in the PROC PRINT step.

Using Dates in Calculations

Sorting Dates

Because SAS date values are numeric variables, you can sort them and use them in calculations. The following example uses the data set MYLIB.TOURDATES to extract other information about the Tradewinds Travel data.

To help determine how frequently tours are scheduled, you can print a report with the tours listed in chronological order. The first step is to specify the following BY statement in a PROC SORT step to tell SAS to arrange the observations in ascending order of the date variable DepartureDate:

```
by DepartureDate;
```

By using a VAR statement in the following PROC PRINT step, you can list the departure date as the first column in the report:

```
proc sort data=mylib.fmttourdate out=sortdate;
   by DepartureDate;
run;

proc print data=sortdate;
   var DepartureDate Country Nights;
   title 'Departure Dates Listed in Chronological Order';
run;
```

The following output displays the results.

Figure 15.10 *Sorting by SAS Date Values*

Departure Dates Listed in Chronological Order

Obs	DepartureDate	Country	Nights
1	03JUN1997	Russia	14
2	24OCT1998	Australia	12
3	17OCT1999	Greece	12
4	13MAY2000	Japan	8
5	27AUG2000	Ireland	7
6	10NOV2000	Venezuela	9
7	14JAN2001	Switzerland	9
8	03FEB2001	New Zealand	16
9	28FEB2001	Brazil	8
10	25APR2001	Italy	8

The observations in the data set SORTDATE are now arranged in chronological order. Note that there are no FORMAT statements in this example, so the dates are displayed in the DATE9. format that you assigned to DepartureDate when you created the data set MYLIB.FMTTOURDATE.

Creating New Date Variables

Because you know the departure date and the number of nights spent on each tour, you can calculate the return date for each tour. To start, create a new variable by adding the number of nights to the departure date, as follows:

```
Return = DepartureDate + Nights;
```

The result is a SAS date value for the return date that you can display by assigning it the DATE9. format, as follows:

```
options yearcutoff=1920;
data home;
   set mylib.tourdates;
   Return = DepartureDate + Nights;
   format Return date9.;
run;

proc print data=home;
   title 'Dates of Departure and Return';
run;
```

The following output displays the results.

Figure 15.11 Adding Days to a Date Value

Dates of Departure and Return

Obs	Country	DepartureDate	Nights	Return
1	Japan	14743	8	21MAY2000
2	Greece	14534	12	29OCT1999
3	New Zealand	15009	16	19FEB2001
4	Brazil	15034	8	08MAR2001
5	Venezuela	14924	9	19NOV2000
6	Italy	15090	8	03MAY2001
7	Russia	13668	14	17JUN1997
8	Switzerland	14989	9	23JAN2001
9	Australia	14176	12	05NOV1998
10	Ireland	14849	7	03SEP2000

Note that because the variable DepartureDate in the data set MYLIB.TOURDATES has no permanent format, you see a numeric value instead of a readable calendar date for that variable.

Using SAS Date Functions

Finding the Day of the Week

SAS has various functions that produce calendar dates from SAS date values. SAS date functions enable you to do such things as derive partial date information or use the current date in calculations.

If the final payment for a tour is due 30 days before the tour leaves, then the final payment date can be calculated using subtraction. However, Tradewinds Travel is closed on Sundays. If the payment is due on a Sunday, then an additional day must be subtracted to make the payment due on Saturday. The WEEKDAY function, which returns the day of the week as a number from 1 through 7 (Sunday through Saturday), can be used to determine whether the return day is a Sunday.

The following statements determine the final payment date by

- subtracting 30 from the departure date
- checking the value returned by the WEEKDAY function
- subtracting an additional day if necessary

```
DueDate=DepartureDate - 30;
if Weekday(DueDate)=1 then DueDate=DueDate - 1;
```

Constructing a data set with these statements produces a list of payment due dates. The following program includes these statements and assigns the format WEEKDATE29. to the new variable DueDate:

```
options yearcutoff=1920;
data pay;
   set mylib.tourdates;
   DueDate = DepartureDate - 30;
   if Weekday(DueDate) = 1 then DueDate = DueDate - 1;
   format DueDate weekdate29.;
run;

proc print data=pay;
   var Country DueDate;
   title 'Date and Day of Week Payment Is Due';
run;
```

The following output displays the results.

Figure 15.12 Using the WEEKDAY Function

Date and Day of Week Payment Is Due

Obs	Country	DueDate
1	Japan	Thursday, April 13, 2000
2	Greece	Friday, September 17, 1999
3	New Zealand	Thursday, January 4, 2001
4	Brazil	Monday, January 29, 2001
5	Venezuela	Wednesday, October 11, 2000
6	Italy	Monday, March 26, 2001
7	Russia	Saturday, May 3, 1997
8	Switzerland	Friday, December 15, 2000
9	Australia	Thursday, September 24, 1998
10	Ireland	Friday, July 28, 2000

Comparing Durations and SAS Date Values

You can use SAS date values to find the units of time between dates. Tradewinds Travel was founded on February 8, 1982. On November 23, 1999, you decide to find out how old Tradewinds Travel is, and you write the following program:

```
options yearcutoff=1920;
   /* Calculating a duration in days */
data ttage;
   Start = '08feb82'd;
   RightNow = today();
   Age = RightNow - Start;
   format Start RightNow date9.;
run;

proc print data=ttage;
   title 'Age of Tradewinds Travel';
run;
```

The following output displays the results.

Figure 15.13 Calculating a Duration in Days

Age of Tradewinds Travel

Obs	Start	RightNow	Age
1	08FEB1982	30APR2013	11404

The value of Age is 11404, a number that looks like an unformatted SAS date value. However, Age is actually the difference between February 8, 1982, and April 30, 2013, and represents a duration in days, not a SAS date value. To make the value of Age more understandable, divide the number of days by 365 (more precisely, 365.25) to produce a duration in years. The following DATA step calculates the age of Tradewinds Travel in years:

```
options yearcutoff=1920;
   /* Calculating a duration in years */
data ttage2;
   Start = '08feb82'd;
   RightNow = today();
   AgeInDays = RightNow - Start;
   AgeInYears = AgeInDays / 365.25;
   format AgeInYears 4.1 Start RightNow date9.;
run;

proc print data=ttage2;
   title 'Age in Years of Tradewinds Travel';
run;
```

The following output displays the results.

Figure 15.14 Calculating a Duration in Years

Age in Years of Tradewinds Travel

Obs	Start	RightNow	AgeInDays	AgeInYears
1	08FEB1982	30APR2013	11404	31.2

To show a portion of a year, the value for AgeInYears is assigned a numeric format of 4.1 in the FORMAT statement of the DATA step. The 4 tells SAS that the number contains up to four characters. The 1 tells SAS that the number includes one digit after the decimal point.

Summary

Statements

date-variable='*ddMMMyy*'D;
: is an assignment statement that tells SAS to convert the date in quotation marks to a SAS date value and assign it to *date-variable*. The SAS date constant '*ddMMMyy*'D specifies a particular date (for example, '23NOV00'D), and can be used in many SAS statements and expressions, not only assignment statements.

FORMAT *date-variabledate-format*;
: tells SAS to format the values of *date-variable* using *date-format*. A FORMAT statement within a DATA step permanently associates a format with *date-variable*.

INPUT *date-variabledate-informat*;
: tells SAS how to read the values for the date-variable from an external file. *date-informat* is an instruction that tells SAS the form of the date in the external file.

Formats and Informats for Dates

DATE9.
: the form of the *date-variable* is ddMMMyyyy (for example, 30APR2013).

DATE7.
: the form of the *date-variable* is ddMMMyy (for example, 23NOV00).

MMDDYY10.
: the form of the *date-variable* is mm/dd/yyyy (for example, 11/23/2012).

MMDDYY8.
: the form of the *date-variable* is mm/dd/yy (for example, 11/23/00).

WORDDATE18.
: the form of the *date-variable* is month-name dd, yyyy (for example, November 23, 2013).

WEEKDATE29.
: the form of the *date-variable* is day-of-the-week, month-name dd, yyyy (for example, Thursday, November 23, 2013).

Functions

WEEKDAY (*SAS-date-value*)
: is a function that returns the day of the week for a SAS date value. Values are numbers between 1 and 7, with Sunday assigned the value 1.

TODAY()
: is a function that returns a SAS date value corresponding to the date on which the SAS program is initiated.

System Options

YEARCUTOFF=
: specifies the first year of a 100-year span that is used by informats and functions to read two-digit years, and used by formats to display two-digit years. The value that is specified in YEARCUTOFF= can result in a range of years that span two centuries. If YEARCUTOFF=1950, then any two-digit value between 50 and 99 inclusive refers to the first half of the 100-year span, which is in the 1900s. Any two-digit value between 00 and 49 inclusive refers to the second half of the 100-year span, which is in the 2000s. YEARCUTOFF= has no effect on existing SAS dates or dates that are read from input data that include a four-digit year.

Learning More

ATTRIB statement
: Information about using the ATTRIB statement to assign or change a permanent format can be found in *SAS DATA Step Statements: Reference*.

DATASETS procedure
: To assign or change a variable to a permanent format see the DATASETS procedure in Chapter 36, “Managing SAS Libraries,” on page 725.

PUT and INPUT functions
: The PUT and INPUT functions can be used for correcting two common errors in working with SAS dates: treating date values that contain letters or symbols as character variables, or storing dates written as numbers as ordinary numeric variables. Neither method enables you to use dates in calculations. For more information, see “PUT Statement” in *SAS DATA Step Statements: Reference* and “INPUT Statement” in *SAS DATA Step Statements: Reference*.

SAS date values
: Documentation on informats, formats, and functions for working with SAS date values, SAS time, and SAS datetime values can be found in *SAS Language Reference: Concepts*. This documentation includes the following date and time information:

- SAS stores a time as the number of seconds since midnight of the current day. For example, 9:30 am is 34200. A number of this type is known as a

SAS time value. A SAS time value is independent of the date; the count begins at 0 each midnight.

- When a date and a time are both present, SAS stores the value as the number of seconds since midnight, January 1, 1960. For example, 9:30 am, November 23, 2000, is 1290591000. This type of number is known as a SAS datetime value.
- SAS date and time informats read fields of different widths. SAS date and time formats can display date variables in different ways according to the widths that you specify in the format name. The number at the end of the format or informat name indicates the number of columns that SAS can use. For example, the DATE9. informat reads up to nine columns (as in 23NOV2013). The WEEKDATE8. format displays eight columns, as in Thursday, and WEEKDATE27. displays 27 columns, as in Thursday, November 23, 2013.
- SAS provides date, time, and datetime intervals for counting different periods of elapsed time, such as MONTH, which represents an interval from the beginning of one month to the next, not a period of 30 or 31 days.
- International date, time, and datetime formats.

SYSDATE9
: To include the current date in a title, you can use the macro variable SYSDATE9, which is explained in Chapter 27, “Producing Detail Reports with the PRINT Procedure,” on page 449.

PART 4

Combining SAS Data Sets

16

Methods of Combining SAS Data Sets

Introduction to Combining SAS Data Sets

Purpose

SAS provides several methods for combining SAS data sets. In this section, you will be introduced to five methods of combining data sets:

- concatenating
- interleaving
- merging
- updating
- modifying

Subsequent sections teach you how to use these methods.

Prerequisites

Before continuing with this section, you should understand the concepts that are presented in the following sections:

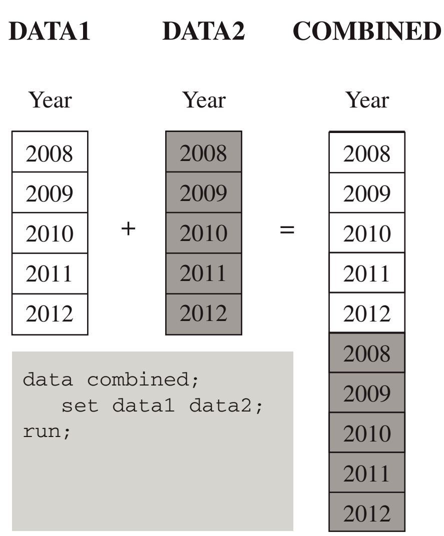
- Chapter 7, “Understanding DATA Step Processing,” on page 109
- Chapter 6, “Starting with SAS Data Sets,” on page 93
- Chapter 7, “Understanding DATA Step Processing,” on page 109

Definition of Concatenating

Concatenating combines two or more SAS data sets, one after the other, into a single SAS data set. You concatenate data sets by using either the SET statement in a DATA step or the APPEND procedure.

The following figure shows the results of concatenating two SAS data sets, and the DATA step that produces the results.

Figure 16.1 Concatenating Two SAS Data Sets

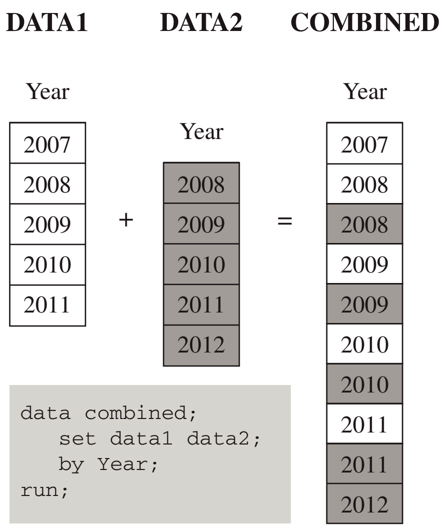


Definition of Interleaving

Interleaving combines individual, sorted SAS data sets into one sorted SAS data set. For each observation, the following figure shows the value of the variable by which the data sets are sorted. You interleave data sets using a SET statement along with a BY statement.

In the following example, the data sets are sorted by the variable Year.

Figure 16.2 *Interleaving SAS Data Sets*



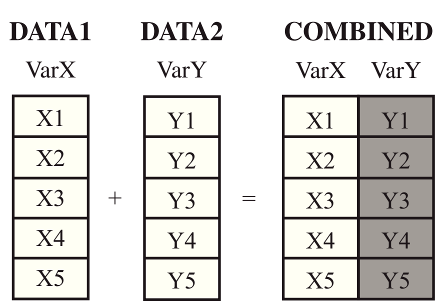

```
data combined;
   set data1 data2;
   by Year;
run;
```

Definition of Merging

Merging combines observations from two or more SAS data sets into a single observation in a new data set.

A one-to-one merge, shown in the following figure, combines observations based on their position in the data sets. You use the MERGE statement for one-to-one merging.

Figure 16.3 *One-to-One Merging*




```
data combined;
   merge data1 data2;
run;
```

A match-merge, shown in the following figure, combines observations based on the values of one or more common variables. If you are performing a match-merge, use the MERGE statement along with a BY statement.

In the following example, two data sets are match-merged by the value of the variable Year.

Figure 16.4 *Match-Merging Two SAS Data Sets*

DATA1

Year	VarX
2008	X1
2009	X2
2010	X3
2011	X4
2012	X5

+

DATA2

Year	VarY
2008	Y1
2008	Y2
2010	Y3
2011	Y4
2012	Y5

=

COMBINED

Year	VarX	VarY
2008	X1	Y1
2008	X1	Y2
2009	X2	.
2010	X3	Y3
2011	X4	Y4
2012	X5	Y5

```
data combined;
   merge data1 data2;
   by Year;
run;
```

Notice that there is a missing value for the variable VarY in the COMBINED data set. The value is missing because the DATA2 data set has no observations for the year 2009.

Definition of Updating

Updating a SAS data set replaces the values of variables in one data set (the master data set) with values from another data set (the transaction data set). If the UPDATEMODE= option in the UPDATE statement is set to MISSINGCHECK, then missing values in a transaction data set do not replace existing values in a master data set. If the UPDATEMODE= option is set to NOMISSINGCHECK, then missing values in a transaction data set replace existing values in a master data set. The default setting is MISSINGCHECK.

You update a data set by using the UPDATE statement along with a BY statement. Both of the input data sets must be sorted by the variable that you use in the BY statement.

The following figure shows the results of updating a SAS data set.

Figure 16.5 *Updating a Master Data Set*

MASTER

Year	VarX	VarY
2002	X1	Y1
2003	X1	Y1
2004	X1	Y1
2005	X1	Y1
2006	X1	Y1
2007	X1	Y1
2008	X1	Y1
2009	X1	Y1
2010	X1	Y1
2011	X1	Y1

+

TRANSACTION

Year	VarX	VarY
2008	X2	•
2009	X2	Y2
2010	X2	•
2010	•	Y2
2012	X2	Y2

=

MASTER

Year	VarX	VarY
2002	X1	Y1
2003	X1	Y1
2004	X1	Y1
2005	X1	Y1
2006	X1	Y1
2007	X1	Y1
2008	X2	Y1
2009	X2	Y2
2010	X2	Y2
2011	X1	Y1
2012	X2	Y2

```
data master;
   update master transaction;
   by Year;
run;
```

Notice that the TRANSACTION data set contains missing values. When the update occurs, the new MASTER data set retains the values from the original MASTER data set, and no missing values appear.

Definition of Modifying

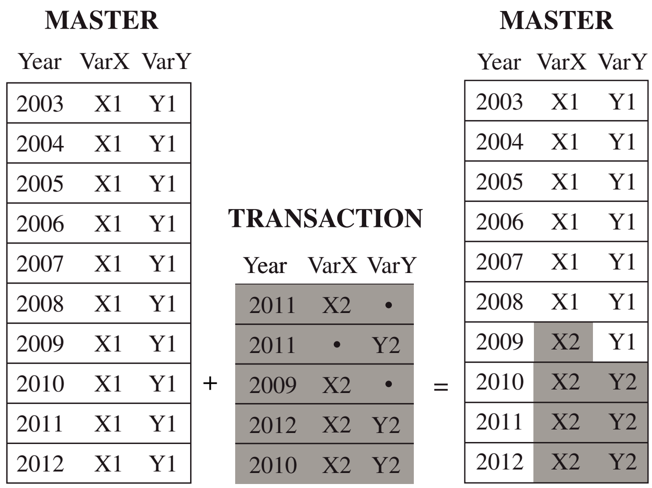
Modifying a SAS data set replaces, deletes, or appends observations in an existing data set. Modifying a SAS data set is similar to updating a SAS data set, but the following differences exist:

- Modifying cannot create a new data set, but updating can.
- Unlike updating, modifying does not require that the master data set or the transaction data set be sorted.

You use a MODIFY statement along with a BY statement to change an existing data set.

In the following example, the MASTER data set is updated by YEAR.

Figure 16.6 Modifying a Data Set




```
data master;
   modify master transaction;
   by Year;
run;
```

Notice that the TRANSACTION data set contains missing values. When the MASTER data set is modified, the new MASTER data set retains the values from the original MASTER data set, and no missing values appear.

Comparing Modifying, Merging, and Updating Data Sets

The table that follows summarizes several differences among the MERGE, UPDATE, and MODIFY statements.

Table 16.1 *Differences among the MERGE, UPDATE, and MODIFY Statements*

Criterion	MERGE	UPDATE	MODIFY
Data sets must be sorted or indexed	Match-merge: Yes One-to-one merge: No	Yes	No
BY values must be unique	No	Master data set: Yes Transaction data set: No	No
Can create or delete variables	Yes	Yes	No

Criterion	MERGE	UPDATE	MODIFY
Number of data sets combined	Any number	2	2
Processing missing values	Overwrites nonmissing values from first data set with missing values from second data set	Default behavior: missing values in the transaction data set do not replace values in the master data set	Depends on the value of the UPDATEMODE= option (see "Handling Missing Values" on page 357) Default: MISSINGCHECK

Learning More

Concatenating data sets
: For more information, see Chapter 17, "Concatenating SAS Data Sets," on page 265.

Interleaving data sets
: For more information, see Chapter 18, "Interleaving SAS Data Sets," on page 291.

Manipulating data sets
: You can manipulate data sets as you combine them. For example, you can select certain observations from each data set and determine which data set an observation came from. For more information, see Chapter 22, "Conditionally Processing Observations from Multiple SAS Data Sets," on page 361.

MERGE, MODIFY, and UPDATE statements
: For more information, see "MERGE Statement" in *SAS DATA Step Statements: Reference*, "MODIFY Statement" in *SAS DATA Step Statements: Reference*, and "UPDATE Statement" in *SAS DATA Step Statements: Reference*.

Merging data sets
: For more information, see Chapter 19, "Merging SAS Data Sets," on page 299.

Modifying data sets
: For more information, see Chapter 21, "Modifying SAS Data Sets," on page 347, and Chapter 22, "Conditionally Processing Observations from Multiple SAS Data Sets," on page 361.

Updating data sets
: For more information, see Chapter 20, "Updating SAS Data Sets," on page 329.

17 Concatenating SAS Data Sets

Introduction to Concatenating SAS Data Sets

Purpose

Concatenating combines two or more SAS data sets, one after the other, into a single data set. The number of observations in the new data set is the sum of the number of observations in the original data sets.

You can concatenate SAS data sets by using one of the following methods:

- the SET statement in a DATA step
- the APPEND procedure

If the data sets that you concatenate contain the same variables, and each variable has the same attributes in all data sets, then the results of the SET statement and PROC APPEND are the same. In other cases, the results differ. In this section you will learn both of these methods and their differences so that you can decide which one to use.

Prerequisites

Before continuing with this section, you should understand the concepts presented in the following sections:

- Chapter 6, “Starting with SAS Data Sets,” on page 93
- Chapter 7, “Understanding DATA Step Processing,” on page 109
- Chapter 8, “Working with Numeric Variables,” on page 121
- Chapter 9, “Working with Character Variables,” on page 135

Concatenating Data Sets with the SET Statement

Understanding the SET Statement

The SET statement reads observations from one or more SAS data sets and uses them to build a new data set.

The SET statement for concatenating data sets has the following form:

SET *SAS-data-sets*;

SAS-data-sets specifies the two or more SAS data sets to concatenate. The observations from the first data set that you name in the SET statement appear first in the new data set. The observations from the second data set follow those from the first data set, and so on. The list can contain any number of data sets.

Using the SET Statement: The Simplest Case

In the simplest situation, the data sets that you concatenate contain the same variables (variables with the same name). In addition, the type, length, informat, format, and label of each variable match across all data sets. In this case, SAS copies all observations from the first data set into the new data set. It then copies all observations from the second data set into the new data set, and so on. Each observation is an exact copy of the original.

In the following example, a company that uses SAS to maintain personnel records for six separate departments decided to combine all personnel records. Two departments, Sales and Customer Support, store their data in the same form. Each observation in both data sets contains values for these variables:

EmployeeID
: specifies a character variable that contains the employee's identification number.

Name
: specifies a character variable that contains the employee's name in the form last name, comma, first name.

HireDate
: specifies a numeric variable that contains the date on which the employee was hired. This variable has a format of DATE9.

Salary
: specifies a numeric variable that contains the employee's annual salary in US dollars.

HomePhone
: specifies a character variable that contains the employee's home telephone number.

The following program creates the SALES and CUSTOMER_SUPPORT data sets:

```
data sales;
   input EmployeeID $ 1-9 Name $ 11-29 @30 HireDate date9.
         Salary HomePhone $;
   format HireDate date9.;
   datalines;
429685482 Martin, Virginia   09aug2002 45000 493-0824
244967839 Singleton, MaryAnn 24apr2004 34000 929-2623
996740216 Leighton, Maurice  16dec2001 57000 933-6908
675443925 Freuler, Carl      15feb2010 54500 493-3993
845729308 Cage, Merce        19oct2009 64000 286-0519
;
run;

proc print data=sales;
   title 'Sales Department Employees';
run;

data customer_support;
   input EmployeeID $ 1-9 Name $ 11-29 @30 HireDate date9.
         Salary HomePhone $;
   format HireDate date9.;
   datalines;
324987451 Sayre, Jay         15nov2005 66000 933-2998
596771321 Tolson, Andrew     18mar2000 54000 929-4800
477562122 Jensen, Helga      01feb2004 70300 286-2816
894724859 Kulenic, Marie     24jun2004 54800 493-1472
988427431 Zweerink, Anna     07jul2011 59000 929-3885
;
run;

proc print data=customer_support;
   title 'Customer Support Department Employees';
run;
```

The following output displays the results of both DATA steps.

Figure 17.1 The SALES Data Set

Sales Department Employees

Obs	EmployeeID	Name	HireDate	Salary	HomePhone
1	429685482	Martin, Virginia	09AUG2002	45000	493-0824
2	244967839	Singleton, MaryAnn	24APR2004	34000	929-2623
3	996740216	Leighton, Maurice	16DEC2001	57000	933-6908
4	675443925	Freuler, Carl	15FEB2010	54500	493-3993
5	845729308	Cage, Merce	19OCT2009	64000	286-0519

Figure 17.2 The CUSTOMER_SUPPORT Data Set

Customer Support Department Employees

Obs	EmployeeID	Name	HireDate	Salary	HomePhone
1	324987451	Sayre, Jay	15NOV2005	66000	933-2998
2	596771321	Tolson, Andrew	18MAR2000	54000	929-4800
3	477562122	Jensen, Helga	01FEB2004	70300	286-2816
4	894724859	Kulenic, Marie	24JUN2004	54800	493-1472
5	988427431	Zweerink, Anna	07JUL2011	59000	929-3885

To concatenate the two data sets, list them in the SET statement. Use the PRINT procedure to display the resulting DEPT1_2 data set.

```
data dept1_2;
   set sales customer_support;
run;

proc print data=dept1_2;
   title 'Employees in Sales and Customer Support Departments';
run;
```

The following output displays the new DEPT1_2 data set. The data set contains all observations from SALES followed by all observations from CUSTOMER_SUPPORT:

Figure 17.3 The Concatenated DEPT1_2 Data Set

Employees in Sales and Customer Support Departments

Obs	EmployeeID	Name	HireDate	Salary	HomePhone
1	429685482	Martin, Virginia	09AUG2002	45000	493-0824
2	244967839	Singleton, MaryAnn	24APR2004	34000	929-2623
3	996740216	Leighton, Maurice	16DEC2001	57000	933-6908
4	675443925	Freuler, Carl	15FEB2010	54500	493-3993
5	845729308	Cage, Merce	19OCT2009	64000	286-0519
6	324987451	Sayre, Jay	15NOV2005	66000	933-2998
7	596771321	Tolson, Andrew	18MAR2000	54000	929-4800
8	477562122	Jensen, Helga	01FEB2004	70300	286-2816
9	894724859	Kulenic, Marie	24JUN2004	54800	493-1472
10	988427431	Zweerink, Anna	07JUL2011	59000	929-3885

Using the SET Statement When Data Sets Contain Different Variables

The two data sets in the previous example contain the same variables, and each variable is defined the same way in both data sets. However, you might want to concatenate data sets when not all variables are common to the data sets that are named in the SET statement. In this case, each observation in the new data set includes all variables from the SAS data sets that are named in the SET statement.

The examples in this section show the SECURITY data set, and the concatenation of this data set to the SALES and the CUSTOMER_SUPPORT data sets. Not all variables are common to the three data sets. The personnel records for the Security department do not include the variable HomePhone. The variable Gender does not appear in the SALES or the CUSTOMER_SUPPORT data sets.

The following program creates the SECURITY data set.

```
data security;
   input EmployeeID $ 1-9 Name $ 11-29 Gender $ 30
         @32 HireDate date9. Salary;
   format HireDate date9.;
   datalines;
744289612 Saparilas, Theresa F 09may2005 45000
824904032 Brosnihan, Dylan   M 04jan2009 49000
242779184 Chao, Daeyong      M 28sep2004 48500
544382887 Slifkin, Leah      F 24jul2011 54000
933476520 Perry, Marguerite  F 19apr2010 49500
;
run;
```

```
proc print data=security;
   title 'Security Department Employees';
run;
```

The following output displays the SECURITY data set.

Figure 17.4 *The SECURITY Data Set*

Security Department Employees

Obs	EmployeeID	Name	Gender	HireDate	Salary
1	744289612	Saparilas, Theresa	F	09MAY2005	45000
2	824904032	Brosnihan, Dylan	M	04JAN2009	49000
3	242779184	Chao, Daeyong	M	28SEP2004	48500
4	544382887	Slifkin, Leah	F	24JUL2011	54000
5	933476520	Perry, Marguerite	F	19APR2010	49500

The following program concatenates the SALES, CUSTOMER_SUPPORT, and SECURITY data sets, and creates the new data set, DEPT1_3:

```
data dept1_3;
   set sales customer_support security;
run;

proc print data=dept1_3;
   title 'Employees in Sales, Customer Support,';
   title2 'and Security Departments';
run;
```

The following output displays the concatenated DEPT1_3 data set.

Figure 17.5 The Concatenated DEPT1_3 Data Set

Employees in Sales, Customer Support, and Security Departments

Obs	EmployeeID	Name	HireDate	Salary	HomePhone	Gender
1	429685482	Martin, Virginia	09AUG2002	45000	493-0824	
2	244967839	Singleton, MaryAnn	24APR2004	34000	929-2623	
3	996740216	Leighton, Maurice	16DEC2001	57000	933-6908	
4	675443925	Freuler, Carl	15FEB2010	54500	493-3993	
5	845729308	Cage, Merce	19OCT2009	64000	286-0519	
6	324987451	Sayre, Jay	15NOV2005	66000	933-2998	
7	596771321	Tolson, Andrew	18MAR2000	54000	929-4800	
8	477562122	Jensen, Helga	01FEB2004	70300	286-2816	
9	894724859	Kulenic, Marie	24JUN2004	54800	493-1472	
10	988427431	Zweerink, Anna	07JUL2011	59000	929-3885	
11	744289612	Saparilas, Theresa	09MAY2005	45000		F
12	824904032	Brosnihan, Dylan	04JAN2009	49000		M
13	242779184	Chao, Daeyong	28SEP2004	48500		M
14	544382887	Slifkin, Leah	24JUL2011	54000		F
15	933476520	Perry, Marguerite	19APR2010	49500		F

All observations in the data set DEPT1_3 have values for both the variable Gender and the variable HomePhone. Observations from data sets SALES and CUSTOMER_SUPPORT, the data sets that do not contain the variable Gender, have missing values for Gender (indicated by blanks under the variable name). Observations from SECURITY, the data set that does not contain the variable HomePhone, have missing values for HomePhone (indicated by blanks under the variable name).

Using the SET Statement When Variables Have Different Attributes

Understanding Attributes

Each variable in a SAS data set can have as many as six attributes that are associated with it. The following is a list of the attributes:

name
: identifies a variable. When SAS looks at two or more data sets, it considers variables with the same name to be the same variable.

type
: identifies a variable as character or numeric.

length
: refers to the number of bytes that SAS uses to store each of the variable's values in a SAS data set. Length is an especially important consideration when you use character variables, because the default length of character variables is eight bytes. If your data values are greater than eight bytes, then you can use a LENGTH statement to specify the number of bytes of storage that you need so that your data is not truncated.

informat
: refers to the instructions that SAS uses when reading data values. These instructions specify the form of an input value.

format
: refers to the instructions that SAS uses when writing data values. These instructions specify the form of an output value.

label
: refers to descriptive text that is associated with a specific variable.

If the data sets that you name in the SET statement contain variables with the same names and types, then you can concatenate the data sets without modification. However, if variable types differ, then you must modify one or more data sets before concatenating them. When lengths, formats, informats, or labels differ, you might want to modify one or more data sets before proceeding.

Using the SET Statement When Variables Have Different Types

If a variable is defined as a character variable in one data set that is named in the SET statement, and as a numeric variable in another, SAS issues an error message and does not concatenate the data sets.

In the following example, the Accounting department in the company treats the employee identification number (EmployeeID) as a numeric variable, whereas all other departments treat it as a character variable.

The following program creates the ACCOUNTING data set, which is concatenated along with other data sets:

```
data accounting;
   input EmployeeID 1-9 Name $ 11-29 Gender $ 30
         @32 HireDate date9. Salary;
   format HireDate date9.;
   datalines;
634875680 Gardinski, Barbara F 29may2001 59000
824576630 Robertson, Hannah  F 14mar2010 65500
744826703 Gresham, Jean      F 28apr1999 67000
824447605 Kruize, Ronald     M 23may2001 58000
988674342 Linzer, Fritz      M 23jul2007 63500
;
run;

proc print data=accounting;
   title 'Accounting Department Employees';
run;
```

The following output displays the ACCOUNTING data set.

Figure 17.6 The ACCOUNTING Data Set

Accounting Department Employees

Obs	EmployeeID	Name	Gender	HireDate	Salary
1	634875680	Gardinski, Barbara	F	29MAY2001	59000
2	824576630	Robertson, Hannah	F	14MAR2010	65500
3	744826703	Gresham, Jean	F	28APR1999	67000
4	824447605	Kruize, Ronald	M	23MAY2001	58000
5	988674342	Linzer, Fritz	M	23JUL2007	63500

The following program attempts to concatenate the data sets for all four departments:

```
data dept1_4;
   set sales customer_support security accounting;
run;
```

The program fails because of the difference in variable type among the four departments. SAS writes the following error message to the log:

```
ERROR: Variable EmployeeID has been defined as both character
       and numeric.
```

Changing the Type of a Variable

One way to correct the error in the previous example is to change the type of the variable EmployeeID in ACCOUNTING from numeric to character. Because performing calculations on employee identification numbers is unlikely, EmployeeID can be a character variable.

You can change the type of the variable EmployeeID in the following ways:

- re-create the data set, changing the INPUT statement so that it identifies EmployeeID as a character variable
- use the PUT function to create a new variable, and data set options to rename and drop variables

The following program uses the PUT function and data set options to change the variable type of EmployeeID from numeric to character.

```
data new_accounting (rename=(TempVar=EmployeeID)drop=EmployeeID);  1
   set accounting;  2
   TempVar=put(EmployeeID, 9.);  3
run;

proc datasets library=work;  4
   contents data=new_accounting;
run;
```

The following list corresponds to the numbered items in the preceding program:

1 The RENAME= data set option renames the variable TempVar to EmployeeID when SAS writes an observation to the output data set. The DROP= data set

option is applied before the RENAME= option. The result is a change in the variable type for EmployeeID from numeric to character.

Note: Although this example creates a new data set called NEW_ACCOUNTING, you can create a data set that has the same name as the data set that is listed in the SET statement. If you do this, then the type attribute for EmployeeID is permanently altered in the ACCOUNTING data set.

2 The SET statement reads observations from the ACCOUNTING data set.

3 The PUT function converts a numeric value to a character value, and applies a format to the variable EmployeeID. The assignment statement assigns the result of the PUT function to the variable TempVar.

4 The DATASETS procedure enables you to verify the new attribute type for EmployeeID.

The following output displays a partial listing from PROC DATASETS. Note that EmployeeID is now a character variable.

Figure 17.7 PROC DATASETS Output for the NEW_ACCOUNTING Data Set

Alphabetic List of Variables and Attributes				
#	Variable	Type	Len	Format
5	EmployeeID	Char	9	
2	Gender	Char	1	
3	HireDate	Num	8	DATE9.
1	Name	Char	19	
4	Salary	Num	8	

Now that the types of all variables match, you can easily concatenate all four data sets using the following program:

```
data dept1_4;
   set sales customer_support security new_accounting;
run;

proc print data=dept1_4;
   title 'Employees in Sales, Customer Support, Security,';
   title2 'and Accounting Departments';
run;
```

The following output displays the concatenated DEPT1_4 data set.

Figure 17.8 *The Concatenated Dept1_4 Data Set*

Employees in Sales, Customer Support, Security, and Accounting Departments

Obs	EmployeeID	Name	HireDate	Salary	HomePhone	Gender
1	429685482	Martin, Virginia	09AUG2002	45000	493-0824	
2	244967839	Singleton, MaryAnn	24APR2004	34000	929-2623	
3	996740216	Leighton, Maurice	16DEC2001	57000	933-6908	
4	675443925	Freuler, Carl	15FEB2010	54500	493-3993	
5	845729308	Cage, Merce	19OCT2009	64000	286-0519	
6	324987451	Sayre, Jay	15NOV2005	66000	933-2998	
7	596771321	Tolson, Andrew	18MAR2000	54000	929-4800	
8	477562122	Jensen, Helga	01FEB2004	70300	286-2816	
9	894724859	Kulenic, Marie	24JUN2004	54800	493-1472	
10	988427431	Zweerink, Anna	07JUL2011	59000	929-3885	
11	744289612	Saparilas, Theresa	09MAY2005	45000		F
12	824904032	Brosnihan, Dylan	04JAN2009	49000		M
13	242779184	Chao, Daeyong	28SEP2004	48500		M
14	544382887	Slifkin, Leah	24JUL2011	54000		F
15	933476520	Perry, Marguerite	19APR2010	49500		F
16	634875680	Gardinski, Barbara	29MAY2001	59000		F
17	824576630	Robertson, Hannah	14MAR2010	65500		F
18	744826703	Gresham, Jean	28APR1999	67000		F
19	824447605	Kruize, Ronald	23MAY2001	58000		M
20	988674342	Linzer, Fritz	23JUL2007	63500		M

Using the SET Statement When Variables Have Different Formats, Informats, or Labels

When you concatenate data sets with the SET statement, the following rules determine which formats, informats, and labels are associated with variables in the new data set.

- An explicitly defined format, informat, or label overrides a default, regardless of the position of the data sets in the SET statement.
- If two or more data sets explicitly define different formats, informats, or labels for the same variable, then the variable in the new data set assumes the attribute from the first data set in the SET statement that explicitly defines that attribute.

Returning to the examples, you might have noticed that the DATA steps that created the SALES, CUSTOMER_SUPPORT, SECURITY, and ACCOUNTING data sets use a FORMAT statement to explicitly assign a format of DATE9. to the variable HireDate. Therefore, although HireDate is a numeric variable, it appears in all displays as DDMMMYYYY (for example, 13DEC2000). The SHIPPING data set that is created in the following example, however, uses a format of DATE11. for HireDate. The DATE11. format is displayed as DD-MMM-YYYY (for example, 13–DEC–2012).

In addition, the SALES, CUSTOMER_SUPPORT, SECURITY, and ACCOUNTING data sets contain a default format for Salary, whereas the SHIPPING data set contains an explicitly defined format, COMMA6., for the same variable. The COMMA6. format inserts a comma in the appropriate place when SAS displays the numeric variable Salary.

The following program creates the data set for the Shipping department:

```
data shipping;
   input employeeID $ 1-9 Name $ 11-29 Gender $ 30
         @32 HireDate date11.
         @42 Salary;
   format HireDate date11.
          Salary comma6.;
   datalines;
688774609 Carlton, Susan     F 28jan2012 41000
922448328 Hoffmann, Gerald   M 12oct2012 40500
544909752 DePuis, David      M 23aug2011 43500
745609821 Hahn, Kenneth      M 23aug2011 45500
634774295 Landau, Jennifer   F 30apr2012 43500
;
run;

proc print data=shipping;
   title 'Shipping Department Employees';
run;
```

The following output displays the SHIPPING data set.

Figure 17.9 The SHIPPING Data Set

Shipping Department Employees

Obs	employeeID	Name	Gender	HireDate	Salary
1	688774609	Carlton, Susan	F	28-JAN-2012	41,000
2	922448328	Hoffmann, Gerald	M	12-OCT-2012	40,500
3	544909752	DePuis, David	M	23-AUG-2011	43,500
4	745609821	Hahn, Kenneth	M	23-AUG-2011	45,500
5	634774295	Landau, Jennifer	F	30-APR-2012	43,500

Now consider what happens when you concatenate SHIPPING with the previous four data sets.

```
data dept1_5;
   set sales customer_support security new_accounting shipping;
```

```
run;

proc print data=dept1_5;
   title 'Employees in Sales, Customer Support, Security,';
   title2 'Accounting, and Shipping Departments';
run;
```

The following output displays the concatenation of five data sets.

Figure 17.10 The DEPT1_5 Data Set: Concatenation of Five Data Sets

Employees in Sales, Customer Support, Security, Accounting, and Shipping Departments

Obs	EmployeeID	Name	HireDate	Salary	HomePhone	Gender
1	429685482	Martin, Virginia	09AUG2002	45,000	493-0824	
2	244967839	Singleton, MaryAnn	24APR2004	34,000	929-2623	
3	996740216	Leighton, Maurice	16DEC2001	57,000	933-6908	
4	675443925	Freuler, Carl	15FEB2010	54,500	493-3993	
5	845729308	Cage, Merce	19OCT2009	64,000	286-0519	
6	324987451	Sayre, Jay	15NOV2005	66,000	933-2998	
7	596771321	Tolson, Andrew	18MAR2000	54,000	929-4800	
8	477562122	Jensen, Helga	01FEB2004	70,300	286-2816	
9	894724859	Kulenic, Marie	24JUN2004	54,800	493-1472	
10	988427431	Zweerink, Anna	07JUL2011	59,000	929-3885	
11	744289612	Saparilas, Theresa	09MAY2005	45,000		F
12	824904032	Brosnihan, Dylan	04JAN2009	49,000		M
13	242779184	Chao, Daeyong	28SEP2004	48,500		M
14	544382887	Slifkin, Leah	24JUL2011	54,000		F
15	933476520	Perry, Marguerite	19APR2010	49,500		F
16	634875680	Gardinski, Barbara	29MAY2001	59,000		F
17	824576630	Robertson, Hannah	14MAR2010	65,500		F
18	744826703	Gresham, Jean	28APR1999	67,000		F
19	824447605	Kruize, Ronald	23MAY2001	58,000		M
20	988674342	Linzer, Fritz	23JUL2007	63,500		M
21	688774609	Carlton, Susan	28JAN2012	41,000		F
22	922448328	Hoffmann, Gerald	12OCT2012	40,500		M
23	544909752	DePuis, David	23AUG2011	43,500		M
24	745609821	Hahn, Kenneth	23AUG2011	45,500		M
25	634774295	Landau, Jennifer	30APR2012	43,500		F

In this concatenation, the input data sets contain the variable HireDate, which was explicitly defined using two different formats. The data sets also contain the variable Salary, which has both a default and an explicit format. You can see from the output that SAS creates the new data set according to the rules mentioned earlier:

- In the case of HireDate, SAS uses the format that is defined in the first data set that is named in the SET statement (DATE9. in SALES).
- In the case of Salary, SAS uses the explicit format (COMMA6.) that is defined in the SHIPPING data set. In this case, SAS does not use the default format.

Notice the difference if you perform a similar concatenation but reverse the order of the data sets in the SET statement.

```
data dept5_1;
   set shipping new_accounting security customer_support sales;
run;

proc print data=dept5_1;
   title 'Employees in Shipping, Accounting, Security,';
   title2 'Customer Support, and Sales Departments';
run;
```

The following output displays the DEPT5_1 data set, but with a different order of concatenation.

Figure 17.11 The DEPT5_1 Data Set: Changing the Order of Concatenation

Employees in Shipping, Accounting, Security, Customer Support, and Sales Departments

Obs	employeeID	Name	Gender	HireDate	Salary	HomePhone
1	688774609	Carlton, Susan	F	28-JAN-2012	41,000	
2	922448328	Hoffmann, Gerald	M	12-OCT-2012	40,500	
3	544909752	DePuis, David	M	23-AUG-2011	43,500	
4	745609821	Hahn, Kenneth	M	23-AUG-2011	45,500	
5	634774295	Landau, Jennifer	F	30-APR-2012	43,500	
6	634875680	Gardinski, Barbara	F	29-MAY-2001	59,000	
7	824576630	Robertson, Hannah	F	14-MAR-2010	65,500	
8	744826703	Gresham, Jean	F	28-APR-1999	67,000	
9	824447605	Kruize, Ronald	M	23-MAY-2001	58,000	
10	988674342	Linzer, Fritz	M	23-JUL-2007	63,500	
11	744289612	Saparilas, Theresa	F	09-MAY-2005	45,000	
12	824904032	Brosnihan, Dylan	M	04-JAN-2009	49,000	
13	242779184	Chao, Daeyong	M	28-SEP-2004	48,500	
14	544382887	Slifkin, Leah	F	24-JUL-2011	54,000	
15	933476520	Perry, Marguerite	F	19-APR-2010	49,500	
16	324987451	Sayre, Jay		15-NOV-2005	66,000	933-2998
17	596771321	Tolson, Andrew		18-MAR-2000	54,000	929-4800
18	477562122	Jensen, Helga		01-FEB-2004	70,300	286-2816
19	894724859	Kulenic, Marie		24-JUN-2004	54,800	493-1472
20	988427431	Zweerink, Anna		07-JUL-2011	59,000	929-3885
21	429685482	Martin, Virginia		09-AUG-2002	45,000	493-0824
22	244967839	Singleton, MaryAnn		24-APR-2004	34,000	929-2623
23	996740216	Leighton, Maurice		16-DEC-2001	57,000	933-6908
24	675443925	Freuler, Carl		15-FEB-2010	54,500	493-3993
25	845729308	Cage, Merce		19-OCT-2009	64,000	286-0519

Compared with the output in Figure 17.10 on page 277, this example shows that not only does the order of the observations change, but in the case of HireDate, the DATE11. format specified in SHIPPING now prevails because that data set now appears first in the SET statement. The COMMA6. format prevails for the variable Salary because SHIPPING is the only data set that explicitly specifies a format for the variable.

Using the SET Statement When Variables Have Different Lengths

If you use the SET statement to concatenate data sets in which the same variable has different lengths, the outcome of the concatenation depends on whether the variable is character or numeric. The SET statement determines the length of variables as follows:

- For a character or numeric variable, an explicitly defined length overrides a default, regardless of the position of the data sets in the SET statement.
- If two or more data sets explicitly define different lengths for the same numeric variable, the variable in the new data set has the same length as the variable in the data set that appears first in the SET statement.
- If the length of a character variable differs among data sets, whether the differences are explicit, the variable in the new data set has the same length as the variable in the data set that appears first in the SET statement.

The following program creates the RESEARCH data set for the sixth department, Research. Notice that the INPUT statement for this data set creates the variable Name with a length of 27. In all other data sets, Name has a length of 19. In this example, if Name had a length of 19, the values of Name would be truncated.

```
data research;
   input EmployeeID $ 1-9 Name $ 11-37 Gender $ 38
         @40 HireDate date9. Salary;
   format HireDate date9.;
   datalines;
922854076 Schoenberg, Marguerite     F 19nov2004 60500
770434994 Addison-Hardy, Jonathon    M 23feb2011 63500
242784883 McNaughton, Elizabeth      F 24jul2001 65000
377882806 Tharrington, Catherine     F 28sep2004 60000
292450691 Frangipani, Christopher    M 12aug2008 63000
;
run;

proc print data=research;
   title 'Research Department Employees';
run;
```

The following output displays the RESEARCH data set.

Figure 17.12 The RESEARCH Data Set

Research Department Employees

Obs	EmployeeID	Name	Gender	HireDate	Salary
1	922854076	Schoenberg, Marguerite	F	19NOV2004	60500
2	770434994	Addison-Hardy, Jonathon	M	23FEB2011	63500
3	242784883	McNaughton, Elizabeth	F	24JUL2001	65000
4	377882806	Tharrington, Catherine	F	28SEP2004	60000
5	292450691	Frangipani, Christopher	M	12AUG2008	63000

If you concatenate all six data sets, naming RESEARCH in any position except the first in the SET statement, SAS defines Name with a length of 19.

If you want your program to use the Name variable that has a length of 27, you have two options:

- change the order of data sets in the SET statement
- change the length of Name in the new data set

For the first option, list the data set (RESEARCH) that uses the longer length first:

```
data dept6_1;
   set research shipping new_accounting
       security customer_support sales;
run;
```

For the second option, include a LENGTH statement in the DATA step that creates the new data set. If you change the length of a numeric variable, then the LENGTH statement can appear anywhere in the DATA step. However, if you change the length of a character variable, then the LENGTH statement must precede the SET statement.

The following program creates the data set DEPT1_6A. The LENGTH statement gives the character variable Name a length of 27, even though the first data set in the SET statement (SALES) assigns it a length of 19.

```
data dept1_6a;
   length Name $ 27;
   set sales customer_support security
       new_accounting shipping research;
run;

proc print data=dept1_6a;
   title 'Employees in All Departments';
run;
```

The following output shows that all values of Name are complete. Note that the order of the variables in the new data set changes because Name is the first variable encountered in the DATA step.

Figure 17.13 The DEPT1_6A Data Set: Using a LENGTH Statement for the Name Variable

Employees in All Departments

Obs	Name	EmployeeID	HireDate	Salary	HomePhone	Gender
1	Martin, Virginia	429685482	09AUG2002	45,000	493-0824	
2	Singleton, MaryAnn	244967839	24APR2004	34,000	929-2623	
3	Leighton, Maurice	996740216	16DEC2001	57,000	933-6908	
4	Freuler, Carl	675443925	15FEB2010	54,500	493-3993	
5	Cage, Merce	845729308	19OCT2009	64,000	286-0519	
6	Sayre, Jay	324987451	15NOV2005	66,000	933-2998	
7	Tolson, Andrew	596771321	18MAR2000	54,000	929-4800	
8	Jensen, Helga	477562122	01FEB2004	70,300	286-2816	
9	Kulenic, Marie	894724859	24JUN2004	54,800	493-1472	
10	Zweerink, Anna	988427431	07JUL2011	59,000	929-3885	
11	Saparilas, Theresa	744289612	09MAY2005	45,000		F
12	Brosnihan, Dylan	824904032	04JAN2009	49,000		M
13	Chao, Daeyong	242779184	28SEP2004	48,500		M
14	Slifkin, Leah	544382887	24JUL2011	54,000		F
15	Perry, Marguerite	933476520	19APR2010	49,500		F
16	Gardinski, Barbara	634875680	29MAY2001	59,000		F
17	Robertson, Hannah	824576630	14MAR2010	65,500		F
18	Gresham, Jean	744826703	28APR1999	67,000		F
19	Kruize, Ronald	824447605	23MAY2001	58,000		M
20	Linzer, Fritz	988674342	23JUL2007	63,500		M
21	Carlton, Susan	688774609	28JAN2012	41,000		F
22	Hoffmann, Gerald	922448328	12OCT2012	40,500		M
23	DePuis, David	544909752	23AUG2011	43,500		M
24	Hahn, Kenneth	745609821	23AUG2011	45,500		M
25	Landau, Jennifer	634774295	30APR2012	43,500		F
26	Schoenberg, Marguerite	922854076	19NOV2004	60,500		F
27	Addison-Hardy, Jonathon	770434994	23FEB2011	63,500		M
28	McNaughton, Elizabeth	242784883	24JUL2001	65,000		F
29	Tharrington, Catherine	377882806	28SEP2004	60,000		F
30	Frangipani, Christopher	292450691	12AUG2008	63,000		M

Concatenating Data Sets By Using the APPEND Procedure

Understanding the APPEND Procedure

The APPEND procedure adds the observations from one SAS data set to the end of another SAS data set. PROC APPEND does not process the observations in the first data set. It adds the observations in the second data set directly to the end of the original data set.

The APPEND procedure has the following form:

PROC APPEND BASE=*base-SAS-data-set* <DATA=*SAS-data-set-to-append*> <FORCE>;

base-SAS-data-set
names the SAS data set to which you want to append the observations. If this data set does not exist, then SAS creates it. At the completion of PROC APPEND, the value of *base-SAS-data-set* becomes the current (most recently created) SAS data set.

SAS-data-set-to-append
names the SAS data set that contains the observations to add to the end of the base data set. If you omit this option, then PROC APPEND adds the observations in the most recently created SAS data set to the end of the base data set.

FORCE
forces PROC APPEND to concatenate the files in some situations in which the procedure would normally fail.

Using the APPEND Procedure: The Simplest Case

The following program appends the data set CUSTOMER_SUPPORT to the data set SALES. Both data sets contain the same variables and each variable has the same attributes in both data sets.

```
proc append base=sales data=customer_support;
run;

proc print data=sales;
   title 'Employees in Sales and Customer Support Departments';
run;
```

The following output shows the results.

Figure 17.14 Output from PROC APPEND

Employees in Sales and Customer Support Departments

Obs	EmployeeID	Name	HireDate	Salary	HomePhone
1	429685482	Martin, Virginia	09AUG2002	45000	493-0824
2	244967839	Singleton, MaryAnn	24APR2004	34000	929-2623
3	996740216	Leighton, Maurice	16DEC2001	57000	933-6908
4	675443925	Freuler, Carl	15FEB2010	54500	493-3993
5	845729308	Cage, Merce	19OCT2009	64000	286-0519
6	324987451	Sayre, Jay	15NOV2005	66000	933-2998
7	596771321	Tolson, Andrew	18MAR2000	54000	929-4800
8	477562122	Jensen, Helga	01FEB2004	70300	286-2816
9	894724859	Kulenic, Marie	24JUN2004	54800	493-1472
10	988427431	Zweerink, Anna	07JUL2011	59000	929-3885

The resulting data set is identical to the data set that was created by naming SALES and CUSTOMER_SUPPORT in the SET statement. (See Figure 17.3 on page 269.) It is important to realize that PROC APPEND permanently alters the SALES data set, which is the data set for the BASE= option. SALES now contains observations from both the Sales and the Customer Support departments.

Using the APPEND Procedure When Data Sets Contain Different Variables

Recall that the SECURITY data set contains the variable Gender, which is not in the SALES data set, and lacks the variable HomePhone, which is present in the SALES data set. What happens if you try to use PROC APPEND to concatenate data sets that contain different variables?

If you try to append SECURITY to SALES using the following program, then the concatenation fails:

```
proc append base=sales data=security;
run;
```

SAS writes the following messages to the log:

Example Code 17.1 *SAS Log: PROC APPEND Error*

```
338  proc append base=sales data=security;
339  run;

NOTE: Appending WORK.SECURITY to WORK.SALES.
WARNING: Variable Gender was not found on BASE file. The variable will not be added
to the BASE
         file.
WARNING: Variable HomePhone was not found on DATA file.
ERROR: No appending done because of anomalies listed above.
       Use FORCE option to append these files.
NOTE: 0 observations added.
NOTE: The data set WORK.SALES has 5 observations and 5 variables.
NOTE: Statements not processed because of errors noted above.
NOTE: PROCEDURE APPEND used (Total process time):
      real time           0.01 seconds
      cpu time            0.03 seconds

NOTE: The SAS System stopped processing this step because of errors.
```

You must use the FORCE option with PROC APPEND when the DATA= data set contains a variable that is not in the BASE= data set. If you modify the program to include the FORCE option, then it successfully concatenates the files.

```
data sales;
    input EmployeeID $ 1-9 Name $ 11-29 @30 HireDate date9.
          Salary HomePhone $;
    format HireDate date9.;
    datalines;
429685482 Martin, Virginia   09aug2002 45000 493-0824
244967839 Singleton, MaryAnn 24apr2004 34000 929-2623
996740216 Leighton, Maurice  16dec2001 57000 933-6908
675443925 Freuler, Carl      15feb2010 54500 493-3993
845729308 Cage, Merce        19oct2009 64000 286-0519
;
run;

data security;
   input EmployeeID $ 1-9 Name $ 11-29 Gender $ 30
         @32 HireDate date9. Salary;
   format HireDate date9.;
   datalines;
744289612 Saparilas, Theresa F 09may2005 45000
824904032 Brosnihan, Dylan   M 04jan2009 49000
242779184 Chao, Daeyong      M 28sep2004 48500
544382887 Slifkin, Leah      F 24jul2011 54000
933476520 Perry, Marguerite  F 19apr2010 49500
;
run;

proc append base=sales data=security force;
run;

proc print data=sales;
   title 'Employees in the Sales and the Security Departments';
run;
```

The following output displays the results.

Figure 17.15 Results of Using FORCE with PROC APPEND

Employees in the Sales and the Security Departments

Obs	EmployeeID	Name	HireDate	Salary	HomePhone
1	429685482	Martin, Virginia	09AUG2002	45000	493-0824
2	244967839	Singleton, MaryAnn	24APR2004	34000	929-2623
3	996740216	Leighton, Maurice	16DEC2001	57000	933-6908
4	675443925	Freuler, Carl	15FEB2010	54500	493-3993
5	845729308	Cage, Merce	19OCT2009	64000	286-0519
6	744289612	Saparilas, Theresa	09MAY2005	45000	
7	824904032	Brosnihan, Dylan	04JAN2009	49000	
8	242779184	Chao, Daeyong	28SEP2004	48500	
9	544382887	Slifkin, Leah	24JUL2011	54000	
10	933476520	Perry, Marguerite	19APR2010	49500	

This output illustrates two important points about using PROC APPEND to concatenate data sets with different variables:

- If the BASE= data set contains a variable that is not in the DATA= data set (for example, HomePhone), then PROC APPEND concatenates the data sets and assigns a missing value to that variable in the observations that are taken from the DATA= data set.
- If the DATA= data set contains a variable that is not in the BASE= data set (for example, Gender), then the FORCE option in PROC APPEND forces the procedure to concatenate the two data sets. But because that variable is not in the descriptor portion of the BASE= data set, the procedure cannot include it in the concatenated data set.

Note: In the current example, each data set contains a variable that is not in the other. It is only the case of a variable in the DATA= data set that is not in the BASE= data set that requires the use of the FORCE option. However, both cases display a warning in the log.

Using the APPEND Procedure When Variables Have Different Attributes

When you use PROC APPEND with variables that have different attributes, the following rules apply:

- If a variable has different attributes in the BASE= data set than it does in the DATA= data set, then the attributes in the BASE= data set prevail. In the cases of different formats, informats, and labels, the concatenation succeeds.

- If the length of a variable is longer in the BASE= data set than in the DATA= data set, then the concatenation succeeds.
- If the length of a variable is longer in the DATA= data set than in the BASE= data set, or if the same variable is a character variable in one data set and a numeric variable in the other, then PROC APPEND fails to concatenate the files unless you specify the FORCE option.

Using the FORCE option has these consequences:

- The length that is specified in the BASE= data set prevails. Therefore, SAS truncates values from the DATA= data set to fit them into the length that is specified in the BASE= data set.
- The type that is specified in the BASE= data set prevails. The procedure replaces values of the wrong type (all values for the variable in the DATA= data set) with missing values.

Choosing between the SET Statement and the APPEND Procedure

If two data sets contain the same variables and the variables have the same attributes, then the file that results from concatenating them with the SET statement is the same as the file that results from concatenating them with the APPEND procedure. The APPEND procedure concatenates much faster than the SET statement, particularly when the BASE= data set is large, because the APPEND procedure does not process the observations from the BASE= data set. However, the two methods of concatenating are sufficiently different when the variables or their attributes differ between data sets. In this case, you must consider the differences in behavior before you decide which method to use.

The following table summarizes the major differences between using the SET statement and using the APPEND procedure to concatenate files.

Table 17.1 Differences between the SET Statement and the APPEND Procedure

Criterion	SET Statement	APPEND Procedure
Number of data sets that you can concatenate	Uses any number of data sets.	Uses two data sets.
Handling of data sets that contain different variables	Uses all variables and assigns missing values where appropriate.	Uses all variables in the BASE= data set and assigns missing values to observations from the DATA= data set where appropriate. Requires the FORCE option to concatenate data sets if the DATA= data set contains variables that are not in the BASE= data set. Cannot include variables found only in the DATA= data set when concatenating the data sets.

Criterion	SET Statement	APPEND Procedure
Handling of different formats, informats, or labels	Uses explicitly defined formats, informats, and labels rather than defaults. If two or more data sets explicitly define the format, informat, or label, then SAS uses the definition from the data set you name first in the SET statement.	Uses formats, informats, and labels from the BASE= data set.
Handling of different variable lengths	If the same variable has a different length in two or more data sets, then SAS uses the length from the data set you name first in the SET statement.	Requires the FORCE option if the length of a variable is longer in the DATA= data set. Truncates the values of the variable to match the length in the BASE= data set.
Handling of different variable types	Does not concatenate the data sets.	Requires the FORCE option to concatenate data sets. Uses the type attribute from the BASE= data set and assigns missing values to the variable in observations from the DATA= data set.

Summary

Statements

LENGTH *variables* <$> *length*;
: specifies the number of bytes that are used for storing variables.

SET *SAS-data-sets*;
: reads one or more SAS data sets and creates a single SAS data set that you specify in the DATA statement.

Procedures

PROC APPEND BASE=*base-SAS-data-set* <DATA=*SAS-data-set-to-append*> <FORCE>;

appends the DATA= data set to the BASE= data set. *Base-SAS-data-set* names the SAS data set to which you want to append the observations. If this data set does not exist, then SAS creates it. At the completion of PROC APPEND, the base data set becomes the current (most recently created) SAS data set. *SAS-data-set-to-append* names the SAS data set that contains the observations to add to the end of the base data set. If you omit this option, then PROC APPEND adds the observations in the current SAS data set to the end of the base data set. The FORCE option forces PROC APPEND to concatenate the files in situations in which the procedure would otherwise fail.

Learning More

CONTENTS statement

displays information about a data set, including the names and attributes of all variables. This information reveals any problems that you might have when you try to concatenate data sets, and helps you decide whether to use the SET statement or PROC APPEND. For more information about using the CONTENTS statement in the DATASETS procedure, see "DATASETS Procedure" in *Base SAS Procedures Guide*.

END= statement option

enables you to determine when SAS is processing the last observation in the DATA step. For more information, see Chapter 22, "Conditionally Processing Observations from Multiple SAS Data Sets," on page 361.

IN= data set option

enables you to process observations from each data set differently. For more information about using the IN= option in the SET statement, see Chapter 22, "Conditionally Processing Observations from Multiple SAS Data Sets," on page 361.

Variable attributes

For more information, see "SAS Variable Attributes" in *SAS Language Reference: Concepts*.

18

Interleaving SAS Data Sets

Introduction to Interleaving SAS Data Sets

Purpose

Interleaving combines individual sorted SAS data sets into one sorted data set. You interleave data sets by using a SET statement and a BY statement in a DATA step. The number of observations in the new data set is the sum of the number of observations in the original data sets.

In this section, you will learn how to use the BY statement, how to sort data sets to prepare for interleaving, and how to use the SET and BY statements together to interleave observations.

Prerequisites

Before continuing with this section, you should understand the concepts that are presented in the following sections:

- Chapter 4, “Starting with Raw Data: The Basics,” on page 51
- Chapter 6, “Starting with SAS Data Sets,” on page 93

Understanding BY-Group Processing Concepts

The BY statement specifies the variable or variables by which you want to interleave the data sets. In order to understand interleaving, you must understand BY variables, BY values, and BY groups.

BY variable
: specifies a variable that is named in a BY statement and by which the data is sorted or needs to be sorted.

BY value
: specifies the value of a BY variable.

BY group
: specifies the set of all observations with the same value for a BY variable (when only one BY variable is specified). If you use more than one variable in a BY statement, then a BY group is a group of observations with a unique combination of values for those variables. In discussions of interleaving, BY groups commonly span more than one data set.

Interleaving Data Sets

Preparing to Interleave Data Sets

Before you can interleave data sets, the data must be sorted by the same variable or variables that will be used with the BY statement that accompanies your SET statement.

For example, the Research and Development division and the Publications division of a company both maintain data sets containing information about each project currently under way. Each data set includes these variables:

Project
: specifies a unique code that identifies the project.

Department
: specifies the name of a department that is involved in the project.

Manager
: specifies the last name of the manager from Department.

StaffCount
: specifies the number of people working for Manager on this project.

Senior management for the company wants to combine the data sets by Project so that the new data set shows the resources that both divisions are devoting to each project. Both data sets must be sorted by Project before they can be interleaved.

The following program creates and displays the data set RESEARCH_DEVELOPMENT. Note that the input data is already sorted by Project.

```
data research_development;
   length Department Manager $ 10;
   input Project $ Department $ Manager $ StaffCount;
   datalines;
MP971 Designing Daugherty 10
MP971 Coding Newton 8
MP971 Testing Miller 7
SL827 Designing Ramirez 8
SL827 Coding Cho 10
SL827 Testing Baker 7
WP057 Designing Hascal 11
WP057 Coding Constant 13
WP057 Testing Slivko 10
;
run;

proc print data=research_development;
   title 'Research and Development Project Staffing';
run;
```

The following output displays the RESEARCH_DEVELOPMENT data set.

Figure 18.1 *The RESEARCH_DEVELOPMENT Data Set*

Research and Development Project Staffing

Obs	Department	Manager	Project	StaffCount
1	Designing	Daugherty	MP971	10
2	Coding	Newton	MP971	8
3	Testing	Miller	MP971	7
4	Designing	Ramirez	SL827	8
5	Coding	Cho	SL827	10
6	Testing	Baker	SL827	7
7	Designing	Hascal	WP057	11
8	Coding	Constant	WP057	13
9	Testing	Slivko	WP057	10

The following program creates, sorts, and displays the second data set, PUBLICATIONS. Note that the output data set is sorted by Project.

```
data publications;
   length Department Manager $ 10;
   input Manager $ Department $ Project $ StaffCount;
   datalines;
Cook Writing WP057 5
Deakins Writing SL827 7
Franscombe Editing MP971 4
```

```
Henry Editing WP057 3
King Production SL827 5
Krysonski Production WP057 3
Lassiter Graphics SL827 3
Miedema Editing SL827 5
Morard Writing MP971 6
Posey Production MP971 4
Spackle Graphics WP057 2
;
run;

proc sort data=publications;
   by Project;
run;

proc print data=publications;
   title 'Publications Project Staffing';
run;
```

The following output displays the PUBLICATIONS data set.

Figure 18.2 The PUBLICATIONS Data Set

Publications Project Staffing

Obs	Department	Manager	Project	StaffCount
1	Editing	Franscombe	MP971	4
2	Writing	Morard	MP971	6
3	Production	Posey	MP971	4
4	Writing	Deakins	SL827	7
5	Production	King	SL827	5
6	Graphics	Lassiter	SL827	3
7	Editing	Miedema	SL827	5
8	Writing	Cook	WP057	5
9	Editing	Henry	WP057	3
10	Production	Krysonski	WP057	3
11	Graphics	Spackle	WP057	2

Understanding the Interleaving Process

When you interleave data sets, SAS creates a new data set as follows:

1 Before executing the SET statement, SAS reads the descriptor portion of each data set that you name in the SET statement. Then SAS creates a program data vector that, by default, contains all the variables from all data sets as well as any

variables created by the DATA step. SAS sets the value of each variable to missing.

2 SAS looks at the first BY group in each data set in the SET statement in order to determine which BY group should appear first in the new data set.

3 SAS copies to the new data set all observations in that BY group from each data set that contains observations in the BY group. SAS copies from the data sets in the same order as they appear in the SET statement.

4 SAS looks at the next BY group in each data set to determine which BY group should appear next in the new data set.

5 SAS sets the value of each variable in the program data vector to missing.

6 SAS repeats steps 3 through 5 until it has copied all observations to the new data set.

Using the Interleaving Process

The following program uses the SET and BY statements to interleave the data sets RESEARCH_DEVELOPMENT and PUBLICATIONS.

```
data rnd_pubs;
   set research_development publications;
   by Project;
run;

proc print data=rnd_pubs;
   title 'Project Participation by Research and Development';
   title2 'and Publications Departments';
   title3 'Sorted by Project';
run;
```

The new data set, RND_PUBS, includes all observations from both data sets. Each BY group in the new data set contains observations from RESEARCH_DEVELOPMENT followed by observations from PUBLICATIONS.

Figure 18.3 Interleaving Two Data Sets

Project Participation by Research and Development and Publications Departments Sorted by Project

Obs	Department	Manager	Project	StaffCount
1	Designing	Daugherty	MP971	10
2	Coding	Newton	MP971	8
3	Testing	Miller	MP971	7
4	Editing	Franscombe	MP971	4
5	Writing	Morard	MP971	6
6	Production	Posey	MP971	4
7	Designing	Ramirez	SL827	8
8	Coding	Cho	SL827	10
9	Testing	Baker	SL827	7
10	Writing	Deakins	SL827	7
11	Production	King	SL827	5
12	Graphics	Lassiter	SL827	3
13	Editing	Miedema	SL827	5
14	Designing	Hascal	WP057	11
15	Coding	Constant	WP057	13
16	Testing	Slivko	WP057	10
17	Writing	Cook	WP057	5
18	Editing	Henry	WP057	3
19	Production	Krysonski	WP057	3
20	Graphics	Spackle	WP057	2

Summary

Statements

SET *SAS-data-sets*;
BY *variable-list*;

The SET statement reads multiple sorted SAS data sets and creates one sorted SAS data set. *SAS-data-sets* is a list of the SAS data sets to interleave.

The BY statement is used with a SET statement to perform BY-group processing. *Variable-list* contains the names of one or more variables (BY variables) by which to interleave the data sets. All of the data sets must be sorted by the same variables before you can interleave them.

Learning More

Indexes
: You do not need to sort unordered data sets before interleaving them if the data sets have an index on the variable or variables by which you want to interleave. For more information, see "Understanding SAS Indexes" in *SAS Language Reference: Concepts*.

Combining SAS data sets
: For information about combining SAS data sets using the SET statement when the data sets contain different variables, attributes, types, or lengths, see "Concatenating Data Sets with the SET Statement" on page 266.

: For information about combining SAS data sets with the APPEND procedure, see "Concatenating Data Sets By Using the APPEND Procedure" on page 283.

: The same rules apply to interleaving data sets as to concatenating them.

SORT procedure and the BY statement
: For more information, see Chapter 12, "Working with Grouped or Sorted Observations," on page 191.

19

Merging SAS Data Sets

Introduction to Merging SAS Data Sets

Purpose

Merging combines observations from two or more SAS data sets into a single observation in a new SAS data set. The new data set contains all variables from all the original data sets unless you specify otherwise.

In this section, you will learn about two types of merging: one-to-one merging and match merging. In one-to-one merging, you do not use a BY statement. Observations are combined based on their positions in the input data sets. In match merging, you use a BY statement to combine observations from the input data sets based on common values of the variable by which you merge the data sets.

Prerequisites

Before continuing with this section, you should understand the concepts that are presented in the following sections:

- Chapter 4, “Starting with Raw Data: The Basics,” on page 51
- Chapter 6, “Starting with SAS Data Sets,” on page 93

Understanding the MERGE Statement

You merge data sets using the MERGE statement in a DATA step. The form of the MERGE statement that is used in this section is the following:

MERGE *SAS-data-set-list*;

BY *variable-list*;

SAS-data-set-list
: specifies the names of two or more SAS data sets to merge. The list can contain any number of data sets.

variable-list
: specifies one or more variables by which to merge the data sets. If you use a BY statement, then the data sets must be sorted by the same BY variables before you can merge them.

One-to-One Merging

Definition of One-to-One Merging

When you use the MERGE statement without a BY statement, SAS combines the first observation in all data sets you name in the MERGE statement into the first observation in the new data set, the second observation in all data sets into the second observation in the new data set, and so on. In a one-to-one merge, the number of observations in the new data set is equal to the number of observations in the largest data set that you name in the MERGE statement.

Performing a Simple One-to-One Merge

Input SAS Data Set for Examples

The instructor of a college acting class wants to schedule a conference with each student. One data set, CLASS, contains these variables:

Name
: specifies the student's name.

Year
: specifies the student's year: first, second, third, or fourth.

Major
: specifies the student's area of specialization. This value is always missing for first-year and second-year students, who have not yet selected a major subject to study.

The following program creates and displays the CLASS data set.

```
data class;
   input Name $ 1-25 Year $ 26-34 Major $ 36-50;
   datalines;
Abbott, Jennifer         first
Carter, Tom              third     Theater
Mendoza, Elissa          fourth    Mathematics
Tucker, Rachel           first
Uhl, Roland              second
Wacenske, Maurice        third     Theater
;
run;

proc print data=class;
   title 'Acting Class Roster';
run;
```

The following output displays the CLASS data set.

Figure 19.1 Acting Class Data Set

Acting Class Roster

Obs	Name	Year	Major
1	Abbott, Jennifer	first	
2	Carter, Tom	third	Theater
3	Mendoza, Elissa	fourth	Mathematics
4	Tucker, Rachel	first	
5	Uhl, Roland	second	
6	Wacenske, Maurice	third	Theater

A second data set contains a list of the dates and times the instructor scheduled conferences, and the rooms in which the conferences are to take place. The following program creates and displays the TIME_SLOT data set. Note the use of the date format and informat.

```
data time_slot;
   input Date date9.  @12 Time $ @19 Room $;
   format date date9.;
   datalines;
14sep2012  10:00  103
14sep2012  10:30  103
14sep2012  11:00  207
15sep2012  10:00  105
15sep2012  10:30  105
17sep2012  11:00  207
;
run;

proc print data=time_slot;
   title 'Dates, Times, and Locations of Conferences';
run;
```

The following output displays the TIME_SLOT data set.

Figure 19.2 The TIME_SLOT Data Set

Dates, Times, and Locations of Conferences

Obs	Date	Time	Room
1	14SEP2012	10:00	103
2	14SEP2012	10:30	103
3	14SEP2012	11:00	207
4	15SEP2012	10:00	105
5	15SEP2012	10:30	105
6	17SEP2012	11:00	207

The Program

The following program performs a one-to-one merge of these data sets, assigning a time slot for a conference to each student in the class.

```
data schedule;
   merge class time_slot;
run;

proc print data=schedule;
   title 'Student Conference Assignments';
run;
```

The following output displays the SCHEDULE data set.

Figure 19.3 One-to-One Merge: The Conference Schedule Data Set

Student Conference Assignments

Obs	Name	Year	Major	Date	Time	Room
1	Abbott, Jennifer	first		14SEP2012	10:00	103
2	Carter, Tom	third	Theater	14SEP2012	10:30	103
3	Mendoza, Elissa	fourth	Mathematics	14SEP2012	11:00	207
4	Tucker, Rachel	first		15SEP2012	10:00	105
5	Uhl, Roland	second		15SEP2012	10:30	105
6	Wacenske, Maurice	third	Theater	17SEP2012	11:00	207

Explanation

The preceding output, One-to-One Merge. the SCHEDULE Data Set shows that the new data set combines the first observation from CLASS with the first observation from TIME_SLOT. It then combines the second observation from CLASS with the second observation from TIME_SLOT, and so on.

Performing a One-to-One Merge on Data Sets with the Same Variables

Input SAS Data Set for Examples

The previous example illustrates the simplest case of a one-to-one merge: the data sets contain the same number of observations, all variables have unique names, and you want to keep all variables from both data sets in the new data set. This example merges data sets that contain variables that have the same names. Also, the second data set in this example contains one more observation than the first data set. Each data set contains data about a separate acting class.

In addition to the CLASS data set, the instructor also uses the CLASS2 data set, which contains the same variables as CLASS but one more observation. The following program creates and displays the CLASS2 data set:

```
data class2;
   input Name $ 1-25 Year $ 26-34 Major $ 36-50;
   datalines;
Hitchcock-Tyler, Erin    second
Keil, Deborah            third     Theater
Nacewicz, Chester        third     Theater
Norgaard, Rolf           second
Prism, Lindsay           fourth    Anthropology
Singh, Rajiv             second
Wittich, Stefan          third     Physics
;
run;

proc print data=class2;
   title 'Acting Class Roster';
   title2 '(second section)';
run;
```

The following output displays the CLASS2 data set.

Figure 19.4 The CLASS2 Data Set

Acting Class Roster (second section)

Obs	Name	Year	Major
1	Hitchcock-Tyler, Erin	second	
2	Keil, Deborah	third	Theater
3	Nacewicz, Chester	third	Theater
4	Norgaard, Rolf	second	
5	Prism, Lindsay	fourth	Anthropology
6	Singh, Rajiv	second	
7	Wittich, Stefan	third	Physics

The Program

Instead of scheduling conferences for one class, the instructor wants to schedule acting exercises for pairs of students, one student from each class. The instructor wants to create a data set in which each observation contains the name of one student from each class and the date, time, and location of the exercise. The variables Year and Major should not be in the new data set.

This new data set can be created by merging the data sets CLASS, CLASS2, and TIME_SLOT. Because Year and Major are not wanted in the new data set, the DROP= data set option can be used to drop them. Notice that the data sets CLASS and CLASS2 both contain the variable Name, but the values for Name are different in each data set. To preserve both sets of values, the RENAME= data set option must be used to rename the variable in one of the data sets.

The following program uses the DROP and RENAME data set options to merge the three data sets:

```
data exercise;
   merge class (drop=Year Major)
   class2 (drop=Year Major rename=(Name=Name2))
   time_slot;
run;

proc print data=exercise;
   title 'Acting Class Exercise Schedule';
run;
```

The following output displays the merged data set.

Figure 19.5 *Merging Three Data Sets*

Acting Class Exercise Schedule

Obs	Name	Name2	Date	Time	Room
1	Abbott, Jennifer	Hitchcock-Tyler, Erin	14SEP2012	10:00	103
2	Carter, Tom	Keil, Deborah	14SEP2012	10:30	103
3	Mendoza, Elissa	Nacewicz, Chester	14SEP2012	11:00	207
4	Tucker, Rachel	Norgaard, Rolf	15SEP2012	10:00	105
5	Uhl, Roland	Prism, Lindsay	15SEP2012	10:30	105
6	Wacenske, Maurice	Singh, Rajiv	17SEP2012	11:00	207
7		Wittich, Stefan	.		

Explanation

The following steps describe how SAS merges the data sets:

1 Before executing the DATA step, SAS reads the descriptor portion of each data set that you name in the MERGE statement. Then SAS creates a program data vector for the new data set that, by default, contains all of the variables from all of the data sets. It also contains variables that are created by the DATA step. However, in this case the DROP= data set option excludes the variables Year and Major from the program data vector. The RENAME= data set option adds the variable Name2 to the program data vector. Therefore, the program data vector contains the variables Name, Name2, Date, Time, and Room.

2 SAS sets the value of each variable in the program data vector to missing, as the following figure illustrates.

Figure 19.6 *Program Data Vector Before Reading from Data Sets*

Name	Name2	Date	Time	Room
		.		

3 Next, SAS reads and copies the first observation from each data set into the program data vector (reading the data sets in the same order they appear in the MERGE statement), as the following figure illustrates.

Figure 19.7 Program Data Vector After Reading from Each Data Set

Name	Name2	Date	Time	Room
Abbott, Jennifer		.		

Name	Name2	Date	Time	Room
Abbott, Jennifer	Hitchcock-Tyler, Erin	.		

Name	Name2	Date	Time	Room
Abbott, Jennifer	Hitchcock-Tyler, Erin	14SEP2000	10:00	103

4 After processing the first observation from the last data set and executing any other statements in the DATA step, SAS writes the contents of the program data vector to the new data set. If the DATA step attempts to read past the end of a data set, then the values of all variables from that data set in the program data vector are set to missing.

This behavior has two important consequences:

- If a variable exists in more than one data set, then the value from the last data set SAS reads is the value that goes into the new data set, even if that value is missing. If you want to keep all the values for like-named variables from different data sets, then you must rename one or more of the variables with the RENAME= data set option so that each variable has a unique name.
- After SAS processes all observations in a data set, the program data vector and all subsequent observations in the new data set have missing values for the variables unique to that data set. So, as the next figure shows, the program data vector for the last observation in the new data set contains missing values for all variables except Name2.

Figure 19.8 Program Data Vector for the Last Observation

Name	Name2	Date	Time	Room
	Wittich, Stefan	.		

5 SAS continues to merge observations until it has copied all observations from all data sets.

Match-Merging

Merging with a BY Statement

Merging with a BY statement enables you to match observations according to the values of the BY variables that you specify. Before you can perform a match-merge, all data sets must be sorted by the variables that you want to use for the merge.

In order to understand match-merging, you must understand three key concepts:

BY *variable*
: specifies a variable that is named in a BY statement.

BY *value*
: specifies the value of a BY variable.

BY *group*
: specifies the set of all observations with the same value for the BY variable (if there is only one BY variable). If you use more than one variable in a BY statement, then a BY group is the set of observations with a unique combination of values for those variables. In discussions of match-merging, BY groups commonly span more than one data set.

Input SAS Data Set for Examples

The director of a small repertory theater company, the Little Theater, maintains company records in two SAS data sets, COMPANY and FINANCE.

Table 19.1 *Variables in the COMPANY and FINANCE Data Sets*

Data Set	Variable	Description
COMPANY	Name	player's name
	Age	player's age
	Gender	player's gender
FINANCE	Name	player's name
	IdNumber	player's employee ID number
	Salary	player's annual salary

The following program creates, sorts, and displays the COMPANY and FINANCE data sets:

```
data company;
   input Name $ 1-25 Age 27-28 Gender $ 30;
   datalines;
Vincent, Martina          34 F
Phillipon, Marie-Odile    28 F
Gunter, Thomas            27 M
Harbinger, Nicholas       36 M
Benito, Gisela            32 F
Rudelich, Herbert         39 M
Sirignano, Emily          12 F
Morrison, Michael         32 M
;
run;

proc sort data=company;
   by Name;
run;

data finance;
   input IdNumber $ 1-11 Name $ 13-37 Salary;
   datalines;
074-53-9892 Vincent, Martina          35000
776-84-5391 Phillipon, Marie-Odile    29750
929-75-0218 Gunter, Thomas            27500
446-93-2122 Harbinger, Nicholas       33900
228-88-9649 Benito, Gisela            28000
029-46-9261 Rudelich, Herbert         35000
442-21-8075 Sirignano, Emily          5000
;
run;

proc sort data=finance;
   by Name;
run;

proc print data=company;
   title 'Little Theater Company Roster';
run;

proc print data=finance;
   title 'Little Theater Employee Information';
run;
```

The following output displays the COMPANY and FINANCE data sets. Notice that the FINANCE data set does not contain an observation for Michael Morrison.

Figure 19.9 The COMPANY Data Set

Little Theater Company Roster

Obs	Name	Age	Gender
1	Benito, Gisela	32	F
2	Gunter, Thomas	27	M
3	Harbinger, Nicholas	36	M
4	Morrison, Michael	32	M
5	Phillipon, Marie-Odile	28	F
6	Rudelich, Herbert	39	M
7	Sirignano, Emily	12	F
8	Vincent, Martina	34	F

Figure 19.10 The FINANCE Data Set

Little Theater Employee Information

Obs	IdNumber	Name	Salary
1	228-88-9649	Benito, Gisela	28000
2	929-75-0218	Gunter, Thomas	27500
3	446-93-2122	Harbinger, Nicholas	33900
4	776-84-5391	Phillipon, Marie-Odile	29750
5	029-46-9261	Rudelich, Herbert	35000
6	442-21-8075	Sirignano, Emily	5000
7	074-53-9892	Vincent, Martina	35000

The Program

To avoid having to maintain two separate data sets, the director wants to merge the records for each player from both data sets into a new data set that contains all of the variables. The variable that is common to both data sets is Name. Therefore, Name is the appropriate BY variable.

The data sets are already sorted by Name, so no further sorting is required. The following program merges them by Name:

```
data employee_info;
   merge company finance;
   by name;
run;
```

```
proc print data=employee_info;
   title 'Little Theater Employee Information';
   title2 '(including personal and financial information)';
run;
```

The following output displays the merged EMPLOYEE_INFO data set.

Figure 19.11 Match-Merging: The EMPLOYEE_INFO Data Set

Little Theater Employee Information
(including personal and financial information)

Obs	Name	Age	Gender	IdNumber	Salary
1	Benito, Gisela	32	F	228-88-9649	28000
2	Gunter, Thomas	27	M	929-75-0218	27500
3	Harbinger, Nicholas	36	M	446-93-2122	33900
4	Morrison, Michael	32	M		.
5	Phillipon, Marie-Odile	28	F	776-84-5391	29750
6	Rudelich, Herbert	39	M	029-46-9261	35000
7	Sirignano, Emily	12	F	442-21-8075	5000
8	Vincent, Martina	34	F	074-53-9892	35000

Explanation

The new data set contains one observation for each player in the company. Each observation contains all the variables from both data sets. Notice in particular the fourth observation. The data set FINANCE does not have an observation for Michael Morrison. In this case, the values of the variables that are unique to FINANCE (IdNumber and Salary) are missing.

Match-Merging Data Sets with Multiple Observations in a BY Group

Input SAS Data Set for Examples

The Little Theater has a third data set, REPERTORY, that tracks the casting assignments in each of the season's plays. REPERTORY contains these variables:

Play
: specifies the name of one of the plays in the repertory.

Role
: specifies the name of a character in Play.

IdNumber
: specifies the employee ID number of the player playing Role.

The following program creates and displays the REPERTORY data set:

```
data repertory;
   input Play $ 1-23 Role $ 25-48 IdNumber $ 50-60;
   datalines;
No Exit                  Estelle                  074-53-9892
No Exit                  Inez                     776-84-5391
No Exit                  Valet                    929-75-0218
No Exit                  Garcin                   446-93-2122
Happy Days               Winnie                   074-53-9892
Happy Days               Willie                   446-93-2122
The Glass Menagerie      Amanda Wingfield         228-88-9649
The Glass Menagerie      Laura Wingfield          776-84-5391
The Glass Menagerie      Tom Wingfield            929-75-0218
The Glass Menagerie      Jim O'Connor             029-46-9261
The Dear Departed        Mrs. Slater              228-88-9649
The Dear Departed        Mrs. Jordan              074-53-9892
The Dear Departed        Henry Slater             029-46-9261
The Dear Departed        Ben Jordan               446-93-2122
The Dear Departed        Victoria Slater          442-21-8075
The Dear Departed        Abel Merryweather        929-75-0218
;
run;

proc print data=repertory;
   title 'Little Theater Season Casting Assignments';
run;
```

The following output displays the REPERTORY data set.

Figure 19.12 *The REPERTORY Data Set*

Little Theater Season Casting Assignments

Obs	Play	Role	IdNumber
1	No Exit	Estelle	074-53-9892
2	No Exit	Inez	776-84-5391
3	No Exit	Valet	929-75-0218
4	No Exit	Garcin	446-93-2122
5	Happy Days	Winnie	074-53-9892
6	Happy Days	Willie	446-93-2122
7	The Glass Menagerie	Amanda Wingfield	228-88-9649
8	The Glass Menagerie	Laura Wingfield	776-84-5391
9	The Glass Menagerie	Tom Wingfield	929-75-0218
10	The Glass Menagerie	Jim O'Connor	029-46-9261
11	The Dear Departed	Mrs. Slater	228-88-9649
12	The Dear Departed	Mrs. Jordan	074-53-9892
13	The Dear Departed	Henry Slater	029-46-9261
14	The Dear Departed	Ben Jordan	446-93-2122
15	The Dear Departed	Victoria Slater	442-21-8075
16	The Dear Departed	Abel Merryweather	929-75-0218

To maintain confidentiality during preliminary casting, this data set identifies players by employee ID number. However, casting decisions are now final, and the manager wants to replace each employee ID number with the player's name. Of course, it is possible to re-create the data set, entering each player's name instead of the employee ID number in the raw data. However, it is more efficient to make use of the FINANCE data set, which already contains the name and employee ID number of all players.

When the data sets are merged, SAS adds the players' names to the data set. Of course, before you can merge the data sets, you must sort them by IdNumber.

```
proc sort data=finance;
   by IdNumber;
run;

proc sort data=repertory;
   by IdNumber;
run;

proc print data=finance;
   title 'Little Theater Employee Information';
   title2 '(sorted by employee ID number)';
run;
```

```
proc print data=repertory;
   title 'Little Theater Season Casting Assignments';
   title2 '(sorted by employee ID number)';
run;
```

The following output displays the FINANCE and REPERTORY data sets, sorted by IdNumber.

Figure 19.13 *The FINANCE Data Set Sorted by IdNumber*

Little Theater Employee Information
(sorted by employee ID number)

Obs	IdNumber	Name	Salary
1	029-46-9261	Rudelich, Herbert	35000
2	074-53-9892	Vincent, Martina	35000
3	228-88-9649	Benito, Gisela	28000
4	442-21-8075	Sirignano, Emily	5000
5	446-93-2122	Harbinger, Nicholas	33900
6	776-84-5391	Phillipon, Marie-Odile	29750
7	929-75-0218	Gunter, Thomas	27500

Figure 19.14 The REPERTORY Data Set Sorted by IdNumber

Little Theater Season Casting Assignments
(sorted by employee ID number)

Obs	Play	Role	IdNumber
1	The Glass Menagerie	Jim O'Connor	029-46-9261
2	The Dear Departed	Henry Slater	029-46-9261
3	No Exit	Estelle	074-53-9892
4	Happy Days	Winnie	074-53-9892
5	The Dear Departed	Mrs. Jordan	074-53-9892
6	The Glass Menagerie	Amanda Wingfield	228-88-9649
7	The Dear Departed	Mrs. Slater	228-88-9649
8	The Dear Departed	Victoria Slater	442-21-8075
9	No Exit	Garcin	446-93-2122
10	Happy Days	Willie	446-93-2122
11	The Dear Departed	Ben Jordan	446-93-2122
12	No Exit	Inez	776-84-5391
13	The Glass Menagerie	Laura Wingfield	776-84-5391
14	No Exit	Valet	929-75-0218
15	The Glass Menagerie	Tom Wingfield	929-75-0218
16	The Dear Departed	Abel Merryweather	929-75-0218

These two data sets contain seven BY groups. That is, among the 23 observations are seven different values for the BY variable, IdNumber. The first BY group has a value of 029-46-9261 for IdNumber. FINANCE has one observation in this BY group; REPERTORY has two. The last BY group has a value of 929-75-0218 for IdNumber. FINANCE has one observation in this BY group; REPERTORY has three.

The Program

The following program merges the data sets FINANCE and REPERTORY. It also illustrates what happens when a BY group in one data set has more observations in it than the same BY group in the other data set.

The resulting data set contains all variables from both data sets.

```
data repertory_name;
   merge finance repertory;
   by IdNumber;
run;

proc print data=repertory_name;
   title 'Little Theater Season Casting Assignments';
   title2 'with employee financial information';
```

```
run;
```

The following output displays the merged data set.

Figure 19.15 Match-Merge with Multiple Observations in a BY Group

Little Theater Season Casting Assignments
with employee financial information

Obs	IdNumber	Name	Salary	Play	Role
1	029-46-9261	Rudelich, Herbert	35000	The Glass Menagerie	Jim O'Connor
2	029-46-9261	Rudelich, Herbert	35000	The Dear Departed	Henry Slater
3	074-53-9892	Vincent, Martina	35000	No Exit	Estelle
4	074-53-9892	Vincent, Martina	35000	Happy Days	Winnie
5	074-53-9892	Vincent, Martina	35000	The Dear Departed	Mrs. Jordan
6	228-88-9649	Benito, Gisela	28000	The Glass Menagerie	Amanda Wingfield
7	228-88-9649	Benito, Gisela	28000	The Dear Departed	Mrs. Slater
8	442-21-8075	Sirignano, Emily	5000	The Dear Departed	Victoria Slater
9	446-93-2122	Harbinger, Nicholas	33900	No Exit	Garcin
10	446-93-2122	Harbinger, Nicholas	33900	Happy Days	Willie
11	446-93-2122	Harbinger, Nicholas	33900	The Dear Departed	Ben Jordan
12	776-84-5391	Phillipon, Marie-Odile	29750	No Exit	Inez
13	776-84-5391	Phillipon, Marie-Odile	29750	The Glass Menagerie	Laura Wingfield
14	929-75-0218	Gunter, Thomas	27500	No Exit	Valet
15	929-75-0218	Gunter, Thomas	27500	The Glass Menagerie	Tom Wingfield
16	929-75-0218	Gunter, Thomas	27500	The Dear Departed	Abel Merryweather

Explanation

Carefully examine the first few observations in the new data set and consider how SAS creates them.

1 Before executing the DATA step, SAS reads the descriptor portion of the two data sets and creates a program data vector that contains all variables from both data sets:

- IdNumber, Name, and Salary from FINANCE
- Play and Role from REPERTORY.

IdNumber is already in the program data vector because it is in the FINANCE data set. SAS sets the values of all variables to missing, as the following figure illustrates.

Figure 19.16 Program Data Vector Before Reading from Data Sets

IdNumber	Name	Salary	Play	Role
		.		

2 SAS looks at the first BY group in each data set to determine which BY group should appear first. In this case, the first BY group, observations with the value 029-46-9261 for IdNumber, is the same in both data sets.

3 SAS reads and copies the first observation from FINANCE into the program data vector, as the next figure illustrates.

Figure 19.17 Program Data Vector After Reading FINANCE Data Set

IdNumber	Name	Salary	Play	Role
029-46-9261	Rudelich, Herbert	35000		

4 SAS reads and copies the first observation from REPERTORY into the program data vector, as the next figure illustrates. If a data set does not have any observations in a BY group, then the program data vector contains missing values for the variables that are unique to that data set.

Figure 19.18 Program Data Vector After Reading REPERTORY Data Set

IdNumber	Name	Salary	Play	Role
029-46-9261	Rudelich, Herbert	35000	The Glass Menagerie	Jim O'Connor

5 SAS writes the observation to the new data set and retains the values in the program data vector. (If the program data vector contained variables created by the DATA step, then SAS would set them to missing after writing to the new data set.)

6 SAS looks for a second observation in the BY group in each data set. REPERTORY has one; FINANCE does not. The MERGE statement reads the second observation in the BY group from REPERTORY. Because FINANCE has only one observation in the BY group, the statement uses the values of Name (`Rudelich, Herbert`) and Salary (`35000`) that were retained in the program data vector for the second observation in the new data set. The next figure illustrates this behavior.

Figure 19.19 Program Data Vector with Second Observation in the BY Group

IdNumber	Name	Salary	Play	Role
029-46-9261	Rudelich, Herbert	35000	The Dear Departed	Henry Slater

7 SAS writes the observation to the new data set. Neither data set contains any more observations in this BY group. Therefore, as the final figure illustrates, SAS sets all values in the program data vector to missing and begins processing the next BY group. It continues processing observations until it exhausts all observations in both data sets.

Figure 19.20 Program Data Vector before New BY Groups

IdNumber	Name	Salary	Play	Role
		.		

Match-Merging Data Sets with Dropped Variables

Now that casting decisions are final, the director wants to post the casting list, but does not want to include salary or employee ID information. As the next program illustrates, Salary and IdNumber can be eliminated by using the DROP= data set option when creating the new data set.

```
data newrep (drop=IdNumber);
   merge finance (drop=Salary) repertory;
   by IdNumber;
run;

proc print data=newrep;
   title 'Final Little Theater Season Casting Assignments';
run;
```

Note: The difference in placement of the two DROP= data set options is crucial. Dropping IdNumber in the DATA statement means that the variable is available to the MERGE and BY statements (to which it is essential), but that it does not go into the new data set. Dropping Salary in the MERGE statement means that the MERGE statement does not even read this variable, so Salary is unavailable to the program statements. Because the variable Salary is not needed for processing, it is more efficient to prevent it from being read into the PDV in the first place.

The following output displays the merged data set without the IdNumber and Salary variables.

Figure 19.21 Match-Merging Data Sets with Dropped Variables

Final Little Theater Season Casting Assignments

Obs	Name	Play	Role
1	Rudelich, Herbert	The Glass Menagerie	Jim O'Connor
2	Rudelich, Herbert	The Dear Departed	Henry Slater
3	Vincent, Martina	No Exit	Estelle
4	Vincent, Martina	Happy Days	Winnie
5	Vincent, Martina	The Dear Departed	Mrs. Jordan
6	Benito, Gisela	The Glass Menagerie	Amanda Wingfield
7	Benito, Gisela	The Dear Departed	Mrs. Slater
8	Sirignano, Emily	The Dear Departed	Victoria Slater
9	Harbinger, Nicholas	No Exit	Garcin
10	Harbinger, Nicholas	Happy Days	Willie
11	Harbinger, Nicholas	The Dear Departed	Ben Jordan
12	Phillipon, Marie-Odile	No Exit	Inez
13	Phillipon, Marie-Odile	The Glass Menagerie	Laura Wingfield
14	Gunter, Thomas	No Exit	Valet
15	Gunter, Thomas	The Glass Menagerie	Tom Wingfield
16	Gunter, Thomas	The Dear Departed	Abel Merryweather

Match-Merging Data Sets with the IN= Data Set Option

You can merge data sets after checking to see if an observation occurs in one or more data sets by using the IN= data set option. Suppose that you create a data set called HIGH_SALARY that includes only members of the company that make more than $28,000. You want to see a list of all the roles for these higher paid actors. You can create this list if you merge the REPERTORY data set with the HIGH_SALARY data set. Use the IN= data set option to include only roles that were portrayed by a higher paid actor. That is, you want to include a role in the merged data set only if the actor was also in the HIGH_SALARY data set.

First, create the HIGH_SALARY data set.

```
data high_salary;
  set finance;
  if (salary > 28000);
run;
```

Sort the data sets by IdNumber and then merge them. Use the IN= data set option to include only the roles that were portrayed by actors in the HIGH_SALARY data set. Print the list of HIGH_PAID_ROLES to see the resulting data set.

```
proc sort data=high_salary;
  by IdNumber;
run;

proc sort data=repertory;
  by IdNumber;
run;

data high_paid_roles(drop=IdNumber);
  merge high_salary(in=in_high_sal) repertory;
  by IdNumber;
  if in_high_sal then output;
run;

proc print data=high_paid_roles;
title 'Roles of Highest Paid Performers';
run;
```

The following output shows the list of roles for the higher paid actors. The list includes 10 observations. This is shorter than the entire list of 16 observations in the REPERTORY data set (see Figure 19.14 on page 315).

Figure 19.22 Roles for Actors in HIGH_SALARY

Roles of Highest Paid Performers

Obs	Name	Salary	Play	Role
1	Rudelich, Herbert	35000	The Glass Menagerie	Jim O'Connor
2	Rudelich, Herbert	35000	The Dear Departed	Henry Slater
3	Vincent, Martina	35000	No Exit	Estelle
4	Vincent, Martina	35000	Happy Days	Winnie
5	Vincent, Martina	35000	The Dear Departed	Mrs. Jordan
6	Harbinger, Nicholas	33900	No Exit	Garcin
7	Harbinger, Nicholas	33900	Happy Days	Willie
8	Harbinger, Nicholas	33900	The Dear Departed	Ben Jordan
9	Phillipon, Marie-Odile	29750	No Exit	Inez
10	Phillipon, Marie-Odile	29750	The Glass Menagerie	Laura Wingfield

Match-Merging Data Sets with the Same Variables

You can match-merge data sets that contain the same variables (variables with the same name) by using the RENAME= data set option, just as you would when performing a one-to-one merge (see “Performing a One-to-One Merge on Data Sets with the Same Variables” on page 304).

If you do not use the RENAME= option and a variable exists in more than one data set, then the value of that variable in the last data set that is read is the value that goes into the new data set.

Match-Merging Data Sets That Lack a Common Variable

You can name any number of data sets in the MERGE statement. However, if you are match-merging the data sets, then you must be sure they all have a common variable and are sorted by that variable. If the data sets do not have a common variable, then you might be able to use another data set that has variables common to the original data sets to merge them.

For example, consider the data sets that are used in the match-merge examples. The following table displays the names of the data sets and the names of the variables in each data set.

Table 19.2   Data Sets and Variables That Are Used in Match-Merge Examples

Data Set	Variables
COMPANY	Name, Age, Gender
FINANCE	Name, IdNumber, Salary
REPERTORY	Play, Role, IdNumber

These data sets do not share a common variable. However, COMPANY and FINANCE share the variable Name. Similarly, FINANCE and REPERTORY share the variable IdNumber. Therefore, as the next program shows, you can merge the data sets into one with two separate DATA steps. As usual, you must sort the data sets by the appropriate BY variable. (REPERTORY is already sorted by IdNumber.)

```
   /* Sort FINANCE and COMPANY by Name */
 proc sort data=finance;
   by Name;
run;

proc sort data=company;
   by Name;
run;

   /* Merge COMPANY and FINANCE into a */
   /* temporary data set.              */
data temp;
   merge company finance;
   by Name;
run;

proc sort data=temp;
   by IdNumber;
run;

   /* Merge the temporary data set with REPERTORY */
data all;
   merge temp repertory;
   by IdNumber;
```

```
run;

proc print data=all;
   title 'Little Theater Complete Casting Information';
run;
```

In order to merge the three data sets, this program performs the following tasks:

- sorts FINANCE and COMPANY by Name
- merges COMPANY and FINANCE into a temporary data set, TEMP
- sorts TEMP by IdNumber
- merges TEMP and REPERTORY by IdNumber

The following output displays the resulting data set, ALL.

Figure 19.23 Match-Merging Data Sets That Lack a Common Variable

Little Theater Complete Casting Information

Obs	Name	Age	Gender	IdNumber	Salary	Play	Role
1	Morrison, Michael	32	M		.		
2	Rudelich, Herbert	39	M	029-46-9261	35000	The Glass Menagerie	Jim O'Connor
3	Rudelich, Herbert	39	M	029-46-9261	35000	The Dear Departed	Henry Slater
4	Vincent, Martina	34	F	074-53-9892	35000	No Exit	Estelle
5	Vincent, Martina	34	F	074-53-9892	35000	Happy Days	Winnie
6	Vincent, Martina	34	F	074-53-9892	35000	The Dear Departed	Mrs. Jordan
7	Benito, Gisela	32	F	228-88-9649	28000	The Glass Menagerie	Amanda Wingfield
8	Benito, Gisela	32	F	228-88-9649	28000	The Dear Departed	Mrs. Slater
9	Sirignano, Emily	12	F	442-21-8075	5000	The Dear Departed	Victoria Slater
10	Harbinger, Nicholas	36	M	446-93-2122	33900	No Exit	Garcin
11	Harbinger, Nicholas	36	M	446-93-2122	33900	Happy Days	Willie
12	Harbinger, Nicholas	36	M	446-93-2122	33900	The Dear Departed	Ben Jordan
13	Phillipon, Marie-Odile	28	F	776-84-5391	29750	No Exit	Inez
14	Phillipon, Marie-Odile	28	F	776-84-5391	29750	The Glass Menagerie	Laura Wingfield
15	Gunter, Thomas	27	M	929-75-0218	27500	No Exit	Valet
16	Gunter, Thomas	27	M	929-75-0218	27500	The Glass Menagerie	Tom Wingfield
17	Gunter, Thomas	27	M	929-75-0218	27500	The Dear Departed	Abel Merryweather

Choosing between One-to-One Merging and Match-Merging

Comparing Match-Merge Methods

Use one-to-one merging when you want to combine one observation from each data set, but it is not important to match observations. For example, when merging an observation that contains a student's name, year, and major with an observation that contains a date, time, and location for a conference, it does not matter which student gets which time slot. Therefore, a one-to-one merge is appropriate.

In cases where you must merge certain observations, use a match-merge. For example, when merging employee information from two different data sets, it is crucial that you merge observations that relate to the same employee. Therefore, you must use a match-merge.

Sometimes you might want to merge by a particular variable, and your data is arranged in such a way that you can see that a one-to-one merge will work. The next example illustrates a case when you could use a one-to-one merge for matching observations because you are certain that your data is ordered correctly. However, as a subsequent example shows, it is risky to use a one-to-one merge in such situations.

Input SAS Data Set for Examples

Consider the COMPANY2 data set. Each observation in this data set corresponds to an observation with the same value of Name in FINANCE. The program that follows creates and displays the COMPANY2 data set. It also displays the FINANCE data set for comparison.

```
data company2;
   input name $ 1-25 age 27-28 gender $ 30;
   datalines;
Benito, Gisela            32 F
Gunter, Thomas            27 M
Harbinger, Nicholas       36 M
Phillipon, Marie-Odile    28 F
Rudelich, Herbert         39 M
Sirignano, Emily          12 F
Vincent, Martina          34 F
;
run;

proc print data=company2;
   title 'Little Theater Company Roster';
run;
```

```
proc print data=finance;
   title 'Little Theater Employee Information';
run;
```

The following output displays the two data sets.

Figure 19.24 The COMPANY2 Data Set

Little Theater Company Roster

Obs	name	age	gender
1	Benito, Gisela	32	F
2	Gunter, Thomas	27	M
3	Harbinger, Nicholas	36	M
4	Phillipon, Marie-Odile	28	F
5	Rudelich, Herbert	39	M
6	Sirignano, Emily	12	F
7	Vincent, Martina	34	F

Figure 19.25 The FINANCE Data Set

Little Theater Employee Information

Obs	IdNumber	Name	Salary
1	228-88-9649	Benito, Gisela	28000
2	929-75-0218	Gunter, Thomas	27500
3	446-93-2122	Harbinger, Nicholas	33900
4	776-84-5391	Phillipon, Marie-Odile	29750
5	029-46-9261	Rudelich, Herbert	35000
6	442-21-8075	Sirignano, Emily	5000
7	074-53-9892	Vincent, Martina	35000

When to Use a One-to-One Merge

The following program shows that because both data sets are sorted by Name and because each observation in one data set has a corresponding observation in the other data set, a one-to-one merge has the same result as merging by Name.

```
   /* One-to-one merge */
data one_to_one;
   merge company2 finance;
```

```
run;

proc print data=one_to_one;
   title 'Using a One-to-One Merge to Combine';
   title2 'COMPANY2 and FINANCE';
run;

   /* Match-merge */
data match;
   merge company2 finance;
   by name;
run;

proc print data=match;
   title 'Using a Match-Merge to Combine';
   title2 'COMPANY2 and FINANCE';
run;
```

The following output displays the results of the two merges. You can see that they are identical.

Figure 19.26 Using a One-to-One Merge to Combine Observations When Observations Correspond

Using a One-to-One Merge to Combine
COMPANY2 and FINANCE

Obs	name	age	gender	IdNumber	Salary
1	Benito, Gisela	32	F	228-88-9649	28000
2	Gunter, Thomas	27	M	929-75-0218	27500
3	Harbinger, Nicholas	36	M	446-93-2122	33900
4	Phillipon, Marie-Odile	28	F	776-84-5391	29750
5	Rudelich, Herbert	39	M	029-46-9261	35000
6	Sirignano, Emily	12	F	442-21-8075	5000
7	Vincent, Martina	34	F	074-53-9892	35000

Figure 19.27 Using a Match-Merge to Combine Observations When Observations Correspond

Using a Match-Merge to Combine COMPANY2 and FINANCE

Obs	name	age	gender	IdNumber	Salary
1	Benito, Gisela	32	F	228-88-9649	28000
2	Gunter, Thomas	27	M	929-75-0218	27500
3	Harbinger, Nicholas	36	M	446-93-2122	33900
4	Phillipon, Marie-Odile	28	F	776-84-5391	29750
5	Rudelich, Herbert	39	M	029-46-9261	35000
6	Sirignano, Emily	12	F	442-21-8075	5000
7	Vincent, Martina	34	F	074-53-9892	35000

Even though the resulting data sets are identical, it is not wise to use a one-to-one merge when it is essential to merge a particular observation from one data set with a particular observation from another data set.

When to Use a Match-Merge

In the previous example, you can easily determine that the data sets contain the same values for Name and that the values appear in the same order. However, if the data sets contained hundreds of observations, then it would be difficult to determine that all the values match. If the observations do not match, then serious problems can occur. The next example illustrates why you should not use a one-to-one merge for matching observations.

Consider the original data set, COMPANY, which contains an observation for Michael Morrison (see Figure 19.9 on page 310). The FINANCE data set has no corresponding observation. If you do not realize this difference and try to use the following program to perform a one-to-one merge with FINANCE, then several problems could appear.

```
data badmerge;
   merge company finance;
run;

proc print data=badmerge;
   title 'Using a One-to-One Merge Instead of a Match-Merge';
run;
```

The following output shows the potential problems.

Figure 19.28 One-to-One Merge with Unequal Numbers of Observations in Each Data Set

Using a One-to-One Merge Instead of a Match-Merge

Obs	Name	Age	Gender	IdNumber	Salary
1	Benito, Gisela	32	F	228-88-9649	28000
2	Gunter, Thomas	27	M	929-75-0218	27500
3	Harbinger, Nicholas	36	M	446-93-2122	33900
4	Phillipon, Marie-Odile	32	M	776-84-5391	29750
5	Rudelich, Herbert	28	F	029-46-9261	35000
6	Sirignano, Emily	39	M	442-21-8075	5000
7	Vincent, Martina	12	F	074-53-9892	35000
8	Vincent, Martina	34	F		.

The first three observations merge correctly. However, FINANCE does not have an observation for Michael Morrison. A one-to-one merge makes no attempt to match parts of the observations from the different data sets. It simply combines observations based on their positions in the data sets that you name in the MERGE statement. Therefore, the fourth observation in BADMERGE combines the fourth observation in COMPANY (Michael's name, age, and gender) with the fourth observation in FINANCE (Marie-Odile's name, employee ID number, and salary). As SAS combines the observations, Marie-Odile's name overwrites Michael's. After writing this observation to the new data set, SAS processes the next observation in each data set. These observations are similarly mismatched.

This type of mismatch continues until the seventh observation when the MERGE statement exhausts the observations in the smaller data set, FINANCE. After writing the seventh observation to the new data set, SAS begins the next iteration of the DATA step. Because SAS has read all observations in FINANCE, it sets the values for variables from that data set to missing in the program data vector. Then it reads the values for Name, Age, and Gender from COMPANY and writes the contents of the program data vector to the new data set. Therefore, the last observation has the same value for NAME as the previous observation and contains missing values for IdNumber and Salary.

These missing values and the duplication of the value for Name might make you suspect that the observations did not merge as you intended them to. However, if instead of being an additional observation, the observation for Michael Morrison replaced another observation in COMPANY2, then no observations would have missing values, and the problem would not be as easy to detect. Therefore, you are safer using a match-merge in situations that call for it even if you think the data is arranged so that a one-to-one merge has the same results.

Summary

Statements

MERGE *SAS-data-set-list*;
BY *variable-list*;

The MERGE statement reads observations in multiple SAS data sets and combines them into one observation in one new SAS data set. *SAS-data-set-list* is a list of the SAS data sets to merge. The list can contain any number of data sets.

Variable-list is the name of one or more variables by which to merge the data sets. If you use a BY statement, then the data sets must be sorted by the same BY variables before you can merge them. If you do not use a BY statement, then SAS merges observations based on their positions in the original data sets.

Learning More

Indexes

If a data set has an index on the variable or variables named in the BY statement that accompanies the MERGE statement, then you do not need to sort that data set. For more information, see "Understanding SAS Indexes" in *SAS Language Reference: Concepts*.

SAS date and time formats and informats

The examples in this section read Time as a character variable, and they read Date with a SAS date informat. You could read Time using special SAS time informats. For more information about SAS date and time informats, see "Working with SAS Dates and Times" in *SAS Language Reference: Concepts*.

20

Updating SAS Data Sets

Introduction to Updating SAS Data Sets

Purpose

Updating replaces the values of variables in one data set with nonmissing values from another data set. In this section, you will learn about the following concepts:

- difference between master data sets and transaction data sets
- using the UPDATE statement
- how to choose between updating and merging

Prerequisites

Before using this section, you should understand the concepts that are presented in the following sections:

- Chapter 4, “Starting with Raw Data: The Basics,” on page 51
- Chapter 6, “Starting with SAS Data Sets,” on page 93
- Chapter 19, “Merging SAS Data Sets,” on page 299

Understanding the UPDATE Statement

When you update, you work with two SAS data sets. The data set that contains the original information is the master data set. The data set that contains the new information is the transaction data set. Many applications, such as maintaining mailing lists and inventories, call for periodic updates of information.

In a DATA step, the UPDATE statement reads observations from the transaction data set and updates corresponding observations (observations with the same value of all BY variables) from the master data set. All nonmissing values for variables in the transaction data set replace the corresponding values that are read from the master data set. SAS writes the modified observations to the data set that you name in the DATA statement without modifying either the master or the transaction data set.

The general form of the UPDATE statement follows:

UPDATE *master-SAS-data-set transaction-SAS-data-set*;

BY *identifier-list*;

master-SAS-data-set
: specifies the SAS data set that contains information that you want to update.

transaction-SAS-data-set
: specifies the SAS data set that contains information for updating the master data set.

identifier-list
: specifies the list of BY variables by which you identify corresponding observations.

If the master data set contains an observation that does not correspond to an observation in the transaction data set, then the DATA step writes that observation to the new data set without modification. An observation from the transaction data set that does not correspond to any observation in the master data set becomes the basis for a new observation. The new observation can be modified by other observations from the transaction data set before it is written to the new data set.

Understanding How to Select BY Variables

The master data set and the transaction data set must be sorted by the same variable or variables that you specify in the BY statement. Select a variable that meets these criteria:

- The value of the variable is unique for each observation in the master data set. If you use more than one BY variable, no two observations in the master data set should have the same values for all BY variables.
- The variable or variables never need to be updated.

Some examples of variables that you can use in the BY statement include employee or student identification numbers, stock numbers, and the names of objects in an inventory.

If you are updating a data set, you probably do not want duplicate values of BY variables in the master data set. For example, if you update by Name, each observation in the master data set should have a unique value of Name. If you update by Name and Age, two or more observations can have the same value for either Name or Age but should not have the same values for both. SAS warns you if it finds duplicates but proceeds with the update. It applies all transactions only to the first observation in the BY group in the master data set.

Updating a Data Set

In this example, the circulation department of a magazine maintains a mailing list that contains tens of thousands of names. Each issue of the magazine contains a form for readers to fill out when they change their names or addresses. To simplify the maintenance job, the form requests that readers send only new information. New subscribers can start a subscription by completing the entire form. When a form is received, a data entry operator enters the information about the form into a raw data file. The mailing list is updated once per month from the raw data file.

The mailing list includes these variables for each subscriber:

SubscriberId
: specifies a unique number that is assigned to the subscriber at the time the subscription begins. A subscriber's SubscriberId never changes.

Name
: specifies the subscriber's name. The last name appears first, followed by a comma and the first name.

StreetAddress
: specifies the subscriber's street address.

City
: specifies the subscriber's city.

StateProv
: specifies the subscriber's state or province. This variable is missing for addresses outside the United States and Canada.

PostalCode
: specifies the subscriber's postal code (ZIP code for addresses in the United States).

Country
: specifies the subscriber's country.

The following program creates and displays the first part of this data set. The raw data are already sorted by SubscriberId.

```
data mail_list;
   input SubscriberId 1-8 Name $ 9-27 StreetAddress $ 28-47 City $ 48-62
         StateProv $ 63-64 PostalCode $ 67-73 Country $ ;
   datalines;
1001    Ericson, Jane      111 Clancey Court   Chapel Hill    NC  27514   USA
1002    Dix, Martin        4 Shepherd St.      Vancouver      BC  V6C 3E8 Canada
1003    Gabrielli, Theresa Via Pisanelli, 25   Roma               00196   Italy
1004    Clayton, Aria      14 Bridge St.       San Francisco  CA  94124   USA
1005    Archuleta, Ruby    Box 108             Milagro        NM  87429   USA
1006    Misiewicz, Jeremy  43-C Lakeview Apts. Madison        WI  53704   USA
1007    Ahmadi, Hafez      52 Rue Marston      Paris              75019   France
1008    Jacobson, Becky    1 Lincoln St.       Tallahassee    FL  32312   USA
1009    An, Ing            95 Willow Dr.       Toronto        ON  M5J 2T3 Canada
1010    Slater, Emily      1009 Cherry St.     York           PA  17407   USA
;
run;

proc print data=mail_list;
   title 'Magazine Master Mailing List';
run;
```

The following output displays the master MAIL_LIST data set.

Figure 20.1 Magazine Master Mailing List

Magazine Master Mailing List

Obs	SubscriberId	Name	StreetAddress	City	StateProv	PostalCode	Country
1	1001	Ericson, Jane	111 Clancey Court	Chapel Hill	NC	27514	USA
2	1002	Dix, Martin	4 Shepherd St.	Vancouver	BC	V6C 3E8	Canada
3	1003	Gabrielli, Theresa	Via Pisanelli, 25	Roma		00196	Italy
4	1004	Clayton, Aria	14 Bridge St.	San Francisco	CA	94124	USA
5	1005	Archuleta, Ruby	Box 108	Milagro	NM	87429	USA
6	1006	Misiewicz, Jeremy	43-C Lakeview Apts.	Madison	WI	53704	USA
7	1007	Ahmadi, Hafez	52 Rue Marston	Paris		75019	France
8	1008	Jacobson, Becky	1 Lincoln St.	Tallahassee	FL	32312	USA
9	1009	An, Ing	95 Willow Dr.	Toronto	ON	M5J 2T3	Canada
10	1010	Slater, Emily	1009 Cherry St.	York	PA	17407	USA

This month the information that follows is received for updating the mailing list:

- Martin Dix changed his name to Martin Dix-Rosen.
- Jane Ericson's postal code changed.
- Jeremy Misiewicz moved to a new street address. His city, state, and postal code remain the same.
- Ing An moved from Toronto, Ontario, to Calgary, Alberta.
- Martin Dix-Rosen, shortly after changing his name, moved from Vancouver, British Columbia, to Seattle, Washington.
- Two new subscribers joined the list. They are given SubscriberID numbers 1011 and 1012.

Each change is entered into the raw data file as soon as it is received. In each case, only the customer's SubscriberId and the new information are entered. The raw data file looks like this:

```
1002    Dix-Rosen, Martin
1001                                                              27516
1006                      932 Webster St.
1009                      2540 Pleasant St.   Calgary        AB   T2P 4H2
1011    Mitchell, Wayne   28 Morningside Dr.  New York       NY   10017   USA
1002                      P.O. Box 1850       Seattle        WA   98101   USA
1012    Stavros, Gloria   212 Northampton Rd. South Hadley   MA   01075   USA
```

The data is in fixed columns, matching the INPUT statement that created MAIL_LIST.

First, you must transform the raw data into a SAS data set and sort that data set by SubscriberId so that you can use it to update the master list.

```
data mail_trans;
   infile datalines missover;
   input SubscriberId 1-8 Name $ 9-27 StreetAddress $ 28-47 City $ 48-62
         StateProv $ 63-64 PostalCode $ 67-73 Country $ 75-80;
   datalines;
1002    Dix-Rosen, Martin
1001                                                              27516
1006                      932 Webster St.
1009                      2540 Pleasant St.   Calgary        AB   T2P 4H2
1011    Mitchell, Wayne   28 Morningside Dr.  New York       NY   10017   USA
1002                      P.O. Box 1850       Seattle        WA   98101   USA
1012    Stavros, Gloria   212 Northampton Rd. South Hadley   MA   01075   USA
;
run;

proc sort data=mail_trans;
   by SubscriberId;
run;

proc print data=mail_trans;
   title 'Magazine Mailing List Changes';
   title2 '(for current month)';
run;
```

Note the MISSOVER option in the INFILE statement. The MISSOVER option prevents the INPUT statement from going to a new line to search for values for variables that have not received values. Instead, any variables that have not received values are set to missing. For example, when the first record is read, the end of the record is encountered before any value has been assigned to the Country variable. Instead of going to the next record to search for a value for Country, the Country variable is assigned a missing value. For more information about the MISSOVER option, see "Methods of Control: Your Options" on page 87.

The following output displays the sorted MAIL_TRANS transaction data set, which lists the magazine changes for the current month.

Figure 20.2 Magazine Mailing List Changes: Sorted

Magazine Mailing List Changes
(for current month)

Obs	SubscriberId	Name	StreetAddress	City	StateProv	PostalCode	Country
1	1001					27516	
2	1002	Dix-Rosen, Martin					
3	1002		P.O. Box 1850	Seattle	WA	98101	USA
4	1006		932 Webster St.				
5	1009		2540 Pleasant St.	Calgary	AB	T2P 4H2	
6	1011	Mitchell, Wayne	28 Morningside Dr.	New York	NY	10017	USA
7	1012	Stavros, Gloria	212 Northampton Rd.	South Hadley	MA	01075	USA

Now that the new data are in a sorted SAS data set, the following program updates the mailing list.

```
data mail_newlist;
   update mail_list mail_trans;
   by SubscriberId;
run;

proc print data=mail_newlist;
   title 'Magazine Mailing List';
   title2 '(updated for current month)';
run;
```

The following output displays the MAIL_NEWLIST data set.

Figure 20.3 *The Updated Mailing List*

Magazine Mailing List
(updated for current month)

Obs	SubscriberId	Name	StreetAddress	City	StateProv	PostalCode	Country
1	1001	Ericson, Jane	111 Clancey Court	Chapel Hill	NC	27516	USA
2	1002	Dix-Rosen, Martin	P.O. Box 1850	Seattle	WA	98101	USA
3	1003	Gabrielli, Theresa	Via Pisanelli, 25	Roma		00196	Italy
4	1004	Clayton, Aria	14 Bridge St.	San Francisco	CA	94124	USA
5	1005	Archuleta, Ruby	Box 108	Milagro	NM	87429	USA
6	1006	Misiewicz, Jeremy	932 Webster St.	Madison	WI	53704	USA
7	1007	Ahmadi, Hafez	52 Rue Marston	Paris		75019	France
8	1008	Jacobson, Becky	1 Lincoln St.	Tallahassee	FL	32312	USA
9	1009	An, Ing	2540 Pleasant St.	Calgary	AB	T2P 4H2	Canada
10	1010	Slater, Emily	1009 Cherry St.	York	PA	17407	USA
11	1011	Mitchell, Wayne	28 Morningside Dr.	New York	NY	10017	USA
12	1012	Stavros, Gloria	212 Northampton Rd.	South Hadley	MA	01075	USA

The data for subscriber 1002, who has two update transactions (see the MAIL_TRANS data set), is used below to show what happens when you update an observation in the master data set with corresponding observations from the transaction data set.

1 Before executing the DATA step, SAS reads the descriptor portion of each data set that is named in the UPDATE statement and. By default, SAS then creates a program data vector that contains all of the variables from all data sets. As the following figure shows, SAS sets the value of each variable to missing. (Use the DROP= or KEEP= data set option to exclude one or more variables.)

Figure 20.4 *Program Data Vector before Execution of the DATA Step*

SubscriberId	Name	Street Address	City	StateProv	PostalCode	Country
.						

2 Next, SAS reads the first observation from the master data set and copies it into the program data vector, as the following figure shows.

Figure 20.5 *Program Data Vector After Reading the First Observation from the Master Data Set*

SubscriberId	Name	Street Address	City	StateProv	PostalCode	Country
1002	Dix, Martin	4 Shepherd St.	Vancouver	BC	V6C 3E8	Canada

3 SAS applies the first transaction by copying all nonmissing values (the value of Name) from the first observation in this BY group (ID=1002) into the program data vector, as the following figure shows.

Figure 20.6 Program Data Vector After Applying the First Transaction

SubscriberId	Name	Street Address	City	StateProv	PostalCode	Country
1002	Dix-Rosen, Martin	4 Shepherd St.	Vancouver	BC	V6C 3E8	Canada

4 After completing this transaction, SAS looks for another observation in the same BY group in the transaction data set. If it finds a second observation with the same value for ID, then it also applies the second transaction (new values for StreetAddress, City, StateProv, PostalCode, and Country). Now the observation contains the new values from both transactions, as the following figure shows.

Figure 20.7 Program Data Vector After Applying the Second Transaction

SubscriberId	Name	Street Address	City	StateProv	Postal Code	Country
1002	Dix-Rosen, Martin	P.O. Box 1850	Seattle	WA	98101	USA

5 After completing the second transaction, SAS looks for a third observation in the same BY group. Because no such observation exists, it writes the observation in its current form to the new data set and sets the values in the program data vector to missing.

As the DATA step iterates, the UPDATE statement continues processing observations in this way until it reaches the end of the master and transaction data sets. The two observations in the transaction data set that describe new subscribers (and therefore have no corresponding observation in the master data set) become observations in the new data set.

Remember that if there are duplicate observations in the master data set, all matching observations in the transaction data set are applied only to the first of the duplicate observations in the master data set.

Updating with Incremental Values

Some applications do not update a data set by overwriting values in the master data set with new values from a transaction data set. Instead, they update a variable by mathematically manipulating its value based on the value of a variable in the transaction data set.

In this example, a bookstore uses SAS to keep track of weekly sales and year-to-date sales. The program that follows creates, sorts by Title, and displays the data set, YEAR_SALES, which contains the year-to-date information.

```
data year_sales;
   input Title $ 1-25 Author $ 27-50 Sales;
   datalines;
The Milagro Beanfield War Nichols, John            303
The Stranger              Camus, Albert            150
Always Coming Home        LeGuin, Ursula            79
Falling through Space     Gilchrist, Ellen         128
Don Quixote               Cervantes, Miguel de      87
The Handmaid's Tale       Atwood, Margaret          64
;
```

```
proc sort data=year_sales;
   by title;
run;

proc print data=year_sales;
   title 'Bookstore Sales, Year-to-Date';
   title2 'By Title';
run;
```

The following output displays the YEAR_SALES data set.

Figure 20.8 The YEAR_SALES Data Set, Sorted by Title

Bookstore Sales, Year-to-Date
By Title

Obs	Title	Author	Sales
1	Always Coming Home	LeGuin, Ursula	79
2	Don Quixote	Cervantes, Miguel de	87
3	Falling through Space	Gilchrist, Ellen	128
4	The Handmaid's Tale	Atwood, Margaret	64
5	The Milagro Beanfield War	Nichols, John	303
6	The Stranger	Camus, Albert	150

Every Saturday a SAS data set is created containing information about all the books that were sold during the past week. The following program creates, sorts by Title, and displays the data set WEEK_SALES, which contains the current week's information.

```
data week_sales;
   input Title $ 1-25 Author $ 27-50 Sales;
   datalines;
The Milagro Beanfield War Nichols, John           32
The Stranger              Camus, Albert           17
Always Coming Home        LeGuin, Ursula          10
Falling through Space     Gilchrist, Ellen        12
The Accidental Tourist    Tyler, Anne             15
The Handmaid's Tale       Atwood, Margaret        8
;
proc sort data=week_sales;
   by title;
run;

proc print data=week_sales;
   title 'Bookstore Sales for Current Week';
   title2 'By Title';
run;
```

The following output displays the WEEK_SALES data set, which contains the same variables as the YEAR_SALES data set, but the variable Sales represents sales for only one week.

Figure 20.9 The WEEK_SALES Data Set, Sorted by Title

Bookstore Sales for Current Week
By Title

Obs	Title	Author	Sales
1	Always Coming Home	LeGuin, Ursula	10
2	Falling through Space	Gilchrist, Ellen	12
3	The Accidental Tourist	Tyler, Anne	15
4	The Handmaid's Tale	Atwood, Margaret	8
5	The Milagro Beanfield War	Nichols, John	32
6	The Stranger	Camus, Albert	17

Note: If the transaction data set is updating only titles that are already in YEAR_SALES, it does not need to contain the variable Author. However, because this variable is there, the transaction data set can be used to add complete observations to the master data set.

The program that follows uses the weekly information to update the YEAR_SALES data set and displays the new data set.

```
data total_sales;
   drop NewSales;  1
   update year_sales week_sales (rename=(Sales=NewSales));  2
   by Title;
   sales=sum(Sales,NewSales);  3
run;

proc print data=total_sales;
   title 'Updated Year-to-Date Sales';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 The program drops the variable NewSales because it is not needed in the new data set.

2 The RENAME= data set option in the UPDATE statement changes the name of the variable Sales in the transaction data set (WEEK_SALES) to NewSales. As a result, these values do not replace the value of Sales that are read from the master data set (YEAR_SALES).

3 The Sales value that is in the updated data set (TOTAL_SALES) is the sum of the year-to-date sales and the weekly sales.

The following output displays the TOTAL_SALES data set. In addition to updating sales information for the titles already in the master data set, the UPDATE statement has added a new title, The Accidental Tourist.

Figure 20.10 Updated Year-to-Date Sales with Weekly Sales

Updated Year-to-Date Sales

Obs	Title	Author	Sales
1	Always Coming Home	LeGuin, Ursula	89
2	Don Quixote	Cervantes, Miguel de	87
3	Falling through Space	Gilchrist, Ellen	140
4	The Accidental Tourist	Tyler, Anne	15
5	The Handmaid's Tale	Atwood, Margaret	72
6	The Milagro Beanfield War	Nichols, John	335
7	The Stranger	Camus, Albert	167

Understanding the Differences between Updating and Merging

General Comparisons between Updating and Merging

The MERGE statement and the UPDATE statement both match observations from two SAS data sets. However, the two statements differ significantly. It is important to distinguish between the two processes and to choose the one that is appropriate for your application.

The most straightforward differences are as follows:

- The UPDATE statement uses only two data sets. The number of data sets that the MERGE statement can use is limited only by machine-dependent factors such as memory and disk space.
- A BY statement must accompany an UPDATE statement. The MERGE statement performs a one-to-one merge if no BY statement follows it.
- The two statements also process observations differently when a data set contains missing values or multiple observations in a BY group.

To illustrate the differences, compare the results of updating and merging the SAS data set MAIL_LIST and the data set MAIL_TRANS. You have already seen the results of updating in the example that created the MAIL_NEWLIST data set. That output is displayed again for easy comparison.

The following output displays the MAIL_NEWLIST data set.

Figure 20.11 The Updated Magazine Mailing List

Magazine Mailing List
(updated for current month)

Obs	SubscriberId	Name	StreetAddress	City	StateProv	PostalCode	Country
1	1001	Ericson, Jane	111 Clancey Court	Chapel Hill	NC	27516	USA
2	1002	Dix-Rosen, Martin	P.O. Box 1850	Seattle	WA	98101	USA
3	1003	Gabrielli, Theresa	Via Pisanelli, 25	Roma		00196	Italy
4	1004	Clayton, Aria	14 Bridge St.	San Francisco	CA	94124	USA
5	1005	Archuleta, Ruby	Box 108	Milagro	NM	87429	USA
6	1006	Misiewicz, Jeremy	932 Webster St.	Madison	WI	53704	USA
7	1007	Ahmadi, Hafez	52 Rue Marston	Paris		75019	France
8	1008	Jacobson, Becky	1 Lincoln St.	Tallahassee	FL	32312	USA
9	1009	An, Ing	2540 Pleasant St.	Calgary	AB	T2P 4H2	Canada
10	1010	Slater, Emily	1009 Cherry St.	York	PA	17407	USA
11	1011	Mitchell, Wayne	28 Morningside Dr.	New York	NY	10017	USA
12	1012	Stavros, Gloria	212 Northampton Rd.	South Hadley	MA	01075	USA

In contrast, the following program merges the two data sets.

```
data mail_merged;
   merge mail_list mail_trans;
   by SubscriberId;
run;

proc print data=mail_merged;
   title 'Magazine Mailing List';
run;
```

The following output displays the MAIL_MERGED data set.

Figure 20.12 Magazine Mailing List: Merging the Master and Transaction Data Sets

Magazine Mailing List

Obs	SubscriberId	Name	StreetAddress	City	StateProv	PostalCode	Country
1	1001					27516	
2	1002	Dix-Rosen, Martin					
3	1002		P.O. Box 1850	Seattle	WA	98101	USA
4	1003	Gabrielli, Theresa	Via Pisanelli, 25	Roma		00196	Italy
5	1004	Clayton, Aria	14 Bridge St.	San Francisco	CA	94124	USA
6	1005	Archuleta, Ruby	Box 108	Milagro	NM	87429	USA
7	1006		932 Webster St.				
8	1007	Ahmadi, Hafez	52 Rue Marston	Paris		75019	France
9	1008	Jacobson, Becky	1 Lincoln St.	Tallahassee	FL	32312	USA
10	1009		2540 Pleasant St.	Calgary	AB	T2P 4H2	
11	1010	Slater, Emily	1009 Cherry St.	York	PA	17407	USA
12	1011	Mitchell, Wayne	28 Morningside Dr.	New York	NY	10017	USA
13	1012	Stavros, Gloria	212 Northampton Rd.	South Hadley	MA	01075	USA

The MERGE statement produces a data set that contains 13 observations, whereas UPDATE produces a data set containing 12 observations. In addition, merging the data sets results in several missing values, whereas updating does not. Obviously, using the wrong statement can result in incorrect data. The differences between the merged and updated data sets result from the ways the two statements handle missing values and multiple observations in a BY group.

How the UPDATE and MERGE Statements Process Missing Values Differently

During an update, if a value for a variable is missing in the transaction data set, SAS uses the value from the master data set when it writes the observation to the new data set. When merging the same observations, SAS overwrites the value in the program data vector with the missing value. For example, the following observation exists in data set MAILING_MASTER.

```
1001    ERICSON, JANE      111 CLANCEY COURT   CHAPEL HILL    NC  27514
```

The following corresponding observation exists in MAILING_TRANS.

```
1001                                                              27516
```

Updating combines the two observations and creates the following observation:

```
1001    ERICSON, JANE      111 CLANCEY COURT   CHAPEL HILL    NC  27516
```

Merging combines the two observations and creates this observation:

```
1001                                                              27516
```

How the UPDATE and MERGE Statements Process Multiple Observations in a BY Group Differently

SAS does not write an updated observation to the new data set until it has applied all the transactions in a BY group. When merging data sets, SAS writes one new observation for each observation in the data set with the largest number of observations in the BY group. For example, consider this observation from MAILING_MASTER:

```
1002    DIX, MARTIN        4 SHEPHERD ST.      NORWICH        VT  05055
```

Consider the corresponding observations from MAILING_TRANS:

```
1002    DIX-ROSEN, MARTIN
1002                       R.R. 2, BOX 1850    HANOVER        NH  03755
```

The UPDATE statement applies both transactions and combines these observations into a single one:

```
1002    DIX-ROSEN, MARTIN  R.R. 2, BOX 1850    HANOVER        NH  03755
```

The MERGE statement, on the other hand, first merges the observation from MAILING_MASTER with the first observation in the corresponding BY group in MAILING_TRANS. All values of variables from the observation in MAILING_TRANS are used, even if they are missing. Then SAS writes the observation to the new data set:

```
1002    DIX-ROSEN, MARTIN
```

Next, SAS looks for other observations in the same BY group in each data set. Because more observations are in the BY group in MAILING_TRANS, all the values in the program data vector are retained. SAS merges them with the second observation in the BY group from MAILING_TRANS and writes the result to the new data set:

```
1002                       R.R. 2, BOX 1850    HANOVER        NH  03755
```

Therefore, merging creates two observations for the new data set, whereas updating creates only one.

Handling Missing Values

If you update a master data set with a transaction data set, and the transaction data set contains missing values, then you can use the UPDATEMODE= option in the UPDATE statement to tell SAS how you want to handle the missing values. The UPDATEMODE= option specifies whether missing values in a transaction data set replace existing values in a master data set.

The syntax for using the UPDATEMODE= option with the UPDATE statement follows:

UPDATE *master-SAS-data-set transaction-SAS-data-set*
<UPDATEMODE=MISSINGCHECK | NOMISSINGCHECK>;

BY *by-variable*;

The MISSINGCHECK value in the UPDATEMODE= option prevents missing values in a transaction data set from replacing values in a master data set. This is the default. The NOMISSINGCHECK value in the UPDATEMODE= option enables missing values in a transaction data set to replace values in a master data set by preventing the check for missing data from being performed.

The following examples show how SAS handles missing values when you use the UPDATEMODE= option in the UPDATE statement.

The following example creates and sorts a master data set:

```
data inventory;
   input PartNumber $ Description $ Stock @17
   ReceivedDate date9. @27 Price;
   format  ReceivedDate date9.;
   datalines;
K89R seal   34  27jul2004 245.00
M4J7 sander 98  20jun2004 45.88
LK43 filter 121 19may2005 10.99
MN21 brace 43   10aug2005 27.87
BC85 clamp 80   16aug2005 9.55
NCF3 valve 198  20mar2005 24.50
;
run;

proc sort data=inventory;
   by PartNumber;
run;

proc print data=inventory;
   title 'Master Data Set';
   title2 'Tool Warehouse Inventory';
run;
```

The following output displays the master INVENTORY data set.

Figure 20.13 *The Master Inventory Data Set*

Master Data Set
Tool Warehouse Inventory

Obs	PartNumber	Description	Stock	ReceivedDate	Price
1	BC85	clamp	80	16AUG2005	9.55
2	K89R	seal	34	27JUL2004	245.00
3	LK43	filter	121	19MAY2005	10.99
4	M4J7	sander	98	20JUN2004	45.88
5	MN21	brace	43	10AUG2005	27.87
6	NCF3	valve	198	20MAR2005	24.50

The following example creates and sorts a transaction data set:

```
data add_inventory;
   input PartNumber $ 1-4 Description $ 6-11 Stock 13-15 @17 Price;
```

```
   datalines;
K89R seal        245.00
M4J7 sander 121   45.88
LK43 filter 34   10.99
MN21 brace        28.87
BC85 clamp  57   11.64
NCF3 valve  121     .
;
run;

proc sort data=add_inventory;
   by PartNumber;
run;

proc print data=add_inventory;
   title 'Transaction Data Set';
   title2 'Tool Warehouse Inventory';
run;
```

The following output displays the transaction ADD_INVENTORY data set.

Figure 20.14 The Transaction Data Set

Transaction Data Set
Tool Warehouse Inventory

Obs	PartNumber	Description	Stock	Price
1	BC85	clamp	57	11.64
2	K89R	seal	.	245.00
3	LK43	filter	34	10.99
4	M4J7	sander	121	45.88
5	MN21	brace	.	28.87
6	NCF3	valve	121	.

In the following example, SAS uses the NOMISSINGCHECK value of the UPDATEMODE= option in the UPDATE statement:

```
data new_inventory;
   update inventory add_inventory updatemode=nomissingcheck;
   by PartNumber;
   ReceivedDate=today();
run;

proc print data=new_inventory;
   title 'Updated Master Data Set';
   title2 'Tool Warehouse Inventory';
run;
```

The following output displays the results of using the NOMISSINGCHECK value. Observations 2 and 5 contain missing values for STOCK because the transaction data set contains missing values for STOCK for these items. Because checking for missing values in the transaction data set is not done, the original value in STOCK is replaced by missing values. In the sixth observation, the original value of PRICE is replaced by a missing value.

Figure 20.15 *Updated Master Data Set: UPDATEMODE=NOMISSINGCHECK*

Updated Master Data Set
Tool Warehouse Inventory

Obs	PartNumber	Description	Stock	ReceivedDate	Price
1	BC85	clamp	57	09APR2013	11.64
2	K89R	seal	.	09APR2013	245.00
3	LK43	filter	34	09APR2013	10.99
4	M4J7	sander	121	09APR2013	45.88
5	MN21	brace	.	09APR2013	28.87
6	NCF3	valve	121	09APR2013	.

The following output displays the results of using the MISSINGCHECK value. Note that no missing values are written to the updated master data set. The missing data in observations 2, 5, and 6 of the transaction data set is ignored, and the original data from the master data set remains.

Figure 20.16 *Updated Master Data Set: UPDATEMODE=MISSINGCHECK*

Updated Master Data Set
Tool Warehouse Inventory

Obs	PartNumber	Description	Stock	ReceivedDate	Price
1	BC85	clamp	57	09APR2013	11.64
2	K89R	seal	34	09APR2013	245.00
3	LK43	filter	34	09APR2013	10.99
4	M4J7	sander	121	09APR2013	45.88
5	MN21	brace	43	09APR2013	28.87
6	NCF3	valve	121	09APR2013	24.50

For more information, see "UPDATE Statement" in *SAS DATA Step Statements: Reference*.

Summary

Statements

UPDATE *master-SAS-data-set transaction-SAS-data-set*;
BY *identifier-list*;

The UPDATE statement replaces the values of variables in one SAS data set with nonmissing values from another SAS data set. *Master-SAS-data-set* is the SAS data set that contains information that you want to update. *Transaction-SAS-data-set* is the SAS data set that contains information for updating the master data set.

Identifier-list in the BY statement is the list of BY variables by which you identify corresponding observations.

Learning More

DATASETS procedure

When you update a data set, you create a new data set containing the updated information. Typically, you want to use PROC DATASETS to delete the old master data set and rename the new one so that you can use the same program the next time you update the information. For more information, see "Understanding the DATASETS Procedure" on page 726.

Indexes

If a data set has an index on the variable or variables named in the BY statement that accompanies the UPDATE statement, you do not need to sort that data set. For more information, see "Understanding SAS Indexes" in *SAS Language Reference: Concepts*.

MERGE statement

For more information, see Chapter 19, "Merging SAS Data Sets," on page 299.

21

Modifying SAS Data Sets

Introduction to Modifying SAS Data Sets

Purpose

Modifying changes observations directly in the original master file. It does not create a copy of the file. In this section, you will learn how to use the MODIFY statement in a DATA step to do the following:

- replace values in a data set
- replace values in a master data set with values from a transaction data set
- append observations to an existing SAS data set
- delete observations from an existing SAS data set

Prerequisites

Before continuing with this section, you should understand the concepts that are presented in the following sections:

- Chapter 4, “Starting with Raw Data: The Basics,” on page 51
- Chapter 6, “Starting with SAS Data Sets,” on page 93
- Chapter 19, “Merging SAS Data Sets,” on page 299
- Chapter 20, “Updating SAS Data Sets,” on page 329

Input SAS Data Set for Examples

This section looks at examples from an inventory tracking system that is used by a tool vendor. The examples use the SAS data set INVENTORY as input. The data set contains these variables:

PartNumber
: is a character variable that contains a unique value that identifies each item.

Description
: is a character variable that contains the text description of each item.

InStock
: is a numeric variable that contains a value that describes how many units of each tool the warehouse has in stock.

ReceivedDate
: is a numeric variable that contains the SAS date value that is the day for which InStock values are current.

Price
: is a numeric variable that contains the price of each item.

The following program creates and displays the INVENTORY_TOOL data set.

```
data inventory_tool;
   input PartNumber $ Description $ InStock @17
         ReceivedDate date9. @27 Price;
   format ReceivedDate date9.;
   datalines;
K89R seal   34  27jul2010 245.00
M4J7 sander 98  20jun2011 45.88
LK43 filter 121 19may2011 10.99
MN21 brace 43   10aug2012 27.87
BC85 clamp 80   16aug2012 9.55
NCF3 valve 198  20mar2012 24.50
KJ66 cutter 6   18jun2010 19.77
UYN7 rod  211   09sep2010 11.55
JD03 switch 383 09jan2013 13.99
BV1E timer 26   03aug2013 34.50
;
```

```
run;

proc print data=inventory_tool;
   title 'Tool Warehouse Inventory';
run;
```

The following output displays the INVENTORY_TOOL data set.

Figure 21.1 The INVENTORY_TOOL Data Set

Tool Warehouse Inventory

Obs	PartNumber	Description	InStock	ReceivedDate	Price
1	K89R	seal	34	27JUL2010	245.00
2	M4J7	sander	98	20JUN2011	45.88
3	LK43	filter	121	19MAY2011	10.99
4	MN21	brace	43	10AUG2012	27.87
5	BC85	clamp	80	16AUG2012	9.55
6	NCF3	valve	198	20MAR2012	24.50
7	KJ66	cutter	6	18JUN2010	19.77
8	UYN7	rod	211	09SEP2010	11.55
9	JD03	switch	383	09JAN2013	13.99
10	BV1E	timer	26	03AUG2013	34.50

Modifying a SAS Data Set: The Simplest Case

You can use the MODIFY statement to replace all values for a specific variable or variables in a data set. The syntax for using the MODIFY statement for this purpose is

MODIFY *SAS-data-set*;

In the following program, the price of each part in the inventory is increased by 15%. The new values for PRICE replace the old values on all records in the original INVENTORY_TOOL data set. The FORMAT statement in the print procedure writes the price of each item with two-digit decimal precision.

```
data inventory_tool;
   modify inventory_tool;
   price=price+(price*.15);
run;

proc print data=inventory_tool;
   title 'Tool Warehouse Inventory';
   title2 '(Price reflects 15% increase)';
```

```
      format price 8.2;
   run;
```

The following output displays the modified INVENTORY_TOOL data set.

Figure 21.2 *The INVENTORY_TOOL Data Set with Updated Prices*

Tool Warehouse Inventory
(Price reflects 15% increase)

Obs	PartNumber	Description	InStock	ReceivedDate	Price
1	K89R	seal	34	27JUL2010	281.75
2	M4J7	sander	98	20JUN2011	52.76
3	LK43	filter	121	19MAY2011	12.64
4	MN21	brace	43	10AUG2012	32.05
5	BC85	clamp	80	16AUG2012	10.98
6	NCF3	valve	198	20MAR2012	28.18
7	KJ66	cutter	6	18JUN2010	22.74
8	UYN7	rod	211	09SEP2010	13.28
9	JD03	switch	383	09JAN2013	16.09
10	BV1E	timer	26	03AUG2013	39.68

Modifying a Master Data Set with Observations from a Transaction Data Set

Understanding the MODIFY Statement

The MODIFY statement replaces data in a master data set with data from a transaction data set, and makes the changes in the original master data set. You can use a BY statement to match observations from the transaction data set with observations in the master data set. The syntax for using the MODIFY statement and the BY statement follows:

MODIFY *master-SAS-data-set transaction-SAS-data-set*;

BY *by-variable*;

Master-SAS-data-set specifies the SAS data set that you want to modify. *Transaction-SAS-data-set* specifies the SAS data set that provides the values for updating the master data set. *By-variable* specifies one or more variables by which you identify corresponding observations.

When you use a BY statement with the MODIFY statement, the DATA step uses dynamic WHERE processing to find observations in the master data set. Neither the master data set nor the transaction data set needs to be sorted. However, for large data sets, sorting the data before you modify it can enhance performance significantly.

Adding New Observations to the Master Data Set

You can use the MODIFY statement to add observations to an existing master data set. If the transaction data set contains an observation that does not match an observation in the master data set, then SAS enables you to write a new observation to the master data set if you use an explicit OUTPUT statement in your program. When you specify an explicit OUTPUT statement, you must also specify a REPLACE statement if you want to replace observations in place. All new observations append to the end of the master data set.

Checking for Program Errors

You can use the _IORC_ automatic variable for error checking in your DATA step program. The _IORC_ automatic variable contains the return code for each I/O operation that the MODIFY statement attempts to perform.

The best way to test the values of _IORC_ is with the mnemonic codes that are provided by the SYSRC autocall macro. Each mnemonic code describes one condition. The mnemonics provide an easy method for testing problems in a DATA step program. The following is a partial list of codes:

_DSENMR
: specifies that the transaction data set observation does not exist in the master data set (used only with MODIFY and BY statements). If consecutive observations with different BY values do not find a match in the master data set, then both of them return _DSENMR.

_DSEMTR
: specifies that multiple transaction data set observations with a given BY value do not exist in the master data set (used only with MODIFY and BY statements). If consecutive observations with the same BY values do not find a match in the master data set, then the first observation returns _DSENMR and the subsequent observations return _DSEMTR.

_DSENOM
: specifies that no matching observation was found.

_SOK
: specifies that the observation was located in the master data set and indicates that the MODIFY statement executed successfully.

The Program

The program in this section updates values in a master data set with values from a transaction data set. If a transaction does not exist in the master data set, then the program adds the transaction to the master data set.

In this example, a warehouse received a shipment of new items, and the INVENTORY_TOOL master data set must be modified to reflect the changes. The master data set contains a complete list of the inventory items. The transaction data set contains items that are on the master inventory as well as new inventory items.

The following program creates the ADD_INVENTORY transaction data set, which contains items for updating the master data set. The PartNumber variable contains the part number for the item and corresponds to PartNumber in the INVENTORY_TOOL data set. The Description variable names the item. The NewStock variable contains the number of each item in the current shipment. The NewPrice variable contains the new price of the item.

The program attempts to update the master data set INVENTORY_TOOL (see Figure 21.1 on page 349) according to the values in the ADD_INVENTORY transaction data set. The program uses the _IORC_ automatic variable to detect errors.

```
data inventory_tool;
   input PartNumber $ Description $ InStock @17
         ReceivedDate date9. @27 Price;
   format ReceivedDate date9.;
   datalines;
K89R seal   34  27jul2010 245.00
M4J7 sander 98  20jun2011 45.88
LK43 filter 121 19may2011 10.99
MN21 brace 43   10aug2012 27.87
BC85 clamp 80   16aug2012 9.55
NCF3 valve 198  20mar2012 24.50
KJ66 cutter 6   18jun2010 19.77
UYN7 rod  211   09sep2010 11.55
JD03 switch 383 09jan2013 13.99
BV1E timer 26   03aug2013 34.50
;
run;

data add_inventory;  1
   input PartNumber $ Description $ NewStock @16 NewPrice;
   datalines;
K89R seal   6  247.50
AA11 hammer 55 32.26
BB22 wrench 21 17.35
KJ66 cutter 10 24.50
CC33 socket 7  22.19
BV1E timer 30  36.50
;
run;

data inventory_tool;
   modify inventory_tool add_inventory;  2
```

```
      by PartNumber;
      select (_iorc_);  3
         /* The observation exists in the master data set. */
         when (%sysrc(_sok)) do;  4
            InStock=InStock+NewStock;
            ReceivedDate=today();
            Price=NewPrice;
            replace;  5
         end;
         /* The observation does not exist in the master data set. */
         when (%sysrc(_dsenmr)) do;  6
            InStock=NewStock;
            ReceivedDate=today();
            Price=NewPrice;
            output;  7
            _error_=0;
         end;
         otherwise do;  8
              put 'An unexpected I/O error has occurred.'/
                'Check you data and your program.';  8
            _error_=0;
            stop;
         end;
      end;
    run;

   proc print data=inventory_tool;
      title 'Tool Warehouse Inventory';
   run;
```

The following list corresponds to the numbered items in the preceding program:

1 The DATA statement creates the ADD_INVENTORY transaction data set.

2 The MODIFY statement loads the data from the INVENTORY_TOOL and ADD_INVENTORY data sets.

3 The _IORC_ automatic variable is used for error checking. The value of _IORC_ is a numeric return code that indicates the status of the most recent I/O operation.

4 The SYSRC autocall macro checks to see whether the value of _IORC_ is _SOK. If the value is _SOK, then an observation in the transaction data set matches an observation in the master data set.

5 The REPLACE statement updates the INVENTORY master data set by replacing the observation in the master data set with the observation from the transaction data set.

6 The SYSRC autocall macro checks to see whether the value of _IORC_ is _DSENMR. If the value is _DSENMR, then an observation in the transaction data set does not exist in the master data set.

7 The OUTPUT statement writes the current observation to the end of the master data set.

8 If neither condition is met, the PUT statement writes a message to the log.

The following output displays the updated INVENTORY_TOOL data set.

Figure 21.3 The Updated INVENTORY_TOOL Data Set

Tool Warehouse Inventory

Obs	PartNumber	Description	InStock	ReceivedDate	Price
1	K89R	seal	40	09APR2013	247.50
2	M4J7	sander	98	20JUN2011	45.88
3	LK43	filter	121	19MAY2011	10.99
4	MN21	brace	43	10AUG2012	27.87
5	BC85	clamp	80	16AUG2012	9.55
6	NCF3	valve	198	20MAR2012	24.50
7	KJ66	cutter	16	09APR2013	24.50
8	UYN7	rod	211	09SEP2010	11.55
9	JD03	switch	383	09JAN2013	13.99
10	BV1E	timer	56	09APR2013	36.50
11	AA11	hammer	55	09APR2013	32.26
12	BB22	wrench	21	09APR2013	17.35
13	CC33	socket	7	09APR2013	22.19

SAS writes the following message to the log:

```
NOTE: The data set WORK.INVENTORY_TOOL has been updated.  There were 3 observations
rewritten, 3 observations added and 0 observations deleted.
```

CAUTION

If you execute your program without the OUTPUT and REPLACE statements, then your master file might not update correctly. Using OUTPUT or REPLACE in a DATA step overrides the default replacement of observations. If you use these statements in a DATA step, then you must explicitly program each action that you want to take.

For more information, see "OUTPUT Statement" in *SAS DATA Step Statements: Reference* and "REPLACE Statement" in *SAS DATA Step Statements: Reference*.

Understanding How Duplicate BY Variables Affect File Update

How the DATA Step Processes Duplicate BY Variables

When you use a BY statement with MODIFY, both the master and the transaction data sets can have observations with duplicate values of BY variables. Neither the master nor the transaction data set needs to be sorted, because BY-group processing uses dynamic WHERE processing to find an observation in the master data set.

The DATA step processes duplicate observations in the following ways:

- If duplicate BY values exist in the master data set, then MODIFY applies the current transaction to the first occurrence in the master data set.
- If duplicate BY values exist in the transaction data set, then the observations are applied one on top of another so that the values overwrite each other. The value in the last transaction is the final value in the master data set.
- If both the master and the transaction data sets contain duplicate BY values, then MODIFY applies each transaction to the first occurrence in the group in the master data set.

The Program

The program in this section updates the INVENTORY_2 master data set with observations from the ADD_INVENTORY_2 transaction data set. Both data sets contain consecutive and nonconsecutive duplicate values of the BY variable PartNumber.

The following program creates the master data set INVENTORY_2. Note that the data set contains three observations for PartNumber M4J7.

```
data inventory_2;
   input PartNumber $ Description $ InStock @17
         ReceivedDate date9. @27 Price;
   format ReceivedDate date9.;
   datalines;
K89R seal   34  27jul1998 245.00
M4J7 sander 98  20jun2012 45.88
M4J7 sander 98  20jun2012 45.88
LK43 filter 121 19may2013 10.99
MN21 brace 43   10aug2013 27.87
M4J7 sander 98  20jun2012 45.88
BC85 clamp 80   16aug2013 9.55
NCF3 valve 198  20mar2013 24.50
KJ66 cutter 6   18jun2013 19.77
```

```
;
run;

proc print data=inventory_2;
   title 'INVENTORY_2 Data Set';
run;
```

The following output displays the INVENTORY_2 data set.

Figure 21.4 The INVENTORY_2 Data Set

INVENTORY_2 Data Set

Obs	PartNumber	Description	InStock	ReceivedDate	Price
1	K89R	seal	34	27JUL1998	245.00
2	M4J7	sander	98	20JUN2012	45.88
3	M4J7	sander	98	20JUN2012	45.88
4	LK43	filter	121	19MAY2013	10.99
5	MN21	brace	43	10AUG2013	27.87
6	M4J7	sander	98	20JUN2012	45.88
7	BC85	clamp	80	16AUG2013	9.55
8	NCF3	valve	198	20MAR2013	24.50
9	KJ66	cutter	6	18JUN2013	19.77

The following program creates the transaction data set ADD_INVENTORY_2, and then modifies the master data set INVENTORY_2. Note that the data set ADD_INVENTORY_2 contains three observations for PartNumber M4J7.

```
data add_inventory_2;
   input PartNumber $ Description $ NewStock;
   datalines;
K89R abc 17
M4J7 def 72
M4J7 ghi 66
LK43 jkl 311
M4J7 mno 43
BC85 pqr 75
;
run;

data inventory_2;
   modify inventory_2 add_inventory_2;
   by PartNumber;
   ReceivedDate=today();
   InStock=InStock+NewStock;
run;

proc print data=inventory_2;
   title 'Tool Warehouse Inventory';
run;
```

The following output displays the updated INVENTORY_2 data set.

Figure 21.5 The Updated INVENTORY_2 Data Set: Duplicate BY Variables

Tool Warehouse Inventory

Obs	PartNumber	Description	InStock	ReceivedDate	Price
1	K89R	abc	51	09APR2013	245.00
2	M4J7	mno	279	09APR2013	45.88
3	M4J7	sander	98	20JUN2012	45.88
4	LK43	jkl	432	09APR2013	10.99
5	MN21	brace	43	10AUG2013	27.87
6	M4J7	sander	98	20JUN2012	45.88
7	BC85	pqr	155	09APR2013	9.55
8	NCF3	valve	198	20MAR2013	24.50
9	KJ66	cutter	6	18JUN2013	19.77

Handling Missing Values

By default, if the transaction data set contains missing values for a variable that is common to both the master and the transaction data sets, then the MODIFY statement does not replace values in the master data set with missing values.

If you want to replace values in the master data set with missing values, then you use the UPDATEMODE= option in the MODIFY statement. UPDATEMODE= specifies whether missing values in a transaction data set replace existing values in a master data set.

The syntax for using the UPDATEMODE= option with the MODIFY statement follows:

MODIFY *master-SAS-data-set transaction-SAS-data-set*
<UPDATEMODE=MISSINGCHECK | NOMISSINGCHECK>;
BY *by-variable*;

MISSINGCHECK prevents missing values in a transaction data set from replacing values in a master data set. This is the default. NOMISSINGCHECK enables missing values in a transaction data set to replace values in a master data set by preventing the check for missing data from being performed.

The following example creates the master data set Event_List, which contains the schedule and codes for athletic events. The example then updates Event_List with the transaction data set Event_Change, which contains new information about the schedule. Because the MODIFY statement uses the NOMISSINGCHECK value of the UPDATEMODE= option, values in the master data set are replaced by missing values from the transaction data set.

The following program creates the EVENT_LIST master data set.

```
data Event_List;
   input Event $ 1-10 Weekday $ 12-20 TimeofDay $ 22-30 Fee Code;
   datalines;
Basketball Monday    evening   10 58
Soccer     Tuesday   morning   5  33
Yoga       Wednesday afternoon 15 92
Swimming   Wednesday morning   10 63
;
run;

proc print data=Event_List;
   title 'EVENT_LIST Data Set';
run;
```

The following output displays the EVENT_LIST data set.

Figure 21.6 The EVENT_LIST Data Set

EVENT_LIST Data Set

Obs	Event	Weekday	TimeofDay	Fee	Code
1	Basketball	Monday	evening	10	58
2	Soccer	Tuesday	morning	5	33
3	Yoga	Wednesday	afternoon	15	92
4	Swimming	Wednesday	morning	10	63

The following program creates the EVENT_CHANGE transaction data set.

```
data Event_Change;
   input Event $ 1-10 Weekday $ 12-20 Fee Code;
   datalines;
Basketball Wednesday 10 .
Yoga       Monday    . 63
Swimming             .  .
;
run;

proc print data=Event_Change;
   title 'EVENT_CHANGE Data Set';
run;
```

The following output displays the EVENT_CHANGE transaction data set.

Figure 21.7 The EVENT_CHANGE Transaction Data Set

EVENT_CHANGE Data Set

Obs	Event	Weekday	Fee	Code
1	Basketball	Wednesday	10	.
2	Yoga	Monday	.	63
3	Swimming		.	.

The following program modifies and writes the master data set:

```
data Event_List;
    modify Event_List Event_Change updatemode=nomissingcheck;
    by Event;
 run;

proc print data=Event_List;
   title 'Schedule of Athletic Events';
run;
```

The following output displays the modified EVENT_LIST data set.

Figure 21.8 The EVENT_LIST Master Data Set: Missing Values

Schedule of Athletic Events

Obs	Event	Weekday	TimeofDay	Fee	Code
1	Basketball	Wednesday	evening	10	.
2	Soccer	Tuesday	morning	5	33
3	Yoga	Monday	afternoon	.	63
4	Swimming		morning	.	.

Summary

Statements

BY *by-variable*;
: identifies corresponding observations in a master data set and a transaction data set. *By-variable* specifies one or more variables to use with the BY statement.

MODIFY *master-SAS-data-set transaction-SAS-data-set* <UPDATEMODE=MISSINGCHECK|NOMISSINGCHECK>;
: replaces the values of variables in one SAS data set with values from another SAS data set. *Master-SAS-data-set* contains data that you want to update. *Transaction-SAS-data-set* contains observations for updating the master data set.

  The UPDATEMODE= argument determines whether missing values in the transaction data set overwrite values in the master data set. The MISSINGCHECK option prevents missing values in a transaction data set from replacing values in a master data set. This is the default. The NOMISSINGCHECK option enables missing values in a transaction data set to replace values in a master data set by preventing the check for missing data from being performed.

MODIFY *SAS-data-set*;
: replaces the values of variables in a data set with values that you specify in your program.

OUTPUT;
: if a MODIFY statement is present, writes the current observation to the end of the master data set.

REPLACE;
: if a MODIFY statement is present, writes the current observation to the same physical location from which it was read in a data set that is named in the DATA statement.

Learning More

MERGE statement
: For more information, see "MERGE Statement" in *SAS DATA Step Statements: Reference*.

MODIFY statement
: For more information about the various applications of the MODIFY statement, see "MODIFY Statement" in *SAS DATA Step Statements: Reference*.

UPDATE statement
: For more information, see "UPDATE Statement" in *SAS DATA Step Statements: Reference*.

22

Conditionally Processing Observations from Multiple SAS Data Sets

Introduction to Conditional Processing from Multiple SAS Data Sets

Purpose

When combining SAS data sets, you can process observations conditionally, based on which data set contributed that observation. You can do the following:

- determine which data set contributed each observation in the combined data set
- create a new data set that includes only selected observations from the data sets that you combine

- determine when SAS is processing the last observation in the DATA step so that you can execute conditional operations, such as creating totals

You have seen some of these concepts in earlier topics, but in this section you will apply them to the processing of multiple data sets. The examples use the SET statement, but you can also use all of the features that are discussed here with the MERGE, MODIFY, and UPDATE statements.

Prerequisites

Before using this section, you should understand the concepts that are presented in the following sections:

- Chapter 4, “Starting with Raw Data: The Basics,” on page 51
- Chapter 6, “Starting with SAS Data Sets,” on page 93
- Chapter 18, “Interleaving SAS Data Sets,” on page 291

Input SAS Data Sets for Examples

The following program creates two SAS data sets, SOUTHAMERICAN and EUROPEAN. Each data set contains the following variables:

Year
: is the year in which South American and European countries competed in the World Cup Finals from 1954 to 1998.

Country
: is the name of the competing country.

Score
: is the final score of the game.

Result
: is the result of the game. The value for winners is `won`; the value for losers is `lost`.

The PROC SORT statements in the example below sort the data sets in ascending order according to the BY variable. To create the interleaved data set in the next example, the data must be in ascending order.

```
data southamerican;
   title 'South American World Cup Finalists from 1954 to 1998';
   input  Year $  Country $ 9-23 Score $ 25-28 Result $ 32-36;
   datalines;
1998    Brazil          0-3    lost
1994    Brazil          3-2    won
1990    Argentina       0-1    lost
1986    Argentina       3-2    won
1978    Argentina       3-1    won
1970    Brazil          4-1    won
1962    Brazil          3-1    won
1958    Brazil          5-2    won
```

```
;

data european;
   title 'European World Cup Finalists From 1954 to 1998';
   input  Year $  Country $ 9-23 Score $ 25-28 Result $ 32-36;
   datalines;
1998    France          3-0    won
1994    Italy           2-3    lost
1990    West Germany    1-0    won
1986    West Germany    2-3    lost
1982    Italy           3-1    won
1982    West Germany    1-3    lost
1978    Netherlands     1-3    lost
1974    West Germany    2-1    won
1974    Netherlands     1-2    lost
1970    Italy           1-4    lost
1966    England         4-2    won
1966    West Germany    2-4    lost
1962    Czechoslovakia  1-3    lost
1958    Sweden          2-5    lost
1954    West Germany    3-2    won
1954    Hungary         2-3    lost
;
run;

proc sort data=southamerican;
   by year;

proc print data=southamerican;
   title 'World Cup Finalists:';
   title2 'South American Countries';
   title3 'from 1954 to 1998';
run;

proc sort data=european;
   by year;
run;

proc print data=european;
   title 'World Cup Finalists:';
   title2 'European Countries';
   title3 'from 1954 to 1998';
run;
```

The PROC SORT statement sorts the data set in ascending order according to the BY variable. To create the interleaved data set in the next example, the data must be in ascending order.

The following output displays the SOUTHAMERICAN data set.

Figure 22.1 World Cup Finalists by Continent: South America

World Cup Finalists:
South American Countries
from 1954 to 1998

Obs	Year	Country	Score	Result
1	1958	Brazil	5-2	won
2	1962	Brazil	3-1	won
3	1970	Brazil	4-1	won
4	1978	Argentina	3-1	won
5	1986	Argentina	3-2	won
6	1990	Argentina	0-1	lost
7	1994	Brazil	3-2	won
8	1998	Brazil	0-3	lost

The following output displays the EUROPEAN data set.

Figure 22.2 World Cup Finalists by Continent: Europe

World Cup Finalists:
European Countries
from 1954 to 1998

Obs	Year	Country	Score	Result
1	1954	West Germany	3-2	won
2	1954	Hungary	2-3	lost
3	1958	Sweden	2-5	lost
4	1962	Czechoslovakia	1-3	lost
5	1966	England	4-2	won
6	1966	West Germany	2-4	lost
7	1970	Italy	1-4	lost
8	1974	West Germany	2-1	won
9	1974	Netherlands	1-2	lost
10	1978	Netherlands	1-3	lost
11	1982	Italy	3-1	won
12	1982	West Germany	1-3	lost
13	1986	West Germany	2-3	lost
14	1990	West Germany	1-0	won
15	1994	Italy	2-3	lost
16	1998	France	3-0	won

Determining Which Data Set Contributed the Observation

Understanding the IN= Data Set Option

When you create a new data set by combining observations from two or more data sets, knowing which data set an observation came from can be useful. For example, you might want to perform a calculation based on which data set contributed an observation. Otherwise, you might lose important contextual information that you need for later processing. You can determine which data set contributed a particular observation by using the IN= data set option.

The IN= data set option enables you to determine which data sets have contributed to the observation that is currently in the program data vector. The syntax for this option in the SET statement follows:

SET *SAS-data-set-1* (IN=*variable*) *SAS-data-set-2*;
BY *a-common-variable*;

When you use the IN= option with a data set in a SET, MERGE, MODIFY, or UPDATE statement, SAS creates a temporary variable associated with that data set. The value of *variable* is 1 if the data set has contributed to the observation currently in the program data vector. The value is 0 if it has not contributed. You can use the IN= option with any or all the data sets that you name in a SET, MERGE, MODIFY, or UPDATE statement. But, you must use a different variable name in each case.

Note: The IN= variable exists during the execution of the DATA step only. It is not written to the output data set that is created.

The Program

The original data sets, SOUTHAMERICAN and EUROPEAN, do not need a variable that identifies the countries' continent because all observations in SOUTHAMERICAN pertain to the South American continent, and all observations in EUROPEAN pertain to the European continent. However, when you combine the data sets, you lose the context, which in this case is the relevant continent for each observation. The following example uses the SET statement with a BY statement to combine the two data sets into one data set that contains all the observations in chronological order:

```
data finalists;
   set southamerican european;
   by year;
run;

proc print data=finalists;
   title 'World Cup Finalists';
   title2 'from 1954 to 1998';
run;
```

The following output displays the FINALISTS data set.

Figure 22.3 World Cup Finalists Grouped by Year

World Cup Finalists
from 1954 to 1998

Obs	Year	Country	Score	Result
1	1954	West Germany	3-2	won
2	1954	Hungary	2-3	lost
3	1958	Brazil	5-2	won
4	1958	Sweden	2-5	lost
5	1962	Brazil	3-1	won
6	1962	Czechoslovakia	1-3	lost
7	1966	England	4-2	won
8	1966	West Germany	2-4	lost
9	1970	Brazil	4-1	won
10	1970	Italy	1-4	lost
11	1974	West Germany	2-1	won
12	1974	Netherlands	1-2	lost
13	1978	Argentina	3-1	won
14	1978	Netherlands	1-3	lost
15	1982	Italy	3-1	won
16	1982	West Germany	1-3	lost
17	1986	Argentina	3-2	won
18	1986	West Germany	2-3	lost
19	1990	Argentina	0-1	lost
20	1990	West Germany	1-0	won
21	1994	Brazil	3-2	won
22	1994	Italy	2-3	lost
23	1998	Brazil	0-3	lost
24	1998	France	3-0	won

Notice that this output would be more useful if it showed from which data set each observation originated. To solve this problem, the following program uses the IN= data set option in conjunction with IF-THEN/ELSE statements. By determining which data set contributed an observation, the conditional statement executes and assigns the appropriate value to the variable Continent in each observation in the new data set FINALISTS.

```
data finalists;
   set southamerican (in=S) european;   1
   by Year;
```

```
   if S then Continent='South America';   2
   else Continent='Europe';
run;

proc print data=finalists;
   title 'World Cup Finalists';
   title2 'from 1954 to 1998';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 The IN= option in the SET statement tells SAS to create a variable named S.

2 When the current observation comes from the data set SOUTHAMERICAN, the value of S is 1. Otherwise, the value is 0. The IF-THEN/ELSE statements execute one of two assignment statements, depending on the value of S. If the observation comes from the data set SOUTHAMERICAN, then the value that is assigned to Continent is South America. If the observation comes from the data set EUROPEAN, then the value that is assigned to Continent is Europe.

The following output displays the updated FINALISTS data set.

Figure 22.4 World Cup Finalists with Continent

World Cup Finalists from 1954 to 1998

Obs	Year	Country	Score	Result	Continent
1	1954	West Germany	3-2	won	Europe
2	1954	Hungary	2-3	lost	Europe
3	1958	Brazil	5-2	won	South America
4	1958	Sweden	2-5	lost	Europe
5	1962	Brazil	3-1	won	South America
6	1962	Czechoslovakia	1-3	lost	Europe
7	1966	England	4-2	won	Europe
8	1966	West Germany	2-4	lost	Europe
9	1970	Brazil	4-1	won	South America
10	1970	Italy	1-4	lost	Europe
11	1974	West Germany	2-1	won	Europe
12	1974	Netherlands	1-2	lost	Europe
13	1978	Argentina	3-1	won	South America
14	1978	Netherlands	1-3	lost	Europe
15	1982	Italy	3-1	won	Europe
16	1982	West Germany	1-3	lost	Europe
17	1986	Argentina	3-2	won	South America
18	1986	West Germany	2-3	lost	Europe
19	1990	Argentina	0-1	lost	South America
20	1990	West Germany	1-0	won	Europe
21	1994	Brazil	3-2	won	South America
22	1994	Italy	2-3	lost	Europe
23	1998	Brazil	0-3	lost	South America
24	1998	France	3-0	won	Europe

Combining Selected Observations from Multiple Data Sets

To create a data set that contains only the observations that are selected according to a particular criterion, you can use the subsetting IF statement and a SET statement that specifies multiple data sets. The following DATA step reads two input data sets to create a combined data set that lists only the winning teams:

```
data champions(drop=result); 1
   set southamerican (in=S) european; 2
   by Year;
   if result='won';   3
   if S then Continent='South America';   4
   else Continent='Europe';
run;

proc print data=champions;
   title 'World Cup Champions from 1954 to 1998';
   title2 'including Countries'' Continent';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 The DROP= data set option drops the variable Result from the new data set CHAMPIONS because all values for this variable are the same.

2 The SET statement reads observations from two data sets: SOUTHAMERICAN and EUROPEAN. The S= data option creates the variable S, which is set to 1 each time an observation is contributed by the SOUTHAMERICAN data set.

3 A subsetting IF statement writes the observation to the output data set CHAMPIONS only if the value of the Result variable is `won`.

4 When the current observation comes from the data set SOUTHAMERICAN, the value of S is 1. Otherwise, the value is 0. The IF-THEN/ELSE statements execute one of two assignment statements, depending on the value of S. If the observation comes from the data set SOUTHAMERICAN, then the value assigned to Continent is South America. If the observation comes from the data set EUROPEAN, then the value assigned to Continent is Europe.

The following output displays the CHAMPIONS data set.

Figure 22.5 Combining Selected Observations

World Cup Champions from 1954 to 1998
including Countries' Continent

Obs	Year	Country	Score	Continent
1	1954	West Germany	3-2	Europe
2	1958	Brazil	5-2	South America
3	1962	Brazil	3-1	South America
4	1966	England	4-2	Europe
5	1970	Brazil	4-1	South America
6	1974	West Germany	2-1	Europe
7	1978	Argentina	3-1	South America
8	1982	Italy	3-1	Europe
9	1986	Argentina	3-2	South America
10	1990	West Germany	1-0	Europe
11	1994	Brazil	3-2	South America
12	1998	France	3-0	Europe

Performing a Calculation Based on the Last Observation

Understanding When the Last Observation Is Processed

Many applications require that you determine when the DATA step processes the last observation in the input data set. For example, you might want to perform calculations only on the last observation in a data set, or you might want to write an observation only after the last observation has been processed. For this purpose, you can use the END= option for the SET, MERGE, MODIFY, or UPDATE statements. The syntax for this option is:

SET *SAS-data-set-list* END=*variable*;

The END= option defines a temporary variable whose value is 1 when the DATA step is processing the last observation. At all other times, the value of variable is 0. Although the DATA step can use the END= variable, SAS does not add it to the resulting data set.

Note: Chapter 13, “Using More Than One Observation in a Calculation,” on page 207 explains how to use the END= option in the SET statement with a single data set. The END= option works the same way with multiple data sets. However, it is important to note that END= is set to 1 only when the last observation from all input data sets is being processed.

The Program

This example uses the data in SOUTHAMERICAN and EUROPEAN to calculate how many years a team from each continent won the World Cup from 1954 to 1998.

To perform this calculation, this program must perform the following tasks:

1 Identify on which continent a country is located.

2 Keep a running total of how many times a team from each continent won the World Cup.

3 After processing all observations, multiply the final total for each continent by 4 (the length of time between World Cups) to determine the length of time each continent has been a World Cup champion.

4 Write only the final observation to the output data set. The variables that contain the totals do not contain the final total until the last observation is processed.

The following DATA step calculates the running totals and produces the output data set that contains only those totals.

```
data timespan (keep=YearsSouthAmerican keep=YearsEuropean);  1
   set southamerican (in=S) european end=LastYear;  2
   by Year;
   if result='won' then
      do;
         if S then SouthAmericanWins+1;  3
         else EuropeanWins+1;  3
      end;
   if lastyear then  4
      do;
         YearsSouthAmerican=SouthAmericanWins*4;
         YearsEuropean=EuropeanWins*4;
         output;  5
      end;
run;

proc print data=timespan;
   title 'Total Years as Reigning World Cup Champions';
   title2 'from 1954 to 1998';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 The KEEP= option writes only the YearsSouthAmerican and YearsEuropean variables to the TIMESPAN data set.

2 The END= option creates the temporary variable LastYear. The value of LastYear is 0 until the DATA step begins processing the last observation. At that point, the value of LastYear is set to 1.

3 Two new variables, SouthAmericanWins and EuropeanWins, keep a running total of the number of victories each continent achieved. For each observation in which the value of the variable Result is `won`, a different sum statement executes, based on the data set that the observation came from:

```
SouthAmericanWins+1;
```

or

```
EuropeanWins+1
```

4 When the DATA step begins processing the last observation, the value of LASTYEAR changes from 0 to 1. When this change occurs, the conditional statement `IF LastYear` becomes true, and the statements that follow it are executed. The assignment statement multiplies the total number of victories for each continent by 4 and assigns the result to the appropriate variable, YearsSouthAmerican or YearsEuropean.

5 The OUTPUT statement writes the observation to the newly created data set. Remember that the DATA step automatically writes an observation at the end of each iteration. However, the OUTPUT statement turns off this automatic feature. The DATA step writes only the last observation to TIMESPAN. When the DATA step writes the observation from the program data vector to the output data set, it writes only two variables, YearsSouthAmerican and YearsEuropean, as directed by the KEEP= data set option in the DATA statement.

The following output displays the TIMESPAN data set.

Figure 22.6 *Using the END= Option to Perform a Calculation Based on the Last Observation in the Data Sets*

Total Years as Reigning World Cup Champions from 1954 to 1998

Obs	YearsSouthAmerican	YearsEuropean
1	24	24

Summary

Statements

IF *condition*;
tests whether the condition is true. If it is true, then SAS continues processing the current observation. If it is false, then SAS stops processing the observation and returns to the beginning of the DATA step. This type of IF statement is called

a subsetting IF statement because it produces a subset of the original observations.

IF *condition* THEN *action*;
<ELSE *action*;>
: tests whether condition is true. If it is true, then the action in the THEN clause is executed. If the condition is false and an ELSE statement is present, the ELSE action is executed. If the condition is false and no ELSE statement is present, then execution proceeds to the next statement in the DATA step.

SET *SAS-data-set* (IN=*variable*) *SAS-data-set-list*;
: creates a variable that is associated with a SAS data set. The value of *variable* is 1 if the data set has contributed to the observation currently in the program data vector. The value is 0 if it has not. The IN= variable exists only while the DATA step executes. It is not written to the output data set.

  You can use the IN= option with any data set that you name in the SET, MERGE, MODIFY, or UPDATE statement, but use a different variable name for each one.

SET *SAS-data-set-list* END=*variable*;
: creates a variable whose value is 0 until the DATA step starts to process its last observation. When processing of the last observation begins, the value of *variable* changes to 1. The END= variable exists only while the DATA step executes. It is not written to the output data set.

  You can also use the END= option with the MERGE, MODIFY, and UPDATE statements.

Learning More

DATA set options
: For an introduction to data set options, see "Reading Selected Variables" on page 98.

DO statement
: For information about DO-loop processing, see Chapter 14, "Finding Shortcuts in Programming," on page 223.

IF statements
: For more information about both the subsetting and conditional IF statements, see Chapter 10, "Acting on Selected Observations," on page 153.

OUTPUT and subsetting IF statement
: For information about using the OUTPUT and subsetting IF statements, see Chapter 10, "Acting on Selected Observations," on page 153.

SUM statement and END= option
: For information about accumulating totals and using the END= option, see "Accumulating a Total for an Entire Data Set" on page 210 and "Obtaining a Total for Each BY Group" on page 212.

PART 5

Debugging SAS Programs

23

Analyzing Your SAS Session with the SAS Log

Introduction to Analyzing Your SAS Session with the SAS Log

Purpose

The SAS log is a useful tool for analyzing your SAS session and programs. In this section, you will learn about the following concepts:

- the log in relation to output
- types of messages in the SAS log
- the log structure
- writing to the SAS log
- suppressing information in the SAS log

Prerequisites

You should understand the basic SAS programming concepts that are presented in the following sections:

- Chapter 1, "What is the SAS System?," on page 3
- Chapter 7, "Understanding DATA Step Processing," on page 109
- Chapter 4, "Starting with Raw Data: The Basics," on page 51

Understanding the SAS Log

Understanding the Role of the SAS Log

The SAS log results from executing a SAS program, and in that sense, it is output. The SAS log provides a record of everything that you do in your SAS session or with your SAS program, from the names of the data sets that you create to the number of observations and variables in those data sets. This record can tell you what statements were executed, how much time the DATA and PROC steps required, and whether your program contains errors.

As with SAS output, the destination of the SAS log varies depending on your method of running SAS and on your operating environment. The content of the SAS log varies according to the DATA and PROC steps that are executed and the options that are used.

The sample log in the following example was created by a SAS program that contains a DATA step and two PROC steps. The DATA step uses the file that is located in "The UNIVERSITY_TEST_SCORES Data Set" on page 853. Use the LIBNAME statement to create a libref and identify a location for your data set. The data set is stored in a SAS library that is referenced by the libref OUT throughout the rest of this section.

Use the following form of the LIBNAME statement:

```
libname libref 'your-data-library';
```

The sample log shown below is created by executing the following SAS program:

```
libname out 'your-data-library';

data out.university_test_scores;
   infile out 'your-input-file';
   input Test $ Gender $ Year TestScore;
run;

proc sort data=out.university_test_scores;
   by test;
run;

proc print data=out.university_test_scores;
   by test;
   label TestScore='Test Score';
   title1 'University Test Scores by Year, 2005-2011';
   title3 'Separate Statistics by Test Type';
run;
```

Example Code 23.1 *Example of a SAS Log*

```
1    libname out 'your-data-library';
NOTE: Libref OUT was successfully assigned as follows:
      Engine:        V9
      Physical Name: your-data-library
2
3    data out.university_test_scores;
4       infile 'your-input-file';
5       input Test $ Gender $ Year TestScore;
6    run;

NOTE: The infile 'your-input-file' is:
      Filename=your-input-file
      RECFM=V,LRECL=32767,File Size (bytes)=544,
      Last Modified=03May2013:07:18:05,
      Create Time=01May2013:10:41:25

NOTE: 28 records were read from the infile 'your-input-file'.
      The minimum record length was 17.
      The maximum record length was 18.
NOTE: The data set OUT.UNIVERSITY_TEST_SCORES has 28 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds



7
8    proc sort data=out.university_test_scores;
9       by test;
10   run;

NOTE: There were 28 observations read from the data set OUT.UNIVERSITY_TEST_SCORES.
NOTE: The data set OUT.UNIVERSITY_TEST_SCORES has 28 observations and 4 variables.
NOTE: PROCEDURE SORT used (Total process time):
      real time           0.15 seconds
      cpu time            0.04 seconds



11
12   proc print data=out.university_test_scores;
NOTE: Writing HTML Body file: sashtml.htm
13      by test;
14      label TestScore='Test Score';
15      title1 'University Test Scores by Year, 2005-2011';
16      title3 'Separate Statistics by Test Type';
17   run;

NOTE: There were 28 observations read from the data set OUT.UNIVERSITY_TEST_SCORES.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.51 seconds
      cpu time            0.39 seconds
```

The SAS program that created this log ran without errors. The notes are informational messages that indicate how SAS processed your program.

Resolving Errors with the Log

If the previous program contained errors, then those errors would be reflected, as part of the session, in the SAS log. SAS generates messages for data errors, syntax errors, and programming errors. You can browse those messages, make necessary changes to your program, and then rerun the program successfully.

SAS does not always identify all of the program errors the first time you execute your program. Fixing one error might uncover other errors in your program.

Locating the SAS Log

The destination of your log depends on the method that you are using to start, run, and exit SAS. It also depends on your operating environment and on the setting of SAS system options. The following table shows the default destination for each method of operation:

Table 23.1 Default Destinations for the SAS Log

Method of Operation	Destination of SAS Log
SAS windowing environment (interactive full-screen)	Log window
Interactive line mode	On the terminal display, as statements are entered
Noninteractive SAS programs	Depends on the operating environment
Batch jobs	Printer or disk file, depending on your operating environment

Understanding the Log Structure

The Components of a SAS Log

The SAS log provides valuable information that helps you identify problems when you execute your programs. The SAS log is especially helpful if you have questions and need to contact on-site SAS personnel or SAS Technical Support. The contents of the log aids in diagnosing your problem.

The log contains the following elements:

- SAS statements for the DATA and PROC steps
- error messages
- notes and warning messages
- notes that contain the number of observations and variables for each data set that is created

Messages in the SAS Log

SAS performs error processing during the compilation and execution phases of your program, and writes note, warning, and error messages to the log. If your program has an error, SAS attempts to interpret the intended meaning of the error. If SAS cannot correct the error, SAS writes a message to the log. Some errors are explained fully by the message in the log. Other messages are not as easy to interpret because SAS is not always able to detect exactly where the error occurred. You can debug SAS programs by understanding processing messages in the SAS log and then modifying your code.

The SAS log displays the following types of messages that can help you debug your programs:

- notes
- warnings
- errors

Each of these messages gives you different information about the program that is being processed. Reviewing all messages in the log is a good practice to follow.

Notes in the SAS Log

A SAS note is an informational message and does not stop your program from executing. A note can indicate that part of your code is programmatically incorrect.

A SAS note can also provide information about such items as processing time, the successful or unsuccessful completion of a DATA or PROC step, the number of records that were read from a file, and the name of the input file that is used in your program.

The following are examples of SAS notes:

- NOTE: The data set WORK.TEST has 50 observations and five variables.
- NOTE: 35 records were read from the INFILE *file-name*.
- NOTE: Variable ABCD is uninitialized.
- NOTE: The SAS System stopped processing this step because of errors.
- NOTE: No variables in data set WORK.TEST.
- NOTE: Invalid data for *variable-name* at line *n*.

The following program creates the STOCK data set that is used as input to the second DATA step. The STOCK data set has an invalid value for Inventory. The INPUT statement identifies Inventory as a numeric value, but the fourth observation has alphabetic characters in this field. The program uses PUT statements to write user-supplied messages to the log. (For more information about the PUT statement, see “Writing Messages to the SAS Log: The PUT Statement” on page 387.) Notice that the first record has a missing value in the Product field. This missing value does not cause the program to stop executing.

```
data stock;
   input inventory QuantitySold Idnum 8-11 Product $ 13-18 cost 20-24;
```

```
   datalines;
100 52 1001        67.45
345 49 1020 saw    99.99
237 55 2003 wrench 34.97
abc 65 3015 shovel 25.99
932 38 4215 rake   22.50
;
run;

data stock2;
   set stock;
   if inventory < 300 and QuantitySold > 50 then
      put 'Time to order product: ' @27 product= @42 idnum=;
      else;
         if inventory > 300 then
            put 'No need to order product: ' @27 product= @42 idnum=;
   run;
```

Example Code 23.2 *Log Output from the Stock Inventory Program*

```
94   data stock;
95      input inventory QuantitySold Idnum 8-11 Product $ 13-18;
96      datalines;

NOTE: Invalid data for inventory in line 100 1-3.
RULE:      ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----
+----8----+-
100        abc 65 3015 shovel
inventory=. QuantitySold=65 Idnum=3015 Product=shovel _ERROR_=1 _N_=4
NOTE: The data set WORK.STOCK has 5 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


102  ;
103  run;
104
105  data stock2;
106     set stock;
107     if inventory < 300 and QuantitySold > 50 then
108        put 'Time to order product: ' @27 product= @42 idnum=;
109     if inventory > 300 then
110        put 'No need to order product: ' @27 product= @42 idnum=;
111  run;

Time to order product:    Product=       Idnum=1001
No need to order product: Product=saw    Idnum=1020
Time to order product:    Product=wrench Idnum=2003
Time to order product:    Product=shovel Idnum=3015
No need to order product: Product=rake   Idnum=4215
NOTE: There were 5 observations read from the data set WORK.STOCK.
NOTE: The data set WORK.STOCK2 has 5 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

The NOTE identifies invalid data for an inventory item. SAS was expecting a numeric value for Inventory, and instead the value of Inventory for the fourth observation is a character. SAS continues to execute the program.

Warning Messages in the SAS Log

A SAS warning message alerts you to potential problems with your code but does not stop program execution. For example, warning messages are issued when you enter a word incorrectly and SAS is able to interpret the word, and when a program produces no output.

It is important to view the warning messages in the SAS log to verify whether your program executed as expected. The following are examples of warning messages in the SAS log:

- WARNING: The data set WORK.TEST might be incomplete. When this step was stopped, there were 0 observations and 0 variables.
- WARNING: Data set WORK.TEST was not replaced because this step was stopped.
- WARNING: Assuming that the symbol DATA was misspelled as date.

Executing the following DATA step results in an error message, a note, and a warning in the SAS log. In the example, the SET statement identifies the input data set. However, SAS could not find the data set.

```
data test;
   set mydataset;
run;
```

Example Code 23.3 *Log Output with Warning Messages*

```
114  data test;
115     set mydataset;
ERROR: File WORK.MYDATASET.DATA does not exist.
NOTE: The SAS System stopped processing this step because of errors.
WARNING: The data set WORK.TEST may be incomplete.  When this step was stopped there
were 0 observations and 0 variables.
WARNING: Data set WORK.TEST was not replaced because this step was stopped.
NOTE: DATA statement used (Total process time):
      real time           0.03 seconds
      cpu time            0.00 seconds
```

The WARNING messages in the log give you information about the temporary output data set, WORK.TEST, that the program was attempting to create.

To correct the problem, make sure that the input data set in the SET statement already exists. The error might be as simple as a misspelled data set name. Execute the program again and review your log messages.

Error Messages in the SAS Log

A SAS error message alerts you to a significant problem with your code. SAS either stops program processing or flags errors and continues to process your program. An error message is written to the log.

One of the most common errors is a missing semicolon at the end of a statement. SAS can write multiple messages to the log when it encounters a missing semicolon, depending on where in the program the error occurred. It might be difficult to determine the location of the error because there is no specific message that identifies the error as a missing semicolon.

The following are examples of error messages in the SAS log:

- ERROR: Variable ITEM2 not found.
- ERROR: Illegal reference to array ALL.
- ERROR: LIBNAME MYLIB is not assigned.
- ERROR: Syntax error, statement will be ignored.

For an example of an error message in a SAS log, see “Warning Messages in the SAS Log” on page 384. Often, multiple types of messages occur in the same log.

Detecting a Syntax Error

The following SAS program contains one DATA step and two PROC steps. However, the DATA step has a syntax error. It does not end with a semicolon. The SAS log that is located below the program explains program processing in detail.

```
libname out 'your-data-library';

   /* omitted semicolon */
data out.university_test_scores2
   infile 'your-input-file';
   input test $ gender $ year TestScore;
run;

proc sort data=out.university_test_scores2;
   by test;
run;

proc print data=out.university_test_scores2;
   by test;
run;
```

The following log shows how SAS processes the program step by step:

Example Code 23.4 *Log Output That Identifies a Syntax Error*

```
16  libname out 'your-data-library';
NOTE: Libref OUT was successfully assigned as follows:  1
      Engine:        V9
      Physical Name: your-data-library
17
18
19      /* omitted semicolon */
20   data out.university_test_scores2  2
21      infile 'your-input-file';
22      input test $ gender $ year TestScore;
23   run;

ERROR: No DATALINES or INFILE statement.  3
ERROR: Extension for physical file name "your-input-file" does not
       correspond to a valid member type.  3
NOTE: The SAS System stopped processing this step because of errors.  3
WARNING: The data set OUT.UNIVERSITY_TEST_SCORES2 may be incomplete.  When this step
was stopped
         there were 0 observations and 4 variables.  4
WARNING: The data set WORK.INFILE may be incomplete.  When this step was stopped
there were 0
         observations and 4 variables.  4
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds



24
25   proc sort data=out.university_test_scores2;  5
26      by test;
27   run;

NOTE: Input data set is empty.  5
NOTE: The data set OUT.UNIVERSITY_TEST_SCORES2 has 0 observations and 4 variables.
5
NOTE: PROCEDURE SORT used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds



28
29   proc print data=out.university_test_scores2;  6
30      by test;
31   run;

NOTE: No observations in data set OUT.UNIVERSITY_TEST_SCORES2.  6
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

The following list corresponds to the numbered items in the preceding log:

1. The LIBNAME statement successfully associates the libref OUT with your library.
2. The DATA statement is missing a semicolon, causing an error in the program.
3. The error messages identify the error, and the note shows that the program stopped executing.
4. Warning messages provide information about the OUT.UNIVERSITY_TEST_SCORES2 and WORK.INFILE data sets. SAS reads past the DATA statement until it encounters a semicolon and interprets WORK.INFILE as a data set that is to be created.

5 SAS attempts to sort the output data set.

6 SAS attempts to write the OUT.UNIVERSITY_TEST_SCORES2 data set.

To correct the error, add a semicolon after the DATA statement and execute the program again.

Writing to the SAS Log

Default Output to the SAS Log

The previous sample logs show the information that appears in the log by default. You can also write to the log by using the PUT statement or the LIST statement within a DATA step. You can also use the %PUT macro statement anywhere in your program. These statements can be used to debug your SAS programs.

Writing Messages to the SAS Log: The PUT Statement

Introduction to the PUT Statement

The PUT statement enables you to write information that you specify, including text strings and variable values, to the log. Each time the DATA step iterates, the PUT statement is executed, and a message is written to the log. Values can be written in column, list, formatted, or named output style. (For more information, see the different forms of the INPUT statement in *SAS DATA Step Statements: Reference*.) The PUT statement can be a useful debugging tool. You can write messages from different parts of your program to the log, and track the execution of your program.

This is a simplified form of the PUT statement:

PUT <'*message*'> | <*variable-name*>;

message specifies the message that you would like to see displayed in the SAS log. Character literals must be enclosed in quotation marks. Your message text can include a word or phrase, such as "Notice This", that helps you identify the message more easily.

variable-name specifies a variable whose value is written to the log. If you use an equal sign after the variable name, both the variable name and the value will be written to the log.

By using the following PUT statement, you can write the values of all variables, including the automatic variables _ERROR_ and _N_, that are defined in the current DATA step:

PUT _ALL_;

For more information about the PUT statement and how it can be used, see "PUT Statement" in *SAS DATA Step Statements: Reference*.

Example: Writing to the Log with the PUT Statement

The first DATA step in the following example creates a temporary data set called INVENTORY. This data set is used as input to the SET statement in the second DATA step. The PUT statements write messages to the log indicating whether items need to be ordered. By entering the variable name Item followed by an equal sign in the PUT statement, the PUT statement writes both the variable name and its value to the log. This example shows the log output for the PUT statement.

```
data inventory;
   input InStock QuantitySold Idnum 8-11 Item $ 13-18;
   datalines;
100 52 1001 hammer
345 49 1020 saw
237 55 2003 wrench
864 65 3015 shovel
932 38 4215 rake
;
run;

data inventory2;
   set inventory;
   if InStock < 300 and QuantitySold > 50 then
      put 'Time to order product: ' Item=;
   if InStock > 300 then
      put 'No need to order product: ' Item=;
run;
```

Example Code 23.5 *Log Output Using the PUT Statement*

```
1    data inventory;
2       input InStock QuantitySold Idnum 8-11 Item $ 13-18;
3       datalines;

NOTE: The data set WORK.INVENTORY has 5 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.30 seconds
      cpu time            0.09 seconds


9    ;
10   run;
11
12   data inventory2;
13      set inventory;
14      if InStock < 300 and QuantitySold > 50 then
15         put 'Time to order product: ' Item=;
16      if InStock > 300 then
17         put 'No need to order product: ' Item=;
18   run;

Time to order product: Item=hammer
No need to order product: Item=saw
Time to order product: Item=wrench
No need to order product: Item=shovel
No need to order product: Item=rake
NOTE: There were 5 observations read from the data set WORK.INVENTORY.
NOTE: The data set WORK.INVENTORY2 has 5 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

The PUT statement writes five lines to the log.

Your program code can include instructions for writing output in specific columns. If you do this, it might make your output more readable. In the example above, you can change the IF statements in the following way:

```
if Inventory < 300 and QuantitySold > 50 then
   put 'Time to order product: ' @27 Item= @39 Idnum=;
if Inventory > 300 then
   putlog 'No need to order product: ' @27 Item= @39 Idnum=;
```

The @27 indicates that the variable Item begins in column 27. The @39 indicates that the variable Idnum begins in column 39. The following partial SAS log shows the output:

```
Time to order product:    Item=hammer Idnum=1001
No need to order product: Item=saw    Idnum=1020
Time to order product:    Item=wrench Idnum=2003
No need to order product: Item=shovel Idnum=3015
No need to order product: Item=rake   Idnum=4215
```

Writing the Contents of an Input Record: The LIST Statement

Introduction to the LIST Statement

Use the LIST statement in the DATA step to write the current input record to the log. You can use the LIST statement only on data that is read from an INPUT statement. It has no effect on data that is read with the SET, MERGE, MODIFY, or UPDATE statements. The LIST statement writes observations at the end of each iteration of the DATA step.

Example: Listing the Current Input Record

The following program shows that the LIST statement, like the PUT statement, can be very effective when combined with conditional processing to write selected information to the log.

```
libname out 'your-data-library';

data out.university_test_scores3;
   infile 'your-data-file';
   input test $ gender $ year TestScore;
   if TestScore < 525 then delete;
   else list;
run;
```

Example Code 23.6 *Listing the Contents of a Record*

```
46  libname out 'your-data-library';
NOTE: Libref OUT was successfully assigned as follows:
      Engine:        V9
      Physical Name: your-data-library
47
48
49
50   data out.university_test_scores3;
51      infile 'your-input-file';
52      input test $ gender $ year TestScore;
53      if TestScore < 525 then delete;
54      else list;
55   run;

NOTE: The infile 'your-input-file' is:
      Filename=your-input-file,
      RECFM=V,LRECL=32767,File Size (bytes)=544,
      Last Modified=03May2013:07:18:05,
      Create Time=01May2013:10:41:25

RULE:     ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----
+----8----+--
21        Math   m 2008 525  18
23        Math   m 2009 527  18
25        Math   m 2010 530  18
27        Math   m 2011 531  18
NOTE: 28 records were read from the infile 'your-input-file'.
      The minimum record length was 17.
      The maximum record length was 18.
NOTE: The data set OUT.UNIVERSITY_TEST_SCORES3 has 4 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

When the LIST statement is executed, SAS causes the current input buffer to be written to the log. Note the presence of the columns ruler before the first line of data. The ruler indicates that input data was written to the log. The ruler can be used to reference column positions in the input buffer. Notice that the LIST statement causes the record length to be written at the end of each line (in this case, each record has a length of 18). This feature of the LIST statement works only in operating environments that support variable-length input records.

Example: Listing Records That Have Missing Data

The following is another example of using the LIST statement to write records to the log. The example creates the EMPLOYEE data set. The program uses an INPUT statement to describe the arrangement of values in the input record. The input data for each employee is three lines long and begins with an employee ID number. The third line contains the value for Salary. After reading the ID number, the #3 notation instructs SAS to go to the third line of each record to read the value for Salary. The IF statement instructs SAS to list the record for any employees that have a missing value for Salary.

```
data employee;
   input IdNum 1-9 #3 Salary 1-8;
   if salary=. then list;
   datalines;
234567890
James Smith
```

```
70356.79
345678912
Jeffery Feldenstern
.
382623454
Sandy Lineman
75724.96
346521145
Jose Garcia
.
;
run;

proc print data=employee;
   format salary dollar10.2;
   title 'Employee Salary';
run;
```

You can see that two observations have missing values for Salary.

Example Code 23.7 *Listing the Contents of a Record That Has Missing Values*

```
70   data employee;
71      input IdNum 1-9 #3 Salary 1-8;
72      if salary=. then list;
73      datalines;

RULE:      ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----
+----8----+-
77         345678912
78         Jeffery Feldenstern
79         .
83         346521145
84         Jose Garcia
85         .
NOTE: The data set WORK.EMPLOYEE has 4 observations and 2 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


86   ;
87   run;
88
89   proc print data=employee;
90      format salary dollar10.2;
91      title 'Employee Salary';
92   run;

NOTE: There were 4 observations read from the data set WORK.EMPLOYEE.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.00 seconds
      cpu time            0.01 seconds
```

The following output shows the missing values.

Figure 23.1 Employee Salary with Missing Values

Employee Salary

Obs	IdNum	Salary
1	234567890	$70,356.79
2	345678912	.
3	382623454	$75,724.96
4	346521145	.

Writing Messages to the SAS Log: The %PUT Macro Statement

Introduction to the %PUT Macro Statement

The %PUT statement is a macro statement that is independent of the DATA step. It can be used anywhere in your program to write a message to the log.

Example: Writing Messages to the Log

The following example shows how the %PUT macro statement can be used in a SAS program:

```
data professions;
   input Name $ 1-17 Gender $ 19 Occupation $ 21-33;
   datalines;
Shirley Grayson   F attorney
Kristen Hagshould F doctor
Matthew Rodriguez M
Michael Wu        M mathematician
Sophie Majkut     F physicist
;

%put Notice: This is the end of the first DATA step.;

data professions2;
   set professions;
   %put Notice: Testing for missing values.;
   if gender = 'M' and Occupation = ' ' then Occupation='MISSING';
run;

%put Notice: This is the end of the second DATA step.;

proc print data=professions2;
   title 'Staff Occupations';
run;
%put Notice: This is the end of the program.;
```

Example Code 23.8 *Output from Using the %PUT Macro Statement*

```
11   data professions;
12      input Name $ 1-17 Gender $ 19 Occupation $ 21-33;
13      datalines;

NOTE: The data set WORK.PROFESSIONS has 5 observations and 3 variables.
NOTE: DATA statement used (Total process time):
      real time           0.07 seconds
      cpu time            0.00 seconds


19   ;
20
21   %put Notice: This is the end of the first DATA step.;
Notice: This is the end of the first DATA step.
22
23   data professions2;
24      set professions;
25      %put Notice: Testing for missing values.;
Notice: Testing for missing values.
26      if gender = 'M' and Occupation = ' ' then Occupation='MISSING';
27   run;

NOTE: There were 5 observations read from the data set WORK.PROFESSIONS.
NOTE: The data set WORK.PROFESSIONS2 has 5 observations and 3 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds


28
29   %put Notice: This is the end of the second DATA step.;
Notice: This is the end of the second DATA step.
30
31   proc print data=professions2;
32      title 'Staff Occupations';
33   run;

NOTE: There were 5 observations read from the data set WORK.PROFESSIONS2.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.04 seconds
      cpu time            0.01 seconds


34   %put Notice: This is the end of the program.;
Notice: This is the end of the program.
```

SAS produces the following results.

Figure 23.2 Staff Occupations

Staff Occupations

Obs	Name	Gender	Occupation
1	Shirley Grayson	F	attorney
2	Kristen Hagshould	F	doctor
3	Matthew Rodriguez	M	MISSING
4	Michael Wu	M	mathematician
5	Sophie Majkut	F	physicist

Suppressing Information in the SAS Log

Using SAS System Options to Suppress Log Output

There might be times when you want to prevent some information from being written to the SAS log. You can suppress SAS statements, system messages, and error messages with the NOSOURCE, NONOTES, and ERRORS= SAS system options. You can specify these options when you invoke SAS, in the OPTIONS window, or in an OPTIONS statement. In this section, the options are specified in OPTIONS statements.

Note: All SAS system options remain in effect for the duration of your session or until you change the options.

Suppressing SAS Statements

If you regularly execute large SAS programs without making changes, then you can use the NOSOURCE system option as follows to suppress the listing of the SAS statements to the log:

```
options nosource;
```

The NOSOURCE system option causes only source lines that contain errors to be written to the log. You can return to the default by specifying the SOURCE system option as follows:

```
options source;
```

The SOURCE system option causes all subsequent source lines to be written to the log.

You can also control whether secondary source statements (from files that are included with a %INCLUDE statement) are written to the log. Use the NOSOURCE2 system option to suppress secondary statements:

```
options nosource2;
```

Use the SOURCE2 system option to include secondary source statements in the log:

```
options source2;
```

Suppressing System Notes

Much of the information that is supplied by the log appears as notes, including the following items:

- copyright information
- licensing and site information
- number of observations and variables in the data set

SAS also issues a note when it has stopped processing a step because of errors.

If you do not want the notes to appear in the log, then use the NONOTES system option to suppress them:

```
options nonotes;
```

All messages starting with NOTE are suppressed. You can return to the default by specifying the NOTES system option:

```
options notes;
```

Limiting the Number of Error Messages

SAS writes messages for data input errors that appear in your SAS program. The default number for the error messages is usually 20, but might vary from site to site. Use the ERRORS= system option to specify the maximum number of observations for which error messages are written to the log.

Note that this option limits only the error messages that are produced for incorrect data. This type of error is caused primarily by trying to read character values for a variable that the INPUT statement defines as numeric.

If data errors are detected in more observations than the number that you specify, then processing continues, but error messages are not written for the additional errors. For example, the following OPTIONS statement specifies writing for a maximum of five observations:

```
options errors=5;
```

However, as discussed in "Suppressing SAS Statements, Notes, and Error Messages" on page 396, it might not be to your advantage to suppress error messages.

Note: No option is available to eliminate warning messages.

Controlling the Level of Detail in the SAS Log

The MSGLEVEL= system option controls the level of detail in messages that are written to the SAS log. The values for MSGLEVEL= are either N or I. N indicates that SAS writes notes, warning, and error messages only. This is the default. I indicates that SAS writes additional messages that relate to index usage, merge processing, and sort utilities.

The PRINTMSGLIST system option controls the writing of extended lists of messages to the SAS log. PRINTMSGLIST is the default, and writes the entire list of messages to the SAS log. NOPRINTMSGLIST writes the top-level messages only.

Suppressing SAS Statements, Notes, and Error Messages

The following SAS program reads the test score data as in other examples, but in this example the character symbol for the variable Gender is omitted. Also, the data is not sorted before using a BY statement with PROC PRINT. For efficiency, statements, notes, and error messages are suppressed.

```
libname out 'your-data-library';
options nosource nonotes errors=0;

data out.university_test_scores4;
   infile 'your-input-file';
   input test $ gender year TestScore 25-27;
run;

proc print;
   by test;
run;
```

The SAS log that appears is shown in the following output. Because the SAS system option ERRORS=0 is specified, the error limit is reached immediately, and the errors that result from trying to read Gender as a numeric value are not written to the log. Also, specifying the NOSOURCE and NONOTES system options causes the log to contain no SAS statements that can be verified and no notes to explain SAS processing. The log does contain an error message that explains that OUT.UNIVERSITY_TEST_SCORES4 is not sorted in ascending sequence. This error is not caused by invalid input data, so the ERRORS=0 option has no effect on this error.

Example Code 23.9 *Suppressing Information in the SAS Log*

```
1    libname out 'your-data-library';
NOTE: Libref OUT was successfully assigned as follows:
      Engine:        V9
      Physical Name: your-data-library
2    options nosource nonotes errors=0;
ERROR: Data set OUT.UNIVERSITY_TEST_SCORES4 is not sorted in ascending sequence. The
current BY
       group has test = Verbal and the next BY group has test = Math.
```

Note: The NOSOURCE, NONOTES, and ERRORS= system options are used to save space. They are most useful with a program that has already been tested, such as one that is run regularly. However, as demonstrated in this section, using these system options is not always appropriate. During development of a new program, the error messages in the log might be essential for debugging, and should not be limited. Similarly, notes should not be suppressed because they can help you identify problems with a program. They are especially important if you seek help in debugging your program from someone who is unfamiliar with it. You should not suppress any information in the log until you have already executed the program without errors.

The following partial output shows the results if the previous example is executed again with the SOURCE, NOTES, and ERRORS= options:

```
options source notes errors=4;

data out.university_test_scores5;
   infile 'your-input-file';
   input test $ gender year TestScore;
run;

proc print data=out.university_test_scores5;
   by test;
run;
```

Example Code 23.10 *SAS Log with Output: ERRORS=4*

```
13   libname out 'your-data-library';
NOTE: Libref OUT was successfully assigned as follows:
      Engine:        V9
      Physical Name: your-data-library
14
15   options source notes errors=4;
16
17   data out.university_test_scores5;
18      infile 'your-input-file';
19      input test $ gender year TestScore;
20   run;

NOTE: The infile 'your-input-file' is:
      Filename=your-input-file,
      RECFM=V,LRECL=32767,File Size (bytes)=544,
      Last Modified=03May2013:07:18:05,
      Create Time=01May2013:10:41:25

NOTE: Invalid data for gender in line 1 8-8.
RULE:     ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----
+----8----+--
1         Verbal m 2005 504  18
test=Verbal gender=. year=2005 TestScore=504 _ERROR_=1 _N_=1
NOTE: Invalid data for gender in line 2 8-8.
2         Verbal f 2005 496 17
test=Verbal gender=. year=2005 TestScore=496 _ERROR_=1 _N_=2
NOTE: Invalid data for gender in line 3 8-8.
3         Verbal m 2006 504  18
test=Verbal gender=. year=2006 TestScore=504 _ERROR_=1 _N_=3
NOTE: Invalid data for gender in line 4 8-8.
WARNING: Limit set by ERRORS= option reached.  Further errors of this type will not
be printed.
4         Verbal f 2006 497 17
test=Verbal gender=. year=2006 TestScore=497 _ERROR_=1 _N_=4
NOTE: 28 records were read from the infile 'your-input-file'.
      The minimum record length was 17.
      The maximum record length was 18.
NOTE: The data set OUT.UNIVERSITY_TEST_SCORES5 has 28 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.04 seconds
      cpu time            0.04 seconds



21
22   proc print data=out.university_test_scores5;
23      by test;
24   run;

ERROR: Data set OUT.UNIVERSITY_TEST_SCORES5 is not sorted in ascending sequence. The
current BY
       group has test = Verbal and the next BY group has test = Math.
NOTE: The SAS System stopped processing this step because of errors.
NOTE: There were 15 observations read from the data set OUT.UNIVERSITY_TEST_SCORES5.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.06 seconds
      cpu time            0.04 seconds
```

With this execution of the program, the log is a more effective problem-solving tool. The log includes all the SAS statements from the program, as well as many informative notes. Specifically, it includes enough messages about the invalid data for the variable Gender so that the problem can be identified. With this information, the program can be modified and rerun successfully.

Changing the Appearance of the Log

Except in an interactive session, you can customize the log by using the PAGE and SKIP statements. Use the PAGE statement to move to a new page in the log. Use the SKIP statement to skip lines in the log. With the SKIP statement, you can specify the number of lines that you want to skip. If you do not specify a number, then SAS skips one line. If the number that you specify exceeds the number of lines remaining on the page, then SAS treats the SKIP statement like a PAGE statement and skips to the top of the next page. The PAGE and SKIP statements do not appear in the log.

Summary

Statements

LIST;
: lists in the SAS log the contents of the input buffer for the observation that is being processed.

SAS Log
: *SAS Language Reference: Concepts* provides additional information about the SAS log.

PAGE;
: skips to a new page in the log.

PUT '*message*' <*variable-name*>;
PUT <*variable-list*> | <_ALL_>;
: writes lines to the SAS log, the output file, or any file that is specified in a FILE statement. If no FILE statement was executed in the current iteration of the DATA step, then the PUT statement writes to the SAS log.

  message specifies the text that you enter to be written to the log.

  variable-name specifies the variable whose value is written to the log.

  variable-list names a list of variables whose values are written to the log.

  ALL specifies that the values of all variables, including _ERROR_ and _N_, are to be written to the log.

  The PUT statement is valid in a DATA step.

  For more information, see "PUT Statement" in *SAS DATA Step Statements: Reference*.

%PUT '*message*';
: writes a message to the SAS log.

  message specifies the text that you enter to be written to the log.

You can use the %PUT macro statement anywhere in your program.

For more information, see “%PUT Macro Statement” in *SAS Macro Language: Reference*.

SKIP <*n*>;
: in the SAS log, skips the number of lines that you specify with the value *n*. If you do not specify a value, then SAS writes a blank line to the log. If you specify a number that is greater than the number of lines remaining on the page, then SAS treats the SKIP statement like a PAGE statement and skips to the top of the next page.

System Options

ERRORS=*n*
: specifies the maximum number of observations for which error messages about data input errors are written to the log.

NOTES | NONOTES
: controls whether notes are written to the log.

SOURCE | NOSOURCE
: controls whether SAS statements are written to the log.

SOURCE2 | NOSOURCE2
: controls whether secondary SAS statements from files included by %INCLUDE statements are written to the log.

Learning More

Automatic variables
: For information about the automatic variables _N_ and _ERROR_, see Chapter 25, “Diagnosing and Avoiding Errors,” on page 413.

Debugging
: For more information about debugging, see Chapter 25, “Diagnosing and Avoiding Errors,” on page 413.

FILE and PUT statements
: For more information, see Chapter 33, “Understanding and Customizing SAS Output: The Basics,” on page 637.

Log window
: For more information about the Log window, see “Working with SAS Windows” on page 792 and “The SAS Log” in *SAS Language Reference: Concepts*.

Operating environment-specific information
: The SAS documentation for your operating environment contains information about the appearance and destination of the SAS log, as well as for routing output.

The SAS environment
: For more information about starting a SAS session and the different ways that you can execute your programs, see “Introduction to the SAS Environment” on

page 771 and "Introduction to the SAS Windowing Environment" in *SAS Language Reference: Concepts*.

SAS statements
: *SAS DATA Step Statements: Reference* provides complete reference information about SAS statements that work across all operating environments. Refer to the SAS documentation for your operating environment for information about operating-environment specific options.

SAS system options
: *SAS System Options: Reference* provides complete reference information about SAS system options that work across all operating environments. Refer to the SAS documentation for your operating environment for information about operating-environment specific options.

24

Directing SAS Output and the SAS Log

Introduction to Directing SAS Output and the SAS Log

Purpose

SAS provides several methods to direct SAS output and the SAS log to different destinations. In this section, you learn how to use the following SAS language elements:

- PRINTTO procedure from within a program or session to route DATA step output, the SAS log, or procedure output from their default destinations to another destination
- FILE command, in the SAS windowing environment, to store the contents of the Log and Output windows in files
- PRINT= and LOG= system options when you invoke SAS to redefine the destination of the log and output for an entire SAS session

Prerequisites

Before proceeding with this section, you should understand the following features and concepts:

- creating DATA step or PROC step output
- locating the log and procedure output
- referencing external files

Input File and SAS Data Set for Examples

The examples in this section are based on data from university test scores. The data contains test scores for entering university classes from 2005 to 2011. For a complete listing of the input data, see "The UNIVERSITY_TEST_SCORES Data Set" on page 853. The input file has the following structure:

```
Verbal f 2009 503
Verbal m 2010 507
Verbal f 2010 503
Verbal m 2011 509
Verbal f 2011 502
Math   m 2005 521
Math   f 2005 484
Math   m 2006 524
Math   f 2006 484
```

The input file contains the following values from left to right:

- type of test
- gender of student
- year of the exam
- average score

The following program creates the data set that this section uses:

```
data test_scores;
   input Test $ Gender $ Year TestScore;
   datalines;
Verbal m 2005 504
Verbal f 2005 496
```

```
Verbal m 2006 504
Verbal f 2006 497
Verbal m 2007 501
Verbal f 2007 497
   ... more data lines ...
Math   f 2009 492
Math   m 2010 530
Math   f 2010 494
Math   m 2011 531
Math   f 2011 496
;
```

Routing the Output and the SAS Log with PROC PRINTTO

Routing Output to an Alternate Location

You can use the PRINTTO procedure to redirect SAS procedure output from the HTML destination to an alternate location. These locations are:

- a permanent file
- a SAS catalog entry
- a dummy file, which serves to suppress the output

After PROC PRINTTO executes, all procedure output is sent to the alternate location until you execute another PROC PRINTTO statement or until your program or session ends.

The default destination for the procedure output depends on how you configure SAS to handle output. For more information, see the discussion of SAS output in Chapter 34, “Understanding and Customizing SAS Output: The Output Delivery System (ODS),” on page 669 and Chapter 33, “Understanding and Customizing SAS Output: The Basics,” on page 637.

Note: If you used the Output Delivery System (ODS) to close the HTML destination, then PROC PRINTTO does not receive any output to redirect. However, the procedure results still go to the destination that you specified with ODS.

You use the PRINT= option in the PROC PRINTTO statement to specify the name of the file or SAS catalog that will contain the procedure output. If you specify a file, then either use the complete name of the file in quotation marks or use a fileref for the file. (See “Using External Files in Your SAS Job” on page 45 for more information about filerefs and filenames.) You can also specify the NEW option in the PROC PRINTTO statement so that SAS replaces the previous contents of the output file. Otherwise, SAS appends the output to any output that is currently in the file.

To route output to an alternate file, insert a PROC PRINTTO step in the program before the PROC step that generates the procedure output. The following program routes the output from PROC PRINT to an external file:

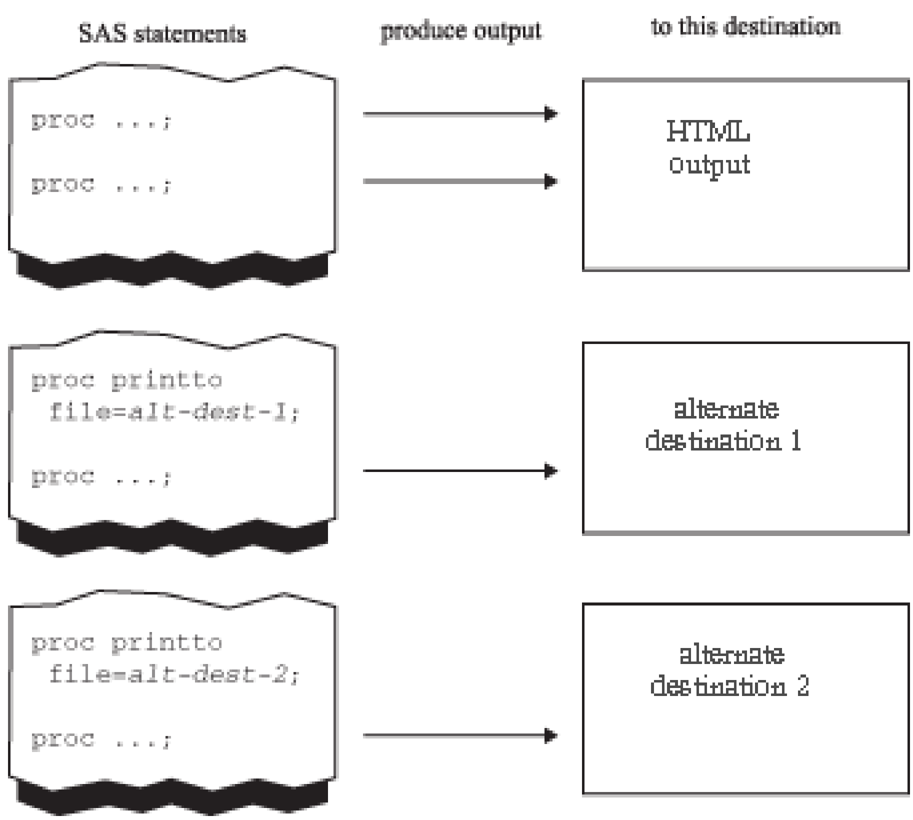
```
proc printto print='alternate-output-file' new;
run;

proc print data=test_scores;
   title 'Test Scores for Entering University Classes';
run;

proc printto;
run;
```

After the PROC PRINT step executes, *alternate-output-file* contains the procedure output. The second PROC PRINTTO step redirects output back to its default location.

The PRINTTO procedure does not produce the output. Instead, it tells SAS to route the results of all subsequent procedures until another PROC PRINTTO statement executes. Therefore, the PROC PRINTTO statement must precede the procedure whose output you want to route.

The figure below shows how SAS uses PROC PRINTTO to route procedure output. You can also use PROC PRINTTO multiple times in a program so that output from different steps of a SAS job is stored in different files.

Figure 24.1 Using PROC PRINTTO Route Output



Routing the SAS Log to an Alternate Location

You can use the PRINTTO procedure to redirect the SAS log to an alternate location. The location can be one of the following:

- a permanent file
- a SAS catalog entry
- a dummy file to suppress the log

After PROC PRINTTO executes, the log is sent either to a permanent external file or to a SAS catalog entry until you execute another PROC PRINTTO statement, or until your program or session ends.

You use the LOG= option in the PROC PRINTTO statement to specify the name of the file or SAS catalog that will contain the log. If you specify a file, then either use the complete name of the file in quotation marks or use a fileref for the file. You can also specify the NEW option in the PROC PRINTTO statement so that SAS replaces the previous contents of the file. Otherwise, SAS appends the log to any log that is currently in the file.

The following program routes the SAS log to an alternate file:

```
proc printto log='alternate-log-file';
run;
```

After the PROC PRINT step executes, *alternate-log-file* contains the SAS log.

Restoring the Default Destination

Specify the PROC PRINTTO statement with no argument when you want to route the log and the output back to their default destinations:

```
proc printto;
run;
```

You might want to return only the log or only the procedure output to its default destination. The following PROC PRINTTO statement routes only the log back to the default destination:

```
proc printto log=log;
run;
```

The following PROC PRINTTO statement routes only the procedure output to the default destination:

```
proc printto print=print;
run;
```

Storing the Output and the SAS Log in the SAS Windowing Environment

Understanding the Default Destination

Within the SAS windowing environment, the default destination for most procedure output is HTML output that appears in the Results Viewer window. However, you can use the Output Delivery System (ODS) to change the format of your output.

Each time you execute a procedure within a single session, SAS appends the output to the existing output. To view the results, you can use one of the following methods:

- scroll the Results Viewer window, which contains the output in the order in which you generated it
- use the Results window to select a pointer that is a link to the procedure output

The SAS windowing environment interacts with certain aspects of ODS to format, control, and manage your output.

In the SAS windowing environment, the default destination for the SAS log messages is the Log window. When you execute a procedure, SAS appends the log messages to the existing log messages in the Log window. You can scroll the Log window to see the results. To print your log messages, execute the PRINT command. To clear the contents of the Log window, execute the CLEAR command. When your session ends, SAS automatically clears the window.

Within the SAS windowing environment, you can use the PRINTTO procedure to route log messages or procedure output to a location other than the default location, just as you can in other methods of operation. For details, see "Routing the Output and the SAS Log with PROC PRINTTO" on page 405. You can also use ODS to change the format of the procedure output.

For additional information about using ODS, viewing procedure output, and changing the format of the procedure output, see Chapter 33, "Understanding and Customizing SAS Output: The Basics," on page 637.

Storing the Contents of the Output and Log Windows

If you want to store a copy of the contents of the Results Viewer or Log window in a file, then use the FILE command. On the command line, specify the FILE command followed by the name of the file:

file '*file-to-store-contents-of-window*'

SAS has a built-in safeguard that prevents you from accidentally overwriting a file. If you inadvertently specify an existing file, then a dialog box appears. The dialog box asks you to choose a course of action, provides you with information, and might prevent you from overwriting the file by mistake. You are asked whether to:

- replace the contents of the file
- append the contents of the file
- cancel the FILE command

Redefining the Default Destination in a Batch or Noninteractive Environment

Determining the Default Destination

Usually, in a batch or noninteractive environment, SAS routes procedure output to the listing file and routes the SAS log to a log file. These files are usually defined by your installation and are created automatically when you invoke SAS. Contact your on-site SAS support personnel if you have questions pertaining to your site.

Changing the Default Destination

If you want to redefine the default destination for procedure output, then use the PRINT= system option. If you want to redefine the default destination for the SAS log, then use the LOG= system option. You specify these options only at initialization.

Operating Environment Information: The way that you specify output destinations when you use SAS system options depends on your operating environment. For details, see the SAS documentation for your operating environment.

Options that you must specify at initialization are called configuration options. The configuration options affect the following:

- the initialization of the SAS System
- the hardware interface
- the operating system interface

In contrast to other SAS system options, which affect the appearance of output, file handling, use of system variables, or processing of observations, you cannot change configuration options in the middle of a program. You specify configuration options when SAS is invoked, either in the configuration file or in the SAS command.

Understanding the Configuration File

The configuration file is a special file that contains configuration options as well as other SAS system options and their settings. Each time you invoke SAS, the settings of the configuration file are examined. You can specify the options in the configuration file in the same format as they are used in the SAS command for your operating environment. For example, under UNIX this file's contents might include the following:

```
WORK=WORK
SASUSER=SASUSER
EXPLORER
```

SAS automatically sets the options as they appear in the configuration file. If you specify options both in the configuration file and in the SAS command, then the options are concatenated. If you specify the same option in the SAS command and in the configuration file, then the setting in the SAS command overrides the setting in the file. For example, specifying the NOEXPLORER option in the SAS command overrides the EXPLORER option in the configuration file and tells SAS to start your session without displaying the Explorer window.

Summary

PROC PRINTTO Statement Options

PROC PRINTTO <PRINT='*alternate-output-file*'> <LOG='*alternate-log-file*'> <NEW>;

PRINT='*alternate-output-file*'
: identifies the location and routes the procedure output to this alternate location.

LOG='*alternate-log-file*'
: identifies the location and routes the SAS log to this alternate location.

NEW
: specifies that the current log or procedure output writes over the previous contents of the file.

SAS Windowing Environment Commands

CLEAR
: clears the contents of a window, as specified.

FILE <*file-to-store-contents-of-window*>
: routes a copy of the contents of a window to the file that you specify. The original contents remain in place.

PRINT
: writes the contents of the window.

SAS System Options

LOG=*system-filename*
: redefines the default destination for the SAS log to the file named *system-filename*.

PRINT=*system-filename*
: redefines the default destination for procedure output to the file named *system-filename*.

Learning More

Output Delivery System
: For complete reference documentation about the Output Delivery System, see *SAS Output Delivery System: User's Guide*.

PROC PRINTTO
: For complete reference documentation, see "PRINTTO Procedure" in *Base SAS Procedures Guide*.

SAS environment
: For details about the methods of operating SAS and interactive processing in the windowing environment, see Chapter 40, "Introducing the SAS Environment," on page 771, Chapter 41, "Using the SAS Windowing Environment," on page 783, and Chapter 42, "Customizing the SAS Environment," on page 829.

SAS log
: For complete reference information about the SAS log and procedure output, see *SAS Language Reference: Concepts*.

SAS system options
: For details about SAS system options, including configuration options, see *SAS System Options: Reference*.

: For operating-environment specific information about routing output, the PRINT= option, LOG= option, and other SAS system options, see the SAS documentation for your operating environment.

25

Diagnosing and Avoiding Errors

Introduction to Diagnosing and Avoiding Errors

Purpose

In this section, you will learn how to diagnose errors in your programs by learning about the following concepts:

- how the SAS Supervisor checks a program for errors
- how to distinguish among the types of errors
- how to interpret the notes, warning messages, and error messages in the log
- what to check for as you develop a program

Prerequisites

You should understand the concepts that are presented in the following sections:

- Chapter 3, “Introduction to DATA Step Processing,” on page 25
- Chapter 4, “Starting with Raw Data: The Basics,” on page 51
- Chapter 7, “Understanding DATA Step Processing,” on page 109
- Chapter 23, “Analyzing Your SAS Session with the SAS Log,” on page 377

Understanding How the SAS Supervisor Checks a Job

To better understand the errors that you make so that you can avoid them in the future, it is important to understand how the SAS Supervisor checks a job. The SAS Supervisor is the part of SAS that is responsible for executing SAS programs. To check the syntax of a SAS program, the SAS Supervisor does the following:

- reads the SAS statements and data
- translates the program statements into executable machine code or intermediate code
- creates data sets
- calls SAS procedures, as requested
- writes error messages
- ends the job

The SAS Supervisor knows the following information about DATA and PROC steps:

- the forms and types of statements that can be present in a DATA step
- the types of statements and the options that can be present in a PROC step

To process a program, the SAS Supervisor scans all the SAS statements and breaks each statement into words. Each word is processed separately. When all the words in a step are processed, the step is executed. If the SAS Supervisor detects an error, then it flags the error at its location and writes an explanation in the log. The SAS Supervisor assumes that anything that it does not recognize is an error.

Understanding How SAS Processes Errors

When SAS detects an error, it usually underlines the error in the log or underlines the point at which it detects the error, identifying the error with a number. Each number is uniquely associated with an error message. Then SAS enters syntax check mode, and reads the remaining program statements, checks their syntax, and underlines additional errors if necessary.

In a batch or noninteractive program, an error in a DATA step statement causes SAS to remain in syntax check mode for the rest of the program. It does not execute any more DATA or PROC steps that create external files or SAS data sets. Procedures that are read from SAS data sets execute with 0 observations, and procedures that do not read SAS data sets execute normally. A syntax error in a PROC step usually affects only that step. At the end of the step, SAS writes a message in the log for each error that is detected.

Distinguishing Types of Errors

SAS Programming Errors

The following types of errors can occur when SAS compiles and executes your program:

- syntax
- execution-time
- data
- semantic

Syntax Errors

Syntax errors are errors that are made in the SAS statements of a program. They occur when program statements do not conform to the rules of the SAS language. SAS detects syntax errors as it compiles each DATA and PROC step. These are some of the types of syntax errors:

- misspelled SAS keywords
- unmatched quotation marks
- missing or invalid punctuation
- invalid statement or data set options

Execution-time Errors

Execution-time errors cause a program to fail when it is submitted for execution. Most execution-time errors that are not serious produce notes in the SAS log, but the program is allowed to run to completion. However, for more serious errors, SAS issues error messages and stops all processing. These are some of the types of execution-time errors:

- invalid arguments to functions
- invalid mathematical operations, such as division by 0
- observations in the wrong order for BY-group processing
- references to a nonexistent member of an array
- INPUT statements that do not match the data lines
- an incorrect reference in an INFILE statement (for example, misspelling or otherwise incorrectly stating the external file)

Data Errors

Data errors are a type of execution-time error. Data errors occur when the raw data that you are analyzing with a SAS program contains invalid values. For example, a data error occurs if you specify a numeric variable in an INPUT statement when the data is character data. Data errors do not cause a program to stop. Instead, they generate notes in the SAS log. These are some of the types of data errors:

- defining a variable as numeric when the data value is actually character
- generating missing values as a result of performing an operation on missing values
- reading a variable with an INPUT statement when the variable is not in the correct position in a file
- using the Sum statement with character variables

Semantic Errors

Semantic errors are another type of an execution-time error. They occur when the form of a SAS statement is correct, but some elements are not valid in a particular usage. These are some of the types of semantic errors:

- specifying the wrong number of arguments for a function
- using a numeric variable name where only character variables are valid
- using invalid references to an array
- using a libref that has not yet been assigned

Diagnosing Errors

Examples in This Section

Many of the programs in this section use university test scores to illustrate errors in the SAS log. Other programs in this section use other data.

Diagnosing Syntax Errors

When SAS Detects a Syntax Error

The SAS Supervisor detects syntax errors as it compiles each step, and then SAS does the following:

- writes the word ERROR to the log
- identifies the error's location
- writes an explanation of the error

Example: Missing Semicolon and Misspelled Keyword

In the following program, the CHART procedure is used to analyze data. Note that a semicolon in the DATA statement is omitted, and the keyword INFILE is misspelled.

```
libname out 'your-data-library';

data out.error1
   infill 'your-input-file';
   input test $ gender $ year TestScore;
run;

proc chart data=out.error1;
   hbar test / sumvar=TestScore type=mean group=gender discrete;
run;
```

The following output shows the result of the two syntax errors:

Example Code 25.1 *Diagnosing Syntax Errors: Missing Semicolon and Misspelled Keyword*

```
11   libname out 'your-data-library';
NOTE: Libref OUT was successfully assigned as follows:
      Engine:        V9
      Physical Name: your-data-library
12
13   data out.error1
14      infill 'your-input-file';
15      input test $ gender $ year TestScore;
16   run;

ERROR: No DATALINES or INFILE statement.
ERROR: Extension for physical file name "your-input-file" does not
       correspond to a valid member type.
NOTE: The SAS System stopped processing this step because of errors.
WARNING: The data set OUT.ERROR1 may be incomplete.  When this step was stopped
there were 0
         observations and 4 variables.
WARNING: Data set OUT.ERROR1 was not replaced because this step was stopped.
WARNING: The data set WORK.INFILL may be incomplete.  When this step was stopped
there were 0
         observations and 4 variables.
WARNING: Data set WORK.INFILL was not replaced because this step was stopped.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


17
18   proc chart data=out.error1;
19      hbar test / sumvar=TestScore type=mean group=gender discrete;
20   run;

NOTE: No observations in data set OUT.ERROR1.
NOTE: PROCEDURE CHART used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

As the log indicates, SAS recognizes the keyword DATA and attempts to process the DATA step. Because the DATA statement must end with a semicolon, SAS assumes that INFILL is a data set name, and that two data sets are being created: OUT.ERROR1 and WORK.INFILL. Because SAS considers INFILL the name of a data set, it does not recognize it as part of another statement, and therefore does not detect the spelling error. Because the string in quotation marks is invalid in a DATA statement, SAS stops processing here and created no observations for either data set.

SAS attempts to execute the program logically based on the statements that it contains, according to the steps outlined earlier in this section. The second syntax error, the misspelled keyword, is never recognized because SAS considers the DATA statement to be in effect until a semicolon ends the statement. The point to remember is that when multiple errors are made in the same program, not all of them might be detected the first time the program is executed. Errors might also be flagged differently in a group than if they were made alone. You might find that one correction uncovers another error or at least changes its explanation in the log.

To illustrate this point, the previous program is executed again with the semicolon added to the DATA statement. An attempt to correct the misspelled keyword introduces a different spelling error, as shown below:

```
libname out 'your-data-library';
```

```
data out.error2;
   unfile 'your-input-file';
   input test $ gender $ year TestScore;
run;

proc chart data=out.error2;
   hbar test / sumvar=TestScore type=mean group=gender discrete;
run;
```

Example Code 25.2 *Diagnosing Syntax Errors: Misspelled Keyword*

```
19   libname out 'your-data-library';
NOTE: Libref OUT was successfully assigned as follows:
      Engine:        V9
      Physical Name: your-data-library
20

21   data out.error2;
22      unfile 'your-input-file';
        ------
        180
ERROR 180-322: Statement is not valid or it is used out of proper order.

23      input test $ gender $ year TestScore;
24   run;

ERROR: No DATALINES or INFILE statement.
NOTE: The SAS System stopped processing this step because of errors.
WARNING: The data set OUT.ERROR2 may be incomplete.  When this step was stopped
there were 0
         observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds



25
26   proc chart data=out.error2;
27      hbar test / sumvar=TestScore type=mean group=gender discrete;
28   run;

NOTE: No observations in data set OUT.ERROR2.
NOTE: PROCEDURE CHART used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

With the semicolon added, SAS now attempts to create only one data set. From then on, SAS reads the SAS statements as it did before, and issues many of the same messages. However, this time SAS considers the UNFILE statement invalid or out of proper order, and it creates no observations for the data set.

If this example is rerun with the correct spelling for INFILE but with a misspelling of the filename in the INFILE statement, then the error is detected at execution time and the data is not read.

Example: Missing Semicolon in SET Statement

The following example shows the SAS log when you use a SET statement without a semicolon. The first DATA step creates the data set INSURANCE. The SET statement in the second DATA step uses INSURANCE as input. The SAS log shows that an error was encountered.

```
data insurance;
   input PolicyNum $ Name $ Amount 23-27 District $;
   datalines;
4356 Susan Bellingham 45000 North
2678 James Hastings   35000 West
4967 Jan Spiro        49000 North
1367 Robert Hernandez 63000 South
7366 Walter Peters    66000 East
;
run;

data policy;
   set insurance
run;

proc print data=policy;
run;
```

Example Code 25.3 *Log Output for a Missing Semicolon in a SET Statement*

```
44   data insurance;
45      input PolicyNum $ Name $ Amount 23-27 District $;
46      datalines;

NOTE: The data set WORK.INSURANCE has 5 observations and 4 variables. 1
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


52   ;
53   run;
54
55   data policy;
56      set insurance
57   run;
ERROR: File WORK.RUN.DATA does not exist.  2
58

NOTE: The SAS System stopped processing this step because of errors.  3
WARNING: The data set WORK.POLICY may be incomplete.  When this step was stopped
there were 0
         observations and 4 variables.  4
WARNING: Data set WORK.POLICY was not replaced because this step was stopped.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds



59   proc print data=policy;
60   run;

NOTE: No observations in data set WORK.POLICY.  5
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

The following list corresponds to the numbered items in the preceding log:

1 SAS successfully creates the INSURANCE data set.

2 SAS encounters an error when the SET statement in the second DATA step is read (the semicolon is missing as the end of the statement). SAS continues to read the next line until it encounters a semicolon.

3 The note indicates that the program stopped processing.

4 The warning message indicates that there are no observations in the POLICY data set.

5 The PRINT procedure produces no output because the POLICY data set is empty.

To correct the program error, add a semicolon after the SET statement. Execute your program again.

Diagnosing Execution-time Errors

When SAS Detects an Execution-time Error

Several types of errors are detected at execution time. Errors occur when the language element is correct, but the element might not be valid for a particular usage.

When the SAS Supervisor encounters an execution-time error, it does the following:

- writes a note, warning, or error message to the log, depending on the seriousness of the error
- in some cases, lists the values that are stored in the program data vector
- continues or stops processing, depending on the seriousness of the error

Example: Misspelled Input File

If the following program executes with the correct spelling for INFILE but with a misspelling of the filename in the INFILE statement, then the error is detected at execution time and the data is not read.

```
   /* misspelled filename in the INFILE statement */
libname out 'your-data-library';

data out.error3;
   infile 'an-incorrect-filename';
   input test $ gender $ year TestScore;
run;

proc chart data=out.error3;
   hbar test / sumvar=TestScore type=mean group=gender discrete;
run;
```

Example Code 25.4 *Log Output for a Misspelled Input File*

```
29      /* misspelled filename in the INFILE statement */
30   libname out 'your-data-library';
NOTE: Libref OUT was successfully assigned as follows:
      Engine:        V9
      Physical Name: your-data-library
31
32   data out.error3;
33      infile 'your-input-file';
34      input test $ gender $ year TestScore @@;
35   run;

ERROR: Physical file does not exist, your-input-file.
NOTE: The SAS System stopped processing this step because of errors.
WARNING: The data set OUT.ERROR3 may be incomplete.  When this step was stopped
there were 0
         observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds



36
37   proc chart data=out.error3;
38      hbar test / sumvar=TestScore type=mean group=gender discrete;
39   run;

NOTE: No observations in data set OUT.ERROR3.
NOTE: PROCEDURE CHART used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

As the log indicates, SAS cannot find the file. SAS stops processing because of errors and creates no observations in the data set.

Diagnosing Data Errors

When SAS Detects a Data Error

Data errors occur when data values are invalid. When SAS detects data errors during execution, it continues processing, and writes the following information to the SAS log:

- a note that describes the error
- a list of values that are stored in the input buffer
- a list of values that are stored in the program data vector

Note that the values that are listed in the program data vector include two variables that are created automatically by SAS:

_N_
: counts the number of times the DATA step iterates.

ERROR
: indicates the occurrence of an error during an execution of the DATA step. The value that is assigned to the variable _ERROR_ is 0 when no error is encountered and 1 when an error is encountered.

These automatic variables are assigned temporarily to each observation, and are not stored with the data set.

Example: Invalid Raw Data

The following program uses raw input data that is not aligned correctly in the columns that are described in the INPUT statement. The sixth data line is shifted two spaces to the right, and the rest of the data lines, except for the first, are shifted one space to the right. The program uses formats to determine how variable values are written:

```
   /* data in wrong columns */
proc format;
   value xscore . ='accurate scores unavailable';
run;

data out.error4;
   input test $ 1-8 gender $ 18 year 20-23 TestScore 25-27;
   format TestScore xscore.;
   datalines;
verbal           m 2008 463
 verbal           f 2008 468
 verbal           m 2011 459
 verbal           f 2011 461
 math             m 2008 514
  math             f 2008 467
 math             m 2011 509
 math             f 2011 509
 ;

proc print data=out.error4;
   title 'Viewing Incorrect Output';
run;
```

The following output shows the results of the SAS program.

Figure 25.1 *Detecting Data Errors in Raw Data*

Viewing Incorrect Output

Obs	test	gender	year	TestScore
1	verbal	m	2008	463
2	verbal		200	46
3	verbal		201	45
4	verbal		201	46
5	math		200	51
6	math		.	accurate scores unavailable
7	math		201	50
8	math		201	50

This program generates output, but it is not the expected output. The first observation appears to be correct, but subsequent observations have the following problems:

- The values for the variable Gender are missing.
- Only the first three digits of the value for the variable Year are shown, except in the sixth observation, where a missing value is indicated.
- The third digit of the value for the variable TestScore is missing, except in the sixth observation, which does show the assigned value for the missing value.

The following SAS log explains program processing:

Example Code 25.5 *Diagnosing Data Errors*

```
61      /* data in wrong columns */
62   proc format;
63      value xscore . ='accurate scores unavailable';
NOTE: Format XSCORE has been output.
64   run;

NOTE: PROCEDURE FORMAT used (Total process time):
      real time           0.01 seconds
      cpu time            0.00 seconds


65
66   data out.error4;
67      input test $ 1-8 gender $ 18 year 20-23 TestScore 25-27;
68      format TestScore xscore.;
69      datalines;

NOTE: Invalid data for year in line 75 20-23.
NOTE: Invalid data for TestScore in line 75 25-27.
RULE:      ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----
+----8----+-
75          math            f 2008 467
test=math gender=  year=. TestScore=accurate scores unavailable _ERROR_=1 _N_=6
NOTE: The data set OUT.ERROR4 has 8 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds


78    ;
79
80   proc print data=out.error4;
81      title 'Viewing Incorrect Output';
82   run;

NOTE: There were 8 observations read from the data set OUT.ERROR4.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds
```

The errors are flagged, starting with the first message that line 75 contains invalid data for the variable Year. The rule indicates that input data has been written to the log. SAS lists in the log the values that are stored in the program data vector. The following lines from the log indicate that SAS encountered an error:

```
NOTE: Invalid data for year in line 75 20-23.
NOTE: Invalid data for TestScore in line 75 25-27.
RULE:      ----+----1----+----2----+----3----+----4----+----5----+----6
----+----7----+----8----+-
16          math             f 2008 467
test=math gender=  year=. TestScore=accurate scores unavailable _ERROR_=1 _N_=6
```

Missing values are shown for the variables Gender and Year. The notes in the log indicate that the sixth line of input contained the error. The _ERROR_ automatic variable indicates that an error has occurred, and the _N_ automatic variable identifies the sixth iteration of the DATA step as having the error.

To debug the program, either the raw data can be repositioned or the INPUT statement can be rewritten. Remember that all data lines, except the first, were shifted at least one space to the right. The variable Test was unaffected, but the variable Gender was completely removed from its designated field, except in the first observation. Therefore, SAS reads the variable Gender as a missing value for the second through the eighth observation. In the sixth observation, for which the data was shifted to the right an additional space, the character value for Gender occupied part of the field for the numeric variable Year. When SAS encounters the invalid data, it treats the value as a missing value but also notes in the log that the data is invalid. It is important to remember that SAS can use only the information that you provide, not what you intended to provide. For valid output, your input data must be valid.

Diagnosing Semantic Errors

When SAS Detects a Semantic Error

Semantic errors occur when the language element is correct, but the element might not be valid for a particular usage.

Example: Missing Argument in a Function

The following example shows the SAS log when SAS encounters a semantic error. The example uses the COUNT function to find the number of times that a substring, in this case "th", appears within the character string "This is the thistle." The COUNT function has two arguments. The first argument contains the string that is to be searched. The second argument contains the string that is searched for. An error occurs if you use only one argument with the COUNT function, as the following example shows.

```
data _null_;
   x='This is the thistle.';
   y='th';
   occurrences=count(x);
   put occurrences=;
run;
```

Example Code 25.6 *Missing Argument in a Function*

```
data _null_;
   x='This is the thistle.';
   y='th';
   occurrences=count(x);
               -----
               71
ERROR 71-185: The COUNT function call does not have enough arguments.

   put occurrences=;
run;

NOTE: The SAS System stopped processing this step because of errors.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

An error occurred because one of the arguments for the COUNT function is missing. To correct the error, add the second argument to COUNT. (The syntax for the COUNT function is `count(`*`string`*`, `*`substring`*`);`.) Execute the program again. SAS searches the string for any character string that matches "th". Because the COUNT function identifies two occurrences of "th", the value of Occurrences is 2. Notice that the first word in the string is uppercase and therefore does not match "th".

Using a Quality Control Checklist

If you follow some basic guidelines as you develop a program, then you can avoid common errors. Use the following checklist to flag and correct common mistakes before you submit your program.

- Check the syntax of your program. In particular, check that the following items are correct:
  - All SAS statements must end with a semicolon. Make sure that you have not omitted any semicolons or accidentally entered the wrong character.
  - Any starting and ending quotation marks must match. You can use either single or double quotation marks.
  - Most SAS statements begin with a SAS keyword. (Exceptions are assignment statements and Sum statements.) Make sure that you have not misspelled or omitted any of the keywords.
  - Every DO and SELECT statement must be followed by an END statement.
- Check the order of your program.

  SAS usually executes the statements in a DATA step one by one, in the order in which they appear. After executing the DATA step, SAS moves to the next step and continues in the same way. Make sure that all the SAS statements appear in order so that SAS can execute them properly. For example, an INFILE statement, if used, must precede an INPUT statement.

  Also, be sure to end steps with the RUN statement. This is especially important at the end of your program because the RUN statement causes the previous step to be executed.

- Check your INPUT statement and your data.

  SAS classifies all variables as either character or numeric. The assignment in the INPUT statement as either character or numeric must correspond to the actual values of variables in your data. Also, SAS allows for list, column, formatted, or named input. The method of input that you specify in the INPUT statement must correspond with the actual arrangement of raw data.

Learning More

INFILE statement options
: The "INFILE Statement" in *SAS DATA Step Statements: Reference* contains information about using the MISSOVER and STOPOVER options in the INFILE statement as debugging tools.

  The MISSOVER option prevents a SAS program from going past the end of a line to read values with list input if it does not find values in the current line for all INPUT statement variables. SAS then assigns missing values to variables for which no values appear in the current input line.

  The STOPOVER option stops processing the DATA step when an INPUT statement that uses list input reaches the end of the current record without finding values for all variables in the statement. SAS then sets _ERROR_ to 1, stops building the data set, and writes an incomplete data line.

PUT statement
: For information about the PUT statement, see "PUT Statement" in *SAS DATA Step Statements: Reference*.

Program data vector and input buffer
: "Introduction to DATA Step Processing" on page 26, and "Introduction to Raw Data" on page 52 contain information about the program data vector and the input buffer.

The SAS log
: Chapter 23, "Analyzing Your SAS Session with the SAS Log," on page 377 contains information about the SAS log and its structure. "The SAS Log" in *SAS Language Reference: Concepts* contains more information about the SAS log.

SAS output
: "SAS Output" in *SAS Language Reference: Concepts* contains more information about SAS output.

Your SAS session
: Other sections provide more information about your SAS session. "Introduction to Analyzing Your SAS Session with the SAS Log" on page 378 discusses log structure, types of messages in the log, and the log in relation to output.

26

Finding Logic Errors in Your Program

Finding Logic Errors in Your Program

Purpose

The DATA step debugger, which consists of windows and a group of commands, helps you to interactively identify logic errors, and sometimes data errors, in your SAS programs. Unlike syntax errors, logic errors do not stop a program from running. Instead, logic errors cause the program to produce unexpected results. For example, if you create a DATA step that keeps track of inventory, and your program shows that you are out of stock but your warehouse is full, you have a logic error in your program.

Prerequisites

Before continuing with this session, you should understand the concepts that are presented in the following sections:

- Chapter 3, "Introduction to DATA Step Processing," on page 25
- Chapter 7, "Understanding DATA Step Processing," on page 109

Using the DATA Step Debugger

By issuing commands, you can execute DATA step statements one by one and pause to display the resulting variable values in a window. By observing the results that are displayed, you can determine where the logic error lies. Because the debugger is interactive, you can repeat the process of issuing commands and observing the results as many times as needed in a single debugging session. To invoke the debugger, add the DEBUG option to the DATA statement and execute the program.

The DATA step debugger enables you to perform these tasks:

- execute statements one by one or in groups
- bypass the execution of one or more statements
- suspend execution at selected statements, either in each iteration of DATA step statements or on a condition that you specify, and resume execution on command
- monitor the values of selected variables and suspend execution at the point a value changes
- display the values of variables and assign new values to them
- display the attributes of variables
- receive help for individual debugger commands
- assign debugger commands to function keys
- use the macro facility to generate customized debugger commands

The following section provides usage information and examples.

For a list of debugger commands and their descriptions, see "DATA Step Debugger Commands" on page 861.

Basic Usage

How a Debugger Session Works

When you submit a DATA step with the DEBUG option, SAS compiles the step, displays the debugger windows, and pauses until you enter a debugger command to begin execution. For example, if you begin execution with the GO command, SAS executes each statement in the DATA step. To suspend execution at a particular line in the DATA step, use the BREAK command to set breakpoints at statements that you select. Then issue the GO command. The GO command starts or resumes execution until the breakpoint is reached.

To execute the DATA step one statement at a time or a few statements at a time, use the STEP command. By default, the STEP command is mapped to the ENTER key.

In a debugging session, statements in a DATA step can iterate as many times as they would outside the debugging session. When the last iteration has finished, a message appears in the DEBUGGER LOG window.

You cannot restart DATA step execution in a debugging session after the DATA step finishes executing. You must resubmit the DATA step in your SAS session. However, you can examine the final values of variables after execution has ended.

You can debug only one DATA step at a time. You can use the debugger only with a DATA step, and not with a PROC step.

Restriction: The DATA step debugger debugs only a single DATA step. If the code you are debugging contains code other than a single DATA step, the debugger stops with errors. For more information, see "Troubleshooting the Debugger" on page 445.

Using the Windows

The DATA step debugger contains two primary windows, the DEBUGGER LOG and the DEBUGGER SOURCE windows. The windows appear when you execute a DATA step with the DEBUG option.

The DEBUGGER LOG window records the debugger commands that you issue and their results. The last line is the debugger command line, where you issue debugger commands. The debugger command line is marked with a greater than (>) prompt.

The DEBUGGER SOURCE window contains the SAS statements that comprise the DATA step that you are debugging. The window enables you to view your position in the DATA step as you debug your program. In the window, the SAS statements have the same line numbers as they do in the SAS log.

You can enter windowing environment commands on the window command lines. You can also execute commands by using function keys.

Entering Commands

For a list of commands, see "DATA Step Debugger Commands" on page 861.

Enter DATA step debugger commands on the debugger command line. Follow these rules when you enter a command:

- A command can occupy only one line (except for a DO group).
- A DO group can extend over more than one line.
- To enter multiple commands, separate the commands with semicolons:

```
examine _all_; set letter='bill'; examine letter
```

Working with Expressions

All SAS operators that are described in "SAS Operators in Expressions" in *SAS Language Reference: Concepts* are valid in debugger expressions. Debugger expressions cannot contain functions.

A debugger expression must fit on one line. You cannot continue an expression on another line.

Assigning Commands to Function Keys

To assign debugger commands to function keys, open the Keys window. Position your cursor in the Definitions column of the function key that you want to assign, and begin the command with the term DSD. To assign more than one command to a function key, enclose the commands (separated by semicolons) in quotation marks. Be sure to save your changes. These examples show commands assigned to function keys:

- `dsd step3`
- `dsd 'examine cost saleprice; go 120;'`

Using the Macro Facility with the Debugger

Using Macros as Debugging Tools

You can use the SAS macro facility with the debugger to invoke macros from the DEBUGGER LOG command line. You can also define macros and use macro program statements, such as %LET, on the debugger command line.

Macros are useful for storing a series of debugger commands. Executing the macro at the DEBUGGER LOG command line then generates the entire series of debugger commands. You can also use macros with parameters to build different series of debugger commands based on various conditions.

Creating Customized Debugging Commands with Macros

You can create a customized debugging command by defining a macro on the DEBUGGER LOG command line. Then invoke the macro from the command line. For example, to examine the variable COST, to execute five statements, and then to examine the variable DURATION, define the following macro (in this case the macro is called EC). Note that the example uses the alias for the EXAMINE command.

```
%macro ec; ex cost; step 5; ex duration; %mend ec;
```

To issue the commands, invoke macro EC from the DEBUGGER LOG command line:

```
%ec
```

The DEBUGGER LOG displays the value of COST, executes the next five statements, and then displays the value of DURATION.

Note: Defining a macro on the DEBUGGER LOG command line enables you to use the macro only during the current debugging session, because the macro is not permanently stored. To create a permanently stored macro, use the Program Editor.

Debugging a DATA Step Generated by a Macro

You can use a macro to generate a DATA step, but debugging a DATA step that is generated by a macro can be difficult. The SAS log displays a copy of the macro, but not the DATA step that the macro generated. If you use the DEBUG option at this point, the text that the macro generates appears as a continuous stream to the debugger. As a result, there are no line breaks where execution can pause.

To debug a DATA step that is generated by a macro:

1. Use the MPRINT and MFILE system options when you execute your program.
2. Assign the fileref MPRINT to an existing external file. MFILE routes the program output to the external file. Note that if you rerun your program, current output appends to the previous output in your file.
3. Invoke the macro from a SAS session.
4. In the Editor window, issue the INCLUDE command or use the File menu to open your external file.
5. Add the DEBUG option to the DATA statement and begin a debugging session.
6. When you locate the logic error, correct the portion of the macro that generated that statement or statements.

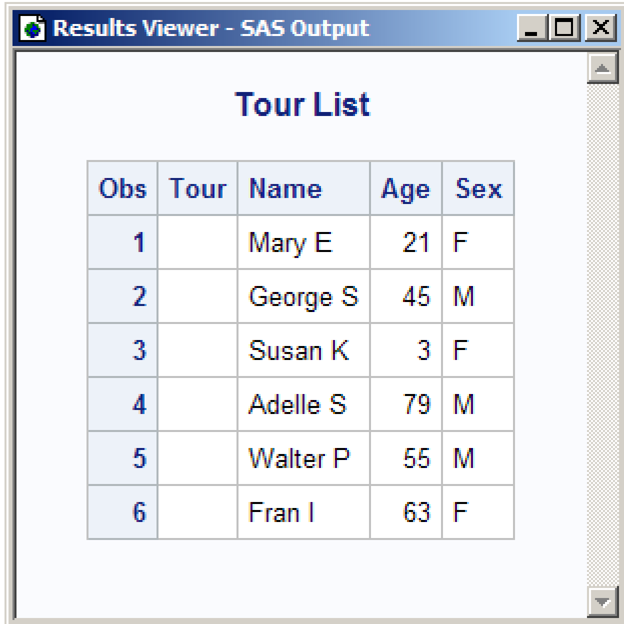
Examples

Example 1: Debugging a Simple DATA Step When Output Is Missing

Discovering a Problem

This program creates information about a travel tour group. The data files contain two types of records. One type contains the tour code, and the other type contains customer information. The program creates a report listing tour number, name, age, and gender for each customer.

```
/* first execution */
data tours (drop=type);
   input @1 type $ @;
   if type='H' then do;
      input @3 Tour $20.;
      return;
      end;
   else if type='P' then do;
      input @3 Name $10. Age 2. +1 Sex $1.;
      output;
      end;
   datalines;
H Tour 101
P Mary E    21 F
P George S  45 M
P Susan K    3 F
H Tour 102
P Adelle S  79 M
P Walter P  55 M
P Fran I    63 F
;

proc print data=tours;
   title 'Tour List';
run;
```



Tour List

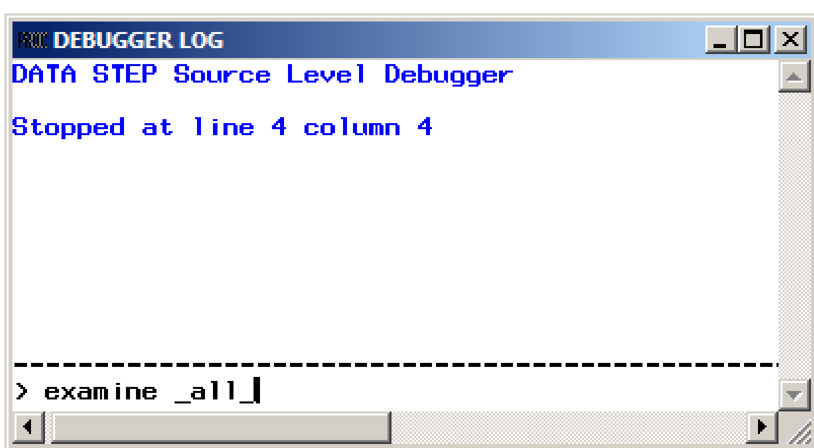
Obs	Tour	Name	Age	Sex
1		Mary E	21	F
2		George S	45	M
3		Susan K	3	F
4		Adelle S	79	M
5		Walter P	55	M
6		Fran I	63	F

The program executes without error, but the output is unexpected. The output does not contain values for the variable Tour. Viewing the SAS log will not help you debug the program because the data are valid and no errors appear in the log. To help identify the logic error, run the DATA step again using the DATA step debugger.

Examining Data Values after the First Iteration

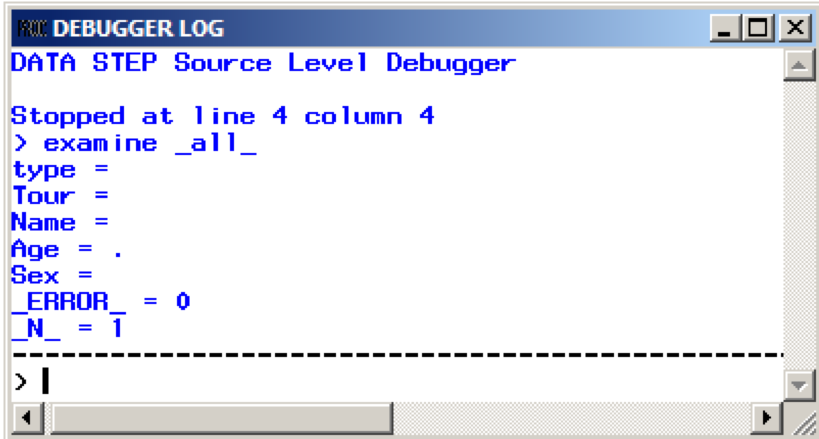
To debug a DATA step, create a hypothesis about the logic error and test it by examining the values of variables at various points in the program. For example, issue the EXAMINE command from the debugger command line to display the values of all variables in the program data vector before execution begins:

```
examine _all_
```



Note: Most debugger commands have abbreviations, and you can assign commands to function keys. The examples in this section, however, show the full command.For a list of all commands, see "DATA Step Debugger Commands".

When you press ENTER, the following display appears:



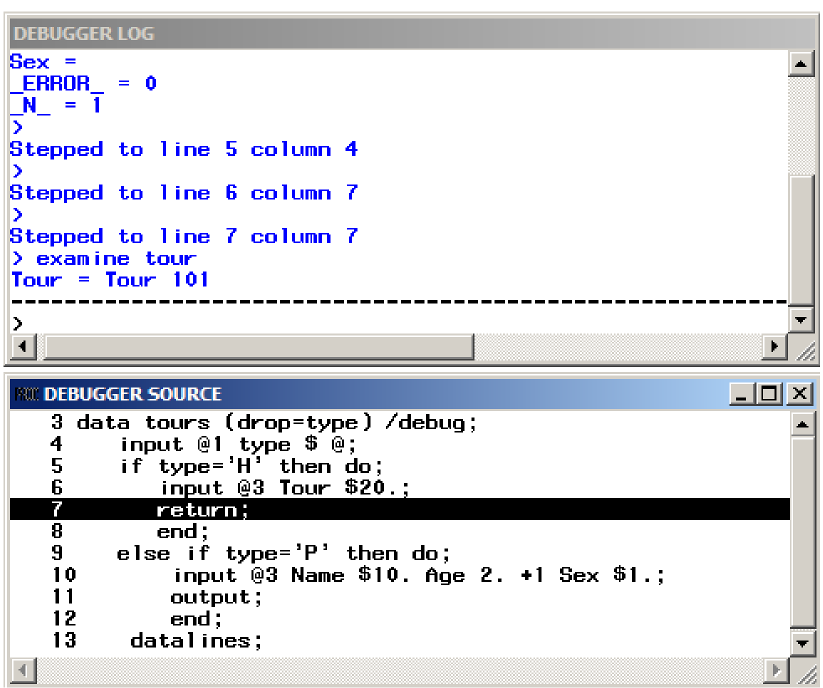
The values of all variables appear in the DEBUGGER LOG window. SAS has compiled, but not yet executed, the INPUT statement.

Use the STEP command to execute the DATA step statements one at a time. By default, the STEP command is assigned to the ENTER key. Press ENTER repeatedly to step through the first iteration of the DATA step, and stop when the RETURN statement in the program is highlighted in the DEBUGGER SOURCE window.

Because Tour information was missing in the program output, enter the EXAMINE command to view the value of the variable Tour for the first iteration of the DATA step.

```
examine tour
```

The following display shows the results:



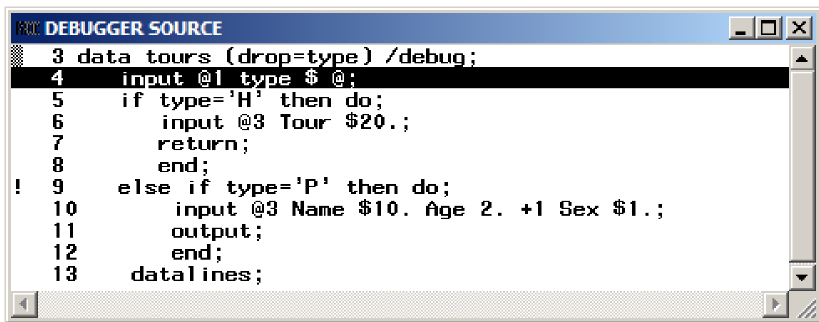
The variable Tour contains the value Tour 101, showing you that Tour was read. The first iteration of the DATA step worked as intended. Press ENTER to reach the top of the DATA step.

Examining Data Values after the Second Iteration

You can use the BREAK command (also known as setting a breakpoint) to suspend DATA step execution at a particular line that you designate. In this example, suspend execution before executing the ELSE statement by setting a breakpoint at line 9.

```
break 9
```

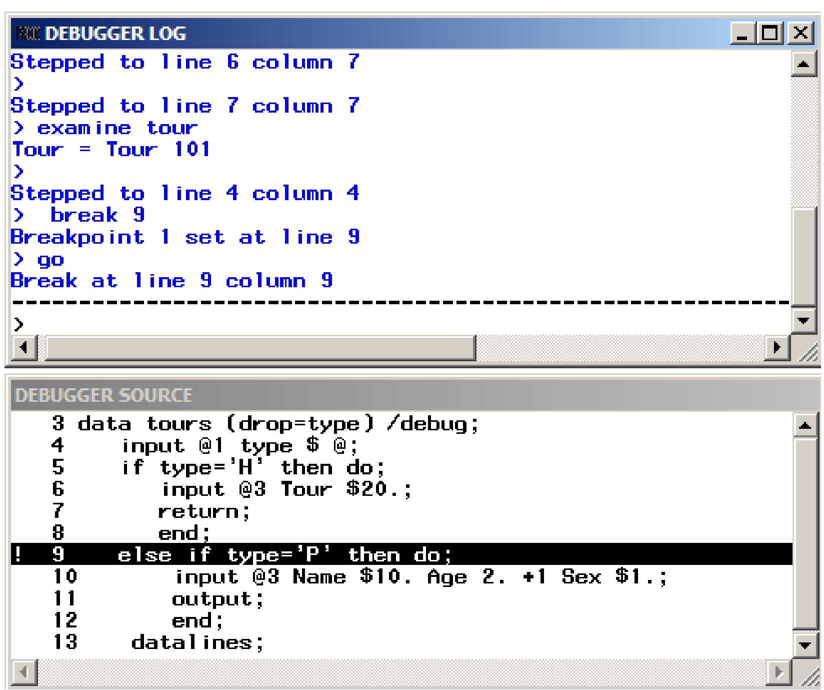
When you press ENTER, an exclamation point appears at line 9 in the DEBUGGER SOURCE window to mark the breakpoint:



Execute the GO command to continue DATA step execution until it reaches the breakpoint (in this case, line 9):

```
go
```

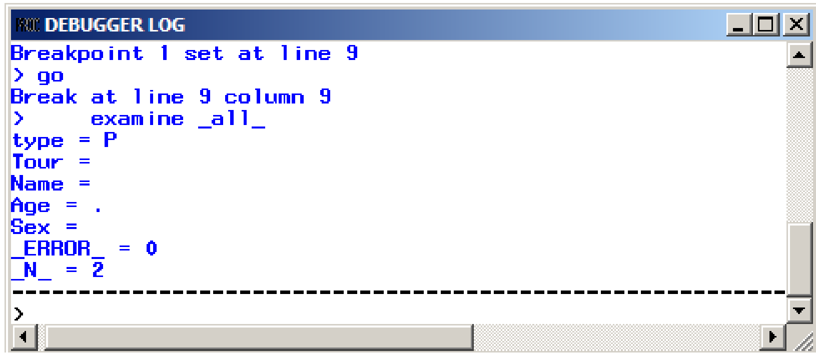
The following display shows the result:



SAS suspended execution just before the ELSE statement in line 7. Examine the values of all the variables to see their status at this point.

```
examine _all_
```

The following display shows the values:



You expect to see a value for Tour, but it does not appear. The program data vector gets reset to missing values at the beginning of each iteration and therefore does not retain the value of Tour. To solve the logic problem, you need to include a RETAIN statement in the SAS program.

Ending the Debugger

To end the debugging session, issue the QUIT command on the debugger command line:

```
quit
```

The debugging windows disappear, and the original SAS session resumes.

Correcting the DATA Step

Correct the original program by adding the RETAIN statement. Delete the DEBUG option from the DATA step, and resubmit the program:

```
   /* corrected version */
data tours (drop=type);
   retain Tour;
   input @1 type $ @;
   if type='H' then do;
      input @3 Tour $20.;
      return;
      end;
   else if type='P' then do;
      input @3 Name $10. Age 2. +1 Sex $1.;
      output;
      end;
datalines;
H Tour 101
P Mary E    21 F
P George S  45 M
P Susan K    3 F
H Tour 102
P Adelle S  79 M
P Walter P  55 M
P Fran I    63 F
;

run;

proc print;
```

```
    title 'Tour List';
run;
```

The values for Tour now appear in the output:

Results Viewer - SAS Output

Tour List

Obs	Tour	Name	Age	Sex
1	Tour 101	Mary E	21	F
2	Tour 101	George S	45	M
3	Tour 101	Susan K	3	F
4	Tour 102	Adelle S	79	M
5	Tour 102	Walter P	55	M
6	Tour 102	Fran I	63	F

Example 2: Working with Formats

This example shows how to debug a program when you use format statements to format dates. The following program creates a report that lists travel tour dates for specific countries.

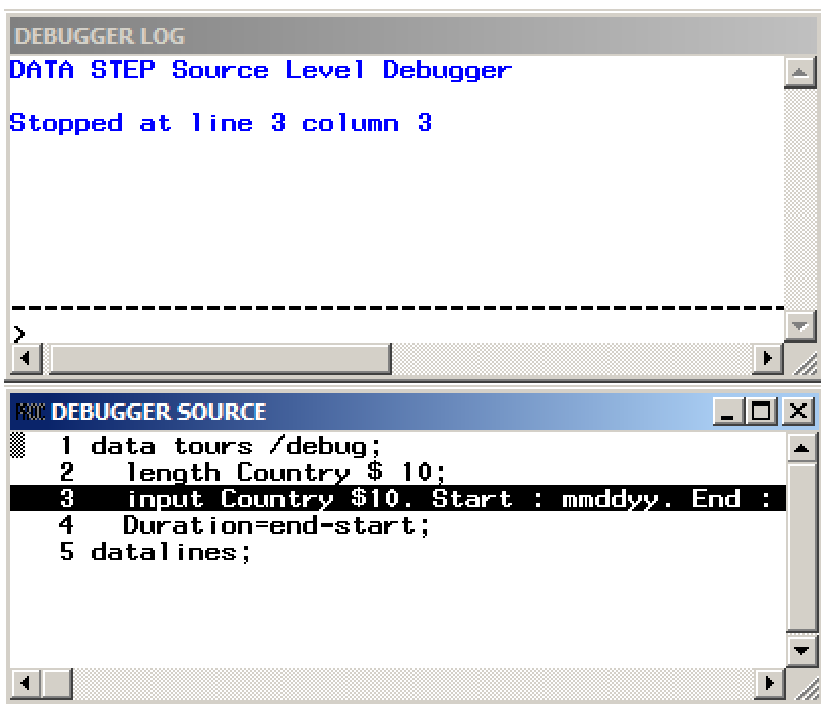
```
data tours;
  length Country $ 10;
  input Country $10. Start : mmddyy. End : mmddyy.;
  Duration=end-start;
datalines;
Italy        033012 041312
Brazil       021912 022812
Japan        052212 061512
Venezuela    110312 11801
Australia    122112 011513
;

proc print data=tours;
   format start end date9.;
   title 'Tour Duration';
run;
```

Results Viewer - SAS Output

Tour Duration

Obs	Country	Start	End	Duration
1	Italy	30MAR2012	13APR2012	14
2	Brazil	19FEB2012	28FEB2012	9
3	Japan	22MAY2012	15JUN2012	24
4	Venezuela	03NOV2012	18JAN2012	-290
5	Australia	21DEC2012	15JAN2013	25

The value of Duration for the tour to Venezuela shows a negative number, -290 days. To help identify the error, run the DATA step again using the DATA step debugger. SAS displays the following debugger windows:



At the DEBUGGER LOG command line, issue the EXAMINE command to display the values of all variables in the program data vector before execution begins:

```
examine _all_
```

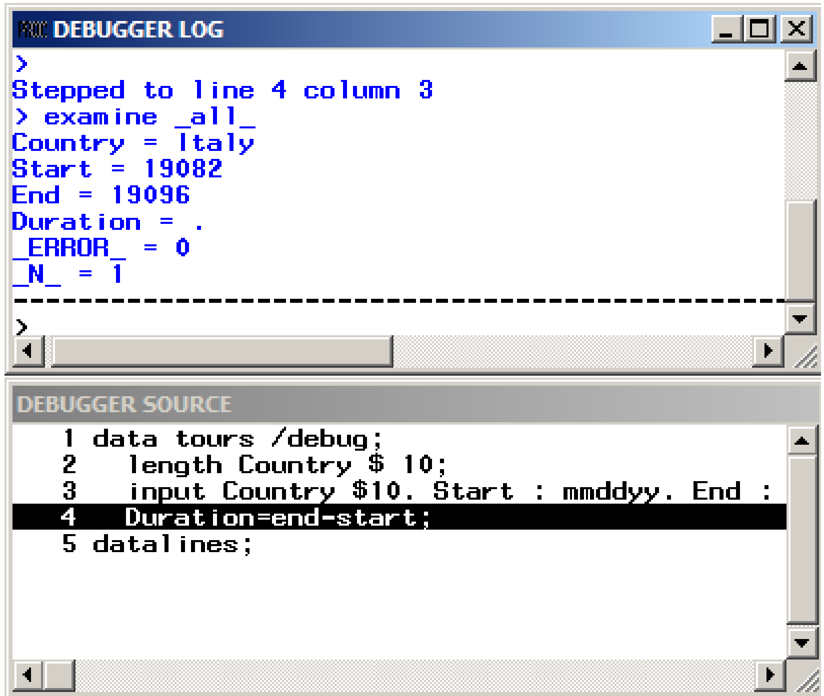
Initial values of all variables appear in the DEBUGGER LOG window. SAS has not yet executed the INPUT statement.

Press ENTER to issue the STEP command. SAS executes the INPUT statement, and the assignment statement is now highlighted.

Issue the EXAMINE command to display the current value of all variables:

```
examine _all_
```

The following display shows the results:



Because a problem exists with the Venezuela tour, suspend execution before the assignment statement when the value of Country equals Venezuela. Set a breakpoint to do this:

```
break 4 when country='Venezuela'
```

Execute the GO command to resume program execution:

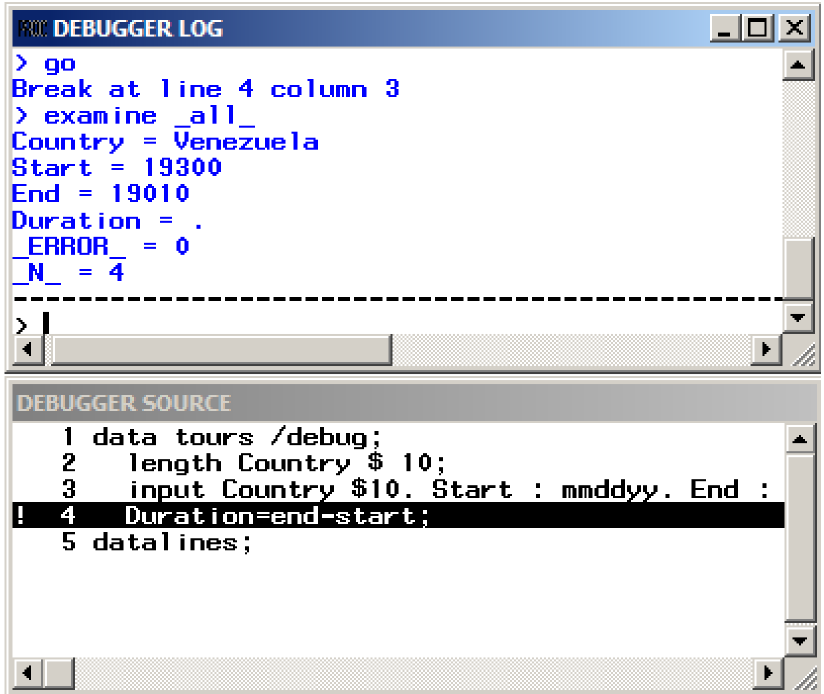
```
go
```

SAS stops execution when the country name is Venezuela. You can examine Start and End tour dates for the Venezuela trip. Because the assignment statement is highlighted (indicating that SAS has not yet executed that statement), there will be no value for Duration.

Execute the EXAMINE command to view the value of the variables after execution:

```
examine _all_
```

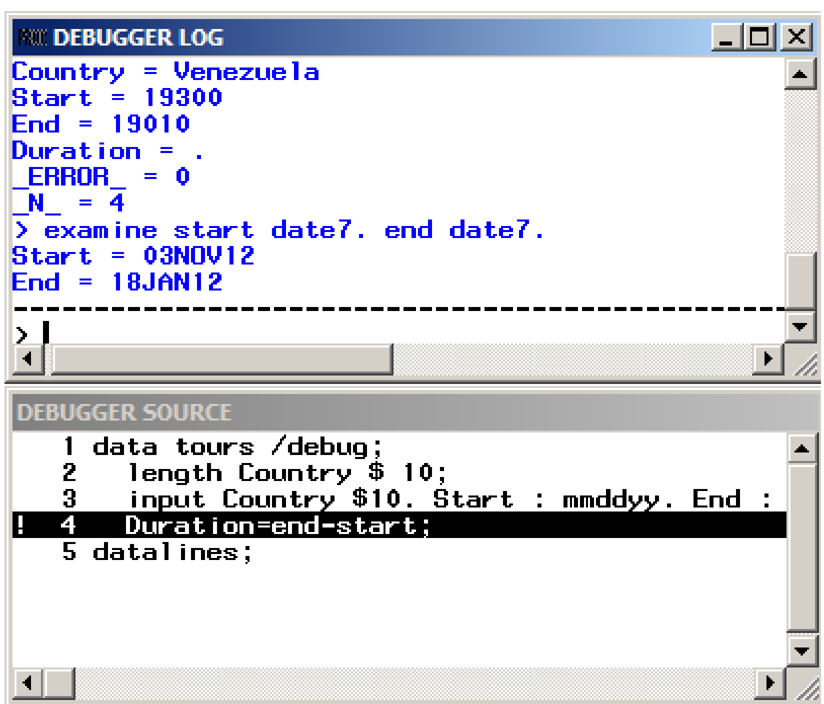
The following display shows the results:



To view formatted SAS dates, issue the EXAMINE command using the DATEw. format:

```
examine start date7. end date7.
```

The following display shows the results:



Because the tour ends on November 18, 2012, and not on January 18, 2012, there is an error in the variable End. Examine the source data in the program and notice that the value for End has a typographical error. By using the SET command, you can temporarily set the value of End to November 18 to see whether you get the anticipated result. Issue the SET command using the DDMMMYY*w*. format:

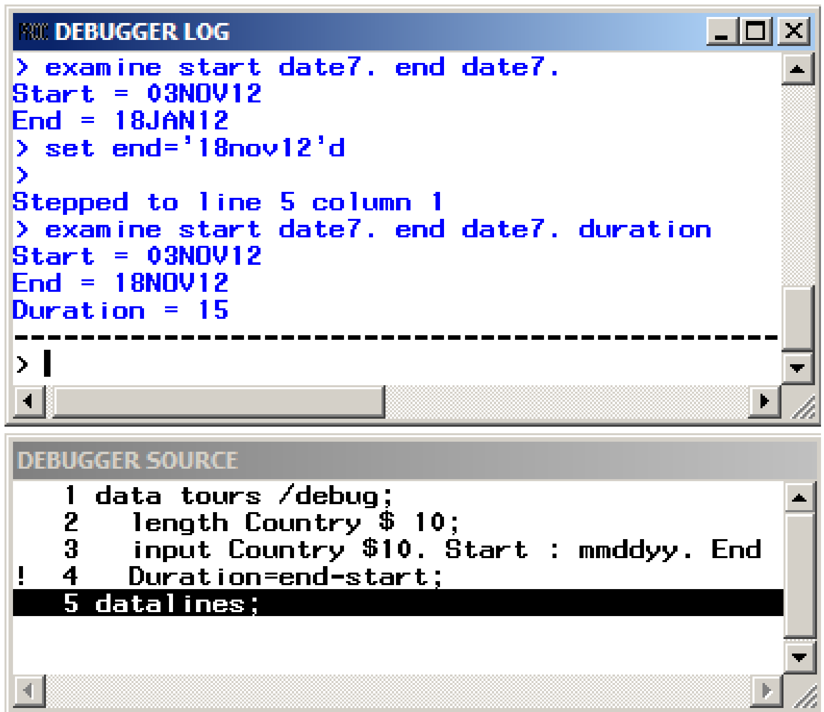
```
set end='18nov12'd
```

Press ENTER to issue the STEP command and execute the assignment statement.

Issue the EXAMINE command to view the tour date and Duration fields:

```
examine start date7. end date7. duration
```

The following display shows the results:



The Start, End, and Duration fields contain correct data.

End the debugging session by issuing the QUIT command on the DEBUGGER LOG command line. Correct the original data in the SAS program, delete the DEBUG option, and resubmit the program.

```
   /* corrected version */

data tours;
  length Country $ 10;
  input Country $10. Start : mmddyy. End : mmddyy.;
  duration=end-start;
datalines;
Italy       033012 041312
Brazil      021912 022812
Japan       052212 061512
Venezuela   110312 111812
Australia   122112 011513
;

proc print data=tours;
   format start end date9.;
   title 'Tour Duration';
run;
```

Results Viewer - SAS Output

Tour Duration

Obs	Country	Start	End	Duration
1	Italy	30MAR2012	13APR2012	14
2	Brazil	19FEB2012	28FEB2012	9
3	Japan	22MAY2012	15JUN2012	24
4	Venezuela	03NOV2012	18NOV2012	15
5	Australia	21DEC2012	15JAN2013	25

Example 3: Debugging DO Loops

An iterative DO, DO WHILE, or DO UNTIL statement can iterate many times during a single iteration of the DATA step. When you debug DO loops, you can examine several iterations of the loop by using the AFTER option in the BREAK command. The AFTER option requires a number that indicates how many times the loop will iterate before it reaches the breakpoint. The BREAK command then suspends program execution. For example, consider this data set:

```
data new / debug;
   set old;
   do i=1 to 20;
      newtest=oldtest+i;
      output;
   end;
run;
```

To set a breakpoint at the assignment statement (line 4 in this example) after every five iterations of the DO loop, issue this command:

```
break 4 after 5
```

When you issue the GO commands, the debugger suspends execution when `i` has the values of 5, 10, 15, and 20 in the DO loop iteration.

In an iterative DO loop, select a value for the AFTER option that can be divided evenly into the number of iterations of the loop. For example, in this DATA step, 5 can be evenly divided into 20. When the DO loop iterates the second time, `i` again has the values of 5, 10, 15, and 20.

If you do not select a value that can be evenly divided (such as 3 in this example), the AFTER option causes the debugger to suspend execution when `i` has the values of 3, 6, 9, 12, 15, and 18. When the DO loop iterates the second time, `i` has the values of 1, 4, 7, 10, 13, and 16.

Example 4: Examining Formatted Values of Variables

You can use a SAS format or a user-created format when you display a value with the EXAMINE command. For example, assume that the variable BEGIN contains a SAS date value. To display the day of the week and date, use the WEEKDATE*w*. format with EXAMINE:

```
examine begin weekdate17.
```

When the value of BEGIN is 033012, the debugger displays the following:

```
Sun, Mar 30, 2012
```

As another example, you can create a format named SIZE:

```
proc format;
   value size 1-5='small'
              6-10='medium'
             11-high='large';
run;
```

To debug a DATA step that applies the format SIZE. to the variable STOCKNUM, use the format with EXAMINE:

```
examine stocknum size.
```

For example, when the value of STOCKNUM is 7, the debugger displays the following:

```
STOCKNUM = medium
```

Troubleshooting the Debugger

Issues and Resolutions

The DEBUGGER SOURCE window is empty, and when you attempt to set a breakpoint you receive the message “Line number `xx` out of range for compiled source”.

The DATA step debugger is unable to retrieve source lines in some scenarios. For example, this occurs when a macro variable is referenced in the DATA statement and a DATA step or procedure has already been run in the current SAS session. To avoid the issue, remove the macro variable reference from the DATA statement. Or, restart SAS and run the debugger on the DATA step prior to running any other DATA steps or procedures.

PART 6

Producing Reports

27

Producing Detail Reports with the PRINT Procedure

Introduction to Producing Reports with the PRINT Procedure

Purpose

Reports that you create with the PRINT procedure contain one row for every observation that is selected for inclusion in the report. A report provides information about every record that is processed. For example, a report for a sales company can include all of the information about every sale made during a particular quarter of the year. The PRINT procedure is one of several report writing tools that you can use to create a variety of reports.

In this section, you will learn how to do the following:

- produce simple reports by using a few basic PROC PRINT options and statements
- produce enhanced reports by adding additional statements that format values, sum columns, group observations, and compute totals
- customize the appearance of reports by adding titles, footnotes, column labels, and the style of the report output
- substitute text by using macro variables

Prerequisites

Before proceeding with this section, you should be familiar with the following features and concepts:

- the assignment statement
- the SORT procedure
- the BY statement
- the location of the procedure output

Input File and SAS Data Sets for Examples

The examples in this section use one input file and five SAS data sets. For a complete listing of the input data, see “The YEAR_SALES Data Set” on page 854.

The input file contains sales records for a company, TruBlend Coffee Makers, that distributes the coffee machines. The file has the following structure:

```
01      1       Hollingsworth  Deluxe      260       49.50
01      1       Garcia         Standard     41       30.97
01      1       Hollingsworth  Deluxe      330       49.50
01      1       Jensen         Standard   1110       30.97
01      1       Garcia         Standard    715       30.97
01      1       Jensen         Deluxe      675       49.50
02      1       Jensen         Standard     45       30.97
02      1       Garcia         Deluxe       10       49.50

…more data lines…

12      4       Hollingsworth  Deluxe      125       49.50
12      4       Jensen         Standard   1254       30.97
12      4       Hollingsworth  Deluxe      175       49.50
```

The input file contains the following values from left to right:

- the month in which a sale was made
- the quarter of the year in which a sale was made
- the name of the sales representative
- the type of coffee maker sold (standard or deluxe)
- the number of units sold
- the price of each unit in US dollars

The first of the five SAS data sets is named YEAR_SALES. This data set contains all the sales data from the input file, and a new variable named AmountSold, which is created by multiplying Units by Price. The other four data sets are created from the YEAR_SALES data set. Each of the four data sets contains a subset of the data for each quarter. The data sets are QTR01, QTR02, QTR03, and QTR04.

The following program creates the five SAS data sets:

```
data year_sales;
   infile 'your-input-file';
   input Month $ Quarter $ SalesRep $14. Type $ Units Price;
   AmountSold = Units * Price;
run;

data qtr01;
   set year_sales(where=(quarter='1'));
run;

data qtr02;
   set year_sales(where=(quarter='2'));
run;

data qtr03;
   set year_sales(where=(quarter='3'));
run;

data qtr04;
   set year_sales(where=(quarter='4'));
run;
```

Creating Simple Reports

Showing All the Variables

By default, the PRINT procedure generates a simple report that shows the values of all the variables and the observations in the data set. For example, the following PROC PRINT step creates a report for the first sales quarter:

```
proc print data=qtr01;
   title 'TruBlend Coffee Makers First Quarter Sales Report';
run;
```

The following output shows the values of all the variables for all the observations in QTR01.

Figure 27.1 Showing All Variables and All Observations

TruBlend Coffee Makers First Quarter Sales Report

Obs	Month	Quarter	SalesRep	Type	Units	Price	AmountSold
1	01	1	Hollingsworth	Deluxe	260	49.50	12870.00
2	01	1	Garcia	Standard	41	30.97	1269.77
3	01	1	Hollingsworth	Standard	330	30.97	10220.10
4	01	1	Jensen	Standard	110	30.97	3406.70
5	01	1	Garcia	Deluxe	715	49.50	35392.50
6	01	1	Jensen	Standard	675	30.97	20904.75
7	02	1	Garcia	Standard	2045	30.97	63333.65
8	02	1	Garcia	Deluxe	10	49.50	495.00
9	02	1	Garcia	Standard	40	30.97	1238.80
10	02	1	Hollingsworth	Standard	1030	30.97	31899.10
11	02	1	Jensen	Standard	153	30.97	4738.41
12	02	1	Garcia	Standard	98	30.97	3035.06
13	03	1	Hollingsworth	Standard	125	30.97	3871.25
14	03	1	Jensen	Standard	154	30.97	4769.38
15	03	1	Garcia	Standard	118	30.97	3654.46
16	03	1	Hollingsworth	Standard	25	30.97	774.25
17	03	1	Jensen	Standard	525	30.97	16259.25
18	03	1	Garcia	Standard	310	30.97	9600.70

The Obs column identifies each observation by number. By default, SAS displays the observation number at the beginning of each row.

The top of the report has a title. The TITLE statement in the PROC PRINT step produces the title. For more information about the TITLE statement, see "Creating Customized Reports" on page 475. For now, remember that all the examples include at least one TITLE statement that produces a descriptive title similar to the one in this example.

The content of the report is very similar to the contents of the original data set QTR01. However, the report is easy to produce and to enhance.

Labeling the Observation Column

A quick way to modify the report is to label the observation number (Obs column). The following SAS program includes the OBS= option in the PROC PRINT statement to change the column label for the Obs column:

```
proc print data=qtr01 obs='Observation Number';
   title 'TruBlend Coffee Makers First Quarter Sales Report';
run;
```

The following output shows the report.

Figure 27.2 Labeling the Observation Column

TruBlend Coffee Makers First Quarter Sales Report

Observation Number	Month	Quarter	SalesRep	Type	Units	Price	AmountSold
1	01	1	Hollingsworth	Deluxe	260	49.50	12870.00
2	01	1	Garcia	Standard	41	30.97	1269.77
3	01	1	Hollingsworth	Standard	330	30.97	10220.10
4	01	1	Jensen	Standard	110	30.97	3406.70
5	01	1	Garcia	Deluxe	715	49.50	35392.50
6	01	1	Jensen	Standard	675	30.97	20904.75
7	02	1	Garcia	Standard	2045	30.97	63333.65
8	02	1	Garcia	Deluxe	10	49.50	495.00
9	02	1	Garcia	Standard	40	30.97	1238.80
10	02	1	Hollingsworth	Standard	1030	30.97	31899.10
11	02	1	Jensen	Standard	153	30.97	4738.41
12	02	1	Garcia	Standard	98	30.97	3035.06
13	03	1	Hollingsworth	Standard	125	30.97	3871.25
14	03	1	Jensen	Standard	154	30.97	4769.38
15	03	1	Garcia	Standard	118	30.97	3654.46
16	03	1	Hollingsworth	Standard	25	30.97	774.25
17	03	1	Jensen	Standard	525	30.97	16259.25
18	03	1	Garcia	Standard	310	30.97	9600.70

Suppressing the Observation Column

A quick way to simplify the report is to suppress the observation number (Obs column). Usually, it is unnecessary to identify each observation by number. (In some cases, you might want to show the observation numbers.) The following SAS program includes the NOOBS option in the PROC PRINT statement to suppress the Obs column:

```
proc print data=qtr01 noobs;
   title 'TruBlend Coffee Makers First Quarter Sales Report';
run;
```

The following output shows the report.

Figure 27.3 Suppressing the Observation Column

TruBlend Coffee Makers First Quarter Sales Report

Month	Quarter	SalesRep	Type	Units	Price	AmountSold
01	1	Hollingsworth	Deluxe	260	49.50	12870.00
01	1	Garcia	Standard	41	30.97	1269.77
01	1	Hollingsworth	Standard	330	30.97	10220.10
01	1	Jensen	Standard	110	30.97	3406.70
01	1	Garcia	Deluxe	715	49.50	35392.50
01	1	Jensen	Standard	675	30.97	20904.75
02	1	Garcia	Standard	2045	30.97	63333.65
02	1	Garcia	Deluxe	10	49.50	495.00
02	1	Garcia	Standard	40	30.97	1238.80
02	1	Hollingsworth	Standard	1030	30.97	31899.10
02	1	Jensen	Standard	153	30.97	4738.41
02	1	Garcia	Standard	98	30.97	3035.06
03	1	Hollingsworth	Standard	125	30.97	3871.25
03	1	Jensen	Standard	154	30.97	4769.38
03	1	Garcia	Standard	118	30.97	3654.46
03	1	Hollingsworth	Standard	25	30.97	774.25
03	1	Jensen	Standard	525	30.97	16259.25
03	1	Garcia	Standard	310	30.97	9600.70

Emphasizing a Key Variable

Understanding the ID Statement

To emphasize a key variable in a data set, you can use the ID statement in the PROC PRINT step. When you identify a variable in the ID statement, PROC PRINT displays the values of this variable in the first column of each row of the report. Highlighting a key variable in this way can help answer questions about your data. For example, the report can answer this question: “For each sales representative, what are the sales figures for the first quarter of the year?” The following two examples demonstrate how to answer this question quickly using data that is unsorted and sorted.

Using an Unsorted Key Variable

To produce a report that emphasizes the sales representative, the PROC PRINT step includes an ID statement that specifies the variable SalesRep. Here is the revised program:

```
proc print data=qtr01;
   id SalesRep;
   title 'TruBlend Coffee Makers First Quarter Sales Report';
run;
```

Because the ID statement automatically suppresses the observation numbers, the NOOBS option is not needed in the PROC PRINT statement.

The following output shows the report.

Figure 27.4 Using the ID Statement with an Unsorted Variable

TruBlend Coffee Makers First Quarter Sales Report

SalesRep	Month	Quarter	Type	Units	Price	AmountSold
Hollingsworth	01	1	Deluxe	260	49.50	12870.00
Garcia	01	1	Standard	41	30.97	1269.77
Hollingsworth	01	1	Standard	330	30.97	10220.10
Jensen	01	1	Standard	110	30.97	3406.70
Garcia	01	1	Deluxe	715	49.50	35392.50
Jensen	01	1	Standard	675	30.97	20904.75
Garcia	02	1	Standard	2045	30.97	63333.65
Garcia	02	1	Deluxe	10	49.50	495.00
Garcia	02	1	Standard	40	30.97	1238.80
Hollingsworth	02	1	Standard	1030	30.97	31899.10
Jensen	02	1	Standard	153	30.97	4738.41
Garcia	02	1	Standard	98	30.97	3035.06
Hollingsworth	03	1	Standard	125	30.97	3871.25
Jensen	03	1	Standard	154	30.97	4769.38
Garcia	03	1	Standard	118	30.97	3654.46
Hollingsworth	03	1	Standard	25	30.97	774.25
Jensen	03	1	Standard	525	30.97	16259.25
Garcia	03	1	Standard	310	30.97	9600.70

Notice that the names of the sales representatives are not in any particular order. The report will be easier to read when the observations are grouped together in alphabetical order by sales representative.

Using a Sorted Key Variable

If your data is not already ordered by the key variable, then use PROC SORT to sort the observations by this variable. If you do not specify an output data set, then PROC SORT permanently changes the order of the observations in the input data set.

The following program shows how to alphabetically order the observations by sales representative:

```
proc sort data=qtr01;  1
   by SalesRep;  2
run;

proc print data=qtr01;
   id SalesRep;  3
   title 'TruBlend Coffee Makers First Quarter Sales Report';
run;
```

The following list corresponds to the numbered items in the preceding program:

1. A PROC SORT step precedes the PROC PRINT step. PROC SORT orders the observations in the data set alphabetically by the values of the BY variable and overwrites the input data set.
2. A BY statement sorts the observations alphabetically by SalesRep.
3. An ID statement identifies the observations with the value of SalesRep rather than with the observation number. PROC PRINT uses the sorted order of SalesRep to create the report.

The following output shows the report.

Figure 27.5 *Using the ID Statement with a Sorted Key Variable*

TruBlend Coffee Makers First Quarter Sales Report

SalesRep	Month	Quarter	Type	Units	Price	AmountSold
Garcia	01	1	Standard	41	30.97	1269.77
Garcia	01	1	Deluxe	715	49.50	35392.50
Garcia	02	1	Standard	2045	30.97	63333.65
Garcia	02	1	Deluxe	10	49.50	495.00
Garcia	02	1	Standard	40	30.97	1238.80
Garcia	02	1	Standard	98	30.97	3035.06
Garcia	03	1	Standard	118	30.97	3654.46
Garcia	03	1	Standard	310	30.97	9600.70
Hollingsworth	01	1	Deluxe	260	49.50	12870.00
Hollingsworth	01	1	Standard	330	30.97	10220.10
Hollingsworth	02	1	Standard	1030	30.97	31899.10
Hollingsworth	03	1	Standard	125	30.97	3871.25
Hollingsworth	03	1	Standard	25	30.97	774.25
Jensen	01	1	Standard	110	30.97	3406.70
Jensen	01	1	Standard	675	30.97	20904.75
Jensen	02	1	Standard	153	30.97	4738.41
Jensen	03	1	Standard	154	30.97	4769.38
Jensen	03	1	Standard	525	30.97	16259.25

Now, the report clearly shows what each sales representative sold during the first three months of the year.

Reporting the Values of Selected Variables

By default, the PRINT procedure reports the values of all the variables in the data set. However, to control which variables are shown and in what order, add a VAR statement to the PROC PRINT step.

For example, the information for the variables Quarter, Type, and Price is unnecessary. Therefore, the report needs to show only the values of the variables that are specified in the following order:

```
SalesRep  Month  Units  AmountSold
```

The following program adds the VAR statement to create a report that lists the values of the four variables in a specific order:

```
proc print data=qtr01 noobs;
   var SalesRep Month Units AmountSold;
   title 'TruBlend Coffee Makers First Quarter Sales Report';
run;
```

This program does not include the ID statement. It is unnecessary to identify the observations because the variable SalesRep is the first variable that is specified in the VAR statement. The NOOBS option in the PROC PRINT statement suppresses the observation numbers so that the sales representative appears in the first column of the report.

Note: If the ID statement is used and it names one of the variables in the VAR statement, the information is duplicated and two columns for the same variable appear in the report.

The following output shows the report.

Figure 27.6 Showing Selected Variables

TruBlend Coffee Makers First Quarter Sales Report

SalesRep	Month	Units	AmountSold
Garcia	01	41	1269.77
Garcia	01	715	35392.50
Garcia	02	2045	63333.65
Garcia	02	10	495.00
Garcia	02	40	1238.80
Garcia	02	98	3035.06
Garcia	03	118	3654.46
Garcia	03	310	9600.70
Hollingsworth	01	260	12870.00
Hollingsworth	01	330	10220.10
Hollingsworth	02	1030	31899.10
Hollingsworth	03	125	3871.25
Hollingsworth	03	25	774.25
Jensen	01	110	3406.70
Jensen	01	675	20904.75
Jensen	02	153	4738.41
Jensen	03	154	4769.38
Jensen	03	525	16259.25

The report is concise because it contains only those variables that are specified in the VAR statement.

The next example revises the report to show only those observations that satisfy a particular condition.

Selecting Observations

Understanding the WHERE Statement

To select observations that meet a particular condition from a data set, use a WHERE statement. The WHERE statement subsets the input data by specifying certain conditions that each observation must meet before it is available for processing.

The condition that you define in a WHERE statement is an arithmetic or logical expression that generally consists of a sequence of operands and operators.[1] To compare character values, you must enclose them in single or double quotation marks and the values must match exactly, including capitalization. You can also specify multiple comparisons that are joined by logical operators in the WHERE statement.

Using the WHERE statement might improve the efficiency of your SAS programs because SAS is not required to read all the observations in the input data set.

Making a Single Comparison

You can select observations based on a single comparison by using the WHERE statement. The following program uses a single comparison in a WHERE statement to produce a report that shows the sales activity for a sales representative named Garcia:

```
proc print data=qtr01 noobs;
   var SalesRep Month Units AmountSold;
   where SalesRep='Garcia';
   title 'TruBlend Coffee Makers Quarterly Sales for Garcia';
run;
```

In the WHERE statement, the value `Garcia` is enclosed in quotation marks because SalesRep is a character variable. In addition, the letter G in the value `Garcia` is uppercase so that it matches exactly the value in the data set QTR01.

The following output shows the report.

Figure 27.7 Making a Single Comparison

TruBlend Coffee Makers First Quarter Sales Report

SalesRep	Month	Units	AmountSold
Garcia	01	41	1269.77
Garcia	01	715	35392.50
Garcia	02	2045	63333.65
Garcia	02	10	495.00
Garcia	02	40	1238.80
Garcia	02	98	3035.06
Garcia	03	118	3654.46
Garcia	03	310	9600.70

Making Multiple Comparisons

You can also select observations based on two or more comparisons by using the WHERE statement. However, when you use multiple WHERE statements in a PROC step, then only the last statement is used. You can create a compound

1. The construction of the WHERE statement is similar to the construction of IF and IF-THEN statements.

comparison by using the AND operator. For example, the following WHERE statement selects observations where Garcia sold only the deluxe coffee maker:

```
where SalesRep = 'Garcia' and Type='Deluxe';
```

The following program uses two comparisons in a WHERE statement to produce a report that shows sales activities for a sales representative (Garcia) during the first month of the year:

```
proc print data=year_sales noobs;
   var SalesRep Month Units AmountSold;
   where SalesRep='Garcia' and Month='01';
   title 'TruBlend Coffee Makers First Month Sales Report for Garcia';
run;
```

The WHERE statement uses the logical AND operator. Therefore, both comparisons must be true for PROC PRINT to include an observation in the report.

The following output shows the report.

Figure 27.8 Making Two Comparisons

TruBlend Coffee Makers First Month Sales Report for Garcia

SalesRep	Month	Units	AmountSold
Garcia	01	41	1269.77
Garcia	01	715	35392.50

You might also want to select observations that meet at least one of several conditions. The following program uses two comparisons in the WHERE statement to create a report that shows every sale during the first quarter of the year that was greater than 500 units or more than $20,000:

```
proc print data=qtr01 noobs;
   var SalesRep Month Units AmountSold;
   where Units>500 or AmountSold>20000;
   title 'Sales Rep Q1 Monthly Report for Sales Above 500 Units or $20,000';
run;
```

Notice this WHERE statement uses the logical OR operator. Therefore, only one of the comparisons must be true for PROC PRINT to include an observation in the report.

The following output shows the report.

Figure 27.9 Making Comparisons for One Condition or Another

Sales Rep Q1 Monthly Report for Sales Above 500 Units or $20,000

SalesRep	Month	Units	AmountSold
Garcia	01	715	35392.50
Jensen	01	675	20904.75
Garcia	02	2045	63333.65
Hollingsworth	02	1030	31899.10
Jensen	03	525	16259.25

Creating Enhanced Reports

Ways to Enhance a Report

With just a few PROC PRINT statements and options, you can produce a variety of detail reports. By using additional statements and options that enhance the reports, you can do the following using PROC PRINT:

- format the columns
- sum the numeric variables
- group the observations based on variable values
- sum the groups of variable values
- group the observations in separate sections

The examples in this section use the SAS data set QTR02, which was created in "Input File and SAS Data Sets for Examples" on page 450.

Specifying Formats for the Variables

Specifying the formats of variables is a simple yet effective way to enhance the readability of your reports. By adding the FORMAT statement to your program, you can specify formats for variables. The format of a variable is a pattern that SAS uses to write the values of the variables. For example, SAS contains formats that add commas to numeric values, that add dollar signs to figures, or that report values as Roman numerals.

Using a format can make the values of the variables Units and AmountSold easier to read than in the previous reports. Specifically, Units can use a COMMA format with a total field width of 7, which includes commas to separate every three digits and omits decimal values. AmountSold can use a DOLLAR format with a total field width of 14, which includes commas to separate every three digits, a decimal point, two decimal places, and a dollar sign.

The following program illustrates how to apply these formats using a FORMAT statement:

```
proc print data=qtr02 noobs;
   var SalesRep Month Units AmountSold;
   where Units>500 or AmountSold>20000;
   format Units comma7. AmountSold dollar14.2;
   title 'Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000';
run;
```

PROC PRINT applies the COMMA7. format to the values of the variable Units and the DOLLAR14.2 format to the values of the variable AmountSold.

The following output shows the report.

Figure 27.10 Formatting Numeric Variables

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep	Month	Units	AmountSold
Hollingsworth	04	530	$16,414.10
Jensen	04	1,110	$34,376.70
Garcia	04	1,715	$53,113.55
Jensen	04	675	$20,904.75
Hollingsworth	05	1,120	$34,686.40
Hollingsworth	05	1,030	$31,899.10
Garcia	06	512	$15,856.64
Garcia	06	1,000	$30,970.00

AmountSold uses the DOLLAR14.2 format. The maximum column width is 14 spaces. Two spaces are reserved for the decimal part of a value. The remaining 12 spaces include the decimal point, whole numbers, the dollar sign, commas, and a minus sign if a value is negative.

Units uses the COMMA7. format. The maximum column width is seven spaces. The column width includes the numeric value, commas, and a minus sign if a value is negative.

The formats do not affect the internal data values that are stored in the SAS data set. The formats change only how the current PROC step displays the values in the report.

Note: Be sure to specify enough columns in the format to contain the largest value. If the format that you specify is not wide enough to contain the largest value, including special characters such as commas and dollar signs, then SAS applies the most appropriate format.

Summing Numeric Variables

In addition to reporting the values in a data set, you can add the SUM statement to compute subtotals and totals for the numeric variables. The SUM statement enables you to request totals for one or more variables.

The following program produces a report that shows totals for the two numeric variables Units and AmountSold:

```
proc print data=qtr02 noobs;
   var SalesRep Month Units AmountSold;
   where Units>500 or AmountSold>20000;
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   title 'Sales Rep Q2 Monthly Report for Sales above 500 Units or $20,000';
run;
```

The following output shows the report.

Figure 27.11 Summing Numeric Variables

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep	Month	Units	AmountSold
Hollingsworth	04	530	$16,414.10
Jensen	04	1,110	$34,376.70
Garcia	04	1,715	$53,113.55
Jensen	04	675	$20,904.75
Hollingsworth	05	1,120	$34,686.40
Hollingsworth	05	1,030	$31,899.10
Garcia	06	512	$15,856.64
Garcia	06	1,000	$30,970.00
		7,692	$238,221.24

The totals for Units and AmountSold are computed by summing the values for each sale made by all the sales representatives. As the next example shows, the PRINT procedure can also separately compute subtotals for each sales representative.

Grouping Observations by Variable Values

Overview of Grouping Observations by Variable Values

The BY statement enables you to obtain separate analyses on groups of observations. The previous example used the SUM statement to compute totals for the variables Units and AmountSold. However, the totals were for all three sales representatives as one group. The following examples show how to use the BY, ID, and SUMBY statements as a part of the PROC PRINT step to separate the sales representatives into three groups with three separate subtotals and one grand total.

Computing Group Subtotals

To obtain separate subtotals for specific numeric variables, add a BY statement to the PROC PRINT step. When you use a BY statement, the PRINT procedure expects that you have already sorted the data set by using the BY variables. Therefore, if your data is not sorted in the proper order, then you must add a PROC SORT step before the PROC PRINT step.

The BY statement produces a separate table for each BY group in the report. Above each table is a BY line that is a heading for the BY group.

Note: Do not specify in the VAR statement the variable that you use in the BY statement. Otherwise, the values of the BY variable appear twice in the report, as a header across the page and in columns down the page.

The following program uses the BY statement in the PROC PRINT step to obtain separate subtotals of the variables Units and AmountSold for each sales representative:

```
proc sort data=qtr02;
   by SalesRep; 1
run;

proc print data=qtr02 noobs;
   var Month Units AmountSold; 2
   where Units>500 or AmountSold>20000;
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   by SalesRep; 2
   title1 'Sales Rep Q2 Totals for Sales above 500 Units or $20,000';
  run;
```

The following list corresponds to the numbered items in the preceding program:

1 The BY statement in the PROC SORT step sorts the data.

2 The variable SalesRep becomes part of the BY statement instead of the VAR statement.

The following output shows the report.

Figure 27.12 Grouping Observations with the BY Statement

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep=Garcia

Month	Units	AmountSold
04	1,715	$53,113.55
06	512	$15,856.64
06	1,000	$30,970.00
SalesRep	3,227	$99,940.19

SalesRep=Hollingsworth

Month	Units	AmountSold
04	530	$16,414.10
05	1,120	$34,686.40
05	1,030	$31,899.10
SalesRep	2,680	$82,999.60

SalesRep=Jensen

Month	Units	AmountSold
04	1,110	$34,376.70
04	675	$20,904.75
SalesRep	1,785	$55,281.45
	7,692	$238,221.24

Labeling Subtotals and the Grand Total

The previous example uses the default labels for the subtotal and the grand total labels. The subtotal default label is the BY variable, and the grand total default label is no label. You can use the SUMLABEL= option to replace the default subtotal label and the GRANDTOTAL_LABEL= option to replace a blank grand total label.

The following example adds the SUMLABEL= option and the GRANDTOTAL_LABEL= option to the PROC PRINT statement. This program assumes that QTR02 data has been previously sorted by the variables SalesRep.

```
proc print data=qtr02 noobs sumlabel="Total" grandtotal_label="Grand Total";
   var Month Units AmountSold;
   where Units>500 or AmountSold>20000;
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
```

```
   by SalesRep;
   title1 'Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000';
run;
```

The following output shows the report.

Sales Rep Q2 Monthy Report for Sales Above 500 Units or $20,000

SalesRep=Garcia

Month	Units	AmountSold
04	1,715	$53,113.55
06	512	$15,856.64
06	1,000	$30,970.00
Total	**3,227**	**$99,940.19**

SalesRep=Hollingsworth

Month	Units	AmountSold
04	530	$16,414.10
05	1,120	$34,686.40
05	1,030	$31,899.10
Total	**2,680**	**$82,999.60**

SalesRep=Jensen

Month	Units	AmountSold
04	1,110	$34,376.70
04	675	$20,904.75
Total	**1,785**	**$55,281.45**
Grand Total	**7,692**	**$238,221.24**

Identifying Group Subtotals

You can use both the BY and ID statements in the PROC PRINT step to modify the appearance of your report. When you specify the same variables in both the BY and ID statements, the PRINT procedure uses the ID variable to identify the start of the BY group.

The following example uses the data set that was sorted in the last example and adds the ID statement to the PROC PRINT step:

```
proc print data=qtr02 sumlabel="Total" grandtotal_label="Grand Total";
   var Month Units AmountSold;
```

```
where Units>500 or AmountSold>20000;
format Units comma7. AmountSold dollar14.2;
sum Units AmountSold;
by SalesRep;
id SalesRep;
title1 'Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000';
run;
```

The following output shows the report.

Figure 27.13 Grouping Observations with the BY and ID Statements

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep	Month	Units	AmountSold
Garcia	04	1,715	$53,113.55
	06	512	$15,856.64
	06	1,000	$30,970.00
Total		3,227	$99,940.19

SalesRep	Month	Units	AmountSold
Hollingsworth	04	530	$16,414.10
	05	1,120	$34,686.40
	05	1,030	$31,899.10
Total		2,680	$82,999.60

SalesRep	Month	Units	AmountSold
Jensen	04	1,110	$34,376.70
	04	675	$20,904.75
Total		1,785	$55,281.45
Grand Total		7,692	$238,221.24

The report has two distinct features. PROC PRINT separates the report into groups and suppresses the repetitive values of the BY and ID variables. The BY line does not appear above the group because the BY and ID statements are used together in the PROC PRINT step.

Remember these general rules about the SUM, BY, and ID statements:

- You can specify a variable in the SUM statement while omitting it in the VAR statement. PROC PRINT simply adds the variable to the list of variables in the VAR statement.
- You do not specify variables in the SUM statement that you used in the ID or BY statement.

- When you use a BY statement and you specify only one BY variable, PROC PRINT subtotals the SUM variable for each BY group that contains more than one observation.
- When you use a BY statement and you specify multiple BY variables, PROC PRINT shows a subtotal for a BY variable only when the value changes and when there are multiple observations with that value.

Computing Multiple Group Subtotals

You can also use two or more variables in a BY statement to define groups and subgroups. The following program produces a report that groups observations first by sales representative and then by month:

```
proc sort data=qtr02;
   by SalesRep Month;  1
run;

proc print data=qtr02 noobs n='Sales Transactions:'  2
                             'Total Sales Transactions:' 2 ;
   var Units AmountSold;  3
   where Units>500 or AmountSold>20000;
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   by SalesRep Month  3 ;
   title1 'Monthly Sales Rep Totals for Sales Above 500 Units or $20,000';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 The BY statement in the PROC SORT step sorts the data by SalesRep and Month.

2 The N= option in the PROC PRINT statement reports the number of observations in a BY group. Because of the SUM statement, it also reports the overall total number of observations at the end of the report. The first piece of explanatory text that N= provides precedes the number for each BY group. The second piece of explanatory text that N= provides precedes the number for the overall total.

3 The variables SalesRep and Month are omitted in the VAR statement because the variables are specified in the BY statement. This prevents PROC PRINT from reporting the values for these variables twice.

The following output shows the report.

Figure 27.14 Grouping Observations with Multiple BY Variables

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep=Garcia Month=04

Units	AmountSold
1,715	$53,113.55
Sales Transactions:1	

SalesRep=Garcia Month=06

Units	AmountSold
512	$15,856.64
1,000	$30,970.00
1,512	**$46,826.64**
3,227	**$99,940.19**
Sales Transactions:2	

SalesRep=Hollingsworth Month=04

Units	AmountSold
530	$16,414.10
Sales Transactions:1	

SalesRep=Hollingsworth Month=05

Units	AmountSold
1,120	$34,686.40
1,030	$31,899.10
2,150	**$66,585.50**
2,680	**$82,999.60**
Sales Transactions:2	

SalesRep=Jensen Month=04

Units	AmountSold
1,110	$34,376.70
675	$20,904.75
1,785	**$55,281.45**
1,785	**$55,281.45**
7,692	**$238,221.24**
Sales Transactions:2 Total Sales Transactions:8	

Computing Group Totals

When you use multiple BY variables as in the previous example, you can suppress the subtotals every time a change occurs for the value of the BY variables. Use the SUMBY statement to control which BY variable causes subtotals to appear.

You can specify only one SUMBY variable, and this variable must also be specified in the BY statement. PROC PRINT computes sums when a change occurs to the following values:

- the value of the SUMBY variable
- the value of any variable in the BY statement that is specified before the SUMBY variable

For example, consider the following statements:

```
by Quarter SalesRep Month;
sumby SalesRep;
```

SalesRep is the SUMBY variable. In the BY statement, Quarter comes before SalesRep while Month comes after SalesRep. Therefore, these statements cause PROC PRINT to compute totals when either Quarter or SalesRep changes value, but not when Month changes value.

The following program omits the monthly subtotals for each sales representative by designating SalesRep as the variable to sum by:

```
proc print data=qtr02 sumlabel="Total" grandtotal_label="Grand Total";
   var Units AmountSold;
   where Units>500 or AmountSold>20000;
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   by SalesRep Month;
   id SalesRep Month;
   sumby SalesRep;
   title1 'Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000';
run;
```

This program assumes that QTR02 data has been previously sorted by the variables SalesRep and Month.

The following output shows the report.

Figure 27.15 Combining Subtotals for Groups of Observations

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep	Month	Units	AmountSold
Garcia	04	1,715	$53,113.55

SalesRep	Month	Units	AmountSold
Garcia	06	512	$15,856.64
		1,000	$30,970.00
Total		3,227	$99,940.19

SalesRep	Month	Units	AmountSold
Hollingsworth	04	530	$16,414.10

SalesRep	Month	Units	AmountSold
Hollingsworth	05	1,120	$34,686.40
		1,030	$31,899.10
Total		2,680	$82,999.60

SalesRep	Month	Units	AmountSold
Jensen	04	1,110	$34,376.70
		675	$20,904.75
Total		1,785	$55,281.45
Grand Total		7,692	$238,221.24

Grouping Observations in Multiple Sections

You can also create a report with multiple sections by using the PAGEBY statement with the BY statement. The PAGEBY statement identifies a variable in the BY statement that causes the PRINT procedure to begin the report in a new section when a change occurs to the following values:

- the value of the BY variable
- the value of any BY variable that precedes it in the BY statement

The following program uses a PAGEBY statement with the BY statement to create a report with multiple sections. This program assumes that QTR02 data has been previously sorted by the variables SalesRep and Month.

```
proc print data=qtr02 sumlabel="Total" grandtotal_label="Grand Total";
```

```
      var Units AmountSold;
      where Units>500 or AmountSold>20000;
      format Units comma7. AmountSold dollar14.2;
      sum Units AmountSold;
      by SalesRep Month;
      id SalesRep Month;
      sumby SalesRep;
      pageby SalesRep;
      title1 'Sales Rep Quarterly Totals for Sales above 500 Units or $20,000';
   run;
```

The following output shows the report.

Figure 27.16 Grouping Observations on Separate Pages

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep	Month	Units	AmountSold
Garcia	04	1,715	$53,113.55

SalesRep	Month	Units	AmountSold
Garcia	06	512	$15,856.64
		1,000	$30,970.00
Total		3,227	$99,940.19

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep	Month	Units	AmountSold
Hollingsworth	04	530	$16,414.10

SalesRep	Month	Units	AmountSold
Hollingsworth	05	1,120	$34,686.40
		1,030	$31,899.10
Total		2,680	$82,999.60

Sales Rep Q2 Monthly Report for Sales Above 500 Units or $20,000

SalesRep	Month	Units	AmountSold
Jensen	04	1,110	$34,376.70
		675	$20,904.75
Total		1,785	$55,281.45
Grand Total		7,692	$238,221.24

A new section occurs in the report when the value of the variable SalesRep changes from **Garcia** to `Hollingsworth` and from **Hollingsworth** to **Jensen**.

Creating Customized Reports

Ways to Customize a Report

As you have seen from the previous examples, the PRINT procedure produces simple reports quickly and easily. With additional statements and options, you can enhance the readability of your reports. For example, you can do the following:

- Add descriptive titles and footnotes.
- Define and split labels across multiple lines.
- Add double spacing.
- Ensure that the column widths are uniform across the pages of the report.
- Change the style of the output.

Understanding Titles and Footnotes

Adding descriptive titles and footnotes is one of the easiest and most effective ways to improve the appearance of a report. You can use the TITLE statement to include from 1 to 10 lines of text at the top of the report. You can use the FOOTNOTE statement to include from 1 to 10 lines of text at the bottom of the report.

In the TITLE statement, you can specify *n* immediately following the keyword TITLE, to indicate the level of the TITLE statement. *n* is a number from 1 to 10 that specifies the line number of the TITLE. You must enclose the text of each title in single or double quotation marks.

Skipping over some values of *n* indicates that those lines are blank. For example, if you specify TITLE1 and TITLE3 statements but skip TITLE2, then a blank line occurs between the first and third lines.

When you specify a title, SAS uses that title for all subsequent output until you cancel it or define another title for that line. A TITLE statement for a given line cancels the previous TITLE statement for that line and for all lines below it, that is, for those with larger *n* values.

To cancel all existing titles, specify a TITLE statement without the *n* value:

```
title;
```

To suppress the *n*th title and all titles below it, use the following statement:

```
titlen;
```

Footnotes work the same way as titles. In the FOOTNOTE statement, you can specify *n* immediately following the keyword FOOTNOTE, to indicate the level of the FOOTNOTE statement. *n* is a number from 1 to 10 that specifies the line number of the FOOTNOTE. You must enclose the text of each footnote in single or double quotation marks. As with the TITLE statement, skipping over some values of *n* indicates that those lines are blank.

Remember that the footnotes are pushed up from the bottom of the report. In other words, the FOOTNOTE statement with the largest number appears on the bottom line.

When you specify a footnote, SAS uses that footnote for all subsequent output until you cancel it or define another footnote for that line. You cancel and suppress footnotes in the same way that you cancel and suppress titles.

Note: The maximum title length and footnote length that is allowed depends on your operating environment and the value of the LINESIZE= system option. Refer to the SAS documentation for your operating environment for more information.

Adding Titles and Footnotes

The following program includes titles and footnotes in a report of second quarter sales during the month of April:

```
proc sort data=qtr02;
   by SalesRep;
run;

proc print data=qtr02 noobs;
   var SalesRep Month Units AmountSold;
   where Month='04';
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   title1 'TruBlend Coffee Makers, Inc.';
   title3 'Quarterly Sales Report';
   footnote1 'April Sales Totals';
   footnote2 'COMPANY CONFIDENTIAL INFORMATION';
run;
```

The report includes three title lines and two footnote lines. The program omits the TITLE2 statement so that the second title line is blank.

The following output shows the report.

Figure 27.17 Adding Titles and Footnotes

TruBlend Coffee Makers, Inc.

Quarterly Sales Report

SalesRep	Month	Units	AmountSold
Garcia	04	150	$4,645.50
Garcia	04	1,715	$53,113.55
Hollingsworth	04	260	$8,052.20
Hollingsworth	04	530	$16,414.10
Jensen	04	1,110	$34,376.70
Jensen	04	675	$20,904.75
		4,440	**$137,506.80**

April Sales Totals
COMPANY CONFIDENTIAL INFORMATION

Defining Labels

By default, SAS uses variable names for column headings. However, to improve the appearance of a report, you can specify your own column headings.

To override the default headings, you need to do the following:

- Add the LABEL option to the PROC PRINT statement.
- Define the labels in the LABEL statement.

The LABEL option causes the report to display labels, instead of variable names, for the column headings. You use the LABEL statement to assign the labels for the specific variables. A label can be up to 256 characters long, including blanks, and must be enclosed in single or double quotation marks. If you assign labels when you created the SAS data set, then you can omit the LABEL statement from the PROC PRINT step.

The following program modifies the previous program and defines labels for the variables SalesRep, Units, and AmountSold:

```
proc sort data=qtr02;
   by SalesRep;
run;

proc print data=qtr02 noobs label;
   var SalesRep Month Units AmountSold;
   where Month='04';
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
```

```
   label SalesRep   = 'Sales Rep.'
         Units      = 'Units Sold'
         AmountSold = 'Amount Sold';
   title 'TruBlend Coffee Maker Sales Report for April';
   footnote;
run;
```

The TITLE statement redefines the first title and cancels any additional titles that might have been previously defined. The FOOTNOTE statement cancels any footnotes that might have been previously defined.

The following output shows the report.

Figure 27.18 Defining Labels

TruBlend Coffee Maker Sales Report for April

Sales Rep.	Month	Units Sold	Amount Sold
Garcia	04	150	$4,645.50
Garcia	04	1,715	$53,113.55
Hollingsworth	04	260	$8,052.20
Hollingsworth	04	530	$16,414.10
Jensen	04	1,110	$34,376.70
Jensen	04	675	$20,904.75
		4,440	$137,506.80

Splitting Labels across Two or More Lines

Sometimes labels are too long to fit on one line, or you might want to split a label across two or more lines. You can use the SPLIT= option to control where the labels are separated into multiple lines.

The SPLIT= option replaces the LABEL option in the PROC PRINT statement. (You do not need to use both SPLIT= and LABEL because SPLIT= implies that PROC PRINT use labels.) In the SPLIT= option, you specify an alphanumeric character that indicates where to split labels. To use the SPLIT= option, you need to do the following:

- Define the split character as a part of the PROC PRINT statement.
- Define the labels with a split character in the LABEL statement.

The following PROC PRINT step defines the slash (/) as the split character and includes slashes in the LABEL statements to split the labels Sales Representative, Units Sold, and Amount Sold into two lines each:

```
proc sort data=qtr02;
   by SalesRep;
run;
```

```
proc print data=qtr02 noobs split='/';
   var SalesRep Month Units AmountSold;
   where Month='04';
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   title 'TruBlend Coffee Maker Sales Report for April';
   label SalesRep   = 'Sales/Representative'
         Units      = 'Units/Sold'
         AmountSold = 'Amount/Sold';
   run;
```

The following output shows the report.

Figure 27.19 Reporting: Splitting Labels into Two Lines

TruBlend Coffee Maker Sales Report for April

Sales Representative	Month	Units Sold	Amount Sold
Garcia	04	150	$4,645.50
Garcia	04	1,715	$53,113.55
Hollingsworth	04	260	$8,052.20
Hollingsworth	04	530	$16,414.10
Jensen	04	1,110	$34,376.70
Jensen	04	675	$20,904.75
		4,440	$137,506.80

Adding Blanks Lines

You might want to improve the appearance of a report by adding one or more blank lines between the rows of the report. The following program uses the BLANKLINE option in the PROC PRINT statement to add lines between the observations for sales representatives in the report:

```
proc sort data=qtr02;
   by SalesRep;
run;

proc print data=qtr02 noobs split='/' blankline=2;
   var SalesRep Month Units AmountSold;
   where Month='04';
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   title 'TruBlend Coffee Maker Sales Report for April';
   label SalesRep   = 'Sales/Representative'
         Units      = 'Units/Sold'
```

```
          AmountSold = 'Amount/Sold';
   run;
```

The following output shows the report.

Figure 27.20 *Adding Blank Lines*

TruBlend Coffee Maker Sales Report for April

Sales Representative	Month	Units Sold	Amount Sold
Garcia	04	150	$4,645.50
Garcia	04	1,715	$53,113.55
Hollingsworth	04	260	$8,052.20
Hollingsworth	04	530	$16,414.10
Jensen	04	1,110	$34,376.70
Jensen	04	675	$20,904.75
		4,440	**$137,506.80**

Changing the Report Style

By default, the Output Delivery System (ODS) creates reports for the HTML destination using the default style of HTMLBlue. You can change the report style for all ODS destinations except for the LISTING destination and any destination that does not create output. Instead of explicitly using ODS to change a report style, you can use the STYLE= option in the PROC PRINT statement. The STYLE= option interfaces with ODS to change the report style. You can change report attributes such as fonts, colors, text alignment, and table cell size. Here is the syntax of the STYLE= option:

STYLE <(*location(s)*)>=<*style-element-name*> <[*style-attribute-name=style-attribute-value*]>

location(s) identifies the part of the report that the STYLE= option affects. Report locations include the table structure, column headings, data in the cells, BY labels, the SUM line that contains BY group totals and the report grand totals, N= option values, and the OBS column heading and data.

style-element-name is the name of a style element that is registered with ODS. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program. For example, a style element might contain instructions for the presentation of column headings or for the presentation of the data inside table cells. Each location has a default style element.

style-attribute-name=style-attribute-value describes the style attribute to change and its value.

For a list of style elements and style attributes, see *SAS Output Delivery System: User's Guide*.

The following program modifies the previous program to change the cell spacing in the tables, the color and font style for the header, and the grand total. The style for header is based on the headerstrong style element.

```
proc sort data=qtr02;
  by SalesRep;
run;

proc print data=qtr02 noobs split='/'
           style(table)={cellpadding=10}
           style(header)=headerstrong{backgroundcolor=very light green
                                      color=green fontstyle=italic}
           style(grandtotal)={backgroundcolor=very light green color=green};
   var SalesRep Month Units AmountSold;
   where Month='04';
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   label SalesRep= 'Sales/Representative'
        Units = 'Units/Sold'
            AmountSold= 'Amount/Sold';
   title 'TruBlend Coffee Maker Sales Report for April';
run;
```

The following output shows the report.

Figure 27.21 *Changing the Report Style*

TruBlend Coffee Maker Sales Report for April

Sales Representative	*Month*	*Units Sold*	*Amount Sold*
Garcia	04	150	$4,645.50
Garcia	04	1,715	$53,113.55
Hollingsworth	04	260	$8,052.20
Hollingsworth	04	530	$16,414.10
Jensen	04	1,110	$34,376.70
Jensen	04	675	$20,904.75
		4,440	$137,506.80

Making Your Reports Easy to Change

Understanding the SAS Macro Facility

Base SAS includes the macro facility as a tool to customize SAS and to reduce the amount of text that you must enter to do common tasks. The macro facility enables you to assign a name to character strings or groups of SAS programming statements.

Thereafter, you can work with the names rather than with the text itself. When you use a macro facility name in a SAS program, the macro facility generates SAS statements and commands as needed. The rest of SAS receives those statements and uses them in the same way it uses the ones that you enter in the standard manner.

The macro facility enables you to create macro variables to substitute text in SAS programs. One of the major advantages of using macro variables is that it enables you to change the value of a variable in one place in your program and then have the change appear in multiple references throughout your program. You can substitute text by using automatic macro variables or by using your own macro variables, which you define and assign values to.

Using Automatic Macro Variables

The SAS macro facility includes many automatic macro variables. Some of the values associated with the automatic macro variables depend on your operating environment. You can use automatic macro variables to provide the time, the day of the week, and the date based on your computer's internal clock as well as other processing information.

To include a second title on a report that displays the text string “Produced on” followed by today's date, add the following TITLE statement to your program:

```
title2 "Produced on &SYSDATE9";
```

Notice the syntax for this statement. First, the ampersand that precedes SYSDATE9 tells the SAS macro facility to replace the reference with its assigned value. In this case, the assigned value is the date on which the SAS session started and is expressed as *ddmmmyyyy*, where

- *dd* is a two-digit date
- *mmm* is the first three letters of the month name
- *yyyy* is a four-digit year

Second, the text of the TITLE statement is enclosed in double quotation marks because the SAS macro facility resolves macro variable references in the TITLE statement and the FOOTNOTE statement only if they are in double quotation marks.

The following program, which includes a PROC SORT step and the TITLE statement, demonstrates how to use the SYSDATE9 automatic macro variable:

```
proc sort data=qtr04;
   by SalesRep;
run;

proc print data=qtr04 noobs split='/';
   var SalesRep Month Units AmountSold;
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   title1 'TruBlend Coffee Maker Quarterly Sales Report';
   title2 "Produced on &SYSDATE9";
   label SalesRep    = 'Sales/Rep.'
         Units       = 'Units/Sold'
         AmountSold  = 'Amount/Sold';
run;
```

The following output shows the report.

Figure 27.22 Using Automatic Macro Variables

TruBlend Coffee Maker Quarterly Sales Report
Produced on 09APR2013

Sales Rep.	Month	Units Sold	Amount Sold
Garcia	10	250	$7,742.50
Garcia	10	365	$11,304.05
Garcia	11	198	$6,132.06
Garcia	11	120	$3,716.40
Garcia	12	1,000	$30,970.00
Hollingsworth	10	530	$16,414.10
Hollingsworth	10	265	$8,207.05
Hollingsworth	11	1,230	$38,093.10
Hollingsworth	11	150	$7,425.00
Hollingsworth	12	125	$6,187.50
Hollingsworth	12	175	$5,419.75
Jensen	10	975	$30,195.75
Jensen	10	55	$1,703.35
Jensen	11	453	$14,029.41
Jensen	11	70	$2,167.90
Jensen	12	876	$27,129.72
Jensen	12	1,254	$38,836.38
		8,091	$255,674.02

Using Your Own Macro Variables

In addition to using automatic macro variables, you can use the %LET statement to define your own macro variables and refer to them with the ampersand prefix. Defining macro variables at the beginning of your program enables you to change other parts of the program easily. The example in this section shows how to define two macro variables, Quarter and Year, and how to refer to them in a TITLE statement.

Defining Macro Variables

To use two macro variables that produce flexible report titles, first define the macro variables. The following %LET statements define the two macro variables:

```
%let Quarter=Fourth;
%let Year=2011;
```

The name of the first macro variable is Quarter and it is assigned the value Fourth. The name of the second macro variable is Year and it is assigned the value 2011.

Macro variable names such as these conform to the following rules for SAS names:

- macro variable names are one to 32 characters long
- macro variable names begin with a letter or an underscore
- letters, numbers, and underscores follow the first character.

In these simple situations, do not assign values to macro variables that contain unmatched quotation marks or semicolons. If the values contain leading or trailing blanks, then SAS removes the blanks.

Referring to Macro Variables

To refer to the value of a macro variable, place an ampersand prefix in front of the name of the variable. The following TITLE statement contains references to the values of the macro variables Quarter and Year, which were previously defined in %LET statements:

```
title3 "&Quarter Quarter &Year Sales Totals";
```

The complete program, which includes the two %LET statements and the TITLE3 statement, follows:

```
%let Quarter=Fourth;  1
%let Year=2013;  2

proc sort data=qtr04;
   by SalesRep;
run;

proc print data=qtr04 noobs split='/' width=uniform;
   var SalesRep Month Units AmountSold;
   format Units comma7. AmountSold dollar14.2;
   sum Units AmountSold;
   title1 'TruBlend Coffee Maker Quarterly Sales Report';
   title2 "Produced on &SYSDATE9";
   title3 "&Quarter Quarter &Year Sales Totals";  3
   label SalesRep    = 'Sales/Rep.'
         Units       = 'Units/Sold'
         AmountSold  = 'Amount/Sold';
run;
```

1 The %LET statement creates a macro variable with the sales quarter. When an ampersand precedes Quarter, the SAS macro facility knows to replace any reference to &Quarter with the assigned value of Fourth.

2 The %LET statement creates a macro variable with the year. When ampersand precedes Year, the SAS macro facility knows to replace any reference to &Year with the assigned value of 2011.

3 The text of the TITLE2 and TITLE3 statements are enclosed in double quotation marks so that the SAS macro facility can resolve them.

The following list corresponds to the numbered items in the preceding program:

The following output shows the report.

Figure 27.23 *Using Your Own Macro Variables*

TruBlend Coffee Maker Quarterly Sales Report
Produced on 09APR2013
Fourth Quarter 2012 Sales Totals

Sales Rep.	Month	Units Sold	Amount Sold
Garcia	10	250	$7,742.50
Garcia	10	365	$11,304.05
Garcia	11	198	$6,132.06
Garcia	11	120	$3,716.40
Garcia	12	1,000	$30,970.00
Hollingsworth	10	530	$16,414.10
Hollingsworth	10	265	$8,207.05
Hollingsworth	11	1,230	$38,093.10
Hollingsworth	11	150	$7,425.00
Hollingsworth	12	125	$6,187.50
Hollingsworth	12	175	$5,419.75
Jensen	10	975	$30,195.75
Jensen	10	55	$1,703.35
Jensen	11	453	$14,029.41
Jensen	11	70	$2,167.90
Jensen	12	876	$27,129.72
Jensen	12	1,254	$38,836.38
		8,091	$255,674.02

Using macro variables can make your programs easy to modify. For example, if the previous program contained many references to Quarter and Year, then changes in only three places will produce an entirely different report:

- the two values in the %LET statements
- the data set name in the PROC PRINT statement

Summary

PROC PRINT Statements

PROC PRINT <DATA=*SAS-data-set*> <*options*>;
    BY *variable(s)*;
    FOOTNOTE<*n*> <'*footnote*'>;
    FORMAT *variable(s) format-name*;
    ID *variable(s)*;
    LABEL *variable='label'*;
    PAGEBY *variable*;
    SUM *variable(s)*;
    SUMBY *variable*;
    TITLE<*n*> <'*title*'>;
    VAR *variable(s)*;
WHERE *where-expression*;

PROC PRINT <DATA=*SAS-data-set*> <*options*>;
starts the procedure and, when used alone, shows all variables for all observations in the SAS-data-set in the report. Other statements, that are listed below, enable you to control what to report.

You can specify the following options in the PROC PRINT statement:

BLANKLINE=*n* | BLANKLINE=(COUNT=*n* <STYLE=[*style-attribute-specification(s)*]>)
specifies to insert a blank line after every n observations. The observation count is reset to 0 at the beginning of every BY group for all ODS destinations.

DATA=*SAS-data-set*
names the SAS data set that PROC PRINT uses. If you omit DATA=, then PROC PRINT uses the most recently created data set.

GRANDTOTAL_LABEL="*label*"
displays a label on the grand total line.

LABEL
uses variable labels instead of variable names as column headings for any variables that have labels defined. Variable labels appear only if you use the LABEL option or the SPLIT= option. You can specify labels in LABEL statements in the DATA step that creates the data set or in the PROC PRINT step. If you do

not specify the LABEL option or if there is no label for a variable, then PROC PRINT uses the variable name.

N<="*string-1*" <"*string-2*">>
shows the number of observations in the data set, in BY groups, or both. It can also specify explanatory text to include with the number.

NOOBS
suppresses the observation numbers in the output. This option is useful when you omit an ID statement and do not want to show the observation numbers.

OBS="*column-header*"
specifies a column heading for the column that identifies each observation by number.

SPLIT='*split-character*'
specifies the split character, which controls line breaks in column headings. PROC PRINT breaks a column heading when it reaches the split character and continues the header on the next line. The split character is not part of the column heading.

PROC PRINT uses variable labels only when you use the LABEL option or the SPLIT= option. It is not necessary to use both the LABEL and SPLIT= options because SPLIT= implies to use labels.

STYLE=<*location(s)*>=<*style-element-name*> <[*style-attribute-specification(s)*]>
specify one or more style elements for the Output Delivery System to use for different parts of the report.

SUMLABEL="*label*"
displays a label on the summary line in place of the BY variable name.

WIDTH=UNIFORM
uses each variable's formatted width as its column width on all pages. If the variable does not have a format that explicitly specifies a field width, then PROC PRINT uses the widest data value as the column width. Without this option, PROC PRINT fits as many variables and observations on a page as possible. Therefore, the report might contain a different number of columns on each page.

BY *variable(s)*;
produces a separate section of the report for each BY group. The BY group consists of the *variables* that you specify. When you use a BY statement, the procedure expects that the input data set is sorted by the *variables*.

FOOTNOTE<*n*> <'*footnote*'>;
specifies a footnote. The argument *n* is a number from 1 to 10 that immediately follows the word FOOTNOTE, with no intervening blank, and specifies the line number of the FOOTNOTE. The text of each footnote must be enclosed in single or double quotation marks. The maximum footnote length that is allowed depends on your operating environment and the value of the LINESIZE= system option. Refer to the SAS documentation for your operating environment for more information.

FORMAT *variable(s) format-name*;
enables you to report the value of a *variable* using a special pattern that you specify as *format-name*.

ID *variable(s)*;
specifies one or more variables that PROC PRINT uses instead of observation numbers to identify observations in the report.

LABEL *variable*='*label*';
: specifies to use labels for column headings. *Variable* names the variable to label, and *label* specifies a string of up to 256 characters, which includes blanks. The *label* must be enclosed in single or double quotation marks.

PAGEBY *variable*;
: causes PROC PRINT to begin a new page when the *variable* that you specify changes value or when any variable that you list before it in the BY statement changes value. You must use a BY statement with the PAGEBY statement.

SUM *variable(s)*;
: identifies the numeric variables to total in the report. You can specify a variable in the SUM statement and omit it in the VAR statement because PROC PRINT will add the variable to the VAR list. PROC PRINT ignores requests to total the BY and ID variables. In general, when you also use the BY statement, the SUM statement produces subtotals each time the value of a BY variable changes.

SUMBY *variable*;
: limits the number of sums that appear in the report. PROC PRINT reports totals only when *variable* changes value or when any variable that is listed before it in the BY statement changes value. You must use a BY statement with the SUMBY statement.

TITLE<*n*> <'*title*'>;
: specifies a title. The argument *n* is a number from 1 to 10 that immediately follows the word TITLE, with no intervening blank, and specifies the level of the TITLE. The text of each *title* must be enclosed in single or double quotation marks. The maximum title length that is allowed depends on your operating environment and the value of the LINESIZE= system option. Refer to the SAS documentation for your operating environment for more information.

VAR *variable(s)*;
: identifies one or more variables that appear in the report. The variables appear in the order in which you list them in the VAR statement. If you omit the VAR statement, then all the variables appear in the report.

WHERE *where-expression*;
: subsets the input data set by identifying certain conditions that each observation must meet before an observation is available for processing. *Where-expression* defines the condition. The condition is a valid arithmetic or logical expression that generally consists of a sequence of operands and operators.

PROC SORT Statements

PROC SORT <DATA=*SAS-data-set*>;
BY *variable(s)*;

PROC SORT DATA=*SAS-data-set*;
: sorts a SAS data set by the values of variables that you list in the BY statement.

BY *variable(s)*;
: specifies one or more variables by which PROC SORT sorts the observations. By default, PROC SORT arranges the data set by the values in ascending order (smallest value to largest).

SAS Macro Language

%LET *macro-variable=value*;
: is a macro statement that defines a macro-variable and assigns it a value. The value that you define in the %LET statement is substituted for the macro-variable in output. To use the macro-variable in a program, include an ampersand (&) prefix before it.

SYSDATE9
: is an automatic macro variable that contains the date on which a SAS job or session began to execute. SYSDATE9 contains a SAS date value in the DATE9 format (ddmmmyyyy). The date displays a two-digit date, the first three letters of the month name, and a four-digit year. To use it in a program, you include an ampersand (&) prefix before SYSDATE9.

Learning More

Data Set Indexes
: For information about indexing data sets, see *SAS Data Set Options: Reference*. You do not need to sort data sets before using a BY statement in the PRINT procedure if the data sets have an index for the variable or variables that are specified in the BY statement.

Style Elements and Style Attributes
: For complete information about style elements and style attributes, see *SAS Output Delivery System: User's Guide*.

PROC PRINT
: For complete documentation, see *Base SAS Procedures Guide*.

PROC SORT
: For more information, see Chapter 12, "Working with Grouped or Sorted Observations," on page 191. For complete reference documentation about the SORT procedure, see *Base SAS Procedures Guide*.

SAS formats
: For complete documentation, see *SAS Formats and Informats: Reference*. Formats that are available with SAS software include fractions, hexadecimal values, roman numerals, Social Security numbers, date and time values, and numbers written as words.

SAS macro facility
: For complete reference documentation, see *SAS Macro Language: Reference*.

WHERE statement
: For complete reference documentation, see *SAS DATA Step Statements: Reference*. For a complete discussion of WHERE processing, see *SAS Language Reference: Concepts*.

28

Creating Summary Tables with the TABULATE Procedure

Introduction to Creating Summary Tables with the TABULATE Procedure

Purpose

Summary tables display the relationships that exist among the variables in a data set. The variables in the data set form the columns, rows, and pages of summary tables. The data at each intersection of a column and row (that is, each cell) shows a relationship between the variables. The TABULATE procedure enables you to create a variety of summary tables.

In this section, you learn how to do the following:

- produce simple summary tables by using a few basic PROC TABULATE options and statements
- produce enhanced summary tables by summarizing more complex relationships between and across variables, applying formats to variables, and calculating statistics for variables
- add the finishing touches to tables by using labels, by specifying fonts and colors with the Output Delivery System, and by ordering class variables

Prerequisites

To understand the examples in this section, you should be familiar with the following features and concepts:

- "Locating Procedure Output" on page 642
- "Adding Titles and Footnotes" on page 476

Understanding Summary Table Design

If you design your summary table in advance, then you can save time and write simpler SAS code to produce the summary table. The basic steps of summary table design and construction are listed next. For a detailed step-by-step example of the design process, see *PROC TABULATE by Example*.

Before designing a summary table, it is important to understand that the summary table produces summary data wherever values for two or more variables intersect. The point of intersection is a cell. When values for two or more variables intersect, the variables are said to be crossed. The process of crossing variables to form intersections is called crosstabulation. Variables in columns, rows, and pages can be crossed to produce summary data. The following program creates a summary table that shows how two variables are crossed. For the input file and SAS Data set, see "Input File and SAS Data Set for Examples" on page 498.

```
proc format;
   value $slrpclr 'Hollingsworth'='cx00BBBB'
                  other ='cx00DDDD';
   value $slrpmsk 'Hollingsworth'='value Y'
                  'Garcia'       ='value X'
                  'Jensen'       ='value Z';
   value $quarclr '3'='cx00BBBB'
                  other ='cx00DDDD';
   value $quarmsk '1'='value A'
                  '2'='value B'
                  '3'='value C'
                  '4'='value D';
   value sumclr   222290-222291 ='cx00BBBB'
                  225326-225327 ='cx00BBBB'
                  108900-110000 ='cx2E7371'
                   81000- 82000 ='cx00BBBB'
                   96000- 97000 ='cx00BBBB'
                   59000- 59650 ='cx00BBBB'
                  other ='w';
run;

ods html body='/dept/pub/doc/701misc/authoring/TW6025/sgml/delete.htm';
proc tabulate data=year_sales format=comma10.;
   title 'Crossing Value C with Value Y';
   class SalesRep Quarter/ style=[background=cx00DDDD];
   classlev salesrep / style=[background=$slrpclr. just=right];
   classlev quarter / style=[background=$quarclr.];
   var AmountSold / style=[background=cx00DDDD];
   table SalesRep='Variable 2',
         (AmountSold='Variable 1'*sum=' '*Quarter=' ')*
         [s=[background=sumclr. foreground=sumclr.]] /
         box={style={background=cx00DDDD}};
   format salesrep $slrpmsk. Quarter $quarmsk.;
run;
ods html close;
```

The following summary table displays how two variables are crossed by highlighting a single value for each variable.

Figure 28.1 Crossing Variables

Crossing Value C with Value Y

	Variable 1			
	value A	value B	value C	value D
Variable 2				
value X				
value Y				
value Z				

Here are the basic steps for designing and constructing a summary table:

1. Start with a question that you want to answer with a summary table.

2. Identify the variables necessary to answer your question.

   - See whether any of the data sets that you are using already use the variables that you identified. If they do not, then you might be able to use the FORMAT procedure to reclassify the variable values in these data sets. This enables you produce the data that you need.

     For example, you can apply a new format to values for a variable MONTH so that they become values for a variable QUARTER. To do this, assign the values representing the first three months to a value for quarter one, values representing the second set of three months to a value for quarter two, and so on.

   - If possible, use discrete variables rather than continuous variables for categories or headings. If you must use continuous variables, then it might be helpful to create categories. For example, you can group ages into categories such as ages 15-19, 20-35, 36-55, and 56-higher. This creates four categories rather than a possible 56+ categories. You can use PROC FORMAT to categorize the data.

   - Choose formats for the variables and the data that you want to display in your summary table. See whether the data in your data sets is in a format that you can use. You might need to create new formats with PROC FORMAT, or copy the formats of variables from another data set so that the data is formatted in the same way.

3. Review the data for anything that might cause discrepancies in your report.

   - Remove data that does not relate to your needs.
   - Identify missing data.
   - Make sure that the data overall seems to make logical sense.

4. Choose statistics that help answer your question. For a complete list of statistics, see “Statistics Available in PROC TABULATE” in the *Base SAS Procedures Guide*.

5. Decide on the basic structure of the table. Use the variables that you have identified to determine the headings for the columns, rows, and pages. The values of the variables are the subheadings. Statistics are usually represented

as subheadings, but are sometimes represented as headings. is an example of a template for a very basic table.

6 Decide on the style of the table. You can use ODS to customize the appearance of your output. For more information about the Output Delivery System, see *SAS Output Delivery System: User's Guide*.

Understanding the Basics of the TABULATE Procedure

Required Statements for the TABULATE Procedure

The TABULATE procedure requires three statements, usually in the following order:

1 PROC TABULATE statement

2 CLASS statements or VAR statements or both

3 TABLE statements

Note that there can be multiple CLASS statements, VAR statements, and TABLE statements.

Begin with the PROC TABULATE Statement

The TABULATE procedure begins with a PROC TABULATE statement. Many options are available with the PROC TABULATE statement. However, most of the examples in this section use only two options, the DATA= option and the FORMAT= option. The PROC TABULATE statement that follows is used for all of the examples in this section:

```
proc tabulate data=year_sales format=comma10.;
```

You can direct PROC TABULATE to use a specific SAS data set with the DATA= option. If you omit the DATA= option in the current job or session, then the TABULATE procedure uses the SAS data set that was created most recently.

You can specify a default format for PROC TABULATE to apply to the value in each cell in the table with the FORMAT= option. You can specify any valid SAS numeric format or user-defined format.

Specify Class Variables with the CLASS Statement

Use the CLASS statement to specify which variables are class variables. Class variables (that is, classification variables) contain values that are used to form categories. In summary tables, the categories are used as the column, row, and page headings. The categories are crossed to obtain descriptive statistics. See Figure 28.1 on page 494 for an example of crossing categories (variable values).

Class variables can be either character or numeric. The default statistic for class variables is N, which is the frequency or number of observations in the data set for which there are nonmissing variable values.

The following CLASS statement specifies the variables SalesRep and Type as class variables:

```
class SalesRep Type;
```

For important information about how PROC TABULATE behaves when class variables that have missing values are listed in a CLASS statement but are not used in a TABLE statement, see "Identifying Missing Values for Class Variables" on page 497.

Specify Analysis Variables with the VAR Statement

Use the VAR statement to specify which variables are analysis variables. Analysis variables contain numeric values for which you want to compute statistics. The default statistic for analysis variables is SUM.

The following VAR statement specifies the variable AmountSold as an analysis variable:

```
var AmountSold;
```

Define the Table Structure with the TABLE Statement

Syntax of a TABLE Statement

Use the TABLE statement to define the structure of the table that you want PROC TABULATE to produce. A TABLE statement consists of one to three dimension expressions, separated by commas. Dimension expressions define the columns, rows, and pages of a summary table. Options can follow dimension expressions. You must specify at least one TABLE statement, because there is no default table in a PROC TABULATE step. Here are three variations of the syntax for a basic TABLE statement:

```
TABLE column-expression;
TABLE row-expression, column-expression;
TABLE page-expression, row-expression, column-expression;
```

In this syntax

- a column expression is required
- a row expression is optional
- a page expression is optional
- the order of the expressions must be page expression, row expression, and then column expression

Here is an example of a basic TABLE statement with three dimension expressions:

```
table SalesRep, Type, AmountSold;
```

This TABLE statement defines a three-dimensional summary table that places:

- the values of the variable AmountSold in the column dimension
- the values of the variable Type in the row dimension
- the values of the variable SalesRep in the page dimension

Restrictions on a TABLE Statement

Here are restrictions on the TABLE statement:

- A TABLE statement must have a column dimension.
- Every variable that is used in a dimension expression in a TABLE statement must appear in either a CLASS statement or a VAR statement, but not both.
- All analysis variables must be in the same dimension and cannot be crossed. Therefore, only one dimension of any TABLE statement can contain analysis variables.

Identifying Missing Values for Class Variables

You can identify missing values for class variables with the MISSING option. By default, if an observation contains a missing value for any class variable, that observation is excluded from all tables. The value is excluded even if the variable does not appear in the TABLE statement for one or more tables. Therefore, it is helpful to run your program at least once with the MISSING option to identify missing values.

The MISSING option creates a separate category in the summary table for missing values. It can be used with the PROC TABULATE statement or the CLASS statement. If you specify the MISSING option in the PROC TABULATE statement, the procedure considers missing values as valid levels for all class variables:

```
proc tabulate data=year_sales format=comma10. missing;
   class SalesRep;
   class Month Quarter;
   var AmountSold;
```

Because the MISSING option is in the PROC TABULATE statement in this example, observations with missing values for SalesRep, Month, or Quarter are displayed in the summary table.

If you specify the MISSING option in a CLASS statement, PROC TABULATE considers missing values as valid levels for the class variable(s) that are specified in that CLASS statement:

```
proc tabulate data=year_sales format=comma10.;
   class SalesRep;
   class Month Quarter / missing;
   var AmountSold;
```

Because the MISSING option is in the second CLASS statement, observations with missing values for Month or Quarter are displayed in the summary table, but observations with a missing value for SalesRep are not displayed.

If you have class variables with missing values in your data set, then you must decide whether the observations with the missing values should be omitted from every table. If the observations should not be omitted, then you can fill in the missing values where appropriate or continue to run the PROC TABULATE step with the MISSING option. For other options for handling missing values, see “Handling Missing Data” in *PROC TABULATE by Example*. For general information about missing values, see “Missing Values” in *SAS Language Reference: Concepts*.

Input File and SAS Data Set for Examples

The examples in this section use one input file and one SAS data set. For more information, see “The YEAR_SALES Data Set” on page 854.

The input file contains sales records for a company, TruBlend Coffee Makers, that distributes the coffee machines. The file has the following structure:

```
01      1       Hollingsworth  Deluxe       260       49.50
01      1       Garcia         Standard      41       30.97
01      1       Hollingsworth  Deluxe       330       49.50
01      1       Jensen         Standard    1110       30.97
01      1       Garcia         Standard     715       30.97
01      1       Jensen         Deluxe       675       49.50
02      1       Jensen         Standard      45       30.97
02      1       Garcia         Deluxe        10       49.50

…more data lines…

12      4       Hollingsworth  Deluxe       125       49.50
12      4       Jensen         Standard    1254       30.97
12      4       Hollingsworth  Deluxe       175       49.50
```

The input file contains the following data from left to right:

- the month in which a sale was made
- the quarter of the year in which a sale was made
- the name of the sales representative
- the type of coffee maker sold (standard or deluxe)
- the number of units sold
- the price of each unit in US dollars

The SAS data set is named YEAR_SALES. This data set contains all the sales data from the input file and data from a new variable named AmountSold, which is created by multiplying Units by Price.

The following program creates the SAS data set that is used in this section:

```
data year_sales;
   infile 'your-input-file';
   input Month $ Quarter $ SalesRep $14. Type $ Units Price;
   AmountSold = Units * Price;
run;
```

Creating Simple Summary Tables

Creating a Basic One-Dimensional Summary Table

The simplest summary table contains multiple columns but only a single row. It is called a one-dimensional summary table because it has only a column dimension. The PROC TABULATE step that follows creates a one-dimensional summary table that answers the question, “How many times did each sales representative make a sale?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Number of Sales by Each Sales Representative';
   class SalesRep; 1
   table SalesRep; 2
run;
```

The numbered items in the previous program correspond to the following:

1 The variable SalesRep is specified as a class variable in the CLASS statement. A category is created for each value of SalesRep wherever SalesRep is used in a TABLE statement.

2 The variable SalesRep is specified in the column dimension of the TABLE statement. A column is created for each category of SalesRep. Each column shows the number of times (N) that values belonging to the category appear in the data set.

The following summary table displays the results of this program.

Figure 28.2 Basic One-Dimensional Summary Table

TruBlend Coffee Makers, Inc.
Number of Sales by Each Sales Representative

SalesRep		
Garcia	Hollingsworth	Jensen
N	N	N
40	32	38

The values 40, 32, and 38 are the frequency with which each sales representative's name (Garcia, Hollingsworth, and Jensen) occurs in the data set. For this data set, each occurrence of the sales representative's name in the data set represents a sale.

Creating a Basic Two-Dimensional Summary Table

The most commonly used form of a summary table has at least one column and multiple rows, and is called a two-dimensional summary table. The PROC TABULATE step that follows creates a two-dimensional summary table that answers the question, “What was the amount that was sold by each sales representative?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Amount Sold by Each Sales Representative';
   class SalesRep; 1
   var AmountSold; 2
   table SalesRep, 3
         AmountSold; 4 ;
run;
```

The shaded areas in the previous program correspond to the following:

1 The variable SalesRep is specified as a class variable in the CLASS statement. A category is created for each value of SalesRep wherever SalesRep is used in a TABLE statement.

2 The variable AmountSold is specified as an analysis variable in the VAR statement. The values of AmountSold are used to compute statistics wherever AmountSold is used in a TABLE statement.

3 The variable SalesRep is in the row dimension of the TABLE statement. A row is created for each value or category of SalesRep.

4 The variable AmountSold is in the column dimension of the TABLE statement. The default statistic for analysis variables, SUM, is used to summarize the values of AmountSold.

The following summary table displays the results of this program: The variable AmountSold has been crossed with the variable SalesRep to produce each cell of the summary table. The column heading AmountSold includes the subheading SUM. The values that are displayed in the column dimension are sums of the amount sold by each sales representative.

Figure 28.3 Basic Two-Dimensional Summary Table

TruBlend Coffee Makers, Inc.
Amount Sold by Each Sales Representative

	AmountSold
	Sum
SalesRep	
Garcia	512,071
Hollingsworth	347,246
Jensen	461,163

Creating a Basic Three-Dimensional Summary Table

Three-dimensional summary tables produce the output on separate pages with rows and columns on each page. The PROC TABULATE step that follows creates a three-dimensional summary table that answers the question, “What was the amount that was sold during each quarter of the year by each sales representative?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Quarterly Sales by Each Sales Representative';
   class SalesRep Quarter; 1
   var AmountSold; 2
   table SalesRep, 3
         Quarter, 4
         AmountSold; 5
run;
```

The numbered items in the previous program correspond to the following:

1 The variables SalesRep and Quarter are specified as class variables in the CLASS statement. A category is created for each value of SalesRep wherever SalesRep is used in the TABLE statement. Similarly, a category is created for each value of Quarter wherever Quarter is used in a TABLE statement.

2 The variable AmountSold is specified as an analysis variable in the VAR statement. The values of AmountSold are used to compute statistics wherever AmountSold is used in a TABLE statement.

3 The variable SalesRep is used in the page dimension of the TABLE statement. A page is created for each value or category of SalesRep.

4 The variable Quarter is used in the row dimension of the TABLE statement. A row is created for each value or category of Quarter.

5 The variable AmountSold is used in the column dimension of the TABLE statement. The default statistic for analysis variables, SUM, is used to summarize the values of AmountSold.

The following summary table displays the results of this program. This summary table has a separate page for each sales representative. For each sales representative, the amount sold is reported for each quarter. The column heading AmountSold includes the subheading SUM. The values that are displayed in this column indicate the total amount sold in US dollars for each quarter by each sales representative.

Figure 28.4 Basic Three-Dimensional Summary Table

TruBlend Coffee Makers, Inc.
Quarterly Sales by Each Sales Representative

SalesRep Garcia

	AmountSold
	Sum
Quarter	
1	118,020
2	108,860
3	225,326
4	59,865

TruBlend Coffee Makers, Inc.
Quarterly Sales by Each Sales Representative

SalesRep Hollingsworth

	AmountSold
	Sum
Quarter	
1	59,635
2	96,161
3	109,704
4	81,747

TruBlend Coffee Makers, Inc.
Quarterly Sales by Each Sales Representative

SalesRep Jensen

	AmountSold
	Sum
Quarter	
1	50,078
2	74,731
3	222,291
4	114,063

Producing Multiple Tables in a Single PROC TABULATE Step

You can produce multiple tables in a single PROC TABULATE step. However, you cannot change how a variable is used or defined in the middle of the step. In other words, the variables in the CLASS or VAR statements are defined only once for all TABLE statements in the PROC TABULATE step. If you need to change how a variable is used or defined for different TABLE statements, then you must place the TABLE statements, and define the variables, in multiple PROC TABULATE steps. The program that follows produces three summary tables during one execution of the TABULATE procedure:

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Sales of Deluxe Model Versus Standard Model';
   class SalesRep Type;
   var AmountSold Units;
   table Type; 1
   table Type, Units; 2
   table SalesRep, Type, AmountSold; 3
run;
```

The numbered items in the previous program correspond to the following:

1 The first TABLE statement produces a one-dimensional summary table with the values for the variable Type in the column dimension.

2 The second TABLE statement produces a two-dimensional summary table with the values for the variable Type in the row dimension and the variable Units in the column dimension.

3 The third TABLE statement produces a three-dimensional summary table with:

- the values for the variable SalesRep in the page dimension
- the values for the variable Type in the row dimension
- the variable AmountSold in the column dimension

The following summary table displays the results of this program.

Figure 28.5 Multiple Tables Produced by a Single PROC TABULATE Step

TruBlend Coffee Makers, Inc.
Sales of Deluxe Model Versus Standard Model

Type	
Deluxe	Standard
N	N
16	94

TruBlend Coffee Makers, Inc.
Sales of Deluxe Model Versus Standard Model

	Units
	Sum
Type	
Deluxe	2,525
Standard	38,464

TruBlend Coffee Makers, Inc.
Sales of Deluxe Model Versus Standard Model

SalesRep Garcia

	AmountSold
	Sum
Type	
Deluxe	46,778
Standard	465,293

TruBlend Coffee Makers, Inc.
Sales of Deluxe Model Versus Standard Model

SalesRep Hollingsworth

	AmountSold
	Sum
Type	
Deluxe	37,620
Standard	309,626

TruBlend Coffee Makers, Inc.
Sales of Deluxe Model Versus Standard Model

SalesRep Jensen

	AmountSold
	Sum
Type	
Deluxe	40,590
Standard	420,573

Creating More Sophisticated Summary Tables

Creating Hierarchical Tables to Report on Subgroups

You can create a hierarchical table to report on subgroups of your data by crossing elements within a dimension. Crossing elements is the operation that combines two or more elements, such as class variables, analysis variables, format modifiers, statistics, or styles. Dimensions are automatically crossed. When you cross variables in a single dimension expression, values for one variable are placed within the values for the other variable in the same dimension. This forms a hierarchy of variables and, therefore, a hierarchical table. The order in which variables are listed when they are crossed determines the order of the headings in the table. In the column dimension, variables are stacked top to bottom; in the row dimension, left to right; and in the page dimension, front to back. You cross elements in a dimension expression by putting an asterisk between them. Note that two analysis variables cannot be crossed. Also, because dimensions are automatically crossed, all analysis variables must occur in one dimension.

The PROC TABULATE step that follows creates a two-dimensional summary table that crosses two variables and that answers the question, “What was the amount sold of each type of coffee maker by each sales representative?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Amount Sold Per Item by Each Sales Representative';
   class SalesRep Type;
   var AmountSold;
   table SalesRep*Type,
         AmountSold;
run;
```

The expression `SalesRep*Type` in the row dimension uses the asterisk operator to cross the values of the variable SalesRep with the values of the variable Type. Because SalesRep is listed before Type when crossed, and because the elements are crossed in the row dimension, values for Type are listed to the right of values of SalesRep. Values for Type are repeated for each value of SalesRep.

The following summary table displays the results.

Figure 28.6 Crossing Variables

TruBlend Coffee Makers, Inc.
Amount Sold Per Item by Each Sales Representative

		AmountSold
		Sum
SalesRep	Type	
Garcia	Deluxe	46,778
	Standard	465,293
Hollingsworth	Deluxe	37,620
	Standard	309,626
Jensen	Deluxe	40,590
	Standard	420,573

Notice the hierarchy of values that are created when the values for Type are repeated to the right of each value of SalesRep.

Formatting Output

You can override formats in summary table output by crossing variables with format modifiers. You cross a variable with a format modifier by putting an asterisk between them.

The PROC TABULATE step that follows creates a two-dimensional summary table that crosses a variable with a format modifier and that answers the question, “What was the amount sold of each type of coffee maker by each sales representative?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Amount Sold Per Item by Each Sales Representative';
   class SalesRep Type;
   var AmountSold;
   table SalesRep*Type,
         AmountSold*f=dollar16.2;
run;
```

The expression `AmountSold*f=dollar16.2` in the column dimension uses the asterisk operator to cross the values of the variable `AmountSold` with the SAS format modifier `f=dollar16.2`. The values for AmountSold are now displayed using the DOLLAR16.2 format. The DOLLAR16.2 format is better suited for dollar figures than the COMMA10. format, which is specified as the default in the PROC TABULATE statement.

The following summary table displays the results.

Figure 28.7 Crossing Variables with Format Modifiers

TruBlend Coffee Makers, Inc.
Amount Sold Per Item by Each Sales Representative

		AmountSold
		Sum
SalesRep	Type	
Garcia	Deluxe	$46,777.50
	Standard	$465,293.28
Hollingsworth	Deluxe	$37,620.00
	Standard	$309,626.10
Jensen	Deluxe	$40,590.00
	Standard	$420,572.60

Calculating Descriptive Statistics

You can request descriptive statistics for a variable by crossing that variable with the appropriate statistic keyword. Crossing either a class variable or an analysis variable with a statistic tells PROC TABULATE what type of calculations to perform. Note that two statistics cannot be crossed. Also, because dimensions are automatically crossed, all statistics must occur in one dimension.

The default statistic crossed with a class variable is the N statistic or frequency. Class variables can be crossed only with frequency and percent frequency statistics. The default statistic crossed with an analysis variable is the SUM statistic. Analysis variables can be crossed with any of the many descriptive statistics that are available with PROC TABULATE including commonly used statistics like MIN, MAX, MEAN, STD, and MEDIAN. For a complete list of statistics available for use with analysis variables, see “Statistics Available in PROC TABULATE” in the *Base SAS Procedures Guide*.

The PROC TABULATE step that follows creates a two-dimensional summary table that crosses elements with a statistic and that answers the question, “What was the average amount per sale of each type of coffee maker by each sales representative?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Average Amount Sold Per Item by Each Sales Representative';
   class SalesRep Type;
   var AmountSold;
   table SalesRep*Type,
         AmountSold*mean*f=dollar16.2;
run;
```

In this program, the column dimension crosses the variable `AmountSold` with the statistic `mean` and with the format modifier `f=dollar16.2`. The MEAN statistic provides the arithmetic mean for AmountSold.

The following summary table displays the results.

Figure 28.8 Crossing a Variable with a Statistic

TruBlend Coffee Makers, Inc.
Average Amount Sold Per Item by Each Sales Representative

		AmountSold
		Mean
SalesRep	Type	
Garcia	Deluxe	$11,694.38
	Standard	$12,924.81
Hollingsworth	Deluxe	$4,702.50
	Standard	$12,901.09
Jensen	Deluxe	$10,147.50
	Standard	$12,369.78

Reporting on Multiple Statistics

You can create summary tables that report on two or more statistics by concatenating variables. *Concatenating* is the operation that joins the information of two or more elements, such as class variables, analysis variables, or statistics, by placing the output of the second and subsequent elements immediately after the output of the first element. You concatenate elements in a dimension expression by putting a blank space between them.

The PROC TABULATE step that follows creates a two-dimensional summary table that uses concatenation and that answers the question, “How many sales were made, and what was the total sales figure for each type of coffee maker sold by each sales representative?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Sales Summary by Representative and Product';
   class SalesRep Type;
   var AmountSold;
   table SalesRep*Type,
         AmountSold*n AmountSold*f=dollar16.2;
run;
```

In this program, because the expressions `AmountSold*n` and `AmountSold*f=dollar16.2` in the column dimension are separated by a blank space, their output is concatenated.

The following summary table displays the results. In this summary table the frequency (N) of AmountSold is shown in the same table as the SUM of AmountSold.

Figure 28.9 *Concatenating Variables*

TruBlend Coffee Makers, Inc.
Sales Summary by Representative and Product

		AmountSold	AmountSold
		N	Sum
SalesRep	Type		
Garcia	Deluxe	4	$46,777.50
	Standard	36	$465,293.28
Hollingsworth	Deluxe	8	$37,620.00
	Standard	24	$309,626.10
Jensen	Deluxe	4	$40,590.00
	Standard	34	$420,572.60

Reducing Code and Applying a Single Label to Multiple Elements

You can use parentheses to group concatenated elements (variables, formats, statistics, and so on) that are concatenated or crossed with a common element. This can reduce the amount of code used and can change how labels are displayed. The PROC TABULATE step that follows uses parentheses to group elements that are crossed with AmountSold and answers the question, “How many sales were made, and what was the total sales figure for each type of coffee maker sold by each sales representative?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Sales Summary by Representative and Product';
   class SalesRep Type;
   var AmountSold;
   table SalesRep*Type,
         AmountSold*(n sum*f=dollar16.2);
run;
```

In this program, `AmountSold*(n sum*f=dollar16.2)` takes the place of `AmountSold*n AmountSold*f=dollar16.2`. Notice the default statistic SUM from `AmountSold*f=dollar16.2` must now be included in the expression. This is because the format modifier must be crossed with a variable or a statistic. It cannot be in the expression by itself.

The following summary table displays the results.

Figure 28.10 Using Parentheses to Group Elements

TruBlend Coffee Makers, Inc.
Sales Summary by Representative and Product

		AmountSold	
		N	Sum
SalesRep	Type		
Garcia	Deluxe	4	$46,777.50
	Standard	36	$465,293.28
Hollingsworth	Deluxe	8	$37,620.00
	Standard	24	$309,626.10
Jensen	Deluxe	4	$40,590.00
	Standard	34	$420,572.60

Note that the label, AmountSold, spans multiple columns rather than appearing twice in the summary table, as it does in Figure 28.9 on page 509.

Getting Summaries for All Variables

You can summarize all of the class variables in a dimension with the universal class variable ALL. ALL can be concatenated with each of the three dimensions of the TABLE statement and within groups of elements delimited by parentheses. The PROC TABULATE step that follows creates a two-dimensional summary table with the universal class variable ALL, and answers the question, “For each sales representative and for all of the sales representatives as a group, how many sales were made, what was the average amount per sale, and what was the amount sold?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Sales Report';
   class SalesRep Type;
   var AmountSold;
   table SalesRep*Type all,
         AmountSold*(n (mean sum)*f=dollar16.2);
run;
```

In this program, the TABLE statement now includes the universal class variable ALL in the row dimension. SalesRep and Type are summarized.

The following summary table displays the results. This summary table reports the frequency (N), the MEAN, and the SUM of AmountSold for each category of SalesRep and Type. This data has been summarized for all categories of SalesRep and Type in the row labeled All.

Figure 28.11 *Crossing with the Universal Class Variable ALL*

TruBlend Coffee Makers, Inc.
Sales Report

		AmountSold		
		N	Mean	Sum
SalesRep	Type			
Garcia	Deluxe	4	$11,694.38	$46,777.50
	Standard	36	$12,924.81	$465,293.28
Hollingsworth	Deluxe	8	$4,702.50	$37,620.00
	Standard	24	$12,901.09	$309,626.10
Jensen	Deluxe	4	$10,147.50	$40,590.00
	Standard	34	$12,369.78	$420,572.60
All		110	$12,004.36	$1,320,479.48

Defining Labels

You can add your own labels to a summary table or remove headings from a summary table by assigning labels to variables in the TABLE statement. Simply follow the variable with an equal sign (=) followed by either the desired label or by a blank space in quotation marks. A blank space in quotation marks removes the heading from the summary table. The PROC TABULATE step that follows creates a two-dimensional summary table that uses labels in the TABLE statement and that answers the question, “What is the percent of total sales and average amount sold by each sales representative of each type of coffee maker and all coffee makers?”

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Sales Performance';
   class SalesRep Type;
   var AmountSold;
   table SalesRep='Sales Representative' 1 *
         (Type='Type of Coffee Maker' 1 all) all,
         AmountSold=' ' 4 *
         (N='Sales' 2
         SUM='Amount' 2 *f=dollar16.2
         colpctsum='% Sales' 3
         mean='Average Sale' 2 *f=dollar16.2);
run;
```

The numbered items in the previous program correspond to the following:

1 The variables SalesRep and Type are assigned labels.

2 The frequency statistic N, the statistic SUM, and the statistic MEAN are assigned labels.

3 The statistic COLPCTSUM is used to calculate the percentage of the value in a single table cell in relation to the total of the values in the column and is assigned the label `% Sales'.

4 The variable AmountSold is assigned a blank label. As a result, the heading for AmountSold does not appear in the summary table.

The following summary table displays the results. In this table, no heading for the variable AmountSold is displayed. The labels `Sales', `Amount', `% Sales', and `Average Sale' replace the frequency (N), SUM, COLPCTSUM, and MEAN respectively. Labels replace the variables SalesRep and Type.

Figure 28.12 *Using Labels to Customize Summary Tables*

TruBlend Coffee Makers, Inc.
Sales Performance

		Sales	Amount	% Sales	Average Sale
Sales Representative	Type of Coffee Maker				
Garcia	Deluxe	4	$46,777.50	4	$11,694.38
	Standard	36	$465,293.28	35	$12,924.81
	All	40	$512,070.78	39	$12,801.77
Hollingsworth	Type of Coffee Maker				
	Deluxe	8	$37,620.00	3	$4,702.50
	Standard	24	$309,626.10	23	$12,901.09
	All	32	$347,246.10	26	$10,851.44
Jensen	Type of Coffee Maker				
	Deluxe	4	$40,590.00	3	$10,147.50
	Standard	34	$420,572.60	32	$12,369.78
	All	38	$461,162.60	35	$12,135.86
All		110	$1,320,479.48	100	$12,004.36

Using Styles and the Output Delivery System

If you use the Output Delivery System to create output from PROC TABULATE, for any destination other than Listing or Output destinations, you can do the following:

- Set certain style elements (such as font style, font weight, and color) that the procedure uses for various parts of the table.
- Specify style elements for the labels for variables by adding the option to the CLASS statement.
- Specify style elements for cells in the summary table by crossing the STYLE= option with an element of a dimension expression.

When it is used in a dimension expression, the STYLE= option must be enclosed within square brackets ([and]) or braces ({ and }). The PROC TABULATE step that follows creates a two-dimensional summary table that uses the STYLE= option in a CLASS statement and in the TABLE statement and that answers the question, "What is the percent of total sales and average amount sold by each sales representative of each type of coffee maker and all coffee makers?"

```
options linesize=84 pageno=1 nodate;

ods html file='summary-table.htm'; 1
ods pdf file='summary-table.pdf'; 2

proc tabulate data=year_sales format=comma10.;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Sales Performance';
   class SalesRep;
   class Type / style=[font_style=italic] 3 ;
   var AmountSold;
   table SalesRep='Sales Representative'*(Type='Type of Coffee Maker'
         all*[style=[background=yellow font_weight=bold]] 4 )
         all*[style=[font_weight=bold]] 5 ,
         AmountSold=' '*(colpctsum='% Sales' mean='Average Sale'*
         f=dollar16.2);
run;

ods html close; 6
ods pdf close; 7
```

The numbered items in the previous program correspond to the following:

1 The HTML destination is open by default. You can use the ODS HTML to specify the name of your html file. The FILE= opion identifies the file that contains the HTML output. Some browsers require an extension of HTM or HTML on the filename.

2 The ODS PDF statement opens the PDF destination and creates PDF output. The FILE= option identifies the file that contains the PDF output.

3 The STYLE= option is specified in the second CLASS statement, which sets the font style of the label for Type to italic. The label for SalesRep is not affected by the STYLE= option because it is in a separate CLASS statement.

4 The universal class variable ALL is crossed with the STYLE= option, which sets the background for the table cells to yellow and the font weight for these cells to bold.

5 The universal class variable ALL is crossed with the STYLE= option, which sets the font weight for the table cells to bold.

6 The ODS HTML CLOSE statement closes the HTML destination and all of the files that are associated with it.

7 The ODS PDF CLOSE statement closes the PDF destination. You must close the PDF destination before you view the PDF output.

The following summary table displays the HTML results.

Figure 28.13 Using Style Attributes and the ODS HTML Statement

TruBlend Coffee Makers, Inc.
Sales Performance

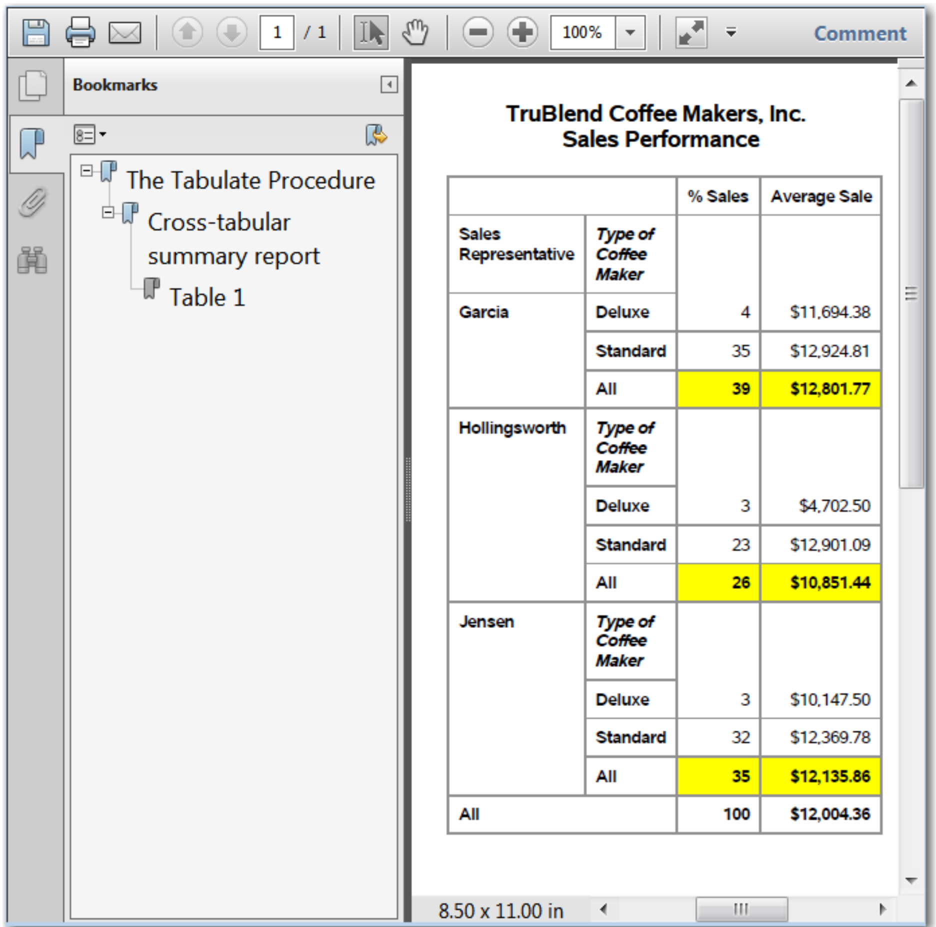
		% Sales	Average Sale
Sales Representative	*Type of Coffee Maker*		
Garcia	Deluxe	4	$11,694.38
	Standard	35	$12,924.81
	All	**39**	**$12,801.77**
Hollingsworth	*Type of Coffee Maker*		
	Deluxe	3	$4,702.50
	Standard	23	$12,901.09
	All	**26**	**$10,851.44**
Jensen	*Type of Coffee Maker*		
	Deluxe	3	$10,147.50
	Standard	32	$12,369.78
	All	**35**	**$12,135.86**
All		**100**	**$12,004.36**

This summary table shows the effects of the three uses of the STYLE= option with the ODS HTML statement in the previous SAS program:

- The repeated label, Type of Coffee Maker, is in italics.
- The subtotals for each value of sales representative are highlighted in a lighter color (yellow) and are bold.
- The totals for all sales representatives are bold.

The following summary table displays the PDF results.

Figure 28.14 Using Style Attributes and the ODS PDF Statement



TruBlend Coffee Makers, Inc.
Sales Performance

		% Sales	Average Sale
Sales Representative	*Type of Coffee Maker*		
Garcia	Deluxe	4	$11,694.38
	Standard	35	$12,924.81
	All	**39**	**$12,801.77**
Hollingsworth	*Type of Coffee Maker*		
	Deluxe	3	$4,702.50
	Standard	23	$12,901.09
	All	**26**	**$10,851.44**
Jensen	*Type of Coffee Maker*		
	Deluxe	3	$10,147.50
	Standard	32	$12,369.78
	All	**35**	**$12,135.86**
All		**100**	**$12,004.36**

This summary table shows the effects of the three uses of the STYLE= option with the ODS PDF statement in the previous SAS program:

- The repeated label, Type of Coffee Maker, is in italics.
- The subtotals for each value of sales representative are highlighted and are bold.
- The totals for all sales representatives are bold.

Ordering Class Variables

You can control the order in which class variable values and their headings are displayed in a summary table with the ORDER= option. You can use the ORDER= option with the PROC TABULATE statement and with individual CLASS statements. The syntax is `ORDER=sort-order`. The four possible sort orders (DATA, FORMATTED, FREQ, and UNFORMATTED) are defined in "Summary" on page 516. The PROC TABULATE step that follows creates a two-dimensional summary table that uses the ORDER= option with the PROC TABULATE statement to order all class variables by frequency, and that answers the question, "Which quarter produced the greatest number of sales, and which sales representative made the most sales overall?"

```
options linesize=84 pageno=1 nodate;

proc tabulate data=year_sales format=comma10. order=freq;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Quarterly Sales and Representative Sales by Frequency';
   class SalesRep Quarter;
   table SalesRep all,
         Quarter all;
run;
```

The following summary table displays the results of this program. The order of the values of the class variable Quarter shows that most sales occurred in quarter 3 followed by quarters 1, 2, and then 4. The order of the values of the class variable SalesRep shows that Garcia made the most sales overall, followed by Jensen and then Hollingsworth. The universal class variable ALL is included in both dimensions of this example to show the frequency data that SAS used to order the data when creating the summary table.

Figure 28.15 *Ordering Class Variables*

TruBlend Coffee Makers, Inc.
Quarterly Sales and Representative Sales by Frequency

	Quarter				All
	3	1	2	4	
	N	N	N	N	N
SalesRep					
Garcia	21	8	6	5	40
Jensen	21	5	6	6	38
Hollingsworth	15	5	6	6	32
All	57	18	18	17	110

Summary

Global Statement

TITLE<n> <'title'>;
: specifies a title. The argument *n* is a number from 1 to 10 that immediately follows the word TITLE, with no intervening blank, and specifies the level of the TITLE. The text of each *title* can be up to 132 characters long (256 characters

long in some operating environments) and must be enclosed in single or double quotation marks.

TABULATE Procedure Statements

PROC TABULATE <*options*>;

CLASS *variable(s)*</*options*>;

VAR *analysis-variable(s)*;

TABLE <<*page-expression*,> *row-expression*,> *column-expression*;

PROC TABULATE <option(s)>;
starts the procedure.

You can specify the following *options* in the PROC TABULATE statement:

DATA=SAS-data-set
specifies the *SAS-data-set* to be used by PROC TABULATE. If you omit the DATA= option, then the TABULATE procedure uses the SAS data set that was created most recently in the current job or session.

FORMAT=format-name
specifies a default format for formatting the value in each cell in the table. You can specify any valid SAS numeric format or user-defined format.

MISSING
considers missing values as valid values to create the combinations of class variables. A heading for each missing value appears in the table.

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED
specifies the sort order that is used to create the unique combinations of the values of the class variables, which form the headings of the table. A brief description of each sort order follows:

DATA
orders values according to their order in the input data set.

FORMATTED
orders values by their ascending formatted values. This order depends on your operating environment.

FREQ
orders values by descending frequency count.

ORDER=
used in a CLASS statement overrides ORDER= used in the PROC TABULATE statement.

UNFORMATTED
orders values by their unformatted values, which yields the same order as PROC SORT. This order depends on your operating environment. This sort sequence is particularly useful for displaying dates chronologically.

CLASS variable(s)/option(s);
identifies class variables for the table. Class variables determine the categories that PROC TABULATE uses to calculate statistics.

MISSING
considers missing values as valid values to create the combinations of class variables. A heading for each missing value appears in the table. If MISSING

should apply only to a subset of the class variables, then specify MISSING in a separate CLASS statement with the subset of the class variables.

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED
: specifies the sort order used to create the unique combinations of the values of the class variables, which form the headings of the table. If ORDER= should apply only to a subset of the class variables, then specify ORDER= in a separate CLASS statement with the subset of the class variables. In this way, a separate sort order can be specified for each class variable. A brief description of each sort order follows:

DATA
orders values according to their order in the input data set.

FORMATTED
orders values by their ascending formatted values. This order depends on your operating environment.

FREQ
orders values by descending frequency count.

ORDER=
used in a CLASS statement overrides ORDER= used in the PROC TABULATE statement.

UNFORMATTED
orders values by their unformatted values, which yields the same order as PROC SORT. This order depends on your operating environment. This sort sequence is particularly useful for displaying dates chronologically.

VAR analysis-variable(s);
: identifies analysis variables for the table. Analysis variables contain values for which you want to compute statistics.

TABLE <<page-expression, >row-expression,> column-expression;
: defines the table that you want PROC TABULATE to produce. You must specify at least one TABLE statement. In the TABLE statement you specify page-expressions, row-expressions, and column-expressions, all of which are constructed in the same way and are referred to collectively as dimension expressions. Use commas to separate dimension expressions from one another. You define relationships among variables, statistics, and other elements within a dimension by combining them with one or more operators. Operators are symbols that tell PROC TABULATE what actions to perform on the variables, statistics, and other elements. The table that follows lists the common operators and the actions that they symbolize:

Table 28.1 *TABLE Statement Operators*

Operator	**Action**
, comma	Separates dimensions of the table
* asterisk	Crosses elements within a dimension
blank space	Concatenates elements within a dimension
= equal	Overrides default cell format or assigns label to an element

Operator	Action
( ) parentheses	Groups elements and associates an operator with each concatenated element in the group
[ ] square brackets	Groups the STYLE= option for crossing, and groups style attribute specifications within the STYLE= option
{ } braces	Groups the STYLE= option for crossing, and groups style attribute specifications within the STYLE= option

Learning More

Locating procedure output
: See Chapter 33, “Understanding and Customizing SAS Output: The Basics,” on page 637.

Missing values
: For a discussion about missing values, see *SAS Language Reference: Concepts*. Information about handling missing values is also in *PROC TABULATE by Example*.

ODS
: For complete documentation on how to use the Output Delivery System, see *SAS Output Delivery System: User’s Guide*.

PROC TABULATE
: See the TABULATE procedure in the *Base SAS Procedures Guide*.

: For a detailed discussion and comprehensive examples of the TABULATE procedure, see *PROC TABULATE by Example*.

SAS formats
: See *SAS Formats and Informats: Reference*. Many formats are available with SAS, such as fractions, hexadecimal values, roman numerals, Social Security numbers, date and time values, and numbers written as words.

Statistics
: For a list of the statistics available in the TABULATE procedure, see the discussion of concepts in the TABULATE procedure in the *Base SAS Procedures Guide*. For more information about the listed statistics, see the discussion of elementary statistics in the appendix of the *Base SAS Procedures Guide*.

Style attributes
: For information about style attributes that can be set for a style element by using the Output Delivery System, see *Base SAS Procedures Guide* or *SAS Output Delivery System: User’s Guide*.

Summary tables

For additional examples of how to produce a variety of summary tables, see *SAS Guide to Report Writing Examples*.

For a discussion of how to use the REPORT procedure to create summary tables, see the REPORT procedure in *Base SAS Procedures Guide*.

Tabular reports

For interactive online examples and discussion, see lessons related to creating tabular reports in SAS Online Tutor for Version 8: SAS Programming.

Title statement

See Chapter 27, “Producing Detail Reports with the PRINT Procedure,” on page 449.

29

Creating Detail and Summary Reports with the REPORT Procedure

Introduction to Creating Detail and Summary Reports with the REPORT Procedure

Purpose

SAS provides a variety of report writing tools that produce detail and summary reports. The reports enable you to communicate information about your data in an organized, concise manner. The REPORT procedure enables you to create detail and summary reports in a single report writing tool.

In this section, you learn how to use PROC REPORT to do the following:

- produce simple detail reports
- produce simple summary reports
- produce enhanced reports by adding additional statements that order and group observations, sum columns, and compute overall totals
- customize the appearance of reports by adding column spacing, column labels, line separators, and formats

Prerequisites

To understand the examples in this section, you should be familiar with the following features and concepts:

- data set options
- the TITLE statement
- the LABEL statement
- WHERE processing
- creating and assigning SAS formats

Understanding How to Construct a Report

Using the Report Writing Tools

The REPORT procedure combines the features of PROC MEANS, PROC PRINT, and PROC TABULATE along with features of the DATA step report writing into a powerful report writing tool. PROC REPORT enables you to do the following:

- Create customized, presentation-quality reports.
- Develop and store report definitions that control the structure and layout.
- View previously defined reports.
- Generate multiple reports from one report definition.

There are three different ways that you can use PROC REPORT to construct reports:

- in a nonwindowing environment where you use PROC REPORT to submit a series of statements. This is the default environment.
- in a windowing environment with a prompting facility.
- in a windowing environment without a prompting facility.

The windowing environment requires minimal SAS programming skills and allows immediate, visual feedback as you develop the report. This section explains how you use the nonwindowing environment to create summary and detail reports.

Types of Reports

The REPORT procedure enables you to construct two types of reports:

detail report
: contains one row for every observation that is selected for the report. For more information, see Output 29.1 on page 527. Each of these rows is a detail row.

summary report
: consolidates data so that each row represents multiple observations. For more information, see Output 29.5 on page 532. Each of these rows is also called a detail row.

Both detail and summary reports can contain summary lines as well as detail rows. A summary line summarizes numerical data for a set of detail rows or for all detail rows. You can use PROC REPORT to provide both default summaries and customized summaries.

Laying Out a Report

Establishing the Layout

If you first decide on the layout of the report, then creating the report is easier. You need to determine the following:

- which columns to display in the report
- the order of the columns and rows
- how to label the rows and columns
- which statistics to display
- whether to display a column for each value of a particular variable
- whether to display a row for every observation, or to consolidate multiple observations in a single row

Once you establish the layout of the report, use the COLUMN statement and DEFINE statement in the PROC REPORT step to construct the layout.

Constructing the Layout

The COLUMN statement lists the report items to include as columns of the report, describes the arrangement of the columns, and defines headers that span multiple columns. A report item is a data set variable, a calculated statistic, or a variable that you compute based on other items in the report.

The DEFINE statement defines the characteristics of an item in the report. These characteristics include how PROC REPORT uses an item in the report, the text of the column heading, and the format to display the values.

You control much of a report's layout by the usages that you specify for variables in the DEFINE statements. The types of variable usages are:

ACROSS
: creates a column for each value of an ACROSS variable.

ANALYSIS
: computes a statistic from a numeric variable for all the observations represented by a cell of the report. The value of the variable depends on where it appears in the report. By default, PROC REPORT treats all numeric variables as ANALYSIS variables and computes the sum.

COMPUTED
: computes a report item from variables that you define for the report. They are not in the input data set, and PROC REPORT does not add them to the input data set.

DISPLAY
: displays a row for every observation in the input data set. By default, PROC REPORT treats all character variables as DISPLAY variables.

GROUP
: consolidates into one row all of the observations from the data set that have a unique combination of the formatted values for all GROUP variables.

ORDER
specifies to order the rows for every observation in the input data set according to the ascending, formatted values of the ORDER variable.

The position and usage of each variable in the report determine the report's structure and content. For example, PROC REPORT orders the detail rows of the report according to the values of ORDER and GROUP variables (from left to right). Similarly, PROC REPORT orders columns for an ACROSS variable from top to bottom, according to the values of the variable. For a complete discussion of how PROC REPORT determines the layout of a report, see the *Base SAS Procedures Guide*.

Input File and SAS Data Set for Examples

The examples in this section use one input file and one SAS data set. For more information, see "The YEAR_SALES Data Set" on page 854.

The input file contains sales records for a company, TruBlend Coffee Makers, that distributes the coffee machines. The file has the following structure:

```
01      1       Hollingsworth  Deluxe      260       49.50
01      1       Garcia         Standard     41       30.97
01      1       Hollingsworth  Deluxe      330       49.50
01      1       Jensen         Standard   1110       30.97
01      1       Garcia         Standard    715       30.97
01      1       Jensen         Deluxe      675       49.50
02      1       Jensen         Standard     45       30.97
02      1       Garcia         Deluxe       10       49.50

…more data lines…

12      4       Hollingsworth  Deluxe      125       49.50
12      4       Jensen         Standard   1254       30.97
12      4       Hollingsworth  Deluxe      175       49.50
```

The input file contains the following values from left to right:

- the month in which a sale was made
- the quarter of the year in which a sale was made
- the name of the sales representative
- the type of coffee maker sold (standard or deluxe)
- the number of units sold
- the price of each unit in US dollars

The SAS data set is named YEAR_SALES. This data set contains all the sales data from the input file and a new variable named AmountSold, which is created by multiplying Units by Price.

The following program creates the SAS data set that this section uses:

```
data year_sales;
   infile 'your-input-file';
   input Month $ Quarter $ SalesRep $14. Type $ Units Price;
   AmountSold = Units * Price;
```

```
run;
```

Creating Simple Reports

Displaying All the Variables

By default, PROC REPORT uses all of the variables in the data set. The layout of the report depends on the type of variables in the data set. If the data set contains any character variables, then PROC REPORT generates a simple detail report that lists the values of all the variables and the observations in the data set. If the data set contains only numeric variables, then PROC REPORT sums the value of each variable over all observations in the data set and produces a one-line summary of the sums. To produce a detail report for a data set with only numeric values, you have to define the columns in the report.

By default, PROC REPORT sends your results to the SAS procedure output. The NOWINDOWS (NOWD) option does not have to be specified. To request that PROC REPORT open the REPORT window, specify the WINDOWS option. The REPORT window enables you to modify a report repeatedly and see the modifications immediately.

The following PROC REPORT step creates the default detail report for the first quarter sales:

```
proc report data=year_sales;
   where quarter='1';
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'First Quarter Sales Report';
run;
```

The WHERE statement specifies a condition that SAS uses to select observations from the YEAR_SALES data set. Before PROC REPORT builds the report, SAS selectively processes observations so that the report contains only data for the observations from the first quarter. For more information about WHERE processing, see “Selecting Observations” on page 460.

The following detail report shows all the variable values for those observations in YEAR_SALES that contains first quarter sales data.

Output 29.1 The Default Report When the Data Set Contains Character Values

TruBlend Coffee Makers, Inc. 2
First Quarter Sales Report

Month 1	Quarter	SalesRep	Type	Units	Price	AmountSold
01	1	Hollingsworth	Deluxe	260	49.5	12870
01	1	Garcia	Standard	41	30.97	1269.77
01	1	Hollingsworth	Standard	330	30.97	10220.1
01	1	Jensen	Standard	110	30.97	3406.7
01	1	Garcia	Deluxe	715	49.5	35392.5
01	1	Jensen	Standard	675	30.97	20904.75
02	1	Garcia	Standard	2045	30.97	63333.65
02	1	Garcia	Deluxe	10	49.5	495
02	1	Garcia	Standard	40	30.97	1238.8
02	1	Hollingsworth	Standard	1030	30.97	31899.1
02	1	Jensen	Standard	153	30.97	4738.41
02	1	Garcia	Standard	98	30.97	3035.06
03	1	Hollingsworth	Standard	125	30.97	3871.25
03	1	Jensen	Standard	154	30.97	4769.38
03	1	Garcia	Standard	118	30.97	3654.46
03	1	Hollingsworth	Standard	25	30.97	774.25
03	1	Jensen	Standard	525	30.97	16259.25
03	1	Garcia	Standard	310	30.97	9600.7

The following list corresponds to the numbered items in the preceding report:

1 The order of the columns corresponds to the position of the variables in the data set.

2 The top of the report has a title, produced by the TITLE statement.

The following PROC REPORT step produces the default summary report when the YEAR_SALES data set contains only numeric values:

```
proc report data=year_sales (keep=Units AmountSold);
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'Total Yearly Sales';
run;
```

The KEEP= data set option specifies to process only the numeric variables Units and AmountSold. PROC REPORT uses these variables to create the report.

The following report displays a one-line summary for the two numeric variables.

Output 29.2 The Default Report When the Data Set Contains Only Numeric Values

TruBlend Coffee Makers, Inc.
Total Yearly Sales

Units	AmountSold
40989	1320479.5

PROC REPORT computed the one-line summary for Units and AmountSold by summing the value of each variable for all the observations in the data set.

Specifying and Ordering the Columns

The first step in constructing a report is to select the columns that you want to appear in the report. By default, the report contains a column for each variable and the order of the columns corresponds to the order of the variables in the data set.

You use the COLUMN statement to specify the variables to use in the report and the arrangement of the columns. In the COLUMN statement, you can list data set variables, statistics that are calculated by PROC REPORT, or variables that are computed from other items in the report.

The following program creates a four column sales report for the first quarter:

```
proc report data=year_sales;
   where Quarter='1';
   column SalesRep Month Type Units;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'First Quarter Sales Report';
run;
```

The COLUMN statement specifies the order of the items in the report. The first column lists the values in SalesRep, the second column lists the values in Month, and so on.

The following output displays the report.

Output 29.3 *Displaying Selected Columns*

TruBlend Coffee Makers, Inc.
First Quarter Sales Report

SalesRep	Month	Type	Units
Hollingsworth	01	Deluxe	260
Garcia	01	Standard	41
Hollingsworth	01	Standard	330
Jensen	01	Standard	110
Garcia	01	Deluxe	715
Jensen	01	Standard	675
Garcia	02	Standard	2045
Garcia	02	Deluxe	10
Garcia	02	Standard	40
Hollingsworth	02	Standard	1030
Jensen	02	Standard	153
Garcia	02	Standard	98
Hollingsworth	03	Standard	125
Jensen	03	Standard	154
Garcia	03	Standard	118
Hollingsworth	03	Standard	25
Jensen	03	Standard	525
Garcia	03	Standard	310

Ordering the Rows

You control much of the layout of a report by deciding how you use the variables. You tell PROC REPORT how to use a variable by specifying a usage option in the DEFINE statement for the variable.

To specify the order of the rows in the report, you can use the ORDER option in one or more DEFINE statements. PROC REPORT orders the rows of the report according to the values of the ORDER variables. If the report contains multiple ORDER variables, then PROC REPORT first orders rows according to the values of the first ORDER variable in the COLUMN statement.[1] Within each value of the first ORDER variable, the procedure orders rows according to the values of the second ORDER variable in the COLUMN statement, and so on.

1. If you omit the COLUMN statement, then PROC REPORT processes the ORDER variables according to their position in the input data set.

The following program creates a detail report of sales for the first quarter that is ordered by the sales representatives and month:

```
proc report data=year_sales nowindows;
   where Quarter='1';
   column SalesRep Month Type Units;
   define SalesRep / order;
   define Month / order;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'First Quarter Sales Report';
run;
```

The DEFINE statements specify that SalesRep and Month are the ORDER variables. The COLUMN statement specifies the order of the columns. By default, the rows are ordered by the ascending formatted values of SalesRep. The rows for each sales representative are ordered by the values of Month.

The following output displays the report.

Output 29.4 *Ordering the Rows*

TruBlend Coffee Makers, Inc.
First Quarter Sales Report

SalesRep	Month	Type	Units
Garcia	01	Standard	41
		Deluxe	715
	02	Standard	2045
		Deluxe	10
		Standard	40
		Standard	98
	03	Standard	118
		Standard	310
Hollingsworth	01	Deluxe	260
		Standard	330
	02	Standard	1030
	03	Standard	125
		Standard	25
Jensen	01	Standard	110
		Standard	675
	02	Standard	153
	03	Standard	154
		Standard	525

PROC REPORT does not repeat the values of the ORDER variables from one row to the next when the values are the same.

Consolidating Several Observations into a Single Row

You can create summary reports with PROC REPORT by defining one or more GROUP variables. A group is a set of observations that has a unique combination of values for all GROUP variables. PROC REPORT tries to consolidate, or summarize, each group into one row of the report.

To consolidate all columns across a row, you must define all variables in the report as either GROUP, ANALYSIS, COMPUTED, or ACROSS. The GROUP option in one or more DEFINE statements identifies the variables that PROC REPORT uses to form groups. You can define more than one variable as a GROUP variable, but GROUP variables must precede variables of the other types of usage. PROC REPORT determines the nesting by the order of the variables in the COLUMN statement. For more information about defining the usage of a variable, see “Constructing the Layout” on page 524.

The value of an ANALYSIS variable for a group is the value of the statistic that PROC REPORT computes for all observations in a group. For each ANALYSIS variable, you can specify the statistic in the DEFINE statement. By default, PROC REPORT uses all numeric variables as the ANALYSIS variables and computes the SUM statistic. The statistics that you can request in the DEFINE statement are as follows:

Table 29.1 *Descriptive Statistics*

Descriptive statistic keywords	
CSS	PCTSUM
CV	RANGE
MAX	STD
MEAN	STDERR
MIN	SUM
N	SUMWGT
NMISS	USS
PCTN	VAR
Quantile statistic keywords	
MEDIAN | P50	Q3 | P75
P1	P90
P5	P95

P10	P99
Q1 | P25	QRANGE
Hypothesis testing keyword	
PRT | PROBT	T

For definitions and discussion of these statistics, see “SAS Elementary Statistics Procedures” in *Base SAS Procedures Guide*.

The following program creates a summary report that shows the total yearly sales for each sales representative:

```
proc report data=year_sales;
   column SalesRep Units AmountSold;
   define SalesRep /group; 1
   define Units / analysis sum; 2
    define AmountSold/ analysis sum; 3
   title1 'TruBlend Coffee Makers Sales Report';
   title2 'Total Yearly Sales';
run;
```

The following list corresponds to the numbered items in the preceding program:

- The DEFINE statement specifies that SalesRep is the GROUP variable.
- The DEFINE statement specifies that Units is an ANALYSIS variable and specifies that PROC REPORT computes the SUM statistic.
- The DEFINE statement specifies that AmountSold is an ANALYSIS variable and specifies that PROC REPORT computes the SUM statistic.

The following output displays the report.

Output 29.5 *Grouping Multiple Observations in a Summary Report*

TruBlend Coffee Makers Sales Report
Total Yearly Sales

SalesRep	Units	AmountSold
Garcia	15969	512070.78
Hollingsworth	10620	347246.1
Jensen	14400	461162.6

Each row of the report represents one group and summarizes all observations that have a unique value for SalesRep. PROC REPORT orders these rows in ascending order of the GROUP variable, which in this example is the sales representative ordered alphabetically. The values of the ANALYSIS variables are the sum of Units and AmountSold for all observations in a group, which in this case is the total units and amount sold by each sales representative.

Changing the Default Order of the Rows

You can modify the default ordering sequence for the rows of a report by using the ORDER= or DESCENDING option in the DEFINE statement. The ORDER= option specifies the sort order for a variable. You can order the rows by:

DATA
: the order of the data in the input data set.

FORMATTED
: ascending formatted values.

FREQ
: ascending frequency count.

INTERNAL
: ascending unformatted or internally stored values.

By default, PROC REPORT uses the formatted values of a variable to order the rows. The DESCENDING option reverses the sort sequence so that PROC REPORT uses descending values to order the rows.

The following program creates a detail report of the first quarter sales that is ordered by number of sales:

```
proc report data=year_sales;
   where Quarter='1';
   column SalesRep Type Units Month;
   define SalesRep / order order=freq;
   define Units / order descending;
   define Type / order;
   title1 'TruBlend Coffee Makers, Inc.';
   title2 'First Quarter Sales Report';
run;
```

The following list corresponds to the numbered items in the preceding program:

- The DEFINE statements specify that SalesRep, Units, and Type are ORDER variables that correspond to the number of sales each sales representative made.
- The ORDER=FREQ option orders the rows of the report by the frequency of SalesRep.
- The DESCENDING option orders the rows for UNITS from the largest to the smallest value.

The following output displays the report.

Output 29.6 *Changing the Order Sequence of the Rows*

TruBlend Coffee Makers, Inc.
First Quarter Sales Report

SalesRep	Type	Units	Month
Hollingsworth	Deluxe	260	01
	Standard	1030	02
		330	01
		125	03
		25	03
Jensen	Standard	675	01
		525	03
		154	03
		153	02
		110	01
Garcia	Deluxe	715	01
		10	02
	Standard	2045	02
		310	03
		118	03
		98	02
		41	01
		40	02

The following list corresponds to the numbered items in the preceding report:

1 The order of the columns corresponds to the order in which the variables are specified in the COLUMN statement. The order of the DEFINE statements does not affect the order of the columns.

2 The order of the rows is by ascending frequency of SalesRep so that the sales representative with the least number of sales (observations) appears first while the sales representative with the greatest number of sales appears last.

3 The order of the rows within SalesRep is by ascending formatted values of Type so that sales information about the deluxe coffee maker occurs before the standard coffee maker.

4 The order of the rows within Type is by descending formatted values of Units so that the observation with the highest number of units sold appears first.

Creating More Sophisticated Reports

Adjusting the Column Layout

Understanding Column Width and Spacing for ODS LISTING Output

If you are working with the ODS LISTING destination, you can modify the column spacing (SPACING=) and the column width (COLWIDTH=) by specifying options in either the PROC REPORT statement or the DEFINE statement.

To control the spacing between columns, you can use the SPACING= option in the following statements:

- PROC REPORT statement to specify the default number of blank characters between all columns
- DEFINE statement to override the default value and to specify the number of blank characters to the left of a particular column

In the LISTING Output, PROC REPORT inserts two blank spaces between the columns. To remove space between columns, specify SPACING=0. The maximum space that PROC REPORT allows between columns depends on the number of columns in the report. The sum of all column widths plus the blank characters to left of each column cannot exceed the line size.

To specify the column widths, you can use the following options:

- the COLWIDTH= option in the PROC REPORT statement to specify the default number of characters for columns that contain computed variables or numeric data set variables
- the WIDTH= option in the DEFINE statement to specify the width of the column that PROC REPORT uses to display a report item

By default, the column width is nine characters for numeric values. You can specify the column width as small as one character and as large as the line size. PROC REPORT sets the width of a column by first looking at the WIDTH= option in the DEFINE statement. If you omit WIDTH=, then PROC REPORT uses a column width large enough to accommodate the format for a report item. If you do not assign a format, then the column width is either the length of the character variable or the value of the COLWIDTH= option.

You can adjust the column layout by specifying how to align the formatted values of a report item and the column heading with the column width. The following options in the DEFINE statement align the columns:

CENTER
: centers the column values and column heading.

LEFT
: left-aligns the column values and column heading

RIGHT
right-aligns the column values and column heading.

Modifying the Column Width and Spacing

The following program modifies column spacing in a summary report that shows the total yearly sales for each sales representative:

```
options linesize=80 pageno=1 nodate;

proc report data=year_sales spacing=3;
   column SalesRep Units AmountSold;
   define SalesRep /group right;
   define Units / analysis sum width=5;
   define AmountSold/ analysis sum width=10;
   title1 'TruBlend Coffee Makers Sales Report';
   title2 'Total Yearly Sales';
run;
```

The following list corresponds to the numbered items in the preceding program:

- The SPACING= option in the PROC REPORT statement inserts three blank characters between all the columns.
- The RIGHT option in the DEFINE statement right-aligns the name of the sales representative and the column heading in the column.
- The WIDTH= options in the DEFINE statements specify enough space to accommodate column headings on one line.

The following output displays the report.

Output 29.7 *Adjusting Column Width and Spacing for LISTING Output*

```
                TruBlend Coffee Makers Sales Report                     1
                         Total Yearly Sales

                      SalesRep   Units   AmountSold
                        Garcia   15969    512070.78
                 Hollingsworth   10620     347246.1
                        Jensen   14400     461162.6
```

The column width for SalesRep is 14 characters wide, which is the length of the variable.

Customizing Column Headings

Understanding the Structure of Column Headings

In ODS LISTING output, PROC REPORT does not insert a vertical space beneath column headings to visually separate the detail rows from the headers. To improve the appearance of a report generated using the ODS LISTING destination, you can underline the column headings, insert a blank line beneath column headings, and specify your own column headings. The HEADLINE and HEADSKIP options in the

PROC REPORT statement enable you to underline the column headings and insert a blank line after the column headings, respectively.

By default, SAS uses the variable name or the variable label, if the data set variable was previously assigned a label, for the column heading. To specify a different column heading, place text between single or double quotation marks in the DEFINE statement for the report item.

By default, PROC REPORT produces line breaks in the column heading based on the width of the column. When you use multiple sets of quotation marks in the label, each set defines a separate line of the header. If you include split characters in the label, then PROC REPORT breaks the header when it reaches the split character and continues the header on the next line. By default, the split character is the slash (/). Use the SPLIT= option in the PROC REPORT statement to specify an alternative split character.

Modifying the Column Headings in the LISTING Output

The following program creates a summary report with multiple-line column headings for the variables SalesRep, Units, and AmountSold:

```
ods listing;
ods html close;
options linesize=80 pageno=1 nodate;

proc report data=year_sales nowindows spacing=3 headskip;
   column SalesRep Units AmountSold;
   define SalesRep /group 'Sales/Representative';
   define Units / analysis sum 'Units Sold' width=5;
   define AmountSold/ analysis sum 'Amount' 'Sold';
   title1 'TruBlend Coffee Makers Sales Report';
   title2 'Total Yearly Sales';
run;
ods listing close;
ods html;
```

The following list corresponds to the numbered items in the preceding program:

- The HEADSKIP option inserts a blank line after the column headings.
- The text in quotation marks specifies the column headings.

The following output displays the report.

Output 29.8 *Modifying the Column Headings for LISTING Output*

```
                    TruBlend Coffee Makers Sales Report                    1
                            Total Yearly Sales

                     Sales             Units      Amount
                     Representative     Sold        Sold

                     Garcia            15969   512070.78
                     Hollingsworth     10620    347246.1
                     Jensen            14400    461162.6
```

The label Units Sold is split between two lines because the column width for this report item is 5 characters wide. The SPLIT= option in the PROC REPORT statement identifies where the label for SalesRep, Sales Representative, is split. In contrast, the label for AmountSold identifies where to split the label by using multiple sets of quotation marks.

Specifying Formats

Using SAS Formats

A simple and effective way to enhance the readability of your reports is to specify a format for the report items. To assign a format to a column, you can use the FORMAT statement or the FORMAT= option in the DEFINE statement. The FORMAT statement only works for data set variables. The FORMAT= option assigns a SAS format or a user-defined format to any report item.

PROC REPORT determines how to format a report item by searching for the format to use in these places and in this order:

1. the FORMAT= option in the DEFINE statement
2. the FORMAT statement
3. the data set

PROC REPORT uses the first format that it finds. If you have not assigned a format, then PROC REPORT uses the BEST9. format for numeric variables and the $w. format for character variables.

Applying Formats to Report Items

The following program illustrates how to apply formats to the columns of a summary report of total yearly sales for each sales representative:

```
proc report data=year_sales;
   column SalesRep Units AmountSold;
   define SalesRep / group 'Sales/Representative';
   define Units / analysis sum 'Units Sold' format=comma7.;
   define AmountSold / analysis sum 'Amount' 'Sold' format=dollar14.2;
   title1 'TruBlend Coffee Makers Sales Report';
   title2 'Total Yearly Sales';
run;
```

PROC REPORT applies the COMMA7. format to the values of the variable Units and the DOLLAR14.2 format to the values of the variable AmountSold.

The following output displays the report.

Output 29.9 *Formatting the Numeric Columns*

TruBlend Coffee Makers Sales Report
Total Yearly Sales

Sales Representative	Units Sold	Amount Sold
Garcia	15,969	$512,070.78
Hollingsworth	10,620	$347,246.10
Jensen	14,400	$461,162.60

The following list corresponds to the numbered items in the preceding report:

1 The variable AmountSold uses the DOLLAR14.2 format for a maximum column width of 14 spaces. Two spaces are reserved for the decimal part of a value. The remaining 12 spaces include the decimal point, whole numbers, the dollar sign, commas, and a minus sign if a value is negative.

2 The variable Units uses the COMMA7. format for a maximum column width of seven spaces. The column width includes the numeric value, commas, and a minus sign if a value is negative.

These formats do not affect the actual data values that are stored in the SAS data set. That is, the formats only affect how values appear in a report.

Using Variable Values as Column Headings

Creating the Column Headings

To create column headings from the values of the data set variables and produce crosstabulations, you can use the ACROSS option in a DEFINE statement. When you define an ACROSS variable, PROC REPORT creates a column for each value of the ACROSS variable.

Columns created by an ACROSS variable contain statistics or computed values. If nothing is above or below an ACROSS variable, then PROC REPORT displays the number of observations in the input data set that belong to a cell of the report (N statistic). A cell is a single unit of a report, formed by the intersection of a row and a column.

The examples in this section show you how to display frequency counts (the N statistic) and statistics that are computed for ANALYSIS variables. For information about placing computed variables in the cells of the report, see "REPORT Procedure" in *Base SAS Procedures Guide*.

Creating Frequency Counts

The following program creates a report that tabulates the number of sales for each sales representative:

```
proc report data=year_sales colwidth=5;
   column SalesRep Type n;
   define SalesRep /group 'Sales Representative';
   define Type / across 'Type of Coffee Maker';
   define n / 'Total';
   title1 'TruBlend Coffee Makers Yearly Sales Report';
   title2 'Number of Sales';
 run;
```

The following list corresponds to the numbered items in the preceding program:

- The COLUMN statement specifies that the report contain two data set variables and a calculated statistic, N. The N statistic causes PROC REPORT to add a third column that displays the number of observations for each sales representative.
- The DEFINE statement specifies that Type is an ACROSS variable.

The following output displays the report.

Output 29.10 *Showing Frequency Counts*

TruBlend Coffee Makers Yearly Sales Report
Number of Sales

	Coffee Maker 1		
Sales Representative	**Deluxe**	**Standard**	**Total 2**
Garcia	4	36	40
Hollingsworth	8	24	32
Jensen	4	34	38

The following list corresponds to the numbered items in the preceding report:

1 Type is an ACROSS variable with nothing above or below it. Therefore, the report shows how many observations the input data set contains for each sales representative and coffee maker type.

2 The column for N statistic is labeled Total and contains the total number of observations for each sales representative.

By default, PROC REPORT ordered the columns of the ACROSS variable according to its formatted values. You can use the ORDER= option in the DEFINE statement to alter the sort order for an ACROSS variable. See for more information.

Sharing a Column with Multiple Analysis Variables

You can create sophisticated crosstabulation by having the value of ANALYSIS variables appear in columns that the ACROSS variable creates. When an ACROSS variable shares columns with one or more ANALYSIS variables, PROC REPORT stacks the columns. For example, you can share the columns of the ACROSS variable Type with the ANALYSIS variable Units so that each column contains the number of units sold for a type of coffee maker.

To stack the value of an ANALYSIS variable in the columns created by the ACROSS variable, place that variable next to the ACROSS variable in the COLUMN statement:

```
column SalesRep Type, Unit;
```

The comma separates the ACROSS variable from the ANALYSIS variable. To specify multiple ANALYSIS variables, list their names in parentheses next to the ACROSS variable in the COLUMN statement:

```
column SalesRep Type,(Unit AmountSold);
```

If you place the ACROSS variable before the ANALYSIS variable, then the name and values of the ACROSS variable are above the name of the ANALYSIS variable in the report. If you place the ACROSS variable after the ANALYSIS variable, then the name and the values of the ACROSS variable are below the name of the ANALYSIS variable.

By default, PROC REPORT calculates the SUM statistic for the ANALYSIS variables. To display another statistic for the column, use the DEFINE statement to specify the statistic that you want computed for the ANALYSIS variable. See Table 29.1 on page 531 for a list of the available statistics.

The following program creates a report that tabulates the number of coffee makers sold and the average sale in dollars for each sales representative:

```
proc report data=year_sales;
   column SalesRep Type,(Units Amountsold);
   define SalesRep /group 'Sales Representative';
   define Type / across '';
   define units / analysis sum 'Units Sold' format=comma7.;
   define AmountSold / analysis mean 'Average/Sale' format=dollar12.2;
   title1 'TruBlend Coffee Makers Yearly Sales Report';
run;
```

The following list corresponds to the numbered items in the preceding program:

- The COLUMN statement creates columns for SalesRep and Type. The ACROSS variable Type shares its columns with the ANALYSIS variables Units and AmountSold.
- The DEFINE statement uses a blank as the label of Type in the column heading.
- The DEFINE statement uses the ANALYSIS variable Units to compute a SUM statistic.
- The DEFINE statement uses the ANALYSIS variable AmountSold to compute a MEAN statistic.

The following output displays the report.

Output 29.11 Sharing a Column with Multiple Analysis Variables

TruBlend Coffee Makers Yearly Sales Report

	Deluxe		Standard	
Sales Representative	Units Sold	Average Sale	Units Sold	Average Sale
Garcia	945	$11,694.38	15,024	$12,924.81
Hollingsworth	760	$4,702.50	9,860	$12,901.09
Jensen	820	$10,147.50	13,580	$12,369.78

The values in the columns for a particular type of coffee maker are the total units sold and the average dollar sale for each sales representative.

Summarizing Groups of Observations

Using Group Summaries

For some reports, you might want to summarize information about a group of observations and visually separate each group. To do so, you can create a break in the report before or after each group.

To visually separate each group, you insert lines of text, called break lines, at a break. Break lines can occur at the beginning or end of a report, at the top or bottom of each page, and whenever the value of a group or order variable changes. The break line can contain the following items:

- text (including blanks)
- summaries of statistics
- report variables
- computed variables

To create group summaries, use the BREAK statement. A BREAK statement must include (in this order) the following:

- the keyword BREAK
- the location of the break (BEFORE or AFTER)
- the name of a GROUP variable that is called the break value

PROC REPORT creates a break each time the value of the break variable changes. If you want summaries to appear before the first row of each group, then use the BEFORE argument. If you want the summaries to appear after the last row of each group, then use the AFTER argument.

To create summary information for the whole report, use the RBREAK statement. An RBREAK statement must include (in this order) the following:

- the keyword RBREAK

- the location of the break (BEFORE or AFTER)

When you use the RBREAK statement, PROC REPORT inserts text, summary statistics for the entire report, or computed variables at the beginning or end of the detail rows of a report. If you want the summary to appear before the first row of the report, then use the BEFORE argument. If you want the summaries to appear after the last row of each group, then use the AFTER argument.

Both the BREAK and RBREAK statements support options that control the appearance of the group and the report summaries. You can use any combination of options in the statement in any order. For a list of available options, see "REPORT Procedure" in *Base SAS Procedures Guide*.

Creating Group Summaries

The following program creates a summary report that uses break lines to display subtotals with yearly sales for each sales representative, and a yearly grand total for all sales representatives:

```
ods listing;
options linesize=80 pageno=1 nodate linesize=84;

proc report data=year_sales headskip;
   column Salesrep Quarter Units AmountSold;
   define SalesRep / group 'Sales Representative';
   define Quarter / group center;
   define Units / analysis sum 'Units Sold' format=comma7.;
   define AmountSold / analysis sum 'Amount/Sold' format=dollar14.2;
   break after SalesRep / summarize skip ol suppress;
   rbreak after / summarize skip dol;
   title1 'TruBlend Coffee Makers Sales Report';
   title2 'Total Yearly Sales';
run;
ods listing close;
```

The following list corresponds to the numbered items in the preceding program:

- The CENTER option (LISTING output only) in the DEFINE statement centers the values of the variable Quarter and the label of the column heading.
- The BREAK statement adds break lines after a change in the value of the GROUP variable SalesRep. The SUMMARIZE option writes a summary line to summarize the statistics for each group of break lines. The SKIP option (LISTING output only) inserts a blank line after each group of break lines. The OL option (LISTING output only) writes a line of hyphens (-) above each value in the summary line. The SUPPRESS option suppresses printing the value of the break variable and the overlines in the break variable column.
- The RBREAK statement adds a break line at the end of the report. The SUMMARIZE option writes a summary line that summarizes the SUM statistics for the ANALYSIS variables Units and AmountSold. The SKIP option (LISTING output only) inserts a blank line before the break line. The DOL option (LISTING output only) writes a line of equal signs (=) above each value in the summary line.

The following displays the report for the LISTING destination:

Output 29.12 *Creating Group Summaries*

```
                          TruBlend Coffee Makers Sales Report
  1
                                  Total Yearly Sales

                 Sales                           Units          Amount
                 Representative  Quarter          Sold            Sold

                 Garcia             1            3,377     $118,019.94
                                    2            3,515     $108,859.55
                                    3            7,144     $225,326.28
                                    4            1,933      $59,865.01
                                               -------  --------------
                                                15,969 1
$512,070.78 1

                 Hollingsworth      1            1,770      $59,634.70
                                    2            3,090      $96,160.55
                                    3            3,285     $109,704.35
                                    4            2,475      $81,746.50
                                               -------  --------------
                                                10,620     $347,246.10

                 Jensen             1            1,617      $50,078.49
                                    2            2,413      $74,730.61
                                    3            6,687     $222,290.99
                                    4            3,683     $114,062.51
                                               -------  --------------
                                                14,400     $461,162.60

                                               =======  ==============
                                                40,989 2
$1,320,479.48 2
```

The following list corresponds to the numbered items in the preceding LISTING output:

1 The values of the ANALYSIS variables Units and AmountSold in the group summary lines are sums for all rows in the group (subtotals).

2 The values of the ANALYSIS variables Units and AmountSold in the report summary line are sums for all rows in the report (grand totals).

In this report, Units and AmountSold are ANALYSIS variables that are used to calculate the SUM statistic. If these variables were defined to calculate a different statistic, then the values in the summary lines would be the value of that statistic for all rows in the group and all rows in the report.

Summary

PROC REPORT Statements

PROC REPORT <DATA=*SAS-data-set*> <*options*>;

BREAK *location break-variable* </*options*>;

COLUMN *column-specification(s)*;

DEFINE *report-item* /<*usage*> <*options*>;

RBREAK *location*</*options*>;

TITLE<*n*> <'*title*'>;

WHERE *where-expression*;

PROC REPORT <DATA=SAS-data-set> <option(s)>;
starts the procedure. If no other statements are used, then SAS shows all variables in the SAS-data-set in a detail report in the REPORT window. If the data set contains only numeric data, then PROC REPORT shows all variables in a summary report. Other statements, listed below, enable you to control the structure of the report.

You can specify the following options in the PROC REPORT statement:

COLWIDTH=column-width
specifies the default number of characters for columns that contain computed variables or numeric data set variables. This option only affects the LISTING output.

DATA=SAS-data-set
names the SAS data set that PROC REPORT uses. If you omit DATA=, then PROC REPORT uses the most recently created data set.

HEADLINE
inserts a line of hyphens (-) under the column headings at the top of each page of the report. This option only affects the LISTING output.

HEADSKIP
inserts a blank line beneath all column headings (or beneath the line that the HEADLINE option inserts) at the top of each page of the report. This option only affects the LISTING output.

SPACING=space-between-columns
specifies the number of blank characters between columns. For each column, the sum of its width and the blank characters between it and the column to its left cannot exceed the line size. This option only affects the LISTING output.

SPLIT='character'
specifies the split character. PROC REPORT breaks a column heading when it reaches that character and continues the header on the next line. The split character itself is not part of the column heading, although each occurrence of the split character is counted toward the 256-character maximum for a label. In the LISTING output, the split character works in header rows and data values. In all other destinations, the split character only works in header row.

WINDOWS | NOWINDOWS
selects a windowing or nonwindowing environment.

When you use NOWINDOWS, PROC REPORT runs without the REPORT window and sends its results to the SAS procedure output. NOWINDOWS (alias NOWD) is the default. When you use WINDOWS, SAS opens the REPORT window, which enables you to modify a report repeatedly and to see the modifications immediately.

BREAK location break-variable </option(s)>;
produces a default summary at a break (a change in the value of a GROUP or ORDER variable). The information in a summary applies to a set of observations. The observations share a unique combination of values for the break variable and all other GROUP or ORDER variables to the left of the break variable in the report.

You must specify the following arguments in the BREAK statement:

location
controls the placement of the break lines, where location is

AFTER
places the break lines immediately after the last row of each set of rows that have the same value for the break variable.

BEFORE
places the break lines immediately before the first row of each set of rows that have the same value for the break variable.

break-variable
is a GROUP or ORDER variable. PROC REPORT writes break lines each time the value of this variable changes. You can specify the following options in the BREAK statement:

OL
inserts a line of hyphens (-) above each value that appears in the summary line. This option only affects the LISTING output.

SKIP
writes a blank line for the last break line. This option only affects the LISTING output.

SUMMARIZE
writes a summary line in each group of break lines.

SUPPRESS
suppresses the printing of the value of the break variable in the summary line, and of any underlining or overlining in the break lines.

COLUMN <column-specification(s)>;
identifies items that form columns in the report and describes the arrangement of all columns. You can specify the following column-specification(s) in the COLUMN statement:

- *report-item(s)*
- *report-item-1*, *report-item-2* <. . . , *report-item-n*>

where *report-item* identifies items that form columns in the report. A report-item is either the name of a data set variable, a computed variable, or a statistic.

report-item-1, report-item-2 <. . . , report-item-n>
identifies report items that collectively determine the contents of the column or columns. These items are said to be stacked in the report because each item

generates a header, and the headers are stacked one above the other. The header for the leftmost item is on top. If one of the items is an ANALYSIS variable, then a computed variable, or a statistic, its values fill the cells in that part of the report. Otherwise, PROC REPORT fills the cells with frequency counts.

DEFINE report-item / <usage> <option(s)>;

describes how to use and display a report item. A report item is either the name or alias (established in the COLUMN statement) of a data set variable, a computed variable, or a statistic. The usage of the report item is

- ACROSS
- ANALYSIS
- COMPUTED
- DISPLAY
- GROUP
- ORDER

You can specify the following options in the DEFINE statement:

CENTER
centers the formatted values of the report item within the column width, and centers the column heading over the values.

column-header
defines the column heading for the report item. Enclose each header in single or double quotation marks. When you specify multiple column headings, PROC REPORT uses a separate line for each one. The split character also splits a column heading over multiple lines.

DESCENDING
reverses the order in which PROC REPORT displays rows or values of a GROUP, ORDER, or ACROSS variable.

FORMAT=format
assigns a SAS format or a user-defined format to the report item. This format applies to *report-item* as PROC REPORT displays it; the format does not alter the format associated with a variable in the data set.

ORDER=DATA | FORMATTED | FREQ | INTERNAL
orders the values of a GROUP, ORDER, or ACROSS variable according to the specified order, where

DATA
orders values according to their order in the input data set.

FORMATTED
orders values by their formatted (external) values. By default, the order is ascending.

FREQ
orders values by ascending frequency count.

INTERNAL
orders values by their unformatted values, which yields the same order that PROC SORT would yield. This order is operating environment dependent. This sort sequence is particularly useful for displaying dates chronologically.

RIGHT
right-justifies the formatted values of the specified report item within the column width and right-justifies the column headings over the values. If the format width is the same as the width of the column, then RIGHT has no affect on the placement of values. This option only affects the LISTING output.

SPACING=horizontal-positions
defines the number of blank characters to leave between the column that is being defined and the column immediately to its left. For each column, the sum of its width and the blank characters between it and the column to its left cannot exceed the line size. This option only affects the LISTING output.

statistic
associates a statistic with an ANALYSIS variable. PROC REPORT uses this statistic to calculate values for the ANALYSIS variable for the observations represented by each cell of the report. If you do not associate a statistic with the variable, then PROC REPORT calculates the SUM statistic. You cannot use *statistic* in the definition of any other type of variable.

WIDTH=column-width
defines the width of the column in which PROC REPORT displays *report-item*. This option only affects the LISTING output.

RBREAK location </option(s)>;
produces a default summary at the beginning or end of a report.

You must specify the following argument in the RBREAK statement:

location
controls the placement of the break lines and is either

AFTER
places the break lines at the end of the report.

BEFORE
places the break lines at the beginning of the report.

You can specify the following options in the RBREAK statement:

DOL
specifies to double overline each value that appears in the summary line. This option only affects the LISTING output.

SKIP
writes a blank line after the last break line of a break located at the beginning of the report. This option only affects the LISTING output.

SUMMARIZE
includes a summary line as one of the break lines. A summary line at the beginning or end of a report contains values for statistics, ANALYSIS variables, or computed variables.

TITLE<n> <'title'>;
specifies a title. The argument *n* is a number from 1 to 10 that immediately follows the word TITLE, with no intervening blank, and it specifies the level of the TITLE. The text of each *title* must be enclosed in single or double quotation marks. The maximum title length depends on your operating environment and the value of the LINESIZE= system option. Refer to the SAS documentation for your operating environment for more information.

WHERE where-expression;
subsets the input data set by identifying certain conditions that each observation must meet before an observation is available for processing. *Where-expression*

defines the condition. The condition is a valid arithmetic or logical expression that generally consists of a sequence of operands and operators.

Learning More

KEEP= data set option
: For an additional example, see "Reading Selected Variables" on page 98. For complete documentation about the KEEP= data set option, see "KEEP= Data Set Option" in *SAS Data Set Options: Reference*.

PROC PRINT
: For a discussion of how to create several types of detail reports, see Chapter 27, "Producing Detail Reports with the PRINT Procedure," on page 449.

PROC REPORT
: For complete documentation, see "REPORT Procedure" in *Base SAS Procedures Guide*.

PROC TABULATE
: For a discussion of how to create several types of summary reports, see Chapter 28, "Creating Summary Tables with the TABULATE Procedure," on page 491.

SAS formats
: For complete documentation, see *SAS Formats and Informats: Reference*. Many formats are available with the SAS software, such as fractions, hexadecimal values, roman numerals, Social Security numbers, date and time values, and numbers written as words.

WHERE statement
: For a discussion, see "Understanding the WHERE Statement" on page 460. For complete reference documentation about the WHERE statement, see *SAS DATA Step Statements: Reference*. For a complete discussion of WHERE processing, see *SAS Language Reference: Concepts*.

PART 7

Producing Plots and Charts

30

Plotting the Relationship between Variables

Introduction to Plotting the Relationship between Variables

Overview

An effective way to examine the relationship between variables is to plot their values. You can use the PLOT procedure to display relationships and patterns in the data.

This section covers the following topics:

- plot one set of variables
- enhance the appearance of a plot
- create multiple plots on separate pages
- create multiple plots on the same page
- plot multiple sets of variables on the same pair of axes

Prerequisites

To understand the examples in this section, you should be familiar with the following features and concepts:

- the LOG function
- the FORMAT statement
- the LABEL statement
- the TITLE statement

Input File and SAS Data Set for Examples

The examples in this section use one input file and one SAS data set. The input file contains information about the high and low values of the Dow Jones Industrial Average from 1968 to 2008. The input file has the following structure:

```
1968  03DEC1968  985.21  21MAR1968  825.13
1969  14MAY1969  968.85  17DEC1969  769.93
1970  29DEC1970  842.00  06MAY1970  631.16
1971  28APR1971  950.82  23NOV1971  797.97
1972  11DEC1972 1036.27  26JAN1972  889.15
...more data lines...
2005  04MAR2005 10940.55 20APR2005 10012.36
2006  27DEC2006 12510.57 20JAN2006 10667.39
2007  09OCT2007 14164.53 05MAR2007 12050.41
2008  02MAY2008 13058.20 10OCT2008 8451.19
```

The input file contains the following values from left to right:

- the year that the observation describes
- the date of the yearly high for the Dow Jones Industrial Average
- the yearly high value for the Dow Jones Industrial Average
- the date of the yearly low for the Dow Jones Industrial Average
- the yearly low value for the Dow Jones Industrial Average

The following program creates the SAS data set HIGHLOW:

```
data highlow;
   infile 'your-input-file';
   input Year @7 DateOfHigh:date9. DowJonesHigh @26 DateOfLow:date9. DowJonesLow;
```

```
   format LogDowHigh LogDowLow 5.2 DateOfHigh DateOfLow date9.;
   LogDowHigh=log(DowJonesHigh);
   LogDowLow=log(DowJonesLow);
run;
```

The computed variables LogDowHigh and LogDowLow contain the log transformation of the yearly high and low values for the Dow Jones Industrial Average.

```
proc print data=highlow;
   title 'Dow Jones Industrial Average Yearly High and Low Values';
run;

data highlow;
   input Year @7 DateOfHigh:date9. DowJonesHigh @26 DateOfLow:date9. DowJonesLow;
   format LogDowHigh LogDowLow 5.2 DateOfHigh DateOfLow date9.;
   LogDowHigh=log(DowJonesHigh);
   LogDowLow=log(DowJonesLow);
datalines;
1968  03DEC1968  985.21  21MAR1968  825.13
1969  14MAY1969  968.85  17DEC1969  769.93
1970  29DEC1970  842.00  06MAY1970  631.16
1971  28APR1971  950.82  23NOV1971  797.97
1972  11DEC1972 1036.27  26JAN1972  889.15
1973  11JAN1973 1051.70  05DEC1973  788.31
1974  13MAR1974  891.66  06DEC1974  577.60
1975  15JUL1975  881.81  02JAN1975  632.04
1976  21SEP1976 1014.79  02JAN1976  858.71
1977  03JAN1977  999.75  02NOV1977  800.85
1978  08SEP1978  907.74  28FEB1978  742.12
1979  05OCT1979  897.61  07NOV1979  796.67
1980  20NOV1980 1000.17  21APR1980  759.13
1981  27APR1981 1024.05  25SEP1981  824.01
1982  27DEC1982 1070.55  12AUG1982  776.92
1983  29NOV1983 1287.20  03JAN1983 1027.04
1984  06JAN1984 1286.64  24JUL1984 1086.57
1985  16DEC1985 1553.10  04JAN1985 1184.96
1986  02DEC1986 1955.57  22JAN1986 1502.29
1987  25AUG1987 2722.42  19OCT1987 1738.74
1988  21OCT1988 2183.50  20JAN1988 1879.14
1989  09OCT1989 2791.41  03JAN1989 2144.64
1990  16JUL1990 2999.75  11OCT1990 2365.10
1991  31DEC1991 3168.83  09JAN1991 2470.30
1992  01JUN1992 3413.21  09OCT1992 3136.58
1993  29DEC1993 3794.33  20JAN1993 3241.95
1994  31JAN1994 3978.36  04APR1994 3593.35
1995  13DEC1995 5216.47  30JAN1995 3832.08
1996  27DEC1996 6560.91  10JAN1996 5032.94
1997  06AUG1997 8259.31  11APR1997 6391.69
1998  23NOV1998 9374.27  31AUG1998 7539.07
1999  31DEC1999 11497.12 22JAN1999 9120.67
2000  14JAN2000 11722.98 07MAR2000 9796.04
2001  21MAY2001 11337.92 21SEP2001 8235.81
2002  19MAR2002 10635.25 09OCT2002 7286.27
2003  31DEC2003 10453.92 11MAR2003 7524.06
2004  28DEC2004 10854.54 25OCT2004 9749.99
2005  04MAR2005 10940.55 20APR2005 10012.36
```

```
2006  27DEC2006 12510.57 20JAN2006 10667.39
2007  09OCT2007 14164.53 05MAR2007 12050.41
2008  02MAY2008 13058.20 10OCT2008 8451.19
;
run;
```

Figure 30.1 SAS Output for the HIGHLOW Data Set

Dow Jones Industrial Average Yearly High and Low Values

Obs	Year	DateOfHigh	DowJonesHigh	DateOfLow	DowJonesLow	LogDowHigh	LogDowLow
1	1968	03DEC1968	985.21	21MAR1968	825.13	6.89	6.72
2	1969	14MAY1969	968.85	17DEC1969	769.93	6.88	6.65
3	1970	29DEC1970	842.00	06MAY1970	631.16	6.74	6.45
4	1971	28APR1971	950.82	23NOV1971	797.97	6.86	6.68
5	1972	11DEC1972	1036.27	26JAN1972	889.15	6.94	6.79
6	1973	11JAN1973	1051.70	05DEC1973	788.31	6.96	6.67
7	1974	13MAR1974	891.66	06DEC1974	577.60	6.79	6.36
8	1975	15JUL1975	881.81	02JAN1975	632.04	6.78	6.45
9	1976	21SEP1976	1014.79	02JAN1976	858.71	6.92	6.76
10	1977	03JAN1977	999.75	02NOV1977	800.85	6.91	6.69
11	1978	08SEP1978	907.74	28FEB1978	742.12	6.81	6.61
12	1979	05OCT1979	897.61	07NOV1979	796.67	6.80	6.68
13	1980	20NOV1980	1000.17	21APR1980	759.13	6.91	6.63
14	1981	27APR1981	1024.05	25SEP1981	824.01	6.93	6.71
15	1982	27DEC1982	1070.55	12AUG1982	776.92	6.98	6.66
16	1983	29NOV1983	1287.20	03JAN1983	1027.04	7.16	6.93
17	1984	06JAN1984	1286.64	24JUL1984	1086.57	7.16	6.99
18	1985	16DEC1985	1553.10	04JAN1985	1184.96	7.35	7.08
19	1986	02DEC1986	1955.57	22JAN1986	1502.29	7.58	7.31
20	1987	25AUG1987	2722.42	19OCT1987	1738.74	7.91	7.46
21	1988	21OCT1988	2183.50	20JAN1988	1879.14	7.69	7.54
22	1989	09OCT1989	2791.41	03JAN1989	2144.64	7.93	7.67
23	1990	16JUL1990	2999.75	11OCT1990	2365.10	8.01	7.77
24	1991	31DEC1991	3168.83	09JAN1991	2470.30	8.06	7.81
25	1992	01JUN1992	3413.21	09OCT1992	3136.58	8.14	8.05
26	1993	29DEC1993	3794.33	20JAN1993	3241.95	8.24	8.08
27	1994	31JAN1994	3978.36	04APR1994	3593.35	8.29	8.19
28	1995	13DEC1995	5216.47	30JAN1995	3832.08	8.56	8.25
29	1996	27DEC1996	6560.91	10JAN1996	5032.94	8.79	8.52
30	1997	06AUG1997	8259.31	11APR1997	6391.69	9.02	8.76
31	1998	23NOV1998	9374.27	31AUG1998	7539.07	9.15	8.93
32	1999	31DEC1999	11497.12	22JAN1999	9120.67	9.35	9.12
33	2000	14JAN2000	11722.98	07MAR2000	9796.04	9.37	9.19
34	2001	21MAY2001	11337.92	21SEP2001	8235.81	9.34	9.02
35	2002	19MAR2002	10635.25	09OCT2002	7286.27	9.27	8.89
36	2003	31DEC2003	10453.92	11MAR2003	7524.06	9.25	8.93
37	2004	28DEC2004	10854.54	25OCT2004	9749.99	9.29	9.19
38	2005	04MAR2005	10940.55	20APR2005	10012.36	9.30	9.21
39	2006	27DEC2006	12510.57	20JAN2006	10667.39	9.43	9.27
40	2007	09OCT2007	14164.53	05MAR2007	12050.41	9.56	9.40
41	2008	02MAY2008	13058.20	10OCT2008	8451.19	9.48	9.04

Plotting One Set of Variables

Understanding the PLOT Statement

The PLOT procedure produces two-dimensional graphs that plot one variable against another within a set of coordinate axes. The coordinates of each point on the plot correspond to the values of two variables. Graphs are automatically scaled to the values of your data, although you can control the scale by specifying the coordinate axes.

You can create a simple two-dimensional plot for one set of measures by using the following PLOT statement:

PROC PLOT <DATA=*SAS-data-set*>;
  PLOT *vertical***horizontal*;

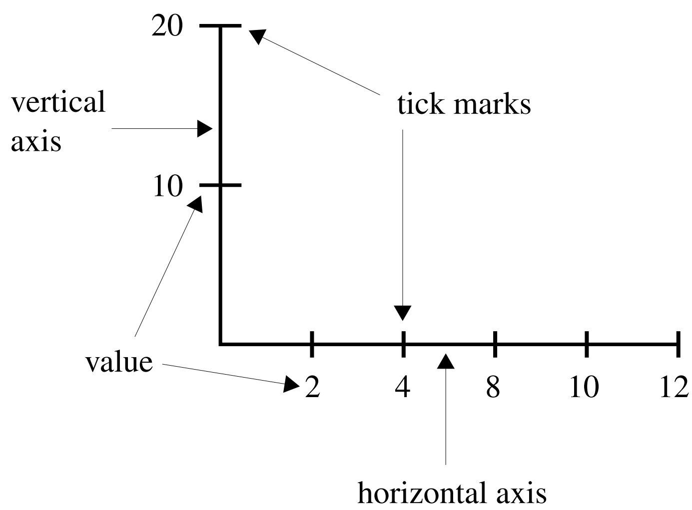
where *vertical* is the name of the variable to plot on the vertical axis and *horizontal* is the name of the variable to plot on the horizontal axis.

By default, PROC PLOT selects plotting symbols. The data determines the labels for the axes, the values of the axes, and the values of the tick marks. The plot displays the following:

- the name of the vertical variable that is next to the vertical axis and the name of the horizontal variable that is beneath the horizontal axis
- the axes and the tick marks that are based on evenly spaced intervals
- the letter A as the plotting symbol to indicate one observation; the letter B as the plotting symbol if two observations coincide; the letter C if three coincide, and so on
- a legend with the name of the variables in the plot and meaning of the plotting symbols

The following display shows the axes, values, and tick marks on a plot.

Figure 30.2 Diagram of Axes, Values, and Tick Marks



Note: PROC PLOT is an interactive procedure. After you issue the PROC PLOT statement, you can continue to submit any statements that are valid with the procedure without resubmitting the PROC statement. Therefore, you can easily and quickly experiment with changing labels, values for tick marks, and so on.

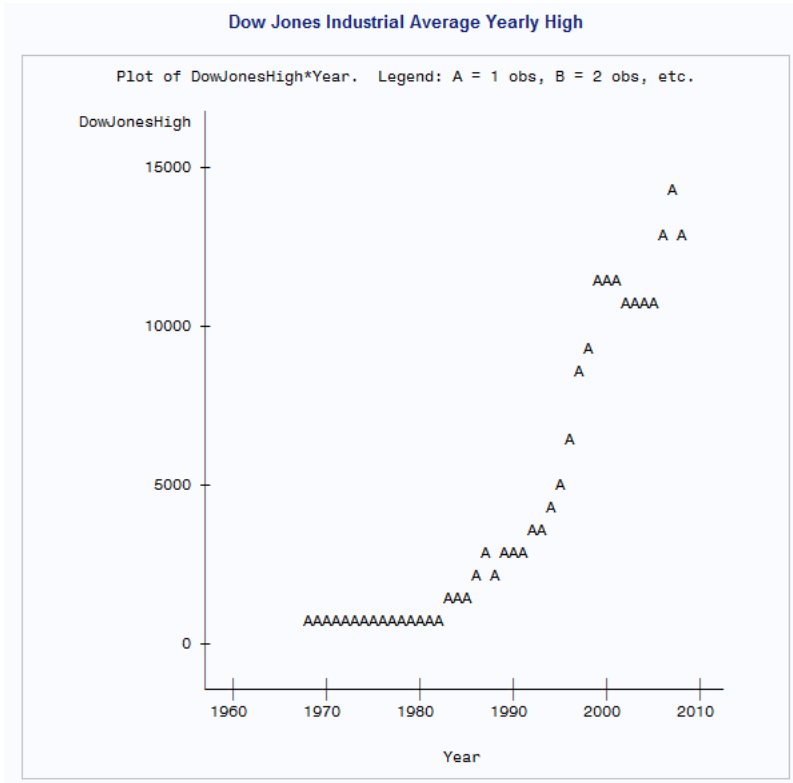
Example

The following program uses the PLOT statement to create a simple plot that shows the trend in high Dow Jones values from 1968 to 2008:

```
proc plot data=highlow;
   plot DowJonesHigh*Year;
   title 'Dow Jones Industrial Average Yearly High';
run;
```

The following output shows the plot.

Figure 30.3 Using a Simple Plot to Show Data Trends



The plot graphically depicts the exponential trend in the high value of the Dow Jones Industrial Average over the past 50 years. The greatest growth has occurred in the past 10 years, increasing by almost 6,000 points.

Enhancing the Plot

Specifying the Axes Labels

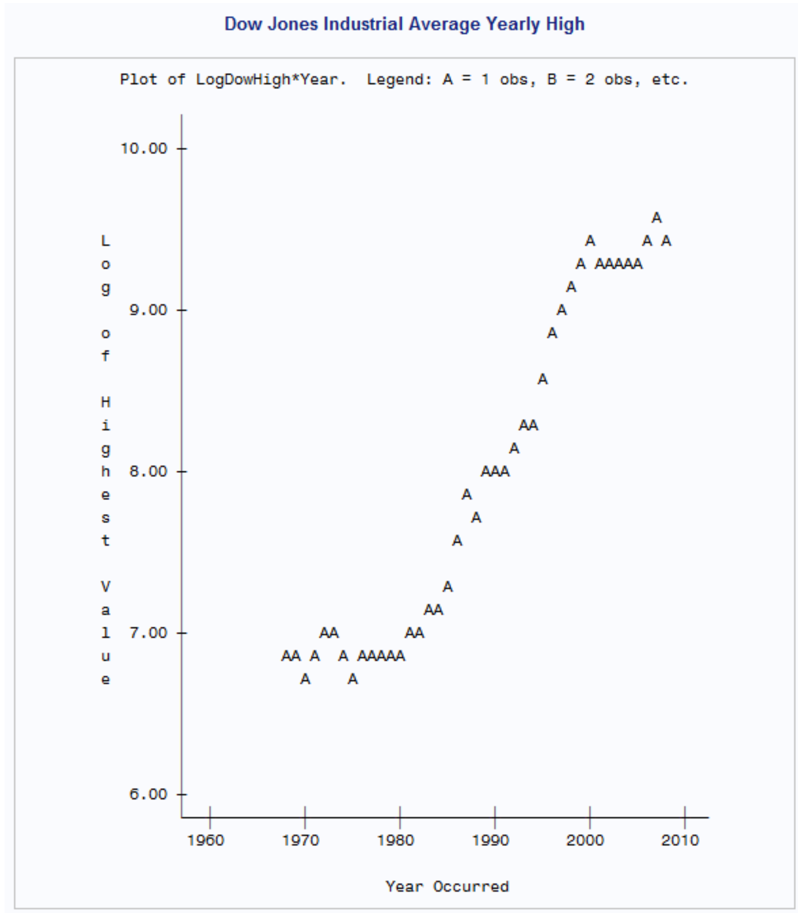
Sometimes you might want to supply additional information about the axes. You can enhance the plot by specifying the labels for the vertical and horizontal axes.

The following program plots the log transformation of DowJonesHigh for each year and uses the LABEL statement to change the axes labels:

```
proc plot data=highlow;
   plot LogDowHigh*Year;
   label LogDowHigh='Log of Highest Value'
         Year='Year Occurred';
   title 'Dow Jones Industrial Average Yearly High';
run;
```

The following output shows the plot.

Figure 30.4 *Specifying the Labels for the Axes*



Plotting the log transformation of DowJonesHigh changes the exponential trend to a linear trend. The label for each variable is centered parallel to its axis.

Specifying the Tick Marks Values

In the previous plots, the range on the horizontal axis is from 1960 to 2010. Tick marks and labels representing the years are spaced at intervals of 10. You can control the selection of the range and the interval on the horizontal axis with the HAXIS= option in the PLOT statement. A corresponding PLOT statement option, VAXIS=, controls the values of the tick mark on the vertical axis.

The forms of the HAXIS= and VAXIS= options follow. You must precede the first option in a PLOT statement with a slash.

PLOT *vertical*horizontal* / HAXIS=*tick-value-list*;

PLOT *vertical*horizontal* / VAXIS=*tick-value-list*;

where *tick-value-list* is a list of all values to assign to tick marks.

For example, to specify tick marks every five years from 1969 to 2010, use the following option:

```
haxis=1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
```

Or, you can abbreviate this list of tick marks:

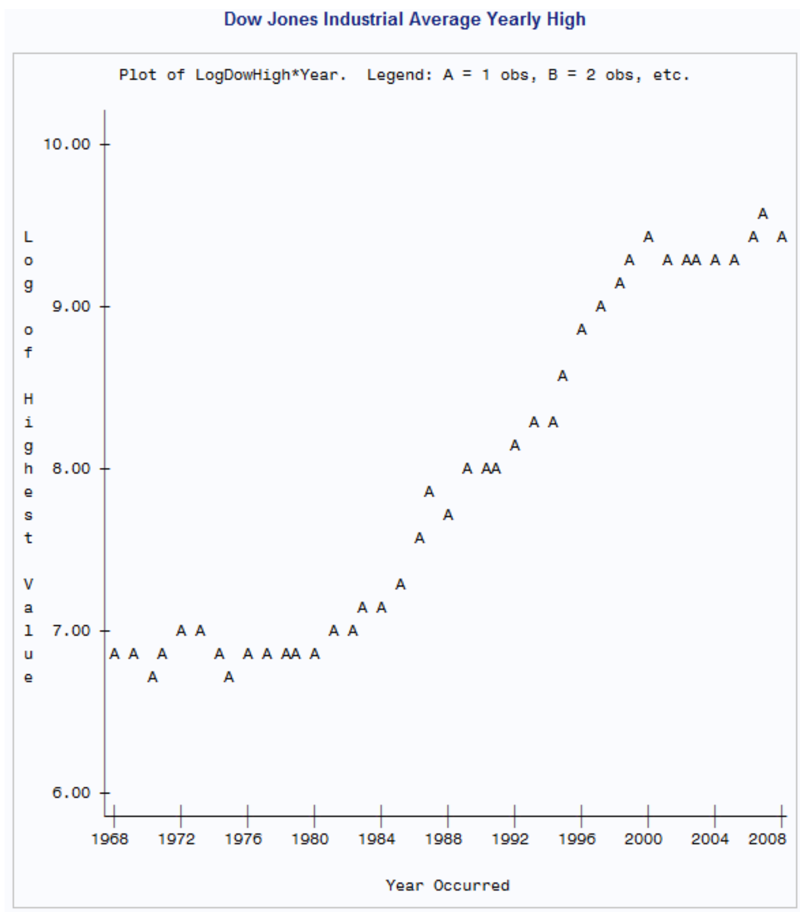
```
haxis=1960 to 2010 by 5
```

The following program uses the HAXIS= option to specify the tick mark values for the horizontal axis:

```
proc plot data=highlow;
   plot LogDowHigh*Year / haxis=1968 to 2008 by 4;
   label LogDowHigh='Log of Highest Value'
         Year='Year Occurred';
   title 'Dow Jones Industrial Average Yearly High';
run;
```

The following output shows the plot.

Figure 30.5 *Specifying the Range and the Intervals of the Horizontal Axis*



The range of the horizontal axis is from 1968 to 2008, and the tick marks are now arranged at four-year intervals.

Specifying Plotting Symbols

By default, PROC PLOT uses the letter A as the plotting symbol to indicate one observation, the letter B as the plotting symbol if two observations coincide, the letter C if three coincide, and so on. The letter Z represents 26 or more coinciding observations.

If you are plotting two sets of data on the same pair of axes, you can use the following form of the PLOT statement to specify your own plotting symbols:

PLOT *vertical*horizontal='character'*;

where *character* is a plotting symbol to mark each point on the plot. PROC PLOT uses this character to represent values from one or more observations.

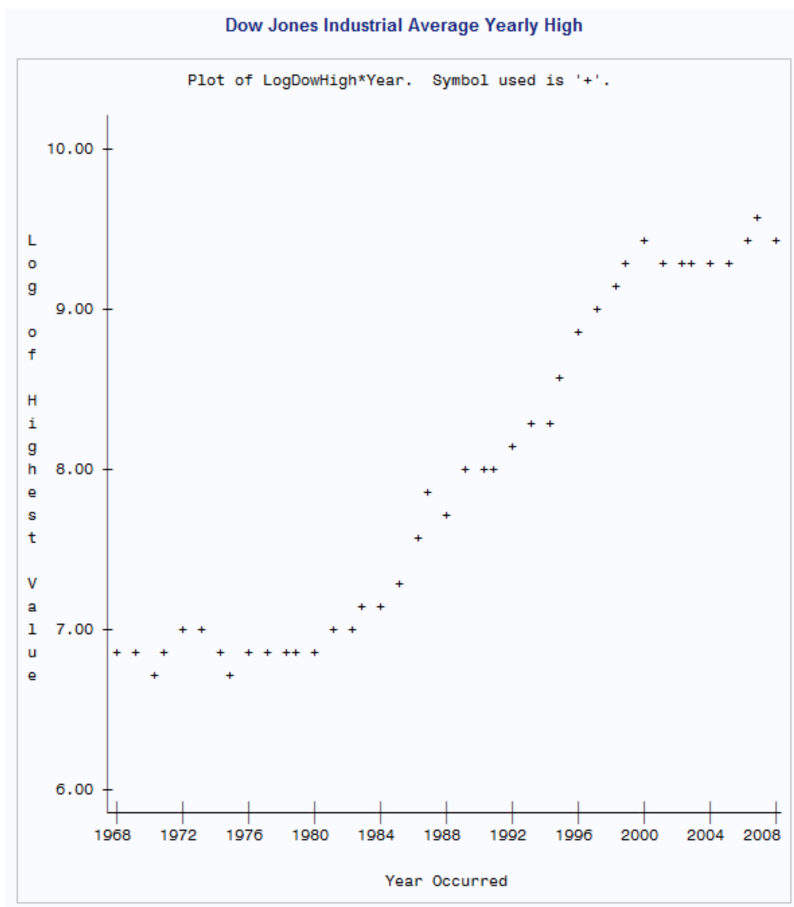
The following program uses the plus sign (+) as the plotting symbol for the plot:

```
proc plot data=highlow;
   plot LogDowHigh*Year='+' / haxis=1968 to 2008 by 4;
   label LogDowHigh='Log of Highest Value'
         Year='Year Occurred';
   title 'Dow Jones Industrial Average Yearly High';
run;
```

The plotting symbol must be enclosed in either single or double quotation marks.

The following output shows the plot.

Figure 30.6 Specifying a Plotting Symbol



Note: When a plotting symbol is specified, PROC PLOT uses that symbol for all points on the plot regardless of how many observations might coincide. If observations coincide, then a message appears at the bottom of the plot telling how many observations are hidden.

Removing the Legend

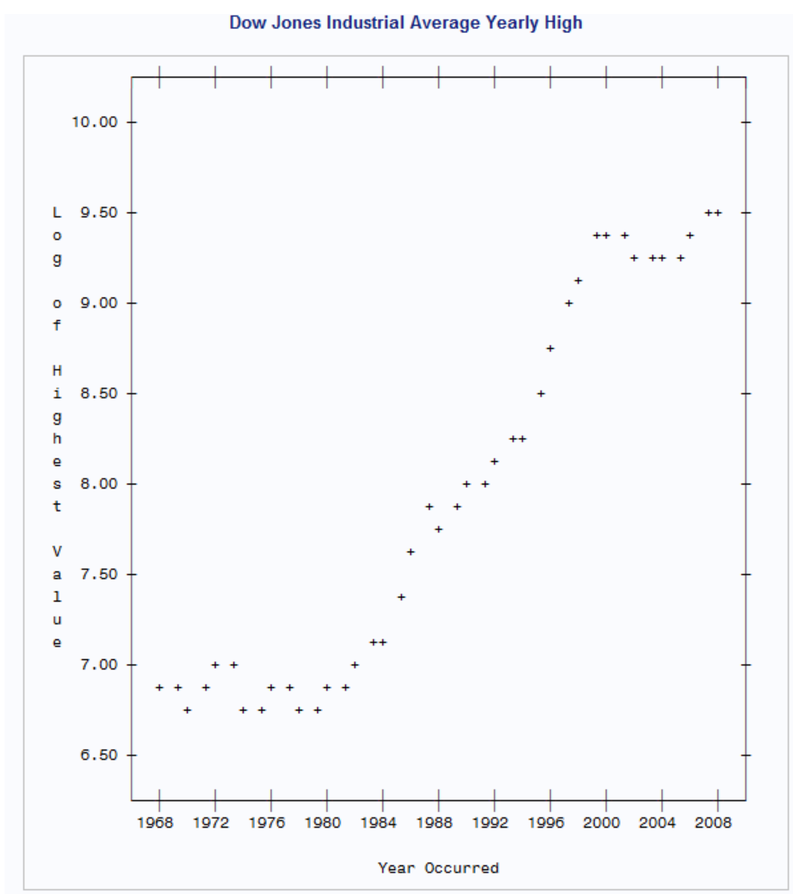
Often, a few simple changes to a plot can improve its appearance. You can draw a frame around the entire plot, rather than just on the left side and bottom. This makes it easier to determine the values that the plotting symbols represent on the left side of the plot. Also, you can suppress the legend when the labels clearly identify the variables in the plot or when the association between the plotting symbols and the variables is clear.

The following program uses the NOLEGEND option to suppress the legend and the BOX option to box the entire plot:

```
proc plot data=highlow nolegend;
   plot LogDowHigh*Year='+' / haxis=1968 to 2008 by 4
                              box;
   label LogDowHigh='Log of Highest Value'
         Year='Year Occurred';
   title 'Dow Jones Industrial Average Yearly High';
run;
```

The following output shows the plot.

Figure 30.7 *Removing the Legend*



Plotting Multiple Sets of Variables

Creating Multiple Plots on Separate Pages

You can compare trends for different sets of measures by creating multiple plots. To request more than one plot from the same SAS data set, simply specify additional sets of variables in the PLOT statement. The form of the statement is shown here:

PLOT *vertical*-1**horizontal*-1 *vertical*-2**horizontal*-2;

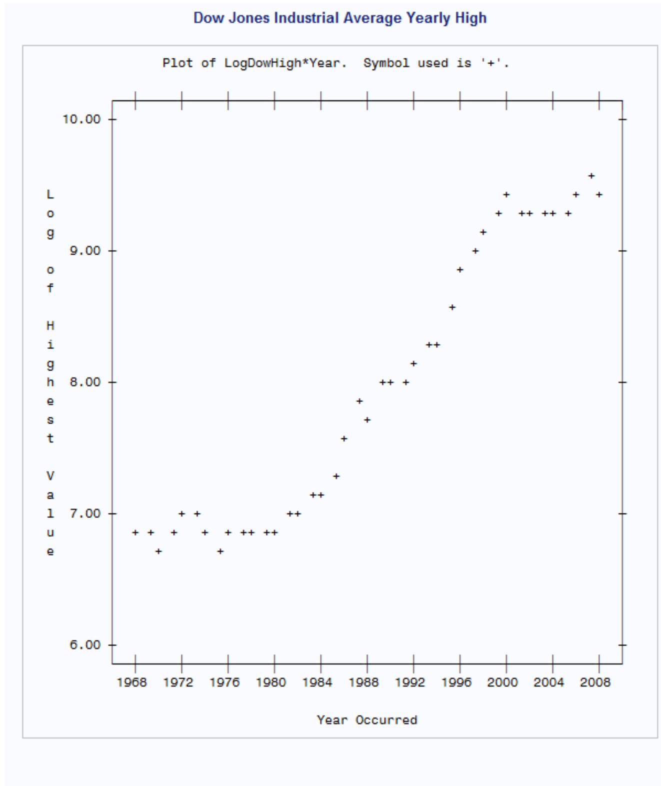
All the options that you list in a PLOT statement apply to all of the plots that the statement produces.

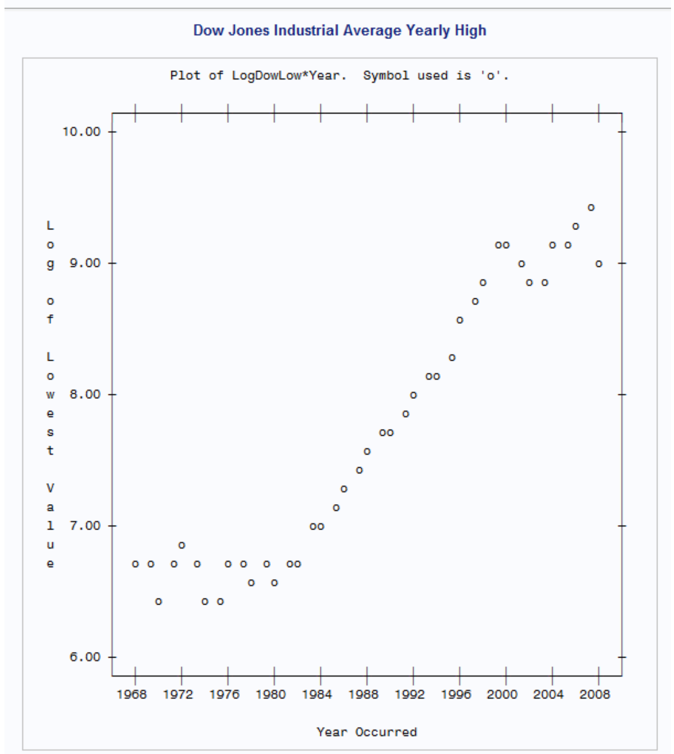
The following program uses the PLOT statement to produce separate plots of the highest and lowest values of the Dow Jones Industrial Average from 1968 to 2008:

```
proc plot data=highlow;
   plot LogDowHigh*Year='+' LogDowLow*Year='o'
                        / haxis=1968 to 2008 by 4 box;
   label LogDowHigh='Log of Highest Value'
         LogDowLow='Log of Lowest Value'
         Year='Year Occurred';
   title 'Dow Jones Industrial Average Yearly High';
run;
```

The following output shows the plots.

Figure 30.8 Creating Multiple Plots on Separate Pages





The plots appear on separate pages and use different vertical axes. Different plotting symbols represent the high and low values of the Dow Jones Industrial Average.

Creating Multiple Plots on the Same Page

You can more easily compare the trends in different sets of measures when the plots appear on the same page. PROC PLOT provides two options that display multiple plots on the same page:

- the VPERCENT= option
- the HPERCENT= option

You can specify these options in the PROC PLOT statement by using one of the following forms:

PROC PLOT <DATA=*SAS-data-set*> VPERCENT=*number*;

PROC PLOT <DATA=*SAS-data-set*> HPERCENT=*number*;

In this syntax, *number* is the percent of the vertical or the horizontal space given to each plot. You can substitute the aliases VPCT= and HPCT= for these options.

To fit two plots on a page, one beneath the other, as in Figure 30.9 on page 567, use VPERCENT=50; to fit three plots, use VPERCENT=33; and so on. To fit two plots on a page, side by side, use HPERCENT=50; to fit three plots, as in Figure 30.10 on page 568, use HPERCENT=33; and so on. Figure 30.11 on page 568 combines both of these options in the same PLOT statement to create a matrix of plots. Because the VPERCENT= option and the HPERCENT= option appear in the PROC PLOT statement, they affect all plots that are created in the PROC PLOT step.

The following examples show the position of the plots.

Figure 30.9 *Plots Produced with VPERCENT=50*

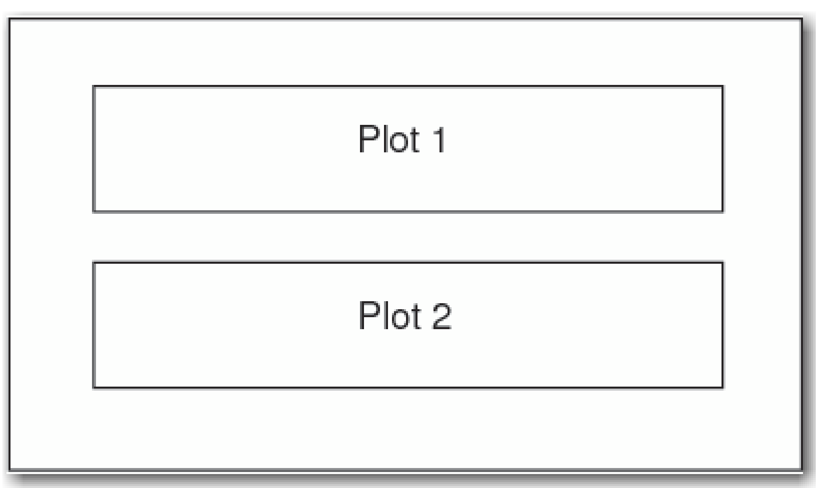


Figure 30.10 *Plots Produced with HPERCENT=33*

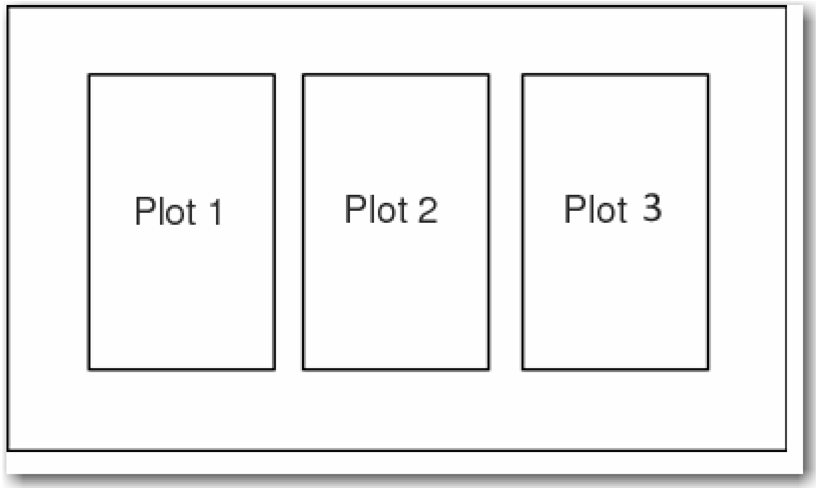
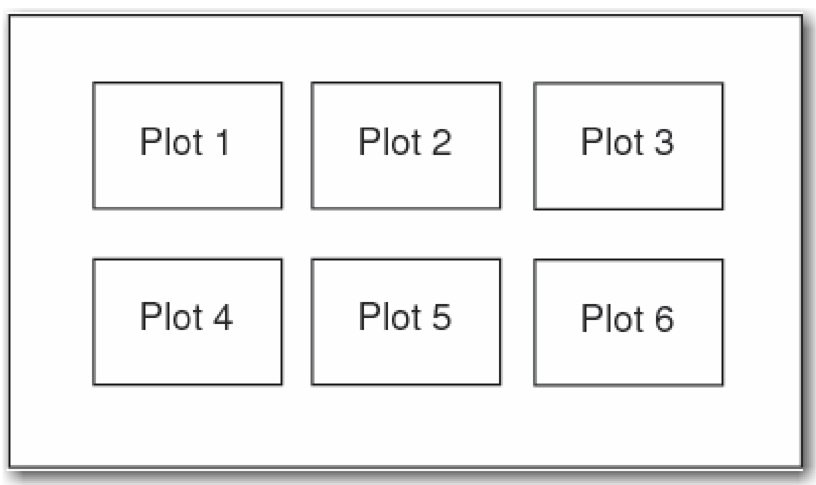


Figure 30.11 *Plots Produced with VPERCENT=50 and HPERCENT=33*



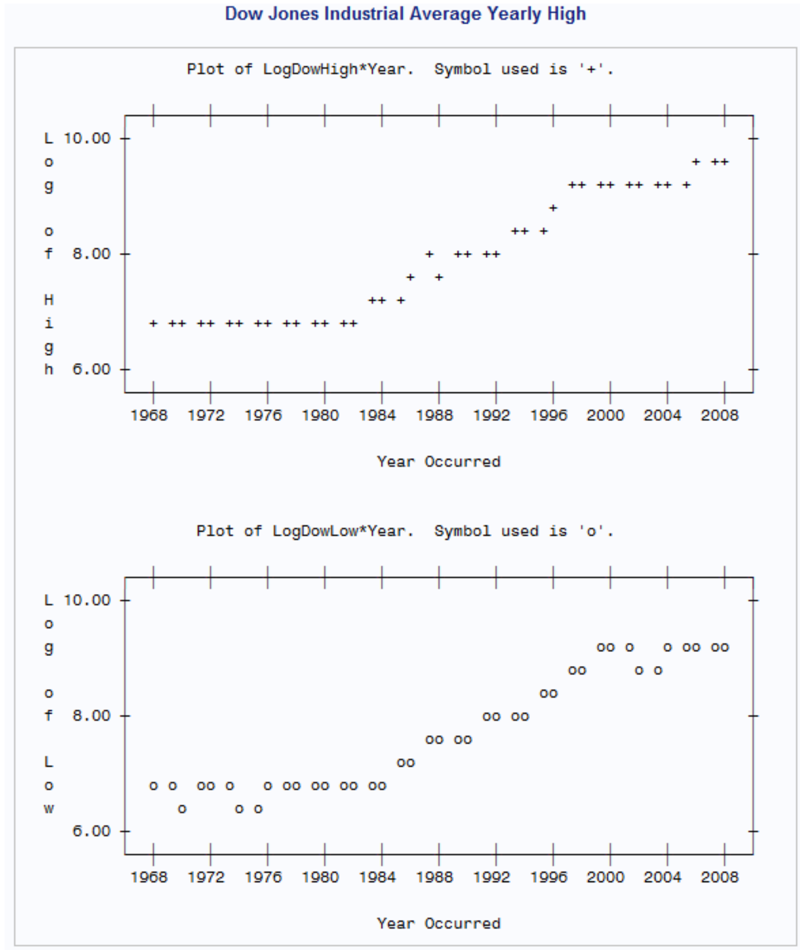
The following program uses the VPERCENT= option to display two plots on the same page so that you can more easily compare the high and the low Dow Jones values:

```
proc plot data=highlow vpercent=50;
   plot LogDowHigh*Year='+' LogDowLow*Year='o'
                        / haxis=1968 to 2008 by 4 box;
   label LogDowHigh='Log of High'
         LogDowLow='Log of Low'
         Year='Year Occurred';
   title 'Dow Jones Industrial Average Yearly High';
run;
```

In the output, PROC PLOT uses 50% of the vertical space on the page to display each plot.

The following output displays the plots.

Figure 30.12 Creating Multiple Plots on the Same Page



The two plots appear on the same page, one beneath the other.

Plotting Multiple Sets of Variables on the Same Axes

The easiest way to compare trends in multiple sets of measures is to superimpose the plots on one set of axes by using the OVERLAY option in the PLOT statement. The variable names, or variable labels if they exist, from the first plot become the axes labels. Unless you use the HAXIS= option or the VAXIS= option, PROC PLOT automatically scales the axes to best fit all the variables.

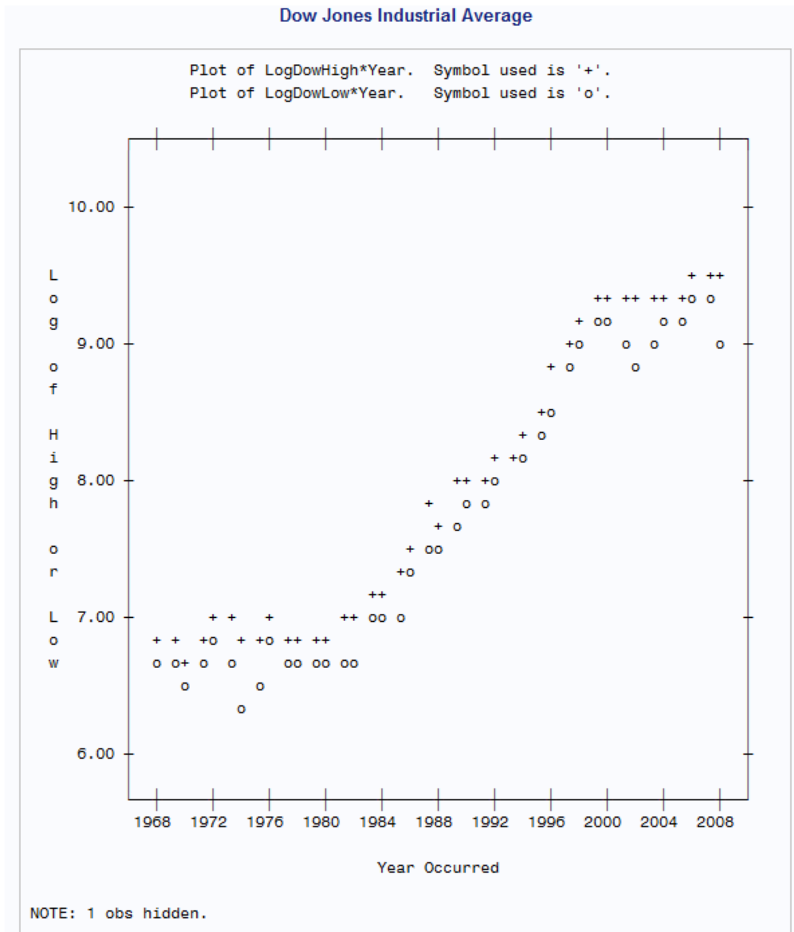
The following program uses the OVERLAY option to plot the high and the low Dow Jones Industrial Average values on the same pair of axes:

```
proc plot data=highlow;
   plot LogDowHigh*Year='+' LogDowLow*Year='o'
                        / haxis=1968 to 2008 by 4
                          overlay box;
   label LogDowHigh='Log of High or Low'
         Year='Year Occurred';
   title 'Dow Jones Industrial Average';
run;
```

A new label for the variable LogDowHigh is specified because PROC PLOT uses only this variable to label the vertical axis.

The following output displays the plot.

Figure 30.13 *Overlaying Two Plots*



The linear trends in the high and low Dow Jones values over the years from 1968 to 2008 are easily noticed.

Note: When the SAS system option OVP is in effect and overprinting is allowed, the plots are superimposed. Otherwise, when NOOVP is in effect, PROC PLOT uses the plotting symbol from the first plot to represent points that appear in more than one plot. In such a case, the output includes a message telling you how many observations are hidden.

Summary

PROC PLOT Statements

PROC PLOT <DATA=*SAS-data-set*> <*options*>;

LABEL *variable='label'*;

PLOT *request-list* </*options*>;

TITLE<*n*> <'*title*'>;

PROC PLOT <DATA=*SAS-data-set*> <*options*> ;

starts the PLOT procedure. You can specify the following *options* in the PROC PLOT statement:

DATA=*SAS-data-set*
names the SAS data set that PROC PLOT uses. If you omit DATA=, then PROC PLOT uses the most recently created data set.

HPERCENT=*percent(s)*
specifies one or more percentages of the available horizontal space to use for each plot. HPERCENT= enables you to put multiple plots on one page. PROC PLOT tries to fit as many plots as possible on a page. After using each of the *percent(s)*, PROC PLOT cycles back to the beginning of the list. A zero in the list forces PROC PLOT to go to a new page even though it could fit the next plot on the same page.

NOLEGEND
suppresses the default legend. The legend lists the names of the variables being plotted and the plotting symbols that are used in the plot.

VPERCENT=*percent(s)*
specifies one or more percentages of the available vertical space to use for each plot. If you use a percentage greater than 100, then PROC PLOT prints sections of the plot on successive pages.

LABEL *variable='label'*;

specifies to use labels for the axes. *Variable* names the variable to label and *label* specifies a string of up to 256 characters, which includes blanks. The *label* must be enclosed in single or double quotation marks.

PLOT *request-list* </*options*>;

enables you to request individual plots in the *request-list* in the PLOT statement. Each element in the list has the following form:

*vertical***horizontal*<='*symbol*'>

where *vertical* and *horizontal* are the names of the variables that appear on the axes and *symbol* is the character to use for all points on the plot.

You can request any number of plot statements in one PROC PLOT step. A list of options pertains to a single plot statement.

BOX
draws a box around the entire plot, rather than only on the left side and bottom.

HAXIS=<*tick-value-list*>
specifies the tick mark values for the horizontal axis. The *tick-value-list* consists of a list of values to use for tick marks.

OVERLAY
superimposes all of the plots that are requested in the PLOT statement on one set of axes. The variable names, or variable labels if they exist, from the first plot are used to label the axes. Unless you use the HAXIS= or the VAXIS= option, PROC PLOT automatically scales the axes in the way that best fits all the variables.

VAXIS=<*tick-value-list*>
specifies tick mark values for the vertical axis. The *tick-value-list* consists of a list of values to use for tick marks.

TITLE<*n*> <'*title*'>;
specifies a title. The argument *n* is a number from 1 to 10 that immediately follows the word TITLE, with no intervening blank, and specifies the level of the TITLE. The text of each *title* must be enclosed in single or double quotation marks. The maximum title length that is allowed depends on your operating environment and the value of the LINESIZE= system option. Refer to the SAS documentation for your operating environment for more information.

Learning More

PROC CHART and PROC UNIVARIATE
When you are preparing graphics presentations, some data lends itself to charts, whereas other data is better suited for plots. For a discussion about how to make a variety of charts, see Chapter 31, “Producing Charts to Summarize Variables,” on page 573.

PROC PLOT
You can also use PROC PLOT to create contour plots, to draw a reference line at a particular value on a plot, and to change the borders of the plot. For complete documentation, see *Base SAS Procedures Guide*.

SAS functions
SAS provides a wide array of numeric functions that include arithmetic and algebraic expressions, trigonometric and hyperbolic expressions, probability distributions, simple statistics, and random number generation. For complete documentation, see *SAS Functions and CALL Routines: Reference*.

31

Producing Charts to Summarize Variables

Introduction to Producing Charts to Summarize Variables

Purpose

Charts, like plots, provide a technique to summarize data graphically. You can use a chart to show the values of a single variable or several variables. A bar chart also enables you to graphically examine the distribution of the values of a variable.

In this section, you will learn how to create the following:

- vertical bar charts
- horizontal bar charts
- pie charts
- block charts
- high-resolution histograms and comparative histograms

The examples range in complexity from simple frequency bar charts to more complex charts that group variables and include summary statistics.

Prerequisites

To understand the examples in this section, you should be familiar with the following features and concepts:

- the LABEL statement
- the TITLE statement
- SAS system options
- creating and assigning SAS formats

Understanding the Charting Tools

Base SAS software provides two procedures that produce charts:

- PROC CHART
- PROC UNIVARIATE

PROC CHART produces a variety of charts for character or numeric variables. The charts include vertical and horizontal bar charts, block charts, pie charts, and star charts. These types of charts graphically display the values of a variable or a statistic that are associated with those values. PROC UNIVARIATE produces histograms for continuous numeric variables that enable you to visualize the distribution of your data.

PROC CHART is a useful tool to visualize data quickly. However, you can use PROC GCHART[1] to produce high-resolution, publication-quality bar charts that include color and various fonts when your site licenses SAS/GRAPH software. You can use PROC UNIVARIATE to customize the histograms by adding tables with summary statistics directly on the graphical display. PROC UNIVARIATE also enables you to overlay the histogram with fitted density curves or kernel density estimates so that you can examine the underlying distribution of your data.

Input File and SAS Data Set for Examples

The examples in this section use one input file and one SAS data set. For a complete listing of the input data, see "The YEAR_SALES Data Set" on page 854. The input file contains the enrollment and exam grades for an introductory chemistry course. The 50 students enrolled in the course attend several lectures, and a discussion section one day a week. The input file has the following structure:

```
Abdallah       F Mon  46 Anderson       M Wed  75
Aziz           F Wed  67 Bayer          M Wed  77
Bhatt          M Fri  79 Blair          F Fri  70
Bledsoe        F Mon  63 Boone          M Wed  58
Burke          F Mon  63 Chung          M Wed  85
Cohen          F Fri  89 Drew           F Mon  49
Dubos          M Mon  41 Elliott        F Wed  85
…more data lines…
Simonson       M Wed  62 Smith N        M Wed  71
Smith R        M Mon  79 Sullivan       M Fri  77
Swift          M Wed  63 Wolfson        F Fri  79
Wong           F Fri  89 Zabriski       M Fri  89
```

The input file contains the following values from left to right:

- the student's last name (and first initial if necessary)
- the student's gender (F or M)
- the day of the week for the student's discussion section (Mon, Wed, or Fri)
- the student's first exam grade

The following program creates the GRADES data set that this section uses. This example shows the first fifteen observations:

```
options pagesize=60 linesize=80 pageno=1 nodate;

data grades;
   infile 'your-input-file';
   input Name & $14. Gender : $2. Section : $3. ExamGrade1 @@;
run;
```

1. PROC GCHART and PROC CHART produce identical charts.

```
proc print data=grades;
   title 'Introductory Chemistry Exam Scores';
run;

options obs=15;
data grades;
   input Name &$14. Gender :$2. Section :$3. ExamGrade1 @@;
   datalines;
Abdallah       F Mon  46 Anderson       M Wed  75
Aziz           F Wed  67 Bayer          M Wed  77
Bhatt          M Fri  79 Blair          F Fri  70
Bledsoe        F Mon  63 Boone          M Wed  58
Burke          F Mon  63 Chung          M Wed  85
Cohen          F Fri  89 Drew           F Mon  49
Dubos L        M Mon  41 Elliott        F Wed  85
Farmer         F Wed  58 Franklin       F Wed  59
Freeman        F Mon  79 Friedman       M Mon  58
Gabriel        M Fri  75 Garcia         M Mon  79
Harding        M Mon  49 Hazelton       M Mon  55
Hinton         M Fri  85 Hung           F Fri  98
Jacob          F Wed  64 Janeway        F Wed  51
Jones          F Mon  39 Jorgensen      M Mon  63
Judson         F Fri  89 Kuhn           F Mon  89
LeBlanc        F Fri  70 Lee            M Fri  48
Litowski       M Fri  85 Malloy         M Wed  79
Meyer          F Fri  85 Nichols        M Mon  58
Oliver         F Mon  41 Park           F Mon  77
Patel          M Wed  73 Randleman      F Wed  46
Robinson       M Fri  64 Shien          M Wed  55
Simonson       M Wed  62 Smith N        M Wed  71
Smith R        M Mon  79 Sullivan       M Fri  77
Swift          M Wed  63 Wolfson        F Fri  79
Wong           F Fri  89 Zabriski       M Fri  89
;
```

Note: Most output in this section uses an OPTIONS statement that specifies PAGESIZE=40 and LINESIZE=80. Other examples use an OPTIONS statement with a different line size or page size to make a chart more readable. When the PAGESIZE= and LINESIZE= options are set, they remain in effect until you reset the options with another OPTIONS statement, or you end the SAS session.

The following output displays the first 15 observations.

Figure 31.1 *Introductory Chemistry Exam Scores*

Introductory Chemistry Exam Scores

Obs	Name	Gender	Section	ExamGrade1
1	Abdallah	F	Mon	46
2	Anderson	M	Wed	75
3	Aziz	F	Wed	67
4	Bayer	M	Wed	77
5	Bhatt	M	Fri	79
6	Blair	F	Fri	70
7	Bledsoe	F	Mon	63
8	Boone	M	Wed	58
9	Burke	F	Mon	63
10	Chung	M	Wed	85
11	Cohen	F	Fri	89
12	Drew	F	Mon	49
13	Dubos	M	Mon	41
14	Elliott	F	Wed	85
15	Farmer	F	Wed	58

You can create bar charts with this data set to do the following:

- Examine the distribution of grades.
- Determine a letter grade for each student.
- Compare the number of students in each section.
- Compare the number of males and females in each section.
- Compare the performance of the students in different sections.

Charting Frequencies with the CHART Procedure

Types of Frequency Charts

By default, PROC CHART creates a frequency chart in which each bar, section, or block in the chart represents a range of values. By default, PROC CHART selects ranges based on the values of the chart variable. At the center of each range is a midpoint. A midpoint does not always correspond to an actual value of the chart variable. The size of each bar, block, or section represents the number of observations that fall in that range.

PROC CHART makes several types of charts:

vertical and horizontal bar charts
: display the magnitude of data with the length or height of bars.

block charts
: display the relative magnitude of data with blocks of varying size.

pie charts
: display data as wedge-shaped sections of a circle that represent the relative contribution of each section to the whole circle.

star charts
: display data as bars that radiate from a center point, like spokes in a wheel.

The shape of each type of chart emphasizes a certain aspect of the data. The chart that you choose depends on the nature of your data and the aspect that you want to emphasize.

Creating Vertical Bar Charts

Understanding Vertical Bar Charts

A vertical bar chart emphasizes individual ranges. The horizontal, or midpoint, axis shows the values of the variable divided into ranges. By default, the vertical axis shows the frequency of values for a given range. The differences in bar heights enable you to quickly determine which ranges contain many observations and which contain few observations.

The VBAR statement in a PROC CHART step produces vertical bar charts. If you use the VBAR statement without any options, then PROC CHART automatically does the following:

- scales the vertical axis
- determines the bar width

- selects the spacing between bars
- labels the axes

For continuous numeric data, PROC CHART determines the number of bars and the midpoint for each bar from the minimum and maximum value of the chart variable. For character variables or discrete numeric variables, PROC CHART creates a bar for each value of the chart variable. However, you can change how PROC CHART determines the axes by using options.

Note: If the number of characters per line (LINESIZE=) is not sufficient to display vertical bars, then PROC CHART automatically produces a horizontal bar chart.

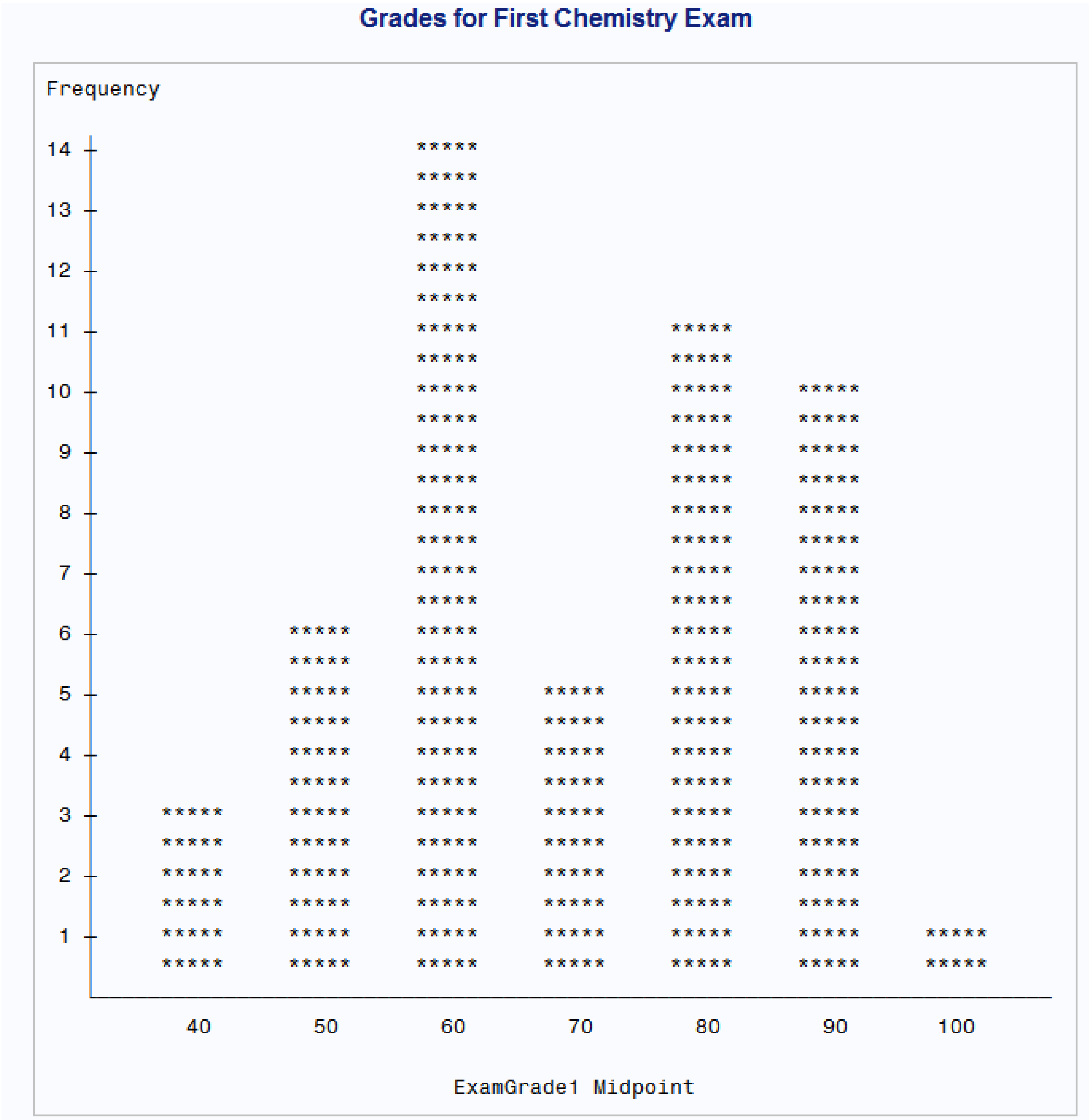
The Program

The following program uses the VBAR statement to create a vertical bar chart of frequencies for the numeric variable ExamGrade1:

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   vbar ExamGrade1;
   title 'Grades for First Chemistry Exam';
run;
```

The following output displays the bar chart.

Figure 31.2 *Using a Vertical Bar Chart to Show Frequencies*



The midpoint axis for the above chart ranges from 40 to 100 and is incremented in intervals of 10. The following table shows the values and frequency of each bar.

Table 31.1 *Values and Frequency*

Range	Midpoint	Frequency
35 to 44	40	3
45 to 54	50	6
55 to 64	60	14

Range	Midpoint	Frequency
65 to 74	70	5
75 to 84	80	11
85 to 94	90	10
95 to 104	10	1

Note: Because PROC CHART selects the size of the ranges and the location of their midpoints based on all values of the numeric variable, the highest and lowest ranges can extend beyond the values in the data. In this example the lowest grade is 39 while the lowest range extends from 35 to 44. Similarly, the highest grade is 98 while the highest range extends from 95 to 104.

Creating a Horizontal Bar Chart

Understanding Horizontal Bar Charts

A horizontal bar chart has essentially the same characteristics as a vertical bar chart. Both charts emphasize individual ranges. However, a horizontal bar chart rotates the bars so that the horizontal axis shows frequency and the vertical axis shows the values of the chart variable. To the right of the horizontal bars, PROC CHART displays a table of statistics that summarizes the data.

The HBAR statement in a PROC CHART step produces horizontal bar charts. By default, the table of statistics includes frequency, cumulative frequency, percentage, and cumulative percentage. You can request specific statistics so that the table contains only these statistics and the frequency.

Understanding HBAR Statistics

The default horizontal bar chart uses less space than charts of other shapes. PROC CHART takes advantage of the small size of horizontal bar charts and displays statistics to the right of the chart. The statistics included are described here:

Frequency
: is the number of observations in a given range.

Cumulative Frequency
: is the number of observations in all ranges up to and including a given range. The cumulative frequency for the last range is equal to the number of observations in the data set.

Percent
: is the percentage of observations in a given range.

Cumulative Percent
: is the percentage of observations in all ranges up to and including a given range. The cumulative percentage for the last range is always 100.

Various options enable you to control the statistics that appear in the table. You can select the statistics by using the following options: FREQ, CFREQ, PERCENT, and CPERCENT. To suppress the table of statistics, use the NOSTAT option.

The Programs

The following program uses the HBAR statement to create a horizontal bar chart of the frequency for the variable ExamGrade1:

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   hbar Examgrade1;
   title 'Grades for First Chemistry Exam';
run;
```

The following output displays the bar chart.

Figure 31.3 Using a Horizontal Bar Chart to Show Frequencies

Grades for First Chemistry Exam

```
 ExamGrade1                                    Cum.              Cum.
  Midpoint                               Freq  Freq  Percent  Percent
                |
        40      |******                     3     3     6.00     6.00
                |
        50      |************               6     9    12.00    18.00
                |
        60      |****************************   14    23    28.00    46.00
                |
        70      |**********                 5    28    10.00    56.00
                |
        80      |**********************    11    39    22.00    78.00
                |
        90      |********************      10    49    20.00    98.00
                |
       100      |**                         1    50     2.00   100.00
                |
                ----+---+---+---+---+---+---+
                    2   4   6   8  10  12  14

                         Frequency
```

The cumulative percent shows that the median grade for the exam (the grade that 50% of observations lie above and 50% below) lies within the midpoint of 70.

The next example produces the same horizontal bar chart as above, but the program uses the NOSTAT option to eliminate the table of statistics.

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   hbar Examgrade1 / nostat;
   title 'Grades for First Chemistry Exam';
run;
```

The following output displays the bar chart.

Figure 31.4 Removing Statistics from a Horizontal Bar Chart

Grades for First Chemistry Exam

```
ExamGrade1
 Midpoint
            |
     40     |************
            |
     50     |************************
            |
     60     |********************************************************
            |
     70     |********************
            |
     80     |********************************************
            |
     90     |****************************************
            |
    100     |****
            |
            ----+---+---+---+---+---+---+---+---+---+---+---+---+---+
                1   2   3   4   5   6   7   8   9  10  11  12  13  14

                                  Frequency
```

Creating Block Charts

Understanding Block Charts

A block chart shows the relative magnitude of data by using blocks of varying height. Each block in a square represents a category of data. A block chart is similar to a vertical bar chart. It uses a more sophisticated presentation of the data to emphasize the individual ranges. However, a block chart is less precise than a bar chart because the maximum height of a block is 10 lines.

The BLOCK statement in a PROC CHART step produces a block chart. You can also use the BLOCK statement to create three-dimensional frequency charts. For an example, see “Creating a Three-Dimensional Chart” on page 597. If you create block charts with a large number of charted values, then you might have to adjust the SAS system options LINESIZE= and PAGESIZE= so that the block chart fits on one page.

Note: If the line size or page size is not sufficient to display all the bars, then PROC CHART automatically produces a horizontal bar chart.

The Program

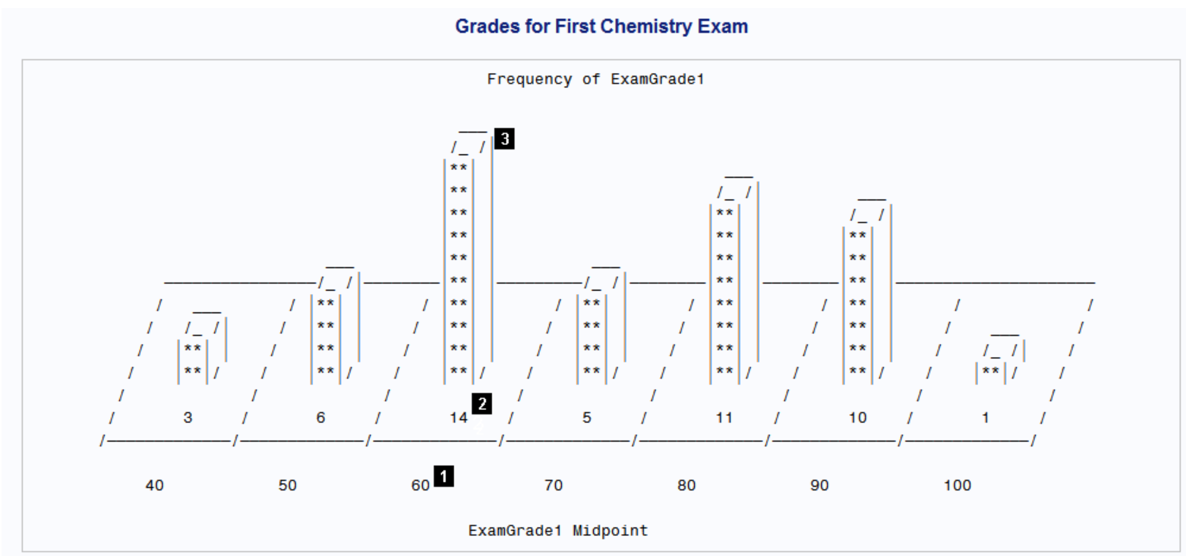
The following program uses the BLOCK statement to create a block frequency chart for the numeric variable ExamGrade1:

```
options linesize=120 pagesize=40 pageno=1 nodate;

proc chart data=grades;
   block Examgrade1;
   title 'Grades for First Chemistry Exam';
run;
```

The OPTIONS statement increases the line size to 120.

The following output displays the block chart.

Figure 31.5 Using a Block Chart to Show Frequencies



The chart shows the effects of using the BLOCK statement.

1. PROC CHART uses the same midpoints for both the bar chart and block chart. The midpoints appear beneath the chart.
2. The number of observations represented by each block appear beneath the block.
3. The height of a block is proportional to the number of observations in a block.

Creating Pie Charts

Understanding Pie Charts

A pie chart emphasizes the relative contribution of parts (a range of values) to the whole. Graphing the distribution of grades as a pie chart shows you the size of each range relative to the others just as the vertical bar chart does. However, the pie chart also enables you to visually compare the number of grades in a range to the total number of grades.

The PIE statement in a PROC CHART step produces a pie chart. PROC CHART determines the number of sections for the pie chart the same way it determines the number of bars for a vertical chart, with one exception: if any slices of the pie account for fewer than three print positions, then PROC CHART groups them into a category called “Other.”

PROC CHART displays the values of the midpoints around the perimeter of the pie chart. Inside each section of the chart, PROC CHART displays the number of observations in the range and the percentage of observations that the number represents.

The SAS system options LINESIZE= and PAGESIZE= determine the size of the pie. If your printer does not print 6 lines per inch and 10 columns per inch, then the pie looks elliptical. To make a circular pie chart, you must use the LPI= option in the PROC CHART statement. For more information, see the CHART procedure in the *Base SAS Procedures Guide*.

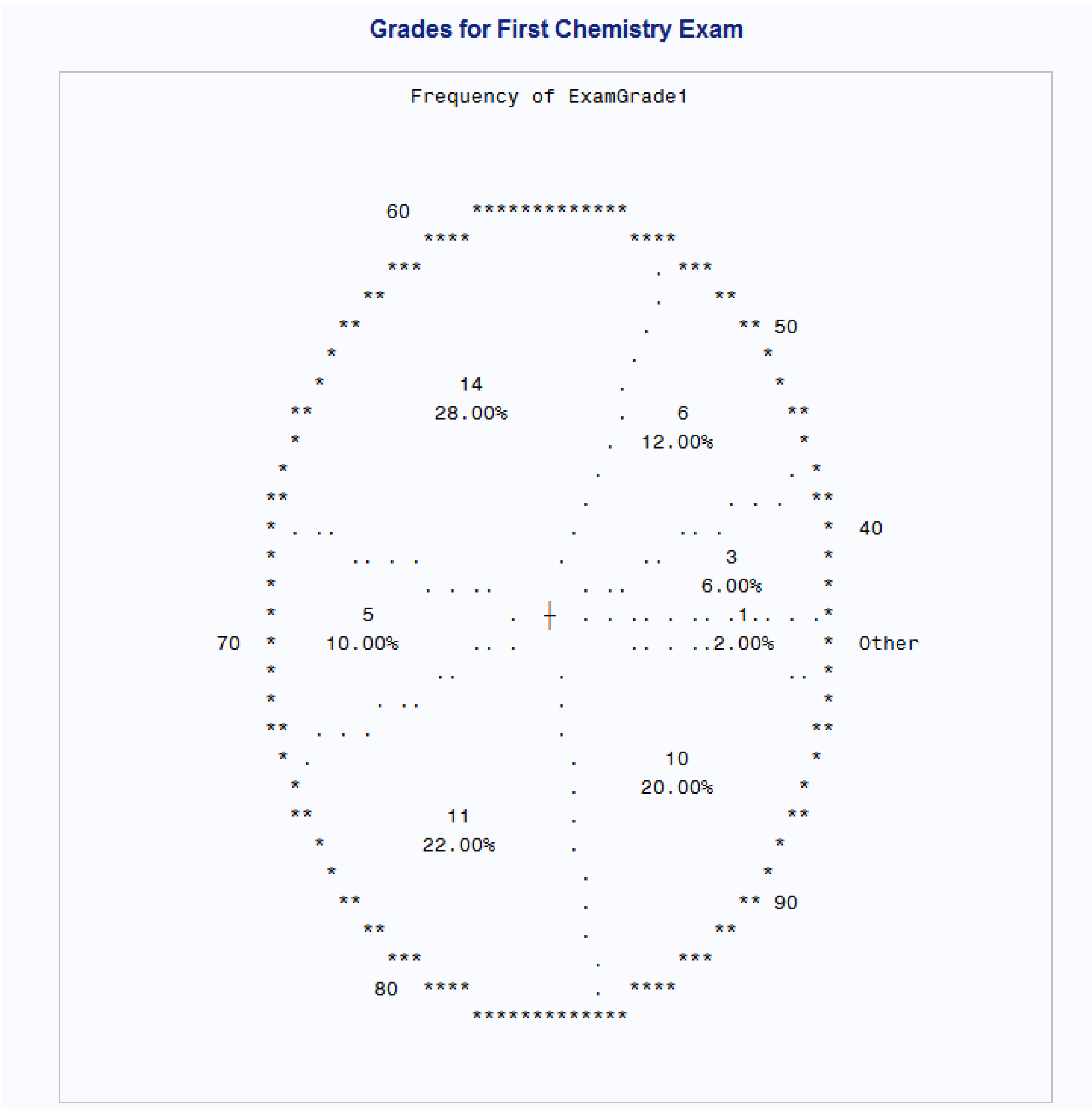
The Program

The following program uses the PIE statement to create a pie chart of frequencies for the numeric variable ExamGrade1:

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   pie ExamGrade1;
   title 'Grades for First Chemistry Exam';
run;
```

The following output displays the pie chart.

Figure 31.6 Using a Pie Chart to Show Frequencies



In this pie chart the `Other` section represents the one grade in the range with a midpoint of 100. The size of a section corresponds to the number of observations that fall in its range.

Customizing Frequency Charts

Changing the Number of Ranges

You can change the appearance of the charts in the following ways:

Table 31.2 Chart Appearance

Action	Option
Specify midpoints that define the range of values that each bar, block, or section represents	MIDPOINTS= option
Specify the number of bars on the chart and let PROC CHART compute the midpoints	LEVELS= option
Specify a variable that contains discrete numeric values. PROC CHART produces a bar chart with a bar for each distinct value	DISCRETE option

Note: Most examples in this section use vertical bar charts. However, unless documented otherwise, you can use any of the options in the PIE, BLOCK, or HBAR statements.

Specifying Midpoints for a Numeric Variable

You can specify midpoints for a continuous numeric variable by using the MIDPOINTS= option in the VBAR statement. The form of this option is shown here:

VBAR *variable* / MIDPOINTS=*midpoints-list*;

In the syntax above, *midpoints-list* is a list of the numbers to use as midpoints.

For example, to specify the traditional grading ranges with midpoints from 55 to 95, use the following option:

```
midpoints=55 65 75 85 95
```

Or, you can abbreviate the list of midpoints:

```
midpoints=55 to 95 by 10
```

The corresponding ranges are as follows:

```
50 to 59
60 to 69
```

```
70 to 79
80 to 89
90 to 99
```

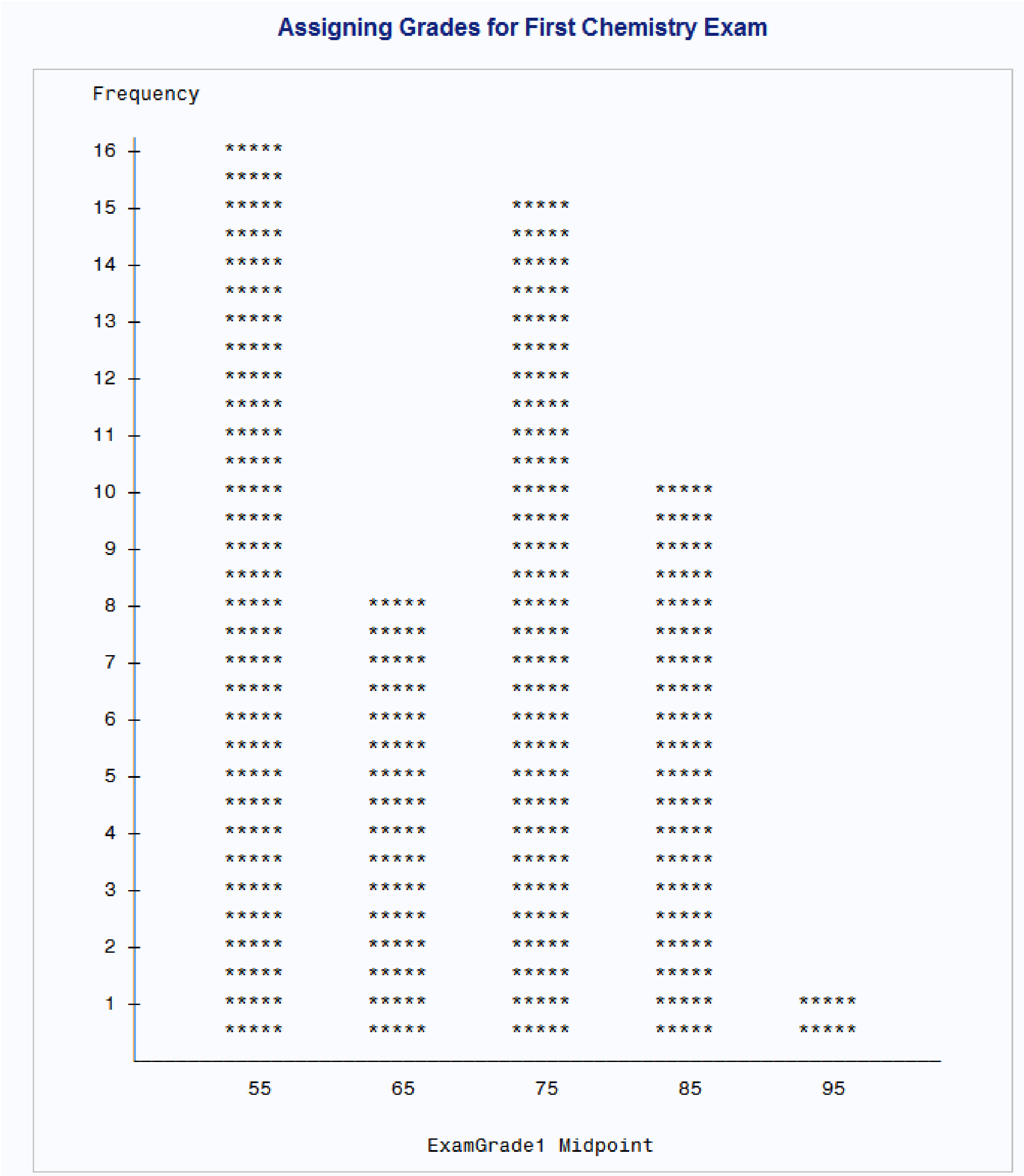
The following program uses the MIDPOINTS= option to create a bar chart for ExamGrade1:

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   vbar Examgrade1 / midpoints=55 to 95 by 10;
   title 'Assigning Grades for First Chemistry Exam';
run;
```

The MIDPOINTS= option forces PROC CHART to center the five bars around the traditional midpoints for exam grades.

The following output displays the bar chart.

Figure 31.7 Specifying the Midpoints for a Vertical Bar Chart



A traditional method to assign grades assumes that the data is normally distributed. However, the bars do not appear as a normal (bell-shaped) curve. If grades are assigned based on these midpoints and the traditional pass or fail boundary of 60, then a substantial portion of the class fails the exam because more observations fall in the bar around the midpoint of 55 than in any other bar.

Specifying the Number of Midpoints in a Chart

You can specify the number of midpoints in the chart rather than the values of the midpoints by using the LEVELS= option. The procedure selects the midpoints.

The form of the option is shown here.

VBAR *variable* / LEVELS=*number-of-midpoints*;

In this syntax, *number-of-midpoints* specifies the number of midpoints.

The following program uses the LEVELS= option to create a bar chart with five bars: [1]

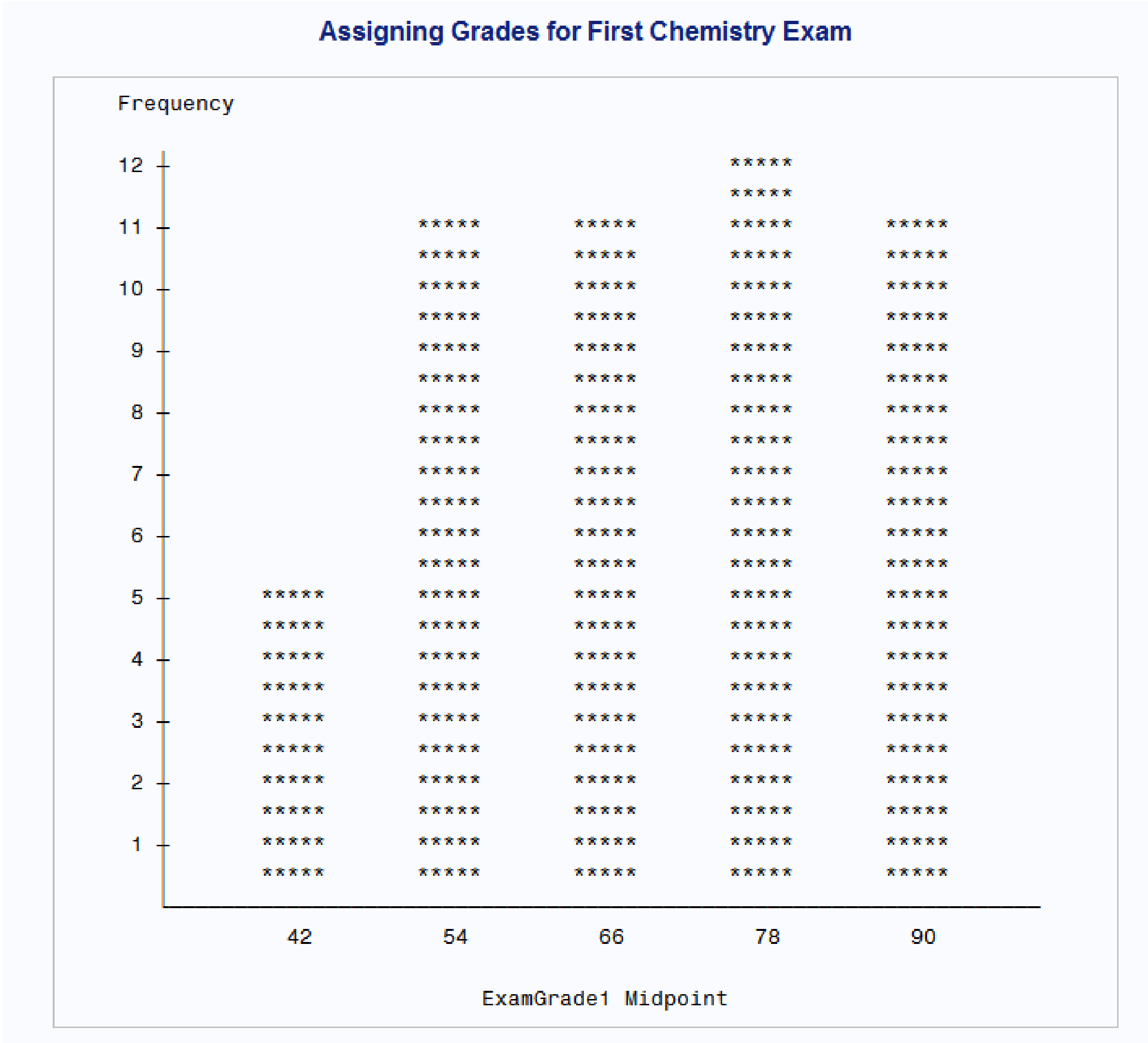
```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   vbar Examgrade1 / levels=5;
   title 'Assigning Grades for First Chemistry Exam';
run;
```

The LEVELS= option forces PROC CHART to compute only five midpoints.

The following output displays the bar chart.

1. You can use SAS to normalize the data before the chart is created.

Figure 31.8 Specifying Five Midpoints for a Vertical Bar



Assigning grades for these midpoints results in three students with exam grades in the lowest range.

Charting Every Value

By default, PROC CHART assumes that all numeric variables are continuous and automatically chooses intervals for them unless you use MIDPOINTS= or LEVELS=. You can specify that a numeric variable is discrete rather than continuous by using the DISCRETE option. PROC CHART creates a frequency chart with bars for each distinct value of the discrete numeric variable.

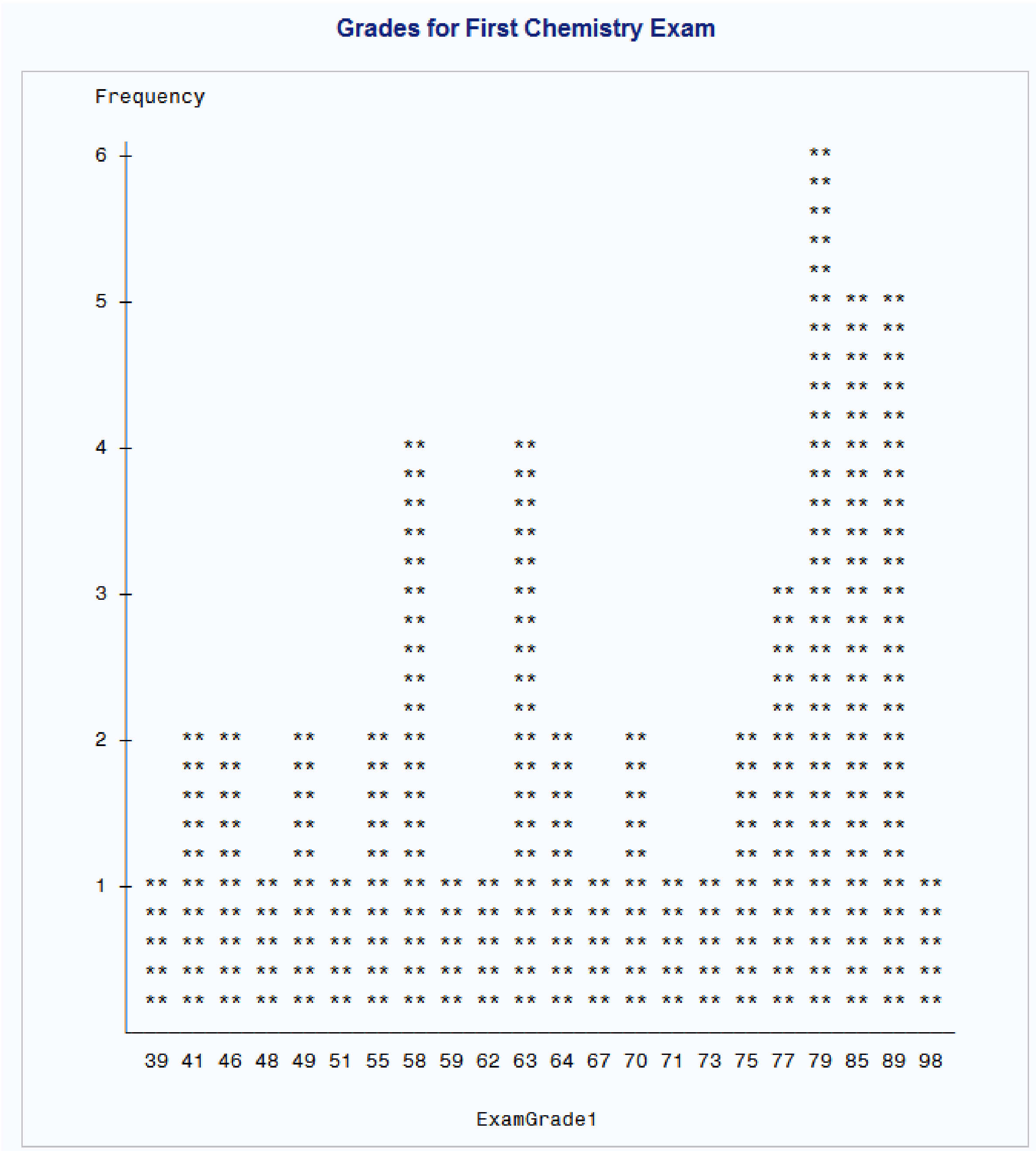
The following program uses the DISCRETE option to create a bar chart with a bar for each value of ExamGrade1:

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   vbar Examgrade1 / discrete;
```

```
      title 'Grades for First Chemistry Exam';
   run;
```

The following output displays the bar chart.

Figure 31.9 *Specifying a Bar for Each Exam Grade*



The chart shows that in most cases only one or two students earned a given grade. However, clusters of three or more students earned grades of 58, 63, 77, 79, 85, and 89. The mode for this exam (most frequently earned exam grade) is 79.

Note: PROC CHART does not proportionally space the values of a discrete numeric variable on the horizontal axis.

Charting the Frequency of a Character Variable

Overview

You can create charts of a character variable as well as a numeric variable. For example, to compare enrollment among sections, PROC CHART creates a chart that shows the number of students in each section.

Creating a frequency chart of a character variable is the same as creating a frequency chart of a numeric variable. However, the main difference between charting a numeric variable and charting a character variable is how PROC CHART selects the midpoints. By default, PROC CHART uses each value of a character variable as a midpoint, as if the DISCRETE option were in effect. You can limit the selection of midpoints to a subset of the variable's values. If you do not define a format for the chart variable, then a single bar, block, or section represents a single value of the variable.

Specifying Midpoints for a Character Variable

By default, the midpoints that PROC CHART uses for character variables are in alphabetical order. However, you can easily rearrange the order of the midpoints with the MIDPOINTS= option. When you use the MIDPOINTS= option for character variables, you must enclose the value of each midpoint in single or double quotation marks. Also, the values must correspond to values in the data set. For example, consider this code fragment:

```
midpoints='Mon' 'Wed' 'Fri'
```

This code uses the three days the class sections meet as midpoints.

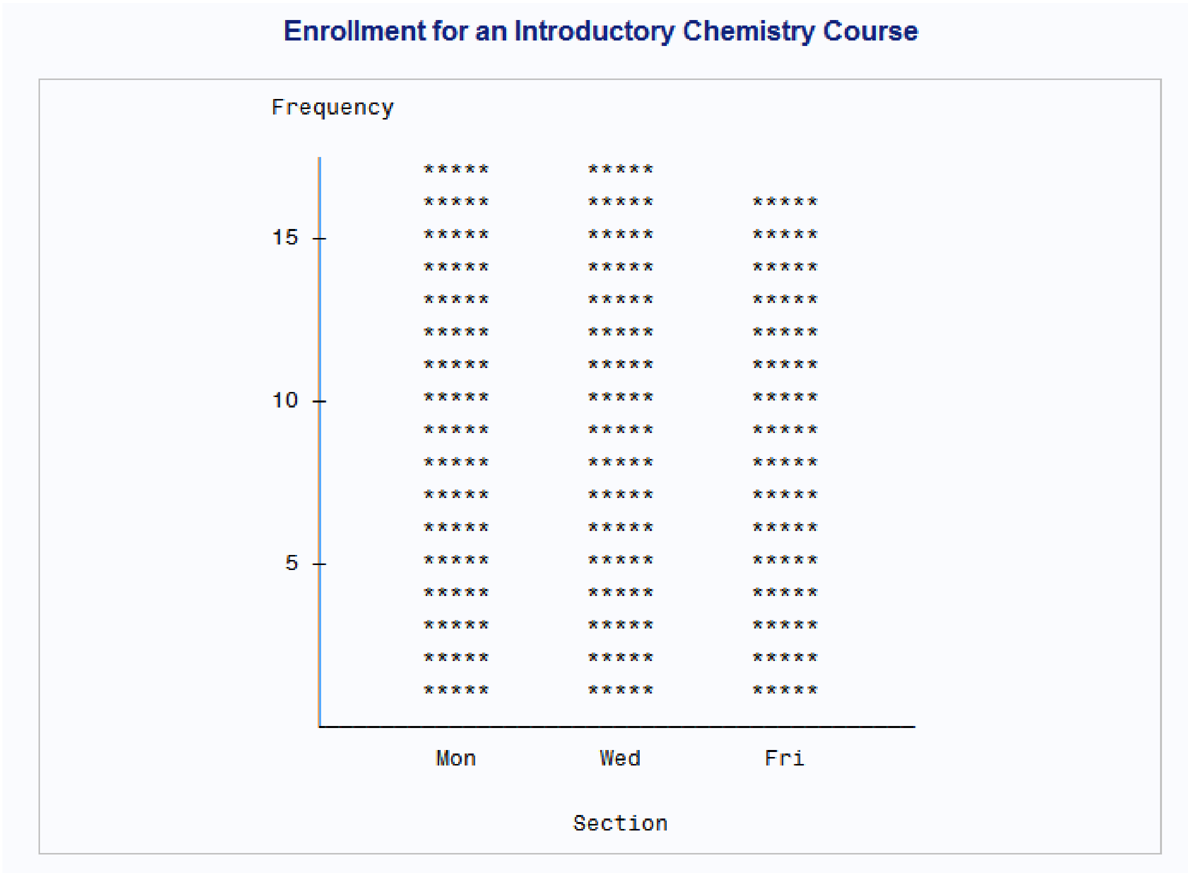
The following program uses the MIDPOINTS= option to create a bar chart that shows the number of students enrolled in each section:

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   vbar Section / midpoints='Mon' 'Wed' 'Fri';
   title 'Enrollment for an Introductory Chemistry Course';
run;
```

The MIDPOINTS= option alters the chart so that the days of the week appear in chronological rather than alphabetical order.

The following output displays the bar chart.

Figure 31.10 Ordering Character Midpoints Chronologically



The chart shows that the Monday and Wednesday sections have the same number of students; the Friday section has one less student.

Creating Subgroups within a Range

You can show how a subgroup contributes to each bar or block by using the SUBGROUP= option in the BLOCK statement, HBAR statement, or VBAR statement. For example, you can use the SUBGROUP= option to explore patterns within a population (gender differences).

The SUBGROUP= option defines a variable called the subgroup variable. PROC CHART uses the first character of each value to fill in the portion of the bar or block that corresponds to that value, unless more than one value begins with the same first character. In that case, PROC CHART uses the letters A, B, C, and so on, to fill in the bars or blocks.

If you assign a format to the variable, then PROC CHART uses the first character of the formatted value. The characters that PROC CHART uses in the chart and the values that they represent are shown in a legend at the bottom of the chart.

PROC CHART orders the subgroup symbols as A through Z, and as 0 through 9, with the characters in ascending order. PROC CHART calculates the height of a bar or block for each subgroup individually and rounds the percentage of the total bar up or down. So the total height of the bar might be greater or less than the height of the same bar without the SUBGROUP= option.

The following program uses GENDER as the subgroup variable to show how many members in each section are male and female:

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   vbar Section / midpoints='Mon' 'Wed' 'Fri'
                  subgroup=Gender;
   title 'Enrollment for an Introductory Chemistry Course';
run;
```

The following output displays the bar chart.

Figure 31.11 *Using Gender to Form Subgroups*

Enrollment for an Introductory Chemistry Course

```
 Frequency

     |       MMMMM       MMMMM
     |       MMMMM       MMMMM       MMMMM
  15 +       MMMMM       MMMMM       MMMMM
     |       MMMMM       MMMMM       MMMMM
     |       MMMMM       MMMMM       MMMMM
     |       MMMMM       MMMMM       MMMMM
     |       MMMMM       MMMMM       MMMMM
  10 +       MMMMM       MMMMM       MMMMM
     |       FFFFF       MMMMM       MMMMM
     |       FFFFF       MMMMM       FFFFF
     |       FFFFF       FFFFF       FFFFF
     |       FFFFF       FFFFF       FFFFF
   5 +       FFFFF       FFFFF       FFFFF
     |       FFFFF       FFFFF       FFFFF
     |       FFFFF       FFFFF       FFFFF
     |       FFFFF       FFFFF       FFFFF
     |       FFFFF       FFFFF       FFFFF
     -------------------------------------------
              Mon         Wed         Fri

                        Section


     Symbol Gender     Symbol Gender

       F     F           M     M
```

PROC CHART fills each bar in the chart with the characters that represent the value of the variable GENDER. The portion of the bar that is filled with Fs represents the number of observations that correspond to females; the portion that is filled with Ms represents the number of observations that correspond to males. Because the value of Gender contains a single character (F or M), the symbol that PROC CHART uses as the fill character is identical to the value of the variable.

Charting Mean Values

PROC CHART enables you to specify what the bars or sections in the chart represent. By default, each bar, block, or section represents the frequency of the chart variable. You can also identify a variable whose values determine the sizes of the bars, blocks, or sections in the chart.

You define a variable called the sumvar variable by using the SUMVAR= option. With the SUMVAR= option, you can also use the TYPE= option to specify whether the sum of the Sumvar variable or the mean of the Sumvar variable determines the size of the bars or sections. Here are the available types:

SUM
: sums the values of the Sumvar variable in each range. Then PROC CHART uses the sums to determine the size of each bar, block, or section. SUM is the default type.

MEAN
: determines the mean value of the Sumvar variable in each range. Then PROC CHART uses the means to determine the size of each bar, block, or section.

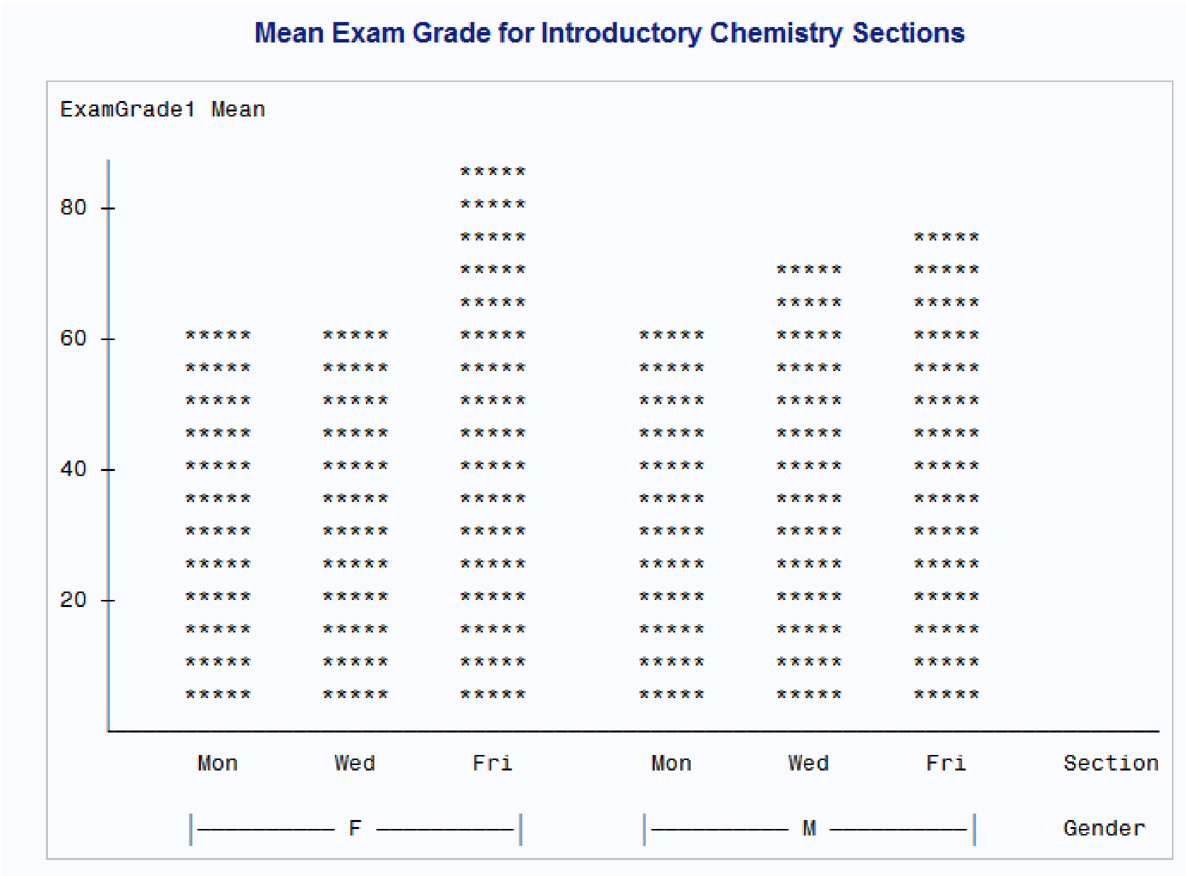
The following program creates a bar chart grouped by gender to compare the mean value of all grades in each section:

```
options pagesize=40 linesize=80 pageno=1 nodate;

proc chart data=grades;
   vbar Section / midpoints='Mon' 'Wed' 'Fri' group=Gender
                  sumvar=Examgrade1 type=mean;
   title 'Mean Exam Grade for Introductory Chemistry Sections';
run;
```

The SUMVAR= option specifies that the values of ExamGrade1 determine the size of the bars. The TYPE=MEAN option specifies to compare the mean grade for each group.

The following output displays the bar chart.

Figure 31.12 *Using the SUMVAR= Option to Compare Mean Values*



The chart shows that the females in the Friday section achieved the highest mean grade, followed by the males in the same section.

Creating a Three-Dimensional Chart

Complicated relationships such as the ones charted with the GROUP= option might be easier to understand if you present them as three-dimensional block charts. The following program uses the BLOCK statement to create a block chart for the numeric variable ExamGrade1:

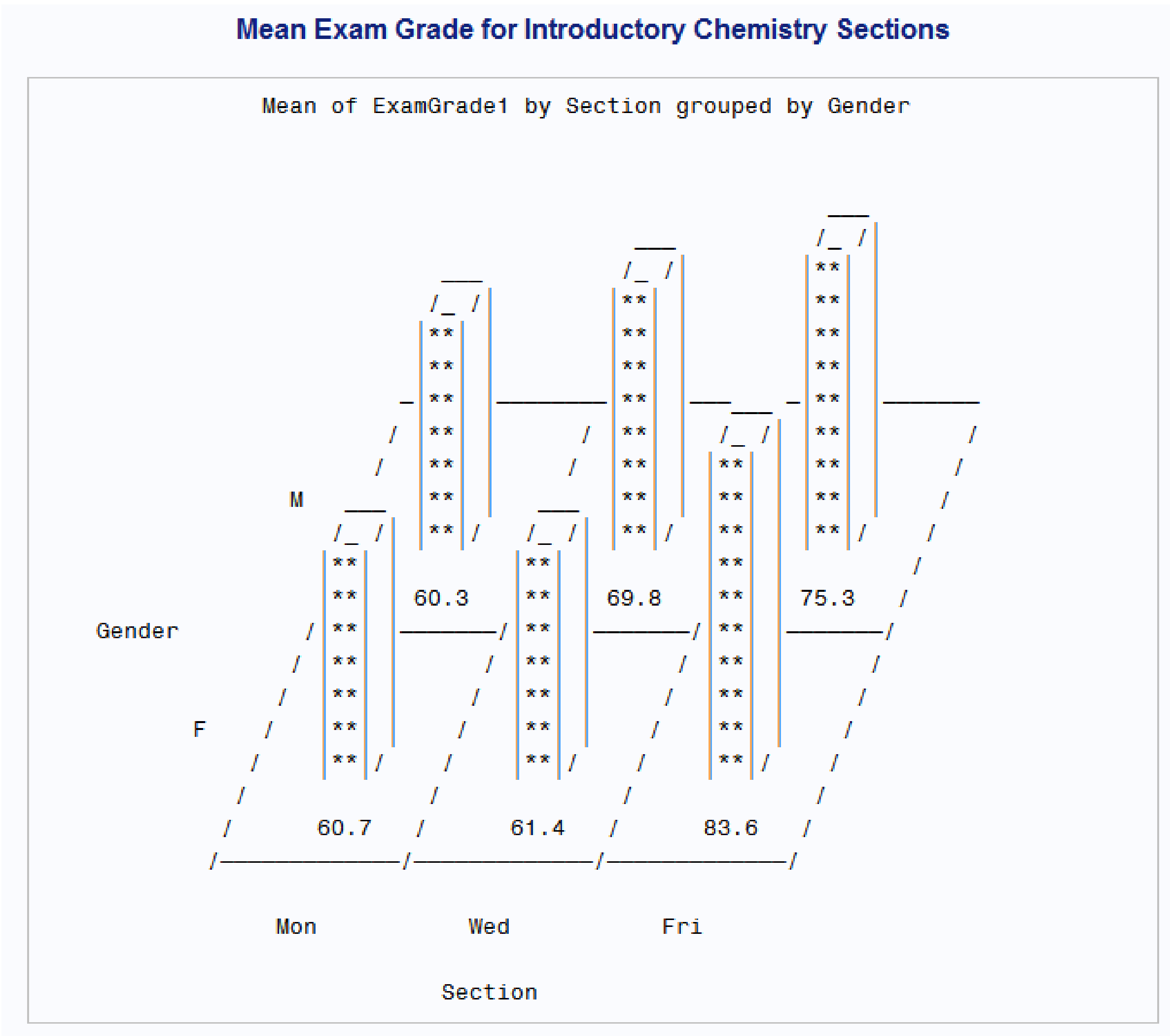
```
options linesize=120 pagesize=40 pageno=1 nodate;
proc chart data=grades;
   block Section / midpoints='Mon' 'Wed' 'Fri'
                   sumvar=Examgrade1 type=mean
                   group=Gender;
   format Examgrade1 4.1;
   title 'Mean Exam Grade for Introductory Chemistry Sections';
run;
```

The FORMAT statement specifies the number of decimals that PROC CHART uses to report the mean value of ExamGrade1 beneath each block.

Note: If the line size or page size is not sufficient to display all the bars, then PROC CHART produces a horizontal bar chart.

The following output displays the block chart.

Figure 31.13 Using a Block Chart to Compare Group Means



The value that is shown beneath each block is the mean of ExamGrade1 for that combination of Section and Gender. You can easily see that both females and males in the Friday section earned higher grades than their counterparts in the other sections.

Creating High-Resolution Histograms

Understanding How to Use the HISTOGRAM Statement

A histogram is similar to a vertical bar chart. This type of bar chart emphasizes the individual ranges of continuous numeric variables and enables you to examine the distribution of your data.

The HISTOGRAM statement in a PROC UNIVARIATE step produces histograms and comparative histograms. PROC UNIVARIATE creates a histogram by dividing the data into intervals of equal length, counting the number of observations in each interval, and plotting the counts as vertical bars that are centered around the midpoint of each interval.

If you use the HISTOGRAM statement without any options, then PROC UNIVARIATE automatically does the following:

- scales the vertical axis to show the percentage of observations in an interval
- determines the bar width based on the method of Terrell and Scott (1985)
- labels the axes

The HISTOGRAM statement provides various options that enable you to control the layout of the histogram and enhance the graph. You can also fit families of density curves and superimpose kernel density estimates on the histograms, which can be useful in examining the data distribution. For additional information about the density curves that SAS computes, see the UNIVARIATE procedure in the *Base SAS Procedures Guide*.

Understanding How to Use SAS/GRAPH to Create Histograms

If your site licenses SAS/GRAPH software, then you can use the HISTOGRAM statement to create high-resolution graphs. When you create charts with a graphics device, you can also use the AXIS, LEGEND, PATTERN, and SYMBOL statements to enhance your plots.

To control the appearance of a high-resolution graph, you can specify a GOPTIONS statement before the PROC step that creates the graph. The GOPTIONS statement changes the values of the graphics options that SAS uses when graphics output is created. Graphics options affect the characteristics of a graph, such as size, colors, type fonts, fill patterns, and line thickness. In addition, they affect the settings of device parameters such as the appearance of the display, the type of output that is produced, and the destination of the output.

Most of the examples in this section use the following GOPTIONS statement:

```
goptions reset=global
         gunit=pct
```

```
hsize= 5.625 in
vsize= 3.5 in
htitle=4
htext=3
vorigin=0 in
horigin= 0 in
cback=white border
ctext=black
colors=(black blue green red yellow)
ftext=swiss
lfactor=3;
```

For additional information about how to modify the appearance of your graphics output, see *SAS/GRAPH: Reference*.

Creating a Simple Histogram

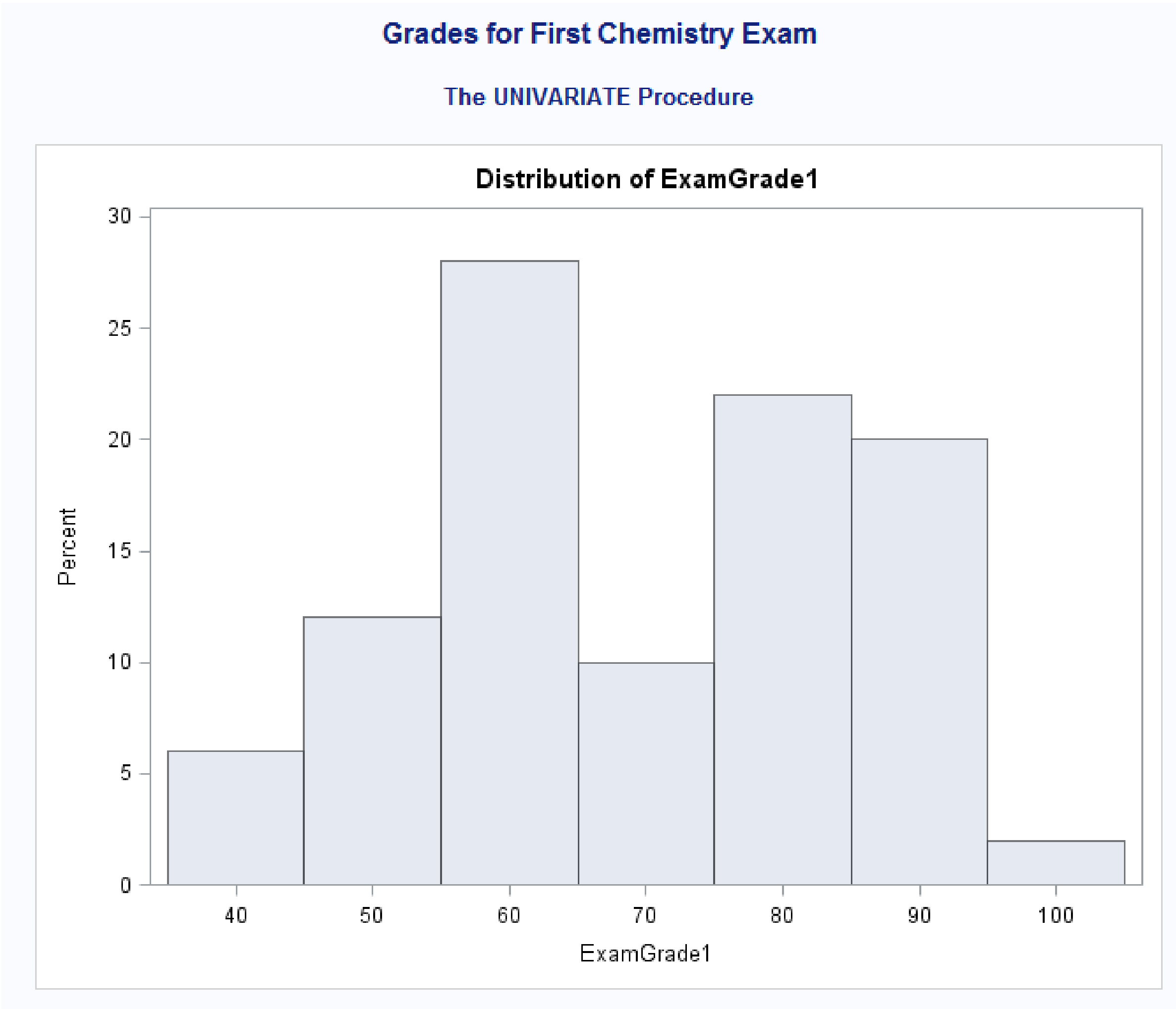
The following program uses the HISTOGRAM statement to create a histogram for the numeric variable ExamGrade1:

```
proc univariate data=grades noprint;
   histogram ExamGrade1;
   title 'Grades for First Chemistry Exam';
run;
```

The NOPRINT option suppresses the tables of statistics that the PROC UNIVARIATE statement creates.

The following figure displays the histogram.

Figure 31.14 Using a Histogram to Show Percentages



The midpoint axis for the above histogram goes from 40 to 100 and is incremented in intervals of 10. The following table shows the values.

Table 31.3 Histogram Values

Interval	Midpoint
35 to 44	40
45 to 54	50
55 to 64	60
65 to 74	70
75 to 84	80
85 to 94	90

Interval	Midpoint
95 to 104	10

Note: Because PROC UNIVARIATE selects the size of the intervals and the location of their midpoints based on all values of the numeric variable, the highest and lowest intervals can extend beyond the values in the data. In this example the lowest grade is 39 while the lowest interval extends from 35 to 44. Similarly, the highest grade is 98 while the highest interval extends from 95 to 104.

Changing the Axes of a Histogram

Enhancing the Vertical Axis

The exact value of a histogram bar is sometimes difficult to determine. By default, PROC UNIVARIATE does not provide minor tick marks between the vertical axis values (major tick marks). You can specify the number of minor tick marks between major tick marks with the VMINOR= option.

To make it easier to see the location of major tick marks, you can use the GRID option to add grid lines on the histogram. Grid lines are horizontal lines that are positioned at major tick marks on the vertical axis. PROC UNIVARIATE provides two options to change the appearance of the grid line:

CGRID=	sets the color of the grid lines.
LGRID=	sets the line type of the grid lines.

By default, PROC UNIVARIATE draws a solid line using the first color in the device color list. For a list of the available line types, see *SAS/GRAPH: Reference*.

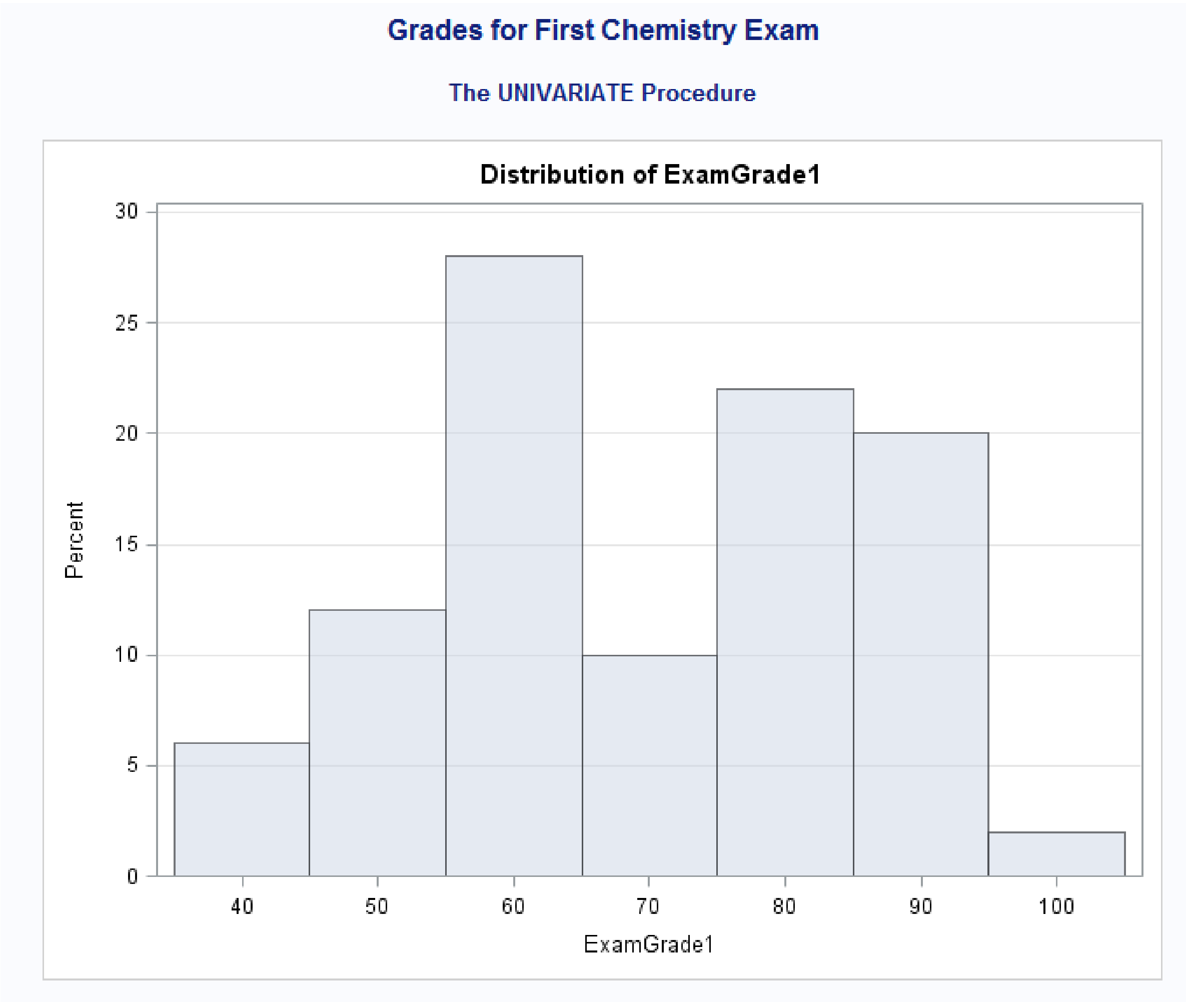
The following program creates a histogram that shows minor tick marks and grid lines for the numeric variable ExamGrade1:

```
proc univariate data=grades noprint;
   histogram Examgrade1 / vminor=4 grid lgrid=34;
   title 'Grades for First Chemistry Exam';
run;
```

Four minor tick marks are inserted between each major tick mark. Closely spaced dots are used to draw the grid lines.

The following figure displays the histogram.

Figure 31.15 *Specifying Grid Lines for a Histogram*



Now, the height of each histogram bar is easily determined from the chart. The following table shows the percentage each interval represents.

Table 31.4 *Percentage of Each Interval*

Interval	Percent
35 to 44	6
45 to 54	12
55 to 64	28
65 to 74	10
75 to 84	22
85 to 94	20

Interval	Percent
95 to 104	2

Specifying the Vertical Axis Values

PROC UNIVARIATE enables you to specify what the bars in the histogram represent, and the values of the vertical axis. By default, each bar represents the percentage of observations that fall into the given interval.

The VSCALE= option enables you to specify the following scales for the vertical axis:

- COUNT
- PERCENT
- PROPORTION

The VAXIS= option enables you to specify evenly spaced tick mark values for the vertical axis. The form of this option is shown here:

HISTOGRAM *variable* / VAXIS=*value-list*;

In this syntax, *value-list* is a list of numbers to use as major tick mark values. The first value is always equal to zero and the last value is always greater than or equal to the height of the largest bar.

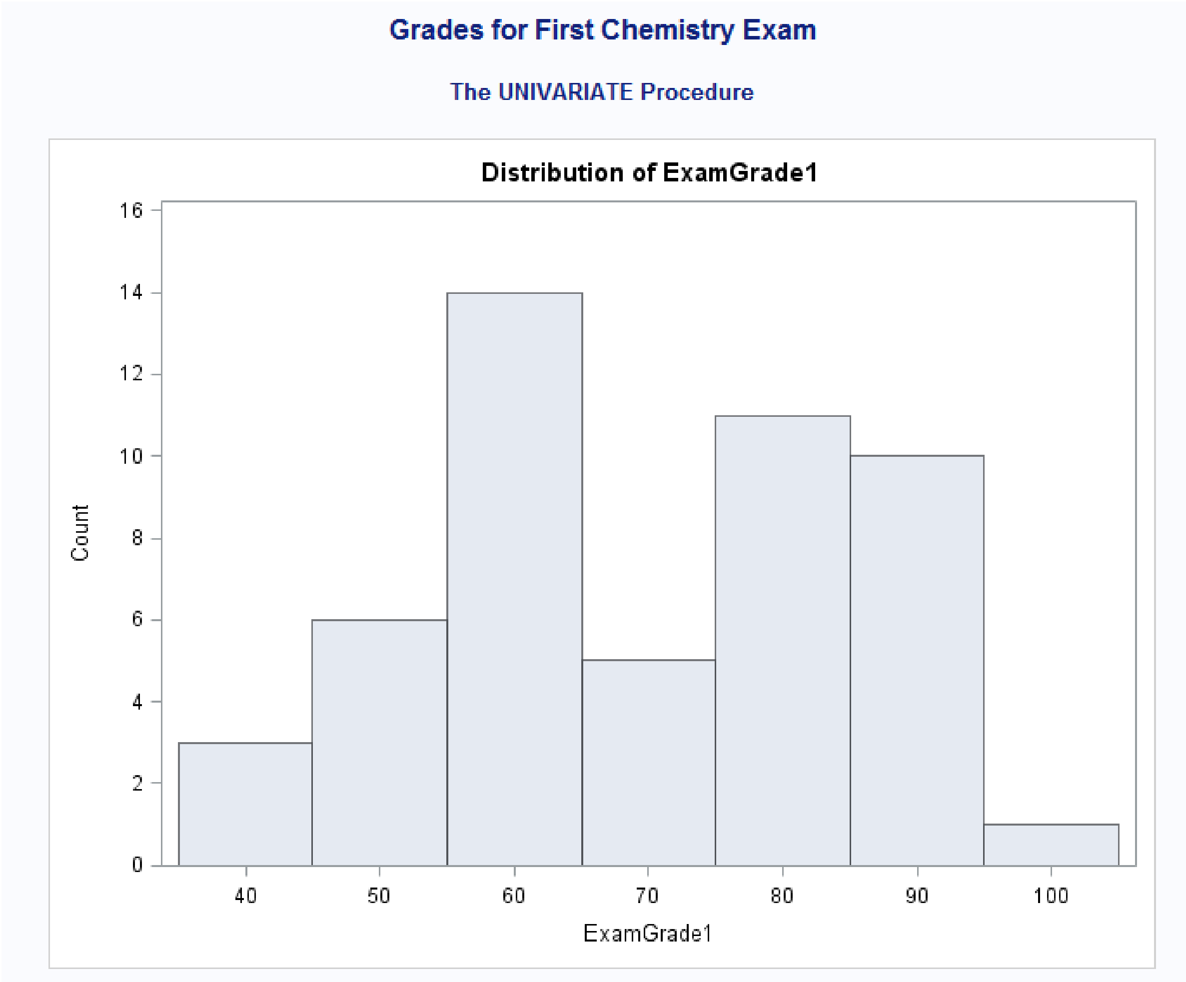
The following program creates a histogram that shows counts on the vertical axis for the numeric variable ExamGrade1:

```
proc univariate data=grades noprint;
   histogram Examgrade1 / vscale=count vaxis=0 to 16 by 2 vminor=1;
   title 'Grades for First Chemistry Exam';
run;
```

The values of the vertical axis range from 0 to 16 in increments of two. One minor tick mark is inserted between each major tick mark.

The following figure displays the histogram.

Figure 31.16 *Using a Histogram to Show Counts*



Specifying the Midpoints of a Histogram

You can control the width of the histogram bars by using the MIDPOINTS= option. PROC UNIVARIATE uses the value of the midpoints to determine the width of the histogram bars. The difference between consecutive midpoints is the bar width.

To specify midpoints, use the MIDPOINTS= option in the HISTOGRAM statement. The form of the MIDPOINTS= option is shown here:

HISTOGRAM *variable* / MIDPOINTS=*midpoint-list*;

In this syntax, *midpoint-list* is a list of numbers to use as midpoints. You must use evenly spaced midpoints that are listed in increasing order.

For example, to specify the traditional grading ranges with midpoints from 55 to 95, use the following option:

```
midpoints=55 65 75 85 95
```

Or, you can abbreviate this list of midpoints:

```
midpoints=55 to 95 by 10
```

The following program uses the MIDPOINTS= option to create a histogram for the numeric variable ExamGrade1:

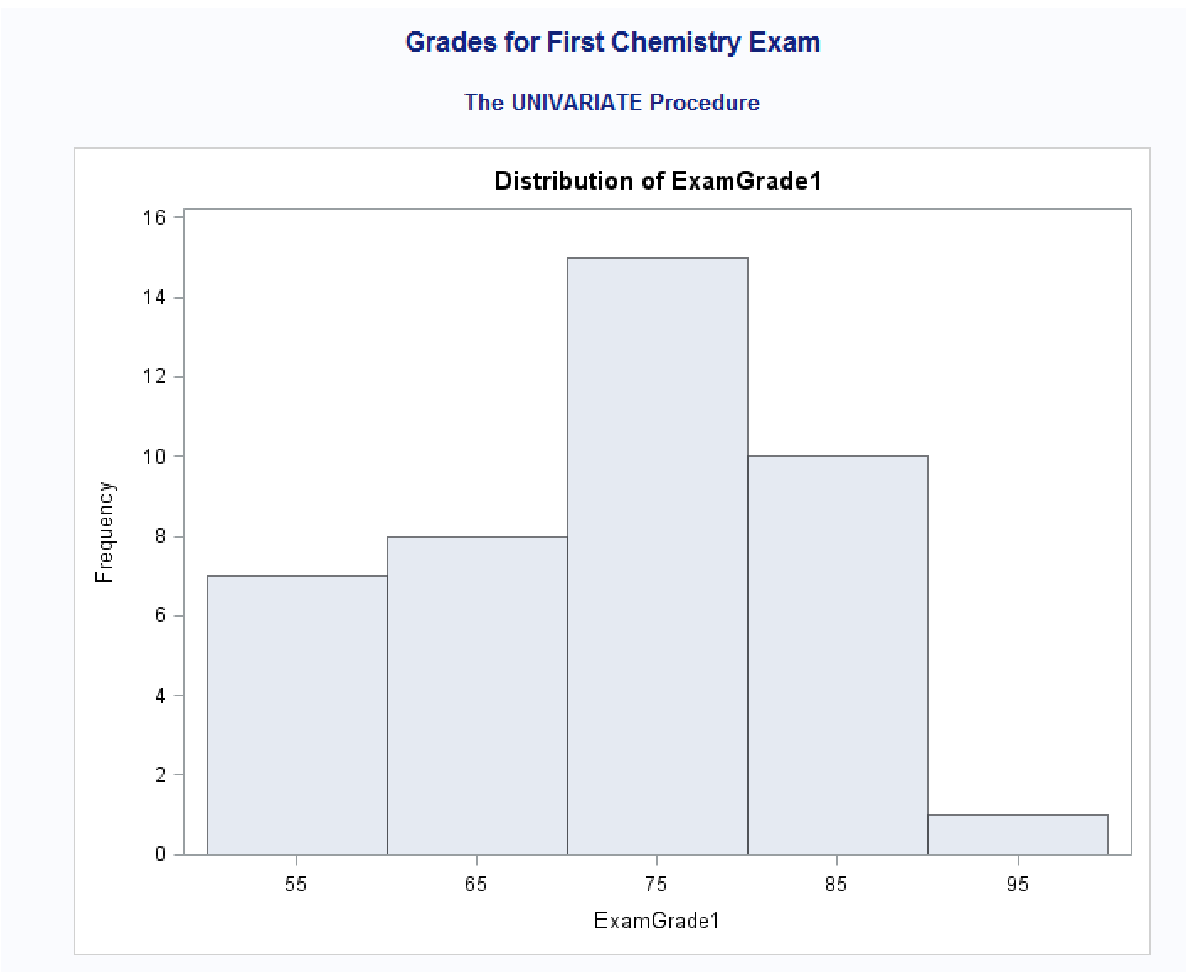
```
proc univariate data=grades
   (where=(examgrade1 ge 55 and examgrade1 le 100 )) noprint;
   histogram Examgrade1 / vscale=count vaxis=0 to 16 by 2 vminor=1
                          midpoints=55 65 75 85 95 hoffset=10
                          vaxislabel='Frequency';
   title 'Grades for First Chemistry Exam';
run;
```

The following list corresponds to the items in the preceding program:

- The MIDPOINTS= option forces PROC UNIVARIATE to center the five bars around the traditional midpoints for exam grades.
- The HOFFSET= option uses a 10% offset at both ends of the horizontal axis.
- The VAXISLABEL= option uses Frequency as the label for the vertical axis. The default label is Count.

The following figure displays the histogram.

Figure 31.17 *Specifying Five Midpoints for a Histogram*



The midpoint axis for the above histogram goes from 55 to 95 and is incremented in intervals of 10. The histogram excludes any exam scores that are below 50.

Displaying Summary Statistics in a Histogram

Understanding How to Use the INSET Statement

PROC UNIVARIATE enables you to add a box or table of summary statistics, called an inset, directly in the histogram. Typically, an inset shows statistics that PROC UNIVARIATE has calculated, but an inset can also display values that you provide in a SAS data set.

To add a table of summary statistics, use the INSET statement. You can use multiple INSET statements in the UNIVARIATE procedure to add more than one table to a histogram. The INSET statements must follow the HISTOGRAM statement that creates the plot that you want augmented. The inset appears in all the graphs that the preceding HISTOGRAM statement produces.

The form of the INSET statement is as follows:

INSET *<keyword(s)> </ options>*

You specify the keywords for inset statistics (such as N, MIN, MAX, MEAN, and STD) immediately after the word INSET. You can also specify the keyword DATA= followed by the name of a SAS data set to display customized statistics that are stored in a SAS data set. The statistics appear in the order in which you specify the keywords.

By default, PROC UNIVARIATE uses appropriate labels and appropriate formats to display the statistics in the inset. To customize a label, specify the keyword followed by an equal sign (=) and the desired label in quotation marks. To customize the format, specify a numeric format in parentheses after the keyword. You can assign labels that are up to 24 characters. If you specify both a label and a format for a keyword, then the label must appear before the format. Here is a code example:

```
inset n='Sample Size' std='Std Dev' (5.2);
```

This code requests customized labels for two statistics (sample size and standard deviation). The standard deviation is also assigned a format that has a field width of five and includes two decimal places.

Various options enable you to customize the appearance of the inset. For example, you can do the following:

- Specify the position of the inset.
- Specify a heading for the inset table.
- Specify graphical enhancements, such as background colors, text colors, text height, text font, and drop shadows.

For a complete list of the keywords and the options that you can use in the INSET statement, see the *Base SAS Procedures Guide*.

The Program

The following program uses the INSET statement to add summary statistics for the numeric variable ExamGrade1 to the histogram:

```
proc univariate data=grades noprint;
   histogram Examgrade1 /vscale=count vaxis=0 to 16 by 2 vminor=1 hoffset=10
```

```
                                  midpoints=55 65 75 85 95 vaxislabel='Frequency';
   inset n='No. Students' mean='Mean Grade' min='Lowest Grade' 1
         max='Highest Grade' / header='Summary Statistics' position=ne 2 3
                                 format=3. 4 ;
   title 'Grade Distribution for the First Chemistry Exam';
run;
```

The following list corresponds to the numbered items in the preceding program:

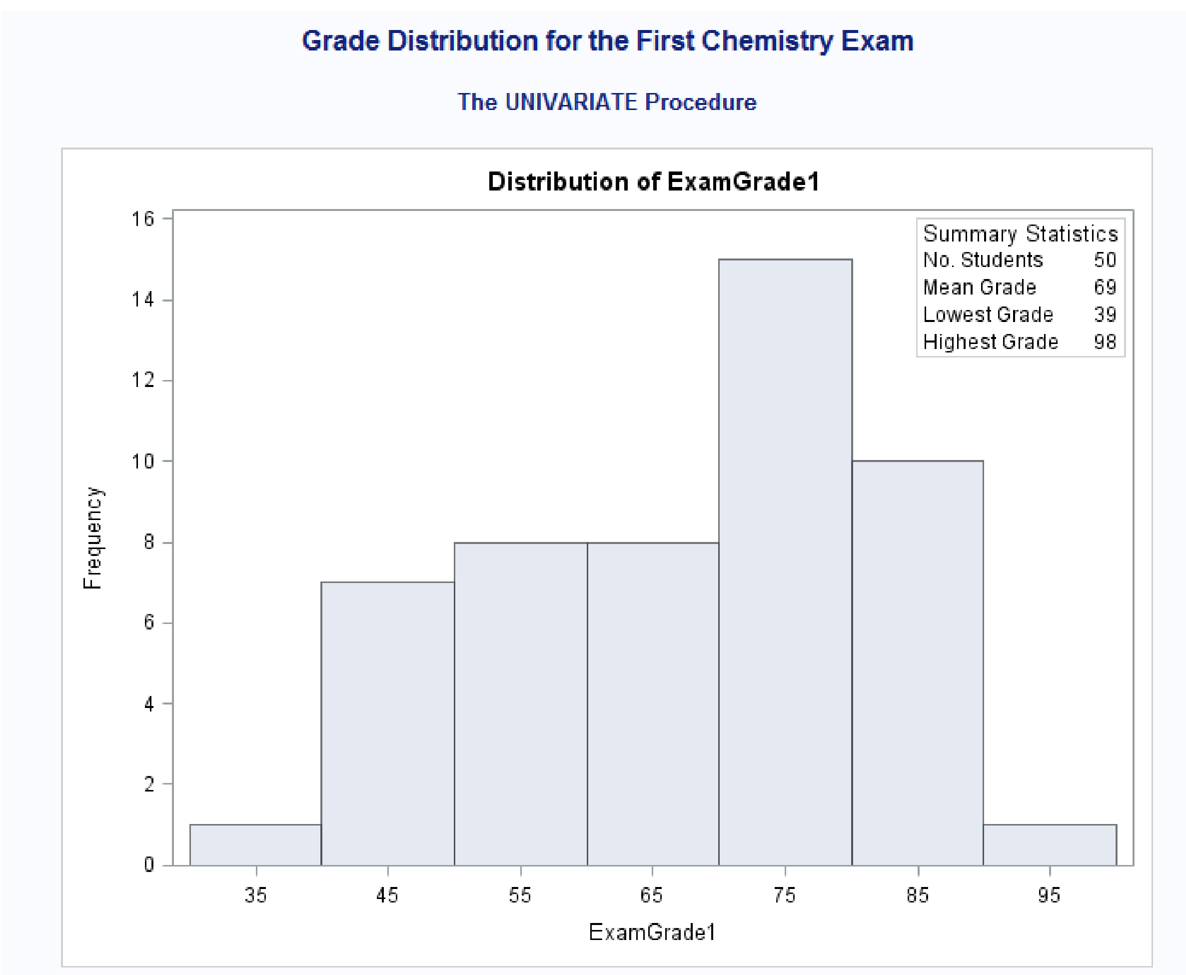
1 The statistical keywords N, MEAN, MIN, and MAX specify that the number of observations, the mean exam grade, the minimum exam grade, and the maximum exam grade appear in the inset. Each keyword is assigned a customized label to identify the statistic in the inset.

2 The HEADER= option specifies the heading text that appears at the top of the inset.

3 The POSITION= option uses a compass point to position the inset. The table appears at the northeast corner of the histogram.

4 The FORMAT= option requests a format with a field width of three for all the statistics in the inset.

Figure 31.18 *Adding an Inset to a Histogram*



The histogram shows the data distribution. The table of summary statistics in the upper right corner of the histogram provides information about the sample size, the mean grade, the lowest value, and the highest value.

Creating a Comparative Histogram

Understanding Comparative Histograms

A comparative histogram is a series of component histograms that are arranged as an array or a matrix. PROC UNIVARIATE uses uniform horizontal and vertical axes to display the component histograms. This enables you to use the comparative histogram to visually compare the distribution of a numeric variable across the levels of up to two classification variables.

You use the CLASS statement with a HISTOGRAM statement to create either a one-way or a two-way comparative histogram. The form of the CLASS statement is as follows:

CLASS *variable-1* <(*variable-options*)> <*variable-2* <(*variable-options*)>> </ *options*>;

Class variables can be numeric or character. Class variables can have continuous values, but they typically have a few discrete values that define levels of the variable. You can reduce the number of classification levels by using a FORMAT statement to combine the values of a class variable.

When you specify one class variable, PROC UNIVARIATE displays an array of component histograms (stacked or side-by-side). To create the one-way comparative histogram, PROC UNIVARIATE categorizes the values of the analysis variable by the formatted values (levels) of the class variable. Each classification level generates a separate histogram.

When you specify two class variables, PROC UNIVARIATE displays a matrix of component plots. To create the two-way comparative histogram, PROC UNIVARIATE categorizes the values of the analysis variable by the cross-classified values (levels) of the class variables. Each combination of the cross-classified levels generates a separate histogram. The levels of class variable-1 are the labels for the rows of the matrix, and the levels of class variable-2 are the labels for the columns of the matrix.

You can specify options in the HISTOGRAM statement to customize the appearance of the comparative histogram. For example, you can do the following:

- Specify the number of rows for the comparative histogram.
- Specify the number of columns for the comparative histogram.
- Specify graphical enhancements, such as background colors and text colors for the labels.

For a complete list of the keywords and the options that you can use in the HISTOGRAM statement, see the *Base SAS Procedures Guide*.

The Program

The following program uses the CLASS statement to create a comparative histogram by gender and section for the numeric variable ExamGrade1:

```
proc format;
   value $gendfmt 'M'='Male'
                  'F'='Female'; 1
run;

proc univariate data=grades noprint;
   class Gender 2 Section(order=data); 3
   histogram Examgrade1 / midpoints=45 to 95 by 10 vscale=count vaxis=0 to 6 by 2
                          vaxislabel='Frequency' turnvlabels 4 nrows=2 ncols=3 5
                          cframe=ligr 6 cframeside=gwh cframetop=gwh cfill=gwh; 7
   inset mean(4.1) n / noframe 8 position=(2,65); 9
   format Gender $gendfmt.; 1
   title 'Grade Distribution for the First Chemistry Exam';
run;
```

The following list corresponds to the numbered items in the preceding program:

1 PROC FORMAT creates a user-written format that labels Gender with a character string. The FORMAT statement assigns the format to Gender.

2 The CLASS statement creates a two-way comparative histogram that uses Gender and Section as the classification variables. PROC UNIVARIATE produces a component histogram for each level (a distinct combination of values) of these variables.

3 The ORDER= option positions the values of Section according to their order in the input data set. The comparative histogram displays the levels of Section according to the days of the week (Mon, Wed, and Fri). The default order of the levels is determined by sorting the internal values of Section (Fri, Mon, and Wed).

4 The TURNVLABELS option turns the characters in the vertical axis labels so that they are displayed vertically instead of horizontally.

5 The NROWS= option and the NCOLS= option specify a 2 × 3 arrangement for the component histograms.

6 The CFRAME= option specifies the color that fills the area of each component histogram that is enclosed by the axes and the frame. The CFRAMESIDE= option and the CFRAMETOP= option specify the color to fill the frame area for the column labels and the row labels that appear down the side and across the top of the comparative histogram. By default, these areas are not filled.

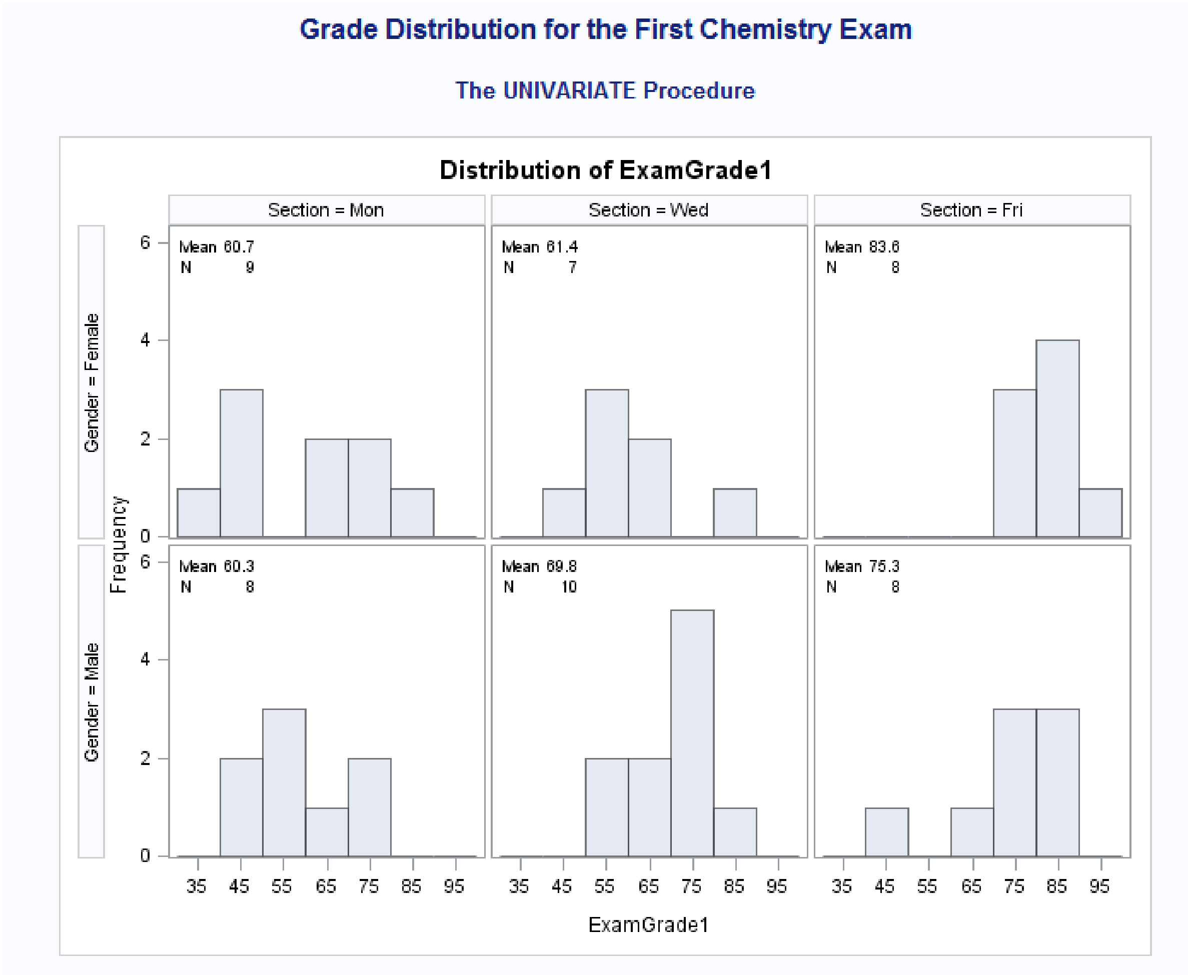
7 The CFILL= option specifies the color to fill the bars of each component histogram. By default, the bars are not filled.

8 The NOFRAME option suppresses the frame around the inset table.

9 The POSITION= option uses axis percentage coordinates to position the inset. The position of the bottom left corner of the inset is 2% of the way across the horizontal axis and 65% of the way up the vertical axis.

The following figure displays the comparative histogram.

Figure 31.19 *Using a Comparative Histogram to Examine Exam Grades by Gender and Section*



The comparative histogram is a 2 × 3 matrix of component histograms for each combination of Section and Gender. Each component histogram displays a table of statistics that reports the mean of ExamGrade1 and the number of students. You can easily see that both females and males in the Friday section earned higher grades than their counterparts in the other sections.

Summary

PROC CHART Statements

PROC CHART <DATA=*SAS-data-set*> <*options*>;
    chart-type variable(s) </*options*>;

PROC CHART <DATA=SAS-data-set> <options> ;
starts the CHART procedure. You can specify the following options in the PROC CHART statement:

DATA=SAS-data-set
names the SAS data set that PROC CHART uses. If you omit DATA=, then PROC CHART uses the most recently created data set.

LPI=value
specifies the proportions of PIE and STAR charts.

chart-type variable(s) < /options>;
is a chart statement where

chart-type
specifies the type of chart and can be any of the following:

- BLOCK
- HBAR
- PIE
- VBAR

You can use any number of chart statements in one PROC CHART step. A list of options pertains to a single chart statement.

variable(s)
identifies the variables to chart (called the chart variables).

options
specifies a list of options. Not all types of chart support all options.

You can use the following options in the VBAR, HBAR, and BLOCK statements:

GROUP=variable
produces a set of bars or blocks for each value of variable.

SUBGROUP=variable
proportionally fills each block or bar with characters that represent different values of variable. You can use the following options in the VBAR, HBAR, BLOCK, and PIE statements:

DISCRETE
creates a bar, block, or section for every value of the chart variable.

LEVELS=number-of-midpoints
specifies the number-of-midpoints. The procedure selects the midpoints.

MIDPOINTS=midpoints-list
specifies the values of the midpoints.

SUMVAR=variable
specifies the variable to use to determine the size of the bars, blocks, or sections.

TYPE=SUM|MEAN
specifies the type of chart to create, where

SUM
sums the values of the Sumvar variable in each range. Then PROC CHART uses the sums to determine the size of each bar, block, or section.

MEAN
determines the mean value of the Sumvar variable in each range. Then PROC CHART uses the means to determine the size of each bar, block, or section.

You can use the following options in the HBAR statement:

NOSTAT
suppresses the printing of the statistics that accompany the chart by default.

FREQ
requests frequency statistics.

CFREQ
requests cumulative frequency statistics.

PERCENT
requests percentage statistics.

CPERCENT
requests cumulative percentage statistics.

PROC UNIVARIATE Statements

PROC UNIVARIATE <*options*>;

CLASS *variable-1* <(*variable-options*)> <*variable-2* <(*variable-options*)>>
</*options*>;

HISTOGRAM <*variable(s)*> </*options*>;

INSET <*keyword(s)*> </*options*>;

PROC UNIVARIATE option(s);
starts the UNIVARIATE procedure. You can specify the following options in the PROC UNIVARIATE statement:

DATA=SAS-data-set
names the SAS data set that PROC UNIVARIATE uses. If you omit DATA=, then PROC UNIVARIATE uses the most recently created data set.

NOPRINT
suppresses the descriptive statistics that the PROC UNIVARIATE statement creates.

CLASS variable-1<(variable-option(s))> <variable-2<(variable-option(s))>>
</ option(s)>;
specifies up to two variables whose values determine the classification levels for the component histograms. Variables in a CLASS statement are referred to as class variables.

You can specify the following option(s) in the CLASS statement:

ORDER=DATA | FORMATTED | FREQ | INTERNAL
specifies the display order for the class variable values, where

DATA
orders values according to their order in the input data set.

FORMATTED
orders values by their ascending formatted values. This order depends on your operating environment.

FREQ
orders values by descending frequency count so that levels with the most observations are listed first.

INTERNAL
orders values by their unformatted values, which yields the same order as PROC SORT. This order depends on your operating environment.

HISTOGRAM <variable(s)> </option(s)>;
creates histograms and comparative histograms using high-resolution graphics for the analysis variables that are specified. If you omit *variable(s)* in the HISTOGRAM statement, then the procedure creates a histogram for each variable that you list in the VAR statement, or for each numeric variable in the DATA= data set if you omit a VAR statement.

You can specify the following options in the PROC UNIVARIATE statement:

CGRID=color
specifies the color for grid lines when a grid is displayed on the histogram.

GRID
specifies to display a grid on the histogram. Grid lines are horizontal lines that are positioned at major tick marks on the vertical axis.

HOFFSET=value
specifies the offset in percentage screen units at both ends of the horizontal axis.

GRID
specifies to display a grid on the histogram. Grid lines are horizontal lines that are positioned at major tick marks on the vertical axis.

LGRID=linetype
specifies the line type for the grid when a grid is displayed on the histogram. The default is a solid line.

MIDPOINTS=value(s)
determines the width of the histogram bars as the difference between consecutive midpoints. PROC UNIVARIATE uses the same *value(s)* for all variables. You must use evenly spaced midpoints that are listed in increasing order.

VAXIS=value(s)
specifies tick mark values for the vertical axis. Use evenly spaced values that are listed in increasing order. The first value must be zero and the last value must be greater than or equal to the height of the largest bar. You must scale the values in the same units as the bars.

VMINOR=n
specifies the number of minor tick marks between each major tick mark on the vertical axis. PROC UNIVARIATE does not label minor tick marks.

VSCALE=scale
specifies the scale of the vertical axis, where *scale* is

COUNT
scales the data in units of the number of observations per data unit.

PERCENT
scales the data in units of percentage of observations per data unit.

PROPORTION
scales the data in units of proportion of observations per data unit.

INSET <keyword(s)> </option(s)>;
places a box or table of summary statistics, called an inset, directly in the histogram.

You can specify the following options in the PROC UNIVARIATE statement:

keyword(s)
specifies one or more keywords that identify the information to display in the inset. PROC UNIVARIATE displays the information in the order in which you request the keywords. For a complete list of keywords, see the INSET statement in *SAS/GRAPH: Reference*.

FORMAT=format
specifies a format for all the values in the inset. If you specify a format for a particular statistic, then this format overrides FORMAT=*format*.

HEADER=string
specifies the heading text where *string* cannot exceed 40 characters.

NOFRAME
suppresses the frame drawn around the text.

POSITION=position
determines the position of the inset. The *position* is a compass point keyword, a margin keyword, or a pair of coordinates (*x*, *y*). The default position is NW, which positions the inset in the upper left (northwest) corner of the display.

GOPTIONS Statement

GOPTIONS options-list;
specifies values for graphics options. Graphics options control characteristics of the graph, such as size, colors, type fonts, fill patterns, and symbols. In addition, they affect the settings of device parameters, which are defined in the device entry. Device parameters control such characteristics as the appearance of the display, the type of output that is produced, and the destination of the output.

FORMAT Statement

FORMAT variable format-name;
enables you to display the value of a *variable* by using a special pattern that you specify as *format-name*.

Learning More

PROC CHART
For complete documentation, see the *Base SAS Procedures Guide*. In addition to the features that are described in this section, you can use PROC CHART to create star charts, to draw a reference line at a particular value on a bar chart, and to change the symbol that is used to draw charts. You can also create charts based, not only on frequency, sum, and mean, but also on cumulative frequency, percent, and cumulative percent.

PROC UNIVARIATE
For complete documentation, see the *Base SAS Procedures Guide*.

PROC PLOT
: For a discussion about how to plot the relationship between variables, see "Introduction to Plotting the Relationship between Variables" on page 553. When you are preparing graphics presentations, some data lends itself to charts. Other data is better suited for plots.

SAS formats
: For complete documentation, see *SAS Formats and Informats: Reference*. Many formats are available with SAS, including fractions, hexadecimal values, roman numerals, Social Security numbers, date and time values, and numbers written as words.

PROC FORMAT
: For complete documentation about how to create your own formats, see the *Base SAS Procedures Guide*.

SAS/GRAPH software
: For complete documentation, see *SAS/GRAPH: Reference*. If your site has SAS/GRAPH software, then you can use the GCHART procedure to take advantage of the high-resolution graphics capabilities of output devices and produce charts that include color, different fonts, and text.

TITLE and FOOTNOTE statements
: For a discussion about using titles and footnotes in a report, see "Understanding Titles and Footnotes" on page 475.

PART 8

Designing Your Own Output

32

Writing Lines to the SAS Log or to an Output File

Introduction to Writing Lines to the SAS Log or to an Output File

Purpose

In previous sections you learned how to store data values in a SAS data set and to use SAS procedures to produce a report that is based on these data values. In this section, you will learn how to do the following:

- design output by positioning data values and character strings in an output file
- prevent SAS from creating a data set by using the DATA _NULL_ statement
- produce reports by using the DATA step instead of using a procedure
- direct data to an output file by using a FILE statement

Prerequisites

Before proceeding with this section, you should be familiar with the concepts presented in the following sections:

- Chapter 1, “What is the SAS System?,” on page 3
- Chapter 3, “Introduction to DATA Step Processing,” on page 25

Understanding the PUT Statement

When you create output using the DATA step, you can customize that output by using the PUT statement to write text to the SAS log or to another output file. The PUT statement has the following form:

PUT<*variable*<*format*>> <'*character-string*'>;

variable
: names the variable that you want to write.

format
: specifies a format to use when you write variable values.

'*character-string*'
: specifies a string of text to write. Be sure to enclose the string in quotation marks.

Writing Output without Creating a Data Set

In many cases, when you use a DATA step to write a report, you do not need to create an additional data set. When you use the DATA _NULL_ statement, SAS processes the DATA step without writing observations to a data set. Using the DATA _NULL_ statement can increase program efficiency considerably.

The following is an example of a DATA _NULL_ statement:

```
data _null_;
```

The following program uses a PUT statement to write women’s Olympic medalist information to the SAS log. Because the program uses a DATA _NULL_ statement, SAS does not create a data set.

```
data _null_;
   length medalist $ 19;
   input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
   put medalist country medal result year;
   datalines;
1984 Lingjuan Li         SILVER CHN 2559
1984 Jin-Ho Kim          BRONZE KOR 2555
1988 Soo-Nyung Kim       GOLD   KOR 2683
     Hee-Kyung Wang      SILVER KOR 2612
1988 Young-Sook Yun      BRONZE KOR 2593
1992 Youn-Jeong Cho      GOLD   KOR 113
1992 Soo-Nyung Kim       SILVER KOR 105
1992 Natalya Valeyeva    BRONZE URS
1996 Kyung-Wook Kim      GOLD   KOR
1996 Ying He             SILVER CHN
1996 Olena Sadovnycha    BRONZE UKR
2000 Mi-Jin Jun          GOLD   KOR 107
2000 Nam-Soon Kim        SILVER KOR 106
2000 Soo-Nyung Kim       BRONZE KOR 103
;
run;
```

The following output shows the results.

Output 32.1 *Writing to the SAS Log*

```
1    data _null_;
2       length medalist $ 19;
3       input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
4       put medalist country medal result year;
5       datalines;

Lingjuan Li CHN SILVER 2559 1984
Jin-Ho Kim KOR BRONZE 2555 1984
Soo-Nyung Kim KOR GOLD 2683 1988
Hee-Kyung Wang KOR SILVER 2612 .
Young-Sook Yun KOR BRONZE 2593 1988
Youn-Jeong Cho KOR GOLD 113 1992
Soo-Nyung Kim KOR SILVER 105 1992
Natalya Valeyeva URS BRONZE . 1992
Kyung-Wook Kim KOR GOLD . 1996
Ying He CHN SILVER . 1996
Olena Sadovnycha UKR BRONZE . 1996
Mi-Jin Jun KOR GOLD 107 2000
Nam-Soon Kim KOR SILVER 106 2000
Soo-Nyung Kim KOR BRONZE 103 2000
NOTE: DATA statement used (Total process time):
      real time           0.02 seconds
      cpu time            0.03 seconds


20   ;
21   run;
```

SAS indicates missing numeric values with a period. Note that the log contains one missing observation for the variable year and four missing observations for the variable result.

Writing Simple Text

Writing a Character String

In its simplest form, the PUT statement writes the character string that you specify to the SAS log, to a procedure output file, or to an external file. If you omit the destination (as in this example), then SAS writes the string to the log. In the following example, SAS executes the PUT statement once during each iteration of the DATA step. If SAS encounters missing values for the variables Year and Result, then the PUT statement writes a message to the log.

```
data _null_;
   length medalist $ 19;
   input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
   if year=. then put '*** Missing Year';
      else
   if result=. then put '*** Missing Results';

   datalines;
1984 Lingjuan Li        SILVER CHN 2559
1984 Jin-Ho Kim         BRONZE KOR 2555
1988 Soo-Nyung Kim      GOLD   KOR 2683
     Hee-Kyung Wang     SILVER KOR 2612
1988 Young-Sook Yun     BRONZE KOR 2593
1992 Youn-Jeong Cho     GOLD   KOR 113
1992 Soo-Nyung Kim      SILVER KOR 105
1992 Natalya Valeyeva   BRONZE URS
1996 Kyung-Wook Kim     GOLD   KOR
1996 Ying He            SILVER CHN
1996 Olena Sadovnycha   BRONZE UKR
2000 Mi-Jin Jun         GOLD   KOR 107
2000 Nam-Soon Kim       SILVER KOR 106
2000 Soo-Nyung Kim      BRONZE KOR 103
;
run;
```

The following output shows the results.

Output 32.2 *Writing a Character String to the SAS Log*

```
22   data _null_;
23      length medalist $ 19;
24      input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
25      if year=. then put '*** Missing Year';
26         else
27      if result=. then put '*** Missing Results';
28
29      datalines;

*** Missing Year
*** Missing Results
*** Missing Results
*** Missing Results
*** Missing Results
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.01 seconds


44   ;
45   run;
```

Writing Variable Values

The previous example shows that the value for Year is missing one observation in the data set and the variable Result is missing four observations. To identify which observations have the missing values, write the value of one or more variables along with the character string. The following program writes the value of Year and Result, as well as the character string:

```
data _null_;
   length medalist $ 19;
   input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
   if year=. then put '*** Missing Year' medalist country;
      else
   if result=. then put '*** Missing Results' medalist country;
   datalines;
1984 Lingjuan Li        SILVER CHN 2559
1984 Jin-Ho Kim         BRONZE KOR 2555
1988 Soo-Nyung Kim      GOLD   KOR 2683
     Hee-Kyung Wang     SILVER KOR 2612
1988 Young-Sook Yun     BRONZE KOR 2593
1992 Youn-Jeong Cho     GOLD   KOR 113
1992 Soo-Nyung Kim      SILVER KOR 105
1992 Natalya Valeyeva   BRONZE URS
1996 Kyung-Wook Kim     GOLD   KOR
1996 Ying He            SILVER CHN
1996 Olena Sadovnycha   BRONZE UKR
2000 Mi-Jin Jun         GOLD   KOR 107
2000 Nam-Soon Kim       SILVER KOR 106
2000 Soo-Nyung Kim      BRONZE KOR 103
;
run;
```

Notice that the last character in each of the strings is blank. This is an example of list output. In list output, SAS automatically moves one column to the right after writing a variable value, but not after writing a character string. The simplest way to include the required space is to include it in the character string.

SAS keeps track of its position in the output line with a pointer. Another way to describe the action in this PUT statement is to say that in list output, the pointer moves one column to the right after writing a variable value, but not after writing a character string. In later parts of this section, you will learn ways to move the pointer to control where the next piece of text is written.

The following output shows the results.

Output 32.3 *Writing a Character String and Variable Values*

```
46   data _null_;
47      length medalist $ 19;
48      input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
49      if year=. then put '*** Missing Year' medalist country;
50         else
51      if result=. then put '*** Missing Results' medalist country;
52
53
54      datalines;

*** Missing YearHee-Kyung Wang KOR
*** Missing ResultsNatalya Valeyeva URS
*** Missing ResultsKyung-Wook Kim KOR
*** Missing ResultsYing He CHN
*** Missing ResultsOlena Sadovnycha UKR
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.01 seconds


69   ;
70   run;
```

Writing on the Same Line More Than Once

By default, each PUT statement begins on a new line. However, you can write on the same line if you use more than one PUT statement and at least one trailing @ ("at" sign).

The trailing @ is a type of pointer control called a line-hold specifier. Pointer controls are one way to specify where SAS writes text. In the following example, using the trailing @ causes SAS to write the item in the second PUT statement on the same line rather than on a new line. The execution of either PUT statement holds the output line for further writing because each PUT statement has a trailing @. SAS continues to write on that line when a later PUT statement in the same iteration of the DATA step is executed, and when a PUT statement in a later iteration is executed.

```
data _null_;
   length medalist $ 19;
   input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
   if year=. then put '*** Missing Year' medalist country @;
      else
```

```
   if result=. then put '*** Missing Results' medalist country @;
   datalines;
1984 Lingjuan Li         SILVER CHN 2559
1984 Jin-Ho Kim          BRONZE KOR 2555
1988 Soo-Nyung Kim       GOLD   KOR 2683
     Hee-Kyung Wang      SILVER KOR 2612
1988 Young-Sook Yun      BRONZE KOR 2593
1992 Youn-Jeong Cho      GOLD   KOR 113
1992 Soo-Nyung Kim       SILVER KOR 105
1992 Natalya Valeyeva    BRONZE URS
1996 Kyung-Wook Kim      GOLD   KOR
1996 Ying He             SILVER CHN
1996 Olena Sadovnycha    BRONZE UKR
2000 Mi-Jin Jun          GOLD   KOR 107
2000 Nam-Soon Kim        SILVER KOR 106
2000 Soo-Nyung Kim       BRONZE KOR 103
;
run;
```

The following output shows the results.

Output 32.4 *Writing on the Same Line More Than Once*

```
data _null_;
   length medalist $ 19;
   input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
   if year=. then put '*** Missing Year' medalist country @;
      else
   if result=. then put '*** Missing Results' medalist country @;


   datalines;

*** Missing YearHee-Kyung Wang KOR *** Missing ResultsNatalya Valeyeva URS *** Missing Results
Kyung-Wook Kim KOR *** Missing ResultsYing He CHN *** Missing ResultsOlena Sadovnycha UKR
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.01 seconds


;
run;
```

If the output line were long enough, then SAS would write all three messages about missing data on a single line. Because the line is not long enough, SAS continues writing on the next line. When it determines that an individual data value or character string does not fit on a line, SAS brings the entire item down to the next line. SAS does not split a data value or character string.

Releasing a Held Line

In the following example, the input file has six missing values. One record has missing values for both the Year and Result variables. Four other records have missing values for either the Year or the Result variable.

To improve the appearance of your report, you can write all the missing variables for each observation on a separate line. When values for the two variables Year and

Result are missing, two PUT statements write to the same line. When either Year or Result is missing, only one PUT statement writes to that line.

SAS determines where to write the output by the presence of the trailing @ in the PUT statement and the presence of a null PUT statement that releases the hold on the line. Executing a PUT statement with a trailing @ causes SAS to hold the current output line for further writing. It holds the line either in the current iteration of the DATA step or in a future iteration. Executing a PUT statement without a trailing @ releases the held line.

To release a line without writing a message, use a null PUT statement:

```
put;
```

A null PUT statement has the same characteristics of other PUT statements: by default, it writes output to a new line, writes what you specify in the statement (nothing in this case), and releases the line when it finishes executing. If a trailing @ is in effect, then the null PUT statement begins on the current line, writes nothing, and releases the line.

The following program shows how to write one or more items to the same line:

- If a value for the variable Year is missing, then the first PUT statement holds the line in case the variable Result is missing a value for that observation.
- If a value for the variable Result is missing, then the next PUT statement writes a message and releases the line.
- If the variable Result does not have a missing value, but if a message has been written for the variable Year (year=.), then the null PUT statement releases the line.
- If neither the variable Year nor the variable Result has missing values, then the line is not released and no PUT statement is executed.

```
data _null_;
   length medalist $ 19;
   input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
   if year=. then put '*** Missing Year' medalist country @;
   if result=. then put '*** Missing Results' medalist country ;
      else if year=. then put;

   datalines;
1984 Lingjuan Li        SILVER CHN 2559
1984 Jin-Ho Kim         BRONZE KOR 2555
1988 Soo-Nyung Kim      GOLD   KOR 2683
     Hee-Kyung Wang     SILVER KOR 2612
1988 Young-Sook Yun     BRONZE KOR 2593
1992 Youn-Jeong Cho     GOLD   KOR 113
1992 Soo-Nyung Kim      SILVER KOR 105
     Natalya Valeyeva   BRONZE URS
1996 Kyung-Wook Kim     GOLD   KOR
1996 Ying He            SILVER CHN
1996 Olena Sadovnycha   BRONZE UKR
2000 Mi-Jin Jun         GOLD   KOR 107
2000 Nam-Soon Kim       SILVER KOR 106
2000 Soo-Nyung Kim      BRONZE KOR 103
;
run;
```

The following output shows the results.

Output 32.5 Writing One or More Times to a Line and Releasing the Line

```
1    data _null_;
2       length medalist $ 19;
3       input year 1-4  medalist $ 6-24  medal $ 26-31 country $ 33-35 result 37-41;
4       if year=. then put '*** Missing Year' medalist country @;
5       if result=. then put '*** Missing Results' medalist country ;
6          else if year=. then put;
7
8       datalines;

*** Missing YearHee-Kyung Wang KOR
*** Missing YearNatalya Valeyeva URS *** Missing ResultsNatalya Valeyeva URS
*** Missing ResultsKyung-Wook Kim KOR
*** Missing ResultsYing He CHN
*** Missing ResultsOlena Sadovnycha UKR
NOTE: DATA statement used (Total process time):
      real time           0.46 seconds
      cpu time            0.03 seconds


23   ;
24   run;
```

Writing a Report

Writing to an Output File

The PUT statement writes lines of text to the SAS log. However, the SAS log is not usually a good destination for a formal report because it also contains the source statements for the program and messages from SAS.

The simplest destination for a printed report is the SAS output file, which is the same place SAS writes output from procedures. SAS automatically defines various characteristics such as page numbers for the procedure output file, and you can take advantage of them instead of defining all the characteristics yourself.

To route lines to the procedure output file, use the FILE statement. The FILE statement has the following form:

FILE PRINT <*options*>;

PRINT is a reserved fileref that directs output that is produced by PUT statements to the same print file as the output that is produced by SAS procedures.

Note: Make sure that the FILE statement precedes the PUT statement in the program code.

FILE statement *options* specify options that you can use to customize output. The report that is produced in this section uses the following options:

NOTITLES
: eliminates the default title line and makes that line available for writing. By default, the procedure output file contains the title "The SAS System." Because the report creates another title that is descriptive, you can remove the default title by specifying the NOTITLES option.

FOOTNOTES
: controls whether currently defined footnotes are written to the report.

Note: When you use the FILE statement to include footnotes in a report, you must use the FOOTNOTES option in the FILE statement and include a FOOTNOTE statement in your program. The FOOTNOTE statement contains the text of the footnote.

Note: You can also remove the default title with a null TITLE statement: `title;`. In this case, SAS writes a line that contains only the date and page number in place of the default title. The line is not available for writing other text.

Designing the Report

After choosing a destination for your report, the next step in producing a report is to decide how you want it to look. You create the design and determine which lines and columns the text will occupy. Planning how you want your final report to look helps you write the necessary PUT statements to produce the report. The rest of the examples in this section show how to modify a program to produce a final report that resembles the one shown here.

Output 32.6 *Morning and Evening Newspaper Circulation Report*

```
                Morning and Evening Newspaper Circulation

       State               Year                         Thousands of Copies
                                                        Morning       Evening

       Massachusetts       1999                           798.4         984.7
                           1998                           834.2         793.6
                           1997                           750.3           .
                                                         ------        ------
                           Total for each category       2382.9        1778.3
                                    Combined total              4161.2

       Alabama             1999                             .           698.4
                           1998                           463.8         522.0
                           1997                           583.2         234.9
                           1996                             .           339.6
                                                         ------        ------
                           Total for each category       1047.0        1794.9
                                    Combined total              2841.9
```

Preliminary Report

Writing Data Values

After you design your report, you can begin to write the program that will create it. The following program shows how to display the data values for the YEAR, MORNING_COPIES, and EVENING_COPIES variables in specific positions.

In a PUT statement, the @ followed by a number is a pointer control, but it is different from the trailing @ described earlier. The @*n* argument is a column-pointer control. It tells SAS to move to column *n*. In this example the pointer moves to the specified locations, and the PUT statement writes values at those points. Using pointer controls is a simple but useful way of writing data values in columns.

```
title;
data _null_;
   input state $ morning_copies evening_copies year;
   file print notitles;
   put @26 year @53 morning_copies @66 evening_copies;
   datalines;
Massachusetts 798.4 984.7 1999
Massachusetts 834.2 793.6 1998
Massachusetts 750.3 .     1997
Alabama       .     698.4 1999
Alabama       463.8 522.0 1998
Alabama       583.2 234.9 1997
Alabama       .     339.6 1996
;
run;
```

The following output shows the results.

Output 32.7 *Data Values in Specific Locations in the Output*

```
                    1999                      798.4        984.7
                    1998                      834.2        793.6
                    1997                      750.3        .
                    1999                      .            698.4
                    1998                      463.8        522
                    1997                      583.2        234.9
                    1996                      .            339.6
```

Improving the Appearance of Numeric Data Values

In the design for your report, all numeric values are aligned on the decimal point. To achieve this result, you have to alter the appearance of the numeric data values by using SAS formats. In the input data all values for MORNING_COPIES and EVENING_COPIES contain one decimal place, except in one case where the decimal value is 0. In list output SAS writes values in the simplest way, that is, by omitting the 0s in the decimal portion of a value. In formatted output, you can show one decimal place for every value by associating a format with a variable in the PUT statement. Using a format can also align your output values.

The format that is used in the program is called the *w.d* format. The *w.d* format specifies the number of columns to be used for writing the entire value, including the decimal point. It also specifies the number of columns to be used for writing the decimal portion of each value. In this example the format 5.1 causes SAS to use five columns, including one decimal place, for writing each value. Therefore, SAS prints the 0s in the decimal portion as necessary. The format also aligns the periods that SAS uses to indicate missing values with the decimal points.

```
title;
data _null_;
   input state $ morning_copies evening_copies year;
   file print notitles;
   put @26 year @53 morning_copies 5.1 @66 evening_copies 5.1;
   datalines;
Massachusetts 798.4 984.7 1999
Massachusetts 834.2 793.6 1998
Massachusetts 750.3 .     1997
Alabama       .     698.4 1999
Alabama       463.8 522.0 1998
Alabama       583.2 234.9 1997
Alabama       .     339.6 1996
;
run;
```

The following output shows the results.

Output 32.8 *Formatted Numeric Output*

```
                         1999                       798.4        984.7
                         1998                       834.2        793.6
                         1997                       750.3          .
                         1999                         .          698.4
                         1998                       463.8        522.0
                         1997                       583.2        234.9
                         1996                         .          339.6
```

Writing a Value at the Beginning of Each BY Group

The next step in creating your report is to add the name of the state to your output. If you include the name of the state in the PUT statement with other data values, then the state will appear on every line. However, remembering what you want your final report to look like, you need to write the name of the state only for the first observation of a particular state. Performing a task once for a group of observations requires the use of the BY statement for BY-group processing. The BY statement has the following form:

BY *by-variable(s)*<NOTSORTED>;

The *by-variable* names the variable by which the data set is sorted. The optional NOTSORTED option specifies that observations with the same BY value are grouped together but are not necessarily sorted in alphabetical or numerical order.

For BY-group processing,

- ensure that observations come from a SAS data set, not an external file.

- when the data is grouped in BY groups but the groups are not necessarily in alphabetical order, use the NOTSORTED option in the BY statement. For example, use

  ```
  by state notsorted;
  ```

The following program creates a permanent SAS data set named NEWS.CIRCULATION, and writes the name of the state on the first line of the report for each BY group.

```
title;
libname news 'SAS-data-library';
data news.circulation;
   length state $ 15;
   input state $ morning_copies evening_copies year;
   datalines;
Massachusetts 798.4 984.7 1999
Massachusetts 834.2 793.6 1998
Massachusetts 750.3 .     1997
Alabama       .     698.4 1999
Alabama       463.8 522.0 1998
Alabama       583.2 234.9 1997
Alabama       .     339.6 1996
;

data _null_;
   set news.circulation;
   by state notsorted;
   file print notitles;
   if first.state then put / @7 state @;
   put @26 year @53 morning_copies 5.1 @66 evening_copies 5.1;
run;
```

During the first observation for a given state, a PUT statement writes the name of the state and holds the line for further writing (the year and circulation figures). The next PUT statement writes the year and circulation figures and releases the held line. In observations after the first, only the second PUT statement is processed. It writes the year and circulation figures and releases the line as usual.

The first PUT statement contains a slash (/), a pointer control that moves the pointer to the beginning of the next line. In this example, the PUT statement prepares to write on a new line (the default action). Then the slash moves the pointer to the beginning of the next line. As a result, SAS skips a line before writing the value of STATE. In the output, a blank line separates the data for Massachusetts from the data for Alabama. The output for Massachusetts also begins one line farther down the page than it would have otherwise. (That blank line is used later in the development of the report.)

The following output shows the results.

Output 32.9 *Effect of BY-Group Processing*

```
Massachusetts      1999                    798.4      984.7
                   1998                    834.2      793.6
                   1997                    750.3        .

Alabama            1999                      .        698.4
                   1998                    463.8      522.0
                   1997                    583.2      234.9
                   1996                      .        339.6
```

Calculating Totals

The next step is to calculate the total morning circulation figures, total evening circulation figures, and total overall circulation figures for each state. Sum statements accumulate the totals, and assignment statements start the accumulation at 0 for each state. When the last observation for a given state is being processed, an assignment statement calculates the overall total, and a PUT statement writes the totals and additional descriptive text.

```
libname news 'SAS-data-library';
title;
data _null_;
   set news.circulation;
   by state notsorted;
   file print notitles;
      /* Set values of accumulator variables to 0 */
      /* at beginning of each BY group.           */
      if first.state then
         do;
            morning_total=0;
            evening_total=0;
            put / @7 state @;
         end;
   put @26 year @53 morning_copies 5.1 @66 evening_copies 5.1;

      /* Accumulate separate totals for morning and */
      /* evening circulations.                      */
   morning_total+morning_copies;
   evening_total+evening_copies;

      /* Calculate total circulation at the end of  */
      /* each BY group.                             */

   if last.state then
      do;
         all_totals=morning_total+evening_total;
         put @52 '------' @65 '------' /
             @26 'Total for each category'
             @52 morning_total 6.1 @65 evening_total 6.1 /
             @35 'Combined total' @59 all_totals 6.1;
      end;
run;
```

The following output shows the results.

Output 32.10 Calculating and Writing Totals for Each BY Group

```
     Massachusetts       1999                        798.4         984.7
                         1998                        834.2         793.6
                         1997                        750.3           .
                                                    ------        ------
                         Total for each category    2382.9        1778.3
                                Combined total            4161.2

     Alabama             1999                          .           698.4
                         1998                        463.8         522.0
                         1997                        583.2         234.9
                         1996                          .           339.6
                                                    ------        ------
                         Total for each category    1047.0        1794.9
                                Combined total            2841.9
```

Notice that Sum statements ignore missing values when they accumulate totals. Also, by default, Sum statements assign the accumulator variables (in this case, MORNING_TOTAL, and EVENING_TOTAL) an initial value of 0. Therefore, although the assignment statements in the DO group are executed for the first observation for both states, you need them only for the second state.

Writing Headings and Footnotes for a One-Page Report

The report is complete except for the title lines, column headings, and footnote. Because this is a simple, one-page report, you can write the heading with a PUT statement that is executed only during the first iteration of the DATA step. The automatic variable _N_ counts the number of times the DATA step has iterated or looped, and the PUT statement is executed when the value of _N_ is 1.

The FOOTNOTES option in the FILE statement and the FOOTNOTE statement create the footnote. The following program is complete:

```
libname news 'SAS-data-library';
title;
data _null_;
   set news.circulation;
   by state notsorted;
   file print notitles footnotes;
   if _n_=1 then put @16 'Morning and Evening Newspaper Circulation' //
                     @7  'State' @26 'Year' @51 'Thousands of Copies' /
                     @51 'Morning      Evening';
   if first.state then
      do;
         morning_total=0;
         evening_total=0;
         put / @7 state @;
      end;
   put @26 year @53 morning_copies 5.1 @66 evening_copies 5.1;
   morning_total+morning_copies;
   evening_total+evening_copies;
   if last.state then
      do;
```

```
            all_totals=morning_total+evening_total;
            put @52 '------' @65 '------' /
                @26 'Total for each category'
                @52 morning_total 6.1 @65 evening_total 6.1 /
                @35 'Combined total' @59 all_totals 6.1;
         end;
      footnote 'Preliminary Report';
   run;
```

The following output shows the results.

Output 32.11 The Final Report

```
             Morning and Evening Newspaper Circulation

     State              Year                   Thousands of Copies
                                               Morning      Evening

     Massachusetts      1999                    798.4        984.7
                        1998                    834.2        793.6
                        1997                    750.3          .
                                               ------       ------
                        Total for each category  2382.9       1778.3
                                 Combined total        4161.2

     Alabama            1999                      .          698.4
                        1998                    463.8        522.0
                        1997                    583.2        234.9
                        1996                      .          339.6
                                               ------       ------
                        Total for each category  1047.0       1794.9
                                 Combined total        2841.9


                           Preliminary Report
```

Notice that a blank line appears between the last line of the heading and the first data for Massachusetts, although the PUT statement for the heading does not write a blank line. The line comes from the slash (/) in the PUT statement that writes the value of STATE in the first observation of each BY group.

Executing a PUT statement during the first iteration of the DATA step is a simple way to produce headings, especially when a report is only one page long.

Summary

Statements

BY *variable-1* <. . . *variable-n* > <NOTSORTED>;

indicates that all observations with common values of the BY variables are grouped together. The NOTSORTED option indicates that the variables are grouped but that the groups are not necessarily in alphabetical or numerical order.

DATA _NULL_;
: specifies that SAS will not create an output data set.

FILE PRINT <NOTITLES> <FOOTNOTES>;
: directs output to the SAS procedure output file. Place the FILE statement before the PUT statements that write to that file. The NOTITLES option suppresses titles that are currently in effect, and makes the lines unavailable for writing other text. The FOOTNOTES option, along with the FOOTNOTE statement, writes a footnote to the file.

PUT;
: by default, begins a new line and releases a previously held line. A PUT statement that does not write any text is known as a null PUT statement.

PUT <*variable* <*format*>> <*character string*>;
: writes lines to the destination that is specified in the FILE statement. If no FILE statement is present, then the PUT statement writes to the SAS log. By default, each PUT statement begins on a new line, writes what is specified, and releases the line. A DATA step can contain any number of PUT statements.

  By default, SAS writes a variable or character-string at the current position in the line. SAS automatically moves the pointer one column to the right after writing a variable value but not after writing a character string. That is, SAS places a blank after a variable value but not after a character string. This form of output is called list output. If you place a format after a variable name, then SAS writes the value of the variable beginning at its current position in the line. SAS also uses the format that you specify. The position of the pointer after a formatted value is the following column. That is, SAS does not automatically skip a column. Using a format in a PUT statement is called formatted output. You can combine list and formatted output in a single PUT statement.

PUT<@*n*> <*variable* <*format*>> <*character-string*> </> <@>;
: writes lines to the destination that is specified in the FILE statement. If no FILE statement is present, then the PUT statement writes to the SAS log. The @n pointer control moves the pointer to column n in the current line. The / moves the pointer to the beginning of a new line. (You can use slashes anywhere in the PUT statement to skip lines.) Multiple slashes skip multiple lines. The trailing @, if present, must be the last item in the PUT statement. Executing a PUT statement with a trailing @ holds the current line for use by a later PUT statement either in the same iteration of the DATA step or a later iteration. Executing a PUT statement without a trailing @ releases a held line.

TITLE;
: specifies title lines for SAS output.

Learning More

Pointer controls
: For more information about pointer controls, see the PUT statement in *SAS DATA Step Statements: Reference*.

Statements
: For more information about the statements that are described in this section, see *SAS DATA Step Statements: Reference*.

ODS
: For information about using ODS with the PUT statement and the DATA step, see *SAS Output Delivery System: User's Guide*.

33

Understanding and Customizing SAS Output: The Basics

Introduction to the Basics of Understanding and Customizing SAS Output

Purpose

In this section, you will learn to understand your output so that you can enhance its appearance and make it more informative. It discusses DATA step and PROC step output.

This section describes how to enhance the appearance of your output by doing the following:

- adding titles, column headings, footnotes, and labels
- customizing headings
- changing a portion of a heading
- numbering pages and controlling page divisions
- printing date and time values
- representing missing numeric values with a character

Prerequisites

Before proceeding with this section, you should understand the concepts that are presented in the following sections:

- Chapter 3, “Introduction to DATA Step Processing,” on page 25
- Chapter 32, “Writing Lines to the SAS Log or to an Output File,” on page 619

Understanding Output

Output from Procedures

When you invoke a SAS procedure, SAS analyzes or processes your data. You can read a SAS data set, compute statistics, print results, or create a new data set. One of the results of executing a SAS procedure is creating procedure output. The location of procedure output varies with the method of running SAS, the operating environment, and the options that you use. The form and content of the output varies with each procedure. Some procedures, such as the SORT procedure, do not produce printed output.

SAS has numerous procedures that you can use to process your data. For example, you can use the PRINT procedure to print a report that lists the values of each variable in your SAS data set. You can use the MEANS procedure to compute descriptive statistics for variables across all observations and within groups of observations. You can use the UNIVARIATE procedure to produce information about the distribution of numeric variables. For a graphic representation of your data, you can use the CHART procedure. Many other procedures are available through SAS.

Output from DATA Step Applications

Although output is usually generated by a procedure, you can also generate output by using a DATA step application. Using the DATA step, you can do the following:

- create a SAS data set
- write to an external file
- produce a report

To generate output, you can use the FILE and PUT statements together within the DATA step. Use the FILE statement to identify your current output file. Then use the PUT statement to write lines that contain variable values or text strings to the output file. You can write the values in column, list, or formatted style.

You can use the FILE and PUT statements to target a subset of data. If you have a large data set that includes unnecessary information, this type of DATA step processing can save time and computer resources. Write your code so that the FILE statement executes before a PUT statement in the current execution of a DATA step. Otherwise, your data is written to the SAS log.

If you have a SAS data set, you can use the FILE and PUT statements to create an external file that another computer language can process. For example, you can create a SAS data set that lists the test scores for high school students. You can then use this file as input to a Fortran program that analyzes test scores. The following table lists the variables and the column positions that an existing Fortran program expects to find in the input SAS data set:

Table 33.1 *Variables and Column Positions*

Variable	Column location
YEAR	10-13
TEST	15-25
GENDER	30
SCORE	35-37

You can use the FILE and PUT statements in the DATA step to create the data set that the Fortran program reads:

```
data _null_;
```

```
      set out.sats1;
      file 'your-output-file';
      put @10 year @15 test
          @30 gender @35 score;
   run;
```

Output from the Output Delivery System (ODS)

Beginning with Version 7, procedure output is much more flexible because of the Output Delivery System (ODS). ODS is a method of delivering output in a variety of formats and of making the formatted output easy to access. Important features of ODS include the following:

- ODS combines raw data with one or more table definitions to produce one or more output objects. When you send these objects to any or all ODS destinations, your output is formatted according to the instructions in the table definition. ODS destinations can produce an output data set, traditional monospace output, output that is formatted for a high-resolution printer, output that is formatted in HyperText Markup Language (HTML), and so on.
- ODS provides table definitions that define the structure of the output from procedures and from the DATA step. You can customize the output by modifying these definitions or by creating your own definitions.
- ODS provides a way for you to choose individual output objects to send to ODS destinations. For example, PROC UNIVARIATE produces five output objects. You can easily create HTML output, an output data set, traditional Listing output, or Printer output from any or all of these output objects. You can send different output objects to different destinations.
- ODS stores a link to each output object in the Results folder in the Results window.

In addition, ODS removes responsibility for formatting output from individual procedures and from the DATA step. The procedure or DATA step supplies raw data and the name of the table definition that contains the formatting instructions. Then ODS formats the output. Because formatting is now centralized in ODS, the addition of a new ODS destination does not affect any procedures or the DATA step. As future destinations are added to ODS, they will automatically become available to the DATA step and to all procedures that support ODS.

For more information and examples, see Chapter 34, “Understanding and Customizing SAS Output: The Output Delivery System (ODS),” on page 669.

Input SAS Data Set for Examples

The following program creates a SAS data set that contains Scholastic Aptitude Test (SAT) information for university-bound high school seniors from 1972 through 1998. (To view the entire DATA step, see “The UNIVERSITY_TEST_SCORES Data Set” on page 853.) The data set in this example is stored in a SAS library that is referenced by the libref ADMIN. For selected years between 1972 and 1998, the data set shows estimated scores that are based on the total number of students nationwide taking the test. Scores are estimated for male (m) and female (f) students, for both the verbal and math portions of the test.

```
options pagesize=60 linesize=80 pageno=1 nodate;
libname admin 'your-data-library';

data admin.sat_scores;
   input Test $ Gender $ Year SATscore @@;
   datalines;
Verbal m 1972 531  Verbal f 1972 529
Verbal m 1973 523  Verbal f 1973 521
Verbal m 1974 524  Verbal f 1974 520
   ...more SAS data lines...
Math   m 1996 527  Math   f 1996 492
Math   m 1997 530  Math   f 1997 494
Math   m 1998 531  Math   f 1998 496
;

proc print data=admin.sat_scores;
run;
```

The following output displays a partial list of the results.

Output 33.1 *The ADMIN.SAT_SCORES Data Set: Partial HTML Output*

Results Viewer - SAS Output

The SAS System

Obs	Test	Gender	Year	SATscore
1	Verbal	m	1972	531
2	Verbal	f	1972	529
3	Verbal	m	1973	523
4	Verbal	f	1973	521
5	Verbal	m	1974	524
6	Verbal	f	1974	520
7	Verbal	m	1975	515
8	Verbal	f	1975	509
9	Verbal	m	1976	511
10	Verbal	f	1976	508
11	Verbal	m	1977	509
12	Verbal	f	1977	505
13	Verbal	m	1978	511
14	Verbal	f	1978	503
15	Verbal	m	1979	509
16	Verbal	f	1979	501
17	Verbal	m	1980	506
18	Verbal	f	1980	498
19	Verbal	m	1981	508

Locating Procedure Output

The location of your procedure output depends on the method that you use to start, run, and exit SAS. It also depends on your operating environment and on the settings of SAS system options. The following table shows the default location for each method of operation.

Table 33.2 Default Locations for Procedure Output

Method of Operation	Location of Procedure Output
Windowing environment	Results Viewer and Results windows
Interactive line mode	On the terminal display, as each step executes
Noninteractive SAS programs	Depends on the operating environment
Batch jobs	Line printer or disk file

By default, SAS stores output in your Work directory. In the SAS windowing environment for Windows and UNIX, after you have opened and closed the HTML destination, your output goes to your current working directory. You can use the ODS PREFERENCE statement anytime during your SAS session to return to the default behavior. This action is helpful when you are creating multiple graphics and do not want them to accumulate in your current working directory.

Making Output Informative

Adding Titles

At the top of each page of output, SAS automatically writes the following title:

```
The SAS System
```

You can make output more informative by using the TITLE statement to specify your own title. A TITLE statement writes the title that you specify at the top of every page. The form of the TITLE statement is:

TITLE<*n*> <'*text*'>;

where *n* specifies the relative line that contains the title, and *text* specifies the text of the title. The value of *n* can be 1 to 10. If you omit *n*, SAS assumes a value of 1.

Therefore, you can specify TITLE or TITLE1 for the first title line. By default, SAS centers a title.

To add the title 'SAT Scores by Year, 1972-1998' to your output, use the following TITLE statement:

```
title 'SAT Scores by Year, 1972-1998';
```

The TITLE statement is a global statement. This means that within a SAS session, SAS continues to use the most recently created title until you change or eliminate it, even if you generate different output later. You can use the TITLE statement anywhere in your program.

You can specify up to ten titles per page by numbering them in ascending order. If you want to add a subtitle to your previous title, then number your titles by the order in which you want them to appear. For example, use the TITLE3 statement to create the subtitle 'Separate Statistics by Test Type'. To add a blank line between titles, skip a number as you number your TITLE statements. Your TITLE statements now become

```
title1 'SAT Scores by Year, 1972-1998';
title3 'Separate Statistics by Test Type';
```

To modify a title line, you change the text in the title and resubmit your program, including all of the TITLE statements. Be aware that a TITLE statement for a given line cancels the previous TITLE statement for that line and for all lines with higher-numbered titles.

To eliminate all titles including the default title, specify

```
title;
```

or

```
title1;
```

The following example shows how to use multiple TITLE statements.

```
libname admin 'SAS-data-library';

data report;
   set admin.sat_scores;
   if year ge 1995 then output;
   title1 'SAT Scores by Year, 1995-1998';
   title3 'Separate Statistics by Test Type';
run;

proc print data=report;
run;
```

The following output displays the results.

Output 33.2 *Report Showing Multiple TITLE Statements*

Results Viewer - SAS Output

SAT Scores by Year, 1995-1998

Separate Statistics by Test Type

Obs	Test	Gender	Year	SATscore
1	Verbal	m	1995	505
2	Verbal	f	1995	502
3	Verbal	m	1996	507
4	Verbal	f	1996	503
5	Verbal	m	1997	507
6	Verbal	f	1997	503
7	Verbal	m	1998	509
8	Verbal	f	1998	502
9	Math	m	1995	525
10	Math	f	1995	490
11	Math	m	1996	527
12	Math	f	1996	492
13	Math	m	1997	530
14	Math	f	1997	494
15	Math	m	1998	531
16	Math	f	1998	496

Although the TITLE statement can appear anywhere in your program, you can associate the TITLE statement with a particular procedure step by positioning it in one of the following locations:

- before the step that produces the output
- after the procedure statement but before the next DATA or RUN statement, or the next procedure

Remember that the TITLE statement applies globally until you change or eliminate it.

Adding Footnotes

The FOOTNOTE statement follows the same guidelines as the TITLE statement. The FOOTNOTE statement is a global statement. This means that within a SAS session, SAS continues to use the most recently created footnote until you change or eliminate it, even if you generate different output later. You can use the FOOTNOTE statement anywhere in your program.

A footnote writes up to ten lines of text at the bottom of the procedure output or DATA step output. The form of the FOOTNOTE statement is:

FOOTNOTE<*n*> <'*text*'>;

where *n* specifies the relative line to be occupied by the footnote, and *text* specifies the text of the footnote. The value of *n* can be 1 to 10. If you omit *n*, SAS assumes a value of 1.

To add the footnote '1967 and 1970 SAT scores estimated based on total number of people taking the SAT,' specify the following statements anywhere in your program:

```
footnote1 '1967 and 1970 SAT scores estimated based on total number';
footnote2 'of people taking the SAT';
```

You can specify up to ten lines of footnotes per page by numbering them in ascending order. When you alter the text of one footnote in a series and execute your program again, SAS changes the text of that footnote. However, if you execute your program with numbered FOOTNOTE statements, SAS eliminates all higher-numbered footnotes.

```
footnote;
```

or

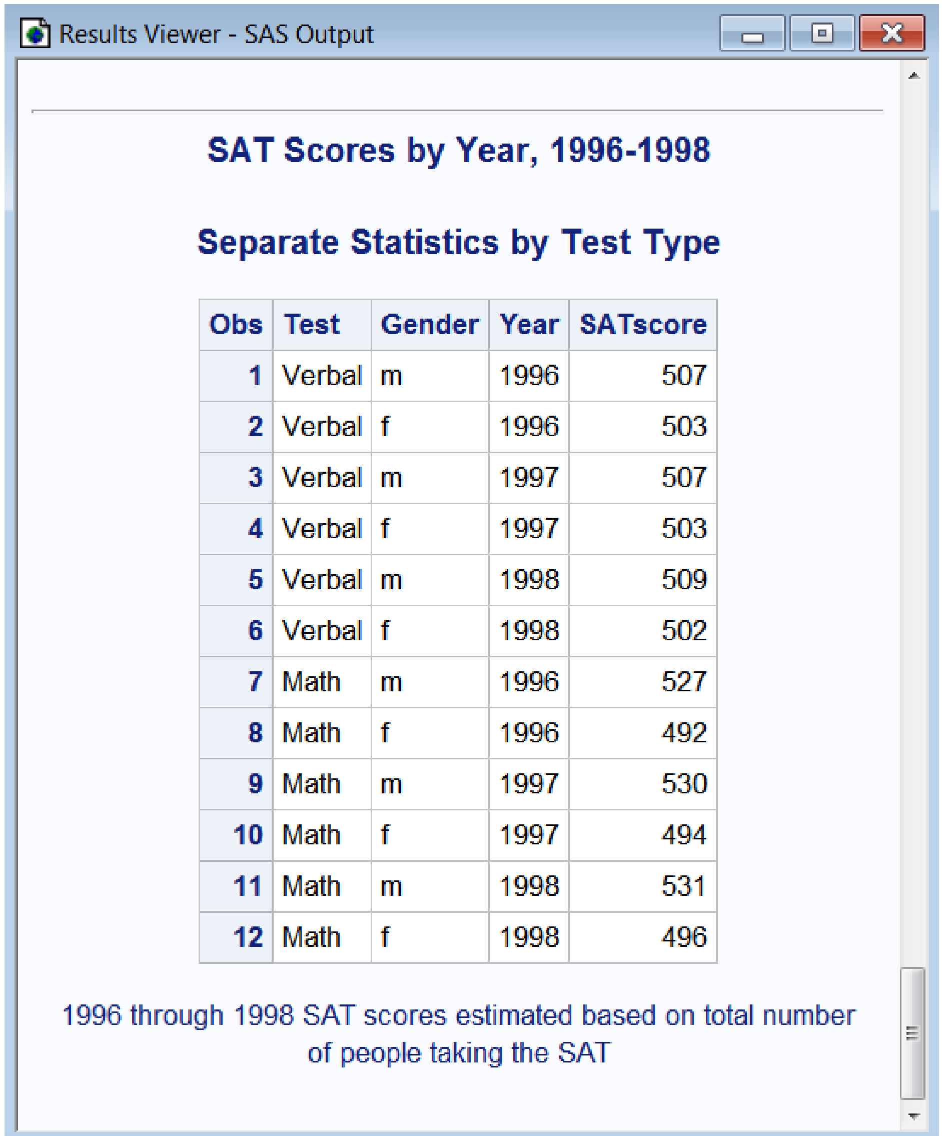
```
footnote1;
```

The following example shows how to use multiple FOOTNOTE statements.

```
libname admin 'SAS-data-library';

data report;
   set admin.sat_scores;
   if year ge 1996 then output;
   title1 'SAT Scores by Year, 1996-1998';
   title3 'Separate Statistics by Test Type';
   footnote1 '1996 through 1998 SAT scores estimated based on total number';
   footnote2 'of people taking the SAT';
run;

proc print data=report;
run;
```

The following output displays the results.

Output 33.3 *Report Showing a Footnote*



SAT Scores by Year, 1996-1998

Separate Statistics by Test Type

Obs	Test	Gender	Year	SATscore
1	Verbal	m	1996	507
2	Verbal	f	1996	503
3	Verbal	m	1997	507
4	Verbal	f	1997	503
5	Verbal	m	1998	509
6	Verbal	f	1998	502
7	Math	m	1996	527
8	Math	f	1996	492
9	Math	m	1997	530
10	Math	f	1997	494
11	Math	m	1998	531
12	Math	f	1998	496

1996 through 1998 SAT scores estimated based on total number of people taking the SAT

Although the FOOTNOTE statement can appear anywhere in your program, you can associate the FOOTNOTE statement with a particular procedure step by positioning it at one of the following locations:

- after the RUN statement for the previous step
- after the procedure statement but before the next DATA or RUN statement, or before the next procedure

Remember that the FOOTNOTE statement applies globally until you change or eliminate it.

Labeling Variables

In procedure output, SAS automatically writes the variables with the names that you specify. However, you can designate a label for some or all of your variables by specifying a LABEL statement either in the DATA step or, with some procedures, in the PROC step of your program. Your label can be up to 256 characters long, including blanks.

For example, to describe the variable SATscore with the phrase 'SAT Score,' specify

```
label SATscore ='SAT Score';
```

If you specify the LABEL statement in the DATA step, the label is permanently stored in the data set. If you specify the LABEL statement in the PROC step, the label is associated with the variable only for the duration of the PROC step. In either case, when a label is assigned, it is written with almost all SAS procedures. The exception is the PRINT procedure. Whether you put the LABEL statement in the DATA step or in the PROC step, with the PRINT procedure, you must specify the LABEL option as follows:

```
proc print data=report label;
run;
```

The following example shows how to use a label statement.

```
libname admin 'SAS-data-library';

data report;
   set admin.sat_scores;
   if year ge 1996 then output;
   label Test='Test Type'
         SATscore='SAT Score';
   title1 'SAT Scores by Year, 1996-1998';
   title3 'Separate Statistics by Test Type';
   footnote1 '1967 and 1970 SAT scores estimated based on total number';
   footnote2 'of people taking the SAT';
run;

proc print data=report label;
run;
```

The following output displays the results.

Output 33.4 *Variable Labels in SAS Output*

Results Viewer - SAS Output

SAT Scores by Year, 1996-1998

Separate Statistics by Test Type

Obs	Test Type	Gender	Year	SAT Score
1	Verbal	m	1996	507
2	Verbal	f	1996	503
3	Verbal	m	1997	507
4	Verbal	f	1997	503
5	Verbal	m	1998	509
6	Verbal	f	1998	502
7	Math	m	1996	527
8	Math	f	1996	492
9	Math	m	1997	530
10	Math	f	1997	494
11	Math	m	1998	531
12	Math	f	1998	496

1996 through 1998 SAT scores estimated based on total number of people taking the SAT

Developing Descriptive Output

The following example incorporates the TITLE, LABEL, and FOOTNOTE statements, and produces output.

```
libname admin 'SAS-data-library';

proc sort data=admin.sat_scores;
   by gender;
run;

proc means data=admin.sat_scores maxdec=2 fw=8;
   by gender;
   label SATscore='SAT score';
   title1 'SAT Scores by Year, 1967-1976';
   title3 'Separate Statistics by Test Type';
   footnote1 '1972 and 1976 SAT scores estimated based on the';
```

```
    footnote2 'total number of people taking the SAT';
run;
```

The following output displays the results.

Output 33.5 *Titles, Labels, and Footnotes in SAS Output*

Results Viewer - SAS Output

SAT Scores by Year, 1967-1976

Separate Statistics by Test Type

The MEANS Procedure

Gender=f

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
Year		54	1985.00	7.86	1972.00	1998.00
SATscore	SAT score	54	492.43	13.13	473.00	529.00

Gender=m

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
Year		54	1985.00	7.86	1972.00	1998.00
SATscore	SAT score	54	516.02	7.91	501.00	531.00

1972 and 1976 SAT scores estimated based on the
total number of people taking the SAT

Controlling Output Appearance of Listing Output

Specifying SAS System Options

You can enhance the appearance of your Listing output by specifying SAS system options in the OPTIONS statement. The changes that result from specifying system options remain in effect for the rest of the job, session, or SAS process, or until you issue another OPTIONS statement to change the options.

You can specify SAS system options through the OPTIONS statement, through the OPTIONS window, at SAS invocation, at the initiation of a SAS process, and in a configuration file. Default option settings can vary among sites. To determine the settings at your site, execute the OPTIONS procedure or browse the OPTIONS window.

The OPTIONS statement has the following form:

OPTIONS *options*;

where *option* specifies one or more SAS options that you want to change.

Note: An OPTIONS statement can appear at any place in a SAS program, except within data lines.

Numbering Pages

By default, SAS numbers pages of output starting with page 1. However, you can suppress page numbers with the NONUMBER system option. To suppress page numbers, specify the following OPTIONS statement:

```
options nonumber;
```

This option, like all SAS system options, remains in effect for the duration of your session or until you change it. Change the option by specifying

```
options number;
```

You can use the PAGENO= system option to specify a beginning page number for the next page of output that SAS writes. The PAGENO= option enables you to reset page numbering in the middle of a SAS session. For example, the following OPTIONS statement resets the next output page number to 5:

```
options pageno=5;
```

Centering Output

By default, SAS centers both the output and output titles. However, you can left-align your output by specifying the following OPTIONS statement:

```
options nocenter;
```

The NOCENTER option remains in effect for the duration of your SAS session or until you change it. Change the option by specifying

```
options center;
```

Specifying Page and Line Size

Procedure output is scaled automatically to fit the size of the page and line. The number of lines per page and the number of characters per line of printed output are determined by the settings of the PAGESIZE= and LINESIZE= system options. The default settings vary from site to site and are further affected by the machine, operating environment, and method of running SAS. For example, when SAS runs in interactive mode, the PAGESIZE= option by default assumes the size of the device that you specify. You can adjust both your page size and line size by resetting the PAGESIZE= and LINESIZE= options.

For example, you can specify the following OPTIONS statement:

```
options pagesize=40 linesize=64;
```

The PAGESIZE= and LINESIZE= options remain in effect for the duration of your SAS session or until you change them.

Writing Date and Time Values

By default, SAS writes at the top of your output the beginning date and time of the SAS session during which your job executed. This automatic record is especially useful when you execute a program many times. However, you can use the NODATE system option to specify that these values not appear. To do this, specify the following OPTIONS statement:

```
options nodate;
```

The NODATE option remains in effect for the duration of your SAS session or until you change it.

Choosing Options Selectively

Choose the system options that you need to meet your specifications. The following program, which uses the conditional IF-THEN/ELSE statement to subset the data set, includes a number of SAS options. The OPTIONS statement specifies a line size of 64, left-aligns the output, numbers the output pages and supplies the date on which the SAS session was started. Because HTML output is created by default, you should first close the ODS HTML destination with the ODS HTML CLOSE statement. If you do not want to create HTML output, closing the HTML destination saves system resources. The ODS LISTING destination is closed by default. You must specify the ODS LISTING statement to open the LISTING destination and create Listing output.

```
ods html close;
ods listing;
options linesize=64 nocenter number date;

libname admin 'SAS-data-library';

data high_scores;
   set admin.sat_scores;
   if SATscore < 525 then delete;
run;

proc print data=high_scores;
   title 'SAT Scores: 525 and Above';
run;
ods listing close;
```

The following output displays the results.

Output 33.6 *Effect of System Options on Listing Output*

```
SAT Scores: 525 and Above                                              1
                              14:30 Thursday, May 2, 2013


Obs     Test     Gender    Year    SATscore

 1     Verbal      m       1972       531
 2     Verbal      f       1972       529
 3     Math        m       1972       527
 4     Math        m       1973       525
 5     Math        m       1995       525
 6     Math        m       1996       527
 7     Math        m       1997       530
 8     Math        m       1998       531
```

Controlling the Appearance of Pages

Input Data Set for Examples of Multiple-page Reports

In the sections that follow, you learn how to customize multiple-page reports.

The following program creates and prints a SAS data set that contains newspaper circulation figures for morning and evening editions. Each record lists the state, morning circulation figures (in thousands), evening circulation figures (in thousands), and year that the data represents. Because HTML output is created by default, you should first close the ODS HTML destination with the ODS HTML CLOSE statement. If you do not want to create HTML output, closing the HTML destination saves system resources. The ODS LISTING destination is closed by default. You must specify the ODS LISTING statement to open the LISTING destination and create Listing output.

```
data circulation_figures;
   length state $ 15;
   input state $ morning_copies evening_copies year;
   datalines;
Colorado  738.6 210.2 1984
Colorado  742.2 212.3 1985
Colorado  731.7 209.7 1986
Colorado  789.2 155.9 1987
Vermont   623.4 566.1 1984
Vermont   533.1 455.9 1985
Vermont   544.2 566.7 1986
Vermont   322.3 423.8 1987
Alaska     51.0  80.7 1984
Alaska     58.7  78.3 1985
Alaska     59.8  70.9 1986
```

```
Alaska      64.3  64.6 1987
Alabama    256.3 480.5 1984
Alabama    291.5 454.3 1985
Alabama    303.6 454.7 1986
Alabama        .  454.5 1987
Maine          .      .  1984
Maine          .   68.0 1985
Maine      222.7  68.6 1986
Maine      224.1  66.7 1987
Hawaii     433.5 122.3 1984
Hawaii     455.6 245.1 1985
Hawaii     499.3 355.2 1986
Hawaii     503.2 488.6 1987
;
run;


ods html close;
ods listing;
proc print data=circulation_figures;

ods listing close;
```

The following output displays the results.

Output 33.7 *SAS Data Set CIRCULATION_FIGURES*

```
                         The SAS System                              1

                         morning_    evening_
         Obs     state      copies      copies     year

           1     Colorado    738.6       210.2     1984
           2     Colorado    742.2       212.3     1985
           3     Colorado    731.7       209.7     1986
           4     Colorado    789.2       155.9     1987
           5     Vermont     623.4       566.1     1984
           6     Vermont     533.1       455.9     1985
           7     Vermont     544.2       566.7     1986
           8     Vermont     322.3       423.8     1987
           9     Alaska       51.0        80.7     1984
          10     Alaska       58.7        78.3     1985
          11     Alaska       59.8        70.9     1986
          12     Alaska       64.3        64.6     1987
          13     Alabama     256.3       480.5     1984
          14     Alabama     291.5       454.3     1985
          15     Alabama     303.6       454.7     1986
```

```
                 The SAS System                                2

                      morning_     evening_
   Obs       state      copies       copies      year

    16     Alabama           .        454.5      1987
    17     Maine             .            .      1984
    18     Maine             .         68.0      1985
    19     Maine         222.7         68.6      1986
    20     Maine         224.1         66.7      1987
    21     Hawaii        433.5        122.3      1984
    22     Hawaii        455.6        245.1      1985
    23     Hawaii        499.3        355.2      1986
    24     Hawaii        503.2        488.6      1987
```

Writing Centered Title and Column Headings

Producing centered titles with TITLE statements is easy, because centering is the default for the TITLE statement. Producing column headings is not so easy. You must insert the correct number of blanks in the TITLE statements so that the entire title, when centered, causes the text to fall in the correct columns. The following example shows how to write centered lines and column headings. The titles and column headings appear at the top of every page of output.

```
ods html close;
ods listing;

options linesize=80 pagesize=20 nodate;

data report1;
   infile 'your-data-file';
   input state $ morning_copies evening_copies year;
run;

title 'Morning and Evening Newspaper Circulation';
title2;
title3
      'State          Year                      Thousands of Copies';
title4
      '                                           Morning       
Evening';

data _null_;
   set report1;
   by state notsorted;
   file print;
   if first.state then
      do;
         morning_total=0;
         evening_total=0;
         put / @7 state @;
      end;
   put @26 year @53 morning_copies 5.1 @66 evening_copies 5.1;
   morning_total+morning_copies;
```

```
      evening_total+evening_copies;
      if last.state then
         do;
            all_totals=morning_total+evening_total;
            put @52 '------' @65 '------' /
                @26 'Total for each category'
                @52 morning_total 6.1 @65 evening_total 6.1
/
                @35 'Combined total' @59 all_totals 6.1;
         end;
   run;
   ods listing close;
```

The following output displays the results.

Output 33.8 Centered Lines and Column Headings in SAS Output

```
                Morning and Evening Newspaper Circulation                   1

    State         Year                    Thousands of Copies
                                           Morning      Evening

Colorado          1984                      738.6        210.2
                  1985                      742.2        212.3
                  1986                      731.7        209.7
                  1987                      789.2        155.9
                                           ------       ------
                  Total for each category  3001.7        788.1
                           Combined total         3789.8

Vermont           1984                      623.4        566.1
                  1985                      533.1        455.9
                  1986                      544.2        566.7
                  1987                      322.3        423.8
                                           ------       ------
                  Total for each category  2023.0       2012.5
                           Combined total         4035.5
```

```
                Morning and Evening Newspaper Circulation                   2

    State         Year                    Thousands of Copies
                                           Morning      Evening

Alaska            1984                       51.0         80.7
                  1985                       58.7         78.3
                  1986                       59.8         70.9
                  1987                       64.3         64.6
                                           ------       ------
                  Total for each category   233.8        294.5
                           Combined total          528.3

Alabama           1984                      256.3        480.5
                  1985                      291.5        454.3
                  1986                      303.6        454.7
                  1987                          .        454.5
                                           ------       ------
                  Total for each category   851.4       1844.0
                           Combined total         2695.4
```

```
              Morning and Evening Newspaper Circulation                  3

     State          Year                    Thousands of Copies
                                             Morning      Evening

 Maine              1984                          .            .
                    1985                          .          68.0
                    1986                       222.7         68.6
                    1987                       224.1         66.7
                                              ------       ------
                    Total for each category    446.8        203.3
                             Combined total          650.1

 Hawaii             1984                       433.5        122.3
                    1985                       455.6        245.1
                    1986                       499.3        355.2
                    1987                       503.2        488.6
                                              ------       ------
                    Total for each category   1891.6       1211.2
                             Combined total         3102.8
```

When you create titles and column headings with TITLE statements, consider the following:

- SAS writes page numbers on title lines by default. Therefore, page numbers appear in this report. If you do not want page numbers, specify the NONUMBER system option.
- The PUT statement pointer begins on the first line after the last TITLE statement. SAS does not skip a line before beginning the text as it does with procedure output. In this example, the blank line between the TITLE4 statement and the first line of data for each state is produced by the slash (/) in the PUT statement in the FIRST.STATE group.

Writing Titles and Column Headings in Specific Columns

The easiest way to program headings in specific columns is to use a PUT statement. Instead of calculating the exact number of blanks that are required to make text fall in particular columns, you move the pointer to the appropriate column with pointer controls and write the text. To write headings with a PUT statement, you must execute the PUT statement at the beginning of each page, regardless of the observation that is being processed or the iteration of the DATA step. The FILE statement with the HEADER= option specifies the headings that you want to write.

Use the following form of the FILE statement to specify column headings.

FILE PRINT HEADER=*label*;

PRINT is a reserved fileref that directs output that is produced by any PUT statements to the same print file as the output that is produced by SAS procedures. The *label* variable defines a statement label that identifies a group of SAS statements that execute each time SAS begins a new output page.

The following program uses the HEADER= option of the FILE statement to add a header routine to the DATA step. The routine uses pointer controls in the PUT statement to write the title, skip two lines, and then write column headings in specific locations.

```
ods html close;
```

```
ods listing;

options linesize=80 pagesize=24;

data _null_;
   set circulation_figures;
   by state notsorted;
   file print notitles header=pagetop;
1
   if first.state then
         do;
            morning_total=0;
            evening_total=0;
            put / @7 state @;
         end;
   put @26 year @53 morning_copies 5.1 @66 evening_copies 5.1;
   morning_total+morning_copies;
   evening_total+evening_copies;
   if last.state then
      do;
         all_totals=morning_total+evening_total;
         put @52 '------' @65 '------' /
             @26 'Total for each category'
             @52 morning_total 6.1 @65 evening_total 6.1 /
             @35 'Combined total' @59 all_totals 6.1;
      end;
   return; 2
   pagetop: 3
      put @16 'Morning and Evening Newspaper Circulation' //
          @7 'State' @26 'Year' @51 'Thousands of Copies'/
          @51 'Morning      Evening';
   return; 4
   run;
ods listing close;
```

The following list corresponds to the numbered items in the preceding program:

1 The PRINT fileref in the FILE statement creates Listing output. The NOTITLES option eliminates title lines so that the lines can be used by the PUT statement. The HEADER= option defines a statement label that points to a group of SAS statements that executes each time SAS begins a new output page. (You can use the HEADER= option only for creating print files.)

2 The RETURN statement that is located before the header routine marks the end of the main part of the DATA step. It causes execution to return to the beginning of the step for another iteration. Without this return statement, the statements in the header routine would be executed during each iteration of the DATA step, as well as at the beginning of each page.

3 The pagetop: label identifies the header routine. Each time SAS begins a new page, execution moves from its current position to the label pagetop: and continues until SAS encounters the RETURN statement. When execution reaches the RETURN statement at the end of the header routine, execution returns to the statement that was being executed when SAS began a new page.

4 The RETURN statement ends the header routine. Execution returns to the statement that was being executed when SAS began a new page.

The following output displays the results.

Output 33.9 *Title and Column Headings in Specific Locations*

```
          Morning and Evening Newspaper Circulation

 State              Year                    Thousands of Copies
                                            Morning      Evening

 Colorado           1984                      738.6        210.2
                    1985                      742.2        212.3
                    1986                      731.7        209.7
                    1987                      789.2        155.9
                                             ------       ------
                    Total for each category  3001.7        788.1
                             Combined total         3789.8

 Vermont            1984                      623.4        566.1
                    1985                      533.1        455.9
                    1986                      544.2        566.7
                    1987                      322.3        423.8
                                             ------       ------
                    Total for each category  2023.0       2012.5
                             Combined total         4035.5

 Alaska             1984                       51.0         80.7
                    1985                       58.7         78.3
                    1986                       59.8
70.9
```

```
          Morning and Evening Newspaper Circulation

 State              Year                    Thousands of Copies
                                            Morning      Evening
                    1987                       64.3         64.6
                                             ------       ------
                    Total for each category   233.8        294.5
                             Combined total          528.3

 Alabama            1984                      256.3        480.5
                    1985                      291.5        454.3
                    1986                      303.6        454.7
                    1987                          .        454.5
                                             ------       ------
                    Total for each category   851.4       1844.0
                             Combined total         2695.4

 Maine              1984                          .            .
                    1985                          .         68.0
                    1986                      222.7         68.6
                    1987                      224.1         66.7
                                             ------       ------
                    Total for each category   446.8        203.3
                             Combined total          650.1
```

Changing a Portion of a Heading

You can use variable values to create headings that change on every page. For example, if you eliminate the default page numbers in the procedure output file, you can create your own page numbers as part of the heading. You can also write the numbers differently from the default method. For example, you can write "Page 1" rather than “1.” Page numbers are an example of a heading that changes with each new page.

The following program creates page numbers using a Sum statement and writes the numbers as part of the header routine.

```
ods html close;
ods listing;
options linesize=80 pagesize=24;

data _null_;
   set circulation_figures;
   by state notsorted;
   file print notitles header=pagetop;
   if first.state then
         do;
            morning_total=0;
            evening_total=0;
            put / @7 state @;
         end;
   put @26 year @53 morning_copies 5.1 @66 evening_copies 5.1;
   morning_total+morning_copies;
   evening_total+evening_copies;
   if last.state then
      do;
         all_totals=morning_total+evening_total;
         put @52 '------' @65 '------' /
             @26 'Total for each category'
             @52 morning_total 6.1 @65 evening_total 6.1 /
             @35 'Combined total' @59 all_totals 6.1;
      end;
   return;

   pagetop:
      pagenum+1;  1
      put @16 'Morning and Evening Newspaper Circulation'
              @67 'Page ' pagenum //
2
          @7 'State' @26 'Year' @51 'Thousands of Copies'/
          @51 'Morning      Evening';
   return;
run;
ods listing close;
```

The following list corresponds to the numbered items in the preceding program:

1 In this Sum statement, SAS adds the value 1 to the accumulator variable PAGENUM each time a new page begins.

2 The literal Page and the current page number are printed at the top of each new page.

The following output displays the results.

Output 33.10 *Changing a Portion of a Heading*

```
           Morning and Evening Newspaper Circulation          Page 1

     State              Year                    Thousands of Copies
                                                Morning      Evening

     Colorado           1984                      738.6        210.2
                        1985                      742.2        212.3
                        1986                      731.7        209.7
                        1987                      789.2        155.9
                                                 ------       ------
                        Total for each category  3001.7        788.1
                                 Combined total         3789.8

     Vermont            1984                      623.4        566.1
                        1985                      533.1        455.9
                        1986                      544.2        566.7
                        1987                      322.3        423.8
                                                 ------       ------
                        Total for each category  2023.0       2012.5
                                 Combined total         4035.5

     Alaska             1984                       51.0         80.7
                        1985                       58.7         78.3
                        1986                       59.8
70.9
```

```
           Morning and Evening Newspaper Circulation          Page 2

     State              Year                    Thousands of Copies
                                                Morning      Evening
                        1987                       64.3         64.6
                                                 ------       ------
                        Total for each category   233.8        294.5
                                 Combined total          528.3

     Alabama            1984                      256.3        480.5
                        1985                      291.5        454.3
                        1986                      303.6        454.7
                        1987                         .         454.5
                                                 ------       ------
                        Total for each category   851.4       1844.0
                                 Combined total         2695.4

     Maine              1984                         .            .
                        1985                         .          68.0
                        1986                      222.7         68.6
                        1987                      224.1         66.7
                                                 ------       ------
                        Total for each category   446.8        203.3
                                 Combined total          650.1
```

Controlling Page Divisions

The report in Output 33.10 on page 660 automatically splits the data for Alaska over two pages. To make attractive page divisions, you need to know that there is sufficient space on a page to print all the data for a particular state before you print any data for it.

First, you must know how many lines are needed to print a group of data. Then you use the LINESLEFT= option in the FILE statement to create a variable whose value is the number of lines remaining on the current page. Before you begin writing a group of data, compare the number of lines that you need to the value of that variable. If more lines are required than are available, use the _PAGE_ pointer control to advance the pointer to the first line of a new page.

In your report, the maximum number of lines that you need for any state is eight (four years of circulation data for each state plus four lines for the underline, the totals, and the blank line between states). The following program creates a variable named CKLINES and compares its value to eight at the beginning of each BY group. If the value is less than eight, SAS begins a new page before writing that state.

```
ods html close;
ods listing;
options pagesize=24;

data _null_;
   set circulation_figures;
   by state notsorted;
   file print notitles header=pagetop linesleft=cklines;
   if first.state then
         do;
            morning_total=0;
            evening_total=0;
            if cklines<8 then put _page_;
            put / @7 state @;
         end;
   put @26 year @53 morning_copies 5.1 @66 evening_copies 5.1;
   morning_total+morning_copies;
   evening_total+evening_copies;
   if last.state then
      do;
         all_totals=morning_total+evening_total;
         put @52 '------' @65 '------' /
             @26 'Total for each category'
             @52 morning_total 6.1 @65 evening_total 6.1 /
             @35 'Combined total' @59 all_totals 6.1;
      end;
   return;

   pagetop:
      pagenum+1;
      put @16 'Morning and Evening Newspaper Circulation'
              @67 'Page ' pagenum //
          @7 'State' @26 'Year' @51 'Thousands of Copies'/
          @51 'Morning      Evening';
   return;
run;
ods listing close;
```

The following output displays the results.

Output 33.11 *Output with Specific Page Divisions*

```
         Morning and Evening Newspaper Circulation         Page 1

State              Year                    Thousands of Copies
                                           Morning      Evening

Colorado           1984                      738.6        210.2
                   1985                      742.2        212.3
                   1986                      731.7        209.7
                   1987                      789.2        155.9
                                            ------       ------
                   Total for each category  3001.7        788.1
                            Combined total          3789.8

Vermont            1984                      623.4        566.1
                   1985                      533.1        455.9
                   1986                      544.2        566.7
                   1987                      322.3        423.8
                                            ------       ------
                   Total for each category  2023.0       2012.5
                            Combined total          4035.5
```

```
         Morning and Evening Newspaper Circulation         Page 2

State              Year                    Thousands of Copies
                                           Morning      Evening

Alaska             1984                       51.0         80.7
                   1985                       58.7         78.3
                   1986                       59.8         70.9
                   1987                       64.3         64.6
                                            ------       ------
                   Total for each category   233.8        294.5
                            Combined total           528.3

Alabama            1984                      256.3        480.5
                   1985                      291.5        454.3
                   1986                      303.6        454.7
                   1987                        .          454.5
                                            ------       ------
                   Total for each category   851.4       1844.0
                            Combined total          2695.4
```

```
         Morning and Evening Newspaper Circulation         Page 3

State              Year                    Thousands of Copies
                                           Morning      Evening

Maine              1984                        .            .
                   1985                        .          68.0
                   1986                      222.7         68.6
                   1987                      224.1         66.7
                                            ------       ------
                   Total for each category   446.8        203.3
                            Combined total           650.1
```

Representing Missing Values

Recognizing Default Values

In the following example, numeric data for male verbal and math scores is missing for 1972. Character data for gender is missing for math scores in 1975. By default, SAS replaces a missing numeric value with a period, and a missing character value with a blank when it creates the data set.

```
libname admin 'SAS-data-library';
data admin.sat_scores2;
   input Test $ 1-8 Gender $ 10 Year 12-15 SATscore 17-19;
   datalines;
verbal   m 1972 .
verbal   f 1972 529
verbal   m 1975 515
verbal   f 1975 509
math     m 1972 .
math     f 1972 489
math       1975 518
math       1975 479
;
run;


ods html close;
ods listing;

options pagesize=60 linesize=80 pageno=1 nodate;

proc print data=admin.sat_scores2;
   title 'SAT Scores for Years 1972 and 1975';
run;

ods listing close;
```

The following output displays the results.

Output 33.12 *Default Display of Missing Values*

```
                    SAT Scores for Years 1972 and 1975                     1

               Obs    Test     Gender    Year    SATscore

                1     verbal     m       1972        .
                2     verbal     f       1972       529
                3     verbal     m       1975       515
                4     verbal     f       1975       509
                5     math       m       1972        .
                6     math       f       1972       489
                7     math               1975       518
                8     math               1975       479
```

Customizing Output of Missing Values By Using a System Option

If your data set contains missing numeric values, you can use the MISSING= system option to display the missing values as a single character rather than as the default period. You specify the character that you want to use as the value of the MISSING= option. You can specify any single character.

In the following program, the MISSING= option in the OPTIONS statement causes the PRINT procedure to display the letter M, rather than a period, for each numeric missing value.

```
options missing='M' pageno=1;

libname admin 'SAS-data-library';
data admin.sat_scores2;
   input Test $ 1-8 Gender $ 10 Year 12-15 SATscore 17-19;
   datalines;
verbal   m 1972
verbal   f 1972 529
verbal   m 1975 515
verbal   f 1975 509
math     m 1972
math     f 1972 489
math       1975 518
math       1975 479
;

ods html close;
ods listing;

proc print data=admin.sat_scores2;
   title 'SAT Scores for Years 1972 and 1975';
run;
ods listing close;
```

The following output displays the results.

Output 33.13 Customized Output of Missing Numeric Values

```
                SAT Scores for Years 1972 and 1975                  1

          Obs     Test     Gender    Year    SATscore

           1     verbal      m       1972        M
           2     verbal      f       1972      529
           3     verbal      m       1975      515
           4     verbal      f       1975      509
           5     math        m       1972        M
           6     math        f       1972      489
           7     math                1975      518
           8     math                1975      479
```

Customizing Output of Missing Values By Using a Procedure

Using the FORMAT procedure is another way to represent missing numeric values. It enables you to customize missing values by formatting them. You first use the FORMAT procedure to define a format, and then use a FORMAT statement in a PROC or DATA step to associate the format with a variable.

The following program uses the FORMAT procedure to define a format, and then uses a FORMAT statement in the PROC step to associate the format with the variable SCORE. Note that you do not follow the format name with a period in the VALUE statement but a period always accompanies the format when you use it in a FORMAT statement.

```
ods html close;
ods listing;

options pageno=1;
libname admin 'SAS-data-library';

proc format;
   value xscore .='score unavailable';
run;

proc print data=admin.sat_scores2;
   format SATscore xscore.;
   title 'SAT Scores for Years 1972 and 1975';
run;

ods listing close;
```

The following output displays the results.

Output 33.14 *Numeric Missing Values Replaced by a Format*

```
                SAT Scores for Years 1972 and 1975                    1

        Obs     Test     Gender    Year        SATscore

         1     verbal      m       1972    score unavailable
         2     verbal      f       1972                  529
         3     verbal      m       1975                  515
         4     verbal      f       1975                  509
         5     math        m       1972    score unavailable
         6     math        f       1972                  489
         7     math                1975                  518
         8     math                1975                  479
```

Summary

Statements

FILE *file-specification*;
: identifies an external file that the DATA step uses to write output from a PUT statement.

FILE PRINT <HEADER=*label*> <LINESLEFT=*number-of-lines*>;
: directs the output that is produced by any PUT statements to the same print file as the output that is produced by SAS procedures. The HEADER option defines a statement label that identifies a group of SAS statements that you want to execute each time SAS begins a new output page. The LINESLEFT= option defines a variable whose value is the number of lines left on the current page.

FOOTNOTE <*n*> <'*text*'>;
: specifies up to ten footnote lines to be printed at the bottom of a page of output. The variable *n* specifies the relative line to be occupied by the footnote, and *text* specifies the text of the footnote.

LABEL variable='*label*';
: associates the variable that you specify with the descriptive text that you specify as the label. Your label can be up to 256 characters long, including blanks. You can use the LABEL statement in either the DATA step or the PROC step.

ODS LISTING <*options*>
: opens, manages, or closes the LISTING destination.

ODS HTML <*options*>
: opens, manages, or closes the HTML destination.

OPTIONS *options*;
: changes the value of one or more SAS system options.

TITLE <*n*> <'*text*'>;
: specifies up to ten title lines to be printed on each page of the procedure output file and other SAS output. The variable *n* specifies the relative line that contains the title line, and *text* specifies the text of the title.

SAS System Options

NUMBER | NONUMBER
: controls whether the page number is printed on the first title line of each page of output.

PAGENO=n
: resets the page number for the next page of output.

CENTER | NOCENTER
: controls whether SAS procedure output is centered.

PAGESIZE=n
: specifies the number of lines that can be printed per page of output.

LINESIZE=n
: specifies the printer line width for the SAS log and the standard procedure output file used by the DATA step and procedures.

DATE | NODATE
: controls whether the date and time are printed at the top of each page of the SAS log, the standard print file, or any file with the PRINT attribute.

MISSING='character'
: specifies the character to be printed for missing numeric variable values.

Learning More

ODS

- “Dictionary of ODS Language Statements” in *SAS Output Delivery System: User’s Guide*

SAS output

- Chapter 32, “Writing Lines to the SAS Log or to an Output File,” on page 619
- Chapter 34, “Understanding and Customizing SAS Output: The Output Delivery System (ODS),” on page 669

34

Understanding and Customizing SAS Output: The Output Delivery System (ODS)

Introduction to Customizing SAS Output By Using the Output Delivery System

Purpose

The Output Delivery System (ODS) enables you to produce output in a variety of formats, such as:

- HTML files
- PDF files
- RTF files (for use with Microsoft Word)
- PowerPoint slides
- output data sets

In this chapter, you will learn how to create ODS output for the formats that are listed above.

Prerequisites

Before using this chapter, you should be familiar with the concepts presented in:

- Chapter 1, “What is the SAS System?,” on page 3
- Chapter 24, “Directing SAS Output and the SAS Log,” on page 403

You should also be familiar with DATA step processing, and creating procedure output.

Input Data Set for Examples

The following program creates the original PROC TABULATE, PROC UNIVARIATE, and PROC SGPANEL output. These procedures produce summary statistics for the sales of office furniture in various countries. When you run this example program, you are creating ODS output. By default, HTML is created when you run code in the SAS windowing environment for Windows or UNIX. Your output (including your graphics) is sent to your Work directory. This output is viewable in the Results Viewer.

Note: By default, SAS stores output created by ODS in your Work directory. In the SAS windowing environment for Windows and UNIX, after you have opened and closed the HTML destination, your output goes to your current working directory.

You can use the ODS PREFERENCE statement anytime during your SAS session to return to the default behavior. This action is helpful when you are creating multiple graphics and do not want them to accumulate in your current working directory.

The program creates the following:

- one output object for PROC TABULATE
- fifteen output objects for PROC UNIVARIATE
- one output object for PROC SGPANEL

The following program creates the output that this chapter uses.

```
options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

title;

proc tabulate data=prdsale;
   class region division prodtype;
   classlev region division prodtype;
   var actual;
   keyword all sum;
   keylabel all='Total';
   table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         misstext=[label='Missing']
         box=[label='Region by Division and Type'];
run;

title 'Actual Product Sales';
title2 '(millions of dollars)';

proc univariate data=prdsale;
   by Country;
   var actual;
run;

title 'Sales Figures for First Quarter by Product';

proc sgpanel data=prdsale;
    where quarter=1;
    panelby product / novarname;
    vbar region / response=predict;
    vline region / response=actual lineattrs=GraphFit;
    colaxis fitpolicy=thin;
    rowaxis label='Sales';
run;
```

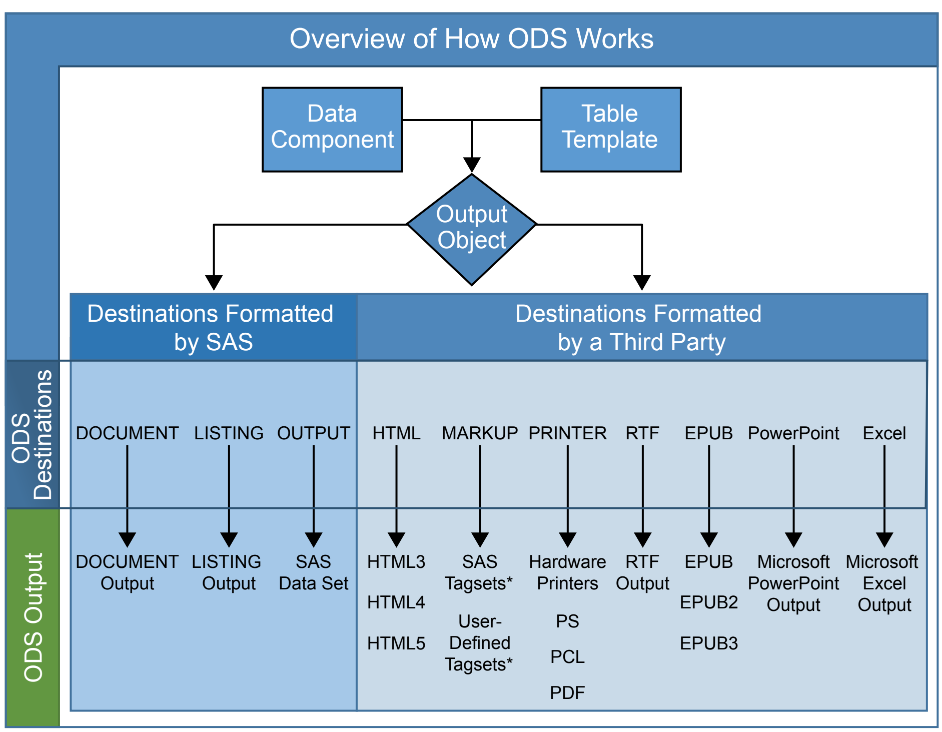
Note: The examples use filenames that might not be valid in all operating environments. For information about how your operating environment uses file specifications, see the documentation for your operating environment.

Understanding ODS Output Formats and Destinations

The Output Delivery System (ODS) enables you to produce output in a variety of formats that you can easily access. ODS creates various types of tabular output by combining raw data with one or more table templates to produce one or more output objects. The basic component of ODS functionality is the output object. The PROC or DATA step that you run provides the data component (raw data) and the name of the table template that contains the formatting instructions. The data component and table template together form the output object. These objects can be sent to any or all ODS destinations, such as PDF, HTML, RTF, or LISTING. By default, in the SAS windowing environment for Windows and UNIX, SAS uses ODS to produce HTML output. By default, in batch mode, SAS produces LISTING output. By specifying an ODS destination, you control the type of output that SAS creates.

The following figure illustrates the concept of output. The data and the table template form an output object, which creates the type of ODS output that you specified in the ODS template.

Figure 34.1 Model of the Production of ODS Output



The following definitions describe the terms in the preceding figure:

data component
: Each procedure that supports ODS and each DATA step produces data, which contains the results (numbers and characters) of the step in a form similar to a SAS data set.

table template
: The table template is a set of instructions that describes how to format the data. This description includes but is not limited to the following items:

- the order of the columns
- text and order of column headings
- formats for data
- font sizes and font faces

output object
: ODS combines formatting instructions with the data to produce an output object. The output object, therefore, contains both the results of the procedure or DATA step and information about how to format the results. An output object has a name, a label, and a path.

Note: Although many output objects include formatting instructions, not all of them do. In some cases the output object consists of only the data.

ODS destinations
: An ODS destination specifies a specific type of output. ODS supports a number of destinations, including but not limited to the following:

EPUB
produces output with the .epub extension. E-books that use the .epub format can be read by a wide variety of e-book readers.

HTML
produces HTML 4.0 output that contains embedded style sheets. You can access the output on the web with your web browser.

OUTPUT
produces a SAS data set.

POWERPOINT
produces PowerPoint output for Microsoft PowerPoint.

LISTING
produces traditional SAS output (monospace format).

PDF
produces PDF output, a form of output that is read by Adobe Acrobat and other applications.

PS
produces PDF output, a form of output that is read by Adobe Acrobat and other applications.

PRINTER
produces printable output.

RTF
produces output written in Rich Text Format for use with Microsoft Word 2002.

ODS output
: ODS output consists of formatted output from any of the ODS destinations.

For detailed information about ODS, see *SAS Output Delivery System: User's Guide*. For information about valid ODS destinations, see "Dictionary of ODS Language Statements" in *SAS Output Delivery System: User's Guide*.

Selecting an Output Format

You select the format for your output by opening and closing ODS destinations in your program. When one or more destinations are open, ODS can send output objects to them and produce formatted output. When a destination is closed, ODS does not send an output object to it and no output is produced.

By default, all programs automatically produce HTML output along with output for other destinations that you specifically open. Therefore, by default, the HTML destination is open, and all other destinations are closed.

To create formatted output, open one or more destinations by using the following statements:

ODS *destination file-specification(s)*;

The *destination* is one of the valid ODS destinations. The argument *file-specification* opens the destination and specifies one or more files to write to.

To view or print the ODS output that you have selected, you need to close all the destinations that you opened, except for the HTML destination. You can use separate statements to close individual destinations, or use one statement to close all destinations (including the HTML destination). To close ODS destinations, use the following statements:

ODS *destination* CLOSE;

ODS _ALL_ **CLOSE**;

Before you can view ODS output (other than the default destination), the ODS destination must be closed. If you run an example without closing the destination, the SAS log lists the file as being created, but you cannot access the file or see the file when you issue the ls command. To access the file, execute the following statement in your SAS session: ODS *destination* CLOSE;

Note: The ODS _ALL_ CLOSE statement, which closes all open destinations, is available with SAS Release 8.2 and higher.

In some cases you might not want to create HTML output. Use the `ODS HTML CLOSE;` statement at the beginning of your program to close the HTML destination and prevent SAS from producing HTML output. Closing unnecessary destinations conserves system resources.

Note: Because ODS statements are global statements, it is good practice to open the HTML destination at the end of your program. If you execute other programs in your current SAS session, HTML output is then available. To open the HTML destination, use the `ODS HTML;` statement at the end of your program.

Creating Formatted Output

Creating HTML Output for a Web Browser

Understanding the Four Types of HTML Output Files

HTML output is created b default. However, if you want to use ODS HTML statement options, or create a table file, page file, or frame file, you must use the ODS HTML statement. When you use the ODS HTML statement, you can create output that is formatted in HTML. You can browse the output files with Internet Explorer, Netscape, or any other browser that fully supports the HTML 4.

The ODS HTML statement can create four types of HTML files:

- a body file that contains the results of the DATA step or procedure
- a table of contents that links to items in the body file
- a table of pages that links to items in the body file
- a frame file that displays the results of the procedure or DATA step, the table of contents, and the table of pages

The body file is created by default with all ODS HTML output. If you do not want to link to your output, then creating a table of contents, a table of pages, and a frame file is not necessary.

Creating HTML Output: The Simplest Case

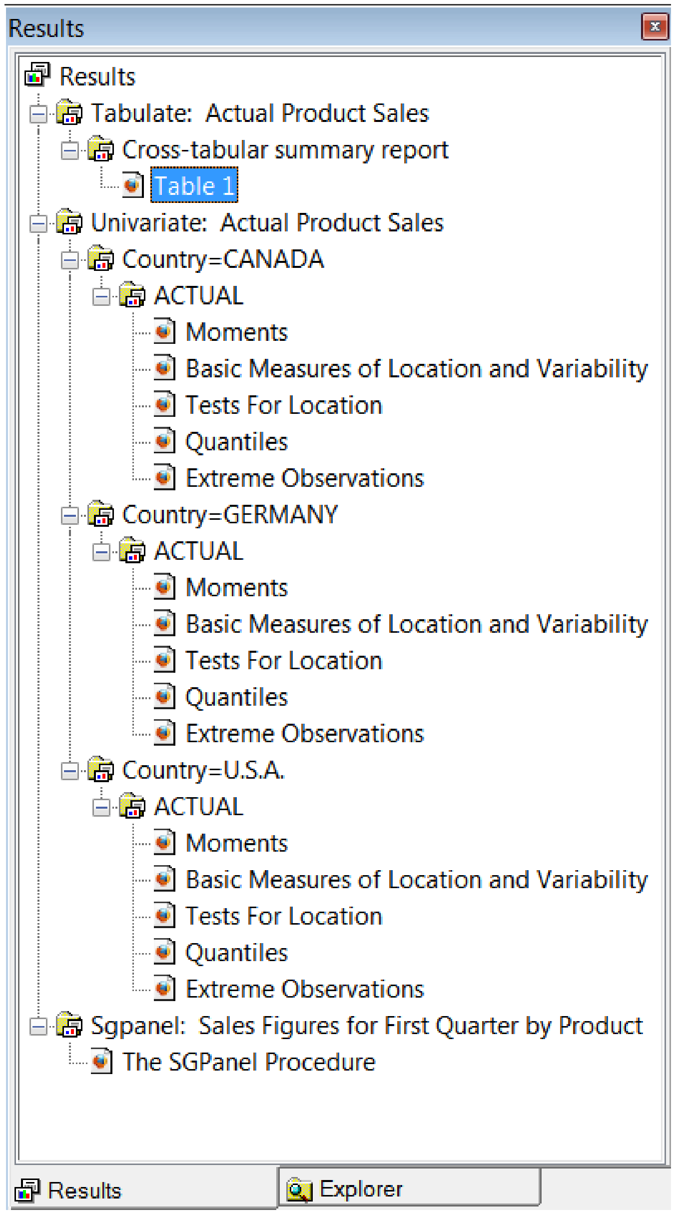
To produce the simplest type of HTML output, the only file that you need to create is a body file. The following example executes the SORT, MEANS, TABULATE, UNIVARIATE, and SGPANEL procedures. These files contain summary statistics for the sales of office furniture in various countries. Notice that no ODS statement is needed, because the HTML destination is open and SAS automatically creates the HTML body file.

```
options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

proc tabulate data=prdsale;
   class region division prodtype;
   classlev region division prodtype;
   var actual;
   keyword all sum;
   keylabel all='Total';
   table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         misstext=[label='Missing']
         box=[label='Region by Division and Type'];
```

```
 run;

title 'Actual Product Sales';
title2 '(millions of dollars)';

proc univariate data=prdsale;
   by Country;
   var actual;
run;

title 'Sales Figures for First Quarter by Product';

proc sgpanel data=prdsale;
    where quarter=1;
    panelby product / novarname;
    vbar region / response=predict;
    vline region / response=actual lineattrs=GraphFit;
    colaxis fitpolicy=thin;
    rowaxis label='Sales';
run;
```

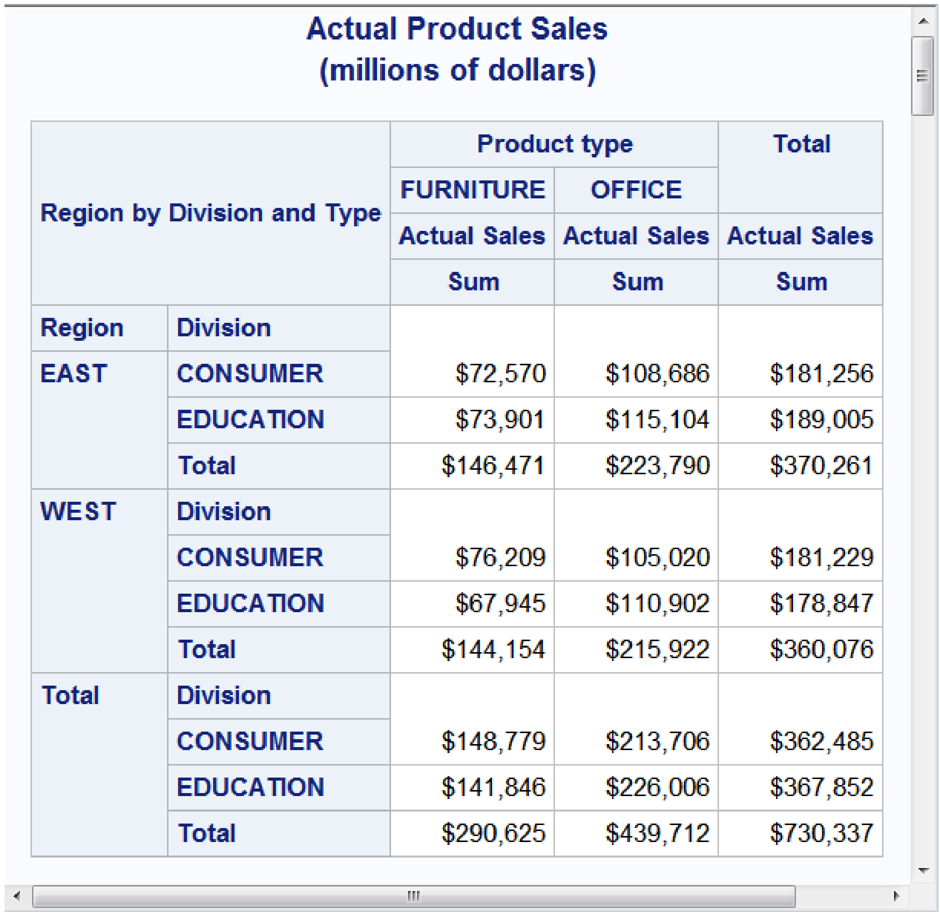
You can view the output in the Results Viewer window, and browse the output objects in the Results window. You can view information about each output object such as name, type, description, and template in the Table Properties window.

Figure 34.2 *Output Viewed in the Results Window*



In the Results window, the following output corresponds to the output object Table 1 under **Tabulate: Actual Product Sales** ⇨ **Cross-tabular summary report**. The name of this output object is Table 1.

Figure 34.3 PROC TABULATE Output



Actual Product Sales
(millions of dollars)

Region by Division and Type		Product type		Total
		FURNITURE	OFFICE	
		Actual Sales	Actual Sales	Actual Sales
		Sum	Sum	Sum
Region	Division			
EAST	CONSUMER	$72,570	$108,686	$181,256
	EDUCATION	$73,901	$115,104	$189,005
	Total	$146,471	$223,790	$370,261
WEST	Division			
	CONSUMER	$76,209	$105,020	$181,229
	EDUCATION	$67,945	$110,902	$178,847
	Total	$144,154	$215,922	$360,076
Total	Division			
	CONSUMER	$148,779	$213,706	$362,485
	EDUCATION	$141,846	$226,006	$367,852
	Total	$290,625	$439,712	$730,337

You can view the properties of each output object in the Table Properties window by right-clicking on the highlight output object and selecting **Properties** from the drop down list.

Figure 34.4 PROC TABULATE: Properties of Table 1

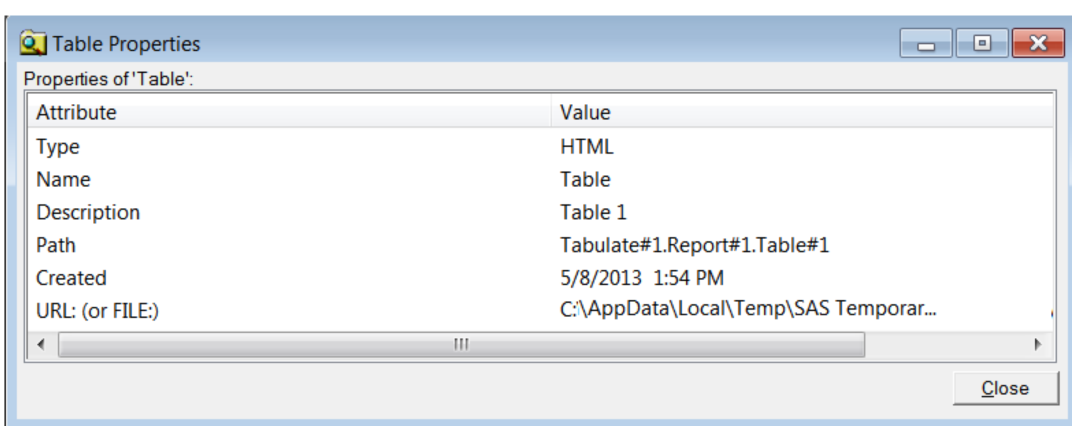


Table Properties

Properties of 'Table':

Attribute	Value
Type	HTML
Name	Table
Description	Table 1
Path	Tabulate#1.Report#1.Table#1
Created	5/8/2013 1:54 PM
URL: (or FILE:)	C:\AppData\Local\Temp\SAS Temporar...

Close

In the Results window, the following output corresponds to the output object Moments under: **Univariate: Actual Product Sales** ⇨ **Country=CANADA** ⇨ **ACTUAL**. The name of this output object is Moments.

Figure 34.5 *PROC UNIVARIATE Output*

Actual Product Sales
(millions of dollars)

The UNIVARIATE Procedure
Variable: ACTUAL (Actual Sales)

Country=CANADA

Moments			
N	480	**Sum Weights**	480
Mean	514.5625	**Sum Observations**	246990
Std Deviation	289.342982	**Variance**	83719.3614
Skewness	-0.0450336	**Kurtosis**	-1.1627896
Uncorrected SS	167193366	**Corrected SS**	40101574.1
Coeff Variation	56.2308723	**Std Error Mean**	13.2066399

Basic Statistical Measures			
Location		**Variability**	
Mean	514.5625	**Std Deviation**	289.34298
Median	513.5000	**Variance**	83719
Mode	688.0000	**Range**	997.00000

You can view the properties of each output object in the Table Properties window by right-clicking on the highlight output object and selecting **Properties** from the drop down list.

Figure 34.6 *PROC UNIVARIATE: Properties of Moments*

Moments Properties

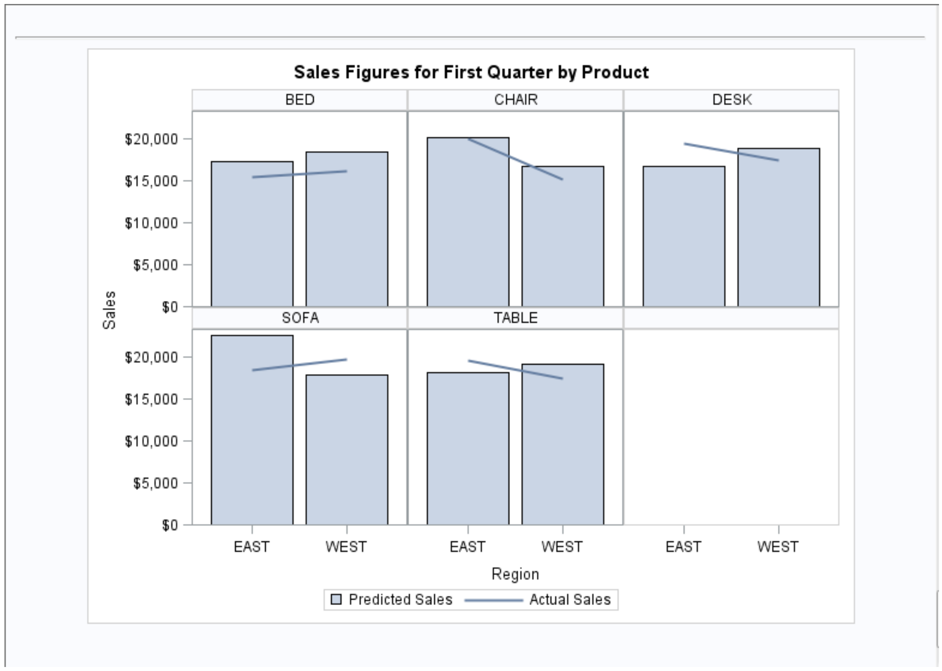
Properties of 'Moments':

Attribute	Value
Type	HTML
Name	Moments
Description	Moments
Template	base.univariate.Moments
Path	Univariate#1.ByGroup1#1.ACTUAL#1.Moments#1
Created	5/8/2013 1:54 PM
URL: (or FILE:)	C:\AppData\Local\Temp\SAS Temporar...

Close

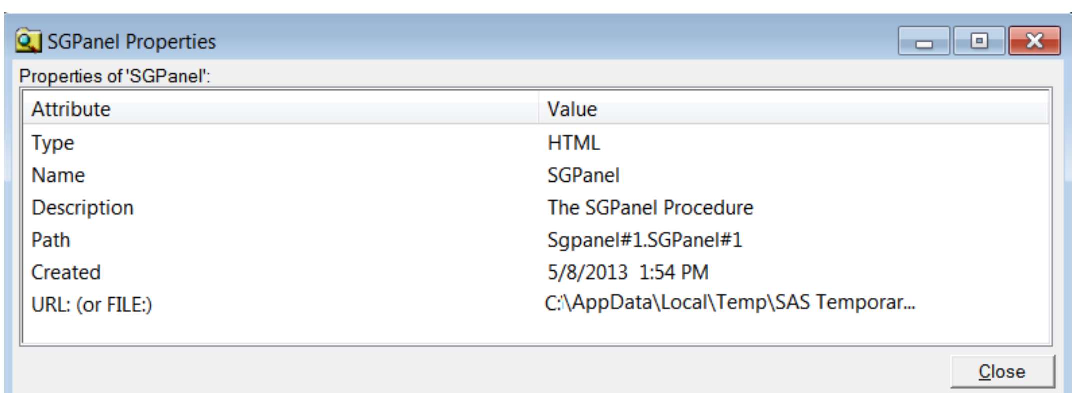
In the Results window, the following output corresponds to the output object **The SGPanel Procedure** under: **Sgpanel: Sales Figures for First Quarter by Product**. The name of this output object is SGPanel.

Figure 34.7 PROC SGPANEL Output



You can view the properties of each output object in the Table Properties window by right-clicking on the highlight output object and selecting **Properties** from the drop down list.

Figure 34.8 PROC SGPANEL: Properties of SGPanel



Creating HTML Output: Linking Results with a Table of Contents

The ODS HTML destination enables you to link to your results from a table of contents and a table of pages. To do this, you need to create the following HTML files: a body file, a frame file, a table of contents, and a table of pages. When you view the frame file and select a link in the table of contents or the table of pages, the HTML table that contains the selected part of the procedure results appears at the top of your browser.

The following example creates multiple pages of output from the UNIVARIATE procedure. You can access specific output results (tables) from links in the table of contents or the table of pages. The results contain statistics for the average SAT scores of entering first-year college classes. The output is grouped by the value of Gender in the CLASS statement and by the value of Test in the BY statement.

```
options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

1 ods html file='SalesFig-body.htm'
         contents='SalesFig-contents.htm'
         page='SalesFig-page.htm'
         frame='SalesFig-frame.htm';

2 proc tabulate data=prdsale;
   class region division prodtype;
   classlev region division prodtype;
   var actual;
   keyword all sum;
   keylabel all='Total';
   table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         misstext=[label='Missing']
         box=[label='Region by Division and Type'];
run;

title 'Actual Product Sales';
title2 '(millions of dollars)';

3 proc univariate data=prdsale;
   by Country;
   var actual;
run;

title 'Sales Figures for First Quarter by Product';

4 proc sgpanel data=prdsale;
    where quarter=1;
    panelby product / novarname;
    vbar region / response=predict;
    vline region / response=actual lineattrs=GraphFit;
    colaxis fitpolicy=thin;
    rowaxis label='Sales';
run;

5 ods html close;
6 ods html;
```

1 The ODS HTML statement opens the HTML destination and creates four types of files:

- the body file (created with the FILE= option), which contains the formatted data
- the contents file, which is a table of contents with links to items in the body file
- the page file, which is a table of pages with links to items in the body file

- the frame file, which displays the table of contents, the table of pages, and the body file

2. The TABULATE procedure creates a summary report for actual product sales.
3. The UNIVARIATE procedure creates moments, basic measures, quantiles, and extreme observations tables for the actual sales for each country.
4. The SGPANEL procedure creates a graph of the sales figures for the first quarter by product.
5. The ODS HTML CLOSE statement closes the HTML destination to make output available for viewing.
6. The ODS HTML statement reopens the HTML destination so that the next program that you run can produce HTML output.

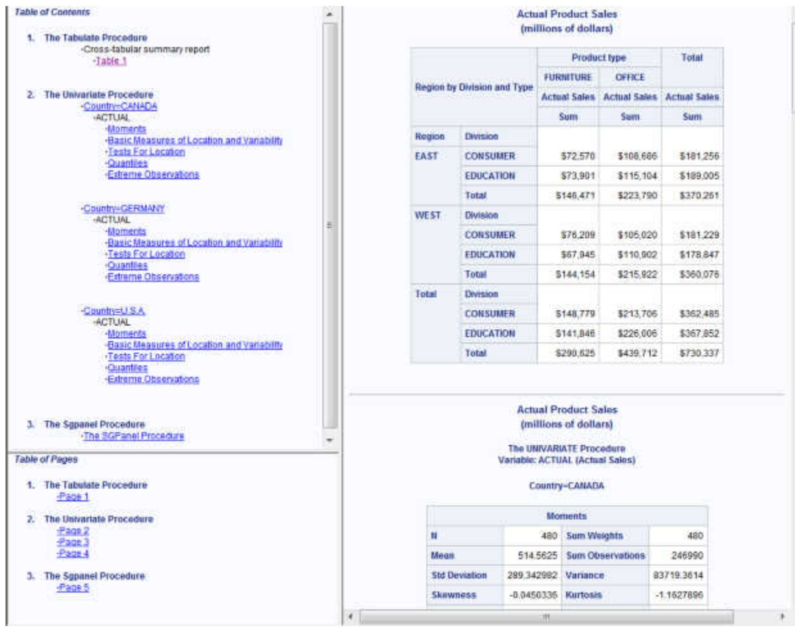
The following SAS log shows that four HTML files are created with the ODS HTML statement:

Example Code 34.1 *Partial SAS Log: HTML File Creation*

```
1    options nodate nonumber;
2    proc sort data=sashelp.prdsale out=prdsale;
3        by Country;
4    run;

NOTE: There were 1440 observations read from the data set SASHELP.PRDSALE.
NOTE: The data set WORK.PRDSALE has 1440 observations and 10 variables.
NOTE: PROCEDURE SORT used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds



5
6    ods html file='SalesFig-body.htm'
7             contents='SalesFig-contents.htm'
8             page='SalesFig-page.htm'
9             frame='SalesFig-frame.htm';
NOTE: Writing HTML Body file: SalesFig-body.htm
NOTE: Writing HTML Contents file: SalesFig-contents.htm
NOTE: Writing HTML Pages file: SalesFig-page.htm
NOTE: Writing HTML Frame file: SalesFig-frame.htm
10
11
12   proc tabulate data=prdsale;
13   class region division prodtype;
```

The following output displays the frame file, name SalesFig-frame.htm, which displays the table of contents (upper left side), the table of pages (lower left side), and the body file (right side). Both the Table of Contents and the Table of Pages contain links to the results in the body file. If you click on a link in the Table of Contents or the Table of Pages, SAS displays the corresponding results at the top of the browser.

Figure 34.9 *View of the HTML Frame File SalesFig-frame.htm*



Creating PDF Output for Adobe Acrobat and Other Applications

You can create output that is formatted for Adobe Acrobat and other applications. Before you can access the file, however, you must close the PDF destination.

The following example executes the SORT, MEANS, TABULATE, UNIVARIATE, and SGPANEL procedures. These files contain summary statistics for the sales of office furniture in various countries.

```
options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

1 ods html close;
2 ods pdf file='odspdf_output.pdf';

3 proc tabulate data=prdsale;
   class region division prodtype;
   classlev region division prodtype;
   var actual;
   keyword all sum;
   keylabel all='Total';
   table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         misstext=[label='Missing']
         box=[label='Region by Division and Type'];
run;

title 'Actual Product Sales';
```

```
title2 '(millions of dollars)';

4 proc univariate data=prdsale;
   by Country;
   var actual;
run;

title 'Sales Figures for First Quarter by Product';

5 proc sgpanel data=prdsale;
    where quarter=1;
    panelby product / novarname;
    vbar region / response=predict;
    vline region / response=actual lineattrs=GraphFit;
    colaxis fitpolicy=thin;
    rowaxis label='Sales';
run;

6 ods pdf close;
7 ods html;
```

The following list corresponds to the numbered items in the preceding program:

1 By default, the HTML destination is open. To conserve resources, the program uses the ODS HTML CLOSE statement to close this destination.

2 The ODS PDF statement opens the PDF destination and specifies the file to write to.

3 The TABULATE procedure creates a summary report for actual product sales.

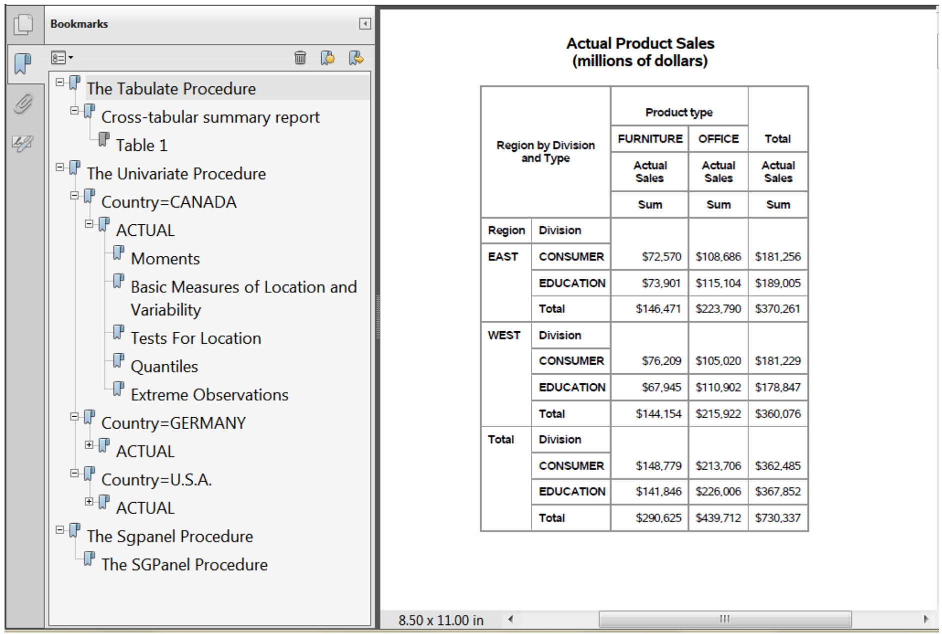
4 The UNIVARIATE procedure creates moments, basic measures, quantiles, and extreme observations tables for the actual sales for each country.

5 The SGPANEL procedure creates a graph of the sales figures for the first quarter by product.

6 The ODS PDF CLOSE statement closes the PDF destination to make output available for viewing.

7 The ODS HTML statement reopens the HTML destination so that the next program that you run can produce HTML output.

Figure 34.10 ODS Output: PDF Format



Actual Product Sales
(millions of dollars)

Region by Division and Type		Product type FURNITURE Actual Sales Sum	Product type OFFICE Actual Sales Sum	Total Actual Sales Sum
Region	Division			
EAST	CONSUMER	$72,570	$108,686	$181,256
	EDUCATION	$73,901	$115,104	$189,005
	Total	$146,471	$223,790	$370,261
WEST	Division			
	CONSUMER	$76,209	$105,020	$181,229
	EDUCATION	$67,945	$110,902	$178,847
	Total	$144,154	$215,922	$360,076
Total	Division			
	CONSUMER	$148,779	$213,706	$362,485
	EDUCATION	$141,846	$226,006	$367,852
	Total	$290,625	$439,712	$730,337

Creating RTF and PowerPoint Output

You can send output to multiple destinations at the same time. The ODS RTF statement create output that is formatted for use with Microsoft Word. The ODS POWERPOINT statement creates output that is formatted for Microsoft PowerPoint. Before you can access the files, you must close the destinations. You can close all open destinations with the ODS _ALL_ CLOSE statement.

The following example executes the SORT, MEANS, TABULATE, UNIVARIATE, and SGPANEL procedures. These files contain summary statistics for the sales of office furniture in various countries.

```
options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

1 ods html close;
2 ods rtf file='odsrtf_output.rtf';
3 ods powerpoint file='odspp_output.ppt';

4 proc tabulate data=prdsale;
   class region division prodtype;
   classlev region division prodtype;
   var actual;
   keyword all sum;
   keylabel all='Total';
   table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         misstext=[label='Missing']
         box=[label='Region by Division and Type'];
```

```
run;

title 'Actual Product Sales';
title2 '(millions of dollars)';

5 proc univariate data=prdsale;
   by Country;
   var actual;
run;

title 'Sales Figures for First Quarter by Product';

6 proc sgpanel data=prdsale;
    where quarter=1;
    panelby product / novarname;
    vbar region / response=predict;
    vline region / response=actual lineattrs=GraphFit;
    colaxis fitpolicy=thin;
    rowaxis label='Sales';
run;

7 ods _all_ close;
8 ods html;
```

The following list corresponds to the numbered items in the preceding program:

1 By default, the HTML destination is open. To conserve resources, the program uses the ODS HTML CLOSE statement to close this destination.

2 The ODS RTF statement opens the RTF destination and specifies the file to write to.

3 The ODS POWERPOINT statement opens the POWERPOINT destination and specifies the file to write to.

4 The TABULATE procedure creates a summary report for actual product sales.

5 The UNIVARIATE procedure creates moments, basic measures, quantiles, and extreme observations tables for the actual sales for each country.

6 The SGPANEL procedure creates a graph of the sales figures for the first quarter by product.

7 The ODS _ALL_ CLOSE statement closes all open destinations to make output available for viewing.

8 The ODS HTML statement reopens the HTML destination so that the next program that you run can produce HTML output.

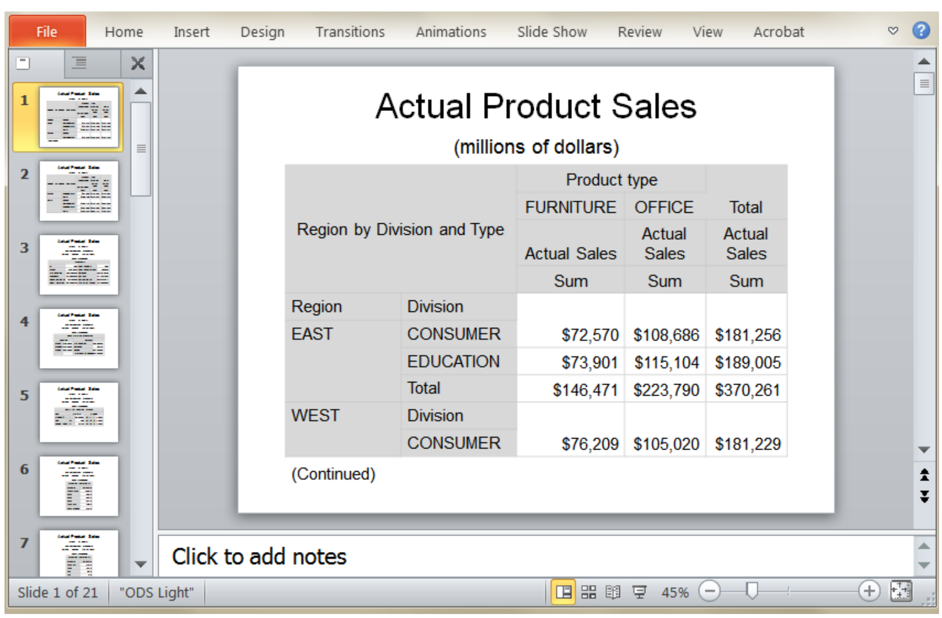
The following output displays the first page of the RTF output.

Figure 34.11 ODS Output: RTF Format

Actual Product Sales
(millions of dollars)

Region by Division and Type		Product type		Total
		FURNITURE	OFFICE	
		Actual Sales	Actual Sales	Actual Sales
		Sum	Sum	Sum
Region	**Division**			
EAST	**CONSUMER**	$72,570	$108,686	$181,256
	EDUCATION	$73,901	$115,104	$189,005
	Total	$146,471	$223,790	$370,261
WEST	**Division**			
	CONSUMER	$76,209	$105,020	$181,229
	EDUCATION	$67,945	$110,902	$178,847
	Total	$144,154	$215,922	$360,076
Total	**Division**			
	CONSUMER	$148,779	$213,706	$362,485
	EDUCATION	$141,846	$226,006	$367,852
	Total	$290,625	$439,712	$730,337

Figure 34.12 ODS Output: PowerPoint Format



Selecting the Output That You Want to Format

Identifying Output

Program output, in the form of output objects, contain both the results of a procedure or DATA step and information about how to format the results. To select an output object for formatting, you need to know which output objects your program creates. To identify the output objects, you can use the ODS TRACE statement. The simplest form of the ODS TRACE statement is as follows:

ODS TRACE ON | OFF;

ODS TRACE determines whether to write to the SAS log a record of each output object that a program creates. The ON option writes the trace record to the log, and the OFF option suppresses the writing of the trace record.

The trace record has the following components:

Name
: is the name of the output object.

Label
: is the label that briefly describes the contents of the output object.

Template
: is the name of the table template that ODS used to format the output object.

Path
: shows the location of the output object.

In the ODS SELECT statement in your program, you can refer to an output object by name, label, or path.

The following program executes the TABULATE, UNIVARIATE, and SGPANEL procedures and writes a trace record to the SAS log.

```
ods trace on;

options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

proc tabulate data=prdsale;
   class region division prodtype;
   classlev region division prodtype;
   var actual;
   keyword all sum;
   keylabel all='Total';
   table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         misstext=[label='Missing']
         box=[label='Region by Division and Type'];
run;
```

```
title 'Actual Product Sales';
title2 '(millions of dollars)';

proc univariate data=prdsale;
   by Country;
   var actual;
run;

title 'Sales Figures for First Quarter by Product';

proc sgpanel data=prdsale;
    where quarter=1;
    panelby product / novarname;
    vbar region / response=predict;
    vline region / response=actual lineattrs=GraphFit;
    colaxis fitpolicy=thin;
    rowaxis label='Sales';
run;

ods trace off;
```

The following output displays the results of ODS TRACE.

Example Code 34.2 *Partial ODS TRACE Output in the Log*

```
22   proc univariate data=prdsale;
23   by Country;
24   var actual;
25   run;


Output Added:
-------------
Name:       Moments
Label:      Moments
Template:   base.univariate.Moments
Path:       Univariate.ByGroup1.ACTUAL.Moments
-------------

......


26   title 'Sales Figures for First Quarter by Product';
27   proc sgpanel data=prdsale;
28       where quarter=1;
29       panelby product / novarname;
30       vbar region / response=predict;
31       vline region / response=actual lineattrs=GraphFit;
32       colaxis fitpolicy=thin;
33       rowaxis label='Sales';
34   run;

NOTE: PROCEDURE SGPANEL used (Total process time):
      real time           2.00 seconds
      cpu time            0.21 seconds


Output Added:
-------------
Name:       SGPanel
Label:      The SGPanel Procedure
Path:       Sgpanel.SGPanel
-------------
NOTE: There were 360 observations read from the data set WORK.PRDSALE.
      WHERE quarter=1;

35
36   ods trace off;
```

Selecting and Excluding Program Output

For each destination, ODS maintains a selection list or an exclusion list. The selection list is a list of output objects that produce formatted output. The exclusion list is a list of output objects for which no output is produced.

You can select and exclude output objects by specifying the destination in an ODS SELECT or ODS EXCLUDE statement. If you do not specify a destination, ODS sends output to all open destinations.

Selection and exclusion lists can be modified and reset at different points in a SAS session, such as at procedure boundaries. If you end each procedure with an explicit QUIT statement, rather than waiting for the next PROC or DATA step to end it for you, the QUIT statement resets the selection list.

To choose one or more output objects and send them to open ODS destinations, use the ODS SELECT statement. The simplest form of the ODS SELECT statement is as follows:

ODS SELECT <*ODS-destination*> *output-object(s)*;

The argument *ODS-destination* identifies the output format, and *output-object* specifies one or more output objects to add to a selection list.

To exclude one or more output objects from being sent to open destinations, use the ODS EXCLUDE statement. The simplest form of the ODS EXCLUDE statement is as follows:

ODS EXCLUDE <*ODS-destination*> *output-object(s)*;

The argument *ODS-destination* identifies the output format, and *output-object* specifies one or more output objects to add to an exclusion list.

The following example executes the TABULATE, UNIVARIATE, and SGPANEL procedures. The ODS SELECT statement uses the name component in the trace records to select only the ExtremeObs, Quantiles, and Moments output objects for PROC UNIVARIATE. Because the ODS SELECT and ODS EXCLUDE statements reset at procedure boundaries, you must specify the ODS EXCLUDE statement before the PROC TABULATE and PROC SGPANEL steps to exclude those output objects.

You can use the ODS EXCLUDE statement before the PROC UNIVARIATE step instead of the ODS SELECT statement. The following ODS EXCLUDE statement gives you the same results:

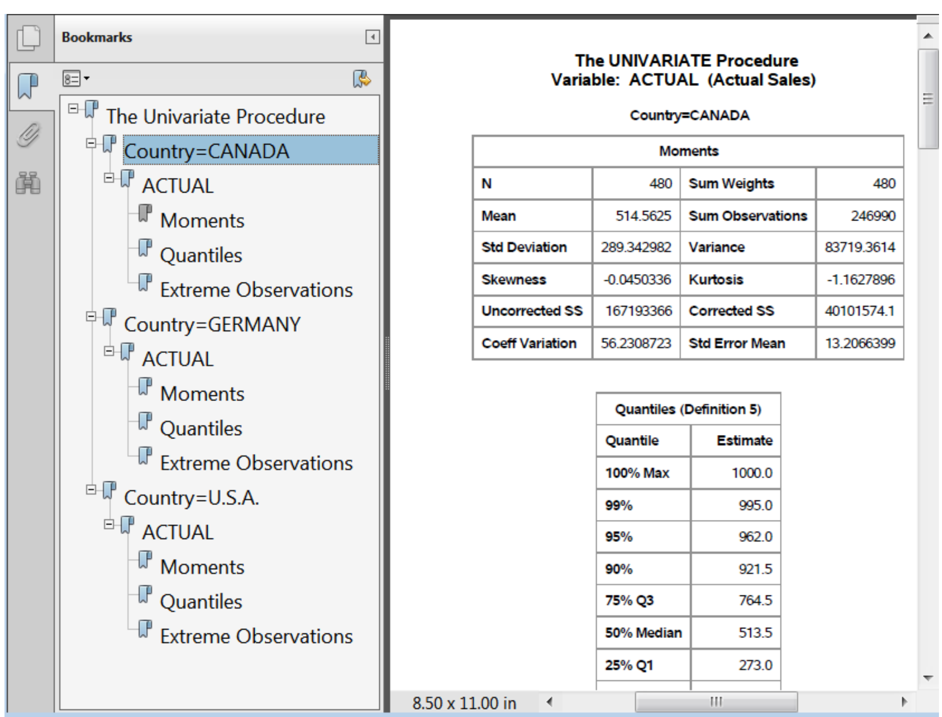
```
ods exclude BasicMeasures TestsForLocation;
```

```
ods html close;
options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

ods pdf file='PDFPrdsale.pdf';

ods exclude table;

title 'Actual Product Sales';
title2 '(millions of dollars)';

proc tabulate data=prdsale;
    class region division prodtype;
    classlev region division prodtype;
    var actual;
    keyword all sum;
    keylabel all='Total';
    table (region all)*(division all),
          (prodtype all)*(actual*f=dollar10.) /
          misstext=[label='Missing']
          box=[label='Region by Division and Type'];
run;

title;
```

```
title2;

ods select ExtremeObs Quantiles Moments;

proc univariate data=prdsale;
    by Country;
    var actual;
run;

title 'Sales Figures for First Quarter by Product';

ods exclude sgpanel;

proc sgpanel data=prdsale;
    where quarter=1;
    panelby product / novarname;
    vbar region / response=predict;
    vline region / response=actual lineattrs=GraphFit;
    colaxis fitpolicy=thin;
    rowaxis label='Sales';
run;

ods pdf close;
ods html open;
```

The following two displays show the results in PDF format. They show the ExtremeObs, Quantiles, and Moments tables for PROC UNIVARIATE.

Figure 34.13 *ODS SELECT Statement: PDF Format*



Moments			
N	480	Sum Weights	480
Mean	514.5625	Sum Observations	246990
Std Deviation	289.342982	Variance	83719.3614
Skewness	-0.0450336	Kurtosis	-1.1627896
Uncorrected SS	167193366	Corrected SS	40101574.1
Coeff Variation	56.2308723	Std Error Mean	13.2066399

Quantiles (Definition 5)	
Quantile	Estimate
100% Max	1000.0
99%	995.0
95%	962.0
90%	921.5
75% Q3	764.5
50% Median	513.5
25% Q1	273.0

Creating a SAS Data Set

ODS enables you to create a SAS data set from an output object. To create a single output data set, use the following form of the ODS OUTPUT statement:

ODS OUTPUT *output-object(s)=SAS-data-set*;

The argument *output-object* specifies one or more output objects to turn into a SAS data set, and *SAS-data-set* specifies the data set that you want to create.

In the following program, ODS opens the Output destination and creates the SAS data set MYFILE.MEASURES from the output object BasicMeasures. ODS then closes the Output destination.

```
data sat_scores;
   input Test $ Gender $ Year SATscore @@;
   datalines;
Verbal m 1972 531  Verbal f 1972 529
Verbal m 1973 523  Verbal f 1973 521
Verbal m 1974 524  Verbal f 1974 520
Verbal m 1975 515  Verbal f 1975 509
Verbal m 1976 511  Verbal f 1976 508
Verbal m 1977 509  Verbal f 1977 505
Verbal m 1978 511  Verbal f 1978 503
Verbal m 1979 509  Verbal f 1979 501
Verbal m 1980 506  Verbal f 1980 498
Verbal m 1981 508  Verbal f 1981 496
Math   m 1985 522  Math   f 1985 480
Math   m 1986 523  Math   f 1986 479
Math   m 1987 523  Math   f 1987 481
Math   m 1988 521  Math   f 1988 483
Math   m 1989 523  Math   f 1989 482
Math   m 1990 521  Math   f 1990 483
Math   m 1991 520  Math   f 1991 482
Math   m 1992 521  Math   f 1992 484
Math   m 1993 524  Math   f 1993 484
Math   m 1994 523  Math   f 1994 487
Math   m 1995 525  Math   f 1995 490
Math   m 1996 527  Math   f 1996 492
Math   m 1997 530  Math   f 1997 494
Math   m 1998 531  Math   f 1998 496
;

proc sort data=sat_scores out=sorted_scores;
   by Test;
run;

ods html close; 1
ods output BasicMeasures=measures;
2

proc univariate data=sat_scores;
3
   var SATscore;
```

```
   class Gender;
run;

ods output close; 4
ods html; 5
```

The following list corresponds to the numbered items in the preceding program:

1 By default, the HTML destination is open. To conserve resources, the ODS HTML CLOSE statement closes this destination.

2 The ODS OUTPUT statement opens the Output destination and specifies the permanent data set to create from the output object BasicMeasures.

3 The UNIVARIATE procedure produces summary statistics for the average SAT scores of entering first-year college students. The output is grouped by the CLASS variable Gender.

4 The ODS OUTPUT CLOSE statement closes the Output destination.

5 The ODS HTML statement reopens the default HTML destination so that the next program that you run can produce HTML output.

The following SAS log shows that the WORK.MEASURES data set was created with the ODS OUTPUT statement:

Example Code 34.3 *Partial SAS Log: SAS Data Set Creation*

```
166
167
168  ods html close;
169  ods output BasicMeasures=measures;
170
171
172  proc univariate data=sat_scores;
173
174     var SATscore;
175     class Gender;
176  run;

NOTE: The data set WORK.MEASURES has 8 observations and 6 variables.
NOTE: PROCEDURE UNIVARIATE used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds


177
178  ods output close;
179  ods html;
NOTE: Writing HTML Body file: sashtml3.htm
```

Customizing ODS Output

Customizing ODS Output at the Level of a SAS Job

ODS provides a way for you to customize output at the level of the SAS job. To do this, you use a style template, which describes how to show such items as color, font face, font size, and so on. The style template determines the appearance of the output. The FancyPrinter style template is one of several that is available with SAS.

To view the available ODS style templates, run the following code:

```
proc template;
   list styles;
run;
```

Output 34.1 *Sample Listing of ODS Styles*

The SAS System

Listing of: SASHELP.TMPLMST		
Path Filter is: Styles		
Sort by: PATH/ASCENDING		
Obs	Path	Type
1	Styles	Dir
2	Styles.Analysis	Style
3	Styles.BarrettsBlue	Style
4	Styles.BlockPrint	Style
5	Styles.Daisy	Style
6	Styles.Default	Style
7	Styles.Dove	Style
8	Styles.Dtree	Style
9	Styles.EGDefault	Style
10	Styles.FancyPrinter	Style
11	Styles.Festival	Style
12	Styles.FestivalPrinter	Style
13	Styles.Gantt	Style
14	Styles.GrayscalePrinter	Style
15	Styles.HTMLBlue	Style
16	Styles.Harvest	Style
17	Styles.HighContrast	Style
18	Styles.Journal	Style
19	Styles.Journal1a	Style
20	Styles.Journal2	Style

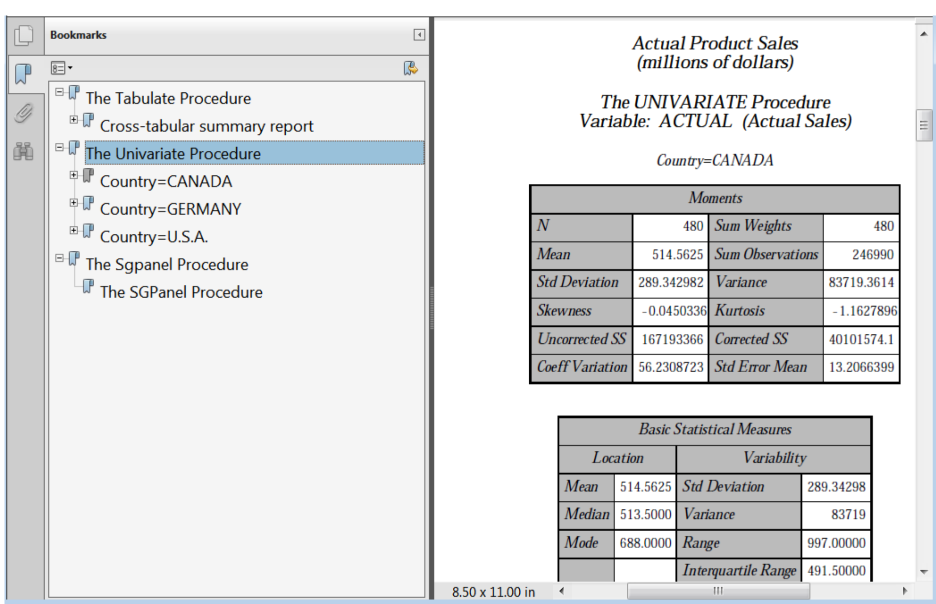
The following example uses the FancyPrinter style template to customize program output. The STYLE= option in the ODS PRINTER statement specifies that the program use the FancyPrinter style. This style causes ODS to write the titles, footnote, and variable names of the printer output in italics. The PDFTOC= option controls the level of the expansion of the table of contents in PDF documents. The PDFTOC=1 option specifies that the TOC has two levels of expansion.

```
options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

ods html close;
ods pdf file='odspdf_output_custom.pdf' pdftoc=2 style=fancyprinter;
title;

proc tabulate data=prdsale;
   class region division prodtype;
```

```
      classlev region division prodtype;
      var actual;
      keyword all sum;
      keylabel all='Total';
      table (region all)*(division all),
            (prodtype all)*(actual*f=dollar10.) /
            misstext=[label='Missing']
            box=[label='Region by Division and Type'];
   run;

   title 'Actual Product Sales';
   title2 '(millions of dollars)';

   proc univariate data=prdsale;
      by Country;
      var actual;
   run;

   title 'Sales Figures for First Quarter by Product';

   proc sgpanel data=prdsale;
       where quarter=1;
       panelby product / novarname;
       vbar region / response=predict;
       vline region / response=actual lineattrs=GraphFit;
       colaxis fitpolicy=thin;
       rowaxis label='Sales';
   run;

   ods pdf close;
   ods html;
```

The following output displays the results.

Figure 34.14 Printer Output: Titles, Footnote, and Variables Printed in Italics



For more information about ODS styles, see “Style Templates” in *SAS Output Delivery System: Procedures Guide*.

Customizing ODS Output By Using a Template

Another way to customize ODS output is by using a table template. A table template describes how to format tabular output. It can determine the order of table headings and footnotes, the order of columns, and the appearance of the output. A table template can contain one or more columns, headings, or footnotes. You can create your own table template, or modify an existing one. Many procedures that fully support ODS provide table templates that you can customize.

In the SAS Windowing Environment, to view the SAS style templates that are supplied by SAS, do the following:

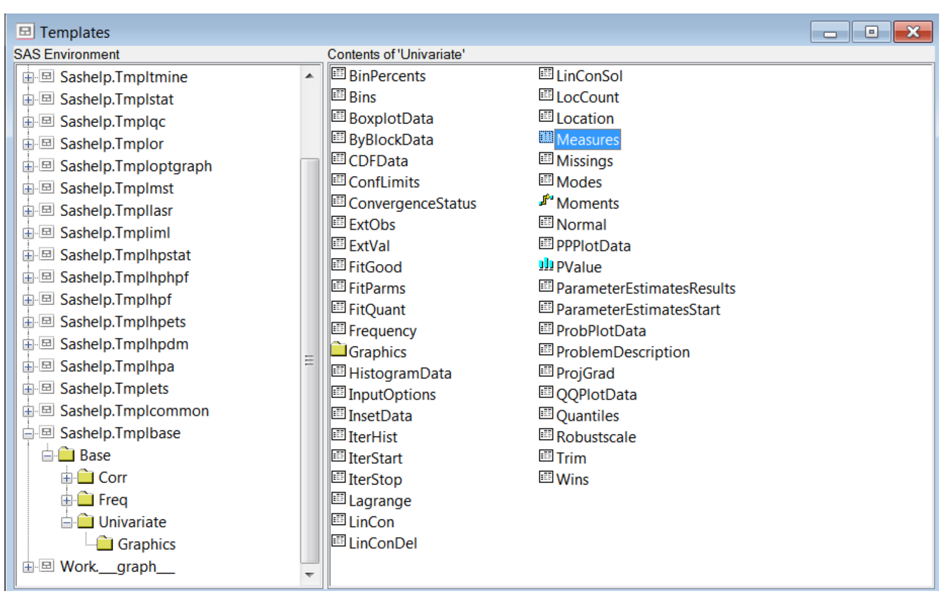
1 In the Results window, select the **Results** folder. Right-click and select **Templates** to open the Templates window.

2 Expand a directory, such as **Sashelp.Tmplmst** or **Sashelp.Tmplbase** to view the contents of that directory.

3 Double-click a directory, such as **Base** to view the contents of that directory.

In this example, we are changing a template that PROC UNIVARIATE creates. To view the template names for PROC UNIVARIATE, in the Templates window, select **Sashelp.Tmplbase** ⇨ **Base** ⇨ **Univariate**. We are using the Measures table template as a template to make changes to the output.

Output 34.2 PROC UNIVARIATE Templates That Are Supplied by SAS



To view the Measures code, double-click **Measures**. The **Measures** template opens in the Template Browser window. You can then copy and paste the code into the Editor window for customization.

Output 34.3 *Measure Templates That Are Supplied by SAS*

Template Browser

```
proc template;
   define table Base.Univariate.Measures / store = SASHELP.TMPLBASE;
      notes "Basic measures of location and variability";
      dynamic MeasHdr varname varlabel;
      column LocMeasure LocValue VarMeasure VarValue;
      header h1 h2 h3;
      translate _val_=._ into "";

      define h1;
         text MeasHdr;
         space = 1;
         spill_margin;
      end;

      define h2;
         text "Location";
         end = LocValue;
         start = LocMeasure;
      end;

      define h3;
         text "Variability";
         end = VarValue;
         start = VarMeasure;
      end;

      define LocMeasure;
         space = 3;
         glue = 2;
         style = Rowheader;
         print_headers = OFF;
      end;

      define LocValue;
         space = 5;
         print_headers = OFF;
      end;

      define VarMeasure;
         space = 3;
         glue = 2;
         style = Rowheader;
         print_headers = OFF;
      end;

      define VarValue;
         format = D10.;
         print_headers = OFF;
      end;
   end;
run;
*** END OF TEXT ***
```

You can create your own table template or modify an existing one by using the TEMPLATE procedure. The following is a simplified form of the TEMPLATE procedure:

PROC TEMPLATE;**DEFINE** *table-definition*;**HEADER** *header(s)*;**COLUMN** *column(s)*;**END**;

The DEFINE statement creates the table template that serves as the template for writing the output. The HEADER statement specifies the order of the headings, and the COLUMN statement specifies the order of the columns. The arguments in each of these statements point to routines in the program that format the output. The END statement ends the table template.

The following example shows how to use PROC TEMPLATE to create customized HTML and PDF output. You can first copy the SAS template code that is supplied by SAS using the method described in Output 34.3 on page 699. In this example, the SAS program creates a customized table template for the Basic Measures output table from PROC UNIVARIATE. The following customized version shows that

- the "Measures of Variability" section precedes the "Measures of Location" section

- column headings are modified
- font colors are modifies
- statistics are displayed in a bold, italic font with a 7.3 format, and a specific font color.

Create the new template.

```
1 options nodate nonumber;

2 proc template;
   3 define table base.univariate.Measures;
   4 header h1 h2 h3;
   5 column VarMeasure VarValue LocMeasure LocValue;


   6 define h1;
      text "Basic Statistical Measures";
      style=data{color=orange fontstyle=italic};
      spill_margin=on;
      space=1;
   end;

   6 define h2;
      text "Measures of Variability";
      start=VarMeasure;
      end=VarValue;
   end;

   6 define h3;
      text "Measures of Location";
      start=LocMeasure;
      end=LocValue;
   end;

   7 define LocMeasure;
      print_headers=off;
      glue=2;
      space=3;
      style=rowheader;
   end;

   7 define LocValue;
      print_headers=off;
      space=5;
      format=7.3;
      style=data{font_style=italic font_weight=bold color=red};
   end;

   7 define VarMeasure;
      print_headers=off;
      glue=2;
      space=3;
      style=rowheader;
      style=data{font_style=italic font_weight=bold color=purple};
   end;
```

```
    7 define VarValue;
         print_headers=off;
         format=7.3;
         style=data{font_style=italic font_weight=bold color=blue};
      end;
  8 end;
  9 run;
```

The following list corresponds to the numbered items in the preceding program:

1 The NODATE and NONUMBER options affect the Printer output. None of the options affects the HTML output.

2 PROC TEMPLATE begins the procedure for creating a table.

3 The DEFINE statement creates the table template base.univariate.Measures in SASUSER.

The base.univariate.Measures table template that SAS provides is stored in a template store in the SASHELP library. (See Output 34.2 on page 698.)

4 The HEADER statement determines the order in which the table template uses the headings, which are defined later in the program.

5 The COLUMN statement determines the order in which the variables appear. PROC UNIVARIATE names the variables.

6 These DEFINE blocks define the three headings and specify the text to use for each heading. By default, a heading spans all columns. This is the case for H1. H2 spans the variables VarMeasure and VarValue. H3 spans LocMeasure and LocValue.

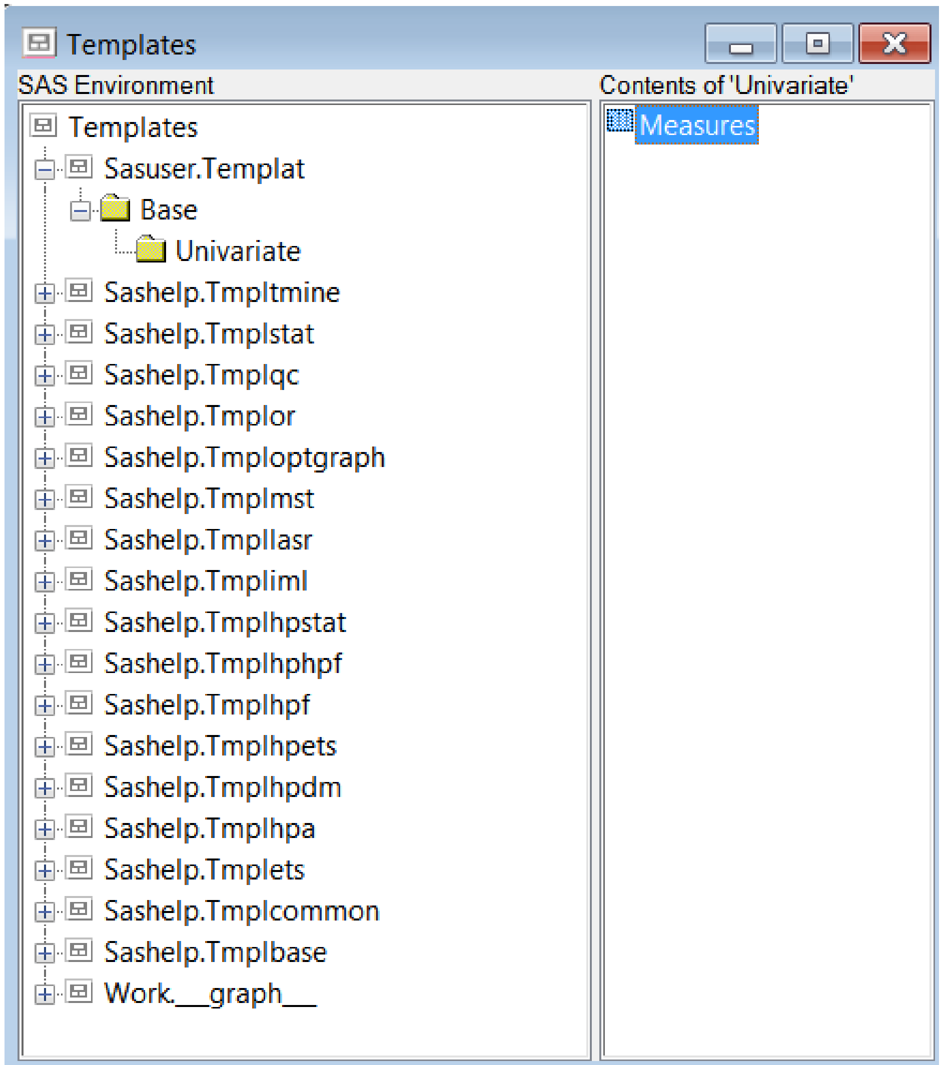
7 These DEFINE blocks specify characteristics for each of the four variables. They use FORMAT= to specify a format of 7.3 for LocValue and VarValue. They also use STYLE= to specify a bold, italic font for these two variables. The STYLE= option does not affect the LISTING output.

8 The END statement ends the table template.

9 The RUN statement executes the procedure.

To view the table template that PROC TEMPLATE created, in the Templates window, select **Sasuser.Templat** ⇨ **Base** ⇨ **Univariate**. By default, ODS searches for a table template in SASUSER before SASHELP. When PROC UNIVARIATE calls for a table definition by this name, ODS uses the one from SASUSER.

Output 34.4 *User Created PROC UNIVARIATE Table Template*



Create the output that uses the new template.

```
1 ods select BasicMeasures;

options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

2 ods html file='SalesFig-body.htm'
         contents='SalesFig-contents.htm'
         page='SalesFig-page.htm'
         frame='SalesFig-frame.htm';

3 ods pdf file='odspdf_output_custom2.pdf' ;

title 'Actual Product Sales';
title2 '(millions of dollars)';
```

```
4 proc univariate data=prdsale;
     by Country;
     var actual;
  run;

5 ods _all_ close;
6 ods html;

7 proc template;
     delete base.univariate.Measures;
  run;
```

1 The ODS SELECT statement selects the output object that contains the basic measures.

2 The ODS HTML statement begins the program that uses the customized table template. It opens the HTML destination and identifies the files to write to.

3 The ODS PDF statement opens the PDF destination and identifies the file to write to.

4 PROC UNIVARIATE produces one object for each variable in each BY group. It uses the customized table template to format the data. By default, ODS searches for a table template in SASUSER before SASHELP. When PROC UNIVARIATE calls for a table definition by this name, ODS uses the one from SASUSER.

5 The ODS _ALL_ CLOSE statement closes all open ODS destinations.

6 The ODS HTML statement opens the HTML destination for output.

7 This PROC TEMPLATE step deletes the base.univariate.Measures template. If you do not delete it, it will be applied to all of your tabular output until you do delete it.

The following displays show the printer output.

Output 34.5 *PDF Output with No Customization*

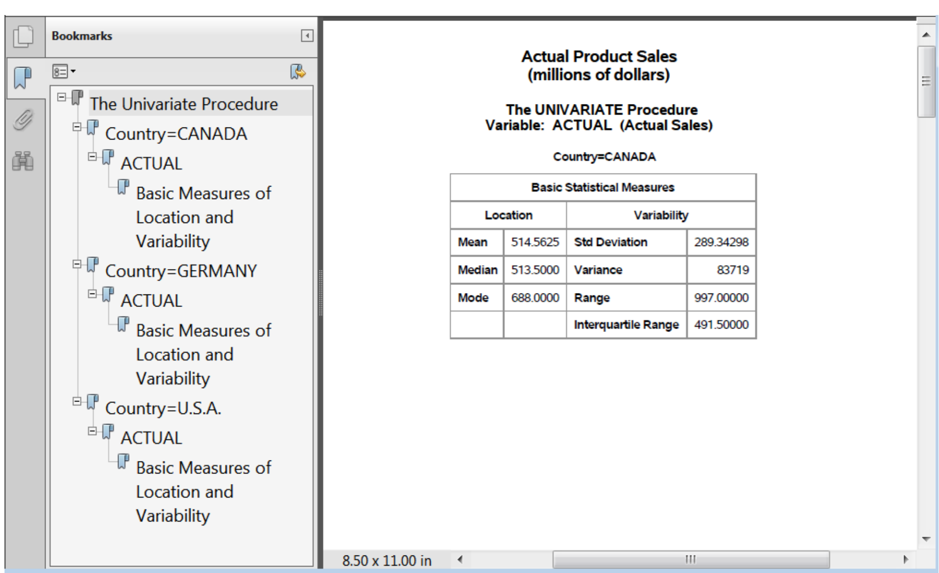
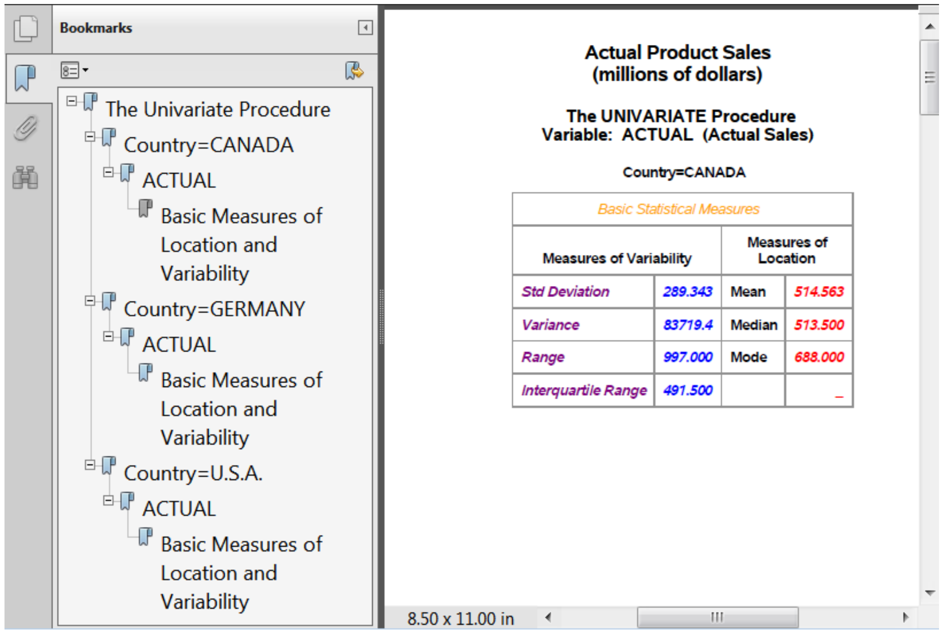
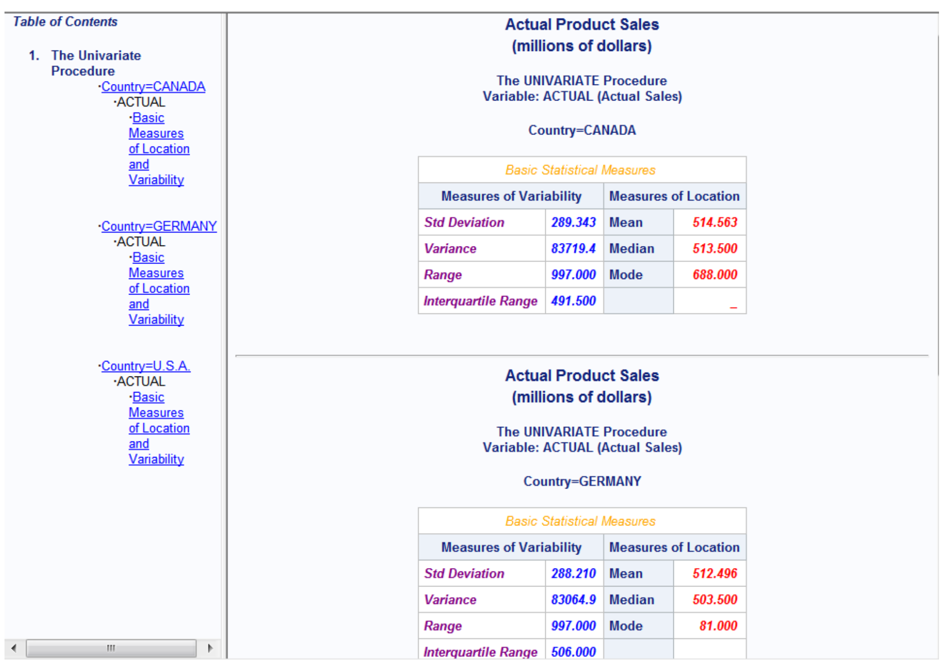


Figure 34.15 Customized Printer Output from the TEMPLATE Procedure



The following display shows the HTML output.

Figure 34.16 Customized HTML Output from the TEMPLATE Procedure



Storing Links to ODS Output

When you run a procedure that supports ODS, SAS automatically stores a link to each piece of ODS output in the Results folder in the Results window. It marks the link with an icon that identifies the output destination that created the output.

In the following example, SAS executes the UNIVARIATE, TABULATE, and SGPANEL procedures and generates HTML, PowerPoint, and Rich Text Format (RTF) output.

```
options nodate nonumber;
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

ods html file='SalesFig-body.htm'
         contents='SalesFig-contents.htm'
         page='SalesFig-page.htm'
         frame='SalesFig-frame.htm';
ods rtf file='odsrtf_output.rtf';
ods powerpoint file='odspp_output.ppt';

proc tabulate data=prdsale;
   class region division prodtype;
   classlev region division prodtype;
   var actual;
   keyword all sum;
   keylabel all='Total';
   table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         misstext=[label='Missing']
         box=[label='Region by Division and Type'];
run;

title 'Actual Product Sales';
title2 '(millions of dollars)';

proc univariate data=prdsale;
   by Country;
   var actual;
run;

title 'Sales Figures for First Quarter by Product';

proc sgpanel data=prdsale;
    where quarter=1;
    panelby product / novarname;
    vbar region / response=predict;
    vline region / response=actual lineattrs=GraphFit;
    colaxis fitpolicy=thin;
    rowaxis label='Sales';
run;
```

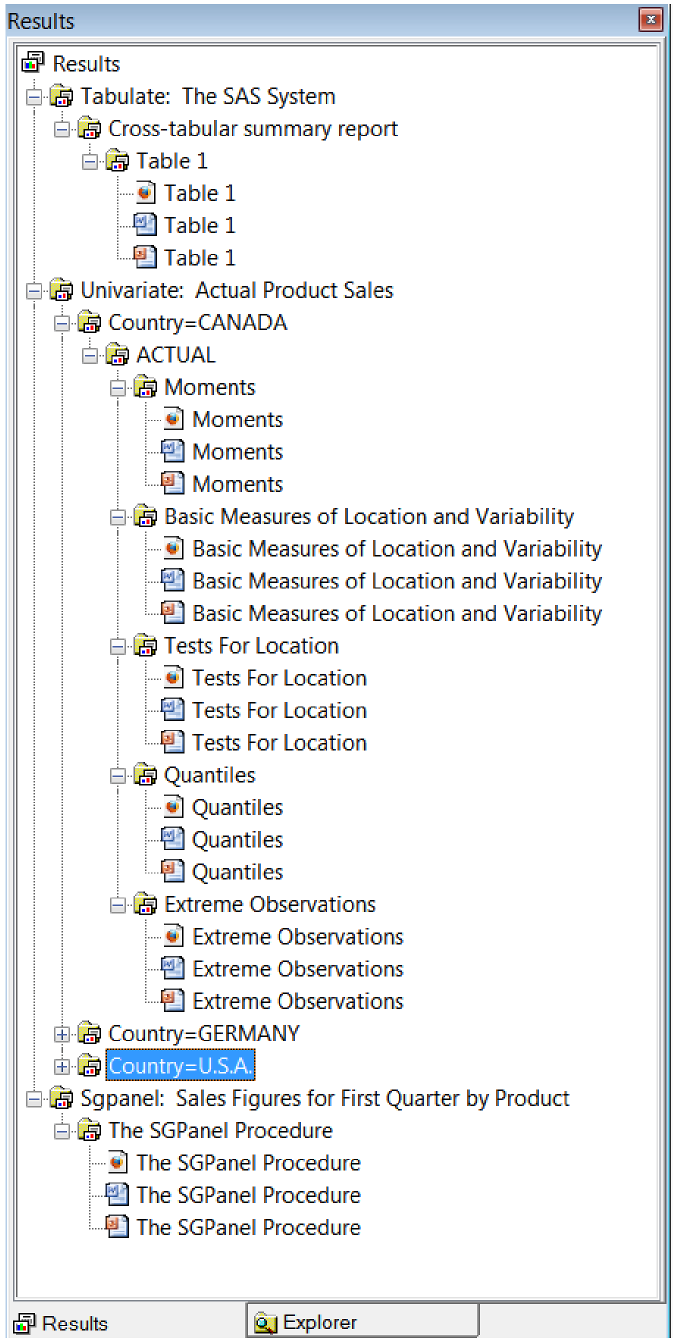
```
ods _all_ close;
ods html;
```

PROC UNIVARIATE, PROC TABULATE, and PROC SGPANEL each generate a folder in the Results window. Within these folders, folder for variables, BY groups, and statistics are created. For example, PROC UNIVARIATE creates a folder name **Country** for each BY group, such as **Country=CANADA**. Within each BY group folder is a folder for each actual variable, named **ACTUAL**. Within the folder **ACTUAL** there is a folder for each statistic, such as **Moments**. The last folders, such as **Moments**, contain the output objects that the procedure creates. The output objects are represented by the appropriate icon.

Within the folder for each output object is a link to each piece of output. The icon next to the link indicates which ODS destination created the output. In this example, the Moments output was sent to the HTML, RTF. and POWEPOINT destinations.

The Results window in the display that follows shows the folders and output objects that the UNIVARIATE, TABULATE, and SGPANEL procedures creates.

Figure 34.17 View of the Results Window



Summary

ODS Statements

ODS EXCLUDE <ODS-destination> *output-object(s)*;
specifies one or more output objects to add to an exclusion list.

ODS HTML *HTML-file-specification(s)* <STYLE='style-definition'>;
opens the HTML destination and specifies the HTML file or files to write to. After the destination is open, you can create output that is written in Hyper Text Markup Language (HTML).

Note: The HTML destination is open by default.

You can specify up to four HTML files to write to. The specifications for these files have the following form:

BODY='*body-file-name*'
identifies the file that contains the HTML output.

CONTENTS='*contents-file-name*'
identifies the file that contains a table of contents for the HTML output. The contents file has links to the body file.

FRAME='*frame-file-name*'
identifies the file that integrates the table of contents, the page contents, and the body file. If you open the frame file, you see a table of contents, a table of pages, or both, as well as the body file. If you specify FRAME=, you must also specify CONTENTS= or PAGE= or both.

PAGE='*page-file-name*'
identifies the file that contains a description of each page of the body file and links to the body file. ODS produces a new page of output whenever a procedure explicitly asks for a new page. The SAS system option PAGESIZE= has no effect on pages in HTML output.

The STYLE= option enables you to choose HTML presentation styles. For complete descriptions of individual styles that are supplied by SAS, see "Style Templates" in *SAS Output Delivery System: Procedures Guide*.

ODS LISTING;
opens the LISTING destination.

ODS LISTING CLOSE;
closes the LISTING destination so that no LISTING output is created.

ODS OUTPUT *output-object(s)=SAS-data-set*;
opens the Output destination and converts one or more output objects to a SAS data set.

ODS POWERPOINT *file-specification*;
opens the POWERPOINT destination and specifies the file to write to.

ODS PDF *file-specification*;
    opens the PDF destination and specifies the file to write to.

ODS RTF *file-specification*;
    opens the RTF destination and specifies the file to write to. After the destination is open, you can create RTF output.

ODS *destination* CLOSE;
    closes the specific *destination* and enables you to view the output.

ODS _ALL_ CLOSE;
    closes all open destinations.

ODS SELECT <ODS-destination> *output-object(s)*;
    specifies one or more output objects to add to a selection list.

ODS TRACE ON | OFF;
    turns the writing of the trace record on or off. Turning trace on is useful because the results list the output objects that your program creates.

PROC SORT Statements

PROC SORT DATA=*SAS-data-set* OUT=*SAS-data-set*;

BY <DESCENDING> *variable-1*<<DESCENDING> *variable-2 …*>;

PROS SORT statement
    orders SAS data set observations by the values of one or more character or numeric variables. The DATA= option specifies the input data set. The OUT= option specifies the output data set.

BY *variable(s)*;
    specifies the sorting variables.

PROC TABULATE Statements

PROC TABULATE <*options*>

CLASS *variable(s)* </ *options*>;

CLASSLEV *variable(s)* </ STYLE=<*style-element*>>;

KEYLABEL *keyword-1='description-1'*
<keyword-2='description-2' ...>;

KEYWORD *keyword(s)* </ STYLE=<*style-element*>>;

TABLE <<*page-expression*,> *row-expression*,> *column-expression*</ *table-options*>;

VAR *analysis-variable(s)*</ *options*>;

PROC TABULATE statement
    displays descriptive statistics in tabular format

CLASS statement
    identifies class variables for the table. Class variables determine the categories that PROC TABULATE uses to calculate statistics.

CLASSLEV statement
: specifies a style element for class variable level value headings.

KEYWORD statement
: specifies a style element for keyword headings.

KEYLABEL statement
: labels a keyword for the duration of the PROC TABULATE step. PROC TABULATE uses the label anywhere that the specified keyword would

TABLE statement
: describes a table to be printed.

VAR statement
: identifies numeric variables to use as analysis variables.

PROC TEMPLATE Statements

PROC TEMPLATE;

  DEFINE <*template-type*> *template-name*</ *options*>;

    statements-and-attributes;

      COLUMN *column(s)*;

      HEADER *header-specification(s)*;

    END;

  DELETE *item-path* / <STORE=*template-store* >

END;

PROC TEMPLATE statement
: begins a PROC TEMPLATE template.

DELETE statement
: deletes the specified item.

COLUMN statement
: declares a symbol as a column in the table and specifies the order of the columns.

DEFINE statement
: creates a template inside a table template. The DEFINE statement uses the COLUMN and HEADER statements to create column and table headings.

HEADER statement
: declares a symbol as a header in the table and specifies the order of the headers.

PROC UNIVARIATE Statements

PROC UNIVARIATE DATA=*SAS-data-set*;

  BY *variable(s)*;

  VAR *variable(s)*;

PROC UNIVARIATE statement
: begins the UNIVARIATE procedure and generates descriptive statistics based on moments (including skewness and kurtosis), quantiles or percentiles (such as the median), frequency tables, and extreme values

CLASS statement
: specifies up to two variables whose values define the classification levels for the analysis.

VAR statement
: specifies the analysis variables and their order in the results.

Learning More

PROC UNIVARIATE
: For detailed information about the UNIVARIATE procedure and other Base Statistical Procedures, see *Base SAS(R) 9.3 Procedures Guide: Statistical Procedures*.

ODS output

- For information about getting started with the Output Delivery System, see *Getting Started with the SAS Output Delivery System*.
- For detailed information about the Output Delivery System, see *SAS Output Delivery System: User's Guide*.
- For complete descriptions of individual SAS style attributes, see "Style Attributes" in *SAS Output Delivery System: Procedures Guide*.
- For complete descriptions of ODS styles, see "Style Templates" in *SAS Output Delivery System: Procedures Guide*.
- For information about valid ODS destinations, see "Dictionary of ODS Language Statements" in *SAS Output Delivery System: User's Guide*.

PROC SGPANEL
: For detailed information about the SGPANEL procedure, see *SAS ODS Graphics: Procedures Guide*.

Base SAS procedures
: For information about the PROC SORT and PROC TABULATE procedures, see *Base SAS Procedures Guide*.

PART 9

Storing and Managing Data in SAS Files

35

Understanding SAS Libraries

Introduction to Understanding SAS Libraries

Purpose

The way in which SAS handles data libraries is different from one operating environment to another. In this section, you will learn basic concepts about the SAS library and how to use libraries in SAS programs. For more detailed information, see the SAS documentation for your operating environment.

Prerequisites

Before proceeding with this section, you should understand the concepts presented in the following sections:

- Chapter 1, “What is the SAS System?,” on page 3
- Chapter 3, “Introduction to DATA Step Processing,” on page 25

What Is a SAS Library?

A SAS library is a collection of one or more SAS files that are recognized by SAS and can be referenced and stored as a unit. Each file is a member of the library. SAS libraries help to organize your work. For example, if a SAS program uses more than one SAS file, then you can keep all the files in the same library. Organizing files in libraries makes it easier to locate the files and reference them in a program.

Under most operating environments, a SAS library usually corresponds to the level of organization that the operating environment uses to organize files. For example, in directory-based operating environments, a SAS library is a group of SAS files in the same directory. The directory might contain other files, but only the SAS files are part of the SAS library.

z/OS Specifics: Under the z/OS operating environment, a SAS library is a specially formatted z/OS data set. This type of data set can contain only SAS files.

Accessing a SAS Library

Telling SAS Where the SAS Library Is Located

No matter which operating environment you are using, to access a SAS library, you must tell SAS where it is. You can do this in the following ways:

- directly specify the operating environment's physical name for the location of the SAS library. The physical name must conform to the naming conventions of your operating environment, and it must be enclosed in quotation marks. For example, in the SAS windowing environment, the following DATA statement creates a data set named MYFILE:

  ```
  data 'c:\my documents\sasfiles\myfile';
  ```

- assign a SAS libref (library reference), which is a SAS name that is temporarily associated with the physical location name of the SAS library.

Assigning a Libref

After you assign a libref to the location of a SAS library, then in your SAS program, you can reference files in the library by using the libref instead of using the long physical name that the operating environment uses. The libref is a SAS name that is temporarily associated with the physical location of the SAS library. There are several ways to assign a libref:

- use the LIBNAME statement
- use the LIBNAME function
- use the New Library window from the SAS Explorer window
- for some operating environments, use operating environment commands

A common method for assigning a libref is to use the LIBNAME statement to associate a name with a SAS library. Here is the simplest form of the LIBNAME statement:

LIBNAME *libref* '*SAS-library*' ;

libref
: specifies a shortcut name to associate with the SAS library. This name must conform to the rules for SAS names. A libref cannot exceed eight characters.

  z/OS Specifics: Under the z/OS operating environment, the libref must also conform to the rules for operating environment names.

  Think of the libref as an abbreviation for the operating environment's name for the library. The libref only lasts for the duration of the SAS session. You can change the libref for any given library from session to session. That is, you do not have to use the same libref for a particular library each time you use SAS.

SAS-library
: specifies the physical name for the SAS library. The physical name is the name that is recognized by your operating environment. Enclose the physical name in single or double quotation marks.

Here are examples of the LIBNAME statement for different operating environments. For more examples, see the SAS documentation for your operating environment.

Windows
```
libname mydata 'c:\my documents\sasfiles';
```

UNIX
```
libname mydata '/u/myid/sasfiles';
```

z/OS
```
libname mydata 'edc.company.sasfiles';
```

When you assign a libref with the LIBNAME statement, SAS writes a note to the SAS log confirming the assignment. This note also includes the operating environment's physical name for the SAS library.

Using Librefs for Temporary and Permanent Libraries

When a libref is assigned to a SAS library, you can use the libref throughout the SAS session to access the SAS files that are stored in that library. The association between a libref and a SAS library lasts only for the duration of the SAS session, or until you change the libref or discontinue it with another LIBNAME statement.

When you start a SAS session, SAS automatically assigns the libref WORK to a special SAS library. Usually, the files in the WORK library are temporary files. That is, SAS initializes the WORK library when you begin a SAS session, and deletes all files in the WORK library when you end the session. Therefore, the WORK library is a useful place to store SAS files that you do not need to save for a subsequent SAS session. The automatic deletion of the WORK library files at the end of the session prevents you from wasting disk space.

Files that are stored in any SAS library other than the WORK library are usually permanent files. That is, they are available from one SAS session to the next. Store SAS files in a permanent library if you plan to use them in multiple SAS sessions.

Storing Files in a SAS Library

What Is a SAS File?

You store all SAS files in a SAS library. A SAS file is a specially structured file that is created, organized, and maintained by SAS. The files reside in SAS libraries as members with specific types. Examples of SAS files are as follows:

- SAS data sets (which can be SAS data files or SAS data views)
- SAS catalogs
- SAS/ACCESS descriptor files
- stored compiled DATA step programs

Note: A file that contains SAS statements, even one that is created during a SAS session, is usually not considered a SAS file. For example, in directory-based operating environments, a .sas file is a text file that typically contains a program and is not considered a SAS file.

Understanding SAS Data Sets

A SAS data set is a SAS file that is stored in a SAS library that consists of descriptor information. Descriptor information identifies the attributes of a SAS data set and its contents, and data values that are organized as a table of observations (rows) and variables (columns). A SAS data set can be either a SAS data file or a SAS data view.

If the descriptor information and the observations are in the same physical location, then the data set is a SAS data file, which has a member type DATA. A SAS data file can be associated with an index. One purpose of an index is to optimize the performance of WHERE processing. Basically, an index contains values in ascending order for a specific variable or variables. The index also includes information about the location of those values within observations in the SAS data file.

If the descriptor and the observations are stored separately, then they form a SAS data view, which has a member type VIEW. The observations in a SAS data view might be stored in a SAS data file, an external database, or an external file. The descriptor contains information about where the data is located and which observations and variables to process. You use a view like you would a SAS data file. You might use a view when you need only a subset of a large amount of data. In addition to saving storage space, views simplify maintenance because they automatically reflect any changes to the data. There are three types of SAS data views:

- DATA step views
- SAS/ACCESS views
- PROC SQL views

Note: SAS data views usually behave like SAS data files. Other topics in this documentation do not distinguish between the two types of SAS data sets.

Understanding Other SAS Files

In addition to SAS data sets, a SAS library can contain the following types of SAS files:

SAS catalog
: specifies a SAS file that stores many types of information in separate units called catalog entries. Each entry is distinguished by an entry name and an entry type. Some catalog entries contain system information such as key definitions. Other catalog entries contain application information about window definitions, help windows, formats, informats, macros, or graphics output. A SAS catalog has a member type CATALOG.

SAS/ACCESS descriptor
: specifies a SAS file that contains information about the layout of an external database. SAS uses this information in order to build a SAS data view in which the observations are stored in an external database. An access descriptor has a member type ACCESS.

stored compiled DATA step program
: specifies a SAS file that contains a DATA step, which has been compiled and stored in a SAS library. A stored compiled DATA step program has a member type PROGRAM.

Complete discussion of all SAS files, except SAS data sets, is beyond the scope of this section. For more information about SAS files, see *SAS Language Reference: Concepts*.

Referencing SAS Data Sets in a SAS Library

Understanding Data Set Names

Every SAS data set has a two-level name of the form *libref.filename*. You can always reference a file with its two-level name. However, you can also use a one-level name (*filename*) to reference a file. By default, a one-level name references a file that uses the libref WORK for the temporary SAS library.

Note: This section separates the issues of permanent versus temporary files and one-level versus two-level names. Other topics in this documentation and in most SAS documentation assume typical use of the WORK libref, and refer to files that are referenced with a one-level name as temporary files. Files that are referenced with a two-level name are considered permanent files.

Operating Environment Information: The documentation that is provided by the vendor for your operating environment provides information about how to create temporary and permanent files. In SAS, files in the WORK library are temporary unless you specify the NOWORKINIT and NOWORKTERM options. Files in all other SAS libraries are permanent. However, your operating environment might consider libraries and files in a different way. For example, the operating environment might enable you to create a temporary directory or a temporary z/OS data set that are deleted when you log off. Because all files in a SAS library are deleted if the underlying operating environment structure is deleted, the way the operating environment views the SAS library determines whether the library endures from one session to the next.

Using a One-Level Name

Typically, when you reference a SAS data set with a one-level name, SAS by default uses the libref WORK for the temporary library. For example, the following program creates a temporary SAS data set named WORK.GRADES:

```
data grades;
   infile 'file-specification';
   input Name $ 1-14 Gender $ 15-20 Section $ 22-24 Grade;
run;
```

However, if you want to use a one-level name to reference a permanent SAS data set, you can assign the reserved libref USER. When USER is assigned and you reference a SAS data set with a one-level name, SAS by default uses the libref USER for a permanent SAS library. For example, the following program creates a permanent SAS data set named USER.GRADES. Note that you assign the libref USER as you do any other libref.

```
libname user 'SAS-library';
```

```
data grades;
   infile 'file-specification';
   input Name $ 1-14 Gender $ 15-20 Section $ 22-24 Grade;
run;
```

Therefore, when you reference a SAS data set with a one-level name, SAS looks for the libref USER. If it is assigned to a SAS library, then USER becomes the default libref for one-level names. If the libref USER has not been assigned, SAS uses WORK as the default libref for one-level names.

If USER is assigned, then you must use a two-level name to access a temporary data set in the WORK library. For example, if USER is assigned, then to print the data set WORK.GRADES requires a two-level name in the PROC PRINT statement:

```
proc print data=work.grades;
run;
```

If USER is assigned, then you need to make only one change in order to use the same program with files of the same name in different SAS libraries. Instead of specifying two-level names, assign USER differently in each case. For example, the following program concatenates five SAS data sets in *SAS-library-1* and puts them in a new SAS data set, WEEK, in the same library:

```
libname user 'SAS-library-1';

data week;
   set mon tues wed thurs fri;
run;
```

By changing just the name of the library in the LIBNAME statement, you can combine files with the same names in another library, *SAS-library-2*:

```
libname user 'SAS-library-2';

data week;
   set mon tues wed thurs fri;
run;
```

Note: At your site, the libref USER might be assigned for you when you start a SAS session. Your on-site SAS support personnel knows whether the libref is assigned.

Using a Two-Level Name

You can always reference a SAS data set with a two-level name, whether the libref that you use is WORK, USER, or some other libref that you have assigned. Usually, any two-level name with a libref other than WORK references a permanent SAS data set.

In the following program, the LIBNAME statement establishes a connection between the SAS name INTRCHEM and *SAS-library*. *SAS-library* is the physical name for the location of an existing data set or directory. The DATA step creates the SAS data set GRADES in the SAS library INTRCHEM. SAS uses the INPUT statement to construct the data set from the raw data in *file-specification*.

```
libname intrchem 'SAS-library';
```

```
data intrchem.grades;
   infile 'file-specification';
   input Name $ 1-14 Gender $ 15-20 Section $ 22-24 Grade;
run;
```

When the SAS data set INTRCHEM.GRADES is created, you can read from it by using its two-level name. The following program reads the file INTRCHEM.GRADES and creates a new SAS data set named INTRCHEM.FRIDAY, which is a subset of the original data set:

```
data intrchem.friday;
   set intrchem.grades;
      if Section='Fri';
run;
```

You can add the following PROC PRINT step to display the SAS data set INTRCHEM.FRIDAY:

```
proc print data=intrchem.friday;
run;
```

Summary

Statements

LIBNAME *libref* '*SAS-library*';
: in most operating environments, associates a *libref* with a SAS library. Enclose the name of the SAS library in single or double quotation marks.

SAS Data Set Reference

You can reference any SAS data set with a two-level name of the form *libref.filename*. By default, if you use a one-level name to reference a SAS data set, then SAS uses the libref USER if it is assigned. If USER is not assigned, then SAS uses the libref WORK.

Learning More

LIBNAME statement
: For more information about the LIBNAME statement, including options for the statement and information about specifying an engine other than the default engine, see “LIBNAME Statement” in *SAS Global Statements: Reference*.

Operating environment
: For operating environment specifics, see the SAS documentation for your operating environment.

SAS files
: Detailed information about SAS files can be found in *SAS Language Reference: Concepts*.

  For detailed information about PROC SQL views, see *SAS SQL Procedure User's Guide*.

SAS tools
: To learn about the tools that are available for managing SAS libraries, including the DATASETS procedure, see Chapter 36, "Managing SAS Libraries," on page 725.

USER libref
: For information about the USER= system option, which you can use instead of the LIBNAME statement to assign the USER libref, see "USER= System Option" in *SAS System Options: Reference*.

  Note: If you assign the libref both ways or if you assign it more than once with either method, then the last definition is the one that is used.

WORK library
: For information about the WORKINIT system option, see "WORKINIT System Option" in *SAS System Options: Reference*. For information about the WORKTERM system option, see "WORKTERM System Option" in *SAS System Options: Reference*. These options control when the WORK library is initialized.

36

Managing SAS Libraries

Introduction to Managing SAS Libraries

Purpose

In this section, you will learn about the tools that are available for managing SAS libraries, including the DATASETS procedure. Subsequent sections describe how to use the DATASETS procedure.

Prerequisites

Before using this section, you should understand the concepts presented in Chapter 35, “Understanding SAS Libraries,” on page 715.

Choosing Your Tools

As you accumulate more SAS files, you will need to manage the SAS libraries. Managing libraries generally involves using SAS procedures to perform routine tasks:

- listing library members and their properties
- renaming, deleting, and moving files
- renaming variables
- copying libraries and files

SAS procedures can perform any file management task for your SAS libraries with no need for operating environment commands.

Several SAS tools are available for basic file management. You can use these features alone or in combination.

SAS Explorer
: includes windows for most file management tasks, with no need for submitting SAS program statements. For example, you can create new libraries and SAS files, open existing SAS files, and perform most file management tasks such as moving, copying, and deleting files. To use SAS Explorer windows, enter **`libname`**, **`catalog`**, or **`dir`** in the command bar, or select the Explorer icon from the **Toolbar** menu.

CATALOG procedure
: provides catalog management utilities with the COPY and CONTENTS statements.

COPY procedure
: copies all members of a library or individual files within the library.

CONTENTS procedure
: lists library members and their properties.

DATASETS procedure
: combines all library management functions into one procedure. If you do not use SAS Explorer, or if you use SAS in batch or interactive line mode, then this procedure can save you time and resources. PROC DATASETS enables you to perform a number of management tasks such as copying, deleting, or modifying SAS files.

Understanding the DATASETS Procedure

The DATASETS procedure is an interactive procedure. That is, the procedure remains active after a RUN statement is executed. After you start the procedure, you can continue to manipulate files within a SAS library until you have finished all the tasks that you have planned. This capability can save time and resources when you have a number of tasks to complete for one session.

Here are some important features to know about the DATASETS procedure:

- You can specify the input library in the PROC DATASETS statement.

  When you start the DATASETS procedure, you can specify the input library, which is referred to as the procedure input library. If you do not specify a library as the source of files, then SAS uses the default library, which could be the temporary library WORK or the USER library. To specify a different input library, you must start the procedure again.

- Statements execute in the order in which they are written.

  For example, you can view the contents of a SAS data set, copy a second data set from another library, and then view and compare the contents of the two data sets. To perform the tasks in the order listed above, the SAS statements that perform these tasks must be specified in the same order.

- Groups of statements can execute without a RUN statement.

  For the DATASETS procedure only, SAS recognizes the following procedure statements as having an implied RUN statement, and executes them immediately when you submit them:

  - APPEND statement
  - CONTENTS statement
  - MODIFY statement
  - COPY statement
  - PROC DATASETS statement

  SAS reads the statements that are associated with one task until it encounters one of the statements above. SAS executes all of the preceding statements immediately and continues reading until it encounters another of the above statements. To cause the last task to execute, you must submit a RUN or QUIT statement.

  Note: If you are running in interactive line mode, this feature enables you to receive messages that statements have already executed before you submit a RUN statement.

- The RUN statement does not stop a PROC DATASETS step.

  You must submit a QUIT statement, a new PROC statement, or a DATA step to stop a PROC DATASETS step. Submitting a QUIT statement executes any statements that have not yet executed and ends the procedure.

Looking at a PROC DATASETS Session

The following example illustrates how PROC DATASETS behaves in a typical session. In the example, a file from one SAS library is used to create a test file in another SAS library. A data set is copied and its contents are described so that the output can be visually checked to be sure that the variables are compatible with an existing file in the test library.

The following program is arranged in groups to show which statements are executed as one task. The tasks and the action by SAS are numbered in the order in which they occur in the program.

```
proc datasets library=test89; 1

   copy in=realdata out=test89; 2
   select income88;

   contents data=income88; 3
run;

   modify income88; 4
   rename Sales=Sales88;

quit; 5
```

The following list corresponds to the numbered items in the preceding program:

1 Starts the DATASETS procedure and specifies TEST89 as the procedure input library.

2 Copies the data set INCOME88 from the SAS library REALDATA to the SAS library TEST89. SAS recognizes these statements as one task. When SAS reads the CONTENTS statement, it immediately executes the COPY statement, and copies INCOME88 into the library TEST89. The CONTENTS statement acts as an implied RUN statement, which causes the COPY statement to execute. This action is more noticeable if you are running SAS in the windowing environment.

3 Describes the contents of the data set. Visually checking the output can verify that the variables are compatible with an existing SAS data set. When SAS encounters the RUN statement, it describes the content of INCOME88. Because the previous task has executed, SAS finds the data set in the procedure input library TEST89.

   After visually checking the contents, you determine that it is necessary to rename the variable Sales. Because the DATASETS procedure is still active, you can submit more statements.

4 Renames the variable Sales to Sales88.

5 Stops the DATASETS procedure. SAS executes the last two statements and ends the DATASETS procedure.

Summary

Procedures

PROC DATASETS <LIBRARY=*libref*>;
   starts the procedure and specifies the library that the procedure processes, that is, the procedure input library. If you do not specify the LIBRARY= option, then

the default is the WORK or USER library. PROC DATASETS creates a directing listing when the procedure is submitted.

Statements

QUIT;
: executes any preceding statements that have not run and stops the procedure.

RUN;
: executes the preceding group of statements that have not run, without ending the procedure.

Learning More

DATASETS procedure
: To learn about using the DATASETS procedure to manage SAS libraries whose members are primarily data sets, see the following sections:

- Chapter 37, “Getting Information about Your SAS Data Sets,” on page 731.
- Chapter 38, “Modifying SAS Data Set Names and Variable Attributes,” on page 743.
- Chapter 39, “Copying, Moving, and Deleting SAS Data Sets,” on page 755.

SAS windowing environment
: For information about managing SAS files through the SAS windowing environment, see Chapter 41, “Using the SAS Windowing Environment,” on page 783.

Operating environment commands
: For information about managing SAS files using operating environment commands, see the SAS documentation for your operating environment.

37

Getting Information about Your SAS Data Sets

Introduction to Getting Information about Your SAS Data Sets

Purpose

As you create libraries of SAS data sets, SAS generates and maintains information about where the library is stored in your operating environment, how and when the data sets were created, and how their contents are defined. Using the DATASETS procedure, you can view this information without displaying the contents of the data set or referring to additional documentation.

In this section, you will learn how to get the following information about SAS libraries and SAS data sets:

- names and types of SAS files that are included in a SAS library
- names and attributes for variables in SAS data sets
- summary information about storage parameters for the operating environment
- summary information about the history and structure of SAS data sets

Prerequisites

Before using this section, you should understand the concepts presented in the following sections:

- Chapter 35, “Understanding SAS Libraries,” on page 715
- Chapter 36, “Managing SAS Libraries,” on page 725

Input Data Library for Examples

The examples in this section use a SAS library that contains information about the climate of the United States. The DATA steps that create the data sets are shown in “The USCLIM Data Sets” on page 857. Note that these DATA steps do not create catalog entries. The catalogs that you see in Figure 37.1 on page 733 have been added for illustration.

Requesting a Directory Listing for a SAS Library

Understanding a Directory Listing

A directory listing is a list of files in a SAS library. Each file is called a member, and each member has a member type that is assigned to it by SAS. The member type indicates the type of SAS file, such as DATA or CATALOG. When SAS processes statements, SAS not only looks for the specified file, it verifies that the file has a member type that can be processed by the statement.

The directory listing contains two main parts:

- directory information
- list of library members and their member types

Listing All Files in a Library

To obtain a directory listing of all members in a library, you need only the PROC DATASETS statement with the LIBRARY= option. For example, the following statements send a directory listing to the Results window for a library that contains climate information. The LIBNAME statement assigns the libref USCLIM to this library:

```
libname usclim 'SAS-library';

proc datasets library=usclim;
```

The following output displays the directory listing.

Figure 37.1 Directory Listing for the Library USCLIM

The SAS System

Directory	
Libref	USCLIM
Engine	V9
Physical Name	c:\Users\userid\climate
Filename	c:\Users\userid\climate

#	Name	Member Type	File Size	Last Modified
1	BASETEMP	CATALOG	3830784	04/16/2013 13:22:20
2	HIGHTEMP	DATA	131072	04/16/2013 13:36:54
3	HURRICANE	DATA	131072	04/16/2013 13:36:54
4	LOWTEMP	DATA	131072	04/16/2013 13:36:54
5	REPORT	CATALOG	2077696	04/16/2013 13:22:20
6	TEMPCHNG	DATA	131072	04/16/2013 13:36:54

The following is a list of the items shown in the output:

Directory
: gives the physical name as well as the libref for the library. Some operating environments provide both additional and different information.

Name
: contains the second-level SAS member name that is assigned to the file. If the files are different member types, then you can have two files of the same name in one library.

Member Type
: indicates the SAS file member type. The most common member types are DATA and CATALOG. For example, the library USCLIM contains two catalogs of type CATALOG and four date sets of type DATA.

File Size
: specifies the size of the file.

Last Modified
: specifies the date on which the file was last modified.

Note: After you execute PROC DATASETS the first time, the DATASETS procedure continues to run. You can execute more procedure statements without executing the PROC DATASETS statement again. To end the DATASETS procedure, execute the `QUIT;` statement.

Listing Files That Have the Same Member Type

To show only certain types of SAS files in the directory listing, use the MEMTYPE= option in the PROC DATASETS statement. The following statement produces a listing for USCLIM that contains only the information about data sets:

```
proc datasets library=usclim memtype=data;
```

The following output displays information about the data sets (member type DATA) that are stored in USCLIM.

Figure 37.2 Directory of Data Sets Only for the Library USCLIM

The SAS System

Directory	
Libref	USCLIM
Engine	V9
Physical Name	c:\Users\userid\climate
Filename	c:\Users\userid\climate

#	Name	Member Type	File Size	Last Modified
1	HIGHTEMP	DATA	131072	04/16/2013 13:36:54
2	HURRICANE	DATA	131072	04/16/2013 13:36:54
3	LOWTEMP	DATA	131072	04/16/2013 13:36:54
4	TEMPCHNG	DATA	131072	04/16/2013 13:36:54

Note: Examples in this document focus on using PROC DATASETS to manage only SAS data sets. You can also list other member types by specifying MEMTYPE=. For example, MEMTYPE=CATALOG lists only SAS catalogs.

Requesting Contents Information about SAS Data Sets

Using the DATASETS Procedure for SAS Data Sets

To look at the contents of a SAS data set without displaying the observations, use the CONTENTS statement in the DATASETS procedure. The CONTENTS statement and its options provide descriptive information about data sets and a list of variables and their attributes.

Listing the Contents of One Data Set

The SAS library USCLIM contains four data sets. The data set TEMPCHNG contains data for extreme changes in temperature. The following program displays the variables in the data set TEMPCHNG:

```
proc datasets library=usclim memtype=data;
   contents data=tempchng;
run;
```

The output from the CONTENTS statement produces information about the TEMPCHNG data set. The DATA= option specifies the name of the data set. The following output shows the results from the CONTENTS statement.

Figure 37.3 Output from CONTENTS Statement for Data Set TEMPCHNG

The SAS System

The DATASETS Procedure

Data Set Name	USCLIM.TEMPCHNG	Observations	5
Member Type	DATA	Variables	6
Engine	V9	Indexes	0
Created	04/05/2013 09:56:16	Observation Length	56
Last Modified	04/05/2013 09:56:16	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	1167
Obs in First Data Page	5
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\Users\userid\climate\tempchng.sas7bdat
Release Created	9.0401B0
Host Created	W32_7PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat
2	Date	Num	8	DATE9.	DATE7.
6	Diff	Num	8		
4	End_f	Num	8		
5	Minutes	Num	8		
3	Start_f	Num	8		
1	State	Char	13		$CHAR13.

Note that output from the CONTENTS statement varies for different operating environments.

The following list describes information that you might find when you use the CONTENTS statement with PROC DATASETS:

The DATASETS Procedure heading
: contains field names. Fields are empty if they do not apply to the data set. Field names are listed below:

  Data Set Name
  specifies the two-level name that is assigned to the data set.

  Member Type
  specifies the type of library member.

  Engine
  specifies the access method that SAS uses to read from or write to the data set.

Created
specifies the date on which the data set was created.

Last Modified
specifies the last date that the data set was modified.

Protection
indicates whether the data set is password protected for READ, WRITE, or ALTER operations.

Data Set Type
applies only to files with the member type DATA. Information in this field indicates that the data set contains special observations and variables for use with SAS statistical procedures.

Label
specifies the descriptive information that you supply in a LABEL= data set option to identify the data set.

Data Representation
specifies the form in which data is stored in a particular operating environment.

Encoding
specifies a mapping of a coded character set to code values. Each character in a character set maps to a unique numeric representation.

Observations
specifies the total number of observations that are currently in the data set.

Variables
specifies the number of variables in the data set.

Indexes
specifies the number of indexes for the data set.

Observation Length
specifies the length of each observation in bytes.

Deleted Observations
specifies the number of observations that are marked for deletion, if applicable.

Compressed
indicates whether the data has fixed-length or variable-length records. If the data set is compressed, then additional fields indicate whether new observations are added to the end of the data set or written to unused space within the data set. It also indicates whether the data set can be randomly accessed by observation number rather than by sequential access only.

Sorted
indicates whether the data set has been sorted.

Engine/Host Dependent Information
lists information about the engine, which is the mechanism for reading from and writing to files, and about how the data set is stored by the operating environment. Depending on the engine, the output in this section might differ. For more information, see the SAS documentation for your operating environment.

Alphabetical List of Variables and Attributes
lists all the variable names in the data set in alphabetical order and describes the attributes that are assigned to the variable when it is defined. The attributes are described below:

#
specifies the logical position of the variable in the observation. This is the number that is assigned to the variable when it is defined.

Variable
specifies the name of the variable.

Type
indicates whether the variable is character or numeric.

Len
specifies the length of the variable in bytes.

Format
specifies the format of the variable.

Informat
specifies the informat of the variable.

In addition, if applicable, the output also displays a table that describes the following information:

- indexes for indexed variables
- any defined integrity constraints
- sort information

Listing the Contents of All Data Sets in a Library

You can list the contents of all the data sets in a library by specifying the keyword _ALL_ with the DATA= option. The following statements produce a directory listing for the library and a contents listing for each data set in the directory:

```
   contents data=_all_;
run;
```

To create only a directory listing, add the NODS option to the CONTENTS statement. The following statements produce a directory listing but suppress a contents listing for individual data sets. Use this form if you want the directory listing for the procedure input library:

```
   contents data=_all_ nods;
run;
```

Include the libref if you want the directory listing for another library. This example specifies the library STORM:

```
   contents data=storm._all_ nods;
run;
```

Requesting Contents Information in Different Formats

For a variation of the contents listing, use the VARNUM option or the SHORT option in the CONTENTS statement. For example, the following statements produce a list of variable names in the order in which they were defined, which is their logical position in the data set:

```
   contents data=tempchng varnum;
run;
```

The CONTENTS statement specifies the data set TEMPCHNG and includes the VARNUM option to list variables in order of their logical position. (By default, the CONTENTS statement lists variables alphabetically.)

The following output shows the contents in variable number order.

Figure 37.4 Contents of the Data Set TEMPCHNG in Variable Number Order

The SAS System

The DATASETS Procedure

Data Set Name	USCLIM.TEMPCHNG	Observations	5
Member Type	DATA	Variables	6
Engine	V9	Indexes	0
Created	04/05/2013 09:56:16	Observation Length	56
Last Modified	04/05/2013 09:56:16	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	1167
Obs in First Data Page	5
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\Users\userid\climate\tempchng.sas7bdat
Release Created	9.0401B0
Host Created	W32_7PRO

Variables in Creation Order

#	Variable	Type	Len	Format	Informat
1	State	Char	13		$CHAR13.
2	Date	Num	8	DATE9.	DATE7.
3	Start_f	Num	8		
4	End_f	Num	8		
5	Minutes	Num	8		
6	Diff	Num	8		

If you do not need all of the information in the contents listing, then you can request an abbreviated version by using the SHORT option in the CONTENTS statement. The following statements request an abbreviated version and then end the DATASETS procedure by issuing the QUIT statement:

```
   contents data=tempchng short;
run;
quit;
```

The following output lists the variable names for the TEMPCHNG data set.

Figure 37.5 *Listing Variable Names Only for the Data Set TEMPCHNG*

The SAS System

The DATASETS Procedure

Alphabetic List of Variables for USCLIM.TEMPCHNG
Date Diff End_f Minutes Start_f State

Summary

Procedures

PROC DATASETS <LIBRARY=*libref* <MEMTYPE=*mtype(s)*>>;

The MEMTYPE= option restricts processing to a certain type or types of SAS files and restricts the library directory listing to SAS files of the specified member types.

DATASETS Procedure Statements

CONTENTS <DATA=<*libref*>.*SAS-data-set*> <NODS> <SHORT> <VARNUM> ;

describes the contents of a specific SAS data set in the library. The default data set is the most recently created data set for the job or session. For the CONTENTS statement in PROC DATASETS, when you specify DATA=, the default libref is the procedure input library. However, for the CONTENTS procedure, the default libref is either WORK or USER.

Use the NODS option with the keyword _ALL_ in the DATA= option to produce only the directory listing of the library in SAS output. That is, the NODS option suppresses the contents of individual files. You cannot use the NODS option when you specify only one SAS data set in the DATA= option.

The SHORT option produces only an alphabetical list of variable names, index information, integrity constraint information, and sort information for the SAS data set.

The VARNUM option produces a list of variable names in the order in which they were defined, which is their logical position in the data set. By default, the CONTENTS statement lists variables alphabetically.

Learning More

CATALOG procedure
: You can use the CATALOG procedure to obtain contents information about catalogs. For more information, see "CATALOG Procedure" in *Base SAS Procedures Guide*.

DATASETS procedure
: The DATASETS procedure is a utility procedure that manages your SAS files. For more information about the DATASETS procedure and the CONTENTS statement, see "DATASETS Procedure" in *Base SAS Procedures Guide*.

CONTENTS procedure
: The CONTENTS procedure shows the contents of a SAS data set and writes the directory of the SAS library. For more information, see "CONTENTS Procedure" in *Base SAS Procedures Guide*.

Windowing environment
: For more information about using the windowing environment to obtain information about SAS data sets, see Chapter 41, "Using the SAS Windowing Environment," on page 783.

38

Modifying SAS Data Set Names and Variable Attributes

Introduction to Modifying SAS Data Set Names and Variable Attributes

Purpose

SAS enables you to modify data set names and variable attributes without creating new data sets. In this section, you will learn how to use statements in the DATASETS procedure to perform the following tasks:

- rename data sets
- rename variables
- modify variable formats
- modify variable labels

This section focuses on using the DATASETS procedure to modify data sets. However, you can also use some of the illustrated statements and options to modify other types of SAS files.

Note: You cannot use the DATASETS procedure to change the values of observations, to create or delete variables, or to change the type or length of variables. These modifications are done with DATA step statements and functions.

Prerequisites

Before using this section, you should understand the concepts presented in the following sections:

- Chapter 35, "Understanding SAS Libraries," on page 715
- Chapter 36, "Managing SAS Libraries," on page 725
- Chapter 37, "Getting Information about Your SAS Data Sets," on page 731

Input Data Library for Examples

The examples in this section use a SAS library that contains information about the climate of the United States. The DATA steps that create the data sets in the SAS library are shown in "The CLIMATE, PRECIP, and STORM Data Sets" on page 859.

Renaming SAS Data Sets

Renaming data sets is often required for effective library management. For example, you might rename a data set when you archive it or when you add new data values.

Use the CHANGE statement in the DATASETS procedure to rename one or more data sets in the same library. Here is the syntax for the CHANGE statement:

CHANGE *old-name*=*new-name*;

old-name
: specifies the current name of the SAS data set.

new-name
: specifies the name that you want to give the data set.

This example renames two data sets in the SAS library USCLIM, which contains information about the climate of the United States. The following program starts the DATASETS procedure. It then changes the name of the data set HIGHTEMP to USHIGH and the name of the data set LOWTEMP to USLOW:

```
libname usclim 'SAS-library';

proc datasets library=usclim;
   change hightemp=ushigh lowtemp=uslow;
run;
```

As it processes these statements, SAS sends messages to the SAS log. The messages verify that the data sets are renamed.

Example Code 38.1 *Renaming Data Sets in the Library USCLIM*

```
38   proc datasets library=usclim;
39      change hightemp=ushigh lowtemp=uslow;
40   run;

NOTE: Changing the name USCLIM.HIGHTEMP to USCLIM.USHIGH (memtype=DATA).
NOTE: Changing the name USCLIM.LOWTEMP to USCLIM.USLOW (memtype=DATA).
```

The following program executes the DATASETS procedure, where you can see the results of the changes:

```
proc datasets library=usclim;
run;
```

The following output shows information about the library.

Figure 38.1 *Renaming Data Sets in the Library USCLIM*

The SAS System

Directory	
Libref	USCLIM
Engine	V9
Physical Name	c:\Users\userid\climate
Filename	c:\Users\userid\climate

#	Name	Member Type	File Size	Last Modified
1	BASETEMP	CATALOG	3830784	04/16/2013 13:22:20
2	HURRICANE	DATA	131072	04/16/2013 13:36:54
3	REPORT	CATALOG	2077696	04/16/2013 13:22:20
4	TEMPCHNG	DATA	131072	04/16/2013 13:36:54
5	USHIGH	DATA	131072	04/16/2013 13:36:54
6	USLOW	DATA	131072	04/16/2013 13:36:54

Modifying Variable Attributes

Understanding How to Modify Variable Attributes

Each variable in a SAS data set has attributes such as name, type, length, format, informat, label, and so on. These attributes enable you to identify a variable as well as define to SAS how the variable can be used.

By using the DATASETS procedure, you can assign, change, or remove certain attributes with the MODIFY statement and subordinate statements. For example, using MODIFY and subordinate statements enables you to perform the following tasks:

- rename variables
- assign, change, or remove a format, which changes how the values are written or displayed
- assign, change, or remove labels

Note: You cannot use the MODIFY statement to modify fixed attributes such as the type or length of a variable.

Renaming Variables

You might need to rename variables, for example, before combining data sets that have one or more matching variable names. The DATASETS procedure enables you to rename one or more variables by using the MODIFY statement and its subordinate RENAME statement. Here is the syntax for the statements:

MODIFY *SAS-data-set*;

  RENAME *old-name*=*new-name*;

SAS-data-set
  specifies the name of the SAS data set that contains the variable that you want to rename.

old-name
  specifies the current name of the variable.

new-name
  specifies the name that you want to give the variable.

This example renames two variables in the data set HURRICANE, which is in the SAS library USCLIM. The following statements change the variable name State to Place and the variable name Deaths to USDeaths. The DATASETS procedure is already active, so the PROC DATASETS statement is not necessary.

```
modify hurricane;
```

```
   rename State=Place Deaths=USDeaths;
run;
```

The SAS log messages verify that the variables are renamed to Place and USDeaths as shown in the following output. All other attributes that are assigned to these variables remain unchanged.

Example Code 38.2 *Renaming Variables in the Data Set HURRICANE*

```
48      modify hurricane;
49      rename State=Place Deaths=USDeaths;
NOTE: Renaming variable State to Place.
NOTE: Renaming variable Deaths to USDeaths.
50   run;

NOTE: MODIFY was successful for USCLIM.HURRICANE.DATA.
```

Assigning, Changing, or Removing Formats

SAS enables you to assign and store formats, which are used by many SAS procedures for output. Assigning, changing, or removing a format changes how the values are written or displayed. By using the DATASETS procedure, you can change a variable's format with the MODIFY statement and its subordinate FORMAT statement. You can change a variable's format either to a SAS format or to a format that you have defined and stored. You can also remove a format. Here is the syntax for these statements:

MODIFY *SAS-data-set*;

FORMAT *variable(s)* <*format*>;

SAS-data-set
: specifies the name of the SAS data set that contains the variable whose format you want to modify.

variable
: specifies the name of one or more variables whose format you want to assign, change, or remove.

format
: specifies the format that you want to give the variable. If you do not specify a format, then SAS removes any format that is associated with the specified variable.

When you assign or change a format, follow these rules:

- List the variable name before the format.
- List multiple variable names or use an abbreviated variable list if you want to assign the format to more than one variable.
- Do not use punctuation to separate items in the list.

The following FORMAT statement illustrates ways to include many variables and formats in the same FORMAT statement:

```
format Date1-Date5 date9. Cost1 Cost2 dollar4.2 Place $char25.;
```

The variables Date1 through Date5 are written in abbreviated list form, and the format DATE9. is assigned to all five variables. The variables Cost1 and Cost2 are listed individually before their format. The format $CHAR25. is assigned to the variable Place.

Two rules apply when you are removing formats from variables:

- List the variable names only.
- Place the variable names last in the list if you are using the same FORMAT statement to assign or change formats.

The following example shows how to change formats in the data set HURRICANE:

```
   contents data=hurricane;
      modify hurricane;
      format Date monyy7. Millions;
   contents data=hurricane;
run;
```

In this example, the following changes are made:

- the format for the variable Date is changed from a full spelling of the month, day, and year to an abbreviation of the month and year
- the format for the variable Millions is removed
- the contents of the data set HURRICANE is displayed before and after the changes

Note that because the FORMAT statement does not send messages to the SAS log, you must use the CONTENTS statement if you want to make sure that the changes were made.

The following output from the two CONTENTS statements displays the contents of the data set before and after the changes. The format for the variable Date is changed from WORDDATE18. to MONYY7., and the format for the variable Millions is removed.

Figure 38.2 Modifying Variable Formats in the Data Set HURRICANE: Before Change

The SAS System

The DATASETS Procedure

Data Set Name	USCLIM.HURRICANE	Observations	6
Member Type	DATA	Variables	5
Engine	V9	Indexes	0
Created	04/16/2013 13:36:54	Observation Length	48
Last Modified	04/17/2013 07:25:49	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	1361
Obs in First Data Page	6
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\Users\userid\climate\hurricane.sas7bdat
Release Created	9.0401B0
Host Created	W32_7PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat	Label
2	Date	Num	8	WORDDATE18.	DATE9.	
4	Millions	Num	8	DOLLAR6.		Damage
5	Name	Char	8			
1	Place	Char	14		$CHAR14.	
3	USDeaths	Num	8			

Figure 38.3 Modifying Variable Formats in the Data Set HURRICANE: After Change

The SAS System

The DATASETS Procedure

Data Set Name	USCLIM.HURRICANE	Observations	6
Member Type	DATA	Variables	5
Engine	V9	Indexes	0
Created	04/16/2013 13:36:54	Observation Length	48
Last Modified	04/17/2013 07:37:02	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	1361
Obs in First Data Page	6
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\Users\userid\climate\hurricane.sas7bdat
Release Created	9.0401B0
Host Created	W32_7PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat	Label
2	Date	Num	8	MONYY7.	DATE9.	
4	Millions	Num	8			Damage
5	Name	Char	8			
1	Place	Char	14		$CHAR14.	
3	USDeaths	Num	8			

Assigning, Changing, or Removing Labels

A label is the descriptive information that identifies variables in tables, plots, and graphs. You usually assign labels when you create a variable. If you do not assign a label, then SAS uses the variable name as the label. However, in CONTENTS output, if a label is not assigned, then the field is blank. By using the MODIFY statement and its subordinate LABEL statement, you can assign, change, or remove a label. Here is the syntax for these statements:

MODIFY *SAS-data-set*;

  LABEL *variable*=<'*label*'>;

SAS-data-set

  specifies the name of the SAS data set that contains the variable whose label you want to modify.

variable

specifies the name of the variable whose label you want to assign, change, or remove.

label

specifies the label, which can be from 1 to 256 characters, that you want to give the variable. If you do not specify a label and one exists, then SAS removes the current label.

When you use the LABEL statement, follow these rules:

- Enclose the text of the label in single or double quotation marks. If a single quotation mark appears in the label (for example, an apostrophe), then enclose the text in double quotation marks.
- Limit the label to no more than 256 characters, including blanks.
- To remove a label, use a blank as the text of the label, that is, *variable*`=' '`.

In the SAS data set HURRICANE, the following statements change the label for the variable Millions and assign a label for the variable Place. Because the LABEL statement does not send messages to the SAS log, the CONTENTS statement is specified to verify that the changes were made. The QUIT statement stops the DATASETS procedure.

```
   contents data=hurricane;
      modify hurricane;
         label Millions='Damage in Millions' Place='State Hardest Hit';
   contents data=hurricane;
run;
quit;
```

The following output from the two CONTENTS statements displays the contents of the data set before and after the changes.

Figure 38.4 Modifying Variable Labels in the Data Set HURRICANE: Before Change

The SAS System

The DATASETS Procedure

Data Set Name	USCLIM.HURRICANE	Observations	6
Member Type	DATA	Variables	5
Engine	V9	Indexes	0
Created	04/16/2013 13:36:54	Observation Length	48
Last Modified	04/17/2013 07:37:02	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	1361
Obs in First Data Page	6
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\Users\userid\climate\hurricane.sas7bdat
Release Created	9.0401B0
Host Created	W32_7PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat	Label
2	Date	Num	8	MONYY7.	DATE9.	
4	Millions	Num	8			Damage
5	Name	Char	8			
1	Place	Char	14		$CHAR14.	
3	USDeaths	Num	8			

Figure 38.5 *Modifying Variable Labels in the Data Set HURRICANE: After Change*

The SAS System

The DATASETS Procedure

Data Set Name	USCLIM.HURRICANE	Observations	6
Member Type	DATA	Variables	5
Engine	V9	Indexes	0
Created	04/16/2013 13:36:54	Observation Length	48
Last Modified	04/17/2013 08:00:42	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	2
First Data Page	1
Max Obs per Page	1361
Obs in First Data Page	6
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\Users\userid\climate\hurricane.sas7bdat
Release Created	9.0401B0
Host Created	W32_7PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat	Label
2	Date	Num	8	MONYY7.	DATE9.	
4	Millions	Num	8			Damage in Millions
5	Name	Char	8			
1	Place	Char	14		$CHAR14.	State Hardest Hit
3	USDeaths	Num	8			

Summary

DATASETS Procedure Statements

CHANGE *old-name*=*new-name*;

renames the SAS data set that you specify with *old-name* to the name that you specify with *new-name*. You can rename more than one data set in the same library by using one CHANGE statement. All new names must be valid SAS names.

MODIFY *SAS-data-set*;
: identifies the SAS data set that you want to modify. These are some of the subordinate statements that you can use with the MODIFY statement:

FORMAT *variable(s) <format>*;
assigns, changes, or removes the format for one or more variables. You specify the variable and the format by using the *variable* and *format* arguments. You can give more than one variable the same format by listing more than one variable before the format. Do not specify *format* if you want to remove a format.

LABEL *variable*=<'*label*'>;
assigns, changes, or removes the label for the variable that you specify with *variable*. To remove a label, place a blank space inside the quotation marks.

RENAME *old-name*=*new-name*;
changes the name of one or more variables that you specify with *old-name* to the name that you specify with *new-name*. You can rename more than one variable in the same data set by using one RENAME statement. All names must be valid SAS names.

Learning More

Informats and formats
: Informats and formats are available for reading and displaying data. For more information, see *SAS Formats and Informats: Reference*.

LABEL statement
: The LABEL statement assigns descriptive labels to variables. For more information, see "LABEL Statement" in *SAS DATA Step Statements: Reference*.

MODIFY statement
: The MODIFY statement in the DATASETS procedure has additional statements that change informats and that create and delete indexes for variables. For more information, see "DATASETS Procedure" in *Base SAS Procedures Guide*.

Renaming variables
: You can use the RENAME= data set option and the RENAME statement in the DATA step to rename variables. For more information, see "RENAME= Data Set Option" in *SAS Data Set Options: Reference* and "RENAME Statement" in *SAS DATA Step Statements: Reference*.

Variables
: To learn how to create and delete variables in the DATA step, see Chapter 6, "Starting with SAS Data Sets," on page 93.

39

Copying, Moving, and Deleting SAS Data Sets

Introduction to Copying, Moving, and Deleting SAS Data Sets

Purpose

Copying, moving, and deleting SAS data sets are the library management tasks that are performed most frequently. For example, you perform these tasks to create test files, make backups, archive files, and remove unused files. The DATASETS procedure enables you to work with all the files in a SAS library or with specific files in the library.

In this section, you will learn how to use the DATASETS procedure to perform the following tasks:

- copy an entire library
- copy specific SAS data sets
- move specific SAS data sets
- delete specific SAS data sets
- delete all files in a library

This section focuses on using the DATASETS procedure to copy, move, and delete data sets. You can also use the illustrated statements and options to copy, move, and delete other types of SAS files.

Prerequisites

Before using this section, you should understand the concepts that are presented in the following sections:

- Chapter 35, “Understanding SAS Libraries,” on page 715
- Chapter 36, “Managing SAS Libraries,” on page 725
- Chapter 38, “Modifying SAS Data Set Names and Variable Attributes,” on page 743

Input Data Libraries for Examples

The examples in this section use five SAS libraries that contain sample data sets that are used to collect and store weather statistics for the United States and other countries. The libraries have the librefs PRECIP, USCLIM, CLIMATE, WEATHER, and STORM. The following LIBNAME statements assign the librefs:

```
libname precip 'SAS-library-1';
libname usclim 'SAS-library-2';
libname climate 'SAS-library-3';
libname weather 'SAS-library-4';
libname storm 'SAS-library-5';
```

Note: For each LIBNAME statement, *SAS-library* is a different physical name for the location of the SAS library. In order to copy all or some SAS data sets from one library to another, the input and output libraries must be in different physical locations.

The DATA steps that create the data sets in the SAS libraries CLIMATE, PRECIP, and STORM are shown in “The CLIMATE, PRECIP, and STORM Data Sets” on page 859. The DATA steps that create the data sets in the SAS library USCLIM are shown in "The USCLIM Data Sets" on page 857.

Copying SAS Data Sets

Copying from the Procedure Input Library

You can use the COPY statement in the DATASETS procedure to copy all or some SAS data sets from one library to another. When copying data sets, SAS duplicates the contents of each file, including the descriptor information, and updates information in the directory for each library.

CAUTION
During processing, SAS automatically writes the data from the input library into an output data set of the same name. If there are duplicate data set names, then you do not receive a warning message before copying starts. Before you make changes to libraries, it is important to obtain directory listings of the input and output libraries in order to visually check for duplicate data set names.

To copy files from the procedure input library (specified in the PROC DATASETS statement), use the COPY statement. Here is the syntax of the COPY statement:

COPY OUT=*libref* <options>;

libref
: specifies the libref for the SAS library to which you want to copy the files. You must specify an output library.

For example, the library PRECIP contains data sets for snowfall and rainfall amounts, and the library CLIMATE contains data sets for temperature. The following program lists the contents so that they can be visually compared before any action is taken:

```
proc datasets library=precip;
   contents data=_all_ nods;
   contents data=climate._all_ nods;
run;
```

The PROC DATASETS statement starts the procedure and specifies the procedure input library PRECIP. The first CONTENTS statement produces a directory listing of the library PRECIP. Then, the second CONTENTS statement produces a directory listing of the library CLIMATE.

The following SAS output displays the two directory listings.

Figure 39.1 Checking the Directory PRECIP Before Copying

The SAS System

The DATASETS Procedure

Directory	
Libref	PRECIP
Engine	V9
Physical Name	c:\Users\userid\precip
Filename	c:\Users\userid\precip

#	Name	Member Type	File Size	Last Modified
1	RAIN	DATA	131072	04/17/2013 08:26:48
2	SNOW	DATA	131072	04/17/2013 08:26:48

Figure 39.2 Checking Directory CLIMATE Before Copying

The SAS System

The DATASETS Procedure

Directory	
Libref	CLIMATE
Engine	V9
Physical Name	c:\Users\userid\climate2
Filename	c:\Users\userid\climate2

#	Name	Member Type	File Size	Last Modified
1	HIGHTEMP	DATA	131072	04/17/2013 08:26:48
2	LOWTEMP	DATA	131072	04/17/2013 08:26:48

There are no duplicate names in the directories, so the COPY statement can be issued to achieve the desired results.

```
   copy out=climate;
run;
```

The following SAS log shows the messages as the data sets in the library PRECIP are copied to the library CLIMATE. There are now two copies of the data sets RAIN and SNOW: one in the PRECIP library and one in the CLIMATE library.

Example Code 39.1 *Messages Sent to the SAS Log during Copying*

```
143     copy out=climate;
144  run;

NOTE: Copying PRECIP.RAIN to CLIMATE.RAIN (memtype=DATA).
NOTE: There were 5 observations read from the data set PRECIP.RAIN.
NOTE: The data set CLIMATE.RAIN has 5 observations and 4 variables.
NOTE: Copying PRECIP.SNOW to CLIMATE.SNOW (memtype=DATA).
NOTE: There were 3 observations read from the data set PRECIP.SNOW.
NOTE: The data set CLIMATE.SNOW has 3 observations and 4 variables.
```

Copying from Other Libraries

You can copy from a library other than the procedure input library without using another PROC DATASETS statement. To do so, use the IN= option in the COPY statement to override the procedure input library. Here is the syntax for the option:

COPY OUT=*libref-1* IN=*libref-2*;

libref-1
: specifies the libref for the SAS library to which you want to copy files.

libref-2
: specifies the libref for the SAS library from which you want to copy files.

The IN= option is a useful tool when you want to copy more than one library into the output library. You can use one COPY statement for each input library without repeating the PROC DATASETS statement.

For example, the following statements copy the libraries PRECIP, STORM, CLIMATE, and USCLIM to the library WEATHER. The procedure input library is PRECIP, which was specified in the previous PROC DATASETS statement.

```
   copy out=weather;
   copy in=storm out=weather;
   copy in=climate out=weather;
   copy in=usclim out=weather;
run;
```

The following SAS log shows that the data sets from these libraries have been consolidated in the library WEATHER.

Example Code 39.2 *Copying Four Libraries into the Library WEATHER*

```
142     copy out=weather;
NOTE: Copying PRECIP.RAIN to WEATHER.RAIN (memtype=DATA).
NOTE: There were 5 observations read from the data set PRECIP.RAIN.
NOTE: The data set WEATHER.RAIN has 5 observations and 4 variables.
NOTE: Copying PRECIP.SNOW to WEATHER.SNOW (memtype=DATA).
NOTE: There were 3 observations read from the data set PRECIP.SNOW.
NOTE: The data set WEATHER.SNOW has 3 observations and 4 variables.
143     copy in=storm out=weather;
NOTE: Copying STORM.HURRICANE to WEATHER.HURRICANE (memtype=DATA).
NOTE: There were 6 observations read from the data set STORM.HURRICANE.
NOTE: The data set WEATHER.HURRICANE has 6 observations and 5 variables.
NOTE: Copying STORM.TORNADO to WEATHER.TORNADO (memtype=DATA).
NOTE: There were 5 observations read from the data set STORM.TORNADO.
NOTE: The data set WEATHER.TORNADO has 5 observations and 4 variables.
144     copy in=climate out=weather;
NOTE: Copying CLIMATE.HIGHTEMP to WEATHER.HIGHTEMP (memtype=DATA).
NOTE: There were 6 observations read from the data set CLIMATE.HIGHTEMP.
NOTE: The data set WEATHER.HIGHTEMP has 6 observations and 4 variables.
NOTE: Copying CLIMATE.LOWTEMP to WEATHER.LOWTEMP (memtype=DATA).
NOTE: There were 5 observations read from the data set CLIMATE.LOWTEMP.
NOTE: The data set WEATHER.LOWTEMP has 5 observations and 4 variables.
NOTE: Copying CLIMATE.RAIN to WEATHER.RAIN (memtype=DATA).
NOTE: There were 5 observations read from the data set CLIMATE.RAIN.
NOTE: The data set WEATHER.RAIN has 5 observations and 4 variables.
NOTE: Copying CLIMATE.SNOW to WEATHER.SNOW (memtype=DATA).
NOTE: There were 3 observations read from the data set CLIMATE.SNOW.
NOTE: The data set WEATHER.SNOW has 3 observations and 4 variables.
145     copy in=usclim out=weather;
146  run;

NOTE: Copying USCLIM.BASETEMP to WEATHER.BASETEMP (memtype=CATALOG).
NOTE: Copying USCLIM.HURRICANE to WEATHER.HURRICANE (memtype=DATA).
NOTE: There were 6 observations read from the data set USCLIM.HURRICANE.
NOTE: The data set WEATHER.HURRICANE has 6 observations and 5 variables.
NOTE: Copying USCLIM.REPORT to WEATHER.REPORT (memtype=CATALOG).
NOTE: Copying USCLIM.TEMPCHNG to WEATHER.TEMPCHNG (memtype=DATA).
NOTE: There were 5 observations read from the data set USCLIM.TEMPCHNG.
NOTE: The data set WEATHER.TEMPCHNG has 5 observations and 6 variables.
NOTE: Copying USCLIM.USHIGH to WEATHER.USHIGH (memtype=DATA).
NOTE: There were 6 observations read from the data set USCLIM.USHIGH.
NOTE: The data set WEATHER.USHIGH has 6 observations and 5 variables.
NOTE: Copying USCLIM.USLOW to WEATHER.USLOW (memtype=DATA).
NOTE: There were 7 observations read from the data set USCLIM.USLOW.
NOTE: The data set WEATHER.USLOW has 7 observations and 5 variables.
```

Copying Specific SAS Data Sets

Selecting Data Sets to Copy

To copy only a few data sets from a large SAS library, use the SELECT statement with the COPY statement. After the keyword SELECT, list the data set names with a blank space between the names, or use an abbreviated member list (such as YRDATA1-YRDATA5) if applicable.

For example, the following statements copy the data set HURRICANE from the library USCLIM to the library STORM. The input procedure library is PRECIP, so the COPY statement includes the IN= option in order to specify the USCLIM input library.

```
   copy in=usclim out=storm;
      select hurricane;
run;
```

The following SAS log shows that only the data set HURRICANE was copied to the library STORM.

Example Code 39.3 *Copying the Data Set HURRICANE to the Library STORM*

```
147     copy in=usclim out=storm;
148        select hurricane;
149  run;

NOTE: Copying USCLIM.HURRICANE to STORM.HURRICANE (memtype=DATA).
NOTE: There were 6 observations read from the data set USCLIM.HURRICANE.
NOTE: The data set STORM.HURRICANE has 6 observations and 5 variables.
```

Excluding Data Sets from Copying

To copy an entire library except for a few data sets, use the EXCLUDE statement with the COPY statement. After the keyword EXCLUDE, list the data set names that you want to exclude with a blank space between the names. You can also use an abbreviated member list (such as YRDATA1-YRDATA5) if applicable.

The following statements copy the files in the library PRECIP to USCLIM except for the data set SNOW. The procedure input library is PRECIP, so the IN= option is not needed.

```
   copy out=usclim;
      exclude snow;
run;
```

The following SAS log shows that the data set RAIN was copied to USCLIM and that the data set SNOW remains only in the library PRECIP.

Example Code 39.4 *Excluding the Data Set SNOW from Copying to the Library USCLIM*

```
150     copy out=usclim;
151        exclude snow;
152  run;

NOTE: Copying PRECIP.RAIN to USCLIM.RAIN (memtype=DATA).
NOTE: There were 5 observations read from the data set PRECIP.RAIN.
NOTE: The data set USCLIM.RAIN has 5 observations and 4 variables.
```

Moving SAS Libraries and SAS Data Sets

Moving Libraries

The COPY statement provides the MOVE option to move SAS data sets from the input library (either the procedure input library or the input library named with the IN= option) to the output library (named with the OUT= option). Note that with the MOVE option, SAS first copies the files to the output library, and then deletes them from the input library.

The following statements move all the data sets in the library PRECIP to the library CLIMATE:

```
   copy out=climate move;
run;
```

The following SAS log shows that the data sets in PRECIP were moved to CLIMATE.

Example Code 39.5 *Moving Data Sets in the Library PRECIP to the Library CLIMATE*

```
153      copy out=climate move;
154   run;

NOTE: Moving PRECIP.RAIN to CLIMATE.RAIN (memtype=DATA).
NOTE: There were 5 observations read from the data set PRECIP.RAIN.
NOTE: The data set CLIMATE.RAIN has 5 observations and 4 variables.
NOTE: Moving PRECIP.SNOW to CLIMATE.SNOW (memtype=DATA).
NOTE: There were 3 observations read from the data set PRECIP.SNOW.
NOTE: The data set CLIMATE.SNOW has 3 observations and 4 variables.
```

After moving files with the MOVE option, a directory listing of PRECIP from the CONTENTS statement confirms that there are no members in the library. As the output from the following statements illustrates, the library PRECIP no longer contains any data sets. Therefore, the library CLIMATE contains the only copy of the data sets RAIN and SNOW.

```
   contents data=_all_ nods;
run;
```

The following outputs show the SAS log, then the directory listing for the library PRECIP.

Example Code 39.6 *SAS Log from the CONTENTS Statement*

```
155      contents data=_all_ nods;
156   run;

WARNING: No matching members in directory.
```

Figure 39.3 Directory Listing of the Library PRECIP Showing No Data Sets

The SAS System

The DATASETS Procedure

Directory	
Libref	PRECIP
Engine	V9
Physical Name	c:\Users\userid\precip
Filename	c:\Users\userid\precip

Note: The data sets are deleted from the SAS library PRECIP, but the libref is still assigned. The name that is assigned to the library in your operating environment is not removed when you move all files from one library to another.

Moving Specific Data Sets

You can use the SELECT and EXCLUDE statements to move one or more SAS data sets. For example, the following statements move the data set HURRICANE from the library USCLIM to the library STORM:

```
   copy in=usclim out=storm move;
      select hurricane;
run;
```

The following output displays the results.

Example Code 39.7 Moving the Data Set HURRICANE from the Library USCLIM to the Library STORM

```
157     copy in=usclim out=storm move;
158        select hurricane;
159  run;

NOTE: Moving USCLIM.HURRICANE to STORM.HURRICANE (memtype=DATA).
NOTE: There were 6 observations read from the data set USCLIM.HURRICANE.
NOTE: The data set STORM.HURRICANE has 6 observations and 5 variables.
```

Similarly, the following example uses the EXCLUDE statement to move all files except the data set SNOW from the library CLIMATE to the library USCLIM.

```
   copy in=climate out=usclim move;
      exclude snow;
run;
```

The following output displays the results.

Example Code 39.8 *Moving All Data Sets except SNOW from the Library CLIMATE to the Library USCLIM*

```
   copy in=climate out=usclim move;
      exclude snow;
run;

NOTE: Moving CLIMATE.HIGHTEMP to USCLIM.HIGHTEMP (memtype=DATA).
NOTE: There were 6 observations read from the data set CLIMATE.HIGHTEMP.
NOTE: The data set USCLIM.HIGHTEMP has 6 observations and 4 variables.
NOTE: Moving CLIMATE.LOWTEMP to USCLIM.LOWTEMP (memtype=DATA).
NOTE: There were 5 observations read from the data set CLIMATE.LOWTEMP.
NOTE: The data set USCLIM.LOWTEMP has 5 observations and 4 variables.
NOTE: Moving CLIMATE.RAIN to USCLIM.RAIN (memtype=DATA).
NOTE: There were 5 observations read from the data set CLIMATE.RAIN.
NOTE: The data set USCLIM.RAIN has 5 observations and 4 variables.
```

Deleting SAS Data Sets

Specifying Data Sets to Delete

Use the DELETE statement to delete one or more data sets from a SAS library. If you want to delete more than one data set, then list the names after the DELETE keyword with a blank space between the names. You can also use an abbreviated member list if applicable (such as YRDATA1-YRDATA5).

CAUTION
SAS immediately deletes the files in a SAS library when the program statements are submitted. You are not asked to verify the Delete operation before it begins, so make sure that you intend to delete the files before submitting the program.

For example, the following program specifies USCLIM as the procedure input library. It then deletes the data set RAIN from the library:

```
proc datasets library=usclim;
   delete rain;
run;
```

The following output shows that SAS sends messages to the SAS log when it processes the DELETE statement.

Example Code 39.9 *Deleting the Data Set RAIN from the Library USCLIM*

```
proc datasets library=usclim;
   delete rain;
run;

NOTE: Deleting USCLIM.RAIN (memtype=DATA).
```

Execute the following program to list the contents of library USCLIM after the RAIN data set has been deleted:

```
proc datasets library=usclim;
run;
quit;
```

Specifying Data Sets to Save

To delete all data sets but a few, you can use the SAVE statement to list the names of the data sets that you want to keep. List the data set names with a blank space between the names, or use an abbreviated member list (such as YRDATA1-YRDATA5) if applicable.

The following statements delete all the data sets except TEMPCHNG from the library USCLIM:

```
proc datasets library=usclim;
   save tempchng;
run;
```

The following output shows the SAS log from the Save operation. SAS sends messages to the log, verifying that it has kept the data sets that you specified in the SAVE statement and deleted all other members of the library.

Example Code 39.10 *Deleting All Members of the Library USCLIM except the Data Set TEMPCHNG*

```
171  proc datasets library=usclim;
172     save tempchng;
173  run;

NOTE: Saving USCLIM.TEMPCHNG (memtype=DATA).
NOTE: Deleting USCLIM.BASETEMP (memtype=CATALOG).
NOTE: Deleting USCLIM.HIGHTEMP (memtype=DATA).
NOTE: Deleting USCLIM.LOWTEMP (memtype=DATA).
NOTE: Deleting USCLIM.REPORT (memtype=CATALOG).
NOTE: Deleting USCLIM.USHIGH (memtype=DATA).
NOTE: Deleting USCLIM.USLOW (memtype=DATA).
```

Deleting All Files in a SAS Library

To delete all files in a SAS library at one time, use the KILL option in the PROC DATASETS statement.

CAUTION
The KILL option deletes all members of the library immediately after the statement is submitted. You are not asked to verify the Delete operation, so make sure that you intend to delete the files before submitting the program.

For example, the following program deletes all data sets in the library WEATHER and stops the DATASETS procedure:

```
proc datasets library=weather kill;
```

```
run;
quit;
```

The following output displays the SAS log.

Example Code 39.11 *Deleting All Members of the Library WEATHER*

```
174  proc datasets library=weather kill;
NOTE: Deleting WEATHER.BASETEMP (memtype=CATALOG).
NOTE: Deleting WEATHER.HIGHTEMP (memtype=DATA).
NOTE: Deleting WEATHER.HURRICANE (memtype=DATA).
NOTE: Deleting WEATHER.LOWTEMP (memtype=DATA).
NOTE: Deleting WEATHER.RAIN (memtype=DATA).
NOTE: Deleting WEATHER.REPORT (memtype=CATALOG).
NOTE: Deleting WEATHER.SNOW (memtype=DATA).
NOTE: Deleting WEATHER.TEMPCHNG (memtype=DATA).
NOTE: Deleting WEATHER.TORNADO (memtype=DATA).
NOTE: Deleting WEATHER.USHIGH (memtype=DATA).
NOTE: Deleting WEATHER.USLOW (memtype=DATA).
175  run;

176  quit;
```

Note: All data sets and catalogs are deleted from the SAS library, but the libref is still assigned for the session. The name that is assigned to the library in your operating environment is not removed when you delete the files that are included in the library.

Summary

Procedures

PROC DATASETS LIBRARY=*libref* <KILL>;
: starts the procedure and specifies the procedure input library for subsequent statements. The KILL option deletes all members and member types from the library.

DATASETS Procedure Statements

COPY OUT=*libref* <IN=*libref*> <MOVE>;
: copies files from the procedure input library that is specified in the PROC DATASETS statement to the output library that is specified in the OUT= option. The IN= option specifies a different input library. The MOVE option deletes files from the input library after copying them to the output library.

You can use the following statements with the COPY statement:

EXCLUDE *SAS-data-set*;
specifies a SAS data set that you want to exclude from the copy process. Files that you do not list in this statement are copied to the output library.

SELECT *SAS-data-set*;
specifies a SAS data set that you want to copy to the output library.

DELETE *SAS-data-set*;
deletes only the SAS data set that you specify in this statement.

SAVE *SAS-data-set*;
deletes all members of the library except those that you specify in this statement.

Learning More

CATALOG procedure
The CATALOG procedure manages entries in SAS catalogs. For more information, see "CATALOG Procedure" in *Base SAS Procedures Guide*.

DATASETS procedure
The DATASETS procedure is a utility procedure that manages your SAS files. For more information, see "DATASETS Procedure" in *Base SAS Procedures Guide*.

PART 10

Understanding Your SAS Environment

40

Introducing the SAS Environment

Introduction to the SAS Environment

Purpose

In this section, you will learn about the various ways that you can run SAS programs. More importantly, it explains the different modes that SAS can run in, and which modes are best, depending on the types of jobs that you are doing.

This section introduces the SAS windowing environment, which is the default processing mode.

Prerequisites

To understand the discussions in this section, you should be familiar with the basics of DATA step programming that are presented in “Overview of DATA Step Processing” on page 109.

Operating Environment Differences

Even though SAS has a different appearance for each operating environment, most of the actions that are available from the menus are the same.

One of the biggest differences between operating environments is the way that you select menu items.

If your workstation is not equipped with a mouse, then here are the keyboard equivalents to mouse actions:

Table 40.1 Mouse Actions and Keyboard Equivalents

Mouse Action	Keyboard Equivalent
Double-click the item	Type an **s** or an **x** in the space next to the item, and then press Enter
Right-click the item	Type **?** in the space next to the item, and then press Enter

Examples in this documentation show SAS windows as they appear in the Microsoft Windows environment. Usually, corresponding windows in other operating environments show similar results. If you do not see the drop-down menus in your operating environment, then enter the global command PMENU at a command prompt.

Starting a SAS Session

To start a SAS session, you must invoke SAS. At the operating environment prompt, execute the SAS command. In most cases, the SAS command is

```
sas
```

Note: The SAS command might vary from site to site. Consult your on-site SAS support personnel for more information.

You can customize your SAS session when it starts by specifying SAS system options, which then remain in effect throughout a session. For example, you can use the LINESIZE= system option to specify a line size for the SAS log and print file. Some system options can be specified only at initialization, and other system options can be specified during a SAS session. For more information, see "Customizing SAS Sessions and Programs at Start-up" on page 831.

Selecting a SAS Processing Mode

Processing Modes and Categories

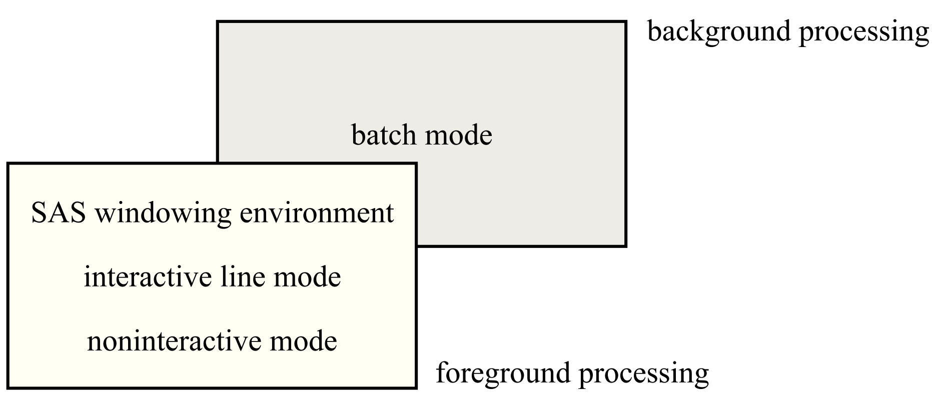
Overview of Processing Modes and Categories

All four modes that you can use to run SAS belong to one of two categories:

- foreground processing
- background processing

The following figure shows the four different modes and the processing types that they belong to. As your processing requirements change, you might find it helpful to change from one processing mode to another.

Figure 40.1 Modes of Running SAS during Foreground or Background Processing



Understanding Foreground Processing

Foreground processing includes all the ways that you can run SAS in except batch mode. Foreground processing begins immediately, but as your program runs, your current workstation session is occupied, so you cannot use it to do anything else.[1] With foreground processing, you can route your output to the workstation display, to a file, to a printer, or to tape.

If you can answer yes to one or more of the following questions, then you might want to consider foreground processing:

- Are you learning SAS programming?

1. In a workstation environment, you can switch to another window and continue working.

- Are you testing a program to see whether it works?
- Do you need fast turnaround?
- Are you processing a fairly small data file?
- Are you using an interactive application?

Understanding Background Processing

Batch processing is the only way to run SAS in the background. Your operating environment coordinates all the work, so you can use your workstation session to do other work at the same time that your program runs. However, because the operating environment also schedules your program for execution and assigns it a priority, the program might have to wait in the input queue (the operating environment's list of jobs to be run) before it is executed. When your program runs to completion, you can browse, delete, or print your output.

Background processing might be required at your site. In addition, consider the following questions:

- Are you an experienced SAS user, likely to make fewer errors than a novice?
- Are you running a program that has already been tested and refined?
- Is fast turnaround less important than minimizing the use of computer resources?
- Are you processing a large data file?
- Will your program run for a long time?
- Are you using a tape?

If you answer yes to one or more of these questions, then you might want to choose background processing.

Processing in the SAS Windowing Environment

Overview of Processing in the SAS Windowing Environment

The SAS windowing environment is a graphical user interface (GUI) that consists of a series of windows with which you can organize files and folders, edit and execute programs, view program output, and view messages about your programs and your SAS session.

Because it is an interactive and graphical facility, you can use a single session to prepare and submit a program and, if necessary, to modify and resubmit the program after browsing the output and messages. You can move from window to window and even interrupt and return to a session at the same point that you left it.

General Characteristics

The SAS windowing environment is the default environment for a SAS session (unless your environment is customized at your site).

Note: Because it is the default environment, many topics in this documentation describe tasks as you would perform them in the SAS windowing environment.

The five most commonly used windows in the SAS windowing environment are Explorer, Results, Editor, Log, and Output.

Explorer
: is a hierarchical system of folders, subfolders, and individual items. It provides a primary graphical interface to SAS from which you can do the following:

- access and work with data, such as catalogs, tables, libraries, and operating environment files
- open SAS programming windows
- access the Output Delivery System (ODS)
- create and define customized folders

You can use Explorer to view or set libraries and file shortcuts, view or set library members and catalog entries, or open and edit SAS files.

Note that when you start the SAS windowing environment, the Explorer might appear as a single-paned window that lists libraries that are currently available. You can add a navigational tree to the Explorer window by selecting **View** ⇨ **Show Tree** or by issuing the TREE command.

Editor or Program Editor
: provides an area to enter, edit, and submit SAS statements and to save SAS source files.

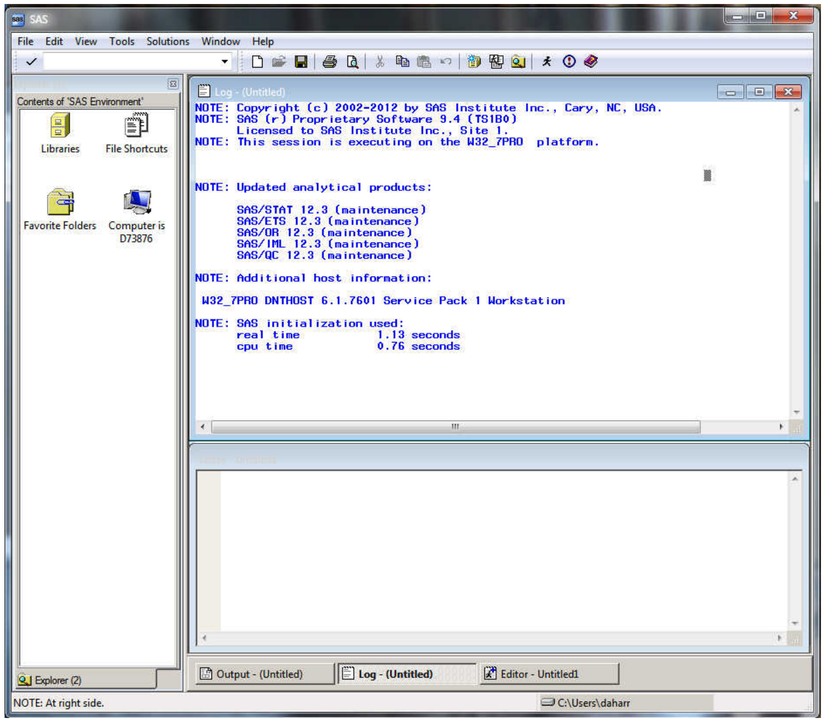
Log
: enables you to browse and scroll the SAS log. The SAS log provides messages about what is happening in your SAS session.

Output
: enables you to browse and scroll procedure output.

Results
: enables you to browse and manipulate an index of your procedure output.

Together, the Program Editor, Log, and Output windows are sometimes referred to as the programming windows.

Figure 40.2 SAS Windowing Environment: SAS Explorer, Log and Editor Windows, (Windows Operating System)



Additional windows are also available in the SAS windowing environment that enable you to do the following:

- access online Help
- view and change some SAS system options
- view and change function key settings
- create and store text information

For more information about these windows and about performing tasks in the windowing environment, see "Introduction to Using the SAS Windowing Environment" on page 784.

Invoking the SAS Windowing Environment

To invoke the SAS windowing environment, execute the SAS command followed by any system options that you want to put into effect. The SAS windowing environment is set as the default method of operation for SAS, but it might not be the default setting at your work site.

If the SAS windowing environment is not the default method of operation, you can specify the DMSEXP option in the SAS command. Or, you can include the DMSEXP option in the configuration file, which contains settings for system options. For more information about the configuration file, see "Customizing SAS Sessions and Programs at Start-up" on page 831.

You specify options in the SAS command as you do any other command options on your system.

The following table shows how you would start the SAS windowing environment and specify the DMSEXP option under various operating environments:

Table 40.2 Starting SAS with the DMSEXP Option

Operating Environment	Command
z/OS	sas options ('dmsexp')
Windows	sas -dmsexp
UNIX	sas -dmsexp

For details about how to specify command options on other systems, see the SAS documentation for your operating environment.

Ending a SAS Windowing Environment Session

You can end your SAS windowing environment session with the BYE or ENDSAS command. Specify BYE or ENDSAS on the SAS command line, and then execute the command by pressing ENTER or RETURN (depending on which operating environment you use).

You can also end your session with the ENDSAS statement in the Program Editor window. Enter the following statement on a data line and submit it for execution:

```
endsas;
```

Interrupting a SAS Windowing Environment Session

You might occasionally find it necessary to return to your operating environment from a SAS session. If you do not want to end your SAS session, then you can escape to the operating environment by issuing the X command. Simply execute the following command on the command line:

```
x
```

From your operating environment, you can then return to the same SAS session as you left it, by executing the appropriate operating environment command. For example, under the z/OS operating environment, the operating environment command is Return or End.

Use this form of the X command to execute a single operating environment command:

X *operating-environment-command*

or, if the command contains embedded blanks,

X *'operating-environment-command'*

For example, on many systems that you can display the current time by specifying

```
x time
```

After the command executes, you can take the appropriate action to return to your SAS session.

For information about interrupting a SAS session in other operating environments, see the SAS documentation for your operating environment.

Processing Interactively in Line Mode

General Characteristics

With line mode processing, you enter programming statements one line at a time; DATA and PROC steps are executed after you enter a RUN statement, or after another step boundary. Program messages and output appear on the monitor.

You can modify program statements only when you first enter them, before you press ENTER or RETURN, which means that you must enter your entries carefully.

Invoking SAS in Line Mode

To invoke SAS in line mode, execute the SAS command followed by any system options that you want to put into effect. The NODMS system option activates an interactive line mode session. If NODMS is not the default system option at your site, you can either specify the option with the SAS command or include the NODMS specification in the configuration file, the file that contains settings for system options that are put into effect at invocation.

The following table shows you how to specify the NODMS system option with the SAS command under various operating environments.

Table 40.3 *Specifying the NODMS System Option*

Operating environment	Command
z/OS	sas options ('nodms')
UNIX	sas -nodms

Using the Run Statement to Execute a Program in Line Mode

In line mode, DATA steps are executed only when a new step boundary is encountered. This occurs after you enter a RUN DATA or PROC statement. In other words, if you submit `DATA X; X=1;` in the windowing environment, then you will not see execution until the next RUN DATA or PROC statement is submitted.

At the beginning of each line, SAS prompts you with a number and a question mark to enter more statements. If you use a DATALINES statement, then a greater-than symbol (>) replaces the question mark, indicating that data lines are expected.

When you are using line mode, the log will be easier to read if you follow this programming tip: cause each DATA or PROC step to execute before you begin entering programming statements for the next step. Either an END statement or a semicolon that marks the end of data lines causes a step to execute immediately.

Ending a Line Mode SAS Session

To end your session, type `endsas;` at the SAS prompt, and then press Enter. Your session ends, and you are returned to your operating environment.

Interrupting a Line Mode SAS Session

In line mode, you can escape to the operating environment by executing the following statement:

```
x;
```

You can return to your SAS session by executing the appropriate operating environment command. Use this form of the X statement to execute a single operating environment command:

X *operating-environment-command*;

or, if the command contains embedded blanks,

X *'operating-environment-command'*;

For example, on many systems that you can display the current time by specifying

```
x time;
```

When you use this form of the X command, the command executes, and you are returned to your SAS session.

Processing in Batch Mode

The first step in executing a program in batch mode is to prepare files that include the following:

- any control language statements that are required by the operating environment that you are using to manage the program
- the SAS statements necessary to execute the program

Then you submit your file to the operating environment, and your workstation session is free for other work while the operating environment executes the program. This is called background processing because you cannot view or change the program in any way until after it executes. The log and output are routed to the destination that you specify in the operating environment control language; without a specification, they are routed to the default. For examples of batch processing, see the SAS documentation for your operating environment.

Processing Noninteractively

General Characteristics

Noninteractive processing has some characteristics of interactive processing and some of batch processing. When you process noninteractively, you execute SAS program statements that are stored in an external file. You use a SAS command to submit the program statements to your operating environment.

Note: The SAS command is implemented differently under each operating environment. For example, under z/OS the command is typically a CLIST.

As in interactive processing, processing begins immediately, and your current workstation session is occupied. However, as with batch processing, you cannot interact with your program.

Note: For some exceptions to this, see the SAS documentation for your operating environment.

You can see the log or procedure output immediately after the program has run. Log and listing output are routed to the workstation, unlike the SAS windowing environment, where you must explicitly save output to a file. If you decide that you must correct or modify your program, then you must use an editor to make necessary changes and then resubmit your program.

Executing a Program in Noninteractive Mode

When you run a program in noninteractive mode, you do not enter a SAS session as you do in interactive mode. Instead of starting a SAS session, you are executing a SAS program. The first step is to enter the SAS statements in a file, just as you would for a batch job. Then, at the system prompt, you specify the SAS command followed by the complete name of the file and any system options that you want to specify.

The following example executes the SAS statements in the member TEMP in the partitioned data set your-userid.UGWRITE.TEXT in the z/OS operating environment:

```
sas input(ugwrite.text(temp))
```

Note that the INPUT operand points to the file that contains the SAS statements for a noninteractive session.

For details about how to use noninteractive mode on other operating environments, see the SAS documentation for your operating environment. Consult your SAS Site Representative for information specific to your site.

Browsing the Log and Output

Log and output information either appears in your workstation display or it is sent to a file. The default action is dependent on your operating environment. In either case, you can browse the information within your display or by opening the appropriate file.

See your operating environment documentation for more information.

Summary

Command

OPTIONS
: view the option settings when you use the windowing environment.

Options

PROC OPTIONS *options*;
: lists the current values of all SAS system options.

System Options

DMS | NODMS
: at invocation, specifies whether the SAS Programming windows are to be active in a SAS session.

LINESIZE=*n*
: specifies the width for SAS LISTING output.

VERBOSE
: at invocation, displays a listing of all options in the configuration file and on the command line.

Statements

DATALINES;
: signals to SAS that the data follows immediately.

ENDSAS;
: causes a SAS job or session to terminate at the end of the current DATA or PROC step.

OPTIONS *option*;
: changes one or more system options from the default value set at a site.

RUN;
: causes the previously entered SAS step to be executed.

X '*operating-environment-command*';
: is used to issue an operating environment command from within a SAS session. Operating-environment-command specifies the command. Omitting the command puts you into the operating environment's submode.

Commands

BYE
: ends a SAS session.

ENDSAS
: ends a SAS session.

EXPLORER
: invokes the Explorer window.

PMENU
: turns on drop-down menus in windows.

X <'*operating-environment-command*'>
: executes the operating environment command and then prompts you to take the appropriate action to return to SAS. Omitting the command puts you into the operating environment's submode.

Learning More

Operating Environment Information

For information about specific customization options and preferences, see the documentation for your operating environment.

Windowing Environment Commands

For a list of all the commands that you can use in the SAS windowing environment, see SAS online Help.

Help ⇨ **SAS Help and Documentation**.

Documentation

For more examples of using the SAS windowing environment, see *Getting Started with the SAS System*.

41

Using the SAS Windowing Environment

Introduction to Using the SAS Windowing Environment

Purpose

In this section, you will learn about the SAS windowing environment, including how to get organized, how to access help, and how to find and use appropriate commands.

In addition, you will learn how to use the SAS windowing environment to work with files, SAS programs, and SAS output.

Prerequisites

Before proceeding with this section, you should understand the concepts presented in “Introduction to the SAS Environment” on page 771.

Operating Environment Differences

Even though SAS has a different appearance for each operating environment, most of the actions that are available from the menus are the same.

One of the biggest differences between operating environments is the way that you select menu items.

If your workstation is not equipped with a mouse, then here are the keyboard equivalents to mouse actions:

Table 41.1 Mouse Actions and Keyboard Equivalents

Mouse Action	Keyboard Equivalent
Double-click the item	Type an `s` or an `x` in the space next to the item, and then press Enter
Right-click the item	Type `?` in the space next to the item, and then press Enter

Examples in this documentation show SAS windows as they appear in the Microsoft Windows environment. Usually, corresponding windows in other operating environments will yield similar results. If you do not see the drop-down menus in your operating environment, then enter the global command PMENU at a command prompt.

Getting Organized

Overview of Data Organization

The SAS windowing environment helps you to organize your data, and to locate and access your files easily. In this section, you learn how to use windows to do the following:

- explore libraries and library members
- assign a library reference

Exploring Libraries and Library Members

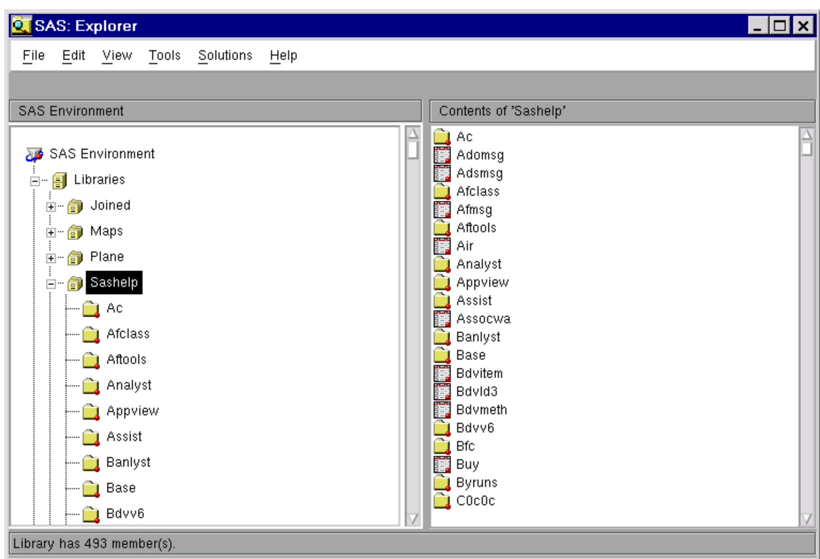
The SAS windowing environment opens to the Explorer window by default on many hosts. You can issue the EXPLORER command to invoke this window if it does not appear by default. You can use Explorer to view the libraries that are currently available, as well as to explore their contents.

- To list available libraries, select the Libraries folder, and then select `Open` from the menu.
- To explore the contents of a library, select a specific library, and then select `Explore from Here` from the menu.
- To explore the contents of a library member, select a specific library member, and then select `Open` from the menu.

Note: If the Explorer Tree view is on, then you can explore libraries and library members by expanding and collapsing tree nodes. You can expand or collapse Tree nodes by selecting their expansion icons, which look like + and - symbols. You can toggle the Explorer Tree view by selecting **View** ⇨ **Show Tree** from the Explorer window.

The following display shows an expanded Tree node.

Figure 41.1 SAS Explorer Window with Tree View On



Assigning a Library Reference

Assign a library reference before continuing your work in a SAS session, so that you can have a permanent storage location for your working SAS files:

1. From the Explorer window, select the **Libraries** folder.
2. Select **File** ⇨ **New**.

   The New Library window appears.
3. Enter a name for the library.
4. Select an engine type.

5 Enter an operating environment directory pathname or browse to select the directory.

6 Fill in any other fields as necessary for the engine, and enter any options that you want to specify.

   If you are not sure which engine to choose, then use the Default engine (which is selected automatically).

   The Default engine enables SAS to choose which engine to use for any data sets that exist at the given path of your new library. If no data sets exist, then the Base SAS engine is assigned.

7 Select **OK**. The new library will appear under the **Libraries** folder in the Explorer window.

Note: If you want SAS to assign the new library automatically at start-up, then select the `Enable at Startup` check box in the New Library window.

You can use the following ways to assign a library, depending on your operating environment:

Menu
: **File** ⇨ **New**

  (from the Explorer window only)

Command
: DMLIBASSIGN (from any window)

Toolbar
: New Library (from any window)

Managing Library Assignment Problems

If any permanent library assignment that is stored in the SAS Registry fails at start-up, then the following note appears in the SAS Log:

```
NOTE: One or more library startup assignments were not restored.
```

The following errors are common causes of library assignment problems:

- library dependencies are missing
- required field values for library assignment in the SAS Registry are missing
- required field values for library assignment in the SAS Registry are invalid

  For example, library names are limited to eight characters, and engine values must match actual engine names.
- encrypted password data for a library reference has changed in the SAS Registry

---

CAUTION
You can correct many library assignment errors in the SAS Registry Editor. If you are unfamiliar with library references or the SAS Registry Editor, ask for assistance.

Errors can be made easily in the SAS Registry Editor, and can prevent your libraries from being assigned at start-up.

To correct a library assignment error in the SAS Registry Editor:

1. Select **Solutions** ⇨ **Accessories** ⇨ **Registry Editor** or issue the REGEDIT command.

2. Select one of the following paths, depending on your operating system, and then make modifications to keys and key values as needed:

   `CORE\OPTIONS\LIBNAMES`

   or

   `CORE\OPTIONS\LIBNAMES\CONCATENATED`

   or

   `CORE\LIBNAMES`

For example, if you determine that a key for a permanent concatenated library has been renamed to something other than a positive whole number, then you can rename that key again so that it is in compliance. Select the key, and then select **`Rename`** from the pop-up menu to begin the process.

Finding Online Help

Accessing SAS Online Help System

To access the SAS online Help, select **Help** ⇨ **SAS Help and Documentation**.

Accessing Window Help

You can access help on an individual window in any of the following ways:

- Issue the HELP command from the command line of the window.
- Select the window's help button, if one exists.
- Select the Help icon on the toolbar.
- From the window for which you want help, select **Help** ⇨ **Using This Window**.

Using SAS Windowing Environment Command Types

Overview of SAS Windowing Environment Command Types

There are specific types of SAS windowing environment commands. The type of commands that you use might depend on the task that you need to complete, or on your personal preferences. These commands can be in the form of:

- command-line commands
- menu commands
- line commands (in text editing windows)
- keyboard function keys

For information about specific commands that can be issued in the SAS windowing environment, see "Working with SAS Windows" on page 792. For information about specific commands that can be used in the SAS text editor, see "Working with Text" on page 798.

Using Command-Line Commands

Command-line commands can be entered in two places:

- on the command line (if it is turned on)
- in the Command window (if it is available)

If the command line is turned on, then you can place your cursor on the command line and type commands. You can toggle the command line on or off for a specific window by selecting **Tools** ⇨ **Options** ⇨ **Turn Command Line On** or **Tools** ⇨ **Options** ⇨ **Turn Command Line Off**.

The Command window (if it is available in your operating environment) includes a text area. You can place your cursor in this area and then issue commands.

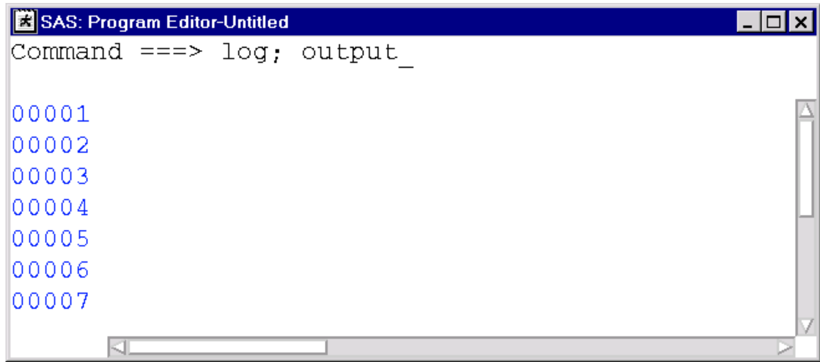
To execute a command, type the command on the command line and then press the ENTER key, depending on which operating environment you are using. You can specify a simple one-word command, multiple commands separated by semicolons, or a command followed by an option.

For example, if you want to move from the Editor window and open both the Log and the Output windows, on the command line of the Editor window, specify

```
log; output
```

The following display shows `log; output` entered on a command line.

Figure 41.2 Entering Commands on the Command Line



Next, press ENTER or RETURN to execute both commands. The Log and Output windows appear. The Output window is the active window because the command to open this window was executed last.

Using Menus

SAS windowing environment windows can display menus instead of a command line. You can then make menu selections to do things that you would usually accomplish by entering commands.

If your operating environment does not default to using drop-down menus, then issue the PMENU command at a command line to turn on menus for all windows that support them.

You can point and click menus and menu items with a mouse to make your selections. In some operating environments, you can also make menu selections by moving your cursor over the menu items and then pressing ENTER or RETURN. Depending on the item that you select, one of three things happens:

- a command executes
- a menu appears
- a dialog box appears

In many cases, double-clicking on items and right-clicking on items will cause different menus to appear. Sometimes you might want to try one or the other when selecting an item does not give you the expected result.

In other operating environments with workstations that are not equipped with a mouse, here are the keyboard equivalents to mouse actions:

Table 41.2 Table of Keyboard Equivalents to Mouse Actions

Mouse Action	Keyboard Equivalent
Double-click	Type an **s** or an **x** in the space next to the item, and then press Enter
Right-click	Instead of right-clicking an item, type **?** in the space next to the item, and then press Enter

Using Line Commands

Line commands are one or more letters that copy, move, delete, and otherwise edit text. You can execute line commands by entering them in the numbered part of a text editing window (such as the Editor or the SAS NOTEPAD).

Although line commands are usually executed in the numbered part of the display or with function keys, they can also be executed from the command line if preceded by a colon.

Note: Issue the NUMBERS command to toggle line numbers on or off in text editing windows.

For more information about line commands, see "Working with Text" on page 798.

Using Function Keys

Your keyboard includes function keys to which default values have already been assigned. You can browse or alter those values in the Keys window. To open the Keys window, select **Tools** ⇨ **Options** ⇨ **Keys** or issue the KEYS command.

To change the setting of a key in the Keys window, type the new value over the old value. The new setting takes effect immediately and is saved permanently when you execute the END command to close the Keys window.

Function keys enable you to customize your key settings to meet your needs in a particular SAS session. For example, if you might need to submit a number of programs and need to move between the Editor window and the Output window. Then each time you finish viewing your output, you must type the PGM and ZOOM commands on the command line and press ENTER or RETURN. As a shortcut, define one of your function keys to perform this action by typing the following commands over an unwanted value or where no value existed before:

```
pgm; zoom
```

Then, each time you press that function key, the commands are executed, saving you time. You can also use function keys to execute line commands. Simply precede the line command with a colon as you would if you were issuing the line command from the command line.

Working with SAS Windows

Opening Windows

The SAS windowing environment has numerous windows that you can use to complete tasks. You can enter commands to open windows. For more information about how to execute commands, see "Using SAS Windowing Environment Command Types" on page 789.

You can use the following commands to open a window and make it active.

Table 41.3 Window Commands

Window Command	Window Name
AF C=library.catalog.entry.type	Build
DMFILEASSIGN	File Shortcut Assignment
DMLIBASSIGN	New Library
EDOP	Editor Options
EXPFIND	Find
EXPLORER	Explorer
FOOTNOTES	Footnotes
FSBROWSE	FSBrowse
FSEDIT	FSEdit
FSFORM formname	FSForm
FSVIEW	FSView
HELP	Help
KEYS	Keys
LOG	Log
NOTEPAD, NOTE	Notepad

Window Command	Window Name
ODSRESULTS	Results
ODSTEMPLATES	Templates
OPTIONS	Options
OUTPUT, LISTING, LIST, LST	Output
PROGRAM, PGM, PROG	Program Editor
REGEDIT	Registry Editor
REPOSMGR	Repository Manager
SASENV	Explorer (Contents Only view)
SETPASSWORD	Password
TITLES	Titles
VAR	Properties

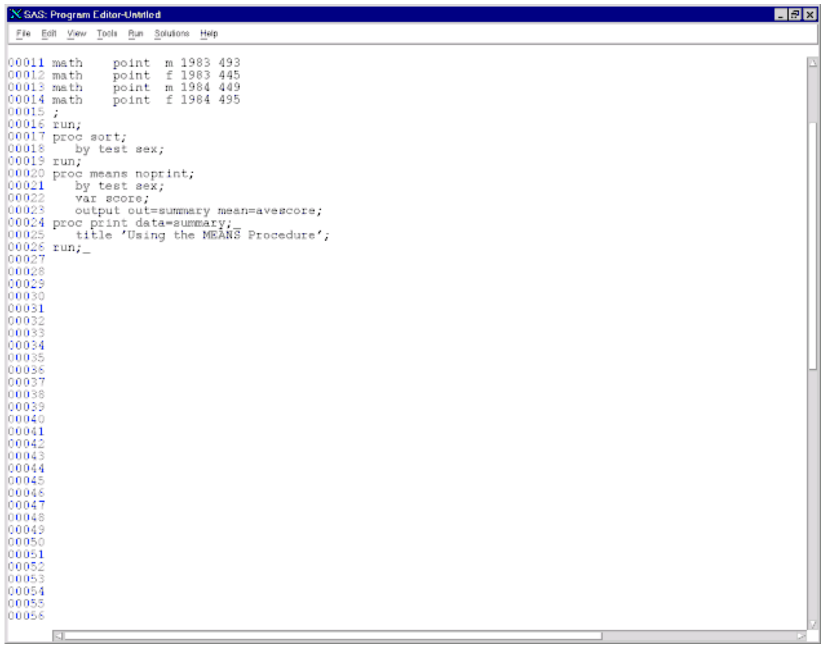
You can use window commands at any command prompt. You might find it helpful to use multiple window commands together.

For example, from the Log window, the following string of commands changes the active window, maximizes it, and changes the word paint to print:

```
pgm; zoom; change paint print
```

The following display shows that the cursor immediately moves to the Editor, which has been maximized to fill the entire display (due to the ZOOM command). The word paint has been changed to print, and the cursor rests after the last character of that text string.

Figure 41.3 Executing a Window-Call Command in a Series



Managing Windows

Window management commands enable you to access and use windows more efficiently. The following list includes the commands that you might use most often when managing windows:

BYE
: ends a SAS session.

CLEAR
: removes all text from an active window.

END
: closes a window. In the Editor, this command acts like the SUBMIT command.

NEXT
: moves the cursor to the next open window and makes it active.

PREVWIND
: moves the cursor to the previous open window and makes it active.

RECALL
: returns statements that are submitted from a text editor window (such as the Editor or SAS NOTEPAD) to the text editor.

ZOOM
: enlarges a window to occupy the entire display. Execute it again to return a window to its previous size. This command is not available in all operating environments.

Scrolling Windows

Scrolling commands enable you to maneuver within text, and the command names indicate what they do. They include the following:

BACKWARD
: moves the contents of a window backward.

FORWARD
: moves the contents of a window forward.

LEFT
: moves the contents of a window to the left.

RIGHT
: moves the contents of a window to the right.

TOP
: moves the cursor to the first character of the first line in a window.

BOTTOM
: displays the last line of text.

HSCROLL, VSCROLL
: HSCROLL determines the amount that you move to the left or right when using the LEFT or RIGHT commands. VSCROLL determines the amount that you move forward or backward when using the FORWARD or BACKWARD commands.

Use the following options with the HSCROLL and VSCROLL commands as needed. HALF is the default scroll amount.

PAGE
is the entire amount that shows in the window.

HALF
is half the amount that shows in the window.

MAX
is the maximum portion to the left or right or to the top or bottom that shows in the window.

n
is n lines or columns, where n is the number that you specify.

CURSOR
When used with HSCROLL, the cursor moves to the left or right of the display, when the LEFT or RIGHT command is executed.

Note: This option is valid only in windows that allow editing.

When used with VSCROLL, the cursor moves up and down when the FORWARD and BACKWARD command is executed.

Example: Scrolling Windows

To set the automatic horizontal scrolling value to five character spaces, specify

```
hscroll 5
```

Now, when you execute the LEFT or RIGHT command, you move five character spaces in the appropriate direction. If you want to set the automatic vertical scrolling value to half a page, then specify

```
vscroll half
```

Then, when you execute the FORWARD command, half of the previous page remains on the display and half of a new page is scrolled into view.

If you need to scroll a specific number of lines forward or backward, then use the scroll amount on the FORWARD command to temporarily override the default scrolling value. You can specify scrolling values with the BACKWARD and FORWARD commands and the LEFT and RIGHT commands.

Changing Colors and Highlighting in Windows

SAS gives you a simple way to customize your environment if your display supports color. You can change SAS windowing environment colors with the COLOR command. You can also change SAS code color schemes by using the SYNCONFIG command. To change windowing environment colors, simply specify the COLOR command followed by the field or window element that you want changed, and the desired color. You might also be able to change highlighting attributes, such as blinking and reverse video.

For example, to change the border of a window to red, specify

```
color border red
```

This changes the border to red.

Other available colors are blue, green, cyan, pink, yellow, white, black, magenta, gray, brown, and orange. If the color that you specify is not available, then SAS attempts to match the color to its closest counterpart.

Some color selections are valid only for certain windows.

For more information, see the online Help for the SASColor window. You can access the SASColor window with the SASCOLOR command.

You can also change the color scheme of text in the windows in which you enter code, such as the Editor window and NOTEPAD. This is useful, because you can make different elements of the SAS language appear in different colors, which makes it easier to parse code. To change the color scheme for code, use the SYNCONFIG command. The SYNCOLOR command toggles color coding off and on in these windows.

For more information about changing the color schemes for windows in which you create and edit code, see the online Help that is available when you issue the SYNCONFIG command.

Finding and Changing Text

Often, you might want to search for a character string and change it. You can locate the character string by specifying the FIND command and then the character string. Then the cursor moves to the first occurrence of the string that you want to locate. Remember to enclose a string in quotation marks if CAPS ON is in effect.

You can change a string by specifying the CHANGE command, then a space and the current character string, and then a space and the new character string. Remember to enclose in quotation marks any string that contains an embedded blank or special characters. For both the FIND and CHANGE commands, the character string can be any length.

With both the FIND and CHANGE commands, you can specify the following options to locate or change a particular occurrence of a string:

- ALL
- FIRST
- ICASE
- LAST
- NEXT
- PREFIX
- PREV
- SUFFIX
- WORD

For details about which options you can use together, see *SAS System Options: Reference*. Note that the option ALL finds or changes all occurrences of the specified string. In the following example, all occurrences of host are changed to operating environment:

```
change host 'operating environment' all
```

To resume the search for a string that was previously specified with the FIND command, specify the RFIND command. To continue changing a string that was previously specified with the CHANGE command, specify the RCHANGE command. To find the previous occurrence of a string, specify the BFIND or FIND PREV command; you can use the PREFIX, SUFFIX, and WORD options with the BFIND command.

Cutting, Pasting, and Storing Text

With the cut and paste facility, you can do the following:

- Identify the text that you want to manipulate.
- Store a copy of the text in a temporary storage place called a paste buffer.
- Insert text.
- List the names of all current paste buffers or delete them.

You can manipulate and store text by using the following commands:

MARK
: identifies the text that you want to cut or paste.

CUT
: removes the marked text from the display and stores it in the paste buffer.

STORE
: copies the marked text and stores it in the paste buffer.

PASTE
: inserts the text that you have stored in the paste buffer at the cursor location.

Working with Text

The SAS Text Editor

The SAS text editor is an editing facility that is available in the Editor and SAS NOTEPAD windows of Base SAS, SAS/FSP, and SAS/AF software. You can edit text from the command line and from any line on which code appears in an edit window.

This section provides information about commands that you can use to perform common text editing tasks by using the SAS text editor. For more information about all SAS windowing environment commands, see "Using SAS Windowing Environment Command Types" on page 789.

Moving and Rearranging Text

Some of the basics of moving, deleting, inserting, and copying single lines of text have already been reviewed. The rules are similar for working with a block of text; simply use double letters on the beginning and ending lines that you want to edit.

For example, alphabetizing the following list requires that you move a block of text. Note the MM (move) block command on lines 5 and 6 and the B line command on line 1 of the example.

```
b 001  c signifies the line command copy
00002  d signifies the line command delete
00003  i signifies the line command insert
00004  m signifies the line command move
mm 05  a signifies the line command after
mm 06  b signifies the line command before
00007  r signifies the line command repeat
```

Press Enter to execute the changes. Here are the results:

```
00001  a signifies the line command after
00002  b signifies the line command before
00003  c signifies the line command copy
```

```
00004  d signifies the line command delete
00005  i signifies the line command insert
00006  m signifies the line command move
00007  r signifies the line command repeat
```

Mastering a few more commands greatly increases the complexity of what you can do within the text editor. Several commands enable you to justify text. Specify the JL (justify left) command to left-justify, the JR (justify right) command to right-justify, and the JC (justify center) command to center text. To justify blocks of text, use the JJL, JJR, and JJC commands. For example, to center the following text, then add the JJC block command on the first and last lines and press Enter.

```
00001 Study of Advertising Responses
00002 Topnotch Hotel Website
00003 Conducted by Global Information, Inc.
```

You can also shift text right or left the number of spaces that you choose by executing the following set of line commands:

> <*n*>
: shifts text to the right the number of spaces that you specify; the default is one space.

< <*n*>
: shifts text to the left the number of spaces that you specify; the default is one space.

To shift a block of text left, specify the following command on the beginning and ending line numbers of the block:

```
<< <n>]
```

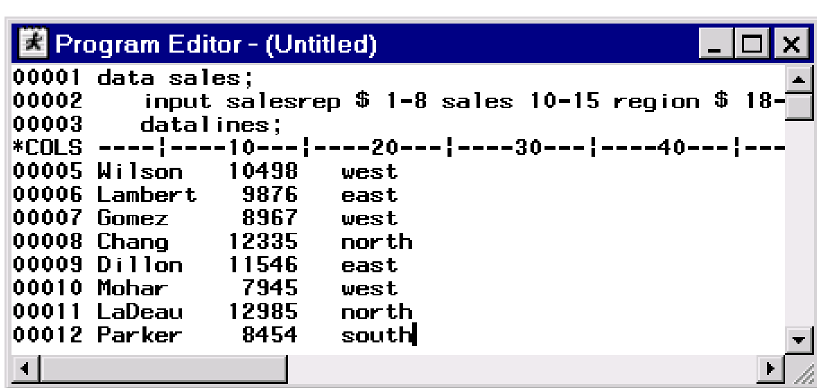
Specify the following command to shift a block of text to the right:

```
>> <n>
```

Displaying Columns and Line Numbers

To display column numbers in the text editor, specify the COLS line command. This command is especially useful if you are writing an INPUT statement in column mode, as shown in the following figure.

Figure 41.4 Executing the COLS Command



To remove the COLS line command or any other pending line command, execute the RESET command on the command line. You can also execute the D (delete) line command on the line where you have specified the COLS command to achieve the same results.

The NUMBERS command numbers the data lines in the Editor and SAS NOTEPAD windows. Specify the following command to add numbers to the data lines:

```
numbers on
```

To remove the numbers, specify

```
numbers off
```

You can also use the NUMBERS command without an argument, executing the command once to turn numbers on, and again to turn them off.

Making Text Uppercase and Lowercase

Overview

Making text uppercase and lowercase involves two sets of commands to accomplish two types of tasks:

Table 41.4 *Changing Text Case*

Command	Action
CAPS	Changes the default
CU, CL line commands	Change the case of existing text

Changing the Default

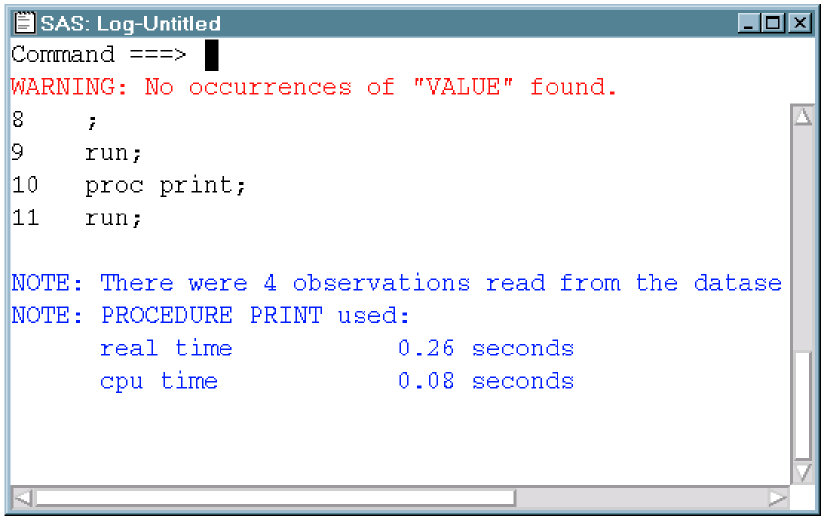
To change the default case of text as you enter it, use the CAPS command. After you execute the CAPS command, the text that you enter is converted to uppercase as soon as you press ENTER or RETURN. Under some operating environments, with CAPS ON, characters that are entered or modified are translated into uppercase when you move the cursor from the line. Character strings that you specify with a FIND, RFIND, or BFIND command are interpreted as having been entered in uppercase unless you enclose the character strings in quotation marks.

For example, if you want to find the word value in the Log window, then on the command line, specify

```
find value
```

If the CAPS command has already been specified, then SAS searches for the word VALUE instead of value. You receive a message indicating that no occurrences of VALUE have been found, as shown in the following display.

Figure 41.5 The Results of the FIND Command with CAPS ON



However, specify the following command and SAS searches for the word value, and finds it:

```
find 'value'
```

Setting CAPS ON remains in effect until the end of your session or until you turn it off. You can execute the CAPS command by specifying

```
caps on
```

To discontinue the automatic uppercasing of text, specify

```
caps off
```

You can also use the CAPS command like a toggle switch, executing it once to turn the command on, and again to turn it off.

Changing the Case of Existing Text

To uppercase or lowercase text that has already been entered, use the line commands CU and CL. Execute the CU (case upper) command to uppercase a line of text and the CL (case lower) command to lowercase a line of text.

In the following example, the CU and CL line commands each mark a line of text that will be converted to uppercase and lowercase, respectively.

```
00001 Study of Gifted Seventh Graders
cu002 Burns County Schools, North Carolina
cl003 Conducted by Educomp, Inc.
```

Press Enter to execute the commands. The lines of text are converted as follows:

```
00001 Study of Gifted Seventh Graders
00002 BURNS COUNTY SCHOOLS, NORTH CAROLINA
00003 conducted by educomp, inc.
```

For a block of text, you have two choices. First, you can execute the CCU block command to uppercase a block of text and the CCL block command to lowercase a block of text. Position the block command on both the first and last lines of text that you want to convert. Second, you can designate a number of lines that you want to uppercase or lowercase by specifying a numeric argument, as shown below:

```
cu3 1 Study of Gifted Seventh Graders
```

```
00002 Burns County Schools, North Carolina
00003 Conducted by Educomp, Inc.
```

Press Enter to execute the command. The three lines of text are converted to uppercase, as shown below:

```
00001 STUDY OF GIFTED SEVENTH GRADERS
00002 BURNS COUNTY SCHOOLS, NORTH CAROLINA
00003 CONDUCTED BY EDUCOMP, INC.
```

Combining and Separating Text

You can combine and separate pieces of text with a number of line commands. With the TC (text connect) command, you can connect two lines of text. For example, if you want to join the following lines, then enter the TC line command as shown below. Note that the second line is deliberately started in column 2 to create a space between the last word of the first line and the first word of the second line.

```
tc001 This study was conducted by
00002  Educomp, Inc., of Annapolis, Md.
```

Press Enter to execute the command. The lines appear as shown below:

```
00001 This study was conducted by Educomp, Inc., of Annapolis, Md.
```

Conversely, the TS (text split) command shifts text after the cursor's current position to the beginning of a new line.

Remember that you can also use a function key to execute the TC line command, the TS line command, or any other line command as long as you precede it with a colon.

Working with Files

Ways to Find a File

Overview

There are a number of ways in which you can find a file or library member in the SAS windowing environment, including the following:

- using the Explorer window
- using the Find window

Using Explorer to Find a File

When the SAS windowing environment opens, the Explorer window also opens by default in many operating environments. You can issue the EXPLORER command to open the Explorer window if it does not open by default.

- To find a file in the Contents Only view of the Explorer window, select the **Libraries** folder or the **File Shortcuts** folder, and then select **Open** from the pop-up menu. You can continue this process with subfolders until you locate the appropriate file.
- To find a file in the Tree view of the Explorer window, use the expansion icons (+ and – icons) located in the tree until the appropriate file appears in the window.

Note: You might find it useful to use specific navigational tools to move through the different levels of the Explorer window:

Menu
View ⇨ Up One Level

Command
UPLEVEL

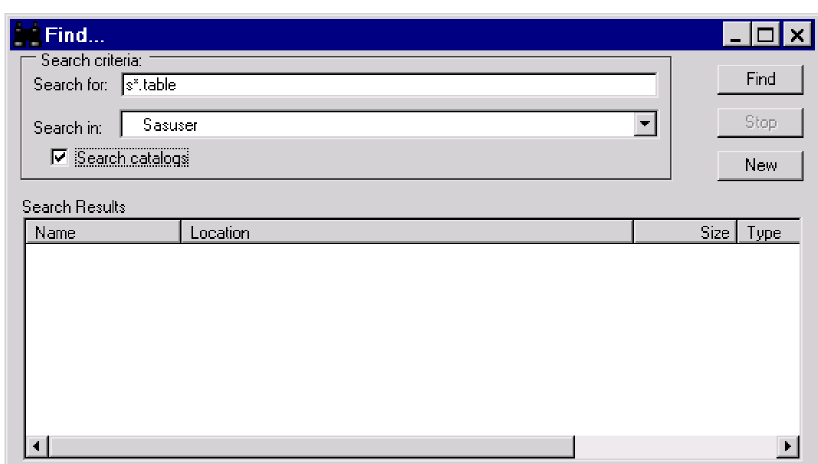
For more information about selecting an Explorer window view, see "Customizing the Explorer Window " on page 840.

Using the Find Window to Find a File

The Find window enables you to search for an expression (such as a text string or a library member) that exists in a SAS library. The default search looks at everything in the library, except catalogs, but you can click the check box for the search to include the catalogs in the library as well.

The following display shows the Find window with the information for a search entered in the **Search for** and **Search in** fields.

Figure 41.6 The Find Window



To search for a file, follow these steps:

1 Select **Tools** ⇨ **Find** from the Explorer window to open the Find window.

Alternatively, issue the EXPFIND or EXPFIND <library-name> command. If you issue the EXPFIND command, then SASUSER is the default library. If you issue the EXPFIND WORK command, then WORK is the default library.

2 In the **Search For** field, enter the expression that you want to find. Wildcard characters are acceptable.

3 From the **Search In** drop-down list, select the library in which you want to search.

4 Click **Search Catalogs** to expand the search to include the catalogs of the library that you have selected.

   Searching catalogs can lengthen search time considerably depending on the size and number of catalogs in the library.

5 Click **Find**.

Example: Finding Files with the Find Window

You can find TABLE files that begin with a specific letter and exist in a specific library. For a file that starts with the letter S and which exists in the SASHELP library.

1 Select **Tools** ⇨ **Find** to open the Find window.

2 Type `s*.table` in the **Search For** field.

3 Select **SASHELP** from the **Search In** drop-down list.

4 Click **Find**.

Issuing File-Specific Commands

There are a number of commands that you can issue against a file after you find the file in the SAS windowing environment. The commands that are available are determined by the type of file with which you are working.

1 Find the file with which you want to work. For more information, see “Ways to Find a File” on page 802.

2 Select the file, and then right-click the file. A list of file-specific commands appears from which you can make a selection.

Operating Environment Information: If you are using the z/OS operating environment, then you can open a pop-up menu by entering `?` in the selection field next to an item. Alternatively, you can enter an `s` or `x` in the selection field next to an item.

Opening Files

There are a number of ways in which you can open files in the SAS windowing environment.

To open a SAS file from Explorer:

1 Open a library and appropriate library members until you see the file that you want to open.

2 Select the file, and then select **Open** from the pop-up menu.

Depending on the file type, you might also be able to select **Open in Editor**.

Note: In some cases, the pop-up menu also enables you to select **Browse in SAS Notepad**, which enables you to open a file in the SAS NOTEPAD window.

To open a file that has a file shortcut:

1 Open the `File Shortcuts` folder.

2 Select a file shortcut, and then select **Open** from the pop-up menu.

Assigning a File Shortcut

File shortcut references provide aliases to external files (such as a .sas program file or a .dat text file). A file shortcut is the same as a file reference or fileref. In operating environments that support drag and drop functionality, you can drag file shortcuts from the Explorer window to the Editor window to display their contents.

To assign a file shortcut:

1 From the Explorer window, select the `File Shortcuts` folder.

2 Select **File** ⇨ **New**.

3 In the **Name** field of the File Shortcut Assignment window, enter a name for the file shortcut.

4 Select the method or device that you want to use for the file shortcut.

  The methods or devices that are available from the **Method** drop-down list depend on your operating environment. The DISK method is the default method (if it is available for your operating environment).

5 Select the **Enable at Startup** check box if you want SAS to automatically assign the file shortcut each time SAS starts. This option is not available for all the file shortcut methods.

  If you want to stop a file shortcut from being enabled at start-up, then select the file shortcut in the SAS Explorer window, and then select **Delete** from the pop-up menu.

6 Fill in the fields of the Method Information area, including the name and location of the file for which you want to create a file shortcut. You can select **Browse** to locate the actual file. The fields that are available in this area depend on the type of method or device that you select.

  Note: Selecting a new method type erases any entries that you might have made in the Method Information fields.

7 Select **OK** to create the new file shortcut. The file shortcut appears in the File Shortcut folder of the SAS Explorer window.

You can use the following ways to create a file shortcut, depending on your operating environment:

Menus
File ⇨ New

while your mouse is positioned on `File Shortcuts` in the Explorer window.

Command
DMFILEASSIGN<*file-shortcut-name*><METHOD=><AUTO=>Yes | No

file-shortcut-name
specifies an existing file shortcut reference.

METHOD= *method-name*
specifies which method to use when the File Shortcut Assignment window appears.

AUTO= Yes|No
sets the state of the File Shortcut Assignment window's **Enable at Startup** check box when the window opens.

Pop-up
`New File Shortcut` if you have opened the **File Shortcut** folder in the Explorer window.

Toolbar
New (while your mouse is positioned on `File Shortcuts` in the Explorer window.)

Modifying an Existing File Shortcut

You can modify existing file shortcut references, if needed.

From the command line:

1 Issue the following command:

   DMFILEASSIGN *file-shortcut-name*

   The File Shortcut Assignment window appears. Its fields include information that is specific to the chosen file shortcut.

2 Edit the fields of the File Shortcut Assignment window as needed.

From the SAS Explorer:

1 Right-click the `File Shortcuts` folder and select **Open**. Alternatively, you can double-click the folder to open it.

2 Right-click the file shortcut reference that you want to change, and then select **Modify**.

3 Edit the fields of the File Shortcut Assignment window as needed.

Operating Environment Information: If you are using the z/OS operating environment, then you can open a pop-up menu by entering `?` in the selection field next to an item. Alternatively, you can enter an `s` or `x` in the selection field next to an item.

Printing Files

There are a number of ways in which you can print files. Often, printing capabilities depend on the type of file with which you are working, as well as your operating environment.

Nonetheless, the following lists common ways in which you might be able to print a file.

Printing from Explorer
: Find the appropriate file in the Explorer window. Right-click over the file, and then select **Print**.

Printing from a Text Editor
: Open your file into a text editor such as the Editor or the SAS NOTEPAD. Use the text editor's printing commands.

Refer to your operating environment documentation for information about printing files.

Working with SAS Programs

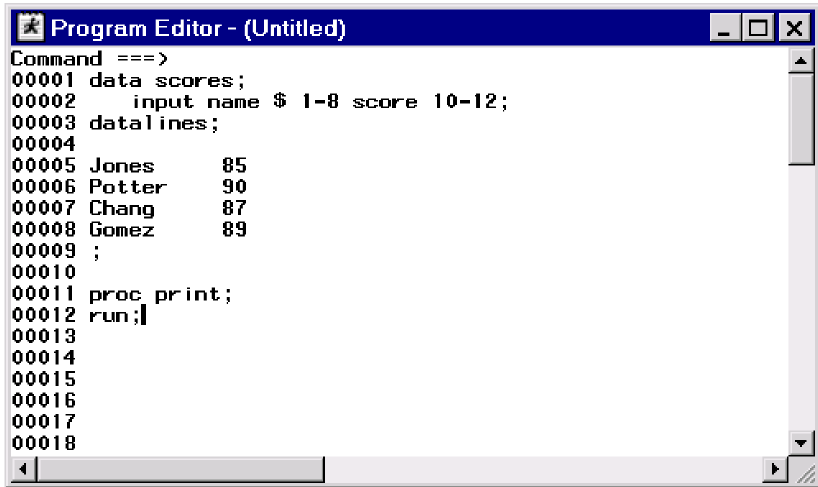
Editor Window

Overview

When you work with SAS programs, you typically use the SAS programming windows (the Editor, Log, and Output windows). Of these programming windows, the Editor is the window that you might use most often. It enables you to do the following:

- Enter and submit the program statements that define a SAS program.
- Edit text.
- Store your program in a file.
- Copy contents from an already-created file.
- Copy contents into another file.

Figure 41.7 *The Editor Window with Line Numbers Turned On*



Note: The Program Editor window shown here includes line numbers. You might find line numbers helpful when creating or editing programs. To toggle line numbers on or off, issue the NUMBERS command.

Command-Line Commands and the Editor

There are a number of commands that you might find useful while working on programs in the Editor. You can execute these commands from the command line:

TOP
: scrolls to the beginning of the Editor.

BOTTOM
: scrolls to the last line of text.

BACKWARD
: scrolls back toward the beginning of the text.

FORWARD
: scrolls forward toward the end of the text.

LEFT
: scrolls to the left of the window.

RIGHT
: scrolls to the right of the window.

ZOOM
: increases the size of the window. You can issue this command again to return the window to its previous size.

UNDO
: cancels the effect of the most recently submitted text editing command. Continuing to execute the UNDO command undoes previous commands, starting with the most recent and moving backward.

SUBMIT
: submits the block of statements in your current SAS windowing environment session.

RECALL
: returns to the Program Editor window the most recently submitted block of statements in your current SAS windowing environment session. Continuing to execute the RECALL command recalls previous statements, starting with the most recent and moving backward.

CLEAR
: clears a window as specified. You can clear the Editor, Log, or Output windows from another window by executing the CLEAR command with the appropriate option as shown in the following examples: `clear pgm clear log clear output`

CAPS
: converts everything that you enter to uppercase.

FIND
: searches for a specified string of characters. Enclose the string in quotation marks if it contains embedded blanks or special characters.

CHANGE
: changes a specified string of characters to another. Follow the command keyword with the first string, a space, and then the second string. The rules for embedded blanks and special characters apply. For example, you might specify `change 'operating system' platform`

  This CHANGE command replaces the first occurrence of operating system with the word platform. Note that the first string must be enclosed in quotation marks because it contains an embedded blank.

Note: Some of the more useful command-line commands have been listed here. Almost all SAS commands are valid in the Program Editor window. For more information about other command-line commands, see "Working with SAS Windows" on page 792.

Line Commands and the Editor

The left-most portion of the Program Editor window includes a numbered field. This field is where you enter line commands. These commands are denoted by one or more letters, and can move, copy, delete, justify, or insert lines.

Some common line commands include

- M — moves a line of text
- C — copies a line of text
- D — deletes a line of text
- I — inserts a line of text

When you use some line commands, you also need to specify a location. For example, if you enter an **M** in the numbered field for a line in the Editor, then you must specify where you want the line of text to be moved. You can use the **A** (after) and **B** (before) line commands to specify a location.

If you type an **A** in the numbered field for a line, then the line of text that you want to move will be placed after the line marked with an A after you press the ENTER key. If you type a **B** in the numbered field for a line, then the line of text that you want to move will be placed before the line marked with a B after you press the ENTER key.

The following examples show how to use line commands to move a line of text in the Program Editor window to a new location. To make the following lines alphabetical, place the first line after the last line. To do this, use the M and A line commands:

```
m 001 Lincoln f Wake Ligon  135
00002 Andrews f Wake Martin 140
00003 Black   m Wake Martin 149
a 004 Jones   m Wake Ligon  142
```

After pressing Enter, your Program Editor window lines appear as follows:

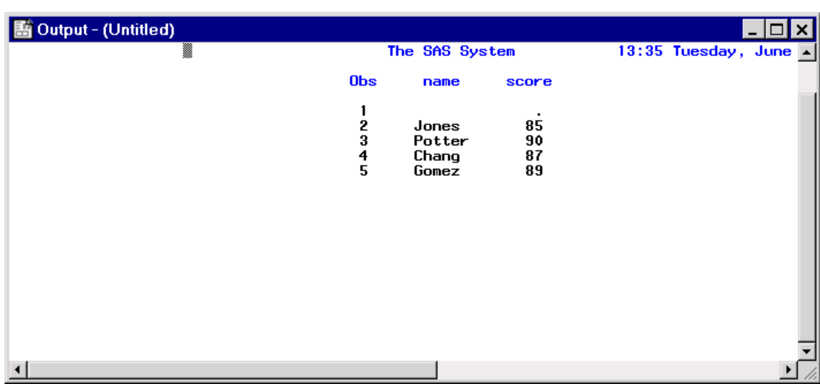
```
00001 Andrews f Wake Martin 140
00002 Black   m Wake Martin 149
00003 Jones   m Wake Ligon  142
00004 Lincoln f Wake Martin 135
```

There are many other line commands and combinations of line commands that you can use to edit the statements of a program in the Program Editor window. For more information, see “Working with Text” on page 798.

Output Window

You can browse and scroll procedure output from your current SAS session with the Output window. The results of submitting a program, if it contains a PROC step that produces output, are usually displayed in the Output window.

Figure 41.8 The Output Window Showing the Results of a Submitted Procedure



Most of the command-line commands described earlier for the Program Editor window can be used in the Output window. The CLEAR command is particularly useful in the Output window because all output is appended to the previous output within a SAS session. If you want to avoid accumulating output, then execute the CLEAR command before you submit your next program. From any other window, you can clear the Output window by specifying

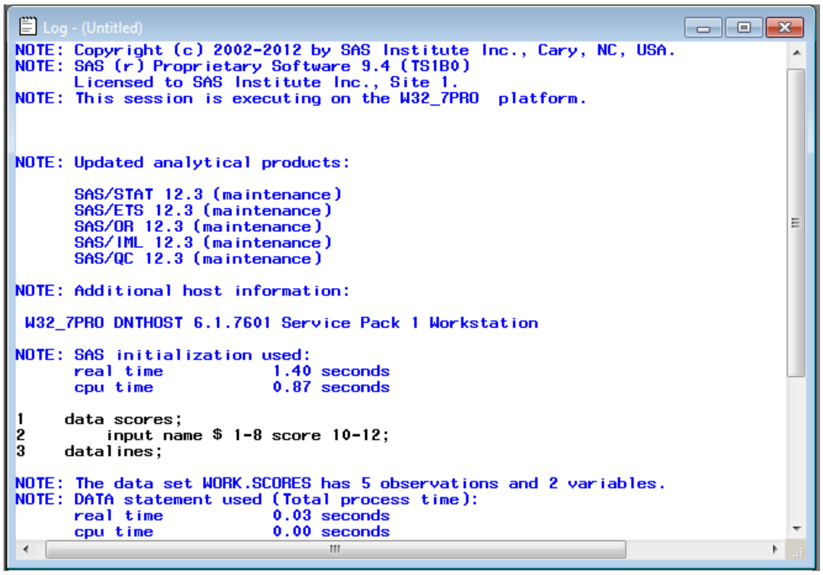
```
clear output
```

Log Window

The Log window enables you to perform these tasks:

- recognize when you have made programming errors
- understand what is necessary to correct those errors
- receive feedback on the steps that you take to correct errors

Figure 41.9 *The Log Window Showing Information about a SAS Session*



The Log window shows the SAS statements that you have submitted as well as messages from SAS concerning your program. Under most operating environments, the Log window displays:

- when the program was executed
- the release of SAS under which the program was run
- details about the computer installation and its site number
- the number of observations and variables for a given output data set
- the computer resources that each step used

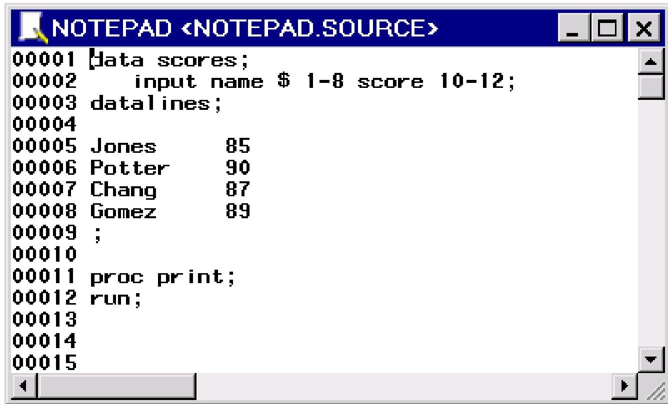
You can use command-line commands in the Log window, just as you can in the Editor and Output windows. For more information, see " Editor Window" on page 807.

Using Other Editors

NOTEPAD Window

Although the Editor was designed for writing SAS programs, you can also use the NOTEPAD window to create and edit SAS programs. The NOTEPAD is a text editor that you can use to create, edit, save, and submit SAS programs. You might find NOTEPAD useful as a separate place to work on code. To open NOTEPAD, issue the NOTEPAD or NOTES command.

Figure 41.10 The SAS NOTEPAD Window with Line Numbers Turned On



Note: The NOTEPAD window shown here includes line numbers. You might find line numbers helpful when you create or edit programs. To toggle line numbers on or off in NOTEPAD, issue the NUMBERS command.

If you open multiple NOTEPADS, then you can cut, copy, and paste text between NOTEPAD windows and the Program Editor window, multiple SAS sessions, and other applications.

Note: To submit a program from NOTEPAD, you must either select **Run** ⇨ **Submit** or issue the NOTESUBMIT command.

Note: The program information that is presented in this documentation uses the Editor windows as the default editor.

Creating and Submitting a Program

To create and submit a SAS program:

1 Enter the text of your program in the Editor.

2 Type `submit` on the command line, and then press Enter.

   You can also use the function key, menu command, or toolbar item that is assigned to submit programs in your environment.

   Note: If you are submitting a program from the NOTEPAD window, then you must use the NOTESUBMIT command instead of the SUBMIT command.

Storing a Program

To store a program:

1. In the Program Editor window, create or edit a program.

2. On the command line, issue the FILE command followed by a fileref or an actual filename. If you use an actual filename, then enclose it in quotation marks.

The FILE command does not clear the contents of the Program Editor window. You can store one copy of a program and then continue working in the Program Editor window.

If you try to store a program with a fileref or filename that already exists, then SAS displays a dialog box. The dialog box enables you to choose to

- overwrite the contents of the existing file with the new file
- append the new file to the existing file
- cancel the FILE command

Often you will want to replace a file with an updated version. To suppress the dialog box, add the REPLACE option to the FILE command after the fileref or complete filename. To add the text in the Program Editor window to the end of an existing file, specify the APPEND option with the FILE command after the fileref or complete filename.

Note: You can also store a program as a SAS object or as a file that is specific to your operating environment. After you have created or edited a program, select **File** ⇨ **Save As Object** or **File** ⇨ **Save As**, respectively.

Debugging a Program

You or someone in your organization might be able to help debug a program with the information that appears in the Log window after a program is submitted. If you are having problems with your program, save the contents of the Log window to an external file, if you need to study it after your SAS session has ended.

To save the contents of the Log window to an external file:

1. Open the Log window if it is not already open.

2. From the command line, execute the FILE command followed by a fileref or an actual filename. If you use a filename, then enclose the name in quotation marks.

The FILE command stores a copy of the information in the Log window without removing what is currently displayed. If you specify the name of an existing fileref or file, then a dialog box appears and offers you three choices: overwriting the contents of the existing file with the new file, appending the new file to the existing file, or canceling the command.

Opening a Program

There is more than one way to open a SAS program. Two of the most popular methods are listed in this section.

To open a SAS program from the Program Editor window:

1 Select **File** ⇨ **Open**.

2 Use the Open window to locate the appropriate SAS program file.

To open a SAS program with commands:

1 Open the Program Editor window if it is not already open.

2 On the command line, specify the INCLUDE command followed by an assigned fileref or an actual filename. Remember to enclose an actual filename in single or double quotation marks.

   By default, a program is appended to the end of any existing program statements.

Note: If program statements already exist in the Editor, then you can determine where your program is appended by using the B (before) or A (after) line commands. For more information about line commands, see "Using Line Commands" on page 791.

If you want to replace the text that is already in the Program Editor window with the program that you open, then specify the REPLACE option with the INCLUDE command after the fileref or filename.

Editing a Program

To edit a program:

1 Open an existing program in the Program Editor window.

2 Edit existing program statements or append new statements to the program.

   Use command-line commands and line commands as needed.

3 Store the program.

Assigning a Program to a File Shortcut

You can assign a program to a file shortcut to make it easier to find and work with the file in the future. For more information about file shortcuts, see "Assigning a File Shortcut" on page 805.

Working with Output

Overview of Working with Output

You can manage your SAS procedure output with the SAS Output Delivery System (ODS). Procedures that fully support ODS can do the following:

- combine the raw data that they produce with one or more table definitions to produce one or more output objects that contain formatted results
- store a link to each output object in the Results folder in the Results window
- can generate various types of file output, such as HTML, LISTING, and in some cases, SAS/GRAPH output
- can generate output data sets from procedure output
- provide a way for you to customize the procedure output by creating table definitions that you can use whenever you run the procedure

The SAS windowing environment enables you to use many features of ODS through the Results, Templates, Preferences, and SAS Registry Editor windows. The Results window provides pointers to the procedure output that is produced by SAS. The Templates window provides a way to manage all the table, column heading, and style templates that can be associated with procedure output.

Finally, the Preferences window and the SAS Registry Editor can be used to set the types of procedure output that you want SAS to produce.

This section details only those portions of ODS that are related to the SAS windowing environment. For more information about ODS, see Chapter 24, “Directing SAS Output and the SAS Log,” on page 403 and *SAS Output Delivery System: User’s Guide*.

Setting Output Format

Overview

Depending on your operating environment, SAS output can be produced in one or more formats (or types). Listing output is the default type. Other output types include HTML, Output Data Sets, and PostScript. Pointers to procedure output appear in the Results window.

To set your output type, use either the Preferences window (if available in your operating environment), the SAS Registry Editor, or both.

Setting Output Type with the Preferences Window

If your operating environment supports the Preferences window, you can set output type as follows:

1 Select **Tools** ⇨ **Options** ⇨ **Preferences** or issue the DLGPREF command to open the Preferences window.

2 Select the **Results** tab.

3 Select or deselect the check boxes that match the output types that you want to produce.

   If you choose to produce HTML output, then you can further define the output by selecting:

   - an HTML style

     Click the **Style** box and highlight a style. Styles among other things, define output colors and fonts.

   - the folder to which the output is saved

     Select **Use WORK folder** to save HTML output only for the duration of the current session. Your output is deleted when your current SAS session ends.

     Enter a path in the **Folder** text box to save HTML output to a folder that is not deleted when your SAS session ends.

   - the **View Results as they are Generated** check box

     If selected, then each time HTML output is produced, your browser automatically opens and loads the output.

Setting Output Type with the SAS Registry Editor

To set output type with the SAS Registry Editor:

1 Select **Solutions** ⇨ **Accessories** ⇨ **Registry Editor** or issue the REGEDIT command to open the SAS Registry Editor.

2 From the tree on the left side, expand the ODS folder.

3 Expand the Preferences folder.

4 Select the appropriate output type.

5 On the right side, select the Value key, and then select `Modify` from the pop-up menu.

6 In the dialog box that appears, edit the Value Data field as needed.

   If this field is set to 1, then the output type is produced. If this field is set to 0, then the output type is not produced.

Assigning a Default Viewer to a SAS Output Type

When you produce output in SAS, output pointers appear in the Results window. You can assign a default viewer for each of the types of output that you produce. After a default viewer is assigned, you can double-click an output pointer in the Results window to open output in its default viewer. For example, double-clicking on a PostScript output pointer could open Ghostview with your PostScript output loaded.

Operating Environment Information: In the Windows operating environment, default viewers are established automatically with information from your Windows Registry.

To assign a default viewer to a SAS Output Type, follow these steps:

1 From the Explorer window, select **Tools** ⇨ **Options** ⇨ **Explorer**.

2 Select **Host Files** from the drop-down menu at the top of the Explorer Options window.

3 Scroll through the registered file types until you find the file type with which you want to work.

4 Select the appropriate file type, and then select **Edit**.

5 Select **Add**, and then enter an action name and action command for the file type in the Edit Action window.

   For example, add the following action name and action command to set Ghostview as the default viewer for PostScript file types:

   Action Name
      &Edit

   Action Command
      x ghostview '%s' &

6 Select **OK** from the Edit Action window.

7 Select the action that you just specified, and then select **Set Default**.

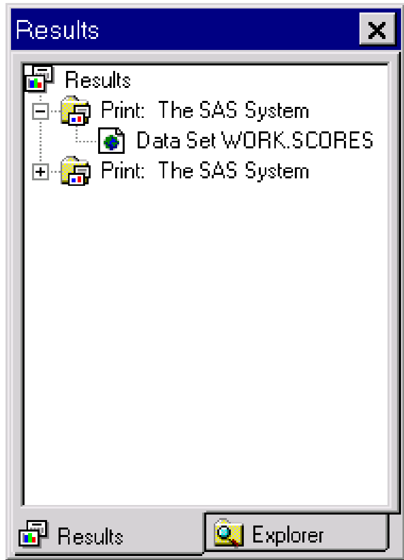
Operating Environment Information: In the Windows operating environment, default viewers are established automatically with information from your Windows Registry.

Working with Output in the Results Window

Overview

The Results window provides pointers to the procedure or DATA step output that SAS produces. This window might open by default when you start a SAS session. You can also open the Results window by selecting **View** ⇨ **Results** or by issuing the ODSRESULTS command.

Figure 41.11 *The Results Window in Tree View*



You can use the Results window to complete the following tasks:

- Navigate pointers to output.
- Delete results pointers.
- Rename results pointers.
- Save listing output to other formats.
- Quickly view the first output pointer item.
- View results properties.

Customizing the Results Window View

You can have the Results window display in one of three views:

- Tree
- Contents Only
- Explorer

In Tree view (the default), only a navigational tree is present. In Contents Only view, the tree is turned off, and contents appear as folders. In Explorer view, the Results window appears with two panes: one for the tree and one for the contents.

To toggle the Tree view pane, issue the TREE command from the Results window. To toggle the Contents pane, issue the CHILD command from the Results window. You can also select commands from the **View** menu of the Results window to perform the same actions, such as **Show Tree**, **Show Contents**, and others.

Note: By default, output pointers are listed by label rather than by name in the Tree pane. Labels are typically more descriptive than output names. You can use the following SAS system option to change this setting: LABEL.

Using Results Pointers to Navigate Output

When SAS runs a procedure or a DATA step, pointers to the output are placed in the Results window. For information about using the pointers in the Results window, see "Navigating the Results Window in Tree View" on page 819, "Navigating the Results Window in Contents Only View" on page 819, or "Navigating the Results Window in Explorer View" on page 820.

Navigating the Results Window in Tree View

In Tree view, output pointers appear in a procedural hierarchy. To work with your SAS output:

1 Locate the folder that matches the procedure output that you want to view.

2 Use the expansion icons (+ or – icons) next to the folder to open or hide its contents.

   You can also:

   - Double-click a folder to make it expand or collapse.
   - Select a folder, and then select **Open** from the pop-up menu.

3 When you locate the appropriate pointer, double-click the pointer or select the pointer and then select **Open** from the pop-up menu.

   The appropriate output appears.

Operating Environment Information: If you are using the z/OS operating environment, then you can open a pop-up menu by entering `?` in the selection field next to an item. Alternatively, you can enter an `s` or `x` in the selection field next to an item.

You can also use the following ways to navigate in the Tree view:

Menu
: **View ⇨ Up One Level**

Command
: UPLEVEL

Toolbar
: Up One Level icon

Key
: Depending on your operating environment, you might also use arrow and backspace keys to navigate.

Navigating the Results Window in Contents Only View

In Contents Only view, output pointers appear in a procedural hierarchy, beginning with the top level of the hierarchy. You can drill down or roll up within the hierarchy to find the appropriate output.

When you open a folder, the current window contents are replaced with the contents of the selected folder. To work with your SAS output:

1 Locate the folder that matches the procedure output that you want to view.

2 Select the folder, and then select **Open** from the pop-up menu.

   You can also double-click a folder to open it.

3 When you locate the appropriate pointer, double-click the pointer or select the pointer, and then select **Open** from the pop-up menu.

   The appropriate output appears.

Operating Environment Information: If you are using the z/OS operating environment, then you can open a pop-up menu by entering **?** in the selection field next to an item. Alternatively, you can enter an **s** or **x** in the selection field next to an item.

Navigating the Results Window in Explorer View

In Explorer view, two window panes exist. The left pane includes a hierarchical view (the Tree view) of the procedure output that you can view. The right pane shows the contents (the Contents view) of the item that is currently in focus.

Deleting Results Pointers

You can delete results pointers by deleting the procedure folder in which the pointers exist. When you delete a procedure folder in the Results window, any output pointer that exists in that folder is removed.

Note: When you delete a procedure folder that contains a listing output pointer, the actual listing output is removed from the Output window. If other output pointers exist in the folder (such as HTML), then only the pointer is removed; the actual output remains available.

To delete procedure output:

1 In the Results window, select the procedure folder that matches the procedure that you want to delete.

2 Select **Delete** from the pop-up menu.

3 Select **Yes** to confirm the deletion.

> **TIP** You can also delete output pointers by selecting the procedure folder that you want to delete, and then selecting **Edit** ⇨ **Delete**.

Renaming Results Pointers

To rename results pointers:

1 Select the pointer that you want to rename.

2 Select **Rename** from the pop-up menu.

3 Type in a new name and/or a description, and then select **OK**.

TIP You can also rename results pointers by selecting the pointer that you want to rename, and then selecting **Edit** ⇨ **Rename**.

Saving Listing Output to Other Formats

To save listing output to a file from the Results window:

1. Expand the Results window tree until you find the appropriate listing output pointer.
2. Select the listing output pointer, and then select **Save As** from the pop-up menu.

To save listing output to a file from the Output window:

1. Access the Output window.
2. On the command line, specify the FILE command followed by a fileref or an actual filename. If you use a filename, then enclose the filename in quotation marks.

Note: The FILE command stores a copy of the information in the Output window without removing what is currently displayed.

To save listing output as a catalog object:

1. Expand the Results window tree until you find the appropriate listing output item.
2. Select the listing output item, and then select **Save As Object** from the pop-up menu.

Viewing the First Output Pointer Item

To view the first output pointer item:

1. Select the appropriate results pointer.
2. Select **View** from the pop-up menu.

   The first output pointer item listed for the results pointer that you selected appears. For example, if you produced listing and HTML output for a procedure and the listing output was created first, then the listing output would appear.

Viewing Results Properties

You can view the properties of a Results window folder, an output pointer, or an output pointer item (such as listing or HTML output).

1. In the Results window, select the appropriate folder, output pointer, or output pointer item.
2. Select **Properties** from the pop-up menu.

Working with Output Templates

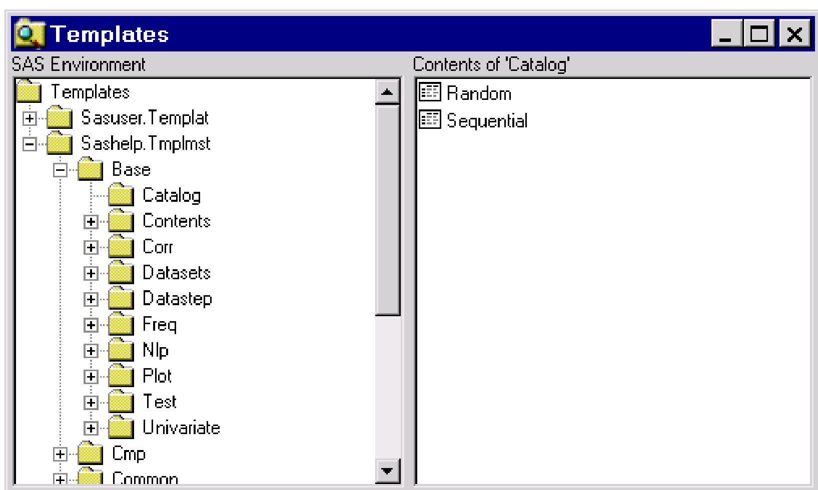
Overview of Working with Output Templates

Templates contain descriptive information that enables the Output Delivery System (ODS) to determine the desired layout of a procedure's results.

The Templates window provides a way to manage all the templates that are currently available to SAS. Specifically, you can use the Templates window to do the following:

- Browse PROC TEMPLATE source code.
- Edit PROC TEMPLATE source code.
- View template properties.

Figure 41.12 The Templates Window in Explorer View



You can open the Templates window by selecting **View** ⇨ **Templates** from the Results window, or by issuing the ODSTEMPLATES command.

You can create or modify templates with PROC TEMPLATE.

Note: Templates that are supplied by SAS are stored in SASHELP. Templates that are created with PROC TEMPLATE are stored in SASUSER or whatever library you specify in the ODS PATH statement.

Customizing the Templates Window View

The Templates window appears in one of three views:

- Explorer
- Tree
- Contents Only

In Explorer view (the default), the Templates window appears with two panes: one for the tree and one for the contents. In Tree view, only a navigational tree is present. In Contents Only view, the tree is turned off.

To toggle the Contents pane, issue the CHILD command from the Templates window. To toggle the Tree pane, issue the TREE command from the Templates window.

For more information, see "Navigating the Results Window in Tree View" on page 819, "Navigating the Results Window in Contents Only View" on page 819, or "Navigating the Results Window in Explorer View" on page 820.

Navigating the Templates Window in Explorer View

In Explorer view, two window panes exist. The left pane includes a hierarchical view (the Tree view) of the templates that you can view. The right pane shows the contents (the Contents view) of the template currently in focus.

You can open additional template windows from the Explorer view by selecting a template, and then selecting **Explore from Here** from the pop-up menu.

Navigating the Templates Window in Tree View

In Tree view, templates appear in a hierarchy. To work with a template:

1. Locate the folder that includes the template that you want to view.
2. Use the expansion icons (+ or – icons) next to the folder to open or hide its contents.

   You can also do the following:

   - Double-click a folder to make it expand or collapse.
   - Select a folder, and then select **Open** from the pop-up menu.
3. Double-click the template that you want to see, or select the template, and then select **Open** from the pop-up menu.

   The template code appears in a browser window.

Operating Environment Information: If you are using the z/OS operating environments, then you can open a pop-up menu by entering **?** in the selection field next to an item. Alternatively, you can double-click by entering an **s** or **x** in the selection field next to an item.

Navigating the Templates Window in Contents Only View

In Contents Only view, templates appear as folders. When you open a folder, the current window contents are replaced with the contents of the selected folder. To work with your templates in this view:

1. Locate the folder that includes the template that you want to view.
2. Select the folder, and then select **Open** from the pop-up menu.

   You can also double-click on a folder to open it.
3. Double-click on the template that you want to see, or select the template, and then select **Open** from the pop-up menu.

The template code appears in a browser window.

Operating Environment Information: If you are using the z/OS operating environments, then you can open a pop-up menu by entering `?` in the selection field next to an item. Alternatively, you can double-click by entering an `s` or `x` in the selection field next to an item.

Browsing PROC TEMPLATE Source Code

To browse the PROC TEMPLATE source code:

1 Locate the appropriate template in the Templates window.

2 Select the template, and then select **Open** from the pop-up menu.

Template code appears in a browser window.

Editing PROC TEMPLATE Source Code

To edit the PROC TEMPLATE source code:

1 Locate the appropriate template in the Templates window.

2 Select the template, and then select **Edit** from the pop-up menu. Template code appears in an editor window.

3 Modify the template code as needed.

4 Select **Run** ⇨ **Submit** to submit your modified template code.

Note: If syntax errors occur when the code for an edited template is submitted, then the errors appear in the Log window.

Note: Additional information for PROC TEMPLATE is available in *SAS Output Delivery System: User's Guide*.

Viewing Template Properties

To view template properties:

1 Locate the appropriate template in the Templates window.

2 Select the template, and then select **Properties** from the pop-up menu.

The Properties dialog box lists the type, path, size, description, and modification date for the template. You can also view this information by selecting **View** ⇨ **Details** when the Templates window is active.

Printing Output

The method that you use to print output depends on the type of output that you produce, as well as your operating environment. SAS windowing environment windows have menus with print options that enable you to print the contents of that particular window. This feature varies from operating system to operating system, but is available in all operating environments.

If you produce HTML output, then you can open the output in a web browser, and then print the output from the web browser with the web browser's printing command.

For more information about printing, refer to your SAS operating environment companion documentation and your operating environment documentation.

Summary

Statements

ODS PATH location(s)
: specifies which locations to search for definitions that were created by PROC TEMPLATE, as well as the order in which to search for them.

  <*libname.*>*item-store* <READ | UPDATE | WRITE>

item-store
: identifies an item store that contains style templates, table definitions, or both.

Windows

File Shortcut Assignment
: enables you to create or edit file shortcut references. To open this window, issue the DMFILEASSIGN command.

Find
: enables you to search for an expression that exists in a SAS library. To open this window, select **Tools** ⇨ **Find** from Explorer or issue the EXPFIND command.

Log
: enables you to review information about the programs that you have run. To open this window, select **View** ⇨ **Log** or issue the LOG command.

Output
: enables you to see listing output. To open this window, select **View** ⇨ **Output** or issue the OUTPUT command.

Editor
: enables you to enter, edit, submit, and save SAS program statements. To open this window, select **View** ⇨ **Editor** or issue the PGM command.

Results
: provides pointers to the procedure output that you produce with SAS. To open this window, select **View** ⇨ **Results** or issue the ODSRESULTS command.

SAS NOTEPAD
: enables you to enter, edit, submit, and save SAS program statements. To open this window, issue the NOTEPAD or NOTES command.

SAS Registry Editor
: enables you to edit the SAS Registry and to customize aspects of the SAS windowing environment. To access this window, issue the REGEDIT command.

Templates
: provides a way to manage the output templates that are currently available. To access this window, select **View** ⇨ **Templates** from within the Results window.

Commands

AUTOEXPAND
: automatically expands the tree hierarchy when you select a tree node or when procedure output is produced.

AUTOSYNC
: enables you to automatically navigate to the first available output in the Output window by means of a single click.

CHILD
: toggles the Contents pane on and off.

CLEAR
: removes all the SAS output pointers.

DELETESELS
: removes the item currently in focus.

Note: If the output pointer is associated with listing output, then the listing output is also removed.

DESELECT_ALL
: deselects any items that are selected while the Contents pane is viewable.

DETAILS
: toggles the item details about and off while the Contents pane is viewable.

DMOPTLOAD
: recalls system option settings saved by DMOPTSAVE.

DMOPTSAVE
: saves all system option settings for recall in later SAS sessions.

FIND
: searches for a match to the string that you provide.

LARGEVIEW
: displays large icons (on some operating environments) while the Contents pane is viewable.

PMENU
: turns on menus in windows.

PRINT
: writes the desired SAS listing output.

REFRESH
: refreshes the window's contents.

RENAMESELS
: enables you to rename the output pointer that currently has focus.

SELECT_ALL
: selects all items while the Contents pane is viewable.

SMALLVIEW
: displays small icons (on some operating environments) in a horizontal fashion while the Contents pane is viewable.

TREE
: toggles the Tree view (hierarchical view) on and off.

UPLEVEL
: moves focus up one level in the hierarchy.

Procedures

Use PROC TEMPLATE to set template information.

Learning More

To learn more about SAS language elements, see
: *SAS Language Elements by Name, Product, and Category* on `support.sas.com`.

To learn more about printing and the SAS Output Delivery System, see
: *SAS Output Delivery System: User’s Guide*.

To find examples that will help you get started, see
: *Getting Started with the SAS System*.

42

Customizing the SAS Environment

Introduction to Customizing the SAS Environment

Purpose

In this section, you will learn how to make the following types of customizations in SAS:

- those that remain in effect for the current session only
- those that remain in effect from session to session
- those that you can apply to the SAS windowing environment, which is the default SAS environment

Prerequisites

To use this section, you should be familiar with the SAS windowing environment. For more information about the SAS windowing environment, see "Introduction to Using the SAS Windowing Environment" on page 784.

Operating Environment Differences

Even though SAS has a different appearance for each operating environment, most of the actions that are available from the menus are the same.

One of the biggest differences between operating environments is the way that you select menu items.

If your workstation is not equipped with a mouse, then here are the keyboard equivalents to mouse actions:

Table 42.1 Mouse Actions and Keyboard Equivalents

Mouse Action	Keyboard Equivalent
Double-click the item	Type an `s` or an `x` in the space next to the item, and then press Enter
Right-click the item	Type `?` in the space next to the item, and then press Enter

Examples in this documentation show SAS windows as they appear in the Microsoft Windows environment. Usually, corresponding windows in other operating environments will yield similar results. If you do not see the drop-down menus in your operating environment, then enter the global command PMENU at a command prompt.

Customizing Your Current Session

Ways to Customize

As you become familiar with SAS, you will probably develop preferences for how you want SAS configured. Many options are available to you to make SAS conform to your preferred working style. Some of the things that you can change are the following:

- window color and font attributes
- library and file shortcuts
- output appearance
- file-handling capabilities
- the use of system variables

You can customize your current SAS session in the following ways:

- at the start-up of a SAS session or program
- through SAS system options
- with drop-down menu options

Customizing SAS Sessions and Programs at Start-up

Setting Invocation-Only Options Automatically

You can specify some system options only when you invoke SAS. These system options affect the following:

- the way SAS interacts with your operating system
- the hardware that you are using
- the way in which your session or program is configured

Note: There are other system options that you can specify at any time. For more information, see "Customizing with SAS System Options" on page 832.

Usually, any invocation-only options are set by default when SAS is installed at your site. However, you can specify invocation-only options on the command line each time you invoke SAS.

To avoid having to specify options that you use every time you run SAS, set the options in a configuration file. Each time you invoke SAS, SAS looks for that file and uses the customized settings that it contains. Be sure to examine the default configuration file before creating your own.

Note: If you specify options both in the configuration file and in the SAS command, then the options are concatenated. If you specify an option in the SAS command that also appears in the configuration file, then the setting from the SAS command overrides the setting in the configuration file.

To display the current settings for all options that are listed in the configuration file and on your command line as you invoke the system, use the VERBOSE system option in the SAS command.

Executing SAS Statements Automatically

Just as you can set SAS system options automatically when you invoke SAS, you can also execute statements automatically when you invoke SAS by creating a special autoexec file. Each time you invoke SAS, it looks for this special file and executes any of the statements that it contains.

You can save time by using this file to execute statements that you use routinely. For example, you might add the following statements:

- OPTIONS statements that include system options that you use regularly
- FILENAME and LIBNAME statements to define the file shortcuts and libraries that you use regularly

Customizing with SAS System Options

Using the OPTIONS Statement and the Options Window

SAS system options determine global SAS settings. For example, the global options can affect the following:

- how your SAS output appears
- how files are handled by SAS
- how observations from SAS data sets are processed
- how system variables are used

The previous section discusses some invocation-only options that must be set at start-up. However, there are many system options that can be set at any time. These system options can be set in an OPTIONS statement as well as in the Options window.

It is important to note that system option settings remain in effect until you change them again, or until your current session ends.

There are several ways to view your system option settings. The two most common methods are the following:

- the Options window (enter OPTIONS at a command line)
- the OPTIONS procedure

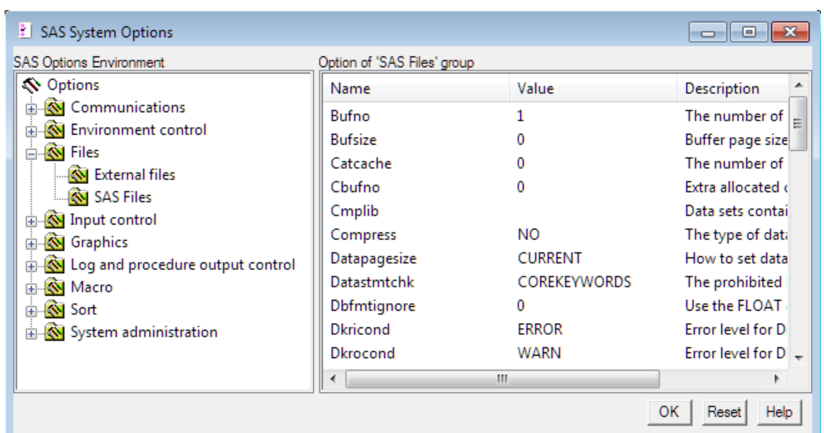
To obtain a complete list of system option settings using the OPTIONS procedure, submit the following statements:

```
proc options;
run;
```

The Options window groups options by function. The left side of the window includes a tree that lists the available option groups. You can expand option groups to see subgroups.

z/OS Specifics: z/OS users can expand groups and subgroups by using the mouse or by typing an `s` or an `x` before the group or subgroup name. When you select a subgroup, the individual options of that subgroup appear on the right side of the window.

Figure 42.1 *SAS Options Window*



To open the Options window, do one of the following tasks:

- Issue the OPTIONS command.
- Select **Tools** ⇨ **Options** ⇨ **System**.

The options in each group or subgroup are listed alphabetically, followed by options that are specific to your operating environment (which are also listed alphabetically).

Finding Options in the SAS Options Window

You can find options in a number of ways:

- Expand the option groups and subgroups on the left side of the window until the appropriate option appears on the right side of the window.
- Select an option group or subgroup, and then select **Find Option** from the pop-up menu. In the Find Option window, enter the name of the option that you want to locate, and then select **OK**.

Setting Options in the SAS Options Window

1 In the Options window, find the option that you want to set.

2 Select the option from the right side of the Options window.

3 Select **Modify Value** or **Set to Default** from the pop-up menu. z/OS users can type an `s` or an `x` before the option name to access the pop-up menu.

   - If you choose **Modify Value**, then a dialog box appears that enables you to edit the option value.
   - If you choose **Set to Default**, then the option value is reset to the default SAS System value.

4 Select **OK** to save your changes. Select **Reset** to return all edited options to their previous values.

Note: If all the items on the pop-up menu are grayed out (that is, unavailable), then the options are invocation-only options and can be set only when a SAS session is started.

Customizing Session-to-Session Settings

Overview of Customizing Session-to-Session Settings

The previous section discusses making customizations that stay in effect for the duration of the current SAS session only. This section provides information about making customizations that remain from SAS session to SAS session.

You can make customizations that remain from session to session by using one of the following windows:

- SAS Registry Editor
- Preferences window
- Options window

Customizing SAS Sessions and Applications with the SAS Registry Editor

Understanding the SAS Registry

The SAS Registry stores information about specific SAS sessions and applications. Unlike system options, customizations to the SAS Registry remain in effect for more than one SAS session. You can make SAS Registry customizations by using either PROC REGISTRY or the SAS Registry Editor.

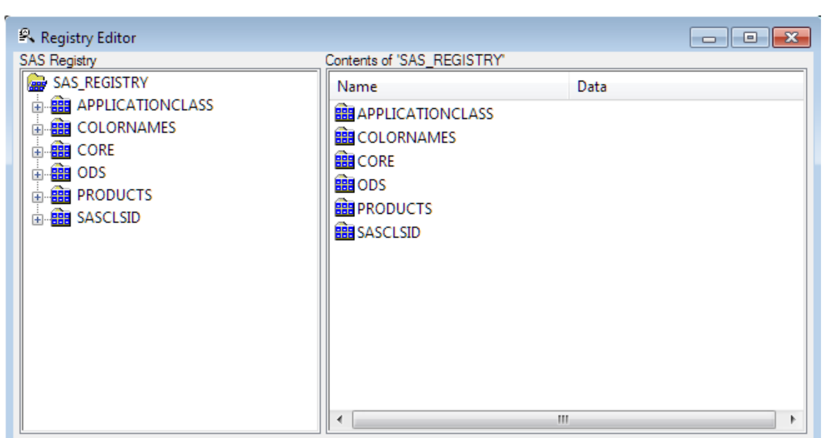
This section shows you how to use the SAS Registry Editor, which is a graphical alternative to PROC REGISTRY. For more information about PROC REGISTRY, see the *Base SAS Procedures Guide*.

CAUTION
Changes to SAS Registry should be well planned. In many cases, it is appropriate to have a designated person in charge of SAS Registry edits. Inappropriate SAS Registry edits can adversely affect your SAS session performance.

SAS Registry Editor values, which store data, exist in keys and subkeys. Keys and subkeys, which look like folders, appear in a tree on the left side of the SAS Registry Editor. If a key has subkeys, then you can expand or collapse it with the + and – icons that are found in the tree. If a key or subkey has values, then the values appear on the right side of the window.

Operating Environment Information: In the z/OS operating environment, you can select a + or – icon by positioning your cursor on it and then pressing the ENTER key.

Figure 42.2 The SAS Registry Editor



To customize SAS sessions and applications, use the SAS Registry Editor to add, modify, rename, and delete keys and key values.

You can also use the SAS Registry Editor to the following:

- import registry files (starting at any key)

- export the contents of the registry (starting at any key)
- unregister a registry file

Opening the SAS Registry Editor

To open the SAS Registry Editor, select **Solutions** ⇨ **Accessories** ⇨ **Registry Editor**, or issue the REGEDIT command.

Finding Information in the SAS Registry Editor

You can search for specific information in the SAS Registry Editor, including specific keys, key value names, and key value data:

1. Select the key from which you want to start a search.
2. Open the drop-down menu and select **Find**.
3. In the Registry Editor Find window, type your search string in the Find What field.
4. Check one or more of the **Keys**, **Value Name**, or **Value Data** check boxes, depending on where you want to perform your search.
5. Select **Find** to begin the search.

Setting Keys in the SAS Registry Editor

You can add, modify, rename, or delete keys in the SAS Registry Editor. For example, you might want SAS to be able to work with a new paper type when printing output. Therefore, you might need to create a new key that represents the paper type. Also, you would have to create and set key values for this new paper type. For more information, see "Setting New Key Values in the SAS Registry Editor" on page 837.

Note: When you add a key, the new key becomes a subkey of the most recently selected key.

To set a key in the SAS Registry Editor:

1. Expand or collapse the keys on the left side of the SAS Registry Editor (using the + and – icons) until you find the appropriate key.
2. With a key selected, select an action from the drop-down menu (such as **New Key**, **Rename**, or **Delete**). A dialog box appears that enables you to enter additional information or confirm an action.

CAUTION
Delete removes all subkeys and values (if any) under the key that you are deleting.

Setting New Key Values in the SAS Registry Editor

If you create a new key, then you might want to add values to that key. Adding values includes assigning a value name as well as the value data.

Note: If your new key is similar to an existing key, then you might want to review that key's subkeys and key values. The review process might help you determine which subkeys and key values you should have for the new key.

To add a new key value, do the following:

1. Select the new key on the left side of the SAS Registry Editor.
2. Select an action from the pop-up menu (such as **New String Value**, **New Binary Value**, or **New Double Value**).
3. In the dialog box, enter a name and a value for the new key value.
4. Select **OK** to complete the process.

Editing Existing Key Values in the SAS Registry Editor

1. Select a key on the left side of the SAS Registry Editor.
2. If the key contains subkeys, then continue to expand the key by selecting the + icon.
3. Select the key value that you want to edit on the right side of the SAS Registry Editor.
4. Select the appropriate action from the pop-up menu (such as **Modify**, **Rename**, or **Delete**). A dialog box appears that enables you to enter additional information or confirm an action.

Importing Registry Files

You can import a registry file to populate and modify the SAS Registry quickly. Registry files are text files that you create with a text editor. For information about registry file syntax, see “REGISTRY Procedure” in *Base SAS Procedures Guide*.

1. Select **File** ⇨ **Import Registry File**.
2. Select the file that you want to import, and then select **OK**.

If errors occur during the import, then a message appears in the status bar and the errors are reported in the Log window. All registry changes can be sent to the log if you use the SAS Registry Editor option `Output full status to Log`. For more information, see “Setting Registry Editor Options” on page 838.

Exporting Registry Files

You can export (or copy) all or a portion of the SAS Registry to a file:

1 Select the key in the existing registry from where you want to begin exporting the file. Selecting a root key exports the entire tree, beginning at the root key that you select.

2 Select **File** ⇨ **Export Registry File**.

3 Enter the full path to the file or browse to select the file to which you want to save the existing registry, and then select **OK**.

If errors occur during the export, then a message appears in the status bar and the errors are reported in the Log window. All registry changes can be sent to the log if you use the `Output full status to Log` SAS Registry Editor option.

Uninstalling an Imported Registry File

The uninstall function reads an imported registry file and removes the keys found in the file from the registry. If any errors occur during this process, then a message appears in the status bar and errors are reported in the Log window.

Note: SAS is shipped with a set of ROOT keys. ROOT keys are not removed during an uninstall process.

1 Select **File** ⇨ **Uninstall Registry File**.

2 Select the external registry file that you want to uninstall from the SAS Registry, and then select **OK**. A message appears in the message line when the uninstall is complete.

Setting Registry Editor Options

1 Open the SAS Registry Editor if it is not already open.

2 From the Registry Editor window, select **Tools** ⇨ **Options** ⇨ **Registry Editor**.

3 In the Select Registry View group box, choose a view for the Registry Editor.

- View Overlay mode enables you to modify data anywhere in the registry. The HKEY_USER_ROOT overlays the HKEY_SYSTEM_ROOT. The parent root for Overlay View mode is shown as SAS REGISTRY.
- In View All mode, the Registry Editor shows all the entries that are contained in the two main entry points into the registry: HKEY_SYSTEM_ROOT and HKEY_USER_ROOT. Typically, the HKEY_SYSTEM_ROOT tree is stored in the SASHELP library and the HKEY_USER_ROOT is stored in the SASUSER library.

4 Select or deselect appropriate check boxes:

Open **HKEY_SYSTEM _ROOT** for Write access
: enables you to open the registry for Write access if you have Write access to SASHELP.

Output full status to Log
: writes to the log all changes that were made when the registry file was imported or uninstalled. Usually, only errors appear in the Log window.

View unsigned integers in hexadecimal format
enables you to view unsigned integers in the value list in HEX or DECIMAL format.

You can select **Reset all options** to return all Registry Editor Options window settings to the default values.

Customizing SAS Sessions with the Preferences Window

The Preferences window includes a series of tabs that you can access to set SAS preferences. Preferences enable you to customize and control your SAS environment. For example, you might use the **General** tab to select a start-up logo, or the **Results** tab to control your output preferences, or even the **Editing** tab to set editor preferences, if, for example, your cursor inserts or overtypes text in an editor.

Preference window settings remain in effect from one SAS session to the next.

To access the Preferences window, select **Tools** ⇨ **Options** ⇨ **Preferences** or issue the DLGPREF command.

Operating Environment Information: The Preferences window is unavailable in some operating environments. Also, some preference settings are specific to your operating environment. Refer to the SAS documentation for your operating environment for more information about setting preferences.

Saving System Option Settings with the DMOPTSAVE and DMOPTLOAD Commands

Perhaps the easiest way to save your system option settings from one SAS session to another is to use the global commands DMOPTSAVE and DMOPTLOAD. After you set up your system options in a way that is most appropriate for your working style, type `DMOPTSAVE` at the command line and press ENTER. This saves the current system option settings for later use. Later, when you have started another SAS session and would like to retrieve your saved settings, type `DMOPTLOAD` at the command line and press ENTER. This changes your system option settings back to the system option settings in effect when you issued the DMOPTSAVE command.

The DMOPTSAVE and DMOPTLOAD commands have other useful features:

- You can issue parameters to name different sets of system option settings and control where they are saved.
- You can view the saved system option settings by using SAS Explorer, because they are saved by default as a data set.
- You can also issue parameters to save the system option settings to a registry key.

When you issue a DMOPTSAVE command without parameters, SAS saves a data set (myopts) that contains the system option settings to the default library. The default library is usually the library where the current user profile is. In most cases, this is the SASUSER library.

See SAS online Help for more details about using these commands.

Customizing the SAS Windowing Environment

Customizing the Explorer Window

Ways to Customize the Explorer Window

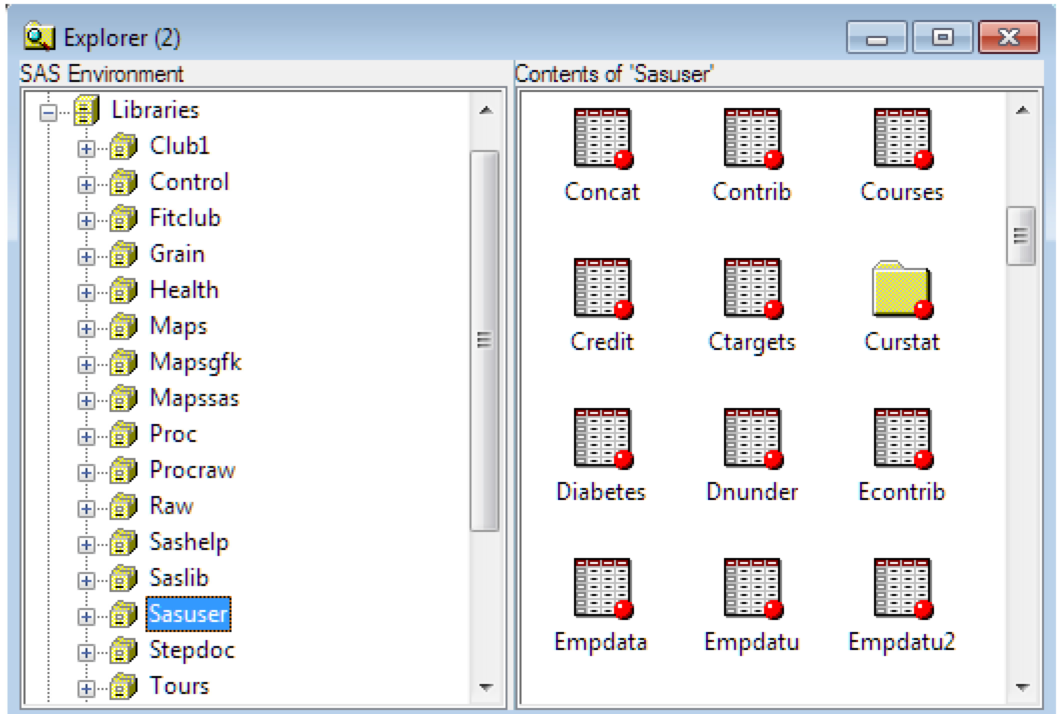
You can customize the Explorer window in these ways:

- Select Contents Only view or Explorer view.
- Change how items appear in the contents view.
- Add and remove folders (including one that adds access to files in your operating environment).
- Enable member, entry, and operating environment file types to appear.
- Add a pop-up menu action.
- Hide member, entry, and operating environment file types.

Selecting Contents Only View or Explorer View

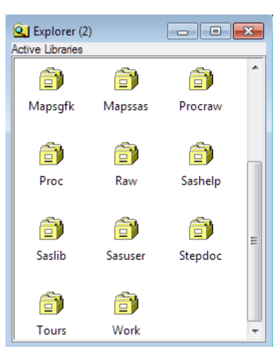
The Explorer window can appear in either Explorer view or Contents Only view. In Explorer view, the Explorer window includes two sides: a tree view on the left that lists folders, and a contents view on the right that shows the contents of the folder that is selected in the tree view.

Figure 42.3 The Explorer Window with Explorer View Enabled



In Contents Only view, the Explorer window is a single-paned window that shows the contents of your SAS environment. As you open folders, the folder contents replace the previous contents in the same window. In Contents Only view, you navigate the Explorer window using pull-down and pop-up menu actions, and toolbar items (if a toolbar is available).

Figure 42.4 The Explorer Window with Contents Only View Enabled



Operating Environment Information: In most operating environments, the Explorer appears in Contents Only view by default.

Depending on your operating environment, you can toggle between the two views in these ways:

Menu:
    View ⇨ Show Tree

Command:
    TREE

Toolbar
: Toggle the Tree tool button

Changing How Items Appear in the Contents View

You can make selections from the **View** menu to determine how files appear in the Contents view of the Explorer window. All possible selections follow, although not all the selections might be available in your operating environment:

Large Icons
: displays a large icon for each file.

Small Icons
: displays a small icon for each file (only available on PC hosts).

List
: displays a left-justified list of files.

Details
: lists files along with columns of descriptive information (such as file size, type, and so on).

You might also be able to use the following commands in your operating environment instead of making selections from the **View** menu:

DETAILS
: lists files along with columns of descriptive information (such as file size, type, and so on).

LARGEVIEW
: displays a large icon for each file.

SMALLVIEW
: depending on your operating environment, this command displays either a list of files or a small icon for each file.

Adding and Removing Folders

The Explorer window shows the Libraries and File Shortcuts folders by default in many operating environments. You can turn off these folders, or turn on other folders, including Extensions, My Favorite Folders, and Results.

1. From the Explorer window, select **Tools** ⇨ **Options** ⇨ **Explorer**.
2. From the drop-down list at the top of the window, select **Initialization**.
3. Select the folder that you want to add or remove, and then select **Add** or **Remove**. The Description field changes to On or Off to reflect your change.

Operating Environment Information: The My Favorite Folders window enables you to access operating environment-specific files from the Explorer. This feature is not available in the z/OS operating environment.

Enabling Member, Entry, and Operating Environment File Types to Appear

Commonly used members, catalog entries, and operating environment files are registered and appear in the Explorer window. Registered types must have at least an icon defined and might also have pop-up menu actions defined. Undefined types do not appear in the Explorer window and have no actions associated with them.

To add (register) an undefined type:

1 From the Explorer window, select **Tools** ⇨ **Options** ⇨ **Explorer**.

2 From the drop-down list at the top of the window, select a category (such as Members, Catalog Entries, or Host Files). The registered types are displayed in the window.

3 Select the **View Undefined Types** check box to see the undefined types for the category.

4 Select a type and then select **Edit**.

5 Select **Select Icon**.

6 In the Select Icon dialog box, choose a category from the drop-down list at the top, select an icon, and then select **OK** to close the dialog box.

7 Add actions for the type (if desired) and then select **OK**. For more information about adding actions to a type, see“Adding a Menu Action to a Member, Entry, or Operating Environment File Type” on page 843. The type is added to the Registered Types list.

Adding a Menu Action to a Member, Entry, or Operating Environment File Type

You can add a menu action to any catalog entry, member, or operating environment file type.

1 From the Explorer window, select **Tools** ⇨ **Options** ⇨ **Explorer**.

2 From the drop-down list at the top of the window, select a category (such as Members, Catalog Entries, or Host Files). The registered types are displayed in the window.

3 Select the registered type that you want to edit.

4 Select **Edit**.

5 In the Options dialog box for that entry, select **Add**.

6 Enter a name for the action (this is the action that will appear on the pop-up menu for the item), and an action command. To see examples of action commands, look at the commands for registered types.

7 Select **OK**.

Note: The letter immediately after the ampersand (&) in the Action section denotes the shortcut key that can be used to perform that action.

Hiding Member, Entry, and Host File Types

You can hide members, catalog entries, and host files so that they do not appear in the Explorer window:

1 From the Explorer window, select **Tools** ⇨ **Options** ⇨ **Explorer**.

2 From the drop-down list at the top of the window, select a category (such as Members, Catalog Entries, or Host Files). The registered types are displayed in the window.

3 Select the registered type that you want to remove from view.

4 Select **Remove**. Confirm the removal by selecting **OK** when prompted.

When you remove a registered type, it is moved to the View Undefined Types view. To add the registered type back, you must redefine its icon.

Customizing an Editor

You can customize general and text editing options for your editor. For example, if you use line commands when you edit programs, then you might always want the Program Editor to appear with line numbers.

To customize your editor, do the following:

1 Select a SAS programming window (such as the Program Editor, Log, Output, or Notepad window).

2 Select **Tools** ⇨ **Options** ⇨ **Editor**.

3 From the drop-down list, select the category of options that you want to edit.

4 In the Options group box, select an option, and then select **Modify** from the pop-up menu.

5 In the dialog box that appears, edit the option name, value, or both.

Customizing Fonts

You can set default font information for the SAS windowing environment with the Font window. To access the Font window, issue the DLGFONT command, or select **Tools** ⇨ **Options** ⇨ **Fonts**.

The Font window is host-specific. Refer to your host documentation for more information.

Customizing Colors

Note: Changes made with the SASColor window are visible only after affected SAS windows are closed and then reopened.

You can also change the default colors in edit windows, such as the Notepad and the Program Editor by using the SYNCONFIG command. This command controls the color of SAS language and programming elements, which makes it easier to parse through a SAS program and understand how it works. SYNCONFIG opens the Edit Scheme window, which gives you several color schemes to select. You can also modify the provided color schemes.

Setting SAS Windowing Environment Preferences

You can use the Preferences window to customize portions of the SAS windowing environment to your liking. For more information, see "Customizing SAS Sessions with the Preferences Window" on page 839.

Summary

Commands

DLGFONT
: opens the Font window, which is used to control the fonts in the SAS windowing environment.

DLGPREF
: opens the Preferences window, in some operating environments.

OPTIONS
: opens the SAS System Options window.

PMENU
: turns on the menu bar in the windowing environment.

REGEDIT
: opens the Registry Editor window.

SASCOLOR
: opens the SASColor window, which is used to change the color of window elements, such as backgrounds and borders.

SYNCONFIG
: opens the Edit Scheme window, which is used to edit color schemes in the Editor, NOTEPAD, or Program Editor windows.

Procedures

PROC OPTIONS <SHORT | LONG>;
: lists the current values of all SAS system options. The SHORT and LONG options determine the format in which you want SAS system options listed.

Note: You can also use the SAS System Options window to see the current values of all SAS system options.

PROC REGISTRY <options>;
: maintains the SAS Registry.

Note: You can also use the SAS Registry Editor to maintain the SAS Registry.

Statements

OPTIONS *option-1* <... *option-n*>;
: changes the value of one or more SAS system options.

System Options

VERBOSE | NOVERBOSE
: controls whether SAS writes the settings of all the system options that are specified in the configuration file to either the workstation or batch log.

Windows

Editor Options window
: enables you to set options for specific SAS windowing environment windows, such as the Program Editor. To open the Editor Options window, go to the window that you want to change, and then select **Tools** ⇨ **Options** ⇨ **Editor** or issue the EDOPT command.

Explorer Options window
: enables you to set Explorer window options. To open this window, select **Tools** ⇨ **Options** ⇨ **Explorer Options** or issue the EXPOPTS command.

Fonts window
: enables you to select the default font that you want to use in the SAS windowing environment. To access this window, issue the DLGFONT command.

Note: This window is specific to your operating environment.

Preferences window
: enables you to set SAS system preferences. To access this window, issue the DLGPREF command.

Note: This window is specific to your operating environment.

SASColor window
: enables you to change the default colors for the different window elements in your SAS windows. To access this window, issue the SASCOLOR command.

SAS Registry Editor
: enables you to edit the SAS Registry and to customize aspects of the SAS windowing environment. To access this window, issue the REGEDIT command.

SAS System Options window
: enables you to view or change current SAS system options. To access this window, issue the OPTIONS command.

Learning More

Customizations
: For information about operating environment-specific customization options and preferences, refer to the SAS documentation for your operating environment.

SAS Procedures
: For more information about SAS procedures, see *Base SAS Procedures Guide*.

Statements and Options
: For more information about the statements and options that are discussed in this section, see *SAS DATA Step Statements: Reference* and *SAS System Options: Reference*.

PART 11

Appendix

Appendix 1

Complete DATA Steps for Selected Examples

Complete DATA Steps for Selected Examples

This documentation shows how to create the data sets that are used in each section. However, when the input data are lengthy or the actual contents of the data set are not crucial to the section, then the DATA steps or raw data that is used to create data sets are listed in this appendix instead of within the section.

Only the DATA steps that are not provided in detail in the section, are included here.

The CITY Data Set

DATA Step to Create the CITY Data Set

```
data city;
   input Year 4. @7 ServicesPolice comma6.
         @15 ServicesFire comma6. @22 ServicesWater_Sewer comma6.
         @30 AdminLabor comma6. @39 AdminSupplies comma6.
         @45 AdminUtilities comma6.;
   ServicesTotal=ServicesPolice+ServicesFire+ServicesWater_Sewer;
   AdminTotal=AdminLabor+AdminSupplies+AdminUtilities;
   Total=ServicesTotal+AdminTotal;
   label               Total='Total Outlays'
                ServicesTotal='Services: Total'
               ServicesPolice='Services: Police'
                 ServicesFire='Services: Fire'
         ServicesWater_Sewer='Services: Water & Sewer'
                   AdminTotal='Administration: Total'
                   AdminLabor='Administration: Labor'
                AdminSupplies='Administration: Supplies'
               AdminUtilities='Administration: Utilities' ;
   datalines;
1980  2,819   1,120    422   391      63     98
1981  2,477   1,160    500   172      47     70
1982  2,028   1,061    510   269      29     79
1983  2,754     893    540   227      21     67
1984  2,195     963    541   214      21     59
1985  1,877     926    535   198      16     80
1986  1,727   1,111    535   213      27     70
1987  1,532   1,220    519   195      11     69
1988  1,448   1,156    577   225      12     58
1989  1,500   1,076    606   235      19     62
1990  1,934     969    646   266      11     63
1991  2,195   1,002    643   256      24     55
1992  2,204     964    692   256      28     70
1993  2,175   1,144    735   241      19     83
1994  2,556   1,341    813   238      25     97
1995  2,026   1,380    868   226      24     97
1996  2,526   1,454    946   317      13     89
1997  2,027   1,486  1,043   226       .     82
1998  2,037   1,667  1,152   244      20     88
1999  2,852   1,834  1,318   270      23     74
2000  2,787   1,701  1,317   307      26     66
;
```

The UNIVERSITY_TEST_SCORES Data Set

DATA Step to Create the UNIVERSITY_TEST_SCORES Data Set

The raw data in the DATA step is used to create the following data sets:

- OUT.UNIVERSITY_TEST_SCORES
- OUT.UNIVERSITY_TEST_SCORES2
- OUT.UNIVERSITY_TEST_SCORES3
- OUT.UNIVERSITY_TEST_SCORES4
- OUT.UNIVERSITY_TEST_SCORES5
- OUT_ERROR1
- OUT.ERROR2
- OUT.ERROR3

```
libname out 'your-data-library';

data out.university_test_scores;
   input Test $ Gender $ Year TestScore;
   datalines;
Verbal m 2005 504
Verbal f 2005 496
Verbal m 2006 504
Verbal f 2006 497
Verbal m 2007 501
Verbal f 2007 497
Verbal m 2008 505
Verbal f 2008 502
Verbal m 2009 507
Verbal f 2009 503
Verbal m 2010 507
Verbal f 2010 503
Verbal m 2011 509
Verbal f 2011 502
Math   m 2005 521
Math   f 2005 484
Math   m 2006 524
Math   f 2006 484
Math   m 2007 523
Math   f 2007 487
Math   m 2008 525
Math   f 2008 490
Math   m 2009 527
Math   f 2009 492
```

```
Math   m 2010 530
Math   f 2010 494
Math   m 2011 531
Math   f 2011 496
;
```

The YEAR_SALES Data Set

DATA Step to Create the YEAR_SALES Data Set

```
data year_sales;
   input Month $ Quarter $ SalesRep $14. Type $ Units Price @@;
   AmountSold=Units*price;
   datalines;
01 1 Hollingsworth Deluxe    260 49.50 01 1 Garcia        Standard   41 30.97
01 1 Hollingsworth Standard  330 30.97 01 1 Jensen        Standard  110 30.97
01 1 Garcia        Deluxe    715 49.50 01 1 Jensen        Standard  675 30.97
02 1 Garcia        Standard 2045 30.97 02 1 Garcia        Deluxe     10 49.50
02 1 Garcia        Standard   40 30.97 02 1 Hollingsworth Standard 1030 30.97
02 1 Jensen        Standard  153 30.97 02 1 Garcia        Standard   98 30.97
03 1 Hollingsworth Standard  125 30.97 03 1 Jensen        Standard  154 30.97
03 1 Garcia        Standard  118 30.97 03 1 Hollingsworth Standard   25 30.97
03 1 Jensen        Standard  525 30.97 03 1 Garcia        Standard  310 30.97
04 2 Garcia        Standard  150 30.97 04 2 Hollingsworth Standard  260 30.97
04 2 Hollingsworth Standard  530 30.97 04 2 Jensen        Standard 1110 30.97
04 2 Garcia        Standard 1715 30.97 04 2 Jensen        Standard  675 30.97
05 2 Jensen        Standard   45 30.97 05 2 Hollingsworth Standard 1120 30.97
05 2 Garcia        Standard   40 30.97 05 2 Hollingsworth Standard 1030 30.97
05 2 Jensen        Standard  153 30.97 05 2 Garcia        Standard   98 30.97
06 2 Jensen        Standard  154 30.97 06 2 Hollingsworth Deluxe     25 49.50
06 2 Jensen        Standard  276 30.97 06 2 Hollingsworth Standard  125 30.97
06 2 Garcia        Standard  512 30.97 06 2 Garcia        Standard 1000 30.97
07 3 Garcia        Standard  250 30.97 07 3 Hollingsworth Deluxe     60 49.50
07 3 Garcia        Standard   90 30.97 07 3 Hollingsworth Deluxe     30 49.50
07 3 Jensen        Standard  110 30.97 07 3 Garcia        Standard   90 30.97
07 3 Hollingsworth Standard  130 30.97 07 3 Jensen        Standard  110 30.97
07 3 Garcia        Standard  265 30.97 07 3 Jensen        Standard  275 30.97
07 3 Garcia        Standard 1250 30.97 07 3 Hollingsworth Deluxe     60 49.50
07 3 Garcia        Standard   90 30.97 07 3 Jensen        Standard  110 30.97
07 3 Garcia        Standard   90 30.97 07 3 Hollingsworth Standard  330 30.97
07 3 Jensen        Standard  110 30.97 07 3 Garcia        Standard  465 30.97
07 3 Jensen        Standard  675 30.97 08 3 Jensen        Standard  145 30.97
08 3 Garcia        Deluxe    110 49.50 08 3 Hollingsworth Standard  120 30.97
08 3 Hollingsworth Standard  230 30.97 08 3 Jensen        Standard  453 30.97
08 3 Garcia        Standard  240 30.97 08 3 Hollingsworth Standard  230 49.50
08 3 Jensen        Standard  453 30.97 08 3 Garcia        Standard  198 30.97
08 3 Hollingsworth Standard  290 30.97 08 3 Garcia        Standard 1198 30.97
08 3 Jensen        Deluxe     45 49.50 08 3 Jensen        Standard  145 30.97
08 3 Garcia        Deluxe    110 49.50 08 3 Hollingsworth Standard  330 30.97
08 3 Garcia        Standard  240 30.97 08 3 Hollingsworth Deluxe     50 49.50
```

```
08 3 Jensen        Standard  453 30.97 08 3 Garcia        Standard  198 30.97
08 3 Jensen        Deluxe    225 49.50 09 3 Hollingsworth Standard  125 30.97
09 3 Jensen        Standard  254 30.97 09 3 Garcia        Standard  118 30.97
09 3 Hollingsworth Standard 1000 30.97 09 3 Jensen        Standard  284 30.97
09 3 Garcia        Standard  412 30.97 09 3 Jensen        Deluxe    275 49.50
09 3 Garcia        Standard  100 30.97 09 3 Jensen        Standard  876 30.97
09 3 Hollingsworth Standard  125 30.97 09 3 Jensen        Standard  254 30.97
09 3 Garcia        Standard 1118 30.97 09 3 Hollingsworth Standard  175 30.97
09 3 Jensen        Standard  284 30.97 09 3 Garcia        Standard  412 30.97
09 3 Jensen        Deluxe    275 49.50 09 3 Garcia        Standard  100 30.97
09 3 Jensen        Standard  876 30.97 10 4 Garcia        Standard  250 30.97
10 4 Hollingsworth Standard  530 30.97 10 4 Jensen        Standard  975 30.97
10 4 Hollingsworth Standard  265 30.97 10 4 Jensen        Standard   55 30.97
10 4 Garcia        Standard  365 30.97 11 4 Hollingsworth Standard 1230 30.97
11 4 Jensen        Standard  453 30.97 11 4 Garcia        Standard  198 30.97
11 4 Jensen        Standard   70 30.97 11 4 Garcia        Standard  120 30.97
11 4 Hollingsworth Deluxe    150 49.50 12 4 Garcia        Standard 1000 30.97
12 4 Jensen        Standard  876 30.97 12 4 Hollingsworth Deluxe    125 49.50
12 4 Jensen        Standard 1254 30.97 12 4 Hollingsworth Standard  175 30.97
;
```

The HIGHLOW Data Set

DATA Step to Create the HIGHLOW Data Set

```
data highlow;
   input Year @7 DateOfHigh:date9. DowJonesHigh @26 DateOfLow:date9. DowJonesLow;
   format LogDowHigh LogDowLow 5.2 DateOfHigh DateOfLow date9.;
   LogDowHigh=log(DowJonesHigh);
   LogDowLow=log(DowJonesLow);
datalines;
1968  03DEC1968  985.21  21MAR1968  825.13
1969  14MAY1969  968.85  17DEC1969  769.93
1970  29DEC1970  842.00  06MAY1970  631.16
1971  28APR1971  950.82  23NOV1971  797.97
1972  11DEC1972 1036.27  26JAN1972  889.15
1973  11JAN1973 1051.70  05DEC1973  788.31
1974  13MAR1974  891.66  06DEC1974  577.60
1975  15JUL1975  881.81  02JAN1975  632.04
1976  21SEP1976 1014.79  02JAN1976  858.71
1977  03JAN1977  999.75  02NOV1977  800.85
1978  08SEP1978  907.74  28FEB1978  742.12
1979  05OCT1979  897.61  07NOV1979  796.67
1980  20NOV1980 1000.17  21APR1980  759.13
1981  27APR1981 1024.05  25SEP1981  824.01
1982  27DEC1982 1070.55  12AUG1982  776.92
1983  29NOV1983 1287.20  03JAN1983 1027.04
1984  06JAN1984 1286.64  24JUL1984 1086.57
1985  16DEC1985 1553.10  04JAN1985 1184.96
1986  02DEC1986 1955.57  22JAN1986 1502.29
```

```
1987  25AUG1987 2722.42  19OCT1987 1738.74
1988  21OCT1988 2183.50  20JAN1988 1879.14
1989  09OCT1989 2791.41  03JAN1989 2144.64
1990  16JUL1990 2999.75  11OCT1990 2365.10
1991  31DEC1991 3168.83  09JAN1991 2470.30
1992  01JUN1992 3413.21  09OCT1992 3136.58
1993  29DEC1993 3794.33  20JAN1993 3241.95
1994  31JAN1994 3978.36  04APR1994 3593.35
1995  13DEC1995 5216.47  30JAN1995 3832.08
1996  27DEC1996 6560.91  10JAN1996 5032.94
1997  06AUG1997 8259.31  11APR1997 6391.69
1998  23NOV1998 9374.27  31AUG1998 7539.07
1999  31DEC1999 11497.12 22JAN1999 9120.67
2000  14JAN2000 11722.98 07MAR2000 9796.04
2001  21MAY2001 11337.92 21SEP2001 8235.81
2002  19MAR2002 10635.25 09OCT2002 7286.27
2003  31DEC2003 10453.92 11MAR2003 7524.06
2004  28DEC2004 10854.54 25OCT2004 9749.99
2005  04MAR2005 10940.55 20APR2005 10012.36
2006  27DEC2006 12510.57 20JAN2006 10667.39
2007  09OCT2007 14164.53 05MAR2007 12050.41
2008  02MAY2008 13058.20 10OCT2008 8451.19
;
run;
```

The GRADES Data Set

DATA Step to Create the GRADES Data Set

```
data grades;
   input Name &$14. Gender :$2. Section :$3. ExamGrade1 @@;
   datalines;
Abdallah       F Mon  46 Anderson       M Wed  75
Aziz           F Wed  67 Bayer          M Wed  77
Bhatt          M Fri  79 Blair          F Fri  70
Bledsoe        F Mon  63 Boone          M Wed  58
Burke          F Mon  63 Chung          M Wed  85
Cohen          F Fri  89 Drew           F Mon  49
Dubos L        M Mon  41 Elliott        F Wed  85
Farmer         F Wed  58 Franklin       F Wed  59
Freeman        F Mon  79 Friedman       M Mon  58
Gabriel        M Fri  75 Garcia         M Mon  79
Harding        M Mon  49 Hazelton       M Mon  55
Hinton         M Fri  85 Hung           F Fri  98
Jacob          F Wed  64 Janeway        F Wed  51
Jones          F Mon  39 Jorgensen      M Mon  63
Judson         F Fri  89 Kuhn           F Mon  89
LeBlanc        F Fri  70 Lee            M Fri  48
Litowski       M Fri  85 Malloy         M Wed  79
Meyer          F Fri  85 Nichols        M Mon  58
```

```
Oliver         F Mon  41 Park           F Mon  77
Patel          M Wed  73 Randleman      F Wed  46
Robinson       M Fri  64 Shien          M Wed  55
Simonson       M Wed  62 Smith N        M Wed  71
Smith R        M Mon  79 Sullivan       M Fri  77
Swift          M Wed  63 Wolfson        F Fri  79
Wong           F Fri  89 Zabriski       M Fri  89
;
```

The USCLIM Data Sets

DATA Step to Create the USCLIM.HIGHTEMP Data Set

```
libname usclim 'SAS-data-library';

data usclim.hightemp;
   input State $char14. City $char14. Temp_f Date date9. Elevation;
   datalines;
Arizona       Parker         127 07jul1905 345
Kansas        Alton          121 25jul1936 1651
Nevada        Overton        122 23jun1954 1240
North Dakota  Steele         121 06jul1936 1857
Oklahoma      Tishomingo     120 26jul1943 6709
Texas         Seymour        120 12aug1936 1291
;
```

DATA Step to Create the USCLIM.HURRICANE Data Set

```
libname usclim 'SAS-data-library';

data usclim.hurricane;
   input @1 State $char14. @16 Date date7. Deaths Millions Name $;
   format Date worddate18. Millions dollar6.;
   informat State $char14. Date date9.;
   label Millions='Damage';
   datalines;
Mississippi    14aug1969 256 1420 Camille
Florida        14jun1972 117 2100 Agnes
Alabama        29aug1979 5   2300 Frederick
Texas          15aug1983 21  2000 Alicia
Texas          03aug1980 28  300  Allen
North Carolina 27aug2011 6   450  Irene
;
```

DATA Step to Create the USCLIM.LOWTEMP Data Set

```
libname usclim 'SAS-data-library';

data usclim.lowtemp;
   input State $char14. City $char14. Temp_f Date date9. Elevation;
   datalines;
Alaska        Prospect Creek -80 23jan1971 1100
Colorado      Maybell        -60 01jan1979 5920
Idaho         Island Prk Dam -60 18jan1943 6285
Minnesota     Pokegama Dam   -59 16feb1903 1280
North Dakota  Parshall       -60 15feb1936 1929
South Dakota  McIntosh       -58 17feb1936 2277
Wyoming       Moran          -63 09feb1933 6770
;
```

DATA Step to Create the USCLIM.TEMPCHNG Data Set

```
libname usclim 'SAS-data-library';

data usclim.tempchng;
   input @1 State $char13. @15 Date date7. Start_f End_f Minutes;
   Diff=End_f-Start_f;
   informat State $char13. Date date7.;
   format Date date9.;
   datalines;
North Dakota  21feb1918 -33 50  720
South Dakota  22jan1943 -4  45  2
South Dakota  12jan1911 49  -13 120
South Dakota  22jan1943 54  -4  27
South Dakota  10jan1911 55  8   15
;
```

Note about the USCLIM.BASETEMP and USCLIM.REPORT Catalogs

The catalogs USCLIM.BASETEMP and USCLIM.REPORT are used to show how the DATASETS procedure processes both SAS data sets and catalogs. The contents of these catalogs are not important in the context of this book. In most cases, you would use SAS/AF, SAS/FSP, or other SAS products to create catalog entries. You can test the examples in this section without having these catalogs.

The CLIMATE, PRECIP, and STORM Data Sets

DATA Step to Create the CLIMATE.HIGHTEMP Data Set

```
libname climate 'SAS-data-library';

data climate.hightemp;
   input Place $ 1-13 Date date9. Degree_f Degree_c;
   datalines;
South Africa 21jan2010 122 50
Israel       21jun1942 129 54
Argentina    02jan1920 120 49
Saskatchewan 05jul1937 113 45
India        18jun1905 124 51
Poland       29jul1921 104 40
;
```

DATA Step to Create the CLIMATE.LOWTEMP Data Set

```
libname climate 'SAS-data-library';

data climate.lowtemp;
   input Place $ 1-13 Date date9. Degree_f Degree_c;
   datalines;
Antarctica    21jul83 -129 -89
Siberia       06feb33 -90  -68
Greenland     09jan54 -87  -66
Yukon         03feb47 -81  -63
Alaska        23jan71 -80  -67
;
```

DATA Step to Create the PRECIP.RAIN Data Set

```
libname precip 'SAS-data-library';

data precip.rain;
   input Place $ 1-12 @13 Date date9. Inches Cms;
   format Date date9.;
   datalines;
La Reunion  15mar1952 74 188
Taiwan      10sep1963 49 125
Australia   04jan1979 44 114
Texas       25jul1979 43 109
Canada      06oct1964 19 49
```

```
;
```

DATA Step to Create the PRECIP.SNOW Data Set

```
libname precip 'SAS-data-library';

data precip.snow;
   input Place $ 1-12 @13 Date date7. Inches Cms;
   format Date date9.;
   datalines;
Colorado    14apr21 76 193
Alaska      29dec55 62 158
France      05apr69 68 173
;
```

DATA Step to Create the STORM.TORNADO Data Set

```
libname storm 'SAS-data-library';

data storm.tornado;
   input State $ 1-12 @13 Date date7. Deaths Millions;
   format Date date9. Millions dollar6.;
   label Millions='Damage in Millions';
   datalines;
Iowa        11apr65 257 200
Texas       11may70 26  135
Nebraska    06may75 3   400
Connecticut 03oct79 3   200
Georgia     31mar73 9   115
;
```

43

DATA Step Debugger Commands

Dictionary

BREAK Command

Suspends program execution at an executable statement.

Category: Manipulating Debugging Requests

Alias: B

Syntax

BREAK *location* <AFTER *count*> <WHEN *expression*> <DO *group* >

Required Argument

location
specifies where to set a breakpoint. *Location* must be one of these:

label
a statement label. The breakpoint is set at the statement that follows the label.

line-number
the number of a program line at which to set a breakpoint.

*
the current line.

Optional Arguments

AFTER *count*
honors the breakpoint each time the statement has been executed *count* times. The counting is continuous. That is, when the AFTER option applies to a statement inside a DO loop, the count continues from one iteration of the loop to the next. The debugger does not reset the *count* value to 1 at the beginning of each iteration.

If a BREAK command contains both AFTER and WHEN, AFTER is evaluated first. If the AFTER count is satisfied, the WHEN expression is evaluated.

Tip The AFTER option is useful in debugging DO loops.

WHEN *expression*
honors a breakpoint when the expression is true.

DO *group*
is one or more debugger commands enclosed by a DO and an END statement. The syntax of the DO *group* is the following:

DO; *command-1*<…;*command-n*;> **END**;

command
specifies a debugger command. Separate multiple commands by semicolons.

A DO group can span more than one line and can contain IF-THEN/ELSE statements, as shown:

IF *expression* **THEN** *command;* <ELSE *command;*>

IF *expression* **THEN DO** *group;* <ELSE DO *group;*>

IF evaluates an expression. When the condition is true, the debugger command or DO group in the THEN clause executes. An optional ELSE command gives an alternative action if the condition is not true. You can use these arguments with IF:

expression
specifies a debugger expression. A nonzero, nonmissing result causes the expression to be true. A result of zero or missing causes the expression to be false.

command
specifies a single debugger command.

DO *group*
specifies a DO group.

Details

The BREAK command suspends execution of the DATA step at a specified statement. Executing the BREAK command is called *setting a breakpoint*.

When the debugger detects a breakpoint, it does the following:

- checks the AFTER *count* value, if present, and suspends execution if *count* breakpoint activations have been reached
- evaluates the WHEN expression, if present, and suspends execution if the condition that is evaluated is true
- suspends execution if neither an AFTER nor a WHEN clause is present
- displays the line number at which execution is suspended
- executes any commands that are present in a DO group
- returns control to the user with a > prompt

If a breakpoint is set at a source line that contains more than one statement, the breakpoint applies to each statement on the source line. If a breakpoint is set at a line that contains a macro invocation, the debugger breaks at each statement generated by the macro.

Example

- Set a breakpoint at line 5 in the current program:

  ```
  b 5
  ```

- Set a breakpoint at the statement after the statement label `eoflabel`:

  ```
  b eoflabel
  ```

- Set a breakpoint at line 45 that will be honored after every third execution of line 45:

  ```
  b 45 after 3
  ```

- Set a breakpoint at line 45 that will be honored after every third execution of that line only when the values of both DIVISOR and DIVIDEND are 0:

  ```
  b 45 after 3
         when (divisor=0 and dividend=0)
  ```

- Set a breakpoint at line 45 of the program and examine the values of variables NAME and AGE:

  ```
  b 45 do; ex name age; end;
  ```

- Set a breakpoint at line 15 of the program. If the value of DIVISOR is greater than 3, execute STEP. Otherwise, display the value of DIVIDEND.

  ```
  b 15 do; if divisor>3 then st;
             else ex dividend; end;
  ```

See Also

Commands:

- "DELETE Command"
- "WATCH Command"

CALCULATE Command

Evaluates a debugger expression and displays the result.

Category: Manipulating DATA Step Variables

Syntax

CALC *expression*

Required Argument

expression

specifies any debugger expression.

Restriction Debugger expressions cannot contain functions.

Details

The CALCULATE command evaluates debugger expressions and displays the result. The result must be numeric.

Example

- Add 1.1, 1.2, 3.4 and multiply the result by 0.5:

```
calc (1.1+1.2+3.4)*0.5
```

- Calculate the sum of STARTAGE and DURATION:

```
calc startage+duration
```

- Calculate the values of the variable SALE minus the variable DOWNPAY and then multiply the result by the value of the variable RATE. Divide that value by 12 and add 50:

```
calc (((sale-downpay)*rate)/12)+50
```

See Also

"Working with Expressions" on page 432

DELETE Command

Deletes breakpoints or the watch status of variables in the DATA step.

Category: Manipulating Debugging Requests

Alias: D

Syntax

DELETE BREAK *location*

DELETE WATCH *variable(s)* | _ALL_

Required Arguments

BREAK
deletes breakpoints.

Alias B

location
specifies a breakpoint location to be deleted. *location* can have one of these values:

ALL
all current breakpoints in the DATA step.

label
the statement after a statement label.

line-number
the number of a program line.

*
the breakpoint from the current line.

WATCH
deletes watched status of variables.

Alias W

variable(s)
names one or more watched variables for which the watch status is deleted.

ALL
specifies that the watch status is deleted for all watched variables.

Example

- Delete the breakpoint at the statement label

```
eoflabel
```

:

```
d b eoflabel
```

- Delete the watch status from the variable ABC in the current DATA step:

```
d w abc
```

See Also

Commands:

- "BREAK Command" on page 861
- "WATCH Command" on page 875

DESCRIBE Command

Displays the attributes of one or more variables.

Category: Manipulating DATA Step Variables

Alias: DESC

Syntax

DESCRIBE *variable(s)* | _ALL_

Required Arguments

variable(s)
identifies one or more DATA step variables

ALL
indicates all variables that are defined in the DATA step.

Details

The DESCRIBE command displays the attributes of one or more specified variables.

DESCRIBE reports the name, type, and length of the variable, and, if present, the informat, format, or variable label.

Example

- Display the attributes of variable ADDRESS:

```
desc address
```

- Display the attributes of array element ARR{*i* + *j*}:

```
desc arr{i+j}
```

ENTER Command

Assigns one or more debugger commands to the ENTER key.

Category: Customizing the Debugger

Syntax

ENTER *command-1* <; *command-2*; …>

Required Argument

command
specifies a debugger command.

Default STEP 1

Details

The ENTER command assigns one or more debugger commands to the ENTER key. Assigning a new command to the ENTER key replaces the existing command assignment.

If you assign more than one command, separate the commands with semicolons.

Example

- Assign the command STEP 5 to the ENTER key:

```
enter st 5
```

- Assign the commands EXAMINE and DESCRIBE, both for the variable CITY, to the ENTER key:

```
enter ex city; desc city
```

EXAMINE Command

Displays the value of one or more variables.

Category: Manipulating DATA Step Variables

Alias: E

Syntax

EXAMINE *variable-1* <*format-1*> <*variable-2* <*format-2* …> >

EXAMINE _ALL_ <*format*>

Required Arguments

variable
identifies a DATA step variable.

ALL
identifies all variables that are defined in the current DATA step.

Optional Argument

format
identifies a SAS format or a user-created format.

Details

The EXAMINE command displays the value of one or more specified variables. The debugger displays the value using the format currently associated with the variable, unless you specify a different format.

Example

- Display the values of variables N and STR:

  ```
  ex n str
  ```

- Display the element *i* of the array TESTARR:

  ```
  ex testarr{i}
  ```

- Display the elements *i*+1, *j**2, and *k*-3 of the array CRR:

  ```
  ex crr{i+1}; ex crr{j*2}; ex crr{k-3}
  ```

- Display the SAS date variable T_DATE with the DATE7. format:

  ```
  ex t_date date7.
  ```

- Display the values of all elements in array NEWARR:

  ```
  ex newarr{*}
  ```

See Also

Commands:

- "DESCRIBE Command" on page 866

GO Command

Starts or resumes execution of the DATA step.

Category: Controlling Program Execution

Alias: G

Syntax

GO <*line-number* | *label*>

Without Arguments

If you omit arguments, GO resumes execution of the DATA step and executes its statements continuously until a breakpoint is encountered, until the value of a watched variable changes, or until the DATA step completes execution.

Optional Arguments

line-number
gives the number of a program line at which execution is to be suspended next.

label
: is a statement label. Execution is suspended at the statement following the statement label.

Details

The GO command starts or resumes execution of the DATA step. Execution continues until all observations have been read, a breakpoint specified in the GO command is reached, or a breakpoint set earlier with a BREAK command is reached.

Example

- Resume executing the program and execute its statements continuously:

```
g
```

- Resume program execution and then suspend execution at the statement in line 104:

```
g 104
```

See Also

Commands:

- "JUMP Command" on page 869
- "STEP Command" on page 873

HELP Command

Displays information about debugger commands.

Category: Controlling the Windows

Syntax

HELP

Without Arguments

The HELP command displays a directory of the debugger commands. Select a command name to view information about the syntax and usage of that command. You must enter the HELP command from a window command line, from a menu, or with a function key.

JUMP Command

Restarts execution of a suspended program.

Category: Controlling Program Execution

Alias: J

Syntax

JUMP *line-number* | *label*

Required Arguments

line-number
indicates the number of a program line at which to restart the suspended program.

label
is a statement label. Execution resumes at the statement following the label.

Details

The JUMP command moves program execution to the specified location without executing intervening statements. After executing JUMP, you must restart execution with GO or STEP. You can jump to any executable statement in the DATA step.

CAUTION
Do not use the JUMP command to jump to a statement inside a DO loop or to a label that is the target of a LINK-RETURN group. In such cases, you bypass the controls set up at the beginning of the loop or in the LINK statement, and unexpected results can appear.

JUMP is useful in two situations:

- when you want to bypass a section of code that is causing problems in order to concentrate on another section. In this case, use the JUMP command to move to a point in the DATA step after the problematic section.
- when you want to re-execute a series of statements that have caused problems. In this case, use JUMP to move to a point in the DATA step before the problematic statements and use the SET command to reset values of the relevant variables to the values that they had at that point. Then re-execute those statements with STEP or GO.

Example

- Jump to line 5:

```
j 5
```

See Also

Commands:

- "GO Command" on page 868
- "STEP Command" on page 873

LIST Command

Displays all occurrences of the item that is listed in the argument.

Category: Manipulating Debugging Requests

Alias: L

Syntax

LIST <_ALL_ | BREAK | DATASETS | FILES | INFILES | WATCH>

Required Arguments

ALL
displays the values of all items.

BREAK
displays breakpoints.

Alias B

DATASETS
displays all SAS data sets used by the current DATA step.

FILES
displays all external files to which the current DATA step writes.

INFILES
displays all external files from which the current DATA step reads.

WATCH
displays watched variables.

Alias W

Example

- List all breakpoints, SAS data sets, external files, and watched variables for the current DATA step:

```
l _all_
```

- List all breakpoints in the current DATA step:

```
l b
```

See Also

Commands:

- "BREAK Command" on page 861
- "DELETE Command" on page 864
- "WATCH Command" on page 875

QUIT Command

Terminates a debugger session.

Category: Terminating the Debugger

Alias: Q

Syntax

QUIT

Without Arguments

The QUIT command terminates a debugger session and returns control to the SAS session.

Details

SAS creates data sets built by the DATA step that you are debugging. However, when you use QUIT to exit the debugger, SAS does not add the current observation to the data set.

You can use the QUIT command at any time during a debugger session. After you end the debugger session, you must resubmit the DATA step with the DEBUG option to begin a new debugging session; you cannot resume a session after you have ended it.

SET Command

Assigns a new value to a specified variable.

Category: Manipulating DATA Step Variables

Alias: None

Syntax

SET *variable*=*expression*

Required Arguments

variable
specifies the name of a DATA step variable or an array reference.

expression
is any debugger expression.

Tip *expression* can contain the variable name that is used on the left side of the equal sign. When a variable appears on both sides of the equal sign, the debugger uses the original value on the right side to evaluate the expression and stores the result in the variable on the left.

Details

The SET command assigns a value to a specified variable. When you detect an error during program execution, you can use this command to assign new values to variables. This enables you to continue the debugging session.

Example

- Set the variable A to the value of 3:

```
set a=3
```

- Assign to the variable B the value `12345` concatenated with the previous value of B:

```
set b='12345' || b
```

- Set array element ARR{1} to the result of the expression a+3:

```
set arr{1}=a+3
```

- Set array element CRR{1,2,3} to the result of the expression crr{1,1,2} + crr{1,1,3}:

```
set crr{1,2,3} = crr{1,1,2} + crr{1,1,3}
```

- Set the variable A to the result of the expression a+c*3:

```
set a=a+c*3
```

STEP Command

Executes statements one at a time in the active program.

Category: Controlling Program Execution

Alias: ST

Syntax

STEP <*n*>

Without Arguments

STEP executes one statement.

Optional Argument

n

specifies the number of statements to execute.

Details

The STEP command executes statements in the DATA step, starting with the statement at which execution was suspended.

When you issue a STEP command, the debugger:

- executes the number of statements that you specify
- displays the line number
- returns control to the user and displays the > prompt.

Note: By default, you can execute the STEP command by pressing the ENTER key.

See Also

Commands:

- "GO Command" on page 868
- "JUMP Command" on page 869

SWAP Command

Switches control between the SOURCE window and the LOG window.

Category: Controlling the Windows

Alias: None

Syntax

SWAP

Without Arguments

The SWAP command switches control between the LOG window and the SOURCE window when the debugger is running.

When you begin a debugging session, the LOG window becomes active by default. While the DATA step is still being executed, the SWAP command enables you to switch control between the SOURCE and LOG window so that you can scroll and view the text of the program and also continue monitoring the program execution.

You must enter the SWAP command from a window command line, from a menu, or with a function key.

TRACE Command

Controls whether the debugger displays a continuous record of the DATA step execution.

Category: Manipulating Debugging Requests

Alias: T

Default: OFF

Syntax

TRACE <ON | OFF>

Without Arguments

Use the TRACE command without arguments to determine whether tracing is on or off.

Optional Arguments

ON
prepares for the debugger to display a continuous record of DATA step execution. The next statement that resumes DATA step execution (such as GO) records all actions taken during DATA step execution in the DEBUGGER LOG window.

OFF
stops the display.

Comparisons

TRACE displays the current status of the TRACE command.

Example

- Determine whether TRACE is ON or OFF:

```
trace
```

- Prepare to display a record of debugger execution:

```
trace on
```

WATCH Command

Suspends execution when the value of a specified variable changes.

Category: Manipulating Debugging Requests

Alias: W

Syntax

WATCH *variable(s)*

Required Argument

variable(s)
specifies one or more DATA step variables.

Details

The WATCH command specifies a variable to monitor and suspends program execution when its value changes.

Each time the value of a watched variable changes, the debugger does the following:

- suspends execution
- displays the line number where execution has been suspended
- displays the variable's old value
- displays the variable's new value
- returns control to the user and displays the > prompt.

Example

- Monitor the variable DIVISOR for value changes:

```
w divisor
```