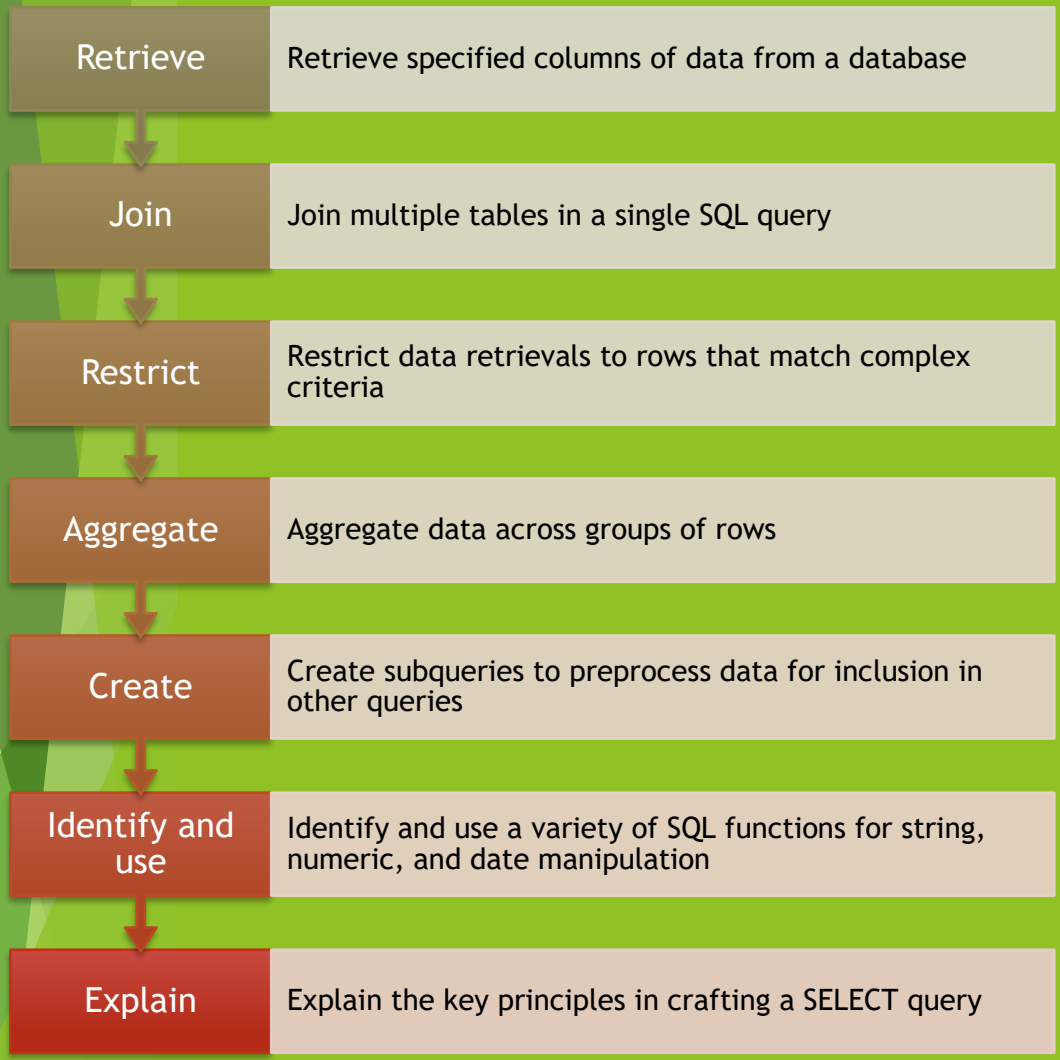
7. Introduction to Structured Query Language (SQL)

Database Design & Business Application Development

Learning Objectives



Introduction to SQL (1 of 4)

Categories of SQL functions

- Data definition language (DDL)
- Data manipulation language (DML)
- Transaction control language (TCL)
- Data control language (DCL)

SQL is relatively easy to learn

- Nonprocedural language with basic command vocabulary set of less than 100 words
- Differences in SQL dialects are minor

Introduction to SQL (2 of 4)

Table 7.2	SQL Data Definition Commands	
Command or Option	Description	
CREATE SCHEMA AUTHORIZATION	**Creates a database schema**	
CREATE TABLE	**Creates a new table in the user's database schema**	
NOT NULL	Ensures that a column will not have null values	
UNIQUE	Ensures that a column will not have duplicate values	
PRIMARY KEY	Defines a primary key for a table	
FOREIGN KEY	Defines a foreign key for a table	
DEFAULT	Defines a default value for a column (when no value is given)	
CHECK	Validates data in an attribute	
CREATE INDEX	**Creates an index for a table**	
CREATE VIEW	**Creates a dynamic subset of rows and columns from one or more tables**	
ALTER TABLE	**Modifies a table's definition (adds, modifies, or deletes attributes or constraints)**	
CREATE TABLE AS	**Creates a new table based on a query in the user's database schema**	
DROP TABLE	**Permanently deletes a table (and its data)**	
DROP INDEX	**Permanently deletes an index**	
DROP VIEW	**Permanently deletes a view**	

Introduction to SQL (3 of 4)

Table 7.3	Other SQL Commands
Command or Option	**Description**
Transaction Control Language	
COMMIT	Permanently saves data changes
ROLLBACK	Restores data to its original values
Data Control Language	
GRANT	Gives a user permission to take a system action or access a data object
REVOKE	Removes a previously granted permission from a user

Introduction to SQL (4 of 4)

Data type: specification about the kinds of data that can be stored in an attribute

Influence queries that retrieve data

Fundamental types of data

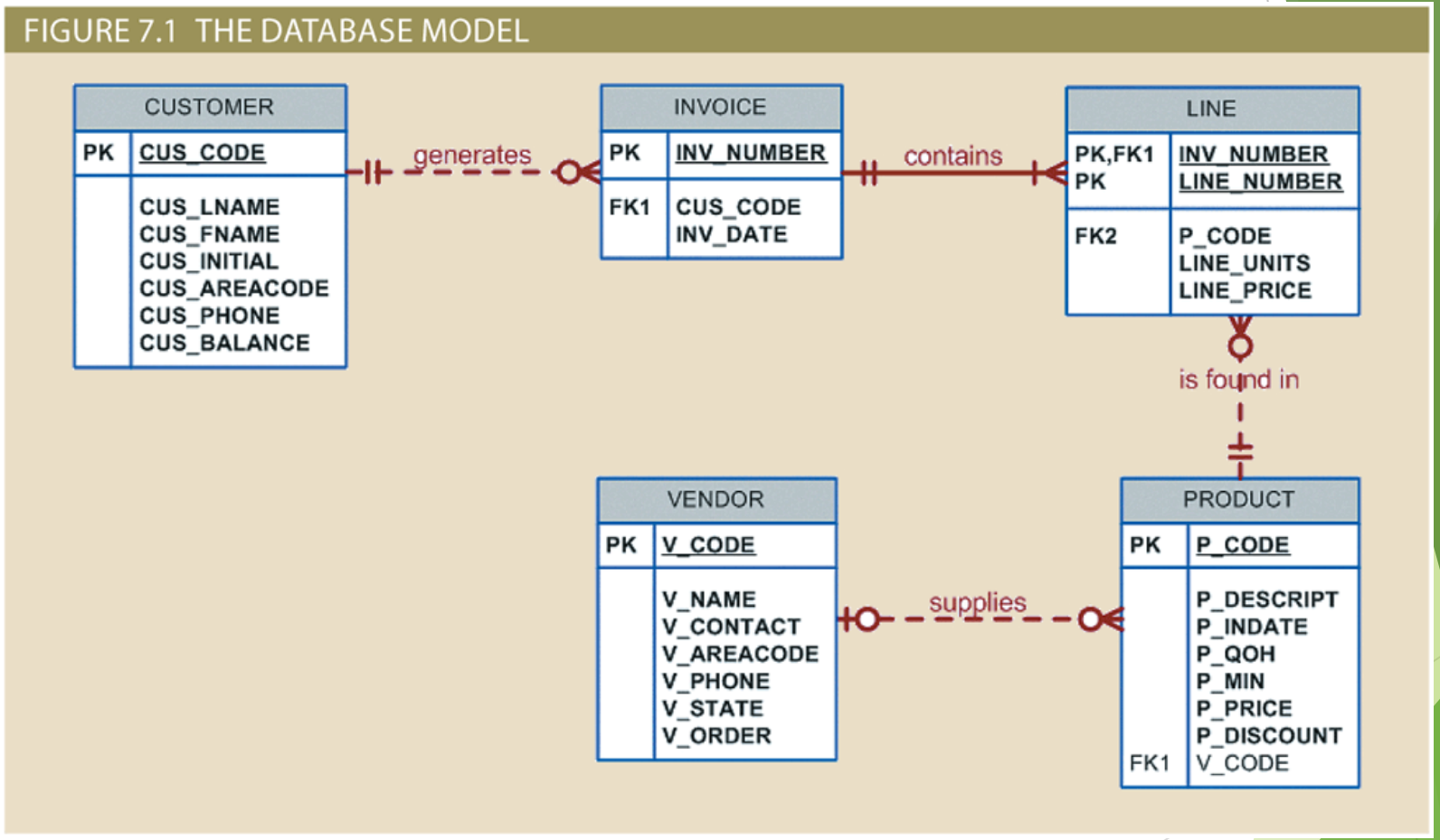
Character data
Numeric data
Date data

At the heart of SQL is the query

Covers both questions and actions

The Database Model

FIGURE 7.1 THE DATABASE MODEL



Basic SELECT Queries

Each clause in a SELECT query performs a specific function

- SELECT: specifies the attributes to be returned by the query
- FROM: specifies the table(s) from which the data will be retrieved
- WHERE: filters the rows of data based on provided criteria
- GROUP BY: groups the rows of data into collections based on sharing the same values in one or more attributes
- HAVING: filters the groups formed in the GROUP BY clause based on provided criteria
- ORDER BY: sorts the final query result rows in ascending or descending order based on the values of one or more attributes

SQL commands can be grouped together on a single line

- Complex command sequences are best shown on separate lines, with space between the SQL command and the command's components

SELECT Statement Options (1 of 7)

The SELECT query specifies the columns to be retrieved as a column list

- Syntax:

SELECT *columnlist*

FROM *tablelist;*

- The columnlist represents one or more attributes, separated by commas
- A wildcard character is a symbol that can be used as a general substitute for other characters or commands

Using column aliases

- Alternative name for a column or table in a SQL statement

Using computed columns

- Computed column (also called a calculated column) represents a derived attribute

Arithmetic operators: the rule of precedence

- Rules that establish the order in which computations are completed

SELECT Statement Options (2 of 7)

FIGURE 7.2 SELECT AN ENTIRE TABLE

P_CODE	P_DESCRIPT	P_INDATE	P_QOH	P_MIN	P_PRICE	P_DISCOUNT	V_CODE
11QER/31	Power painter, 15 psi., 3-nozzle	03-Nov-17	8	5	109.99	0.00	25595
13-Q2/P2	7.25-in. pwr. saw blade	13-Dec-17	32	15	14.99	0.05	21344
14-Q1/L3	9.00-in. pwr. saw blade	13-Nov-17	18	12	17.49	0.00	21344
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15-Jan-18	15	8	39.95	0.00	23119
1558-QW1	Hrd. cloth, 1/2-in., 3x50	15-Jan-18	23	5	43.99	0.00	23119
2232/QTY	B&D jigsaw, 12-in. blade	30-Dec-17	8	5	109.92	0.05	24288
2232/QWE	B&D jigsaw, 8-in. blade	24-Dec-17	6	5	99.87	0.05	24288
2238/QPD	B&D cordless drill, 1/2-in.	20-Jan-18	12	5	38.95	0.05	25595
23109-HB	Claw hammer	20-Jan-18	23	10	9.95	0.10	21225
23114-AA	Sledge hammer, 12 lb.	02-Jan-18	8	5	14.40	0.05	
54778-2T	Rat-tail file, 1/8-in. fine	15-Dec-17	43	20	4.99	0.00	21344
89-WRE-Q	Hicut chain saw, 16 in.	07-Feb-18	11	5	256.99	0.05	24288
PVC23DRT	PVC pipe, 3.5-in., 8-ft	20-Feb-18	188	75	5.87	0.00	
SM-18277	1.25-in. metal screw, 25	01-Mar-18	172	75	6.99	0.00	21225
SW-23116	2.5-in. wd. screw, 50	24-Feb-18	237	100	8.45	0.00	21231
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	17-Jan-18	18	5	119.95	0.10	25595

SELECT Statement Options (3 of 7)

FIGURE 7.3 SELECT WITH A COLUMN LIST

P_CODE	P_DESCRIPT	P_PRICE	P_QOH
11QER/31	Power painter, 15 psi., 3-nozzle	109.99	8
13-Q2/P2	7.25-in. pwr. saw blade	14.99	32
14-Q1/L3	9.00-in. pwr. saw blade	17.49	18
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	39.95	15
1558-QVV1	Hrd. cloth, 1/2-in., 3x50	43.99	23
2232/QTY	B&D jigsaw, 12-in. blade	109.92	8
2232/QWE	B&D jigsaw, 8-in. blade	99.87	6
2238/QPD	B&D cordless drill, 1/2-in.	38.95	12
23109-HB	Claw hammer	9.95	23
23114-AA	Sledge hammer, 12 lb.	14.40	8
54778-2T	Rat-tail file, 1/8-in. fine	4.99	43
89-WRE-Q	Hicut chain saw, 16 in.	256.99	11
PVC23DRT	PVC pipe, 3.5-in., 8-ft	5.87	188
SM-18277	1.25-in. metal screw, 25	6.99	172
SW-23116	2.5-in. wd. screw, 50	8.45	237
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	119.95	18

SELECT Statement Options (4 of 7)

FIGURE 7.4 SELECT WITH COLUMN ALIASES

P_CODE	DESCRIPTION	Unit Price	QTY
11QER/31	Power painter, 15 psi., 3-nozzle	109.99	8
13-Q2/P2	7.25-in. pwr. saw blade	14.99	32
14-Q1/L3	9.00-in. pwr. saw blade	17.49	18
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	39.95	15
1558-QVV1	Hrd. cloth, 1/2-in., 3x50	43.99	23
2232/QTY	B&D jigsaw, 12-in. blade	109.92	8
2232/QWE	B&D jigsaw, 8-in. blade	99.87	6
2238/QPD	B&D cordless drill, 1/2-in.	38.95	12
23109-HB	Claw hammer	9.95	23
23114-AA	Sledge hammer, 12 lb.	14.40	8
54778-2T	Rat-tail file, 1/8-in. fine	4.99	43
89-WRE-Q	Hicut chain saw, 16 in.	256.99	11
PVC23DRT	PVC pipe, 3.5-in., 8-ft	5.87	188
SM-18277	1.25-in. metal screw, 25	6.99	172
SW-23116	2.5-in. wd. screw, 50	8.45	237
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	119.95	18

SELECT Statement Options (5 of 7)

Table 7.4: The Arithmetic Operators	
Operator	**Description**
+	Add
-	Subtract
*	Multiply
/	Divide
^	Raise to the power of (some applications use ** instead of ^)

SELECT Statement Options (6 of 7

- Date arithmetic
  - Values are stored as a number of days; it is possible to perform date arithmetic in a query
- Listing unique values
  - SQL's DISTINCT clause produces a list of only those values that are different from one another
  - Command example:

```
SELECT    DISTINCT V_CODE
FROM      PRODUCT;
```

SELECT Statement Options (7 of 7)

FIGURE 7.7 A LISTING OF DISTINCT V_CODE VALUES IN THE PRODUCT TABLE

V_CODE
21225
21231
21344
23119
24288
25595

FROM Clause Options (1 of 6)

FROM clause of the query specifies the table or tables from which the data is to be retrieved

- Inner joins return only rows from the tables that match on a common value
- Outer joins return the same matched rows as the inner join, plus unmatched rows from one table or the other

Natural join returns all rows with matching values in the matching columns and eliminates duplicate columns

- Determines the common attribute(s) by looking for attributes with identical names and compatible data types
- Selects only the rows with common values in the common attribute(s)
- If there are no common attributes, returns the relational product of the two tables
- Syntax:
  - SELECT *column-list* FROM *table1* NATURAL JOIN *table2*

FROM Clause Options (2 of 6)

Table 7.5 Creating Links through Foreign Keys		
Table	**Attributes To Be Shown**	**Linking Attribute**
PRODUCT	P_DESCRIPT, P_PRICE	V_CODE
VENDOR	V_NAME, V_CONTACT, V_AREACODE, V_PHONE	V_CODE

FROM Clause Options (3 of 6)

- JOIN USING syntax
  - Returns only the rows with matching values in the column indicated in the USING clause—and that column must exist in both tables
  - Syntax:

    SELECT *column-list* FROM *table1* JOIN *table2* USING (*common-column*)
- JOIN ON syntax
  - Express a join when the tables have no common attribute names
  - Query returns only the rows that meet the indicated join condition
  - Syntax:

    SELECT *column-list* FROM *table1* JOIN table2 ON *join-condition*
- Common attribute names
  - Most common cause of duplicate column names is the existence of a foreign key

FROM Clause Options (4 of 6)

FIGURE 7.12 JOIN ON RESULTS

INV_NUMBER	P_CODE	P_DESCRIPT	LINE_UNITS	LINE_PRICE
1001	13-Q2/P2	7.25-in. pwr. saw blade	1	14.99
1001	23109-HB	Claw hammer	1	9.95
1002	54778-2T	Rat-tail file, 1/8-in. fine	2	4.99
1003	2238/QPD	B&D cordless drill, 1/2-in.	1	38.95
1003	1546-QQ2	Hrd. cloth, 1/4-in., 2x50	1	39.95
1003	13-Q2/P2	7.25-in. pwr. saw blade	5	14.99
1004	54778-2T	Rat-tail file, 1/8-in. fine	3	4.99
1004	23109-HB	Claw hammer	2	9.95
1005	PVC23DRT	PVC pipe, 3.5-in., 8-ft	12	5.87
1006	SM-18277	1.25-in. metal screw, 25	3	6.99
1006	2232/QTY	B&D jigsaw, 12-in. blade	1	109.92
1006	23109-HB	Claw hammer	1	9.95
1006	89-WRE-Q	Hicut chain saw, 16 in.	1	256.99
1007	13-Q2/P2	7.25-in. pwr. saw blade	2	14.99
1007	54778-2T	Rat-tail file, 1/8-in. fine	1	4.99
1008	PVC23DRT	PVC pipe, 3.5-in., 8-ft	5	5.87
1008	WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	3	119.95
1008	23109-HB	Claw hammer	1	9.95

FROM Clause Options (5 of 6)

Outer joins

Returns not only the rows matching the join condition (rows with matching values in the common columns) and returns the rows with unmatched values

ANSI standard defines three types of outer joins: left, right, and full

Cross join

Performs a relational product (also known as the *Cartesian product*) of two tables

Joining tables with an alias

An alias may be used to identify the source table from which the data is taken

The ability to specify a table alias is very useful

- Using a table alias allows the database programmer to improve the maintainability of the code by using a table alias that is descriptive of what data the table is providing within the query

Recursive joins

Recursive query: joins a table to itself

FROM Clause Options (6 of 6)

FIGURE 7.17 USING AN ALIAS TO JOIN A TABLE TO ITSELF

EMP_NUM	E.EMP_LNAME	EMP_MGR	M.EMP_LNAME
112	Johnson	100	Kolmycz
103	Jones	100	Kolmycz
102	Vandam	100	Kolmycz
101	Lewis	100	Kolmycz
115	Saranda	105	Williams
113	Smythe	105	Williams
111	Washington	105	Williams
107	Diante	105	Williams
106	Smith	105	Williams
104	Lange	105	Williams
116	Smith	108	Wiesenbach
114	Brandon	108	Wiesenbach
110	Genkazi	108	Wiesenbach
109	Smith	108	Wiesenbach

ORDER BY Clause Options (1 of 2)

- ORDER BY clause is especially useful when the listing order is important
  - Syntax:

    SELECT *columnlist*

    FROM *tablelist*

    [ORDER BY *columnlist* [ASC|DESC]];
  - Cascading order sequence
    - 1. ORDER BY last name
    - 2. Within matching last names, ORDER BY first name
    - 3. Within matching first and last names, ORDER BY middle initial

ORDER BY Clause Options (2 of 2)

FIGURE 7.18 PRODUCTS SORTED BY PRICE IN ASCENDING ORDER

P_CODE	P_DESCRIPT	P_QOH	P_PRICE
54778-2T	Rat-tail file, 1/8-in. fine	43	4.99
PVC23DRT	PVC pipe, 3.5-in., 8-ft	188	5.87
SM-18277	1.25-in. metal screw, 25	172	6.99
SW-23116	2.5-in. wd. screw, 50	237	8.45
23109-HB	Claw hammer	23	9.95
23114-AA	Sledge hammer, 12 lb.	8	14.40
13-Q2/P2	7.25-in. pwr. saw blade	32	14.99
14-Q1/L3	9.00-in. pwr. saw blade	18	17.49
2238/QPD	B&D cordless drill, 1/2-in.	12	38.95
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15	39.95
1558-QVV1	Hrd. cloth, 1/2-in., 3x50	23	43.99
2232/QWE	B&D jigsaw, 8-in. blade	6	99.87
2232/QTY	B&D jigsaw, 12-in. blade	8	109.92
11QER/31	Power painter, 15 psi., 3-nozzle	8	109.99
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	18	119.95
89-WRE-Q	Hicut chain saw, 16 in.	11	256.99

WHERE Clause Options (1 of 4)

Selecting	Selecting rows with conditional restrictions •WHERE clause is used to add conditional restrictions to the SELECT statement that limit the rows returned by the query •Syntax:
Using	Using comparison operators on character attributes •May be used to place restrictions on character-based attributes
Using	Using comparison operators on dates •Date procedures are often more software-specific than other SQL procedures

WHERE Clause Options (2 of 4)

Table 7.6 Comparison Operators	
Symbol	**Meaning**
=	Equal to
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
<> or !=	Not equal to

WHERE Clause Options (3 of 4)

Selecting	Selecting rows with conditional restrictions •WHERE clause is used to add conditional restrictions to the SELECT statement that limit the rows returned by the query •Syntax:
Using	Using comparison operators on character attributes •May be used to place restrictions on character-based attributes
Using	Using comparison operators on dates •Date procedures are often more software-specific than other SQL procedures

WHERE Clause Options (4 of 4)

Logical operators: AND, OR, and NOT

- SQL allows you to include multiple conditions in a query through the use of these logical operators
- Boolean algebra is dedicated to the use of logical operators

Old-style joins

- Generally not recommended
  - Make complex queries more difficult to maintain
  - Susceptible to undetected errors

Special operators

- BETWEEN
- IN
- LIKE
- IS NULL
- NOT

Aggregate Processing (1 of 3)

Takes a collection of rows and reduces it to a single row

- SQL provides useful aggregate functions that count, find minimum and maximum values, calculate averages, etc.

Aggregate functions

- Count
- MIN and MAX
- SUM and AVG

Grouping data

- GROUP BY clause syntax:
  - SELECT *columnlist*
  - FROM *tablelist*
  - [WHERE *conditionlist*]
  - [GROUP BY *columnlist*]
  - [ORDER BY *columnlist* [ASC | DESC]];

Aggregate Processing (2 of 3)

Table 7.7 Some Basic SQL Aggregate Functions	
Function	**Output**
COUNT	The number of rows containing non-null values
MIN	The minimum attribute value encountered in a given column
MAX	The maximum attribute value encountered in a given column
SUM	The sum of all values for a given column
AVG	The arithmetic mean (average) for a specified column

Aggregate Processing (3 of 3)

- HAVING clause
  - Operates very much like the WHERE clause in the SELECT statement
  - HAVING clause is applied to the output of a GROUP BY operation
  - Syntax:

```
SELECT          columnlist
FROM            tablelist
[WHERE          conditionlist ]
[GROUP BY   columnlist ]
[HAVING         conditionlist ]
[ORDER BY   columnlist [ASC | DESC] ];
```

Subqueries (1 of 3)

Key characteristics

- A subquery is a query (SELECT statement) inside another query
- A subquery is normally expressed inside parentheses
- The first query in the SQL statement is known as the outer query
- The query inside the SQL statement is known as the inner query
- The inner query is executed first
- The output of an inner query is used as the input for the outer query
- The entire SQL statement is sometimes referred to as a nested query

Subquery can return one or more values

- One single value (one column and one row)
- A list of values (one column and multiple rows)
- A virtual table (multicolumn, multirow set of values)

Subqueries (2 of 3)

WHERE subqueries

- Most common type of subquery uses an inner SELECT subquery on the right side of a WHERE comparison expression

IN subqueries

- IN operator: used to compare a single attribute to a list of values
- IN subquery: values are not known beforehand, but can be derived using a query

HAVING subqueries

- HAVING clause: used to restrict the output of a GROUP BY query by applying conditional criteria to the grouped rows

Multirow subquery operators: ALL and ANY

- ALL operator compares a single value with a list of values returned by the first subquery using a comparison operator other than equals
- ANY operator compares a single value to a list of values and select only the rows greater than or less than any value in the list

Subqueries (3 of 3)

FROM subqueries

- FROM clause specifies the table(s) from which the data will be drawn

Attribute list subqueries

- Inline subquery: subquery expression
  - Example: can be used to list the difference between each product's price and the average product price

Correlated subquery

- Executes once for each row in the outer query
- Inner query is related to the outer query; the inner query references a column of the outer subquery
- Can also be used with the EXISTS special operator
  - Can be used whenever there is a requirement to execute a command based on the result of another query
  - Can be used with uncorrelated subqueries, but it is almost always used with correlated subqueries

SQL Functions

SQL functions are very useful tools	Many types
Date and time functions	All date functions take one parameter of a date or character data type and return a value; refer to Table 7.10
Numeric functions	Can be grouped in many different ways, such as algebraic, trigonometric, and logarithmic; refer to Table 7.11
String functions	Among the most-used functions in programming; refer to Table 7.12
Conversion functions	Allow you to take a value of a given data type and convert it to the equivalent value in another data type; refer to Table 7.13

Relational Set Operators (1 of 2)

UNION

- Combines rows from two or more queries without including duplicate rows
- Syntax:
  - *query* UNION *query*

UNION ALL

- Used to produce a relation that retains the duplicate rows
- Used to unite more than just two queries

INTERSECT

- Can be used to combine rows from two queries, returning only the rows that appear in both sets
- Syntax:
  - *query* INTERSECT *query*

Relational Set Operators (2 of 2)

- EXCEPT (MINUS)
  - Combines rows from two queries and returns only the rows that appear in the first set but not in the second
  - Syntax:

    query EXCEPT *query*

    and

    query MINUS *query*
- Syntax alternatives
  - Alternative syntax used to achieve the same output

Crafting SELECT Queries (1 of 2)

Know your data

The importance of understanding the data model that you are working in cannot be overstated

Real-world databases are messy; most database systems remain in service in an organization for decades

Know the problem

Understand the question you are attempting to answer

Information reporting requests will come from a range of sources; may be one-time events or ongoing operations within an application

Crafting SELECT Queries (2 of 2)

- Build one clause at a time
  - FROM
  - WHERE
  - GROUP BY
  - HAVING
  - SELECT
  - ORDER BY

Summary (1 of 2)

SQL commands can be divided into two overall categories: data definition language (DDL) commands and data manipulation language (DML) commands

The ANSI standard data types are supported by all RDBMS vendors in different ways

- The basic data types are NUMBER, NUMERIC, INTEGER, CHAR, VARCHAR, and DATE

The SELECT statement is the main data retrieval command in SQL

The column list represents one or more column names separated by commas

Operations that join tables can be classified as inner joins and outer joins

A natural join returns all rows with matching values in the matching columns and eliminates duplicate columns

Joins may use keywords such as USING and ON

The ORDER BY clause is used to sort the output of a SELECT statement

Summary (2 of 2)

The WHERE clause can be used with the SELECT, UPDATE, and DELETE statements to restrict the rows affected by the DDL command

Aggregate functions (COUNT, MIN, MAX, and AVG) are special functions that perform arithmetic computations over a set of rows

Subqueries and correlated queries are used when it is necessary to process data based on other processed data

Most subqueries are executed in a serial fashion

SQL functions are used to extract or transform data

SQL provides relational set operators to combine the output of two queries to generate a new relation

Crafting effective and efficient SQL queries requires a great deal of skill

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