SQL Processing with the SAS® System

Course Notes

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SQL Processing with the SAS® System Course Notes

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Course Description

SQL Processing with the SAS® System Course Notes serves as the text for the SQL Processing with the SAS System course.

This two-day course focuses on using SQL as a data query and manipulation tool with SAS software. You learn to use the SQL procedure as a powerful and efficient data retrieval tool within SAS programs.

After completing this course, you should be able to

- perform queries on data involving column calculations and functions, subsets, summaries, and subqueries
- retrieve data from multiple tables using subqueries, joins, and set operations
- create views, indexes, and tables
- update or delete values in existing tables and views
- use SQL procedure features to debug, test, and optimize performance of SQL queries.

To learn more…

SAS Education

A full curriculum of general and statistical instructor-based training is available at any of the Institute's training facilities. Institute instructors can also provide on-site training.

For information on other courses in the curriculum, contact the SAS Education Division at 1-919-531-7321, or send e-mail to training@sas.com. You can also find this information on the Web at www.sas.com/training/ as well as in the Training Course Catalog.

SAS Publishing

For a list of other SAS books that relate to the topics covered in this Course Notes, USA customers can contact our SAS Publishing Department at 1-800-727-3228 or send e-mail to sasbook@sas.com. Customers outside the USA, please contact your local SAS office.

Also, see the Publications Catalog on the Web at www.sas.com/pubs for a complete list of books and a convenient order form.

Prerequisites

Before selecting this course, you should be able to

- submit SAS programs on your operating system
- create and access SAS data sets
- use arithmetic, comparison, and logical operators
- invoke SAS procedures.

You can gain this experience from the SAS® Programming I: Essentials course.

Little or no knowledge of SQL is necessary.

General Conventions

This section explains the various conventions used in presenting text, SAS language syntax, and examples in this book.

Typographical Conventions

You will see several type styles in this book. This list explains the meaning of each style:

UPPERCASE ROMAN	is used for SAS statements, variable names, and other SAS language elements when they appear in the text.
italic	identifies terms or concepts that are defined in text. Italic is also used for book titles when they are referenced in text, as well as for various syntax and mathematical elements.
bold	is used for emphasis within text.
monospace	is used for examples of SAS programming statements and for SAS character strings. Monospace is also used to refer to field names in windows, information in fields, and user-supplied information.
select	indicates selectable items in windows and menus. This book also uses icons to represent selectable items.

Syntax Conventions

The general forms of SAS statements and commands shown in this book include only that part of the syntax actually taught in the course. For complete syntax, see the appropriate SAS reference guide.

PROC CHART DATA=*SAS-data-set*;
    HBAR | **VBAR** *chart-variables* </ *options*>;
RUN;

This is an example of how SAS syntax is shown in text:

- **PROC** and **CHART** are in uppercase bold because they are SAS keywords.
- DATA= is in uppercase to indicate that it must be spelled as shown.
- *SAS-data-set* is in italic because it represents a value that you supply. In this case, the value must be the name of a SAS data set.
- **HBAR** and **VBAR** are in uppercase bold because they are SAS keywords. They are separated by a vertical bar to indicate they are mutually exclusive; you can choose one or the other.
- *chart-variables* is in italic because it represents a value or values that you supply.
- </ *options*> represents optional syntax specific to the HBAR and VBAR statements. The angle brackets enclose the slash as well as *options* because if no options are specified you do not include the slash.
- **RUN** is in uppercase bold because it is a SAS keyword.

Chapter 1 Introduction

1.1 Structured Query Language

Objectives

- Understand the background and applications of Structured Query Language.

3

Structured Query Language

Structured Query Language (SQL)

- is a standardized language that is widely used to retrieve and update data in tables and in views based on those tables
- was originally designed as a query tool for relational databases, but is now used by many software products.

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Structured Query Language: Timeline

• 1970	Conceptualized and proposed by Dr. E. F. Codd at the IBM Research Laboratory, San Jose, CA
• 1970-1980	Developed by IBM
• 1981	First commercial SQL-based product, the IBM SQL/DS System
• 1989	Over 75 SQL database management systems exist, including SAS Release 6.06.

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The SQL Procedure

The SQL procedure uses SQL to

- query SAS data sets
- generate reports from SAS data sets
- combine SAS data sets in many ways
- create and delete SAS data files, views, and indexes
- update existing SAS data sets.

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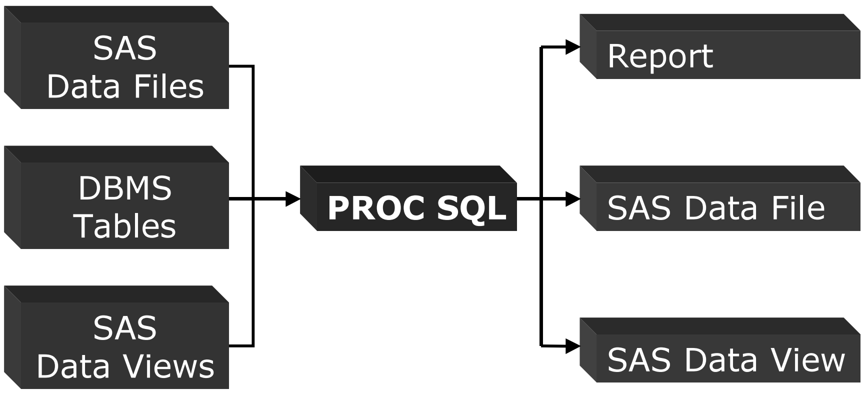
Structured Query Language



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...

More About the SQL Procedure

The SQL procedure

- enables you to use SQL within the SAS System
- follows the guidelines set by the American National Standards Institute (ANSI)
- includes enhancements for compatibility with SAS software
- is part of base SAS software
- can replace the need for multiple DATA and PROC steps with one query.

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The SQL Procedure

IS NOT	IS
• a replacement for the DATA step • a custom reporting tool.	• a tool for queries • for data manipulation • an augmentation to the DATA step.

9

SAS Data Sets

A SAS data set can be a

- SAS data file that stores data descriptions and data values together
- PROC SQL view that stores a PROC SQL query that retrieves data stored in other files
- DATA step view that stores a DATA step that retrieves data stored in other files
- SAS/ACCESS view that stores information required to retrieve data stored in a DBMS.

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Terminology

Data Processing	SAS	SQL
File	SAS Data Set	Table
Record	Observation	Row
Field	Variable	Column

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1.2 SAS Functions

Objectives

- Review the concatenation operator and various SAS functions.

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SAS Numeric Functions

Example: Calculate age and create two new variables.

```
data new;
   date=today();
   birth='01jun1970'd;
   bmonth=month(birth);
   fullage=(date-birth)/365.25;
   age=int(fullage);
proc print data=new noobs;
   format date birth date9.;
run;
```

TODAY returns today's date in SAS date form.

MONTH returns the month portion of a SAS date as an integer, 1-12.

INT returns the integer portion of a numeric value.

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SAS Numeric Functions

Output

```
                 The SAS System

  date       birth     bmonth   fullage    age
22FEB2000 01JUN1970     6       29.7276     29
```

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SAS Character Functions

Use the SUBSTR function to extract individual characters from a character value.

General form of the SUBSTR function:

SUBSTR(*argument,position<,length>)*

argument can be a character constant, variable, or expression.

position specifies the starting position.

length specifies the number of characters to extract. If omitted, the substring consists of the remainder of argument.

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...

SAS Character Functions

Example: Create a full name from a character string.

```
data new;
   name='Gomez, Gabriela  ';
   fname1=substr(name,8)
      ||' '||substr(name,1,5);
   fname2=trim(substr(name,8))
      ||' '||substr(name,1,5);
proc print data=new noobs;
run;
```

SUBSTR extracts part of a character value. Length taken from first argument.

TRIM removes trailing blanks from a value. Length taken from argument.

|| concatenates character values.

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SAS Character Functions

Output

```
                    The SAS System

name                  fname1                 fname2

Gomez, Gabriela   Gabriela    Gomez     Gabriela Gomez
```

18

SAS Character Functions

Use the SCAN function to extract the n^{th} word of a character value.

General form of the SCAN function:

SCAN(*argument,n*<*,delimiters*>)

argument	can be a character constant, variable, or expression.
n	specifies the n^{th} word to extract from the argument.
delimiters	defines characters that delimit (separate) words.

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...

SAS Character Functions

Example: Create a full name from a character string that contains a reversed name.

```
data new;
   name='Gomez, Gabriela  ';
   first=scan(name,2,',');
   last=scan(name,1,',');
   fname='Ms.'||trim(first)||' '||last;
proc print data=new;
run;
```

SCAN returns a specific word from a character string. Default length is 200.

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The above program creates FIRST and LAST columns using 200 bytes, which is the default returned length from the SCAN function. To override this default, use a LENGTH statement, as shown below:

```
data new;
   length first last $20;
   name='Gomez, Gabriela  ';
   first=scan(name,2,',');
   last=scan(name,1,',');
   fname='Ms.'||trim(first)||' '||last;
run;
```

If the second argument of the SCAN function is a negative number, the function counts from the right side of the text string instead of the left.

SAS Character Functions

If the length of these two variables is 200, where are the spaces?

Output

```
                  The SAS System

 name               first   last        fname

Gomez, Gabriela  Gabriela Gomez  Ms. Gabriela Gomez
```

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1.3 Case Study

Objectives

- Explore the tables used in this course.

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The examples and exercises in this course are based on the files of a fictitious airline company. These files include information on

- airline employees
- flights
- frequent flyers.

Airline Employee and Flight Tables

=airline employees =flights =frequent flyers

Airline.payrollmaster	Airline.staffmaster	Airline.supervisors	Airline.flightschedule
DateOfBirth	City	JobCategory	Date
DateOf Hire	FirstName	State	Destination
EmpId	PhoneNumber	EmpId	FlightNumber
JobCode	EmpId		EmpId
Salary	LastName		
gender	State		

Airline.marchflights	Airline.flightdelays	Airline.international flights	Airline.frequentflyers
Boarded	Date		Address
PassengerCapacity	DayOfWeek	Boarded	City
Date	Delay	Date	FFID
DepartureTime	DelayCategory	Destination	PhoneNumber
Deplaned	Destination	FlightNumber	MemberType
Destination	DestinationType		MilesTraveled
FlightNumber	FlightNumber		Name
Freight	Origin		PointsEarned
Mail			PointsUsed
Distance			State
Nonrevenue			ZipCode
Origin			
Transferred			

Not all tables used in this class are shown above.

Airline Destination Codes and Descriptions

CODE	Description
CPH	Copenhagen
DFW	Dallas/Ft. Worth
FRA	Frankfurt
LAX	Los Angeles
LGA	New York
LHR	London
ORD	Chicago
CDG	Paris
WAS	Washington
YYZ	Toronto

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Airline Job Codes and Descriptions

Code	Description
BCK	Baggage Check
FA	Flight Attendant
ME	Mechanic
NA	Navigator
PT	Pilot
SCP	Skycap
TA	Ticket Agent

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1.4 Chapter Summary

Structured Query Language (SQL) is a standardized language that is widely used to retrieve and update data in tables and views based on those tables. The SQL procedure enables you to use SQL within the SAS System. You can use the SQL procedure to accomplish tasks such as querying SAS data sets, generating reports from SAS data sets, and combining SAS data sets.

The SQL procedure supports most of the functions available in the DATA step for data creation and manipulation. There are numeric functions to manipulate data values and character functions to manipulate character strings.

General form of the TODAY function:

> **TODAY**( )

General form of the MONTH function:

> **MONTH**(*SAS date value*)

General form of the INT function:

> **INT**(*numeric value)*

General form of the SUBSTR function:

> **SUBSTR**(*argument,position*<,*length*>)

General form of the TRIM function:

> **TRIM**(*argument*)

General form of the SCAN function:

> **SCAN**(*argument*,*n*<,*delimiters*>)

Chapter 2 Basic Queries

2.1 Overview of the SQL Procedure

Objectives

- Specify columns.
- Specify rows.
- Present data.
- Summarize data.
- Perform subqueries.

3

Features of PROC SQL

- The PROC SQL statement does not need to be repeated with each query.
- Each statement is processed individually.
- No PROC PRINT step is needed to view query results.
- No PROC SORT step is needed to order query results.
- No RUN statement is needed.
- Use a QUIT statement to terminate PROC SQL.

4

SQL is a modular language because queries (or statements) are composed of smaller building blocks (or clauses).

The SELECT Statement

A SELECT statement is used to query one or more SAS data sets.

```
proc sql;
   select EmpID, JobCode, Salary
      from airline.payrollmaster
      where JobCode contains 'NA'
      order by Salary desc;
```

5

Use a comma to separate items in a list, such as column or table names. Place a single semicolon at the end of the last clause.

Features of the SELECT Statement

The SELECT statement

- selects data that meets certain conditions
- groups data
- specifies an order for the data
- formats the data
- queries 1 to 32 tables.

6

Table names can be 1 to 32 characters in length and are not case-sensitive.

Variable names can be 1 to 32 characters in length and are stored in mixed case but are normalized for lookups and comparisons. However, the first usage of the variable determines the capitalization pattern.

Librefs, filerefs, formats, and informats are limited to 8 characters.

SELECT Statement Syntax

General form of the SELECT statement:

```
SELECT column <,column>...
     FROM table|view<,table|view>...
     <WHERE expression>
     <GROUP BY column<,column>...>
     <HAVING expression>
     <ORDER BY column<,column>...>;
```

7

SELECT specifies the columns to be selected.

FROM specifies the table to be queried.

WHERE subsets the data based on a condition.

GROUP BY classifies the data into groups.

HAVING subsets groups of data based on a group condition.

ORDER BY sorts rows by the values of specific columns.

The order of the above clauses within the SQL SELECT statement **does** matter.

table is a SAS data set (data file or data view).

column is a column name, expression, or summary function.

The VALIDATE Keyword

Partial SAS Log

```
1  proc sql;
2     validate
3     select EmployeeNumber, JobCode, Salary
4        from airline.payroll_master
5        where JobCode contains 'NA'
6        order by Salary desc;
NOTE: PROC SQL statement has valid syntax.
```

9

Features of the VALIDATE Keyword

The VALIDATE keyword

- is used only on a SELECT statement
- tests the syntax of a query without executing the query
- checks column name validity
- prints error messages for invalid queries.

9

The NOEXEC Option

The NOEXEC option can also be used for syntax checking.

Partial SAS Log

```
1   proc sql noexec;
2      select EmployeeNumber,JobCode,Salary
3         from airline.payroll_master
4         where JobCode contains 'NA'
5         order by Salary desc;
NOTE:Statement not executed due to NOEXEC
option.
```

10

...

Additional PROC SQL Statements

PROC SQL supports many statements in addition to the SELECT statement.

PROC SQL <*option* <*option*>...>;

ALTER *expression*;

CREATE *expression*;

DELETE *expression*;

DESCRIBE *expression*;

DROP *expression*;

Chapter 4

continued ...

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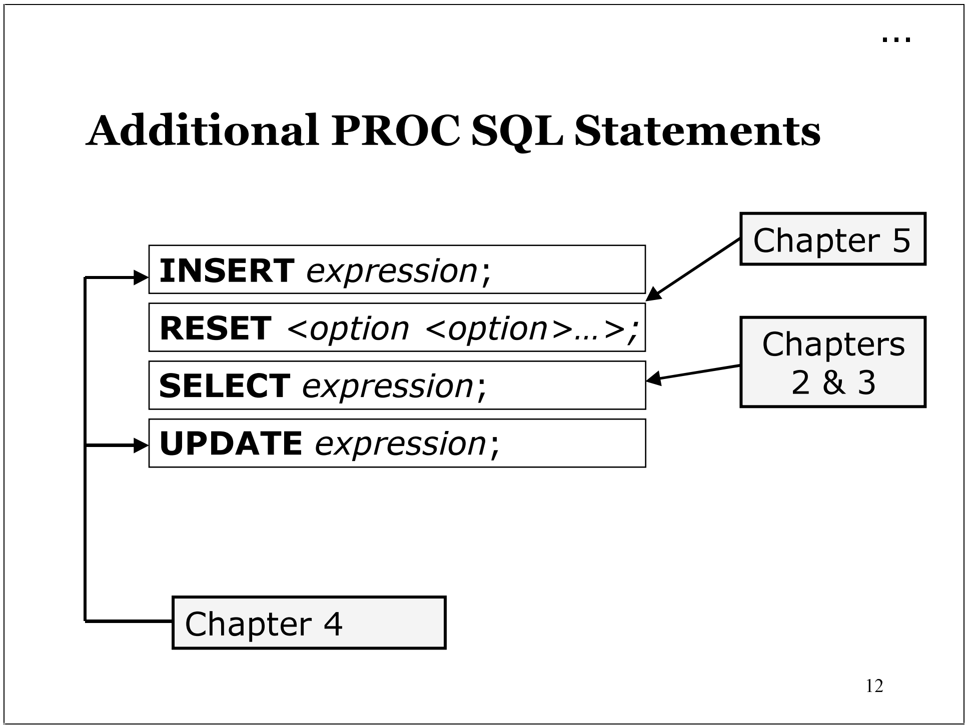
ALTER	adds, drops, and modifies columns in a table.
CREATE	builds new tables.
DELETE	eliminates unwanted rows from a table or view.
DESCRIBE	displays table attributes.
DROP	eliminates entire tables, views, or indexes.



INSERT adds rows of data to tables.

RESET adds to or changes PROC SQL options without re-invoking the procedure.

SELECT specifies columns to be printed.

UPDATE modifies data values in existing rows of a table or view.

✐ The NOEXEC option checks for invalid syntax in all the statements previously mentioned, but the VALIDATE option applies only to the SELECT statement.

2.2 Specifying Columns

Objectives

- Display columns directly from a table.
- Display columns calculated from other columns in a query.

1

Retrieving Data from a Table

If you are familiar with a table, you can specify column names to be printed in the SELECT statement.

Example: Print employee IDs, job codes, and salaries.

```
proc sql;
   select EmpID, JobCode, Salary
      from airline.payrollmaster;
```

1

Employee IDs, Job Codes, and Salaries

Partial Output

The SAS System

Emp ID	Job Code	Salary
1919	TA2	$48,126
1653	ME2	$49,151
1400	ME1	$41,677
1350	FA3	$46,040
1401	TA3	$54,351
1499	ME3	$60,235
1101	SCP	$26,212
1333	PT2	$124,048
1402	TA2	$45,661

1

Retrieving Data from a Table

```
proc sql;
   select *
      from airline.payrollmaster;
```

If you are not familiar with a table, an asterisk in the SELECT statement prints all columns in their originally stored order.

Partial Output

The SAS System

Emp ID	Gender	Job Code	Salary	DateOfBirth	DateOfHire
1919	M	TA2	$48,126	16SEP1958	07JUN1985
1653	F	ME2	$49,151	19OCT1962	12AUG1988
1400	M	ME1	$41,677	08NOV1965	19OCT1988
1350	F	FA3	$46,040	04SEP1963	01AUG1988
1401	M	TA3	$54,351	16DEC1948	21NOV1983
1499	M	ME3	$60,235	29APR1952	11JUN1978

The FEEDBACK Option

Use the FEEDBACK option to write the expanded SELECT statement to the SAS log.

Partial SAS Log

```
22   proc sql feedback;
23      select *
24         from airline.payrollmaster;
NOTE: Statement transforms to:
       select PAYROLLMASTER.EmpID,
              PAYROLLMASTER.Gender, PAYROLLMASTER.JobCode,
              PAYROLLMASTER.Salary,
              PAYROLLMASTER.DateOfBirth,
              PAYROLLMASTER.DateOfHire
          from AIRLINE.PAYROLLMASTER;
```

18

This option expands any use of an asterisk into the list of qualified columns it represents. NOFEEDBACK is the default.

Expressions

Calculate new columns from existing columns and name the new columns using the AS keyword.

Example: Calculate employee bonuses.

```
proc sql;
   select EmpID, JobCode, Salary,
          Salary * .10 as Bonus
      from airline.payrollmaster;
```

19

The new column is called an *alias*. The AS keyword is required. Omission of the alias causes the column heading to be blank.

Employee Bonuses

Partial Output

```
                  The SAS System

                    Job
      EmpID         Code       Salary      Bonus
      ────────────────────────────────────────────
      1919          TA2       $48,126    4812.64
      1653          ME2       $49,151    4915.12
      1400          ME1       $41,677    4167.66
      1350          FA3       $46,040    4604.04
      1401          TA3       $54,351    5435.08
      1499          ME3       $60,235     6023.5
      1101          SCP       $26,212    2621.22
      1333          PT2      $124,048   12404.84
      1402          TA2       $45,661     4566.1
      1479          TA3       $54,299     5429.9
      1403          ME1       $39,301    3930.08
```

20

Expressions

Use SAS DATA step functions for calculating columns.

Example: Calculate the age of each employee.

```
proc sql;
   select EmpID, JobCode,
          int((today()-DateOfBirth)/365.25)
          as Age
      from airline.payrollmaster;
```

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Employee Ages

Partial Output

```
           The SAS System
Emp           Job
ID            Code        Age
_____________________________
1919          TA2          41
1653          ME2          37
1400          ME1          34
1350          FA3          36
1401          TA3          51
1499          ME3          47
1101          SCP          39
1333          PT2          40
1402          TA2          38
1479          TA3          33
```

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All SAS DATA step functions are supported except LAG, DIF.

2.3 Specifying Rows

Objectives

- Eliminate duplicate rows in a query.
- Subset the data displayed in a query.

2

Specifying All Rows in a Table

By default, all rows in a table are returned in a query.

Example: Display all rows and columns of the AIRLINE.INTERNATIONALFLIGHTS table.

```
proc sql;
   select *
      from airline.internationalflights;
```

2

All Rows in a Table

Partial Output

The SAS System

FlightNumber	Date	Destination	Boarded
182	01MAR2000	YYZ	104
219	01MAR2000	LHR	198
387	01MAR2000	CPH	152
622	01MAR2000	FRA	207
821	01MAR2000	LHR	205
132	01MAR2000	YYZ	115
271	01MAR2000	CDG	138
182	02MAR2000	YYZ	116
219	02MAR2000	LHR	147
387	02MAR2000	CPH	105
622	02MAR2000	FRA	176
821	02MAR2000	LHR	201
132	02MAR2000	YYZ	106

2

Eliminating Duplicate Rows

Use the DISTINCT keyword to eliminate duplicate rows in query results.

Example: Determine the international flights that were flown during the month.

```
proc sql;
   select distinct FlightNumber,
          Destination
      from airline.internationalflights;
```

2

The DISTINCT keyword applies to all columns in the SELECT list. One row is displayed for each existing combination of values.

Eliminating Duplicate Rows

Partial Output

```
                The SAS System

          FlightNumber Destination
          ___________________________
             132           YYZ
             182           YYZ
             219           LHR
             271           CDG
             387           CPH
             622           FRA
             821           LHR
```

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Subsetting with the WHERE Clause

Use a WHERE clause to specify a condition that the data must satisfy before being selected.

Example: Display all employees that earn more than $112,000.

```
proc sql;
   select EmpID,JobCode,Salary
      from airline.payrollmaster
      where Salary > 112000;
```

29

Subsetting with the WHERE Clause

Partial Output

```
                  The SAS System

     Emp           Job
     ID            Code      Salary
     ______________________________
     1333          PT2     $124,048
     1404          PT2     $127,926
     1118          PT3     $155,931
     1410          PT2     $118,559
     1777          PT3     $153,482
     1106          PT2     $125,485
     1442          PT2     $118,350
     1478          PT2     $117,884
     1890          PT2     $120,254
```

0

Subsetting with the WHERE Clause

You can use all common comparison operators in a WHERE clause.

Mnemonic	Symbol	Definition
LT	<	Less than
GT	>	Greater than
EQ	=	Equal to
LE	<=	Less than or equal to
GE	>=	Greater than or equal to
NE	¬ =	Not equal to (EBCDIC)
	^ =	Not equal to (ASCII)

1

Subsetting with the WHERE Clause

You can use the IN operator to compare a value to a list of values. If the value matches at least one in the list, the expression is true; otherwise, the expression is false.

```
where JobCategory in ('PT','NA','FA')
where DayOfWeek in (2,4,6)
```

2

Subsetting with the WHERE Clause

You can specify multiple expressions in a WHERE clause by using logical operators.

Mnemonic	Symbol	Definition
OR	|	or, either
AND	&	and, both
NOT	¬	not, negation EBCDIC
NOT	^	not, negation ANSII

Subsetting with the WHERE Clause

Use either **CONTAINS** or **?** to select rows that include the substring specified.

```
where word ? 'LAM'
```

(BLAME, LAMENT, and BEDLAM are selected.)

Use either **IS NULL** or **IS MISSING** to select rows with missing values.

```
where FlightNumber is missing
```

Alternative statements are

- **`where FlightNumber = ' '`**
- **`where FlightNumber = .`**

With the = operator, you must know if FlightNumber is character or numeric. On the other hand, if you use MISSING=, you do not need advance knowledge of column type.

Subsetting with the WHERE Clause

Use **BETWEEN-AND** to select rows containing ranges of values, inclusively.

```
where Date between '01mar2000'd and '07mar2000'd
where Salary between 70000 and 80000;
```

Subsetting with the WHERE Clause

Use **LIKE** to select rows by comparing character values to specified patterns.

A % sign replaces any number of characters.

```
where LastName like 'H%'
```

(H plus any characters; for example, HENDRY, HANSON, and HALL are selected.)

Subsetting with the WHERE Clause

A single underscore ('_') replaces individual characters.

```
where JobCode like '__1'
```

captures any two characters and 1, for example, 'FA1', 'TA1', 'NA1'.

2 underscores, followed by a 1

Subsetting with the WHERE Clause

The sounds-like (**=***) operator selects rows containing a spelling variation of the specified word(s).

```
where LastName =* 'SMITH'
```

selects values SMITT, SMYTHE, and SMOTHE, in addition to SMITH.

8

Subsetting with Calculated Values

Because a WHERE clause is evaluated first, columns used in the WHERE clause must exist in the table or be derived from existing columns.

9

Subsetting with Calculated Values

Example: Display only the flights where the total number of passengers was fewer than 100 people.

```
proc sql;
   select FlightNumber,Date,Destination,
          Boarded + Transferred + Nonrevenue
          as Total
      from airline.marchflights
      where Total < 100;
```

0

Subsetting with Calculated Values

Partial Log

```
ERROR:The following columns were not
found in the contributing tables:Total.
```

1

Subsetting with Calculated Values

One solution is to repeat the calculation in the WHERE clause.

```
proc sql;
   select FlightNumber, Date, Destination,
          Boarded+Transferred+Nonrevenue
          as Total
      from airline.marchflights
      where Boarded+Transferred+Nonrevenue < 100;
```

2

Subsetting with Calculated Values

A more efficient method is to use the CALCULATED keyword to refer to already calculated columns in the SELECT clause.

```
proc sql;
   select FlightNumber, Date, Destination,
          Boarded + Transferred + Nonrevenue
          as Total
      from airline.marchflights
      where calculated Total < 100;
```

Subsetting with Calculated Values

Partial Output

```
                     The SAS System

FlightNumber        Date   Destination      Total
-------------------------------------------------
982            01MAR2000   DFW                 70
416            01MAR2000   WAS                 93
829            01MAR2000   WAS                 96
416            02MAR2000   WAS                 90
302            02MAR2000   WAS                 93
```

Subsetting with Calculated Values

You can also use the CALCULATED keyword in other parts of a query, for example, in a SELECT clause.

```
proc sql;
   select FlightNumber, Date, Destination,
          Boarded + Transferred + Nonrevenue
          as Total,
      calculated Total/2 as half
      from airline.marchflights;
```

Subsetting with Calculated Values

Partial Output

The SAS System

FlightNumber	Date	Destination	Total	half
182	01MAR2000	YYZ	123	61.5
114	01MAR2000	LAX	196	98
202	01MAR2000	ORD	167	83.5
219	01MAR2000	LHR	222	111
439	01MAR2000	LAX	185	92.5
387	01MAR2000	CPH	163	81.5
290	01MAR2000	WAS	119	59.5

2.4 Presenting Data

Objectives

- Order the data displayed in a query.
- Use SAS formats, labels, and titles to enhance query output.

8

Ordering Data

Use the ORDER BY clause to sort query results in

- ascending order (the default)
- descending order by following the column name with the DESC keyword.

9

Ordering Data

```
proc sql;
   select EmpID,JobCode,Salary
      from airline.payrollmaster
      where JobCode contains 'NA'
      order by Salary desc;
```

0

You can specify the collating sequence by using the SORTSEQ= option in the PROC SQL statement. Use this option only if you want a collating sequence other than your system's or installation's default collating sequence. For additional information, see SORTSEQ under the SORT procedure in your online or written documentation.

PROC SQL uses information provided by a table's internal sort indicator (if available) to avoid performing unnecessary sorts.

Ordering Data

Partial Output

Notice the descending order of Salary.

```
                   The SAS System

                  Emp   Job
                  ID    Code      Salary
                  ─────────────────────
                  1352  NA2      $75,317
                  1417  NA2      $73,178
                  1935  NA2      $71,513
                  1839  NA1      $60,806
                  1443  NA1      $59,184
                  1332  NA1      $59,049
                  1269  NA1      $58,366
                  1111  NA1      $56,820
```

1

Ordering Data

In an ORDER BY clause, you order query results by specifying

- any column or expression (display or nondisplay)
- a column name or a number that represents the position of an item in the SELECT list
- multiple columns.

2

Ordering Data

Example: Display the London flights in date order by descending total number of passengers.

Mix and match!

```
proc sql;
   select FlightNumber, Date,
          Origin, Destination,
          Boarded+Transferred+Nonrevenue
      from airline.marchflights
      where Destination='LHR'
      order by Date,5 desc;
```

Ordering Data

Partial Output

The SAS System

FlightNumber	Date	Origin	Destination	
219	01MAR2000	LGA	LHR	222
821	01MAR2000	LGA	LHR	222
821	02MAR2000	LGA	LHR	210
219	02MAR2000	LGA	LHR	172
219	03MAR2000	LGA	LHR	211
821	03MAR2000	LGA	LHR	172
219	04MAR2000	LGA	LHR	250
821	04MAR2000	LGA	LHR	182
219	05MAR2000	LGA	LHR	167
821	06MAR2000	LGA	LHR	185
219	06MAR2000	LGA	LHR	183

Enhancing Query Output

You can use SAS formats and labels to customize PROC SQL output. After the column name in the SELECT list, you specify the

- LABEL= option to alter the column heading
- FORMAT= option to alter the appearance of the values in that column.

The LABEL, FORMAT, INFORMAT, and LENGTH options are not part of the ANSI standard but are SAS enhancements.

Enhancing Query Output

Example: Enhance the report. Display the navigators and their salaries.

```
proc sql;
   select EmpID label='Employee Identifier',
          JobCode label='Job Code',
          Salary label='Annual Salary'
             format=dollar12.2
      from airline.payrollmaster
      where JobCode contains 'NA'
      order by Salary desc;
```

Enhanced Query Output

```
                 The SAS System

          Employee    Job         Annual
          Identifier  Code        Salary
          ------------------------------
          1352        NA2     $75,317.20
          1417        NA2     $73,178.00
          1935        NA2     $71,513.40
          1839        NA1     $60,806.20
          1443        NA1     $59,183.60
          1332        NA1     $59,049.20
          1269        NA1     $58,366.00
          1111        NA1     $56,820.40
```

To force PROC SQL to ignore permanent labels in a table, specify the NOLABEL system option.

Enhancing Query Output

You can

- define a column containing a character constant by placing a text string in the SELECT list
- use SAS titles and footnotes to enhance the query's appearance.

8

Enhancing Query Output

Example: Display bonus values for all flight engineers.

```
proc sql;
title 'Current Bonus Information';
title2 'Navigators - All Levels';
   select EmpID
          label='Employee Identifier',
          'bonus is:',
          Salary *.05 format=dollar12.2
      from airline.payrollmaster
      where JobCode contains 'NA'
      order by Salary desc;
```

9

TITLE and FOOTNOTE statements must precede the SELECT statement.

Also, a column of numeric values can be defined in a way similar to the above character constant **'bonus is:'**.

Enhancing Query Output

```
             Current Bonus Information
              Navigators - All Levels

        Employee
        Identifier
        ___________________________________
        1352        bonus is:     $3,765.86
        1417        bonus is:     $3,658.90
        1935        bonus is:     $3,575.67
        1839        bonus is:     $3,040.31
        1443        bonus is:     $2,959.18
        1332        bonus is:     $2,952.46
        1269        bonus is:     $2,918.30
        1111        bonus is:     $2,841.02
```

0

2.5 Exercises

Submit a LIBNAME statement to assign the libref AIRLINE to the SAS data library for this course.

TSO: `libname airline '.sql8.sasdata';`

Directory-based systems: `libname airline '.';`

1. **Querying a Table**

   a. Submit a PROC SQL query that displays all rows and all columns of AIRLINE.PAYROLLMASTER.

   b. Recall the previous query and alter it so that only the columns for employee ID, gender, job code, and salary are displayed.

   c. Recall the previous query and alter it so that a new column is displayed as one third of the employee's salary. Name the new column **`Tax`**.

   d. Recall the previous query and alter it so that the Tax and Salary columns are displayed with commas and two decimal places.

   e. Recall the previous query and alter it so that only male employees are listed.

   f. Recall the previous query and alter it so that only male flight attendants are displayed.

2. **Eliminating Duplicates**

   Use the AIRLINE.STAFFMASTER table to create a report that displays the cities where airline employees reside. The report must contain only one row per city, be ordered by city, and have an appropriate title.

```
                       Cities Where Employees Live

                             City
                             ---------------
                             BRIDGEPORT
                             MT. VERNON
                             NEW YORK
                             PATERSON
                             PRINCETON
                             STAMFORD
                             WHITE PLAINS
```

3. **Subsetting Data**

   Use the AIRLINE.MARCHFLIGHTS table to create a report that shows all flights whose total number of passengers is less than one third of the airplane's capacity. Display the flights in descending number of total passengers. Create an appropriate title.

```
                      Flights Less Than One Third Full

                                                            Passenger
FlightNumber        Date  Destination      Total         Capacity
_____________________________________________________________________

523            05MAR2000  ORD                 59              210
290            19MAR2000  WAS                 59              180
290            05MAR2000  WAS                 55              180
183            19MAR2000  WAS                 53              180
982            12MAR2000  DFW                 49              180
183            25MAR2000  WAS                 43              180
302            31MAR2000  WAS                 34              180
302            22MAR2000  WAS                 33              180
416            05MAR2000  WAS                 31              180
921            27MAR2000  DFW                  .              180
872            21MAR2000  LAX                  .              210
```

4. **Querying Data (Optional)**

   A customer service representative must contact a person in the frequent flyer table, but the service representative only remembers that the person's first name begins with an N. Use the AIRLINE.FREQUENTFLYERS table to list the names of all possible people.

```
        Frequent Fliers with First Names Beginning with an ‘N’

                    Frequent
Name                FlyerNumber
________________________________

CARAWAY, NEIL       WD4762
CHAPMAN, NEIL       WD8968
OVERBY, NADINE      WD5201
WILDER, NEIL        WD6169
JONES, NATHAN       WD1961
TUCKER, NEIL        WD2719
WELLS, NADINE       WD6504
SANDERSON, NATHAN   WD7916
```

5. Using SAS Functions (Optional)

Query the AIRLINE.PAYROLLMASTER table to determine how old each employee was when the employee was hired. Display the employee's ID, birth date, hire date, and age at time of employment. Format the two dates with the MMDDYY10. format and label each column appropriately.

Partial Output

```
                    Employee Age Information

          Employee                             Age At
          ID        Birth Date   Hire Date  Employment
          ____________________________________________

          1919      09/16/1958  06/07/1985          26
          1653      10/19/1962  08/12/1988          25
          1400      11/08/1965  10/19/1988          22
          1350      09/04/1963  08/01/1988          24
          1401      12/16/1948  11/21/1983          34
          1499      04/29/1952  06/11/1978          26
          1101      06/09/1960  10/04/1988          28
          1333      04/03/1959  02/14/1979          19
```

2.6 Summarizing Data

Objectives

- Use functions to summarize data in a query.

Summary Functions

Example: Find the total number of passengers for each flight in March.

This calculation is performed *across columns* for each row.

```
proc sql;
   select Date, FlightNumber, Boarded,
          Transferred, Nonrevenue,
      sum(Boarded,Transferred,Nonrevenue)
      as Total
      from airline.marchflights;
```

Summary Functions

```
                           The SAS System


              Flight
        Date  Number Boarded  Transferred  Nonrevenue   Total
-------------------------------------------------------------
01MAR2000  182         104           16           3      123
01MAR2000  114         172           18           6      196
01MAR2000  202         151           11           5      167
01MAR2000  219         198           17           7      222
01MAR2000  439         167           13           5      185
01MAR2000  387         152            8           3      163
01MAR2000  290          96    +      16     +     7  =   119
```

If you specify more than one column name in a summary function, the function acts like a DATA step function. The calculation is performed for each row.

Summary Functions

If you specify only one column name in a summary function, the statistic is calculated down the column.

Example: Determine the average salary for the company.

```
proc sql;
   select avg(Salary) as MeanSalary
      from airline.payrollmaster;
```

Summary Functions

Data set AIRLINE.PAYROLLMASTER

Avg(Salary) gives a mean for all rows within this column **only**.

Employee Number	Gender	Job Code	Salary
1919	M	TA2	$48,126
1653	F	ME2	$49,151
1400	M	ME1	$41,677
1350	F	FA3	$46,040
1401	M	TA3	$54,351
1499	M	ME3	$60,235
1101	M	SCP	$26,212
1333	M	PT2	$124,048
1402	M	TA2	$45,661
1479	F	TA3	$54,299
1403	M	ME1	$39,301
1739	M	PT1	$93,124
1658	M	SCP	$25,120
1428	F	PT1	$96,274
1782	M	ME2	$49,483
1244	M	ME2	$51,695
1383	M	BCK	$36,152

This is comparable to a SAS procedure (for example, the MEANS procedure), which computes statistics on table columns.

Summary Functions

Output

```
        The SAS System

          MeanSalary
          ----------
            54079.65
```

8

The SQL procedure supports numerous functions for calculating statistics. Some functions have more than one name to accommodate both SAS and SQL conventions.

Summary Functions

The following are selected functions:

AVG, MEAN	mean or average value
COUNT, FREQ, N	number of nonmissing values
MAX	largest value
MIN	smallest value
NMISS	number of missing values
STD	standard deviation
SUM	sum of values
VAR	variance.

9

Summary Functions

Example: Add the JOBCODE column to the summarized query.

```
proc sql;
   select JobCode, avg(Salary) as average
      from airline.payrollmaster;
```

0

Summary Functions

Partial Output

```
                    The SAS System
                   Job
                   Code   average
                   ───────────────
                   TA2   54079.65
                   ME2   54079.65
                   ME1   54079.65
                   FA3   54079.65
                   TA3   54079.65
                   ME3   54079.65
                   SCP   54079.65
                   PT2   54079.65
                   TA2   54079.65
                   TA3   54079.65
                   ME1   54079.65
```

1

By default, summary functions calculate statistics based on the entire table. The average is calculated and then re-merged with the individual rows in the table.

How can you find the average salary for each job code?

Grouping Data

You can use the GROUP BY clause to

- classify the data into groups based on the values of one or more columns
- calculate statistics for each unique value of the grouping columns.

2

Grouping Data

Example: Display the average salary for each job code.

```
proc sql;
   select JobCode, avg(Salary) as
          average format=dollar11.2
      from airline.payrollmaster
      group by JobCode;
```

Grouping Data

Partial Output

```
                 The SAS System

                Job
                Code     average
                ----------------
                BCK   $36,111.91
                FA1   $32,255.11
                FA2   $39,181.63
                FA3   $46,107.40
                ME1   $39,900.35
                ME2   $49,807.60
                ME3   $59,375.00
                NA1   $58,845.08
                NA2   $73,336.20
                PT1   $95,071.20
                PT2  $122.253.60
                PT3  $154,706.30
                SCP   $25,632.40
```

Analyzing Groups of Data

The COUNT(*) summary function counts
the number of rows.

Example: Determine the total number of employees.

```
proc sql;
   select count(*) as count
      from airline.payrollmaster;
```

```
The SAS System

    count
  --------
      148
```

The COUNT function is the only function that allows an asterisk (*) as an argument.

Analyzing Groups of Data

Example: Determine the total number of employees within each job category.

```
proc sql;
   select substr(JobCode,1,2)
          label='Job Category',
          count(*) as count
      from airline.payrollmaster
      group by 1;
```

Analyzing Groups of Data

Output

```
                The SAS System

              Job
              Category      count
              ___________________
              BC                9
              FA               34
              ME               29
              NA                8
              PT               20
              SC                7
              TA               41
```

Analyzing Groups of Data

Example: Calculate each navigator's salary as a percentage of all navigators' salaries.

```
proc sql;
   select EmpID, Salary,
          (Salary/sum(Salary)) as percent
          format=percent8.2
      from airline.payrollmaster
      where JobCode contains 'NA';
```

8

Analyzing Groups of Data

Output

```
                 The SAS System
Emp
ID                    Salary   percent
--------------------------------------
1269                 $58,366    11.35%
1935                 $71,513    13.91%
1417                 $73,178    14.23%
1839                 $60,806    11.82%
1111                 $56,820    11.05%
1352                 $75,317    14.65%
1332                 $59,049    11.48%
1443                 $59,184    11.51%
```

9

PROC SQL automatically re-merges the summary statistic with the table to calculate the percentage. This requires two passes through the data: one to compute the column sum and another to compute each row's percentage of the total. A note appears in the SAS log when re-merging occurs.

Partial Log

```
NOTE: The query requires re-merging summary statistics back
      with the original data.
```

Selecting Groups of Data with the HAVING Clause

The WHERE clause selects data based on values for individual rows. To select entire groups of data, use the HAVING clause.

Example: Display all job codes with an average salary of more than $56,000.

```
proc sql;
   select JobCode, avg(Salary) as average
      format=dollar11.2
      from airline.payrollmaster
      group by JobCode
      having avg(Salary) > 56000;
```

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Alternatively, you can code the HAVING clause as follows:

- **having average > 56000;**
- **having calculated average > 56000;**

Selecting Groups of Data with the HAVING Clause

Partial Output

```
              The SAS System

           Job
           Code     average
           ----------------
           ME3   $59,375.00
           NA1   $58,845.08
           NA2   $73,336.20
           PT1   $95,071.20
           PT2  $122,253.60
           PT3  $154,706.30
```

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2.7 Subqueries

Objectives

- Understand how to subset data based on values returned from other queries.
- Understand the difference between a correlated and noncorrelated subquery.

8

Subqueries

Subqueries

- are inner queries that return values to be used by an outer query to complete a subsetting expression in a WHERE or HAVING clause
- return single or multiple values to be used by the outer query
- can return only a single column.

8

Subqueries are also known as nested queries, inner queries, and sub-selects.

...

Subqueries: Noncorrelated

Example: Display job codes where the group's average salary exceeds the company's average salary.

```
proc sql;
   select JobCode,avg(Salary) as MeanSalary
      from airline.payrollmaster
      group by JobCode
      having avg(Salary) >
       (select avg(Salary)
          from airline.payrollmaster);
```

Then pass results to outer query

Evaluated first

8

Subqueries: Noncorrelated

Output

```
                The SAS System

                 Job
                 Code   MeanSalary
                 ____________________
                 ME3         59375
                 NA1      58845.08
                 NA2       73336.2
                 PT1       95071.2
                 PT2      122253.6
                 PT3      154706.3
                 TA3      55551.42
```

8

Subqueries: Noncorrelated

Example: Send birthday cards to employees with February birthdays. Names and addresses are in airline.staffmaster, and birth dates in airline.payrollmaster.

```
proc sql;
   select LastName, FirstName, City, State
      from airline.staffmaster
      where EmpID in
         (select EmpID
          from airline.payrollmaster
          where month(DateOfBirth)=2);
```

8

Noncorrelated Subqueries: How Do They Work?

```
proc sql;
   select LastName, FirstName,
      City, State
   from airline.staffmaster
   where EmpID in
     (select EmpID
      from airline.payrollmaster
      where month(DateOfBirth)=2);
```

Airline.payrollmaster
Partial Listing

EmpID	DateOfBirth
...	. . .
1038	11/13/1967
1420	02/23/1963
1561	12/03/1961
1434	07/14/1960
1414	03/28/1970
1112	12/03/1962
1390	02/23/1963
1332	09/20/1968
...	. . .

Step 1: Evaluate the inner query and build a virtual table that satisfies the WHERE criteria.

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Noncorrelated Subqueries: How Do They Work?

Airline.payrollmaster
Partial Listing

EmpID	DateOfBirth
...	. . .
1038	11/13/1967
1420	02/23/1963
1561	12/03/1961
1434	07/14/1960
1414	03/28/1970
1112	12/03/1962
1390	02/23/1963
1332	09/20/1968
...	. . .

```
proc sql;
   select LastName, FirstName,
      City, State
   from airline.staffmaster
   where EmpID in
     (select EmpID
      from airline.payrollmaster
      where month(DateOfBirth)=2);
```

Virtual table contains
'1420','1390','1403','1404','1834','1103'.

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Noncorrelated Subqueries: How Do They Work?

Airline.payrollmaster
Partial Listing

EmpID	DateOfBirth
...	. . .
1038	11/13/1967
1420	02/23/1963
1561	12/03/1961
1434	07/14/1960
1414	03/28/1970
1112	12/03/1962
1390	02/23/1963
1332	09/20/1968
...	. . .

```
proc sql;
   select LastName, FirstName,
      City, State
   from airline.staffmaster
   where EmpID in
      ('1420','1390','1403',
       '1404','1834','1103')
```

Step 2: Pass '1420','1390','1403','1404','1834','1103'
to the outer query.

Noncorrelated Subqueries: Output

```
                         The SAS System

Emp
ID        LastName      FirstName     City            State
-----------------------------------------------------------
1403       BOWDEN        EARL          BRIDGEPORT      CT
1404       CARTER        DONALD        NEW YORK        NY
1834       LONG          RUSSELL       NEW YORK        NY
1103       MCDANIEL      RONDA         NEW YORK        NY
1420       ROUSE         JEREMY        PATERSON        NJ
1390       SMART         JONATHAN      NEW YORK        NY
```

Does this
look familiar?

91

Selecting Data

If you specify the ANY keyword before a subquery, the comparison is true if it is true for any of the values that the subquery returns.

Keyword ANY	**Signifies…**
> ANY(20,30,40) returned from inner query	>20
< ANY(20,30,40) returned from inner query	< 40
= ANY(20,30,40) returned from inner query	=20 or =30 or =40

92

The ANY Keyword

Think:
`<select max(DateOfBirth)`

Example: Are any low-level flight attendants (FA1 or FA2) older than any of the high-level flight attendants (FA3)?

```
proc sql;
title "FA1's or FA2's Older Than ANY FA3's";
   select EmpID, JobCode, DateOfBirth
      from airline.payrollmaster
      where JobCode in ('FA1','FA2')
         and DateOfBirth < any
            (select DateOfBirth
               from airline.payrollmaster
               where JobCode='FA3');
```

9

This would be equivalent to asking, "Who is older than any single level-3 flight attendant?" An alternative WHERE clause is

```
where JobCode in ('FA1','FA2') and DateOfBirth < (select max(DateOfBirth) from...);
```

The ANY Keyword

Output

```
             FA1's or FA2's Older Than ANY FA3's

               Emp            Job
               ID             Code  DateOfBirth
               ________________________________
               1574           FA2     01MAY1958
               1475           FA2     19DEC1959
               1124           FA1     14JUL1956
               1422           FA1     08JUN1962
               1368           FA2     15JUN1959
               1411           FA2     31MAY1959
               1477           FA2     25MAR1962
               1970           FA1     29SEP1962
               1413           FA2     20SEP1963
               1434           FA2     15JUL1960
               1390           FA2     23FEB1963
```

9

The ALL Keyword

The ALL keyword is true only if the comparison is true for all values returned.

Keyword ALL	Signifies...
> ALL(20,30,40) returned from inner query	> 40
< ALL(20,30,40) returned from inner query	< 20

9

Selecting Data

Think:
<select min(DateOfBirth)

Example: Are there FA1's or FA2's who are older than all of the FA3's?

```
proc sql;
title "FA1's or FA2's Older Than ALL FA3's";
   select EmpID, JobCode, DateOfBirth
      from airline.payrollmaster
      where JobCode in('FA1','FA2')
         and DateOfBirth < all
            (select DateOfBirth
            from airline.payrollmaster
            where JobCode='FA3');
```

9

An alternative WHERE clause is

```
where JobCode in('FA1','FA2') and DateOfBirth < (select min(DateOfBirth) from ...);
```

Selecting Data

Output

```
        FA1's or FA2's Older Than ALL FA3's

          Emp            Job
          ID             Code  DateOfBirth
          ______________________________
          1124           FA1     13JUL1956
          1415           FA2     12MAR1956
```

9

Correlated Subqueries

Correlated subqueries

- cannot be evaluated independently, but depend on the values returned by the outer query for their results
- are evaluated for each row in the outer query.

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...

Correlated Subqueries

Example: Display the names and states of all navigator managers.

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'=
         (select JobCategory
            from airline.supervisors
            where staffmaster.EmpID=
                  supervisors.EmpID);
```

You must qualify each column with a table name.

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What does it mean to *qualify* a column? When a column appears in more than one table, the column name is preceded with the table name or alias to avoid ambiguity. In this example you use the table names STAFFMASTER and SUPERVISORS in front of the column name of EmpID. Although table aliases are not used in this example, they are merely table nicknames and are discussed further in Section 3.2.

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'=
         (select JobCategory
          from airline.supervisors
   where staffmaster.EmpID=
         supervisors.EmpID);
```

Step 1: The outer query takes the first row in AIRLINE.STAFFMASTER and finds the EmpID, LastName, FirstName, and State.

Airline.staffmaster - Partial Listing

EmpID	LastName	FirstName
1919	ADAMS	GERALD
1401	AVERY	JERRY
1269	CASTON	FRANKLIN
1935	FERNANDEZ	KATRINA
1124	FIELDS	DIANA
1677	KRAMER	JACKSON
1442	NEWKIRK	SANDRA
1417	NEWKIRK	WILLIAM
1352	RIVERS	SIMON

Airline.supervisors - Partial Listing

EmpID	State	JobCategory
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1385	CT	ME
1420	NJ	ME
1882	NY	ME
1935	CT	NA
1417	NJ	NA
1352	NY	NA
1106	CT	PT
1442	NJ	PT
1405	NJ	SC
1564	NY	SC
1401	NJ	TA
1126	NY	TA

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'=
         (select JobCategory
          from airline.supervisors
   where staffmaster.EmpID=
         supervisors.EmpID);
```

Step 2: Match STAFFMASTER.EMPID with SUPERVISORS.EMPID to find the qualifying row in AIRLINE.SUPERVISORS.

AIRLINE.STAFFMASTER.EMPID=
AIRLINE.SUPERVISORS.EMPID?

NO MATCH

Airline.staffmaster - Partial Listing

EmpID	LastName	FirstName
1919	ADAMS	GERALD
1401	AVERY	JERRY
1269	CASTON	FRANKLIN
1935	FERNANDEZ	KATRINA
1124	FIELDS	DIANA
1677	KRAMER	JACKSON
1442	NEWKIRK	SANDRA
1417	NEWKIRK	WILLIAM
1352	RIVERS	SIMON

Airline.supervisors - Partial Listing

EmpID	State	JobCategory
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1385	CT	ME
1420	NJ	ME
1882	NY	ME
1935	CT	NA
1417	NJ	NA
1352	NY	NA
1106	CT	PT
1442	NJ	PT
1405	NJ	SC
1564	NY	SC
1401	NJ	TA
1126	NY	TA

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'=
         (select JobCategory
          from airline.supervisors
   where staffmaster.EmpID=
         supervisors.EmpID);
```

Steps 1 and 2 (repeated): Read the next row from AIRLINE.STAFFMASTER, and identify the qualifying row in AIRLINE.SUPERVISORS.

AIRLINE.STAFFMASTER.EMPID=
AIRLINE.SUPERVISORS.EMPID?

MATCH

Airline.staffmaster - Partial Listing

EmpID	LastName	FirstName
1919	ADAMS	GERALD
1401	AVERY	JERRY
1269	CASTON	FRANKLIN
1935	FERNANDEZ	KATRINA
1124	FIELDS	DIANA
1677	KRAMER	JACKSON
1442	NEWKIRK	SANDRA
1417	NEWKIRK	WILLIAM
1352	RIVERS	SIMON

Airline.supervisors - Partial Listing

EmpID	State	JobCategory
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1385	CT	ME
1420	NJ	ME
1882	NY	ME
1935	CT	NA
1417	NJ	NA
1352	NY	NA
1106	CT	PT
1442	NJ	PT
1405	NJ	SC
1564	NY	SC
1401	NJ	TA
1126	NY	TA

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'='TA'
         (select JobCategory
          from airline.supervisors
   where staffmaster.EmpID=
         supervisors.EmpID);
```

Resolves to FALSE

Step 3: The inner query now passes the JobCategory of the selected row in AIRLINE.SUPERVISORS back to the outer query via the = operator, where the JobCategory is matched for selection in the outer query.

AIRLINE.STAFFMASTER.EMPID=
AIRLINE.SUPERVISORS.EMPID?

Airline.staffmaster - Partial Listing

EmpID	LastName	FirstName
1919	ADAMS	GERALD
1401	AVERY	JERRY
1269	CASTON	FRANKLIN
1935	FERNANDEZ	KATRINA
1124	FIELDS	DIANA
1677	KRAMER	JACKSON
1442	NEWKIRK	SANDRA
1417	NEWKIRK	WILLIAM
1352	RIVERS	SIMON

Airline.supervisors - Partial Listing

EmpID	State	JobCategory
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1385	CT	ME
1420	NJ	ME
1882	NY	ME
1935	CT	NA
1417	NJ	NA
1352	NY	NA
1106	CT	PT
1442	NJ	PT
1405	NJ	SC
1564	NY	SC
1401	NJ	TA
1126	NY	TA

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'=
         (select JobCategory
          from airline.supervisors
   where staffmaster.EmpID=
         supervisors.EmpID);
```

Continue repeating steps 2 and 3 until all rows are read from AIRLINE.STAFFMASTER.

AIRLINE.STAFFMASTER.EMPID=
AIRLINE.SUPERVISORS.EMPID?

NO MATCH

Airline.staffmaster - Partial Listing

EmpID	LastName	FirstName
1919	ADAMS	GERALD
1401	AVERY	JERRY
1269	CASTON	FRANKLIN
1935	FERNANDEZ	KATRINA
1124	FIELDS	DIANA
1677	KRAMER	JACKSON
1442	NEWKIRK	SANDRA
1417	NEWKIRK	WILLIAM
1352	RIVERS	SIMON

Airline.supervisors - Partial Listing

EmpID	State	JobCategory
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1385	CT	ME
1420	NJ	ME
1882	NY	ME
1935	CT	NA
1417	NJ	NA
1352	NY	NA
1106	CT	PT
1442	NJ	PT
1405	NJ	SC
1564	NY	SC
1401	NJ	TA
1126	NY	TA

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'=
         (select JobCategory
          from airline.supervisors
   where staffmaster.EmpID=
         supervisors.EmpID);
```

Continue repeating steps 2 and 3 until all rows are read from AIRLINE.STAFFMASTER.

AIRLINE.STAFFMASTER.EMPID= AIRLINE.SUPERVISORS.EMPID?

MATCH

Airline.staffmaster - Partial Listing

EmpID	LastName	FirstName
1919	ADAMS	GERALD
1401	AVERY	JERRY
1269	CASTON	FRANKLIN
1935	FERNANDEZ	KATRINA
1124	FIELDS	DIANA
1677	KRAMER	JACKSON
1442	NEWKIRK	SANDRA
1417	NEWKIRK	WILLIAM
1352	RIVERS	SIMON

Airline.supervisors - Partial Listing

EmpID	State	JobCategory
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1385	CT	ME
1420	NJ	ME
1882	NY	ME
1935	CT	NA
1417	NJ	NA
1352	NY	NA
1106	CT	PT
1442	NJ	PT
1405	NJ	SC
1564	NY	SC
1401	NJ	TA
1126	NY	TA

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'='NA'
         (select JobCategory
          from airline.supervisors
   where staffmaster.EmpID=
         supervisors.EmpID);
```

Resolves to TRUE

Pass JobCategory from AIRLINE.SUPERVISORS to outer query for comparison.

Airline.staffmaster - Partial Listing

EmpID	LastName	FirstName
1919	ADAMS	GERALD
1401	AVERY	JERRY
1269	CASTON	FRANKLIN
1935	FERNANDEZ	KATRINA
1124	FIELDS	DIANA
1677	KRAMER	JACKSON
1442	NEWKIRK	SANDRA
1417	NEWKIRK	WILLIAM
1352	RIVERS	SIMON

Airline.supervisors - Partial Listing

EmpID	State	JobCategory
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1385	CT	ME
1420	NJ	ME
1882	NY	ME
1935	CT	NA
1417	NJ	NA
1352	NY	NA
1106	CT	PT
1442	NJ	PT
1405	NJ	SC
1564	NY	SC
1401	NJ	TA
1126	NY	TA

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, State
      from airline.staffmaster
      where 'NA'='NA'
       (select JobCategory
        from airline.supervisors
   where staffmaster.EmpID=
         supervisors.EmpID);
```

Resolves to TRUE

Write LastName, FirstName, and State from AIRLINE.STAFFMASTER as the first row in a newly-created report.

Airline.staffmaster - Partial Listing

EmpID	LastName	FirstName
1919	ADAMS	GERALD
1401	AVERY	JERRY
1269	CASTON	FRANKLIN
1935	FERNANDEZ	KATRINA
1124	FIELDS	DIANA
1677	KRAMER	JACKSON
1442	NEWKIRK	SANDRA
1417	NEWKIRK	WILLIAM
1352	RIVERS	SIMON

Airline.supervisors - Partial Listing

EmpID	State	JobCategory
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1385	CT	ME
1420	NJ	ME
1882	NY	ME
1935	CT	NA
1417	NJ	NA
1352	NY	NA
1106	CT	PT
1442	NJ	PT
1405	NJ	SC
1564	NY	SC
1401	NJ	TA
1126	NY	TA

Correlated Subqueries

Build first row of report:

LastName	FirstName	State
FERNANDEZ	KATRINA	CT

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SAS continues this process until all rows are read from the table referred to in the outer query, AIRLINE.STAFFMASTER. At that point the third and final row of the report is written, as noted in the following slide.

Correlated Subqueries

Build third (and final) row of report:

LastName	FirstName	State
FERNANDEZ	KATRINA	CT
NEWKIRK	WILLIAM	NJ
RIVERS	SIMON	NY

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Correlated Subqueries

The EXISTS condition tests for the existence of a set of values returned by the subquery.

- The EXISTS condition is true if the subquery returns at least one row.
- The NOT EXISTS condition is true if the subquery returns no data.

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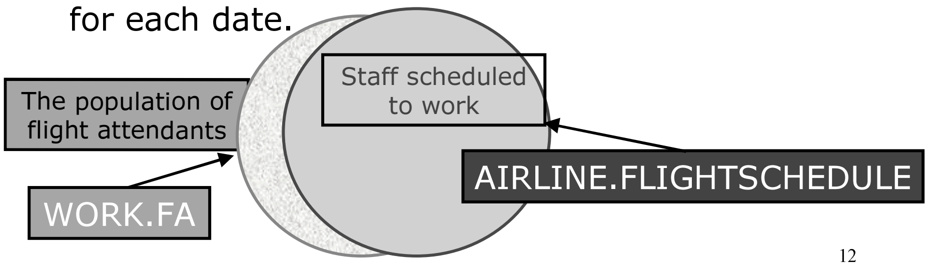
Correlated Subqueries

Example: The temporary table WORK.FA is a subset of AIRLINE.STAFFMASTER containing the names and IDs of all flight attendants.

The AIRLINE.FLIGHTSCHEDULE table contains a row for each crew member assigned to a flight for each date.



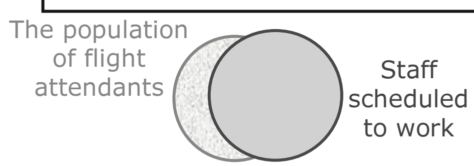
12

...

Correlated Subqueries

Example: Determine which flight attendants have not been scheduled.

```
proc sql;
   select LastName, FirstName
      from work.fa
      where not exists
         (select *
            from airline.flightschedule
            where fa.EmpID=
               flightschedule.EmpID);
```



12

Correlated Subqueries

Find employees who exist here...

```
proc sql;
  select LastName, FirstName
     from work.fa
     where not exists
       (select *
           from airline.flightschedule
           where fa.EmpID=
              flightschedule.EmpID);
```

...who do **not** exist here.

12

...

Correlated Subqueries

```
proc sql;
  select LastName, FirstName, EmpID
     from work.fa
     where not exists
      (select *
       from airline.flightschedule
          where fa.EmpID=
          flightschedule.EmpID);
quit;
```

What you want: Those employees who are here...

but **not** here....

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

12

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

FA.EMPID = FLIGHTSCHEDULE.EMPID?

MATCH

12

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

FA.EMPID = FLIGHTSCHEDULE.EMPID?

MATCH

128

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

FA.EMPID = FLIGHTSCHEDULE.EMPID?

NO MATCH

129

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

Therefore, the NOT EXISTS clause **is** satisfied and the first row is written to the Output report.

```
                                       Employee
LastName          FirstName            Number
------------------------------------------------
VEGA              FRANKLIN             1415
```

1 0

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

FA.EMPID = FLIGHTSCHEDULE.EMPID?

MATCH

LastName	FirstName	Employee Number
VEGA	FRANKLIN	1415

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

11

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

FA.EMPID = FLIGHTSCHEDULE.EMPID?

NO MATCH

LastName	FirstName	Employee Number
VEGA	FRANKLIN	1415

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

12

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

FA.EMPID = FLIGHTSCHEDULE.EMPID?

MATCH

LastName	FirstName	Employee Number
VEGA	FRANKLIN	1415
PATTERSON	RENEE	1424

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

FA.EMPID = FLIGHTSCHEDULE.EMPID?

MATCH

LastName	FirstName	Employee Number
VEGA	FRANKLIN	1415
PATTERSON	RENEE	1424

1

...

Correlated Subqueries

```
proc sql;
   select LastName, FirstName, EmpID
      from work.fa
      where not exists
         (select *
          from airline.flightschedule
             where fa.EmpID=
             flightschedule.EmpID);
quit;
```

PROC SQL terminated at EOF.

WORK.FA - Partial Listing

FirstName	LastName	EmpID
..	..	..
RANDALL	PETERS	1413
NATHAN	SANDERSON	1414
FRANKLIN	VEGA	1415
MARIE	FLETCHER	1422
RENEE	PATTERSON	1424
JENNY	UNDERWOOD	1425
..	..	..

EOF

AIRLINE.FLIGHTSCHEDULE Partial Listing

Flight Number	Date	Destination	EmpID
..	..	..	..
182	02MAR2000	YYZ	1414
271	02MAR2000	CDG	1413
132	03MAR2000	YYZ	1425
821	03MAR2000	LHR	1422
..	..	..	..

LastName	FirstName	Employee Number
VEGA	FRANKLIN	1415
PATTERSON	RENEE	1424

Final Report

1

Correlated Subqueries

Final Report

LastName	FirstName	Emp ID
VEGA	FRANKLIN	1415
PATTERSON	RENEE	1424

1

2.8 Exercises

Submit a LIBNAME statement to assign the libref AIRLINE to the course SAS data library. (TSO only: DISP=SHR)

TSO: `libname airline '.sql8.sasdata';`

Directory-based systems: `libname airline '.';`

6. Summarizing Data

Use the AIRLINE.FLIGHTDELAYS table to answer the questions.

a. What was the maximum delay experienced for any flight in the table?

b. What was the maximum delay experienced by each of the destinations?

c. What was the average delay for each destination?

d. Which destinations have an average delay that is greater than the overall average delay?

7. Summarizing Data in Groups

Use the AIRLINE.STAFFMASTER table to determine the number of people employed by the airline in each city. Order the report by state and city.

Output

```
                 Number of Employees in Each City

                                            Number
               State  City                Employed
               ------------------------------------
               CT     BRIDGEPORT                19
               CT     STAMFORD                  25
               NJ     PATERSON                   5
               NJ     PRINCETON                 10
               NY     MT. VERNON                 5
               NY     NEW YORK                  79
               NY     WHITE PLAINS               5
```

8. Subqueries

Each month a memo is posted that lists the employees who have employment anniversaries for that month. Create the report for February and list the first and last names of all employees who were hired during the month of February of any year. You can find employee names in the AIRLINE.STAFFMASTER table, and employee hire dates in the AIRLINE.PAYROLLMASTER table. Order the report by employee last name.

Output

```
                    Employees with February Anniversaries

                        FirstName        LastName
                        ------------------------------
                        JUSTIN           BLAIR
                        JASON            BROWN
                        GERALD           FOSTER
                        MICHAEL          HOWARD
                        MARILYN          REED
                        WAYNE            THOMPSON
                        KATHY            TRIPP
                        FRANKLIN         VEGA
                        CHIN             WANG
                        ELAINE           WARD
                        CAROLYN          WHALEY
```

9. Correlated Subqueries (Optional)

Create a report that shows the number of employees who are frequent flyers of the airline. Employees are listed in AIRLINE.STAFFMASTER and frequent flyers are in AIRLINE.FREQUENTFLYERS. (Hint: Names are stored differently in the two tables.)

Output

```
                    Number of Employees Listed

                               count
                            --------
                                 135
```

10. Summarizing Data (Optional)

a. Use the AIRLINE.FLIGHTDELAYS table to determine the number of times each flight was delayed in March. (Hint: There should be one row for each flight.) Order the report by flight number.

Partial Output

```
                         Delayed Arrivals

                                                Times
                   FlightNumber  Destination   Delayed
                   -----------------------------------
                   114           LAX                19
                   132           YYZ                21
                   182           YYZ                15
                   183           WAS                16
                   202           ORD                16
```

b. Use the AIRLINE.FLIGHTDELAYS table to determine the number of times each flight was on time (Times Delayed=0) in March. Order your report by flight number.

Partial Output

```
                        On-Time Arrivals

                                                On-time
               FlightNumber  Destination          Count
               ____________________________________________

               114           LAX                      3
               132           YYZ                      2
               182           YYZ                      3
               183           WAS                      3
               202           ORD                      2
```

2.9 Chapter Summary

The SQL procedure enables you to use SQL statements in a SAS program. When you use the SQL procedure, you do not need to repeat the PROC SQL statement with each query, and you do not need a RUN statement. Results of the query are displayed automatically and can be ordered. Queries contain statements that are composed of clauses.

A SELECT statement is used to query one or more SAS data sets. Use the SELECT statement to retrieve data from a table and to specify how to display a report.

You can use the VALIDATE keyword to verify the validity of the query's syntax. Messages are printed in the SAS log.

You can calculate new columns by using expressions or DATA step functions. You can subset rows by using a WHERE clause or eliminate duplicate rows by using the DISTINCT keyword. The CALCULATED keyword enables you to use a previously calculated value elsewhere in the query. Use a GROUP BY clause to apply summary functions to groups of values and include an ORDER BY clause to sort the output. You can customize output with SAS formats, labels, and titles.

Summary functions are available to summarize data for the entire table or for groups of data in the table. You can select groups of data to be processed by using a HAVING clause.

You can use a subquery to select data from a table based on the result returned by another query. Subqueries are typically used in a WHERE or HAVING clause and are evaluated before the outer query. A correlated subquery is a subquery that depends on values returned by the outer query.

General form of the SELECT statement:

SELECT *column* <,*column*> *…*
    FROM *table*|*view* <,*table*|*view*> *…*
    <**WHERE** *expression*>
    <**GROUP BY** *column* <,*column*> *…*>
    <**HAVING** *expression*>
    <**ORDER BY** *column* <,*column*> *…*>;

2.10 Solutions to Exercises

1. **Querying a Table**

   a.

   ```
   proc sql;
      select *
         from airline.payrollmaster;
   ```

   b.

   ```
   select EmpID, Gender, JobCode, Salary
      from airline.payrollmaster;
   ```

   c.

   ```
   select EmpID, Gender, JobCode, Salary,
          Salary/3 as Tax
      from airline.payrollmaster;
   ```

   d.

   ```
   select EmpID, Gender, JobCode,
          Salary format=comma10.2,
          Salary/3 as Tax format=comma10.2
      from airline.payrollmaster;
   ```

   e.

   ```
   select EmpID, Gender, JobCode,
          Salary format=comma10.2,
          Salary/3 as Tax format=comma10.2
      from airline.payrollmaster
      where Gender='M';
   ```

   f.

   ```
   select EmpID, Gender, JobCode,
          Salary format=comma10.2,
          Salary/3 as Tax format=comma10.2
      from airline.payrollmaster
      where Gender='M'and JobCode contains 'FA';
   ```

2. **Eliminating Duplicates**

   ```
   proc sql;
   title 'Cities Where Employees Live';
      select distinct City
         from airline.staffmaster
         order by City;
   ```

3. **Subsetting Data**

   ```
   proc sql;
   title 'Flights Less Than One Third Full';
      select FlightNumber, Date, Destination,
             Boarded+Transferred+Nonrevenue as Total,
             PassengerCapacity
      from airline.marchflights
      where calculated Total<(PassengerCapacity/3)
      order by 4 desc;
   ```

4. **Querying Data (Optional)**

```
proc sql;
title "Frequent Fliers with First Names Beginning with an 'N'";
   select Name, ffid
      from airline.frequentflyers
      where Name like '%, N%';
```

Alternate Solution

```
select Name, ffid
   from airline.frequentflyers
   where left(scan(Name,2,',')) like 'N%';
```

5. **Using SAS Functions (Optional)**

```
proc sql;
title 'Employee Age Information';
   select EmpID label='Employee ID',
          DateOfBirth format=mmddyy8.
                label='Birth Date',
          DateOfHire format=mmddyy8.
                label='Hire Date',
          int((DateOfHire-DateOfBirth)/365.25)
                label='Age At Employment'
      from airline.payrollmaster;
```

6. **Summarizing Data**

a.

```
proc sql;
title 'Maximum Delay Experienced';
   select max(Delay) label='Max Delay'
      from airline.flightdelays;
```

b.

```
title 'Maximum Delay Experienced';
title2 'by Each Destination';
   select Destination,
          max(Delay) label='Max Delay'
      from airline.flightdelays
      group by Destination;
```

c.

```
title 'Average Delay for Each Destination';
   select Destination,
          avg(Delay) label='Average Delay'
      from airline.flightdelays
      group by Destination;
```

d.

```
title 'Destinations Having Average Delay';
title2 'Exceeding Overall Average';
   select Destination,
          avg(Delay) label='Average Delay'
      from airline.flightdelays
      group by Destination
      having avg(Delay)>
         (select avg(Delay)
            from airline.flightdelays);
```

7. Summarizing Data in Groups

```
proc sql;
title 'Number of Employees in Each City';
   select State, City,
          count(*) label='Number Employed'
      from airline.staffmaster
      group by State, City
      order by State, City;
```

8. Subqueries

```
proc sql;
title 'Employees with February Anniversaries';
   select FirstName, LastName
      from airline.staffmaster
      where EmpID in
         (select EmpID
            from airline.payrollmaster
            where month(DateOfHire)=2);
```

9. Correlated Subqueries (Optional)

```
proc sql;
title 'Number of Employees Listed';
title2 'in Frequent Flyer Table';
   select count(*) as count
      from airline.frequentflyers
      where exists
         (select *
            from airline.staffmaster
            where Name=trim(LastName)||', '||FirstName);
```

10. Summarizing Data (Optional)

a.

```
proc sql;
title 'Delayed Arrivals';
   select distinct FlightNumber, Destination,
          count(*) label='Times Delayed'
      from airline.flightdelays
      where Delay>0
      group by FlightNumber
      order by FlightNumber;
```

b.

```
title 'On-time Arrivals';
   select distinct FlightNumber, Destination,
          count(*) label='On-time Count'
      from airline.flightdelays
      where Delay=0
      group by FlightNumber
      order by FlightNumber;
```

Chapter 3 Combining Tables

3.1 Overview

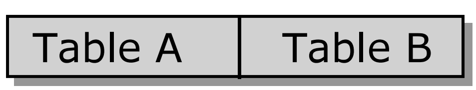
Objectives

- Distinguish between joins and set operations.

3

Combining Data from Multiple Tables

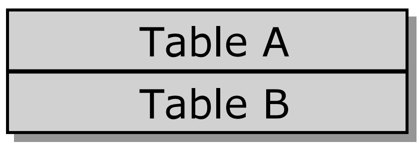
Joins combine tables horizontally (side by side).



4

Combining Data from Multiple Tables

Set operations combine tables vertically (one on top of the other).



5

Which DATA step statements perform similar operations?

3.2 Joins

Objectives

- Describe the different joins available in PROC SQL.
- Use a table alias.
- Compare SQL joins to DATA step merges.

7

Types of Joins

PROC SQL supports two types of joins:

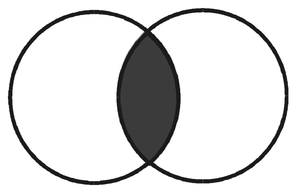
- inner joins
- outer joins.

8

Types of Joins

Inner joins

- return only matching rows
- allow a maximum of 32 tables to be joined at the same time.



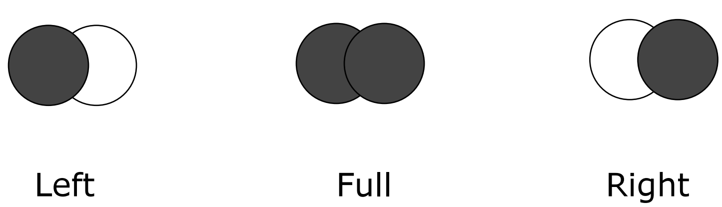
9

If the join involves views, the number of tables underlying the views, not the views themselves, counts towards the limit of 32.

Types of Joins

Outer joins

- return all matching rows, plus nonmatching rows from one or both tables
- can be performed on only two tables or views at a time.



10

Cartesian Product

A query that lists multiple tables in the FROM clause, without row restrictions, results in all possible combinations of rows from all tables. This is called a *Cartesian product*.

```
select *
   from one, two;
```

11

...

Cartesian Product

Table ONE

X	A
1	a
4	d
2	b

Table TWO

X	B
2	x
3	y
5	v

X	A	X	B
1	a	2	x
1	a	3	y
1	a	5	v
4	d	2	x
4	d	3	y
4	d	5	v
2	b	2	x
2	b	3	y
2	b	5	v

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...

Cartesian Product

The number of rows in a Cartesian product is the product of the number of rows in the contributing tables.

3 X 3 = 9

1,000 x 1,000 = 1,000,000

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A Cartesian product is rarely a desired query outcome. The SQL processor prints a warning in the log if a query involved a Cartesian product:

```
NOTE: The execution of this query involves performing one or more Cartesian
product joins that cannot be optimized.
```

Inner Joins

Inner join syntax resembles Cartesian product syntax, **but** it has a WHERE clause that restricts how the rows can be combined.

```
SELECT col1, col2, …
    FROM table1, table2, …
    WHERE join-condition(s)
          <AND other subsetting conditions>
    <other clauses>;
```

24

The distinguishing characteristics of inner join syntax are

- a list of two or more table names in the FROM clause
- one or more join conditions in the WHERE clause.

...

Inner Joins

Conceptually, PROC SQL

- first builds a Cartesian product
- then applies the specified restriction(s) and removes rows.

25

...

Inner Joins

Table ONE

X	A
1	a
4	d
2	b

Table TWO

X	B
2	x
3	y
5	v

X	A	X	B
1	a	2	x
1	a	3	y
1	a	5	v
4	d	2	x
4	d	3	y
4	d	5	v
2	b	2	x
2	b	3	y
2	b	5	v

```
select *
   from one, two ...
```

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...

Inner Joins

Table ONE

X	A
1	a
4	d
2	b

Table TWO

X	B
2	x
3	y
5	v

X	A	X	B
1	a	2	x
1	a	3	y
1	a	5	v
4	d	2	x
4	d	3	y
4	d	5	v
2	b	2	x
2	b	3	y
2	b	5	v

```
select *
   from one, two
   where one.x=two.x;
```

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Inner Joins

Table ONE

X	A
1	a
4	d
2	b

Table TWO

X	B
2	x
3	y
5	v

X	A	X	B
2	b	2	x

```
select *
   from one, two
   where one.x=two.x;
```

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An inner join is sometimes called a conventional join, natural join, or *equijoin*.

Tables do not have to be sorted before they are joined.

Column X exists in both tables and occurs twice in the query result.

Inner Joins

Display the X column only once.

Table ONE

X	A
1	a
4	d
2	b

Table TWO

X	B
2	x
3	y
5	v

```
select one.x, a, b
   from one, two
   where one.x=two.x;
```

X	A	B
2	b	x

29

Inner Joins

Display all combinations of rows with matching keys, including duplicates.

Table THREE

X	A
1	a1
1	a2
2	b1
2	b2
4	d

Table FOUR

X	B
2	x1
2	x2
3	y
5	v

```
select *
   from three, four
   where three.x=four.x;
```

X	A	X	B
2	b1	2	x1
2	b2	2	x1
2	b1	2	x2
2	b2	2	x2

32

How many rows does a DATA step match-merge produce for X = 2?

Inner Joins

Example: Display the names, job codes, and ages of all New York employees.

- Employee names are found in the AIRLINE.STAFFMASTER table.
- Employee job codes and birth dates are found in the AIRLINE.PAYROLLMASTER table.

33

Inner Joins

```
title 'New York Employees';
   select substr(FirstName,1,1)||'. ' ||
          LastName as Name,
          JobCode,
          int((today()-DateOfBirth)/365.25)
             as Age
      from airline.payrollmaster,
           airline.staffmaster
      where payrollmaster.empID=
            staffmaster.empID
            and State='NY'
      order by JobCode;
```

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Inner Joins

Partial Output

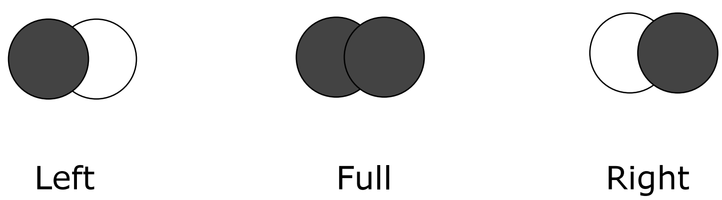
New York Employees

Name	Job Code	Age
R. LONG	BCK	30
L. GORDON	BCK	42
J. PEARSON	BCK	42
N. JONES	BCK	35
T. BURNETTE	BCK	34
R. VANDEUSEN	BCK	41
J. MARKS	BCK	35
D. WOOD	FA1	30

35

Outer Joins

You can retrieve nonmatching rows, as well as matching rows, by using an outer join. Outer joins are limited to two tables at a time.



36

An outer join is an augmentation of an inner join. It returns all the rows generated by an inner join, plus others.

Outer Joins

General form of an outer join:

```
SELECT col1, col2, …
    FROM table1
        LEFT|RIGHT|FULL JOIN
            table2
        ON join-condition(s)
    <other clauses>;
```

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The distinguishing characteristics of outer join syntax are

- exactly two table names flanking one of the three JOIN operators in the FROM clause
- a special ON clause specifying the join condition(s).

A WHERE clause is permitted in order to specify general subsetting conditions.

Outer Joins

A *left join* retrieves matching rows from both tables, plus nonmatching rows from the left table (the first table in the FROM clause).

Table ONE

X	A
1	a
2	b
4	d

Table TWO

X	B
2	x
3	y
5	v

```
select *
   from one left join two
   on one.x=two.x;
```

X	A	X	B
1	a	.	
2	b	2	x
4	d	.	

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Outer Joins

A *right join* retrieves matching rows from both tables, plus nonmatching rows from the right table (the second table in the FROM clause).

Table ONE

X	A
1	a
2	b
4	d

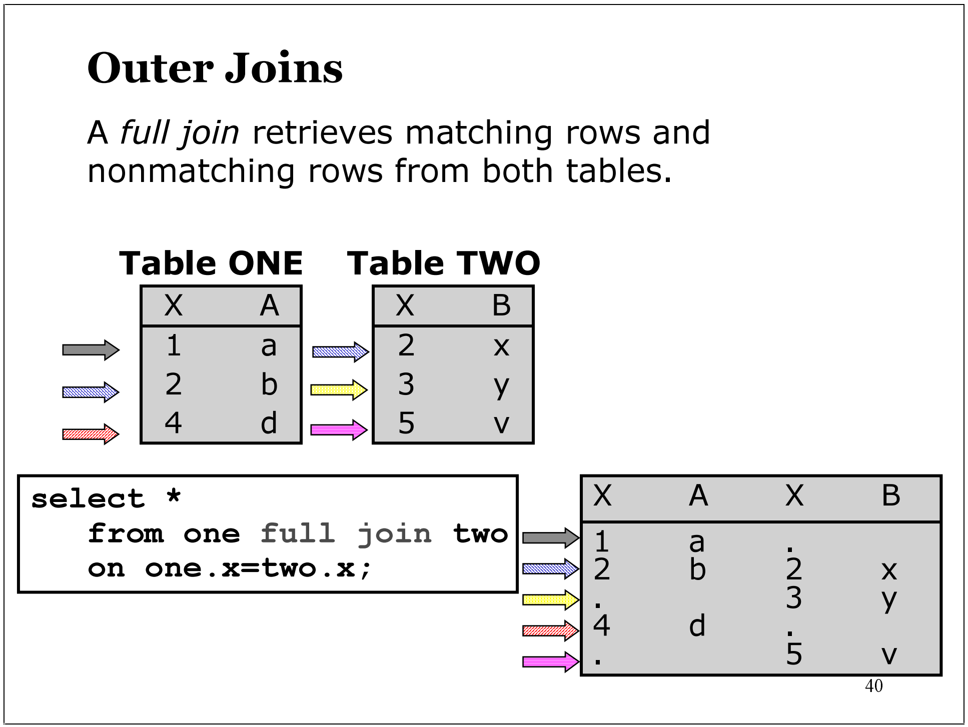
Table TWO

X	B
2	x
3	y
5	v

```
select *
   from one right join two
   on one.x=two.x;
```

X	A	X	B
2	b	2	x
.		3	y
.		5	v

39



Compare this result with the Cartesian product demonstrated earlier.

You can also write an inner join using this style of syntax:

```
SELECT *
    FROM one INNER JOIN two
    ON one.x = two.x;
```

but the join is limited to two tables.

Outer Joins

Example: List all flights during March with corresponding delay information (if it exists).

✐ AIRLINE.FLIGHTDELAYS does **not** contain delay information for all of the March flights.

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Outer Joins

```
title 'All March Flights';
   select marchflights.date,
          marchflights.flightnumber
             label='Flight Number',
          marchflights.destination
             label='Left',
          flightdelays.destination
             label='Right',
          delay
      from airline.marchflights left join
           airline.flightdelays
      on marchflights.date=flightdelays.date
         and marchflights.flightnumber=
             flightdelays.flightnumber
      order by delay;
```

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Outer Joins

Partial Output

All March Flights

Date	Flight Number	Left	Right	DelayIn Minutes
16MAR2000	622	FRA		.
03MAR2000	416	WAS		.
17MAR2000	182	YYZ		.
14MAR2000	271	CDG		.
11MAR2000	290	WAS		.
08MAR2000	182	YYZ		.
.	132	YYZ		.
11MAR2000	202	ORD		.
29MAR2000	829	WAS		.
25MAR2000	872	LAX		.
22MAR2000	183	WAS		.
27MAR2000	982	DFW		.
25MAR2000	829	WAS	WAS	-10
18MAR2000	219	LHR	LHR	-10
09MAR2000	821	LHR	LHR	-10

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Using a Table Alias

An *alias* is a table nickname. You can assign an alias to a table by following the table name in the FROM clause with the AS keyword and a nickname for the table. Then use the alias in other clauses of the QUERY statement.

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A table alias is primarily used to reduce the amount of typing required to write a query. It is usually optional. There are, however, two situations that require a table alias:

- a self-join (a table is joined to itself), for example,

```
from airline.staffmaster as s1, airline.staffmaster as s2
```

- when referencing same-named columns from same-named tables in different libraries, for example,

```
from airline.flightdelays as ad,
   work.flightdelays as wd
      where ad.delay > wd.delay
```

Using a Table Alias

```
select l.date,
       l.flightnumber
          label='Flight Number',
       l.destination label='Left',
       r.destination label='Right',
       delay
   from airline.marchflights as l
        left join
        airline.flightdelays as r
   on l.date=r.date and
      l.flightnumber=r.flightnumber
   order by delay;
```

45

The AS keyword is optional in a table alias. The alias can directly follow the table name in the FROM clause.

SQL Join versus DATA Step Merge

A DATA step with MERGE and BY statements combines rows differently from an outer join.

Table ONE

X	A
1	a
2	b
4	d

Table TWO

X	B
2	x
3	y
5	v

```
data merged;
   merge one two;
   by x;
run;
```

Table MERGED

X	A	B
1	a	
2	b	x
3		y
4	d	
5		v

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SQL Join versus DATA Step Merge

A DATA step with MERGE and BY statements combines rows differently from an outer join.

Table ONE

X	A
1	a
2	b
4	d

Table TWO

X	B
2	x
3	y
5	v

```
proc sql;
   select one.x, a, b
      from one full join two
      on one.x=two.x;
```

X	A	B
1	a	
2	b	x
		y
4	d	
		v

47

In the SQL procedure, the two X columns are not overlaid by default.

How can you achieve the same result using PROC SQL?

SQL Join versus DATA Step Merge

You can use the COALESCE function to overlay two columns.

Table ONE

X	A
1	a
2	b
4	d

Table TWO

X	B
2	x
3	y
5	v

```
select coalesce(one.x,two.x)
          label='x', a, b
   from one full join two
   on one.x=two.x;
```

X	A	B
1	a	
2	b	x
3		y
4	d	
5		v

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The COALESCE function

- returns the first value that is a SAS nonmissing value
- requires all arguments to have the same data type.

If you omit the LABEL= option or an alias in a coalesced column, it appears without a column heading.

SQL Join versus DATA Step Merge

Joins do not require

- sorted or indexed tables
- same-named columns in join expressions
- equality in join expressions.

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Tables can be joined on inequalities, for example,

```
select columns
   from table1 as a, table2 as b
   where  a.itemnumber=b.itemnumber
      and a.cost > b.price;
```

Internal Processing of Joins

Conceptually, during a join,

- a Cartesian product is built internally
- WHERE processing selects the appropriate rows.

In reality, however, the PROC SQL optimizer breaks the Cartesian product into smaller pieces.

50

SAS data sets are stored in pages that contain a certain number of observations. To reduce input/output, the SQL procedure optimizer uses these pages in its processing.

During a two-way join, the following tasks are completed:

1. The first page from table A is read into memory, with as many of the first pages from table B that can fit into available memory.
2. Valid rows are selected.
3. The first page of table A is kept in memory. All subsequent pages from table B that can fit into memory are read and step 2 is repeated.
4. All pages from table B are processed in combination with page 1 from table A. Steps 1 through 4 are repeated for page 2 from table A. The entire process stops once all rows in both tables are processed.

The SQL procedure optimizer can process an equijoin (a join on an equals condition, for example, **`where x.idnum=y.idnum`**) more efficiently than a join involving an inequality.

During a two-way equijoin, the following tasks are completed:

1. Both tables are sorted by the matching column (if necessary) and are grouped by the matching column's value into chunks.

2. The Cartesian product is only performed on matching portions of data.

3. Once a section of data is processed, it is not processed again.

✎ The SQL procedure optimizer has other algorithms from which to select when you optimize a join. For example, you can use a hashing algorithm when you join a small table with a large table.

In a multiway join (more than two tables), in order to minimize the Cartesian product, the SQL procedure optimizer

- splits the join into a number of two-way joins, and eliminates rows and columns from the intermediate tables as soon as they are no longer required
- decides the order in which the tables are processed
- processes the joins in the order that minimizes the intermediate Cartesian product.

3.3 Complex Joins

Objectives

- Understand techniques that simplify the coding of a complex query.
- Compare solving a problem using PROC SQL with traditional SAS programming.

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In-Line Views

An *in-line view* is

- a temporary table that exists only during query execution
- created when a FROM clause contains a query expression in place of a table name.

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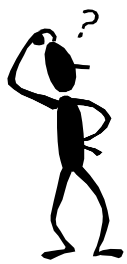
In-Line Views

Example: Which destinations experience the worst delays?



How do you define "worst delays"?

54

In-Line Views

Output

Destination	Average Delay	Maximum Delay	Number of Delays	Number of Early Arrivals	Probability of Delay
WAS	1	15	76	75	0.50
YYZ	2	14	36	24	0.60
DFW	3	20	38	23	0.62
ORD	3	19	51	41	0.55
LAX	5	27	82	41	0.67
LHR	6	30	39	19	0.67
CPH	6	26	16	11	0.59
FRA	6	34	14	12	0.54
CDG	9	39	21	5	0.81

55

In-Line Views

```
select destination,
       summarized columns,
       late / (late + early) as prob
          format=5.2
          label='Probability of Delay'
   from summarized table
   order by 2nd column;
```

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In-Line Views

Boolean expressions can be used in the SELECT clause.

```
select Delay,
       (Delay > 0) as Late
   from airline.flightdelays;
```

Delay	Late
0	0
8	1
-5	0
18	1

57

A Boolean expression resolves either to 1 (true) or 0 (false).

In-Line Views

```
select *, Late/(Late+Early) as prob
       format=5.2 label='Probability of Delay'
   from (select Destination,
               avg(Delay) as average
            format=3.0 label='Average Delay',
               max(Delay) as max
            format=3.0 label='Maximum Delay',
               sum(Delay > 0) as late
            format=3.0 label='Number of Delays',
               sum(Delay <= 0) as early
            format=3.0
               label='Number of Early Arrivals'
            from airline.flightdelays
            group by 1)
   order by 2;
```

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When it is summed, a Boolean expression displays the number of rows that are true.

You can use the calculated columns LATE and EARLY in the SELECT list because the in-line view is evaluated first.

In-Line Views

Output

Destination	Average Delay	Maximum Delay	Number of Delays	Number of Early Arrivals	Probability of Delay
WAS	1	15	76	75	0.50
YYZ	2	14	36	24	0.60
DFW	3	20	38	23	0.62
ORD	3	19	51	41	0.55
LAX	5	27	82	41	0.67
LHR	6	30	39	19	0.67
CPH	6	26	16	11	0.59
FRA	6	34	14	12	0.54
CDG	9	39	21	5	0.81

59

Handling a Complex Query

What are the names of the supervisors
for the crew on the flight to Copenhagen
on March 4, 2000?

60

Because this query involves four tables

- AIRLINE.FLIGHTSCHEDULE
- AIRLINE.STAFFMASTER
- AIRLINE.PAYROLLMASTER
- AIRLINE.SUPERVISORS

it may not be easy to code all at once. Split the query into small parts and test it each time that a new part is added.

The columns needed for this query are

- empid
- firstname
- lastname
- date
- destination
- jobcategory
- state

Handling a Complex Query

Step 1: Identify the crew for the flight.

```
select EmpID
   from airline.flightschedule
   where Date='04mar2000'd
         and Destination='CPH';
```

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Handling a Complex Query

Step 1 Output

Emp ID
1556
1830
1124
1135
1437
1839

63

Handling a Complex Query

Step 2: Find the states and job categories of the crew returned from the first query.

```
select substr(JobCode,1,2) as JobCategory,
       State
   from airline.staffmaster as s,
        airline.payrollmaster as p
   where s.empid=p.empid and s.empid in
      (select EmpID
         from airline.flightschedule
         where  Date='04mar2000'd
            and Destination='CPH');
```

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There is one supervisor for each state and job category.

Handling a Complex Query

Step 2 Output

JobCategory	State
FA	CT
FA	NY
NA	NY
PT	NY
PT	CT
FA	NY

65

Handling a Complex Query

Step 3: Find the employee numbers of the crew supervisors based on the states and job categories generated by the second query.

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Handling a Complex Query

```
select EmpId
   from airline.supervisors as m,
      (select substr(JobCode,1,2) as JobCategory,
              State
         from airline.staffmaster as s,
              airline.payrollmaster as p
         where s.empid=p.empid and s.empid in
            (select EmpID
               from airline.flightschedule
               where Date='04mar2000'd and
                     Destination='CPH')) as c
   where  m.jobcategory=c.jobcategory
      and m.state=c.state;
```

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You can assign an alias to an inline view.

Handling a Complex Query

Step 3 Output

Supervisor Id
1431
1983
1352
1118
1106
1983

68

Handling a Complex Query

Step 4: Find the names of the supervisors.

69

Handling a Complex Query

```
select FirstName, LastName
   from airline.staffmaster where empid in
      (select EmpID
         from airline.supervisors as m,
            (select substr(JobCode,1,2) as
                    JobCategory, State
               from airline.staffmaster as s,
                    airline.payrollmaster as p
               where s.empid=p.empid and s.empid in
                  (select EmpID
                     from airline.flightschedule
                     where Date='04mar2000'd and
                           Destination='CPH')) as c
   where  m.jobcategory=c.jobcategory
      and m.state=c.state);
```

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Handling a Complex Query

Step 4 Output

FirstName	LastName
SHARON	DEAN
ROGER	DENNIS
JASPER	MARSHBURN
SIMON	RIVERS
DEBORAH	YOUNG

71

Handling a Complex Query

You can also solve this problem by using a multiway join.

```
select distinct e.firstname, e.lastname
   from airline.flightschedule as a,
        airline.staffmaster as b,
        airline.payrollmaster as c,
        airline.supervisors as d,
        airline.staffmaster as e
   where a.date='04mar2000'd and
         a.destination='CPH' and
         a.empid=b.empid and
         a.empid=c.empid and
         d.jobcategory=substr(c.jobcode,1,2)
     and d.state=b.state and
         d.empid=e.empid;
```

72

This code provides a more efficient solution to the query, but it is more difficult to build step-by-step.

You must have two copies of the STAFFMASTER table: one to look up the states of the crewmembers, and the other to look up the names of the supervisors. If you use a single copy of the table, it restricts the query to supervisors who were actually in the flight crew, if any.

Comparison with Traditional SAS Programs

Perform the same task using traditional SAS programming.

```
/* Find the crew for the flight. */


proc sort data=airline.flightschedule (drop=flightnumber)
          out=crew (keep=empid);
   where destination='CPH' and date='04MAR2000'd;
   by empid;
run;

/* Find the State and job code for the crew. */

proc sort data=airline.payrollmaster
               (keep=empid jobcode)
          out=payroll;
   by empid;
run;

proc sort data=airline.staffmaster
             (keep=empid state firstname lastname)
          out=staff;
   by empid;
run;

data st_cat (keep=state jobcategory);
   merge crew (in=c)
         staff
         payroll;
   by empid;
   if c;
   jobcategory=substr(jobcode,1,2);
run;

/* Find the supervisor IDs. */

proc sort
     data=st_cat;
        by jobcategory state;
run;

proc sort data=airline.supervisors
          out=superv;
   by jobcategory state;
run;

data super (keep=empid);
   merge st_cat(in=s)
         superv;
   by jobcategory state;
   if s;
run;
```

```
/* Find the names of the supervisors. */

proc sort data=super;
   by empid;
run;

data names(drop=empid);
   merge super (in=super)
         staff (keep=empid firstname lastname);
   by empid;
   if super;
run;

proc print data=names noobs uniform;
run;
```

Output

```
                                LastName      FirstName

                                 MARSHBURN     JASPER
                                 DENNIS        ROGER
                                 RIVERS        SIMON
                                 YOUNG         DEBORAH
                                 DEAN          SHARON
                                 DEAN          SHARON
```

The SQL query eliminated the duplicate names seen in this output.

In the example, the SQL query uses less CPU time, but more I/O operations, than the non-SQL program (based on a mainframe benchmark in batch mode).

Choosing Between SQL Joins and DATA Step Merges

- DATA step merges are usually more efficient than SQL joins in combining small tables.
- SQL joins are usually more efficient than DATA step merges in combining large, unsorted tables.
- SQL joins are usually more efficient than DATA step merges in combining a large, indexed table with a small table.

73

A DATA step merge requires sorted data that call for one or more SORT procedure steps. PROC SQL does not require sorted data.

Choosing Between SQL Joins and DATA Step Merges

- For ad hoc queries, select the method that you can code in the shortest time.
- For production jobs, experiment with different coding techniques and evaluate performance statistics.

74

3.4 Exercises

Submit a LIBNAME statement to assign the libref AIRLINE to the course SAS data library:

TSO: `libname airline '.sql8.sasdata';`

Directory-based systems: `libname airline '.';`

1. Combining Data from Two Tables

Display the names of employees who have more than 20 years of service as of January 1, 2001. The AIRLINE.STAFFMASTER table contains employee names, and the AIRLINE.PAYROLLMASTER table contains hire date information. Order the output by employee last name.

```
           Employees with > 20 Years of Service
                     as of 01JAN2001

                FirstName        LastName
                --------------------------------
                JOSEPH           BAREFOOT
                JUSTIN           BLAIR
                DAVIS            CARAWAY
                DONALD           CARTER
                ROGER            DENNIS
                KATRINA          FERNANDEZ
                RAYMOND          HARTFORD
                ANNE             KIRBY
                ROY              LUFKIN
                ALICE            MURPHY
                JAMES            PEARSON
                ROBERT           STEPHENSON
                WAYNE            THOMPSON
                ALAN             TUCKER
                THERESA          UPDIKE
                ELAINE           WARD
                DARIUS           WELCH
```

2. Combining Data from Two Tables

Enhance the output from Exercise 1 by showing the number of years of service for each employee as of January 1, 2001.

```
                Employees with 20 Years of Service
                          as of 01JAN2001

                                                   YearsOf
            FirstName        LastName              Service
            ----------------------------------------------
            JOSEPH           BAREFOOT                   22
            JUSTIN           BLAIR                      21
            DAVIS            CARAWAY                    24
            DONALD           CARTER                     22
            ROGER            DENNIS                     22
            KATRINA          FERNANDEZ                  21
            RAYMOND          HARTFORD                   21
            ANNE             KIRBY                      22
            ROY              LUFKIN                     21
            ALICE            MURPHY                     22
            JAMES            PEARSON                    22
            ROBERT           STEPHENSON                 23
            WAYNE            THOMPSON                   23
            ALAN             TUCKER                     24
            THERESA          UPDIKE                     21
            ELAINE           WARD                       22
            DARIUS           WELCH                      21
```

3. Combining Data from Two Tables

Create a report that compares the number of passengers boarded with the capacity of the flight for all international flights. The AIRLINE.INTERNATIONALFLIGHTS table contains boarding information for **international** flights, and the AIRLINE.MARCHFLIGHTS table contains capacity information for **all** flights. Order the output by flight number and date.

Hints:

- Use the PERCENT5. format for the column calculated as Boarded/PassengerCapacity.
- Ignore the BOARDED column in AIRLINE.MARCHFLIGHTS.

Partial Output

```
                Capacity Figures for International Flights

                                                     Passenger
        FlightNumber        Date    Boarded           Capacity  Percent
        _______________________________________________________________

        132                    .         98                178      55%
        132            01MAR2000        115                178      65%
        132            02MAR2000        106                178      60%
        132            03MAR2000         75                178      42%
        132            04MAR2000        117                178      66%
        132            05MAR2000        157                178      88%
        132            06MAR2000        150                178      84%
        132            07MAR2000        164                178      92%
        132            08MAR2000        104                178      58%
        132            09MAR2000        119                178      67%
        132            10MAR2000         98                178      55%
```

4. Summarizing Data from Two Tables

Report the number of employees per job code for each state. Also display the average, maximum, and minimum salaries within the job code for each state. The AIRLINE.STAFFMASTER table contains state data, and the AIRLINE.PAYROLLMASTER table contains job code and salary data. Order the report by state and job code.

Partial Output

Salary Statistics by State and Job Code

State	Job Code	Total Employees	Average Salary	Maximum Salary	Minimum Salary
CT	BCK	2	$36,038.80	$36,409.80	$35,667.80
CT	FA1	3	$32,615.80	$33,570.60	$31,175.20
CT	FA2	4	$39,373.25	$40,070.80	$38,498.60
CT	FA3	2	$46,433.80	$46,522.00	$46,345.60
CT	ME1	2	$39,121.60	$39,300.80	$38,942.40
CT	ME2	5	$49,864.08	$51,367.40	$49,151.20
CT	ME3	3	$59,600.33	$61,460.00	$58,171.40
CT	NA1	3	$58,866.27	$59,183.60	$58,366.00
CT	NA2	1	$71,513.40	$71,513.40	$71,513.40
CT	PT1	3	$95,962.07	$99,030.40	$92,582.00
CT	PT2	4	$121,587.90	$125,484.80	$118,259.40
CT	TA1	4	$38,736.25	$39,981.20	$37,146.20
CT	TA2	6	$47,056.80	$48,724.20	$45,887.80
CT	TA3	2	$55,638.10	$56,364.00	$54,912.20

5. Combining Data from Multiple Tables (Optional)

Create a flight and employee schedule that is ordered by flight number, date, last name, and first name. The data is in the tables AIRLINE.STAFFMASTER (name information), AIRLINE.FLIGHTSCHEDULE (schedule information), and AIRLINE.MARCHFLIGHTS (flight information).

Partial Output

```
                     Flight Schedule for Airline Employees

      Flt                                             Emp      Dep
      Num       Date  FirstName        LastName    Num     Time  Dest
      -------------------------------------------------------------------
      132  01MAR2000  JONATHAN         BOYCE       1739   15:35  YYZ
      132  01MAR2000  SHARON           DEAN        1983   15:35  YYZ
      132  01MAR2000  JAMES            NEWTON      1478   15:35  YYZ
      132  01MAR2000  JEREMY           RHODES      1111   15:35  YYZ
      132  01MAR2000  JONATHAN         SMART       1390   15:35  YYZ
      132  01MAR2000  DEBORAH          WOOD        1130   15:35  YYZ
      132  02MAR2000  MARSHALL         CAHILL      1574   15:35  YYZ
      132  02MAR2000  JACKSON          JOHNSON     1411   15:35  YYZ
      132  02MAR2000  LESLIE           JONES       1113   15:35  YYZ
      132  02MAR2000  JAMES            NEWTON      1478   15:35  YYZ
      132  02MAR2000  MICHAEL          PENNINGTON  1556   15:35  YYZ
      132  02MAR2000  JEREMY           RHODES      1111   15:35  YYZ
      132  03MAR2000  JONATHAN         BOYCE       1739   15:35  YYZ
      132  03MAR2000  DOROTHY          CARTER      1437   15:35  YYZ
      132  03MAR2000  JEREMY           RHODES      1111   15:35  YYZ
```

6. Combining Data from Multiple Tables (Optional)

Display the flight attendants (job code of FA_) who are scheduled to fly to Copenhagen (CPH). Gather information from the tables AIRLINE.STAFFMASTER (name information), AIRLINE.PAYROLLMASTER (job code information), and AIRLINE.FLIGHTSCHEDULE (schedule information). Order the report by employee last name.

```
              Flight Attendants Scheduled for Copenhagen

                    FirstName        LastName
                    ________________________________
                    BARBARA          ARTHUR
                    DOROTHY          CARTER
                    DOROTHY          CARTER
                    ANTHONY          COOPER
                    ALICIA           EATON
                    DIANA            FIELDS
                    MARIE            FLETCHER
                    LESLIE           JONES
                    KATHY            LAWRENCE
                    CAROL            PEARCE
                    EDITH            SANDERSON
                    JONATHAN         SMART
                    JENNY            UNDERWOOD
                    ANNA             VEGA
                    ANNA             VEGA
                    DIANE            WALTERS
                    DEBORAH          WOOD
                    DEBORAH          YOUNG
```

3.5 Set Operators

Objectives

- Use the SQL set operators.
- Compare the SQL set operators to traditional SAS programming tools.

77

Types of Set Operators

Set operators combine rows from two tables vertically.

There are four set operators:

- EXCEPT
- INTERSECT
- UNION
- OUTER UNION.

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...

Default Behavior of Set Operators

EXCEPT
INTERSECT
UNION

- Columns are matched by position and must be the same data type.
- Column names in the result set are determined by the first table.

OUTER UNION

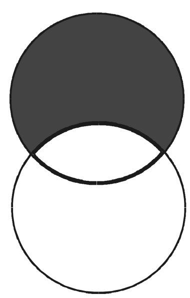
- All columns from both tables are selected.

79

Types of Set Operators

EXCEPT

- Unique rows from the first table that are **not** found in the second table are selected.

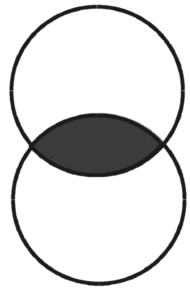


80

Types of Set Operators

INTERSECT

- **Common** unique rows from both tables are selected.

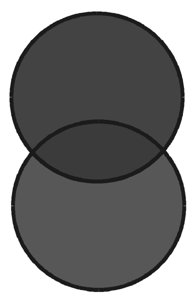


81

Types of Set Operators

UNION

- **All** unique rows from both tables are selected with columns overlaid.

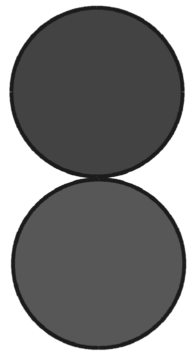


82

Types of Set Operators

OUTER UNION

- **All** rows from both tables, **unique as well as non-unique**, are selected.
- Columns are **not** overlaid.



83

Modifiers

You can use two keywords to modify the behavior of set operators:

- ALL
- CORRESPONDING.

84

Modifiers

ALL

- does not remove duplicate rows, and so avoids an extra pass through the data. Use the ALL keyword for better performance when it is possible.
- is not allowed in connection with an OUTER UNION operator. (It is implicit.)

85

Use ALL when

- you do not care if there are duplicates
- duplicates are not possible; for example, there is a unique or primary key constraint on the column.

Modifiers

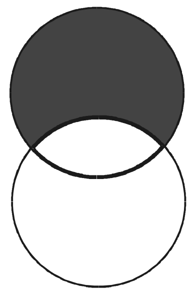
CORRESPONDING

- overlays columns by name, instead of by position
- removes any columns not found in both tables when used in EXCEPT, INTERSECT, and UNION operations
- causes common columns to be overlaid when used in OUTER UNION operations
- can be abbreviated as CORR.

86

EXCEPT

- Unique rows from the first table that are **not** found in the second table are selected.



87

The EXCEPT Operator

Display the unique rows in table ONE that are not found in table TWO.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
except
select *
   from two;
```

X	A
1	a
1	b
2	c
4	e
6	g

91

Duplicate rows are omitted.

How can you include duplicate rows?

The EXCEPT Operator

Display the rows (duplicates included) that are found in table ONE but not in table TWO.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
except all
select *
   from two;
```

X	A
1	a
1	a
1	b
2	c
4	e
6	g

94

The EXCEPT Operator

Display the unique rows that exist in table ONE and not in table TWO, based on same-named columns.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
except corr
select *
   from two;
```

X
4
6

99

The EXCEPT Operator

AIRLINE.STAFFCHANGES and AIRLINE.PAYROLLCHANGES contain information about

- current employees who have salary or job code changes
- new employees.

The new tables have the same layout as the AIRLINE.STAFFMASTER and AIRLINE.PAYROLLMASTER tables.

100

The EXCEPT Operator

Example: Display the names of new employees.

```
select FirstName,
       LastName
   from airline.staffchanges
      except all
select FirstName,
       LastName
   from airline.staffmaster;
```

101

The EXCEPT Operator

```
FirstName          LastName
------------------------------------
AMY                BRIDESTON
JIM                POWELL
```

102

The EXCEPT Operator

Example: How many employees have no changes in salary or job code?

```
select count(*) label='No. of Persons'
   from (select EmpID
            from airline.staffmaster
         except all
         select EmpID
            from airline.staffchanges);
```

103

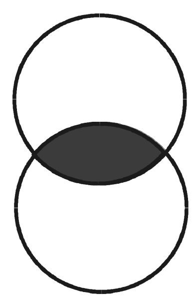
The EXCEPT Operator

No. of Persons
144

104

INTERSECT

- **Common** unique rows from both tables are selected.



105

The INTERSECT Operator

Display the unique rows common to table ONE and table TWO.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
intersect
select *
   from two;
```

X	A
3	v

109

Does the addition of the ALL keyword have any effect in this example?

The INTERSECT Operator

Display the unique rows common to table ONE and table TWO, based on same-named columns.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
intersect corr
select *
   from two;
```

X
1
2
3

114

The INTERSECT Operator

Example: What are the names of the old employees who have changed salary or job code?

```
select FirstName,
       LastName
   from airline.staffmaster
intersect all
select FirstName,
       LastName
   from airline.staffchanges;
```

115

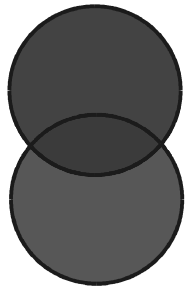
The INTERSECT Operator

FirstName	LastName
DIANE	WALTERS
KAREN	CARTER
NEIL	CHAPMAN
RAYMOND	SANDERS

116

UNION

- **All** unique rows from both tables are selected with columns overlaid.



117

The UNION Operator

Final result set.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
union
select *
   from two;
```

X	A
1	a
1	b
1	x
2	c
2	y
3	v
3	z
4	e
5	w
6	g

121

Does the addition of the ALL keyword make any difference in this example?

Notice the overlay of columns A and B.

The UNION Operator

Final result.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
union corr
select *
   from two;
```

X
1
2
3
4
6
5

125

The UNION Operator

Example: Add the miles traveled, bonus points earned, and bonus points used by frequent flyers.

126

The UNION Operator

```
title 'Points and Miles Traveled '
      'by Frequent Flyers';
select 'Total Points Earned :',
       sum(PointsEarned) format=comma12.
   from airline.frequentflyers
          union
select 'Total Points Used   :',
       sum(PointsUsed) format=comma12.
   from airline.frequentflyers
          union
select 'Total Miles Traveled:',
       sum(MilesTraveled) format=comma12.
   from airline.frequentflyers;
```

127

The UNION Operator

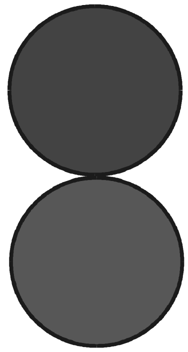
```
Points and Miles Traveled by Frequent Flyers
     ___________________________________

Total Points Earned :    11,083,463
Total Points Used   :     4,429,670
Total Miles Traveled:    10,477,963
```

128

OUTER UNION

- **All** rows from both tables, **unique as well as non-unique**, are selected.
- Columns are **not** overlaid.



129

The OUTER UNION Operator

Display all data values from table ONE and table TWO.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
outer union
select *
   from two;
```

X	A	X	B
1	a	.	
1	a	.	
1	b	.	
2	c	.	
3	v	.	
4	e	.	
6	g	.	
.		1	x
.		2	y
.		3	z
.		3	v
.		5	w

130

With the OUTER UNION operator, the ALL keyword is implied.

The OUTER UNION Operator

Display all data values from table ONE and table TWO, but overlay common columns.

Table ONE

X	A
1	a
1	a
1	b
2	c
3	v
4	e
6	g

Table TWO

X	B
1	x
2	y
3	z
3	v
5	w

```
select *
   from one
outer union corr
select *
   from two;
```

X	A	B
1	a	
1	a	
1	b	
2	c	
3	v	
4	e	
6	g	
1		x
2		y
3		z
3		v
5		w

131

Common columns can be overlaid using the CORR keyword.

The same result is obtained by using a DATA step with a SET statement.

The OUTER UNION Operator

Example: Display the employee numbers, job codes, and salaries of all mechanics.

```
select *
   from airline.mechanicslevel1
      outer union corr
select *
   from airline.mechanicslevel2
      outer union corr
select *
   from airline.mechanicslevel3;
```

132

The OUTER UNION Operator

Partial Output

Employee Number	Job Code	Salary
1400	ME1	$41,677
1403	ME1	$39,301
1120	ME1	$40,067
1121	ME1	$40,757
1412	ME1	$38,919
1200	ME1	$38,942
1995	ME1	$40,334
1418	ME1	$39,207
1653	ME2	$49,151
1782	ME2	$49,483

133

SQL versus Traditional SAS Programming

The following programs produce the same report:

```
data three;
   set one two;
run;
proc print data=three noobs;
run;
```

```
proc sql;
   select * from one
      outer union corr
   select * from two;
quit;
```

```
proc append base=one data=two;
run;
proc print data=one noobs;
run;
```

134

Comparing Methods of Combining Tables Vertically

- PROC APPEND is the fastest method of performing a simple concatenation of two tables. The BASE= table is not completely read; only the DATA= table is completely read.
- When logical conditions are involved, you can choose either the DATA step or PROC SQL.

continued...

135

Comparing Methods of Combining Tables Vertically

- SQL set operators generally require more computer resources, but are more convenient and flexible, than the DATA step equivalents.
- With the DATA step, you can process an unlimited number of tables at one time.
- With SQL set operators, you can work on only two tables at a time.

continued...

136

Although set operators work on only two tables at a time, you can chain multiple operators together, as in the Mechanics example demonstrated earlier in this section.

Comparing Methods of Combining Tables Vertically

- If multiple DATA steps are required to perform the task, consider using PROC SQL.
- If you are unsure which method is best, benchmark using the techniques discussed in Chapter 5.

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3.6 Exercises

Submit a LIBNAME statement to assign the libref AIRLINE to the course SAS data library.

TSO: `libname airline '.sql8.sasdata';`

Directory-based systems: `libname airline '.';`

7. Using Set Operators

Create a report that displays only the domestic (noninternational) flight numbers and destinations. AIRLINE.MARCHFLIGHTS contains data on **all** flights. AIRLINE.INTERNATIONALFLIGHTS contains data on only the **international** flights.

FlightNumber	Destination
114	LAX
183	WAS
202	ORD
290	WAS
302	WAS
308	ORD
416	WAS
431	LAX
439	
439	LAX
523	ORD
829	WAS
872	LAX
921	DFW
982	DFW

8. Handling a Complex Query

AIRLINE.PAYROLLCHANGES and AIRLINE.STAFFCHANGES contain data on employees with changes in job code or salary, as well as data on new employees. Create a report that displays information on new employees only, as shown below.

EmpID	FirstName	LastName	State	Job Code	DateOfHire
1447	AMY	BRIDESTON	NY	FA1	01NOV2000
1998	JIM	POWELL	NY	SCP	05NOV2000

To produce this report, break the problem into several steps.

a. Find the EmpID values of the new employees. Data on long-standing employees is stored in AIRLINE.STAFFMASTER. AIRLINE.STAFFCHANGES contains data on existing employees with status changes, plus new employees.

b. In a separate query, display the EmpID, FirstName, LastName, and State columns from AIRLINE.STAFFCHANGES, with the JobCode and DateOfHire columns from AIRLINE.PAYROLLCHANGES. (Six rows are displayed.)

c. Combine the two queries in parts **a** and **b**, so that the results of **b** (displaying six employees) are subset to display only employees returned from **a**.

3.7 Chapter Summary

PROC SQL provides many ways to combine data from multiple tables. Join operations enable you to combine tables horizontally using a key value. You can use an inner join to retrieve rows from up to 32 tables. Conceptually, PROC SQL forms a Cartesian product (all possible combinations of rows) and then selects the rows that satisfy the WHERE expression(s).

Outer joins enable you to select matching rows as well as nonmatching rows. A left join selects matching rows plus nonmatching rows from the left table. A right join selects matching rows plus nonmatching rows from the right table. A full join selects matching rows plus nonmatching rows from both tables (similar to a DATA step merge). The COALESCE function is available to overlay columns in the output. You can assign an alias to a table to simplify qualified column references in the query.

An in-line view is created when the FROM clause contains a query expression instead of actual table names, and exists only during the execution of the query.

You can use set operators to combine two tables vertically, that is, one table displayed immediately above the other. The EXCEPT operator selects unique rows from the first table that are not found in the second table. The INTERSECT operator selects unique rows found in both tables. The UNION operator selects all unique rows from both tables. The OUTER UNION operator concatenates the two tables. You can use the ALL keyword to prevent duplicate rows from being eliminated. The CORRESPONDING keyword forces PROC SQL to compare columns by name rather than by position.

General form of an inner join:

```
SELECT col1, col2, …
    FROM table1, table2, …
    WHERE join-condition(s)
         <AND other subsetting conditions>
    <other clauses>;
```

General form of an outer join:

```
SELECT col1, col2, …
    FROM table1
        LEFT|RIGHT|FULL JOIN
             table2
        ON join-condition(s)
     <other clauses>;
```

General form of an inner join that is limited to two tables:

```
SELECT *
    FROM one INNER JOIN two
    ON one.x = two.x;
```

General form of a left join:

```
SELECT column-name, column-name, ...
    FROM table-name LEFT JOIN table-name
    ON expression;
```

General form of a right join:

SELECT *column-name*, *column-name*, ...
    FROM *table-name* **RIGHT JOIN** *table-name*
    ON *expression*;

General form of a full join:

SELECT *column-name*, *column-name*, ...
    FROM *table-name* **FULL JOIN** *table-name*
    ON *expression*;

General form of a set operation:

SELECT *column-name*, *column-name*, ...
    FROM *table-name*
set-operator
SELECT *column-name*, *column-name*, ...
    FROM *table-name*;

Set operators:

- **EXCEPT**
- **INTERSECT**
- **UNION**
- **OUTER UNION**

3.8 Solutions to Exercises

1. **Combining Data from Two Tables**

```
select FirstName,
       LastName
   from airline.staffmaster as s,
        airline.payrollmaster as p
   where s.EmpID=p.EmpID
      and int(('01jan2001'd - DateOfHire)/365.25) > 20
   order by LastName;
```

2. **Combining Data from Two Tables**

```
select FirstName,
       LastName,
       int(('01jan2001'd - DateOfHire) / 365.25)
          as YearsOfService
   from airline.staffmaster as s,
        airline.payrollmaster as p
   where s.EmpID=p.EmpID
      and calculated YearsOfService > 20
   order by LastName;
```

3. **Combining Data from Two Tables**

```
select i.FlightNumber,
       i.Date,
       i.Boarded,
       PassengerCapacity,
       i.Boarded / PassengerCapacity as Percent
          format=percent5.
   from airline.internationalflights as i,
        airline.marchflights as m
   where i.FlightNumber=m.FlightNumber
      and i.Date=m.Date
   order by 1,
            2;
```

4. **Summarizing Data from Two Tables**

```
select State,
       JobCode,
       count(*) as TotalEmployees,
       avg(Salary) as AverageSalary
          format=dollar11.2,
       max(Salary) as MaximumSalary
          format=dollar11.2,
       min(Salary) as MinimumSalary
          format=dollar11.2
   from airline.staffmaster as s,
        airline.payrollmaster as p
   where s.EmpID=p.EmpID
   group by State,
            JobCode
   order by State,
            JobCode;
```

5. Combining Data from Multiple Tables (Optional)

```
select f.FlightNumber,
       f.Date,
       FirstName format=$10.,
       LastName format=$10.,
       f.EmpID,
       DepartureTime as DepTime,
       f.Destination as Dest
   from airline.staffmaster as s,
        airline.flightschedule as f,
        airline.marchflights as m
   where s.EmpID=f.EmpID
      and f.FlightNumber=m.FlightNumber
      and f.Date=m.Date
   order by 1, 2, 4, 3;
```

6. Combining Data from Multiple Tables (Optional)

```
select distinct FirstName,
                LastName
   from airline.staffmaster as s,
        airline.payrollmaster as p,
        airline.flightschedule as f
   where s.EmpID=p.EmpID
      and s.EmpID=f.EmpID
      and JobCode like 'FA_'
      and Destination='CPH'
   order by LastName;
```

7. Using Set Operators

```
select FlightNumber,
       Destination
   from airline.marchflights
except
select FlightNumber,
       Destination
   from airline.internationalflights;
```

8. Handling a Complex Query

a.

```
select EmpID
   from airline.staffchanges
except all
select EmpID
   from airline.staffmaster;
```

b.

```
select s.EmpID,
       FirstName,
       LastName,
       State,
       JobCode,
       DateOfHire
   from airline.staffchanges as s,
        airline.payrollchanges as p
   where s.EmpID = p.EmpID;
```

c.

```
select s.EmpID,
       FirstName,
       LastName,
       State,
       JobCode,
       DateOfHire
   from airline.staffchanges as s,
        airline.payrollchanges as p
   where s.EmpID = p.EmpID
      and s.EmpID in
         (select EmpID
            from airline.staffchanges
          except all
          select EmpID
            from airline.staffmaster);
```

Chapter 4 Creating and Modifying Tables and Views

4.1 Creating Tables

Objectives

- Define the column structure of a new table or use the column definitions from an existing table.
- Load data into a new table.
- Create a new table from the results of a query.

3

Creating Tables

Creates an empty table (Methods 1A and 1B).

Use the CREATE TABLE statement in three ways.

CREATE TABLE *table-name (column-name type(length), <column-name, type(length)>,...);*

CREATE TABLE *table-name* **LIKE** *table-name;*

CREATE TABLE *table-name* **AS** *query-expression;*

Populates table with a query result (Method 2).

4

Creating Tables

Method 1A: Define the columns and fill in the data rows later.

```
proc sql;
   create table airline.discount
     (dest char(3),
     BeginDate num format=date9.,
     EndDate num format=date9.,
     Discount num);
```

Name the table.

Define the table.

5

...

Defining Columns

PROC SQL accepts

- types of CHARACTER or VARCHAR, but interprets both as SAS **CHARACTER**. Default length is 8 bytes.
- types of INTEGER, SMALLINT, DECIMAL, NUMERIC, FLOAT, REAL, and DOUBLE PRECISION, interpreting all as SAS **NUMERIC** with a length of 8 bytes.
- a type of DATE, interpreted as a SAS **NUMERIC**, with a length of 8 bytes and a DATE. informat and format.

6

Although SAS reads all of the above mentioned data types, only CHARACTER and NUMERIC are used in SAS tables.

Defining Columns: More Examples

Method 1A:

```
proc sql;
   create table x
      (Name char(20),
       BirthDate date,
       Salary num format=comma10.2);
```

#	Variable	Type	Len	Format
1	Name	Char	20	
2	BirthDate	Num	8	DATE.
3	Salary	Num	8	COMMA10.2

7

The table created above does not contain any rows. Use this method when the table you want to create is unlike any other existing table.

Defining Columns: More Examples

Method 1A:

```
proc sql;
   create table y
      (Dept varchar,
       Code integer label='Dept Code');
```

#	Variable	Type	Len	Label
1	Dept	Char	8	
2	Code	Num	8	Dept Code

8

Defining Columns

Example: Create a table to store discounts for certain destinations and time periods in March. Define columns for destination, discount, and beginning and ending dates of the discount.

```
proc sql;
   create table discount
      (Destination char(3),
       BeginDate date label='BEGINS',
       EndDate date label='ENDS',
       Discount num);
```

```
NOTE:Table WORK.DISCOUNT created, with 0 rows
and 4 columns.
```

9

...

Creating Tables

Method 1B: Copy a table. Use column definitions from another table and fill in the rows of data later.

```
proc sql;
   create table airline.delaycat
      (drop=delayCategory DestinationType)
       like airline.flightdelays;
```

The columns in this table are copied to the new table.

10

Use Methods 1A and 1B to create tables containing columns that do not already exist in other tables, that is, define your own columns.

Creating Tables

Method 2: Store a query result in a table that defines both columns and rows.

```
proc sql;
   create table airline.fa as
      select LastName, FirstName, Salary
         from airline.payrollmaster,
              airline.staffmaster
         where payrollmaster.EmpID
               =staffmaster.EmpID
               and JobCode contains 'FA';
      select *
         from airline.fa;
```

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This method is particularly helpful when you create subsets or supersets of tables.

Use of the CREATE TABLE statement shuts off the automatic report generation. Also, this is the only method of the three that **both** creates **and** populates a table at the same time.

✎ Use this method when the table you want to create is similar or identical to another existing table.

Loading Data into a Table

Partial Output

The SAS System

LastName	FirstName	Salary
ARTHUR	BARBARA	$46,040
CAHILL	MARSHALL	$40,001
CARTER	DOROTHY	$46,346
COOPER	ANTHONY	$45,104
DEAN	SHARON	$46,787
DUNLAP	DONNA	$40,443
EATON	ALICIA	$38,902
FIELDS	DIANA	$32,448
FLETCHER	MARIE	$31,436
GOMEZ	ALAN	$31,175

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Loading Data into a Table

Method A: The SET Clause

INSERT INTO *table-name*
SET *column-name=value,column-name=value,...;*

Method B: The VALUES Clause

INSERT INTO *table-name <(column list)>*
VALUES *(value,value,value, ...);*

Method C: A Query-expression

INSERT INTO *table-name <(column list)>*
SELECT *columns* **FROM** *table-name*

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Loading Data into a Table

Once the table is created, you can enter rows of data using the INSERT statement with one of three methods.

Method A: The SET Clause

Populate DISCOUNT with these values.

```
proc sql;
   insert into discount
      set Destination='LHR',
          BeginDate='01MAR2000'd,
          EndDate='05MAR2000'd,Discount=.33
      set Destination='CPH',
          BeginDate='03MAR2000'd,
          EndDate='10MAR2000'd, Discount=.15;
```

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You may nest a SELECT statement within a SET statement, as follows:

```
proc sql;
   insert into discount
      set Destination='LHR', BeginDate=select max(Date)
          from airline.flightdelays;
```

Loading Data into a Table

Method B: The VALUES Clause

```
proc sql;
   insert into discount
      values('LHR','01MAR2000'd,
             '05MAR2000'd,.33)
      values('CPH','03MAR2000'd,
             '10MAR2000'd,.15);
```

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Loading Data into a Table

Method C: A Query-expression

```
proc sql;
   insert into discount(Destination,Discount)
      select Destination, Rate*.25
         from work.fares
         where Type='special';
```

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...

Loading Data into a Table

Example: Create the discount table, insert four rows of data, and display the table.

```
proc sql;
   create table discount
     (Destination char(3),
      BeginDate date label='BEGINS',
      EndDate date label='ENDS',
      discount num );
   insert into discount
   values('LHR','01MAR2000'd,'05MAR2000'd,.33)
   values('CPH','03MAR2000'd,'10MAR2000'd,.15)
   values('CDG','03MAR2000'd,'10MAR2000'd,.15)
   values('LHR','10MAR2000'd,'12MAR2000'd,.05);
```

Name the table.

Define the table.

Populate the table.

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Loading Data into a Table

```
select *
   from discount;
```

Output

```
                 The SAS System

   Destination   BEGINS      ENDS      discount

    LHR         01MAR2000   05MAR2000     0.33
    CPH         03MAR2000   10MAR2000     0.15
    CDG         03MAR2000   10MAR2000     0.15
    LHR         10MAR2000   12MAR2000     0.05
```

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You can use PROC PRINT in place of the final SELECT statement.

...

Integrity Constraints

- *Integrity constraints* are rules that table modifications must follow to guarantee validity of data.
- You can preserve the consistency and correctness of data by specifying integrity constraints for a SAS data file.
- SAS uses the integrity constraints to validate data when you insert or update the values of a variable for which you have defined integrity constraints.

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Integrity Constraints

Integrity constraints

- are part of Version 8 of base SAS software
- follow ANSI standards
- cannot be defined for views
- cannot be defined for historical versions of generation data sets
- can be specified when a table is created or later when a table contains data.

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Five Integrity Constraints

General:

- NOT NULL
- CHECK
- UNIQUE

Referential:

- PRIMARY KEY
- FOREIGN KEY

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NOT NULL	means that data is required and ensures that corresponding columns have non-missing values in each row.
CHECK	specifies what values may be entered in a column. If a user attempts to enter data that violates this constraint, SAS rejects the value.
UNIQUE	ensures that every value in a column is unique. The same column can be defined as NULL, but only a single null value is allowed per UNIQUE column.
PRIMARY KEY	identifies the column as the table's primary key. Only unique values are permitted and the primary key cannot contain missing values.
FOREIGN KEY	links one or more rows in a table to a specific row in another table by matching a foreign key in one table with the primary key in another table. This parent/child relationship limits modifications made to both primary and foreign keys. The only acceptable values for a foreign key are values of the the primary key or missing values.

Using PROC SQL to Create Integrity Constraints

General form of PROC SQL using integrity constraints:

```
PROC SQL;
    CREATE TABLE table
        (column-specification,…
        <constraint-specification,…>;
```

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Using PROC SQL to Create Integrity Constraints

Example: Re-create the DISCOUNT table with an integrity constraint to limit ticket discounting.

```
proc sql;
   create table discount
      (Destination char(3),
       BeginDate date label='BEGINS',
       EndDate date label='ENDS',
       discount num,
       CONSTRAINT ok_discount check
          (discount le .5));
```

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Using PROC SQL to Create Integrity Constraints

Example: Insert two rows using default UNDO_POLICY option (required).

```
proc sql;
   insert into discount
      values('CDG',03MAR2000'd,'10MAR2000'd,.15)
      values('LHR',10MAR2000'd,'12MAR2000'd,.55);
```

Stockholders may not tolerate excessive airline generosity!

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Using PROC SQL to Create Integrity Constraints

Partial Log

```
proc sql;
   insert into discount
      values('CDG','03MAR2000'd,'10MAR2000'd,.15)
      values('LHR','10MAR2000'd,'12MAR2000'd,.55);
ERROR: Add/Update failed for data set WORK.DISCOUNT
because data value(s) do not comply with integrity
constraint ok_discount.
NOTE: This insert failed while attempting to add
data from VALUES clause 2 to the dataset.
NOTE: Deleting the successful inserts before error
noted above to restore table to a consistent state.
```

0 rows inserted.

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Rollbacks

If an INSERT or UPDATE statement experiences an error while it processes the statement, then the inserts or updates that were completed up to the point of the error by that statement can be undone by use of the UNDO_POLICY option.

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Rollbacks with the UNDO_POLICY Option

- UNDO_POLICY=REQUIRED (the default)

  undoes all inserts or updates that have been done to the point of the error. Sometimes the UNDO operation cannot be done reliably.
- UNDO_POLICY=NONE

  prevents any updates or inserts from violating a constraint.
- UNDO_POLICY=OPTIONAL

  reverses any updates or inserts that it can reverse reliably.

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The ROLLBACK statement, although ANSI standard, is not currently supported in the SQL procedure.

UNDO_POLICY=REQUIRED

PROC SQL performs UNDO processing for INSERT and UPDATE statements.

If the UNDO operation cannot be done reliably, PROC SQL does not execute the statement, and issues an ERROR message.

UNDO cannot be attempted reliably in the following situations:

1. A SAS data set opened with CNTLLEV=RECORD can allow other users to update newly inserted records. An error during the insert deletes the record that the other user inserted.
2. A SAS/ACCESS view is not able to rollback the changes made by this statement without rolling back other changes at the same time.

Default: UNDO_POLICY=REQUIRED

UNDO_POLICY=NONE

PROC SQL skips records that cannot be inserted or updated, and writes to the SAS log a warning message similar to that written by PROC APPEND.

UNDO_POLICY=OPTIONAL

PROC SQL performs UNDO processing if it can be done reliably. If the UNDO cannot be done reliably, then no UNDO processing is attempted.

This option is a combination of the first two. If UNDO can be done reliably, then it is done. PROC SQL proceeds as if UNDO_POLICY=REQUIRED is in effect. Otherwise, it proceeds as if UNDO_POLICY=NONE was specified.

Using PROC SQL to Create Integrity Constraints

Example: Insert two rows using UNDO_POLICY=NONE.

```
proc sql undo_policy=none;
   insert into discount
    values('CDG',03MAR2000'd,'10MAR2000'd,.15)
    values('LHR',10MAR2000'd,'12MAR2000'd,.55);
```

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An alternative is to create constraints using PROC DATASETS.

Using PROC SQL to Create Integrity Constraints

Partial Log

```
WARNING: The SQL option UNDO_POLICY=REQUIRED is not
in effect. If an error is detected when processing
this INSERT statement,that error will not cause the
entire statement to fail.
ERROR: Add/Update failed for data set WORK.DISCOUNT
because data value(s) do not comply with integrity
constraint ok_discount.
NOTE: This insert failed while attempting to add
data from VALUES clause 2 to the data set.
NOTE: 2 rows were inserted into WORK.DISCOUNT. Of
these 1 row was rejected as an ERROR, leaving 1 row
that was inserted successfully.
```

1 of 2 rows inserted successfully.

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Documenting Table and View Definitions and Integrity Constraints

The DESCRIBE statement displays the definition of the view or CREATE TABLE statement of a table.

General form of the DESCRIBE statement:

PROC SQL;
    DESCRIBE TABLE *table-name*,<*,table-name*>…;
    DESCRIBE VIEW *proc-sql-view* <*,proc-sql-view*>…;
    DESCRIBE TABLE CONSTRAINTS *table-name*
        <*,table-name*> …;

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The DESCRIBE TABLE statement (without the CONSTRAINTS keyword) writes a CREATE TABLE statement to the SAS log for the specified table regardless of how the table was originally created (for example, with a DATA step).

If the table contains an index, CREATE INDEX statements for those indexes are also written to the SAS log. A discussion of indexes is in Section 4.3.

Documenting Table Definitions and Integrity Constraints

Example: Show the constraints for the DISCOUNT table.

```
proc sql;
   describe table discount;
```

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Documenting Table Definitions and Integrity Constraints

```
NOTE: SQL table WORK.DISCOUNT was created like:

create table WORK.DISCOUNT( bufsize=4096 )
  (
   Destination char(3),
   BeginDate num format=DATE. informat=DATE. label='BEGINS',
   EndDate num format=DATE. informat=DATE. label='ENDS',
   discount num
  );
      -----Alphabetic List of Integrity Constraints-----

               Integrity                Where
          #    Constraint     Type      Clause
          ------------------------------------------
          1    ok_discount    Check     discount<=0.5
```

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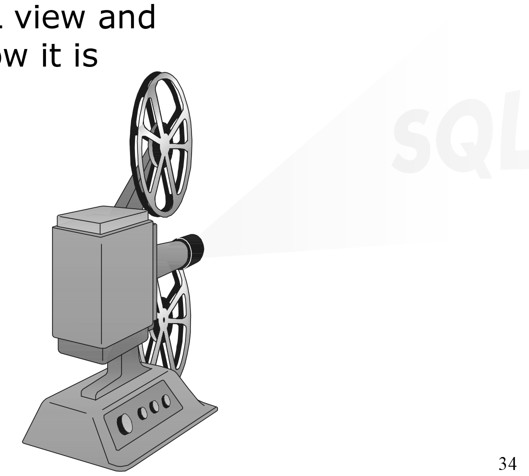
4.2 Creating Views

Objectives

- Create an SQL view and understand how it is best used.



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...

Creating a View

A PROC SQL view

- is a stored query. It contains no rows of data.
- can be used in SAS programs in place of an actual SAS data file.
- can be derived from one or more tables, PROC SQL views, DATA step views, or SAS/ACCESS views.
- extracts underlying data when used, thus accessing the most current data.

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Views are not separate copies of the data and are referred to as *virtual tables* because they do not exist as independent entities as do real tables. It may be helpful to think of a view as a movable frame or window through which you can see the data.

Thus, when the view is referenced by a SAS procedure or in a DATA step, it is executed, and conceptually, an internal table is built. PROC SQL processes this internal table as if it were any other table.

Creating a View

General form of the CREATE VIEW statement:

CREATE VIEW *view-name* **AS**
    query-expression;

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Creating a View

Example: Create a view containing personal information for flight attendants. Have the view always return the employee’s age as of the current date.

```
proc sql;
   create view airline.fa as
      select LastName,FirstName, Gender,
             int((today()-DateOfBirth)/365.25)
                as Age,
             substr(JobCode,3,1) as Level,
             Salary
         from airline.payrollmaster,
              airline.staffmaster
         where JobCode contains 'FA' and
               staffmaster.EmpID=
               payrollmaster.EmpID;
```

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In this example, the view AIRLINE.FA creates a virtual table from the accompanying SELECT statement. Although the underlying tables, AIRLINE.PAYROLLMASTER and AIRLINE.STAFFMASTER, can change, the instructions, which comprise the view, stay constant. Further, when this PROC SQL step is executed, SAS does not actually execute the SELECT statement following the AS keyword, but instead partially compiles and stores the SELECT statement in a data file with a member type of VIEW.

In the above example, if the alias Age were omitted, SAS creates a sequentially suffixed variable, starting with _TEMV001. The librefs for the tables in the FROM clause are optional in this case. It is assumed that the contributing tables are stored in the same library as the view itself, unless otherwise specified.

Using a View

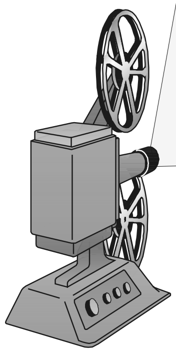
```
proc sql;
   select *
      from airline.fa;
```

Your view to the data

Partial Output

The SAS System

LastName	FirstName	Gender	Age	Level	Salary
ARTHUR	BARBARA	F	36	3	$46,040
CAHILL	MARSHALL	M	41	2	$40,001
CARTER	DOROTHY	F	41	3	$46,346
COOPER	ANTHONY	M	42	3	$45,104
DEAN	SHARON	F	39	3	$46,787
DUNLAP	DONNA	F	33	2	$40,443
EATON	ALICIA	F	40	2	$38,902



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Using a View

Example: Calculate the flight attendants' mean age, by level, using the AIRLINE.FA view.

Your view

```
proc tabulate data=airline.fa;
   class Level;
   var Age;
   table Level*Age*mean;
run;
```

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In both of the above examples, it only appears that the PROC SQL view, AIRLINE.FA, is a table because the view name itself is used in the same way as a SAS table name. However, it is **not** a table but a stored query-expression only! Both tables and views are considered SAS data sets.

Using a View

PROC TABULATE Output

The SAS System

Level		
1	2	3
Age	Age	Age
Mean	Mean	Mean
33.18	37.19	38.71

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Administering Views

Example: Write the view definition for AIRLINE.FA to the SAS log.

```
proc sql;
   describe view airline.fa;
```

```
NOTE: SQL view AIRLINE.FA is defined as:

select LastName, FirstName, Gender,
       INT((TODAY()-DateOfBirth)/365.25) as Age,
       SUBSTR(JobCode, 3, 1) as Level, Salary
   from AIRLINE.PAYROLLMASTER, AIRLINE.STAFFMASTER
      where JobCode contains 'FA' and
      (staffmaster.EmpID=payrollmaster.EmpID);
```

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...

Why Use Views?

You can

- access the most current data in changing tables, DATA step views, or SAS/ACCESS views
- pull together data from multiple database tables or even different databases
- simplify complex query-expressions and prevent users from altering code
- avoid storing a SAS copy of a large table.

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...

Administering Views: Some General Guidelines

- Avoid the ORDER BY clause in a view definition. Otherwise, the data must be sorted each time the view is referenced.
- If the same data is used many times in one program, create a table rather than a view.
- Avoid specifying two-level names in the FROM clause when you create a permanent view that resides in the same library as the contributing table(s).

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Administering Views

Example:

```
proc sql;
   create view sasdata.master as
      select *
         from sasdata.payrollmaster;
```

It is better to omit this.

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Administering Views: Omitting the Libref

Example:

```
proc sql;
   create view sasdata.master as
      select *
         from payrollmaster;
```

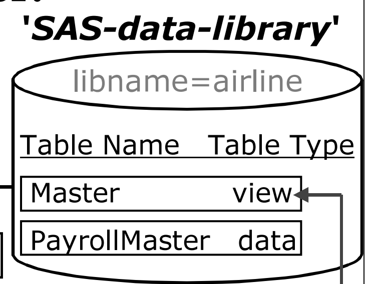
This looks like work.payrollmaster, ...

... but is **in reality** sasdata.payrollmaster!

45

...

Administering Views: Why Is It Better to Omit the Libref?




```
/* master view */

select *
   from sasdata.payrollmaster;
```

Step 1: Assign libref.

```
libname airline 'SAS-data-library';
```

Step 2: Execute instructions in view.

```
proc print data=airline.master;
run;
```

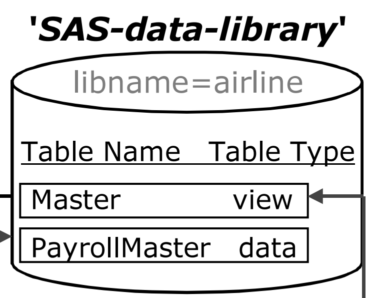
Step 3: See what went wrong!

```
ERROR: Libname SASDATA is not
assigned.
ERROR: SQL View AIRLINE.MASTER
could not be processed.
```

46

...

Administering Views: Why Is It Better to Omit the Libref?




```
select *
from Airline.payrollMaster
```

Step 1: Assign libref.

```
libname airline 'SAS-data-library';
```

Step 2: Execute instructions in view.

```
proc print data=airline.master;
run;
```

Step 3: Relax and be happy.

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Creating Views

An alternative: Embed the LIBNAME statement within a USING clause.

CREATE VIEW *proc-sql-view* **AS** *query-expression*
<USING *statement<, libname-clause>* ... > ;

This allows you to store a SAS libref in the view and does not conflict with an identically named libref in the SAS session.

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...

Administering Views: Using the Embedded LIBNAME Statement

```
libname sasdata 'SAS-data library one';
libname airline 'SAS-data library two';

proc sql;
   create view sasdata.journeymen as
   select *
      from airline.payrollmaster
      where jobcode like '   2'
      using libname airline 'SAS-data library three';
quit;
proc print data = sasdata.journeymen ;
```

1) While the view SASDATA.JOURNEYMEN is executing ...

2) ... libref AIRLINE becomes active ...

3) ... overriding any earlier assignment for the duration of the view's execution.

4) After view executes, original libref assignment (3) is re-established and embedded assignment (2) is cleared.

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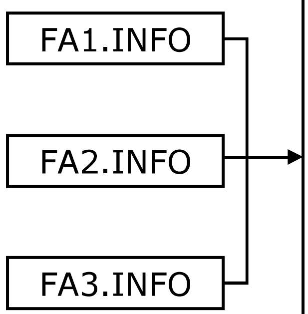
Administering Views

Example: Create a view to maintain table security.




```
create view manager.info as
   select *
      from fa1.info
   outer union corr
   select *
      from fa2.info
   outer union corr
   select *
      from fa3.info;
```

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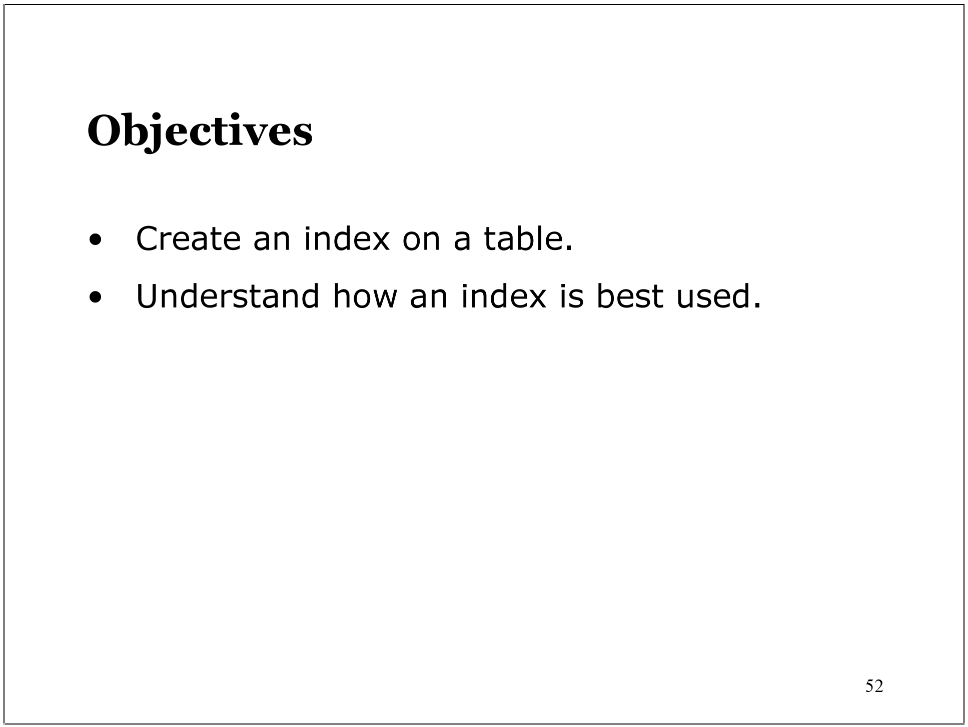
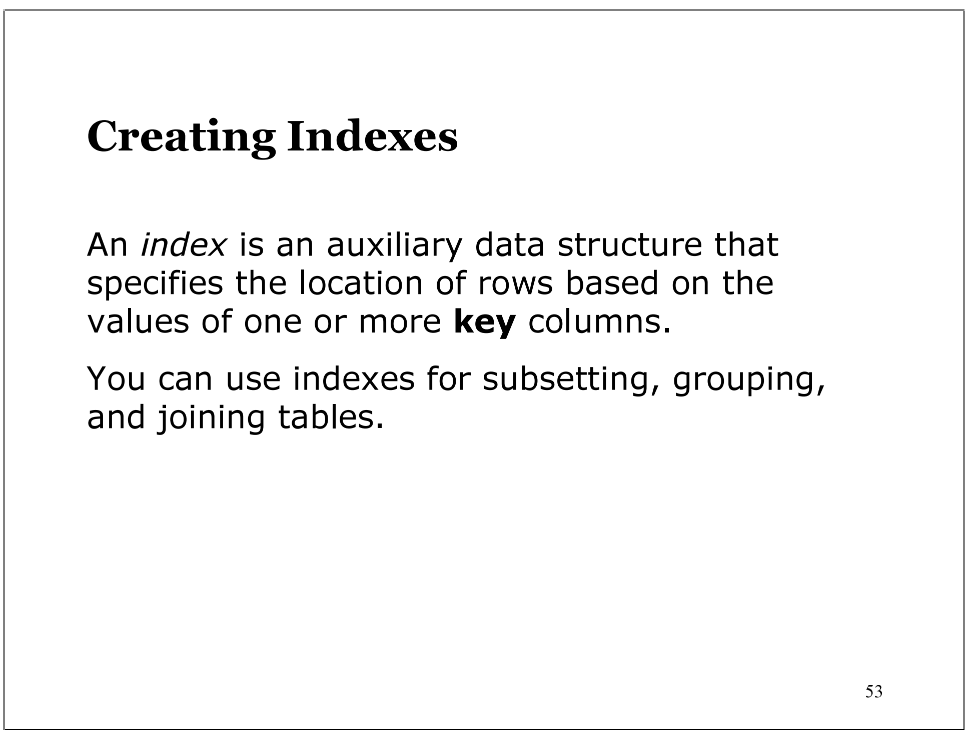
The MANAGER data library can be assigned access privileges at the operating system level and thereby prevent non-managerial flight attendants from reading the library while permitting managers (who are authorized to access all SAS data libraries) to view all information.

4.3 Creating Indexes





The index is a structure that boosts program performance by serving as a logical pointer to a physical location of a given value.

Creating Indexes

Indexed SAS Data Set

Row	EmpID	Gender	Jobcode
1	1001	F	FA1
2	1012	F	FA3
3	1015	M	FA2
.			
.			
.			
11	1104	M	FA3
.			
.			
.			

DATA or PROC Step

```
where Jobcode='FA3';
```

Index File

Key Column=Jobcode

Key Value	Location Page(row,row…)
FA1	1(1,4, …) 2(…) …
FA2	1(3,6, …) 2(…) …
FA3	1(2,11,…) 2(…) …

Data Processed

ROW	EmpID	Gender	Jobcode
2	1012	F	FA3
11	1104	M	FA3
		:	

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Creating Indexes: Overview

Indexes provide fast access to small subsets of data...

```
proc sql;
   select *
      from airline.payrollmaster
      where JobCode='NA1';
```

One of many values of the variable JobCode

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A small subset is <= 15%.

Creating Indexes - Overview

... and also enhance join performance.

```
proc sql;
   select *
      from airline.payrollmaster,
           airline.staffmaster
      where staffmaster.EmpID=
             payrollmaster.EmpID;
```

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When you subset data, you can select an index to optimize not only a WHERE clause with an equals comparison, but also a WHERE clause with the TRIM or SUBSTR function or the CONTAINS or LIKE operator.

...

Index Terminology

Two types of indexes are

simple	based on values of only one column
composite	based on values of more than one column concatenated to form a single value, for example, Date and FlightNumber.

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Index naming rules are the same as the rules for other SAS data files. Start with a letter or underscore, and continue with a combination of letters, characters, or numbers, with a 32-character maximum.

Index Terminology

A table can have

- multiple simple and composite indexes
- character and numeric key columns.

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...

Creating an Index

- Designate the key column(s).
- Select a name for the index. A simple index must have the same name as the column.
- Specify if the index is to be unique.

```
proc sql;
   create unique index EmpID
   on airline.payrollmaster(EmpID);
```

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Creating an Index

General form of the CREATE INDEX statement:

CREATE <UNIQUE> INDEX *index-name*
ON *table-name(column-name, column-name)*;

Precede the INDEX keyword with the UNIQUE keyword to define a unique index.

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Use of the optional UNIQUE keyword ensures that values in the row are unique. If a table contains multiple occurrences of the same value, the UNIQUE keyword is not accepted and the index is not defined on that column. Similarly, if you already have a uniquely defined index on a column and attempt to add a duplicate value to the table, the row is not inserted. For example, an index can be created on a column containing driver license or social security numbers, and thereby can prevent duplicate additions.

Additional notes:

1. Indexes can be based on either a character or numeric variable.
2. You do not want to create two indexes on the same variable.
3. You can achieve improved index performance if you create the index on a pre-sorted data set.
4. A composite index cannot have the same name as a variable.

...

Creating an Index: Examples

This simple index is based on EmpID and allows no duplicate ID numbers in the table.

Names must match for a simple index!

```
proc sql;
   create unique index EmpID
      on airline.payrollmaster(EmpID);
```

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Creating an Index: Examples

The composite index named DAILY is based on FLIGHTNUMBER and DATE.

Cannot be a column name.

```
proc sql;
   create unique index daily
      on airline.marchflights(FlightNumber,Date);
```

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To determine if an index is used, specify the SAS system option MSGLEVEL=I. A note appears in the SAS log when an index is selected for processing.

Indexing and Performance

Example: An index was created for the JobCode column of AIRLINE.PAYROLLMASTER. Use the MSGLEVEL=I system option to determine which queries used the index.

```
options msglevel = i;
proc sql;
   select *
      from airline.payrollmaster
      where JobCode = 'NA1';
INFO:Index JobCode selected for WHERE clause optimization.
   select *
      from airline.payrollmaster
      where salary gt 100000;
```

Applies to this WHERE clause only.

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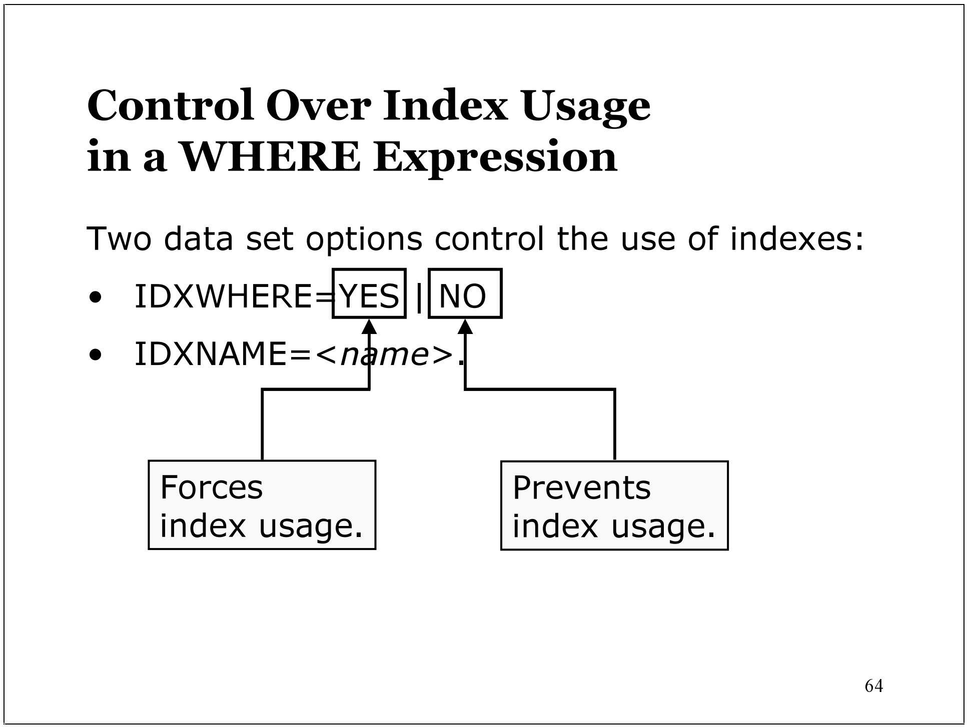

When the IDXWHERE= option is

YES — SAS uses the best available index to process the WHERE expression, even if SAS estimates that sequential processing is faster.

NO — SAS processes the data sequentially even if SAS estimates that processing with an index is better.

When the IDXNAME= option is

<*name*> — SAS uses the named index regardless of performance estimates.

If you do not use the IDXWHERE= option, SAS chooses whether to use an index. You can use either the IDXWHERE= or the IDXNAME= data set option, but not both.

...

Indexing and Performance

Suggested guidelines for using indexes:

- Keep the number of indexes to a minimum to reduce disk storage and update costs.
- Do not create an index for small tables; sequential access is faster on small tables.
- Do not create an index based on columns with a very small number of distinct values, for example, Male and Female.
- An index performs best when it retrieves a relatively small number of rows, that is, <15%.

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Indexing and Performance: Tradeoffs

Benefits	Costs
• Fast access to a small subset of data (<15%).	• Extra CPU cycles and I/O operations to create an index.
• Equijoins can be performed without internal sorts.	• Extra disk space to store the index file.
• Can enforce uniqueness.	• Extra memory to load index pages and code for use.
• BY group processing without sorting.	• Extra CPU cycles and I/O operations to maintain the index.

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4.4 Exercises

Submit a LIBNAME statement to assign the libref AIRLINE to the course SAS data library. (TSO only: DISP=SHR)

TSO: `libname airline '.sql8.sasdata';`

Directory-based systems: `libname airline '.';`

1. Creating a Table

A frequent flyer earns points for each mile traveled with the airline. After accumulating a certain number of points, the frequent flyer is eligible for an award. More accumulated points guarantees that a better award can be claimed.

a. Create a temporary table named AWARDS to store award data. The table's columns must have the following attributes:

Name	Type	Length	Format	Label
PTSREQD	NUM	8		Points Required
RANK	NUM	8	3.	
AWARD	CHAR	25		

b. Load the following data into the table:

PTSREQD	RANK	AWARD
2000	1	free night in hotel
10000	2	50% discount on flight
20000	3	free domestic flight
40000	4	free international flight

c. Display the new table.

d. The AIRLINE.FREQUENTFLYERS table contains the number of points each frequent flyer earned (PointsEarned) and used (PointsUsed). Determine all appropriate awards for each frequent flyer based on the number of remaining points for each frequent flyer. An individual can receive multiple awards. Award levels are found in the new AWARDS table. Process only the frequent flyers who live in Arizona (STATE='AZ'). Order the report by FFID.

Awards Available to AZ Frequent Flyers

FFID	Name	Available Points	Award
WD0227	FOSTER, GERALD	29079	50% discount on flight
WD0227	FOSTER, GERALD	29079	free domestic flight
WD0227	FOSTER, GERALD	29079	free night in hotel
WD0646	BOSTIC, MARIE	64544	50% discount on flight
WD0646	BOSTIC, MARIE	64544	free domestic flight
WD0646	BOSTIC, MARIE	64544	free international flight
WD0646	BOSTIC, MARIE	64544	free night in hotel
WD3022	CAHILL, LEONARD	46386	50% discount on flight
WD3022	CAHILL, LEONARD	46386	free night in hotel
WD3022	CAHILL, LEONARD	46386	free international flight
WD3022	CAHILL, LEONARD	46386	free domestic flight
WD4382	O'NEAL, ALICE	35047	50% discount on flight
WD4382	O'NEAL, ALICE	35047	free domestic flight
WD4382	O'NEAL, ALICE	35047	free night in hotel
WD6061	RODRIGUEZ, MARIA	20642	free night in hotel
WD6061	RODRIGUEZ, MARIA	20642	50% discount on flight
WD6061	RODRIGUEZ, MARIA	20642	free domestic flight
WD6080	SMART, JONATHAN	16266	free night in hotel
WD6080	SMART, JONATHAN	16266	50% discount on flight
WD7208	LONG, CASEY	19443	free night in hotel
WD7208	LONG, CASEY	19443	50% discount on flight
WD8375	COOPER, ANTHONY	5507	free night in hotel
WD9829	COOK, JENNIFER	4401	free night in hotel

e. (Optional) Determine which frequent flyers are not eligible for any award. Order the report by FFID. Include all states.

```
                 Frequent Flyers Ineligible for Awards

                                                Available
             FFID          Name                    Points
             ------------------------------------------
             WD0023        JACKSON, LAURA              -5
             WD0231        GORDON, ANNE            -13054
             WD0632        BROWN, JASON            -19367
             WD1218        GRAHAM, MARY              -441
             WD1637        NELSON, FELICIA          -6047
             WD1700        WOOD, ALAN              -12836
             WD1883        PENNINGTON, MICHAE       -3957
             WD2118        JOHNSON, ANTHONY           609
             WD2741        EDGERTON, WAYNE         -29012
             WD3129        FLOWERS, ANNETTE        -17635
             WD3521        FIELDS, DIANA            -6151
             WD4065        DONALDSON, KAREN         -6733
             WD4781        HUNTER, CLYDE             1931
             WD5020        BOYCE, RANDALL            1922
```

2. Creating a View

a. Create a temporary view named VSCHED that extracts schedule information for airline employees. VSCHED must join data from the tables AIRLINE.STAFFMASTER and AIRLINE.FLIGHTSCHEDULE. The view must include date, flight number, and destination (in AIRLINE.FLIGHTSCHEDULE), and the name and ID number of each crew member assigned to that flight (in AIRLINE.STAFFMASTER). Display the view and order the report by date, flight number, and employee last name.

Partial Output

```
                                View VSCHED

   Date       FlightNumber  Destination  FirstName    LastName        EmpID
   -------------------------------------------------------------------------
   01MAR2000  132           YYZ          JONATHAN     BOYCE           1739
   01MAR2000  132           YYZ          SHARON       DEAN            1983
   01MAR2000  132           YYZ          JAMES        NEWTON          1478
   01MAR2000  132           YYZ          JEREMY       RHODES          1111
   01MAR2000  132           YYZ          JONATHAN     SMART           1390
   01MAR2000  132           YYZ          DEBORAH      WOOD            1130
   01MAR2000  182           YYZ          FRANKLIN     CASTON          1269
   01MAR2000  182           YYZ          ROGER        DENNIS          1118
   01MAR2000  182           YYZ          ALAN         GOMEZ           1094
   01MAR2000  182           YYZ          ALICE        MURPHY          1115
   01MAR2000  182           YYZ          RANDALL      VENTER          1076
   01MAR2000  182           YYZ          JOANN        YOUNG           1122
```

b. Use the VSCHED view to display the schedule of Deborah Young (EmpID='1431'). Order the report by date and flight.

Schedule for Deborah Young

Date	FlightNumber	Destination	FirstName	LastName	EmpID
01MAR2000	387	CPH	DEBORAH	YOUNG	1431
03MAR2000	622	FRA	DEBORAH	YOUNG	1431
04MAR2000	821	LHR	DEBORAH	YOUNG	1431
05MAR2000	132	YYZ	DEBORAH	YOUNG	1431
07MAR2000	821	LHR	DEBORAH	YOUNG	1431

c. (Optional) Use the view VSCHED and the table AIRLINE.FLIGHTDELAYS to determine how many delayed flights (DELAY>0) each crew member was on. Order the report by employee first name and last name.

Partial Output

Number of Delayed Flights
Experienced by Each Crew Member

FirstName	LastName	count
ADAM	STEPHENSON	7
AGNES	WELLS	6
ALAN	GOMEZ	2
ALICE	MURPHY	4
ALICIA	EATON	3
ALVIN	GRAHAM	4
ANNA	VEGA	3
ANNE	PARKER	2
ANTHONY	COOPER	3
BARBARA	ARTHUR	1
CAROL	PEARCE	3
CASEY	RICHARDS	1
CHARLES	HARRIS	4
CHRISTINE	BRADY	2
CLYDE	HUNTER	1
DANIEL	GRANT	5
DEBORAH	WOOD	3

4.5 Maintaining Tables

Objectives

- Update or delete data values in an existing table.
- Add, drop, or alter the attributes of columns in a table.
- Delete tables, views, and indexes.

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...

Maintaining Tables: Overview

You can use PROC SQL to

- **modify values** in a table or view
- **add rows** to a table or view
- **delete rows** from a table or view
- **alter column attributes** of a table
- **add new columns** to a table
- **drop columns** from a table
- **delete** an entire table, SQL view, or index.

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Updating Data Values

Use the UPDATE statement to modify column values in existing rows of a table or SAS/ACCESS view.

General form of the UPDATE statement:

UPDATE *table-name*
  SET *column-name=expression,*
  SET *column-name=expression,…*
  WHERE *expression*;

Careful! If you omit the WHERE expression, all rows are updated.

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Updating Data Values

X	Y
1	a1
2	b1
3	a2
4	b2

```
update one
  set x=x*2
  where y contains 'a';
```

X	Y
2	a1
2	b1
6	a2
4	b2

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Updating Data Values

Example: Give all level 1 employees a 5% raise.

```
proc sql;
   update airline.payrollmaster
      set Salary=Salary * 1.05
      where JobCode like '__1';
   select *
      from airline.payrollmaster;
```

73

A SAS DATA step equivalent is as follows:

```
data airline.test;
   modify airline.payrollmaster;
      if substr(JobCode,3)='1' then
         Salary=Salary * 1.05;
run;
```

You cannot create additional columns using the UPDATE statement.

Conditional Processing

Use a CASE expression to perform conditional processing. Assign new salaries based on job level. Two methods are available.

Method 1:

```
proc sql;
   update airline.payrollmaster
      set Salary=Salary *
          case substr(JobCode,3,1)
             when '1' then 1.05
             when '2' then 1.10
             when '3' then 1.15
             else 1.08
          end;
```

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A CASE expression returns a single value. It is conditionally evaluated for each row of a table or view. Use multiple WHEN clauses when you want to execute the CASE expression for some but not all rows in the table. The optional ELSE expression provides an alternate action if none of the THEN expressions is executed.

Conditional Processing

Method 2:

```
proc sql;
   update airline.payrollmaster
      set Salary=Salary *
          case when substr(JobCode,3,1)='1'
                  then 1.05
               when substr(jobCode,3,1)='2'
                  then 1.10
               when substr(JobCode,3,1)='3'
                  then 1.15
               else 1.08
          end;
```

75

Method 1 above is more efficient because the SUBSTR function is evaluated only once. This method also assumes an = comparison operator, which means that if you need a different operator, you must use Method 2.

If no ELSE expression is present and every WHEN condition is false, the result of the CASE expression is a missing value.

Conditional Processing

You can also use a CASE expression in other parts of a query, such as within a SELECT statement, to create new columns.

General form of the CASE expression within the SELECT statement:

SELECT *column* <,*column*> ...
    CASE <*case-operand*>
    WHEN *when-condition* **THEN** *result-expression*
    <**WHEN** *when-condition* **THEN** *result-expression*>
    <**ELSE** *result-expression*>
END;

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Conditional Processing

Example: Display employee names, job codes, and job levels.

```
proc sql;
   select LastName, FirstName, JobCode,
          case substr(JobCode,3,1)
             when '1' then 'junior'
             when '2' then 'intermediate'
             when '3' then 'senior'
             else 'none'
          end as level
      from airline.payrollmaster,
           airline.staffmaster
      where staffmaster.EmpID=
            payrollmaster.EmpID;
```

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In traditional SAS programming language, you create a user-defined format with the FORMAT procedure to display a character string of your choice, in place of a stored value.

Conditional Processing

Partial Output

The SAS System

LastName	FirstName	Job Code	level
ADAMS	GERALD	TA2	intermediate
ALEXANDER	SUSAN	ME2	intermediate
APPLE	TROY	ME1	junior
ARTHUR	BARBARA	FA3	senior
AVERY	JERRY	TA3	senior
BAREFOOT	JOSEPH	ME3	senior
BAUCOM	WALTER	SCP	none
BLAIR	JUSTIN	PT2	intermediate
BLALOCK	RALPH	TA2	intermediate
BOSTIC	MARIE	TA3	senior

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Loading Data into a Table - Review

Method A: The SET Clause

INSERT INTO *table-name*
 SET *column-name=value,column-name=value,...;*

Method B: The VALUES Clause

INSERT INTO *table-name <(column list)>*
 VALUES *(value,value,value, ...);*

Method C: A Query-expression

INSERT INTO *table-name <(column list)>*
 SELECT *columns* **from** *table-name*

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Deleting Rows

Use the DELETE statement to eliminate unwanted rows from a a table or SAS/ACCESS view.

General form of the DELETE statement:

DELETE FROM *table-name*
 WHERE *expression*;

80

If you do not specify a WHERE clause, all rows are deleted.

...

Deleting Rows

What happens if you accidentally place a semicolon here?

ONE

X	Y
1	a1
2	b1
3	a2
4	b2

```
delete from one
   where y contains '1';
```

ONE

X	Y
3	a2
4	b2

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Deleting Rows

Example: From the AIRLINE.FREQUENTFLYERS table, delete all frequent flyers who have either used up their points or used more than they have.

```
proc sql;
   delete from airline.frequentflyers
      where PointsEarned-PointsUsed <= 0;
```

Partial Log

```
NOTE: 11 rows were deleted from AIRLINE.FREQUENTFLYERS.
```

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✎ Compare this process with the subsetting IF statement used in traditional SAS programming language.

Altering Columns

Use the ALTER statement to manipulate columns in a table three different ways.

General form of the ALTER statement:

> **ALTER TABLE** *table-name*
> **ADD** *column-definition, column-definition*, …
> **DROP** *column-name, column-name*, …
> **MODIFY** *column-definition, column-definition*, …;

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Altering Columns

1. Add columns to a table.

```
proc sql;
   alter table airline.payrollmaster
      add Bonus num format=comma10.2,
          Level char(3);
```

You are *enlarging* the table.

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After adding columns, use the UPDATE statement to assign values to those columns. These added columns initially contain missing values.

Altering Columns

2. Drop columns from a table.

```
proc sql;
   alter table airline.payrollmaster
      drop DestinationType;
```

You are *Shrinking* the table.

85

An alternative is to use the DROP= data set option as follows:

```
create table airline.flightdelays
   select *
      from airline.flightdelays (drop=destype);
```

Altering Columns

3. Modify attributes of existing columns in a table. You can alter a column's length, informat, format, and label.

```
proc sql;
   alter table airline.payrollmaster
      modify Bonus num format=comma8.2,
             Level char(1)
                label='Employee Level';
```

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Altering Columns

Populate the rows here.

Example: Alter AIRLINE.PAYROLLMASTER as follows:

1. Add a new column named Age.
2. Change the DateOfBirth column to the MMDDYY10. format.
3. Drop the DateOfHire column.

Create the columns here.

```
proc sql;
  alter table airline.payrollmaster
     add Age num
     modify DateOfBirth date format=mmddyy10.
     drop DateOfHire;
  update airline.payrollmaster
    set age=int((today()-dateOfBirth)/365.25);
```

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Altering Columns

Before altering

The SAS System

EmpID	Gender	Job Code	Salary	DateOfBirth	DateOfHire
1919	M	TA2	$48,126	16SEP1958	07JUN1985
1653	F	ME2	$49,151	19OCT1962	12AUG1988
1400	M	ME1	$41,677	08NOV1965	19OCT1988

```
select *
   from airline.payrollmaster;
```

After altering

The SAS System

EmpID	Gender	Job Code	Salary	DateOfBirth	Age
1919	M	TA2	$48,126	09/16/1958	41
1653	F	ME2	$49,151	10/19/1962	37
1400	M	ME1	$41,677	11/08/1965	34

Deleting Tables, Indexes, and Views

Use the DROP statement to delete an entire table, SQL view, or index.

General form of the DROP statement:

DROP TABLE *table-name, table-name*, …;
DROP VIEW *view-name, view-name*, …;
DROP INDEX *index-name, index-name, …*
    FROM *table-name;*

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Deleting Tables, Indexes, and Views

Example: Delete the index EmpID from the AIRLINE.PAYROLLMASTER table and delete the temporary table DISCOUNT.

```
proc sql;
   drop index EmpID
        from airline.payrollmaster;

NOTE: Index EmpID has been dropped.
   drop table Discount;

NOTE: Table WORK.DISCOUNT has been dropped.
```

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When you delete a table, all indexes on that table are automatically deleted. If you copy a table, all indexes are copied.

In Summary

- UPDATE
  - SET
  - CASE

  Modifies values in existing columns, that is, changes row values.

- ALTER
  - ADD
  - DROP
  - MODIFY

  Adds or drops columns, or changes column attributes.

- INSERT
  - SET
  - VALUES

  Inserts data rows at end of existing tables.

- DELETE

  Removes rows as specified with a WHERE expression.

- DROP

  Deletes an entire table, view, or index.

1

Updating Views

You can update the data underlying PROC SQL views using the INSERT, DELETE, and UPDATE statements, but

- you can only update a single table through a view. It cannot be joined or linked to another table, nor contain a subquery.
- you can update a column using the column's alias, but not a derived column.
- you cannot update the table through a summary query.
- you cannot update a view containing an ORDER BY clause.

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...

Updating Views

Create a view...

```
proc sql;
   create view airline.raise as
      select EmpID, JobCode,
             Salary, Salary/12
             as MonthlySalary
             format=dollar12.
         from airline.payrollmaster;
```

... and then update the view.

```
proc sql;
   update airline.raise
      set Salary=Salary * 1.20
      where Jobcode='PT3';
```

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4.6 Exercises

Submit a LIBNAME statement to assign the AIRLINE to the course SAS data library.

TSO: `libname airline '.sql8.sasdata';`

Directory-based systems: `libname airline '.';`

3. Modifying a Table

a. Create a temporary table named TDELAY that is a copy of the table AIRLINE.FLIGHTDELAYS, but contains only the data for March 1, 2000.

b. Flight numbers must be modified to differentiate international flights from domestic flights. Change the FLIGHTNUMBER column in the TDELAY table from 3 characters to 4 characters wide.

c. Modify the flight numbers so that international flights (DESTINATIONTYPE='International') have flight numbers beginning with 'I'. Domestic flight numbers remain the same. Display TDELAY.

d. Eliminate the DESTINATIONTYPE column from TDELAY.

e. Delay categories must be altered to reflect new standards. Change the values of the DELAYCATEGORY column as indicated below. Display the TDELAY table.

Value of DELAY	New Value of DELAYCATEGORY
0 and below	'No Delay'
1 to 15	'Acceptable'
16 and over	'Excessive'

f. Delete the TDELAY table.

4.7 Chapter Summary

You can use PROC SQL to create tables in several ways. You can define columns or borrow column definitions with the CREATE TABLE statement. Use an INSERT statement to enter rows of data into the table. Use the CREATE TABLE statement with an AS keyword to store the result of a query into a table.

A view is a stored query that contains no data but can be used as a table. You can create or update views using PROC SQL. You can use the DESCRIBE statement to display the definition of a PROC SQL view in the SAS log.

You can use PROC SQL to create indexes on tables. PROC SQL can use indexes to optimize the processing of WHERE clauses and joins.

PROC SQL enables you to alter or delete rows of data in existing tables or views using the UPDATE and DELETE statements, respectively. You can use the ALTER statement to add, delete, or modify the attributes of columns in an existing table. Use the DROP statement to delete tables, views, and indexes.

General form of PROC SQL using integrity constraints:

```
PROC SQL;
     CREATE TABLE table
          (column-specification,…
          <constraint-specification,…>
```

General forms of the CREATE TABLE statement:

```
CREATE TABLE table-name
     (column-name type(length),
     column-name type(length), …);
```

```
CREATE TABLE table-name
     LIKE table-name;
```

```
CREATE TABLE table-name AS
     SELECT column-name, column-name, …
          FROM table-name …;
```

General forms of the INSERT statement:

```
INSERT INTO table-name
     SET column-name=value,
         column-name=value, …;
```

```
INSERT INTO table-name
     VALUES (value,value, …);
```

```
INSERT INTO table-name
   SELECT column-name, column-name, …
      FROM table …;
```

General form of the CREATE VIEW statement:

```
CREATE VIEW view-name AS
   query-expression;
```

General form of the DESCRIBE statement:

```
DESCRIBE VIEW view-name;
```

General form of the CREATE INDEX statement:

```
CREATE <UNIQUE> INDEX index-name
   ON table-name(column-name,column-name);
```

General form of the UPDATE statement:

```
UPDATE table-name | view-name
   SET column-name= expression,
   SET column-name= expression, …
   WHERE expression;
```

General form of the CASE expression within the SELECT statement:

```
SELECT column <,column> …
   CASE <case-operand>
   WHEN when-condition THEN result-expression
   <WHEN when-condition THEN result-expression>
   <ELSE result-expression>
END;
```

General form of the DELETE statement:

```
DELETE FROM table-name
   WHERE expression;
```

General form of the ALTER statement:

```
ALTER TABLE table-name
   ADD column-definition, column-definition, …
   DROP column-name, column-name, …;
   MODIFY column-definition, column-definition, …
```

General forms of the DROP statement:

```
DROP TABLE table-name, table-name, …;
DROP view-name, view-name, …;
DROP INDEX index-name, index-name, …FROM table-name;
```

4.8 Solutions to Exercises

1. Creating a Table

a.

```
proc sql;
   create table awards
      (ptsreqd num label='POINTS REQUIRED',
      rank num format=3.,
      award char(25));
```

b.

```
      insert into awards
         values( 2000, 1, 'free night in hotel')
         values(10000, 2, '50% discount on flight')
         values(20000, 3, 'free domestic flight')
         values(40000, 4,
            'free international flight');
```

Alternate Solution

```
      insert into awards
         set ptsreqd=2000, rank=1,
             award='free night in hotel'
         set ptsreqd=10000, rank=2,
             award='50% discount on flight'
         set ptsreqd=20000, rank=3,
             award='free domestic flight'
         set ptsreqd=40000, rank=4,
             award='free international flight';
```

c.

```
   select *
      from awards;
```

d.

```
title 'Awards Available to AZ Frequent Flyers';
   select ffid,name,
      PointsEarned-PointsUsed
      label='Available Points',
      award
      from airline.frequentflyers,awards
      where (PointsEarned-PointsUsed)>=ptsreqd
      and state='AZ'
      order by 1;
```

e. (Optional)

```
title 'Frequent Flyers Ineligible for Awards';
   select FFID, Name,
          PointsEarned-PointsUsed
          label='AVAILABLE POINTS'
      from airline.frequentflyers
      where (PointsEarned-PointsUsed)<all
         (select ptsreqd
            from awards)
      order by 1;
```

2. Creating a View

a.

```
proc sql;
   create view vsched as
      select date, FlightNumber,
             flightschedule.Destination,
             FirstName, LastName, staffmaster.EmpID
         from airline.staffmaster, airline.FlightSchedule
         where Staffmaster.EmpID=FlightSchedule.EmpID;
title 'View VSCHED';
   select *
      from vsched
      order by date, FlightNumber, LastName;
```

b.

```
title 'Schedule for Deborah Young';
   select *
      from vsched
      where EmpID='1431'
      order by Date, FlightNumber;
```

c. (Optional)

```
title 'Number of Delayed Flights';
title2 'Experienced by Each Crew Member';
   select FirstName, LastName,
          count(*) as count
      from vsched, airline.flightdelays
      where vsched.FlightNumber=flightdelays.FlightNumber and
            vsched.date=flightdelays.date and
            Delay>0
      group by FirstName, LastName
      order by FirstName, LastName;
```

3. Modifying a Table

a.

```
proc sql;
   create table tdelay as
      select *
         from airline.flightdelays
         where date='01mar2000'd;
```

b.

```
alter table tdelay
   modify flightnumber char(4);
```

c.

```
update tdelay
   set flightnumber='I'||flightnumber
   where DestinationType='International';
select *
   from tdelay;
```

d.

```
alter table tdelay
   drop DestinationType;
```

e.

```
update tdelay
   set Delaycategory=
      case
         when Delay<=0 then 'No Delay'
         when 0<Delay<=15 then 'Acceptable'
         else 'Excessive'
      end;
select *
   from tdelay;
```

f.

```
drop table tdelay;
```

Chapter 5 Additional SQL Features

5.1 Setting PROC SQL Options

Objectives

- Use PROC SQL options to control processing details.
- Reset PROC SQL options without re-invoking the procedure.

3

Controlling Processing

The SQL procedure offers a variety of options and statements that affect processing.

General form of the PROC SQL statement:

PROC SQL *options*;

4

Controlling Processing

Selected options:

INOBS=*n*	sets a limit of *n* rows from each source table that contributes to a query.
OUTOBS=*n*	restricts the number of rows that a query outputs (displays or writes to a table).
LOOPS=*n*	restricts the number of iterations of the inner loop of PROC SQL.

continued... 5

Controlling Processing

NOPROMPT|PROMPT	modifies the effect of the INOBS=, OUTOBS=, and LOOPS= options so that you are prompted to stop or continue when a specified limit is reached.
PRINT|NOPRINT	controls whether the results of a SELECT statement are displayed.
NONUMBER|NUMBER	controls whether the row number is printed as the first column in the output.

continued... 6

The default value appears first in the slides. The PROMPT option only works in interactive modes.

Controlling Processing

NODOUBLE|DOUBLE	double-spaces the report.
NOFLOW|FLOW| FLOW=*n*|FLOW=*n m*	controls the appearance of wide character columns. The FLOW option causes text to be flowed in its column rather than wrapping the entire row. Specifying *n* determines the width of the flowed column. Specifying *n* and *m* floats the width of the column between the limits to achieve a balanced layout.

7

Controlling Processing

Example: Display the AWARDS table with flowed character columns and double-spacing.

```
proc sql flow=13 double;
   select *
      from awards;
```

8

Controlling Processing

Points Required	Rank	Award
2000	1	free night in hotel
10000	2	50% discount on flight
20000	3	free domestic flight
40000	4	free international flight

9

Controlling Processing

Example: Prompt the user to stop or continue processing after 10 rows are read from AIRLINE.MARCHFLIGHTS.

```
proc sql inobs=10 prompt;
   select FlightNumber,
          Date
      from airline.marchflights;
```

10

Controlling Processing

Limit specified by INOBS= option has been reached.

- ● S to stop
- ❍ C to continue

OK

11

The prompter window allows you to decide whether to stop after the first 10 rows, or to continue for another 10 rows.

Controlling Processing

Output

FlightNumber	Date
182	01MAR2000
114	01MAR2000
202	01MAR2000
219	01MAR2000
439	01MAR2000
387	01MAR2000
290	01MAR2000
523	01MAR2000
982	01MAR2000
622	01MAR2000

12

After you specify an option, it remains in effect until you change it or you re-invoke PROC SQL.

Resetting Options

You can use the RESET statement to add or change PROC SQL options without re-invoking the procedure.

General form of the RESET statement:

> **RESET** *options*;

13

Resetting Options

Example: Display two rows from the payroll table and print the row number. Then display the rows without printing the row number.

```
proc sql outobs=2 number;
select * from airline.payrollmaster;
```

Row	Emp ID	Gender	Job Code	Salary	DateOfBirth	DateOfHire
1	1919	M	TA2	$48,126	16SEP1958	07JUN1985
2	1653	F	ME2	$49,151	19OCT1962	12AUG1988

14

Resetting Options

```
reset nonumber;
select *
from airline.payrollmaster;
```

EmpID	Gender	Job Code	Salary	DateOfBirth	DateOfHire
1919	M	TA2	$48,126	16SEP1958	07JUN1985
1653	F	ME2	$49,151	19OCT1962	12AUG1988

15

5.2 Dictionary Tables and Views

Objectives

- Use dictionary tables and views to obtain information about SAS files.

17

Overview

You can retrieve information about SAS session metadata by querying *dictionary tables* with PROC SQL. Dictionary tables are

- created at initialization
- updated automatically
- limited to read-only access.

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"Metadata consist of information that characterizes data. Metadata are used to provide documentation for data products. In essence, metadata answer **who**, **what**, **when**, **where**, **why**, and **how** about every facet of the data that are being documented."

http://geology.usgs.gov/tools/metadata/tools/doc/faq.html#motivation

Overview

The metadata available in dictionary tables includes

- SAS files
- external files
- system options, macros, titles, and footnotes.

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Overview

SAS File Metadata

DICTIONARY.MEMBERS	general information about data library members
DICTIONARY.TABLES	detailed information about data sets
DICTIONARY.COLUMNS	detailed information on variables and their attributes
DICTIONARY.CATALOGS	information about catalog entries
DICTIONARY.VIEWS	general information about data views
DICTIONARY.INDEXES	information on indexes defined for data files

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Overview

Other Metadata

DICTIONARY.EXTFILES	currently assigned filerefs
DICTIONARY.OPTIONS	current settings of SAS system options
DICTIONARY.MACROS	information about macro variables
DICTIONARY.TITLES	text assigned to titles and footnotes

21

SAS librefs are limited to 8 characters. DICTIONARY is an automatically assigned, reserved word.

Exploring Dictionary Tables

```
describe table dictionary.tables;
```

Partial Log

```
create table DICTIONARY.TABLES  (
   libname char(8) label='Library Name',
   memname char(32) label='Member Name',
   memtype char(8) label='Member Type',
   memlabel char(256) label='Dataset Label',
   typemem char(8) label='Dataset Type',
   crdate num format=DATETIME informat=DATETIME
label='Date Created', ...);
```

22

The DESCRIBE TABLE statement is a good tool for exploring dictionary tables. The complete log notes from the above statement are

```
create table DICTIONARY.TABLES
  (
   libname char(8) label='Library Name',
   memname char(32) label='Member Name',
   memtype char(8) label='Member Type',
   memlabel char(256) label='Dataset Label',
   typemem char(8) label='Dataset Type',
   crdate num format=DATETIME informat=DATETIME label='Date Created',
   modate num format=DATETIME informat=DATETIME label='Date Modified',
   nobs num label='Number of Observations',
   obslen num label='Observation Length',
   nvar num label='Number of Variables',
   protect char(3) label='Type of Password Protection',
   compress char(8) label='Compression Routine',
   encrypt char(8) label='Encryption',
   npage num label='Number of Pages',
   pcompress num label='Percent Compression',
   reuse char(3) label='Reuse Space',
   bufsize num label='Bufsize',
   delobs num label='Number of Deleted Observations',
   indxtype char(9) label='Type of Indexes'
  );
```

Using Dictionary Information

Example: Display information about the files in the AIRLINE library.

```
options nolabel nocenter;
select memname format=$20.,
       nobs,
       nvar,
       crdate
   from dictionary.tables
   where libname='AIRLINE';
```

23

Using Dictionary Information

Output

memname	nobs	nvar	crdate
FLIGHTDELAYS	624	8	18MAR00:20:53:16
FLIGHTSCHEDULE	270	4	18MAR00:20:53:17
FREQUENTFLYERS	206	11	18MAR00:20:53:16
INTERNATIONALFLIGHTS	201	4	18MAR00:20:53:16
MARCHFLIGHTS	635	13	18MAR00:20:53:16
MECHANICSLEVEL1	8	3	18MAR00:20:53:17
MECHANICSLEVEL2	14	3	18MAR00:20:53:17
MECHANICSLEVEL3	7	3	18MAR00:20:53:17
PAYROLLCHANGES	6	6	18MAR00:20:53:17
PAYROLLMASTER	148	6	18MAR00:20:53:17
STAFFCHANGES	6	6	18MAR00:20:53:18
STAFFMASTER	148	6	18MAR00:20:53:17
SUPERVISORS	19	3	18MAR00:20:53:18

24

Using Dictionary Information

Example: Determine which tables contain the EmpID column.

```
select memname
   from dictionary.columns
   where libname='AIRLINE'
      and name='EmpID';
```

25

Using Dictionary Information

Output

```
memname
________________________________

FLIGHTSCHEDULE
MECHANICSLEVEL1
MECHANICSLEVEL2
MECHANICSLEVEL3
PAYROLLCHANGES
PAYROLLMASTER
STAFFCHANGES
STAFFMASTER
SUPERVISORS
```

26

Using Dictionary Information

To use session metadata in other procedures or in a DATA step, you can

- create a PROC SQL view based on a dictionary table
- use views provided in the SASHELP library that are based on the dictionary tables.

27

Using Dictionary Information

Example: Use SASHELP.VMEMBER to extract information from DICTIONARY.MEMBERS in a PROC TABULATE step.

```
proc tabulate
      data=sashelp.vmember
      format=8.;
   class libname memtype;
   keylabel N=' ';
   table libname, memtype/
         rts=10 misstext='None';
run;
```

28

Using Dictionary Information

Output

	memtype				
	CATALOG	DATA	ITEMSTOR	MDDB	VIEW
libname					
AIRLINE	1	13	None	None	None
MAPS	3	314	None	None	None
SASHELP	128	104	2	2	18
SASUSER	8	80	1	None	None
WORK	1	None	1	None	None

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5.3 Interfacing PROC SQL with Macro Language (Optional)

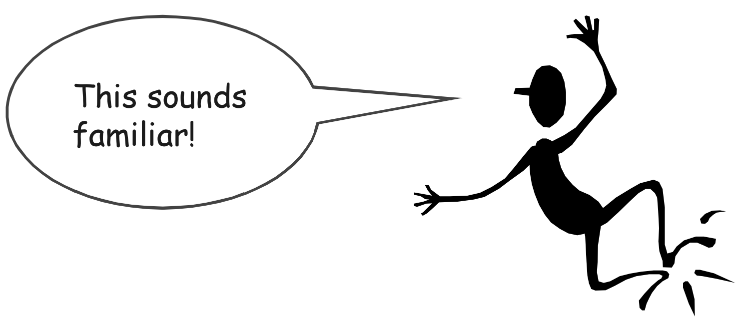
Objectives

- Create and use SAS macro variables in PROC SQL.
- Understand the use of SAS macros with SQL processing.
- Use the automatic SAS macro variables created by PROC SQL.

31

Resolving Symbolic References

Macro variable references embedded within PROC SQL code are resolved as the source code is tokenized.



32

...

Resolving Symbolic References

```
%let datasetname=payrollmaster;
%let bigsalary=100000;
```

SYMBOL TABLE

Name	Value
datasetname	payrollmaster
bigsalary	100000

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...

Resolving Symbolic References

SYMBOL TABLE

Name	Value
datasetname	payrollmaster
bigsalary	100000

```
select *
   from airline.&datasetname
   where Salary > &bigsalary;
```

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Resolving Symbolic References

SYMBOL TABLE

Name	Value
datasetname	payrollmaster
bigsalary	100000

```
select  *
   from airline.payrollmaster
   where Salary > 100000;
```

35

Creating Macro Variables

SQL allows a query to pass data values to variables in the host software system. The SAS System chose to implement these host variables as macro variables.

36

Creating Macro Variables

PROC SQL can create or update macro variables using an INTO clause. This clause can be used in three ways.

37

PROC SQL can create or update macro variables in either local or global symbol tables.

✐ The INTO clause occurs between the SELECT and FROM clauses. It cannot be used in a CREATE TABLE or CREATE VIEW statement. Use the NOPRINT option if you do not need a display of the query result.

Creating Macro Variables: Method 1

General form of the SELECT statement with an INTO keyword:

```
SELECT col1, col2, ...
     INTO :mvar1, :mvar2, ...
     FROM ...
```

Method 1 extracts values **only** from the **first** row of the query result.

38

This method is often used with queries that return only one row.

Creating Macro Variables: Method 1

Example

```
reset noprint;
select avg(salary),
       min(salary),
       max(salary)
   into :mean, :min, :max
   from airline.payrollmaster;
%put &mean &min &max;
```

Log

```
54079.65  25120.2 155930.6
```

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Creating Macro Variables: Method 1

Example

Calculate the average salary of employees with a particular job code. Store the average in a macro variable and use the average to display all employees in that job code who have a salary above the average. Place the average in a title.

40

Creating Macro Variables: Method 1

Example

```
%let code=NA1;
select avg(Salary) into :mean
   from airline.payrollmaster
   where JobCode="&code";
```

41

Creating Macro Variables: Method 1

Example *(continued)*

```
reset print;
title1 "&code Employees Earning Above-Average Salaries";
title2 "Average Salary for &code Employees Is &mean";
select *
   from airline.payrollmaster
   where Salary > &mean
            and
         JobCode="&code";
```

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Creating Macro Variables: Method 1

Output

```
     NA1 Employees Earning Above-Average Salaries
     Average Salary for NA1 Employees Is 58845.08

                 Job
EmpID Gender Code      Salary  DateOfBirth  DateOfHire
-------------------------------------------------------
1839     F    NA1     $60,806    02DEC1968    07JUL1991
1332     M    NA1     $59,049    20SEP1968    07JUN1989
1443     F    NA1     $59,184    21NOV1966    01SEP1989
```

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Creating Macro Variables: Method 2

General form of the SELECT statement to create a macro variable:

SELECT *a*, *b*, …
INTO :*a1*-:*an,* :*b1*-:*bn*
FROM …

Method 2 extracts values from the first *n* rows of the query result, and puts them into a series of *n* macro variables.

44

Creating Macro Variables: Method 2

Example

How many frequent flyers are in each of the three member types (GOLD, SILVER, BRONZE)?

```
reset noprint;
select MemberType,
       count(*) as Frequency
   into :memtype1-:memtype3,
        :freq1-:freq3
   from airline.frequentflyers
   group by MemberType;
```

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Creating Macro Variables: Method 2

Example *(continued)*

```
%put Member types: &memtype1 &memtype2 &memtype3;
%put Frequencies: &freq1 &freq2 &freq3;
```

Log

```
Member types: BRONZE GOLD SILVER
Frequencies: 61 60 85
```

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Creating Macro Variables: Method 3

General form of the SELECT statement to create a macro variable:

SELECT *col1*, *col2*, ...
  INTO :*macrovar1*, :*macrovar2*, ...
    SEPARATED BY *'delimiter'*
  FROM ...

Method 3 extracts values from all rows of the query result, and puts them into a single macro variable, separated by the specified delimiter.

47

Creating Macro Variables: Method 3

Put the unique values of all international destinations into a single macro variable.

```
select distinct Destination
   into :airportcodes
      separated by ' '
   from airline.internationalflights;
%put &airportcodes;
```

Log

```
CDG CPH FRA LHR YYZ
```

48

The long string value in the macro variable can be parsed using %SCAN into the individual short values.

Automatic Macro Variables

Execution of a PROC SQL query or non-query statement updates the following automatic macro variables:

SQLOBS	records the number of rows output or deleted
SQLRC	contains the return code from each SQL statement
SQLOOPS	contains the number of iterations processed by the inner loop of PROC SQL.

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Automatic Macro Variables

Macro Program Example

Write a macro that accepts a state code as a parameter and creates a table containing employees from that state. Display a maximum of 10 rows from the table.

50

Automatic Macro Variables

Example *(continued)*

```
%macro state(st);
proc sql;
create table &st as
select LastName,
       FirstName
   from airline.staffmaster
   where State="&st";
%put NOTE: The table &st has &sqlobs rows.;
```

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Automatic Macro Variables

Example *(continued)*

```
title1 "&st Employees";
%if &sqlobs > 10 %then %do;
   %put NOTE: Only the first 10 rows are displayed.;
   title2 "NOTE: Only 10 rows are displayed.";
   reset outobs=10;
%end;
select * from &st;
quit;
%mend state;
```

52

Automatic Macro Variables

Example *(continued)*

```
%state(NY)
```

Log

```
NOTE: Table WORK.NY created, with 89 rows
and 2 columns.

NOTE: The table NY has 89 rows.
NOTE: Only the first 10 rows are displayed.
WARNING: Statement terminated early due to
OUTOBS=10 option.
```

53

Automatic Macro Variables

Example *(continued)*

Output

```
NY Employees
NOTE: Only 10 rows are displayed.

LastName          FirstName
--------------------------------
APPLE             TROY
ARTHUR            BARBARA
BAUCOM            WALTER
BLALOCK           RALPH
BOSTIC            MARIE
BOYCE             JONATHAN
BRADLEY           JEREMY
BRYANT            LEONARD
BURNETTE          THOMAS
CAHILL            MARSHALL
```

54

5.4 Program Testing and Performance

Objectives

- Use PROC SQL options to test SQL code.
- Understand SAS log messages and accurately benchmark SAS code.

56

Testing and Performance Options

PROC SQL statement options are available to aid in testing programs and evaluating performance. The following are selected options:

- EXEC|NOEXEC controls whether submitted SQL statements are executed.
- NOSTIMER|STIMER reports performance statistics in the SAS log for each SQL statement.
- NOERRORSTOP|ERRORSTOP is used in batch and noninteractive jobs to make PROC SQL enter syntax-check mode after an error occurs.

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To use the STIMER SQL option, the system option STIMER or FULLSTIMER must also be in effect.

Other PROC SQL statement options that are useful in testing include

- INOBS=*n*
- OUTOBS=*n*
- LOOPS=*n*

Testing and Performance Options

Example

Display the columns that are retrieved when you use SELECT * in a query and display any macro variable resolutions, but do not execute the query.

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Testing and Performance Options

Example *(continued)*

```
%let datasetname=payrollmaster;

proc sql
     feedback
     noexec;
   select *
      from airline.&datasetname;
```

59

Testing and Performance Options

Example *(continued)*

Log

```
NOTE: Statement transforms to:

select PAYROLLMASTER.EmpID, PAYROLLMASTER.Gender,
PAYROLLMASTER.JobCode,
PAYROLLMASTER.Salary, PAYROLLMASTER.DateOfBirth,
PAYROLLMASTER.DateOfHire
          from AIRLINE.PAYROLLMASTER;

NOTE: Statement not executed due to NOEXEC option.
```

60

Testing and Performance Options

Example

This is a log from a PROC SQL step with the STIMER statement option, executing a single query. The first note concerns the invocation of PROC SQL:

```
NOTE: The SQL statement used the following resources:
      CPU     time -         00:00:00.01
      Elapsed time -         00:00:00.68
      EXCP count   - 28
      Task memory  - 110K (20K data, 90K program)
      Total memory - 864K (760K data, 104K program)
```

61

This program was run in batch under MVS/XA. Performance measures, as well as the actual numbers, vary greatly across installations and operating systems. (The query used is the one about the supervisors of the crew on the Copenhagen flight, using subqueries and inline views, from Section 3.3.)

Testing and Performance Options

Example *(continued)*

The second note concerns the query itself.

```
NOTE: The SQL statement used the following resources:
      CPU     time -        00:00:00.23
      Elapsed time -        00:00:03.61
      EXCP count   - 157
      Task  memory - 1213K (828K data, 385K program)
      Total memory - 2258K (1840K data, 418K program)
```

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Testing and Performance Options

Example *(continued)*

The third note reflects the totals for the procedure.

```
NOTE: The SQL procedure used the following resources:
      CPU     time -        00:00:00.25
      Elapsed time -        00:00:04.34
      EXCP count   - 186
      Task  memory - 1213K (828K data, 385K program)
      Total memory - 2258K (1840K data, 418K program)
```

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General Guidelines for Benchmarking Programs

- Never use elapsed time for comparison because it may be affected by concurrent tasks.
- Benchmark two programs in separate SAS sessions. If benchmarking is done within one SAS session, statistics for the second program can be misleading because the SAS supervisor might have loaded modules into memory from prior steps.

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General Guidelines for Benchmarking Programs

- Run each program multiple times and average the performance statistics.
- Use realistic data for tests. Program A could be better than program B on small tables and worse on large tables.

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5.5 Chapter Summary

You can use options in the PROC SQL statement to affect SQL processing. You can limit the number of rows read or written during a query or limit the number of internal loops PROC SQL performs. PROC SQL can notify you when any of the processing limits that you set have been reached.

Options are also available that affect the form of the output. You can flow character columns, number your rows, or double-space output. The RESET statement enables you to change options without having to re-invoke the procedure.

Dictionary tables can be queried to display SAS session metadata. The dictionary tables are generated at run time and are read only. You can also use views stored in the SASHELP library that are based on the dictionary tables.

You can combine the SAS macro facility with PROC SQL in the same way as any other SAS step. PROC SQL, however, is capable of passing data from a query result into a macro variable. PROC SQL also updates several automatic macro variables that contain information about the last query executed.

There are PROC SQL statement options available to test and evaluate program performance. For example, the STIMER option in the PROC SQL statement can request resource usage information on each statement executed. The SAS log displays information on CPU usage, I/O counts, and other statistics.

General form of the PROC SQL statement:

PROC SQL *options*;

General form of the RESET statement:

RESET *options*;

General forms of the SELECT statement with an INTO keyword:

SELECT *col1, col2, …*
  INTO :*mvar1, :mvar2, …*
  FROM …

SELECT *a, b, …*
  INTO :*a1-:an, :b1-:bn*
  FROM …

SELECT *col1, col2, …*
  INTO :*macrovar1, :macrovar2, …*
    SEPARATED BY '*delimiter*'
  FROM …

Macro variables created by PROC SQL:

&SQLOBS

&SQLRC

&SQLOOPS

Selected PROC SQL statement options:

INOBS=*n*

OUTOBS= *n*

LOOPS= *n*

NOPROMPT | PROMPT

PRINT | NOPRINT

NONUMBER | NUMBER

NODOUBLE | DOUBLE

NOFLOW | FLOW | FLOW=*n* | FLOW=*n m*

EXEC | NOEXEC

NOSTIMER | STIMER

NOERRORSTOP | ERRORSTOP

Appendix A Overview of Table and Column Names

A.1 Table and Column Names Sorted by Column Names

Column Name	Table Names
Address	FREQUENTFLYERS
Boarded	INTERNATIONALFLIGHTS MARCHFLIGHTS
City	FREQUENTFLYERS STAFFCHANGES STAFFMASTER
Date	FLIGHTDELAYS FLIGHTSCHEDULE INTERNATIONALFLIGHTS MARCHFLIGHTS
DateOfBirth	PAYROLLCHANGES PAYROLLMASTER
DateOfHire	PAYROLLCHANGES PAYROLLMASTER
DayOfWeek	FLIGHTDELAYS
Delay	FLIGHTDELAYS
DelayCategory	FLIGHTDELAYS
DepartureTime	MARCHFLIGHTS
Deplaned	MARCHFLIGHTS
Destination	FLIGHTDELAYS FLIGHTSCHEDULE INTERNATIONALFLIGHTS MARCHFLIGHTS
DestinationType	FLIGHTDELAYS
Distance	MARCHFLIGHTS
EmpID	FLIGHTSCHEDULE MECHANICSLEVEL1 MECHANICSLEVEL2 MECHANICSLEVEL3 PAYROLLCHANGES PAYROLLMASTER STAFFCHANGES STAFFMASTER SUPERVISORS
FFID	FREQUENTFLYERS
FirstName	STAFFCHANGES STAFFMASTER

Column Name	Table Names
FlightNumber	FLIGHTDELAYS FLIGHTSCHEDULE INTERNATIONALFLIGHTS MARCHFLIGHTS
Freight	MARCHFLIGHTS
Gender	PAYROLLCHANGES PAYROLLMASTER
JobCategory	SUPERVISORS
JobCode	MECHANICSLEVEL1 MECHANICSLEVEL2 MECHANICSLEVEL3 PAYROLLCHANGES PAYROLLMASTER
LastName	STAFFCHANGES STAFFMASTER
Mail	MARCHFLIGHTS
MemberType	FREQUENTFLYERS
MilesTraveled	FREQUENTFLYERS
Name	FREQUENTFLYERS
Nonrevenue	MARCHFLIGHTS
Origin	FLIGHTDELAYS MARCHFLIGHTS
PassengerCapacity	MARCHFLIGHTS
PhoneNumber	FREQUENTFLYERS STAFFCHANGES STAFFMASTER
PointsEarned	FREQUENTFLYERS
PointsUsed	FREQUENTFLYERS
Salary	MECHANICSLEVEL1 MECHANICSLEVEL2 MECHANICSLEVEL3 PAYROLLCHANGES PAYROLLMASTER
State	FREQUENTFLYERS STAFFCHANGES STAFFMASTER SUPERVISORS
Transferred	MARCHFLIGHTS
ZipCode	FREQUENTFLYERS

Appendix B Overview of Table and Column Names

B.1 Table and Column Names Sorted by Table Name

Table Name	Column Name	Column Type	Column Length	Column Format
FLIGHTDELAYS	FlightNumber	char	3	
	Date	num	8	DATE9.
	Origin	char	3	
	Destination	char	3	
	DelayCategory	char	15	
	DestinationType	char	15	
	DayOfWeek	num	8	
	Delay	num	8	
FLIGHTSCHEDULE	FlightNumber	char	3	$3.
	Date	num	8	DATE9.
	Destination	char	3	$3.
	EmpID	char	4	
FREQUENTFLYERS	FFID	char	6	
	MemberType	char	6	
	Name	char	25	$18.
	Address	char	20	
	PhoneNumber	char	12	
	City	char	20	$20.
	State	char	2	$2.
	ZipCode	char	5	$5.
	MilesTraveled	num	8	10.
	PointsEarned	num	8	10.
	PointsUsed	num	8	10.
INTERNATIONALFLIGHTS	FlightNumber	char	3	
	Date	num	8	DATE9.
	Destination	char	3	
	Boarded	num	8	

Table Name	Column Name	Column Type	Column Length	Column Format
MARCHFLIGHTS	FlightNumber	char	3	
	Date	num	8	DATE9.
	DepartureTime	num	8	TIME5.
	Origin	char	3	
	Destination	char	3	
	Distance	num	8	
	Mail	num	8	
	Freight	num	8	
	Boarded	num	8	
	Transferred	num	8	
	Nonrevenue	num	8	
	Deplaned	num	8	
	PassengerCapacity	num	8	
MECHANICSLEVEL1	EmpID	char	4	
	JobCode	char	3	
	Salary	num	8	DOLLAR9.
MECHANICSLEVEL2	EmpID	char	4	
	JobCode	char	3	
	Salary	num	8	DOLLAR9.
MECHANICSLEVEL3	EmpID	char	4	
	JobCode	char	3	
	Salary	num	8	DOLLAR9.
PAYROLLCHANGES	EmpID	char	4	
	Gender	char	1	
	JobCode	char	3	
	Salary	num	8	DOLLAR9.
	DateOfBirth	num	8	DATE9.
	DateOfHire	num	8	DATE9.
PAYROLLMASTER	EmpID	char	4	
	Gender	char	1	
	JobCode	char	3	
	Salary	num	8	DOLLAR9.
	DateOfBirth	num	8	DATE9.
	DateOfHire	num	8	DATE9.

Table Name	Column Name	Column Type	Column Length	Column Format
STAFFCHANGES	EmpID	char	4	
	LastName	char	15	
	FirstName	char	15	
	City	char	15	
	State	char	2	
	PhoneNumber	char	12	
STAFFMASTER	EmpID	char	4	
	LastName	char	15	
	FirstName	char	15	
	City	char	15	
	State	char	2	
	PhoneNumber	char	12	
SUPERVISORS	EmpID	char	4	
	State	char	2	
	JobCategory	char	2	

Appendix C Table Listings

C.1 Partial Table Listings

AIRLINE.FLIGHTDELAYS Table

Flight Number	Date	Origin	Destination	Delay Category	Destination Type	Day Of Week	Delay
182	01MAR2000	LGA	YYZ	No Delay	International	4	0
114	01MAR2000	LGA	LAX	1-10 Minutes	Domestic	4	8
202	01MAR2000	LGA	ORD	No Delay	Domestic	4	-5
219	01MAR2000	LGA	LHR	11+ Minutes	International	4	18
439	01MAR2000	LGA	LAX	No Delay	Domestic	4	-4

AIRLINE.FLIGHTSCHEDULE Table

Flight Number	Date	Destination	Emp ID
132	01MAR2000	YYZ	1739
132	01MAR2000	YYZ	1478
132	01MAR2000	YYZ	1130
132	01MAR2000	YYZ	1390
132	01MAR2000	YYZ	1983

AIRLINE.FREQUENTFLYERS Table

FFID	Member Type	Name	Address	PhoneNumber
WD7152	BRONZE	COOPER, LESLIE	66 DRIVING WAY	501/377-0703
WD8472	BRONZE	LONG, RUSSELL	9813 SUMTER SQUARE	501/367-1097
WD1576	GOLD	BRYANT, ALTON	763 THISTLE DRIVE	501/776-0631
WD3947	SILVER	NORRIS, DIANE	77 PARKWAY PLAZA	501/377-3739
WD9347	SILVER	PEARSON, BRYAN	9999 MARKUP MANOR	501/855-4780

City	State	Zip Code	Miles Traveled	Points Earned	PointsUsed
Little Rock	AR	72201	30833	31333	0
Monticello	AR	71655	25570	26070	0
Bauxite	AR	72011	56144	58644	27000
North Little Rock	AR	72119	40922	45922	23000
Bella Vista	AR	72714	4839	9839	0

AIRLINE.INTERNATIONALFLIGHTS Table

Flight Number	Date	Destination	Boarded
182	01MAR2000	YYZ	104
219	01MAR2000	LHR	198
387	01MAR2000	CPH	152
622	01MAR2000	FRA	207
821	01MAR2000	LHR	205

AIRLINE.MARCHFLIGHTS Table

FlightNumber	Date	DepartureTime	Origin	Destination	Distance	Mail	Freight	Boarded	Transferred	NonRevenue	Deplaned	PassengerCapacity
182	01MAR2000	8:21	LGA	YYZ	366	458	390	104	16	3	123	178
114	01MAR2000	7:10	LGA	LAX	2475	357	390	172	18	6	196	210
202	01MAR2000	10:43	LGA	ORD	740	369	244	151	11	5	157	210
219	01MAR2000	9:31	LGA	LHR	3442	412	334	198	17	7	222	250
439	01MAR2000	12:16	LGA	LAX	2475	422	267	167	13	5	185	210

AIRLINE.MECHANICSLEVEL1 Table

Emp ID	Job Code	Salary
1400	ME1	$41,677
1403	ME1	$39,301
1120	ME1	$40,067
1121	ME1	$40,757
1412	ME1	$38,919

AIRLINE.MECHANICSLEVEL2 Table

Emp ID	Job Code	Salary
1653	ME2	$49,151
1782	ME2	$49,483
1244	ME2	$51,695
1065	ME2	$49,126
1129	ME2	$48,901

AIRLINE.MECHANICSLEVEL3 Table

Emp ID	Job Code	Salary
1499	ME3	$60,235
1409	ME3	$58,171
1379	ME3	$59,170
1521	ME3	$58,136
1385	ME3	$61,460

AIRLINE.PAYROLLCHANGES Table

Emp ID	Gender	Job Code	Salary	DateOf Birth	DateOf Hire
1639	F	TA3	$59,164	30JUN1955	31JAN1982
1065	M	ME3	$53,326	29JAN1942	10JAN1985
1561	M	TA3	$51,120	03DEC1961	10OCT1985
1221	F	FA3	$41,854	25SEP1965	07OCT1989
1447	F	FA1	$30,972	11AUG1970	01NOV2000

AIRLINE.PAYROLLMASTER Table

Emp ID	Gender	Job Code	Salary	DateOf Birth	DateOf Hire
1919	M	TA2	$48,126	16SEP1958	07JUN1985
1653	F	ME2	$49,151	19OCT1962	12AUG1988
1400	M	ME1	$41,677	08NOV1965	19OCT1988
1350	F	FA3	$46,040	04SEP1963	01AUG1988
1401	M	TA3	$54,351	16DEC1948	21NOV1983

AIRLINE.STAFFCHANGES Table

Emp ID	LastName	First Name	City	State	PhoneNumber
1639	CARTER	KAREN	STAMFORD	CT	203/781-8839
1065	CHAPMAN	NEIL	NEW YORK	NY	718/384-5618
1561	SANDERS	RAYMOND	NEW YORK	NY	212/588-6615
1221	WALTERS	DIANE	NEW YORK	NY	718/384-1918
1447	BRIDESTON	AMY	NEW YORK	NY	718/384-1213

AIRLINE.STAFFMASTER Table

Emp ID	LastName	First Name	City	State	PhoneNumber
1919	ADAMS	GERALD	STAMFORD	CT	203/781-1255
1653	ALEXANDER	SUSAN	BRIDGEPORT	CT	203/675-7715
1400	APPLE	TROY	NEW YORK	NY	212/586-0808
1350	ARTHUR	BARBARA	NEW YORK	NY	718/383-1549
1401	AVERY	JERRY	PATERSON	NJ	201/732-8787

AIRLINE.SUPERVISORS Table

Emp ID	State	Job Category
1677	CT	BC
1834	NY	BC
1431	CT	FA
1433	NJ	FA
1983	NY	FA

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