



## CHAPTER

# 1

# Introduction to the SQL Procedure

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## What Is SQL?

Structured Query Language (SQL) is a standardized, widely used language that retrieves and updates data in relational tables and databases.

A *relation* is a mathematical concept that is similar to the mathematical concept of a set. Relations are represented physically as two-dimensional tables that are arranged in rows and columns. Relational theory was developed by E. F. Codd, an IBM researcher, and first implemented at IBM in a prototype called System R. This prototype evolved into commercial IBM products based on SQL. The Structured Query Language is now in the public domain and is part of many vendors' products.

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## What Is the SQL Procedure?

The SQL procedure is the Base SAS implementation of Structured Query Language. PROC SQL is part of Base SAS software, and you can use it with any SAS data set (table). Often, PROC SQL can be an alternative to other SAS procedures or the DATA step. You can use SAS language elements such as global statements, data set options, functions, informats, and formats with PROC SQL just as you can with other SAS procedures. PROC SQL can

- generate reports
- generate summary statistics
- retrieve data from tables or views
- combine data from tables or views
- create tables, views, and indexes
- update the data values in PROC SQL tables

- update and retrieve data from database management system (DBMS) tables
- modify a PROC SQL table by adding, modifying, or dropping columns.

PROC SQL can be used in an interactive SAS session or within batch programs, and it can include global statements, such as TITLE and OPTIONS.

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## Terminology

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### Tables

A PROC SQL *table* is the same as a SAS data file. It is a SAS file of type DATA. PROC SQL tables consist of rows and columns. The rows correspond to observations in SAS data files, and the columns correspond to variables. The following table lists equivalent terms that are used in SQL, SAS, and traditional data processing.

SQL Term	SAS Term	Data Processing Term
table	SAS data file	file
row	observation	record
column	variable	field

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You can create and modify tables by using the SAS DATA step, or by using the PROC SQL statements that are described in Chapter 4, “Creating and Updating Tables and Views,” on page 89. Other SAS procedures and the DATA step can read and update tables that are created with PROC SQL.

SAS data files can have a one-level name or a two-level name. Typically, the names of temporary SAS data files have only one level, and the data files are stored in the WORK library. PROC SQL assumes that SAS data files that are specified with a one-level name are to be read from or written to the WORK library, unless you specify a USER library. You can assign a USER library with a LIBNAME statement or with the SAS system option USER=. For more information about how to work with SAS data files and libraries, see “Temporary and Permanent SAS Data Sets” in the *Base SAS Procedures Guide*.

DBMS *tables* are tables that were created with other software vendors’ database management systems. PROC SQL can connect to, update, and modify DBMS tables, with some restrictions. For more information, see “Accessing a DBMS with SAS/ACCESS Software” on page 132.

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### Queries

Queries retrieve data from a table, view, or DBMS. A query returns a *query result*, which consists of rows and columns from a table. With PROC SQL, you use a SELECT statement and its subordinate clauses to form a query. Chapter 2, “Retrieving Data from a Single Table,” on page 11 describes how to build a query.

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## Views

PROC SQL views do not actually contain data as tables do. Rather, a PROC SQL view contains a stored SELECT statement or query. The query executes when you use the view in a SAS procedure or DATA step. When a view executes, it displays data that is derived from existing tables, from other views, or from SAS/ACCESS views. Other SAS procedures and the DATA step can use a PROC SQL view as they would any SAS data file. For more information about views, see Chapter 4, “Creating and Updating Tables and Views,” on page 89.

*Note:* When you process PROC SQL views between a client and a server, getting the correct results depends on the compatibility between the client and server architecture. For more information, see “Accessing a SAS View” in the *SAS/CONNECT User’s Guide*. △

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## Null Values

According to the ANSI Standard for SQL, a missing value is called a *null value*. It is not the same as a blank or zero value. However, to be compatible with the rest of SAS, PROC SQL treats missing values the same as blanks or zero values, and considers all three to be null values. This important concept comes up in several places in this document.

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## Comparing PROC SQL with the SAS DATA Step

PROC SQL can perform some of the operations that are provided by the DATA step and the PRINT, SORT, and SUMMARY procedures. The following query displays the total population of all the large countries (countries with population greater than 1 million) on each continent.

```
proc sql;
  title 'Population of Large Countries Grouped by Continent';
  select Continent, sum(Population) as TotPop format=comma15.
    from sql.countries
    where Population gt 1000000
    group by Continent
    order by TotPop;
quit;
```

**Output 1.1** Sample SQL Output

Population of Large Countries Grouped by Continent	
Continent	TotPop
Oceania	3,422,548
Australia	18,255,944
Central America and Caribbean	65,283,910
South America	316,303,397
North America	384,801,818
Africa	706,611,183
Europe	811,680,062
Asia	3,379,469,458

Here is a SAS program that produces the same result.

```
title 'Large Countries Grouped by Continent';
proc summary data=sq1.countries;
  where Population > 1000000;
  class Continent;
  var Population;
  output out=SumPop sum=TotPop;
run;

proc sort data=SumPop;
  by TotPop;
run;

proc print data=SumPop noobs;
  var Continent TotPop;
  format TotPop commal5.;
  where _type_=1;
run;
```

**Output 1.2** Sample DATA Step Output

Large Countries Grouped by Continent	
Continent	TotPop
Oceania	3,422,548
Australia	18,255,944
Central America and Caribbean	65,283,910
South America	316,303,397
North America	384,801,818
Africa	706,611,183
Europe	811,680,062
Asia	3,379,469,458

This example shows that PROC SQL can achieve the same results as Base SAS software but often with fewer and shorter statements. The SELECT statement that is shown in this example performs summation, grouping, sorting, and row selection. It also displays the query's results without the PRINT procedure.

PROC SQL executes without using the RUN statement. After you invoke PROC SQL you can submit additional SQL procedure statements without submitting the PROC statement again. Use the QUIT statement to terminate the procedure.

## Notes about the Example Tables

For all examples, the following global statements are in effect:

```
options nodate nonumber linesize=80 pagesize=60;
libname sql 'SAS-data-library';
```

The tables that are used in this document contain geographic and demographic data. The data is intended to be used for the PROC SQL code examples only; it is not necessarily up-to-date or accurate.

*Note:* You can find instructions for downloading these data sets at <http://ftp.sas.com/samples/A56936>. These data sets are valid for SAS 9 as well as previous versions of SAS. △

The COUNTRIES table contains data that pertains to countries. The Area column contains a country's area in square miles. The UNDate column contains the year a country entered the United Nations, if applicable.

### Output 1.3 COUNTRIES (Partial Output)

COUNTRIES					
Name	Capital	Population	Area	Continent	UNDate
Afghanistan	Kabul	17070323	251825	Asia	1946
Albania	Tirane	3407400	11100	Europe	1955
Algeria	Algiers	28171132	919595	Africa	1962
Andorra	Andorra la Vell	64634	200	Europe	1993
Angola	Luanda	9901050	481300	Africa	1976
Antigua and Barbuda	St. John's	65644	171	Central America	1981
Argentina	Buenos Aires	34248705	1073518	South America	1945
Armenia	Yerevan	3556864	11500	Asia	1992
Australia	Canberra	18255944	2966200	Australia	1945
Austria	Vienna	8033746	32400	Europe	1955
Azerbaijan	Baku	7760064	33400	Asia	1992
Bahamas	Nassau	275703	5400	Central America	1973
Bahrain	Manama	591800	300	Asia	1971
Bangladesh	Dhaka	1.2639E8	57300	Asia	1974
Barbados	Bridgetown	258534	200	Central America	1966

The WORLD CITY COORDS table contains latitude and longitude data for world cities. Cities in the Western hemisphere have negative longitude coordinates. Cities in the Southern hemisphere have negative latitude coordinates. Coordinates are rounded to the nearest degree.

**Output 1.4** WORLD CITY COORDS (Partial Output)

WORLD CITY COORDS			
City	Country	Latitude	Longitude
Kabul	Afghanistan	35	69
Algiers	Algeria	37	3
Buenos Aires	Argentina	-34	-59
Cordoba	Argentina	-31	-64
Tucuman	Argentina	-27	-65
Adelaide	Australia	-35	138
Alice Springs	Australia	-24	134
Brisbane	Australia	-27	153
Darwin	Australia	-12	131
Melbourne	Australia	-38	145
Perth	Australia	-32	116
Sydney	Australia	-34	151
Vienna	Austria	48	16
Nassau	Bahamas	26	-77
Chittagong	Bangladesh	22	92

The USCITY COORDS table contains the coordinates for cities in the United States. Because all cities in this table are in the Western hemisphere, all of the longitude coordinates are negative. Coordinates are rounded to the nearest degree.

**Output 1.5** USCITY COORDS (Partial Output)

USCITY COORDS			
City	State	Latitude	Longitude
Albany	NY	43	-74
Albuquerque	NM	36	-106
Amarillo	TX	35	-102
Anchorage	AK	61	-150
Annapolis	MD	39	-77
Atlanta	GA	34	-84
Augusta	ME	44	-70
Austin	TX	30	-98
Baker	OR	45	-118
Baltimore	MD	39	-76
Bangor	ME	45	-69
Baton Rouge	LA	31	-91
Birmingham	AL	33	-87
Bismarck	ND	47	-101
Boise	ID	43	-116

The UNITEDSTATES table contains data that is associated with the states. The Statehood column contains the date when the state was admitted into the Union.

**Output 1.6** UNITEDSTATES (Partial Output)

UNITEDSTATES						
Name	Capital	Population	Area	Continent	Statehood	
Alabama	Montgomery	4227437	52423	North America	14DEC1819	
Alaska	Juneau	604929	656400	North America	03JAN1959	
Arizona	Phoenix	3974962	114000	North America	14FEB1912	
Arkansas	Little Rock	2447996	53200	North America	15JUN1836	
California	Sacramento	31518948	163700	North America	09SEP1850	
Colorado	Denver	3601298	104100	North America	01AUG1876	
Connecticut	Hartford	3309742	5500	North America	09JAN1788	
Delaware	Dover	707232	2500	North America	07DEC1787	
District of Columbia	Washington	612907	100	North America	21FEB1871	
Florida	Tallahassee	13814408	65800	North America	03MAR1845	
Georgia	Atlanta	6985572	59400	North America	02JAN1788	
Hawaii	Honolulu	1183198	10900	Oceania	21AUG1959	
Idaho	Boise	1109980	83600	North America	03JUL1890	
Illinois	Springfield	11813091	57900	North America	03DEC1818	
Indiana	Indianapolis	5769553	36400	North America	11DEC1816	

The POSTALCODES table contains postal code abbreviations.

**Output 1.7** POSTALCODES (Partial Output)

POSTALCODES	
Name	Code
Alabama	AL
Alaska	AK
American Samoa	AS
Arizona	AZ
Arkansas	AR
California	CA
Colorado	CO
Connecticut	CT
Delaware	DE
District Of Columbia	DC
Florida	FL
Georgia	GA
Guam	GU
Hawaii	HI
Idaho	ID

The WORLDTEMPS table contains average high and low temperatures from various international cities.

**Output 1.8** WORLDTEMPS (Partial Output)

WORLDTEMPS			
City	Country	AvgHigh	AvgLow
Algiers	Algeria	90	45
Amsterdam	Netherlands	70	33
Athens	Greece	89	41
Auckland	New Zealand	75	44
Bangkok	Thailand	95	69
Beijing	China	86	17
Belgrade	Yugoslavia	80	29
Berlin	Germany	75	25
Bogota	Colombia	69	43
Bombay	India	90	68
Bucharest	Romania	83	24
Budapest	Hungary	80	25
Buenos Aires	Argentina	87	48
Cairo	Egypt	95	48
Calcutta	India	97	56

The OILPROD table contains oil production statistics from oil-producing countries.

**Output 1.9** OILPROD (Partial Output)

OILPROD	
Country	Barrels PerDay
Algeria	1,400,000
Canada	2,500,000
China	3,000,000
Egypt	900,000
Indonesia	1,500,000
Iran	4,000,000
Iraq	600,000
Kuwait	2,500,000
Libya	1,500,000
Mexico	3,400,000
Nigeria	2,000,000
Norway	3,500,000
Oman	900,000
Saudi Arabia	9,000,000
United States of America	8,000,000

The OILRSRVS table lists approximate oil reserves of oil-producing countries.

**Output 1.10 OILRSRVS (Partial Output)**

OILRSRVS	
Country	Barrels
Algeria	9,200,000,000
Canada	7,000,000,000
China	25,000,000,000
Egypt	4,000,000,000
Gabon	1,000,000,000
Indonesia	5,000,000,000
Iran	90,000,000,000
Iraq	110,000,000,000
Kuwait	95,000,000,000
Libya	30,000,000,000
Mexico	50,000,000,000
Nigeria	16,000,000,000
Norway	11,000,000,000
Saudi Arabia	260,000,000,000
United Arab Emirates	100,000,000

The CONTINENTS table contains geographic data that relates to world continents.

**Output 1.11 CONTINENTS**

CONTINENTS					
Name	Area	HighPoint	Height	LowPoint	Depth
Africa	11506000	Kilimanjaro	19340	Lake Assal	-512
Antarctica	5500000	Vinson Massif	16860		.
Asia	16988000	Everest	29028	Dead Sea	-1302
Australia	2968000	Kosciusko	7310	Lake Eyre	-52
Central America	.		.		.
Europe	3745000	El'brus	18510	Caspian Sea	-92
North America	9390000	McKinley	20320	Death Valley	-282
Oceania	.		.		.
South America	6795000	Aconcagua	22834	Valdes Peninsul	-131

The FEATURES table contains statistics that describe various types of geographical features, such as oceans, lakes, and mountains.

**Output 1.12** FEATURES (Partial Output)

FEATURES							
Name	Type	Location	Area	Height	Depth	Length	
Aconcagua	Mountain	Argentina	.	22834	.	.	.
Amazon	River	South America	.	.	.	4000	
Amur	River	Asia	.	.	.	2700	
Andaman	Sea		218100	.	3667	.	
Angel Falls	Waterfall	Venezuela	.	3212	.	.	.
Annapurna	Mountain	Nepal	.	26504	.	.	.
Aral Sea	Lake	Asia	25300	.	222	.	.
Ararat	Mountain	Turkey	.	16804	.	.	.
Arctic	Ocean		5105700	.	17880	.	.
Atlantic	Ocean		33420000	.	28374	.	.
Baffin	Island	Arctic	183810	.	.	.	.
Baltic	Sea		146500	.	180	.	.
Baykal	Lake	Russia	11780	.	5315	.	.
Bering	Sea		873000	.	4893	.	.
Black	Sea		196100	.	3906	.	.