Ryan Stephens
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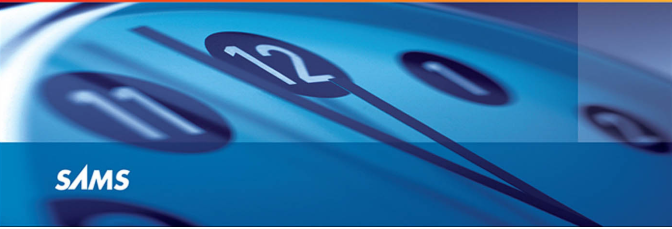
Ron Plew

SIXTH EDITION

Includes Coverage of **Oracle and Microsoft SQL Implementations**

Sams Teach Yourself SQL in 24 Hours



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Sams **Teach Yourself**

SQL

in 24 Hours

SIXTH EDITION

SAMS 800 East 96th Street, Indianapolis, Indiana, 46240 USA

Sams Teach Yourself SQL in 24 Hours, Sixth Edition

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For more than 20 years each, the authors have studied, applied, and documented the SQL standard and its application to critical database systems in this book. The authors are experts in data management, specializing in Oracle, Microsoft, and other leading technologies.

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Dedication

This book is dedicated to my strong and driven wife, Jill, and to my three children by whom I'm equally smitten and amazed—Daniel, Autumn, and Alivia.

—Ryan

I would like to dedicate this book to my wife, Jackie, for being understanding and supportive during the long hours that it took to complete this book.

—Arie

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—Ryan

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HOUR 9

Summarizing Data Results from a Query

What You'll Learn in This Hour:

- Definition of functions
- Using aggregate functions
- Summarizing data with aggregate functions
- Results from using functions

In this hour, you learn about SQL's aggregate functions. You can perform a variety of useful functions with aggregate functions, such as getting the highest total of a sale or counting the number of orders processed on a given day. The real power of aggregate functions will be discussed in the next hour when you tackle the `GROUP BY` clause.

Aggregate Functions

Functions are keywords in SQL used to manipulate values within columns for output purposes. A *function* is a command normally used with a column name or expression that processes the incoming data to produce a result. SQL contains several types of functions. This hour covers aggregate functions. An *aggregate function* provides summarization information for a SQL statement, such as counts, totals, and averages.

The basic set of aggregate functions discussed in this hour are

- `COUNT`
- `SUM`
- `MAX`
- `MIN`
- `AVG`

The following query lists the employee information from the EMPLOYEES table. Note that some of the employees do not have data assigned in some of the columns. We use this data for most of this hour's examples.

```
SELECT TOP 10 EMPLOYEEID,LASTNAME,
 CITY,STATE,PAYRATE,SALARY
 FROM EMPLOYEES;

EMPLOYEEID  LASTNAME          CITY               STATE      PAYRATE        SALARY
----------- ----------------- ------------------ ---------- -------------- --------
1           Iner              Red Dog            NULL                      54000.00
2           Denty             Errol              NH         22.24          NULL
3           Sabbah            Errol              NH         15.29          NULL
4           Loock             Errol              NH         12.88          NULL
5           Sacks             Errol              NH         23.61          NULL
6           Arcoraci          Alexandria         LA         24.79          NULL
7           Astin             Espanola           NM         18.03          NULL
8           Contreraz         Espanola           NM         NULL           60000.00
9           Capito            Espanola           NM         NULL           52000.00
10          Ellamar           Espanola           NM         15.64          NULL

(10 row(s) affected)
```

COUNT

You use the COUNT function to count rows or values of a column that do not contain a NULL value. When used within a query, the COUNT function returns a numeric value. You can also use the COUNT function with the DISTINCT command to only count the distinct rows of a dataset. ALL (opposite of DISTINCT) is the default; it is not necessary to include ALL in the syntax. Duplicate rows are counted if DISTINCT is not specified. One other option with the COUNT function is to use it with an asterisk. COUNT(*) counts all the rows of a table including duplicates, regardless of whether a NULL value is contained in a column.

NOTE

DISTINCT Can Be Used Only in Certain Circumstances

You cannot use the DISTINCT command with COUNT(*), only with COUNT (*column_name*).

The syntax for the COUNT function follows:

```
COUNT [ (*) | (DISTINCT | ALL) ] (COLUMN NAME)
```

This example counts all employee IDs:

```
SELECT COUNT(EMPLOYEEID) FROM EMPLOYEES
```

This example counts only the distinct rows:

```
SELECT COUNT(DISTINCT SALARY)FROM EMPLOYEES
```

This example counts all rows for SALARY:

```
SELECT COUNT(ALL SALARY)FROM EMPLOYEES
```

This final example counts all rows of the EMPLOYEES table:

```
SELECT COUNT(*) FROM EMPLOYEES
```

COUNT(*) is used in the following example to get a count of all records in the EMPLOYEES table. There are 5,611 employees.

```
SELECT COUNT(*)
FROM EMPLOYEES;
-----------
5611

(1 row(s) affected)
```

CAUTION

COUNT(*) Is Different from Other Count Variations

COUNT(*) produces slightly different calculations than other count variations. This is because when the COUNT function is used with the asterisk, it counts the rows in the returned result set without regard to duplicates and NULL values. This is an important distinction. If you need your query to return a count of a particular field and include NULLs, you need to use a function such as ISNULL to replace the NULL values.

COUNT(EMPLOYEEID) is used in the next example to get a count of all the employee identification IDs that exist in the table. The returned count is the same as the last query because all employees have an identification number.

```
SELECT COUNT(EMPLOYEEID)
FROM EMPLOYEES;
-----------
5611

(1 row(s) affected)
```

COUNT([STATE]) is used in the following example to get a count of all the employee records that have a state assigned. Look at the difference between the two counts. The difference is the number of employees who have NULL in the STATE column.

```
SELECT COUNT([STATE])
FROM EMPLOYEES;
-----------
5147
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

The following examples obtain a count of all salary amounts and then all the distinct salary amounts in the EMPLOYEES table.

```
SELECT COUNT(SALARY )
FROM EMPLOYEES;
-----------
1359
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)

SELECT COUNT(DISTINCT SALARY )
FROM EMPLOYEES;
-----------
45
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

The SALARY column had a lot of matching amounts, so the DISTINCT values make the counts drop dramatically.

NOTE

Data Types Do Not Use COUNT

Because the COUNT function counts the rows, data types do not play a part. The rows can contain columns with any data type. The only thing that actually counts is whether the value is NULL.

SUM

The SUM function returns a total on the values of a column for a group of rows. You can also use the SUM function with DISTINCT. When you use SUM with DISTINCT, only the distinct rows are totaled, which might not have much purpose. Your total is not accurate in that case because rows of data are omitted.

The syntax for the SUM function follows:

```
SUM ([ DISTINCT ] COLUMN NAME)
```

CAUTION

SUM Must Be Numeric

The value of an argument must be numeric to use the SUM function. You cannot use the SUM function on columns that have a data type other than numeric, such as character or date.

This example totals the salaries:

```
SELECT SUM(SALARY) FROM EMPLOYEES
```

This example totals the distinct salaries:

```
SELECT SUM(DISTINCT SALARY) FROM EMPLOYEES
```

In the following query, the sum, or total amount, of all salary values is retrieved from the EMPLOYEES table:

```
SELECT SUM(SALARY)
FROM EMPLOYEES;
------------------------------
70791000.00
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

Observe the way the DISTINCT command in the following example skews the previous results by 68 million dollars. This is why it is rarely useful.

```
SELECT SUM(DISTINCT COST)
FROM EMPLOYEES;
------------------------------
2340000.00
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

The following query demonstrates that although some aggregate functions require numeric data, this is only limited to the type of data. Here the ZIP column of the EMPLOYEES table shows that the implicit conversion of the VARCHAR data to a numeric type is supported in Oracle:

```
SELECT SUM(ZIP)
FROM EMPLOYEES;
SUM(ZIP)
-----------
280891448
```

Some aggregate functions require numeric data; this is only limited to the type of data. If the data can be converted implicitly, for example, the string '12345' to an integer, then you can use the aggregate function. When you use a type of data that cannot be implicitly converted to a numeric type, such as the POSITION column, it results in an error, as in the following example:

```
SELECT SUM(POSITION)
FROM EMPLOYEES;
Msg 8117, Level 16, State 1, Line 1
Operand data type varchar is invalid for sum operator.
```

AVG

The AVG function finds the average value for a given group of rows. When used with the DISTINCT command, the AVG function returns the average of the distinct rows. The syntax for the AVG function follows:

```
AVG ([ DISTINCT ] COLUMN NAME)
```

NOTE

AVG Must Be Numeric

The value of the argument must be numeric for the AVG function to work.

The average value for all values in the EMPLOYEES table's SALARY column is retrieved in the following example:

```
SELECT AVG(SALARY)
FROM EMPLOYEES;
------------------------------
52090.507726
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

This example returns the distinct average salary:

```
SELECT AVG(DISTINCT SALARY)
FROM EMPLOYEES;
------------------------------
52000.000000
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

CAUTION

Sometimes Your Data Is Truncated

In some implementations, the results of your query might be truncated to the precision of the data type. You need to review your database system's documentation to ensure you understand what the normal precision for the various data types is. This will prevent you from unnecessarily truncating data and possibly getting an unexpected result due to the data not being of the proper precision.

The next example uses two aggregate functions in the same query. Because some employees are paid hourly and others are on salary, you want to retrieve the average value for both PAYRATE and SALARY.

```
SELECT AVG(PAYRATE) AS AVG_PAYRATE, AVG(SALARY) AS AVG_SALARY
FROM EMPLOYEES;
AVG_PAYRATE                    AVG_SALARY
------------------------------ ------------------------------
18.473012                      52090.507726
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

Notice how the use of aliases makes the output more readable with multiple aggregate values. Also remember that the aggregate function can work on any numeric data. So you can perform calculations within the parentheses of the function as well. So if you need to get the average hourly rate of salaried employees to compare to the average rate of hourly employees, you could write the following:

```
SELECT AVG(PAYRATE) AS AVG_PAYRATE, AVG(SALARY/2040) AS AVG_SALARY_RATE
FROM EMPLOYEES;
AVG_PAYRATE                    AVG_SALARY_RATE
------------------------------ ------------------------------
18.473012                      25.5345625
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

MAX

The MAX function returns the maximum value from the values of a column in a group of rows. NULL values are ignored when using the MAX function. Using MAX with the DISTINCT command is an option. However, because the maximum value for all the rows is the same as the distinct maximum value, DISTINCT is useless.

The syntax for the MAX function is

```
MAX([ DISTINCT ] COLUMN NAME)
```

The following example returns the highest SALARY in the EMPLOYEES table:

```
SELECT MAX(SALARY)
FROM EMPLOYEES;
------------------------------
74000.00
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

This example returns the highest distinct salary:

```
SELECT MAX(DISTINCT SALARY)
FROM EMPLOYEES;
------------------------------
74000.00
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

You can also use aggregate functions such as MAX and MIN (covered in the next section) on character data. In the case of these values, collation of your database comes into play again. Most commonly your database collation is set to a dictionary order, so the results are ranked according to that. For example, say you perform a MAX on the CITY column of the employees table:

```
SELECT MAX(CITY) AS MAX_CITY
FROM EMPLOYEES;
MAX_CITY
------------------------------
Zwara

(1 row(s) affected)
```

In this instance, the function returned the largest value according to a dictionary ordering of the data in the column.

MIN

The MIN function returns the minimum value of a column for a group of rows. NULL values are ignored when using the MIN function. Using MIN with the DISTINCT command is an option. However, because the minimum value for all rows is the same as the minimum value for distinct rows, DISTINCT is useless.

The syntax for the MIN function is

```
MIN([ DISTINCT ] COLUMN NAME)
```

The following example returns the lowest SALARY in the EMPLOYEES table:

```
SELECT MIN(SALARY)
FROM EMPLOYEES;
------------------------------
30000.00
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

This example returns the lowest distinct salary:

```
SELECT MIN(DISTINCT SALARY)
FROM EMPLOYEES;
------------------------------
30000.00
Warning: Null value is eliminated by an aggregate or other SET operation.

(1 row(s) affected)
```

NOTE

DISTINCT and Aggregate Functions Don’t Always Mix

One important thing to keep in mind when using aggregate functions with the DISTINCT command is that your query might not return the wanted results. The purpose of aggregate functions is to return summarized data based on all rows of data in a table. When DISTINCT is used it is applied first to the results and then those results are passed on to the aggregate function, which can dramatically alter the results. You need to ensure that when you work with DISTINCT with aggregate functions that you understand this.

As with the MAX function, the MIN function can work against character data and returns the minimum value according to the dictionary ordering of the data.

```
SELECT MIN(CITY) AS MIN_CITY
FROM EMPLOYEES;
MIN_CITY
------------------------------
 AFB MunicipalCharleston SC

(1 row(s) affected)
```

Summary

Aggregate functions can be useful and are quite simple to use. In this hour you learned how to count values in columns, count rows of data in a table, get the maximum and minimum values for a column, figure the sum of the values in a column, and figure the average value for values in a column. Remember that NULL values are not considered when using aggregate functions, except when using the COUNT function in the format COUNT(*).

Aggregate functions are the first functions in SQL that you have learned in this book, but more follow in the coming hours. You can also use aggregate functions for group values, which are discussed during the next hour. As you learn about other functions, you see that the syntaxes of most functions are similar to one another and that their concepts of use are relatively easy to understand.

Q&A

Q. Why are NULL values ignored when using the MAX or MIN function?

A. A NULL value means that nothing is there, so there would be no maximum or minimum value.

Q. Why don't data types matter when using the COUNT function?

A. The COUNT function counts only rows.

Q. Does the data type matter when using the SUM or AVG function?

A. Not exactly. If the data can be implicitly converted to numeric data, then it will still work. It's less a function of what the data type is and more about what data is stored in it.

Q. Are you limited to using only column names inside of aggregate functions?

A. No, you can use any type of calculation or formula as long as the output corresponds to the proper type of data that the function is expecting to use.

Workshop

The following workshop is composed of a series of quiz questions and practical exercises. The quiz questions are designed to test your overall understanding of the current material. The practical exercises are intended to afford you the opportunity to apply the concepts discussed during the current hour, as well as build upon the knowledge acquired in previous hours of study. Please take time to complete the quiz questions and exercises before continuing. Refer to Appendix C, "Answers to Quizzes and Exercises," for answers.

Quiz

1. True or false: The AVG function returns an average of all rows from a SELECT column, including any NULL values.
2. True or false: The SUM function adds column totals.
3. True or false: The COUNT(*) function counts all rows in a table.
4. True or false: The COUNT([column name]) function counts NULL values.
5. Will the following SELECT statements work? If not, what fixes the statements?

   a.
   ```
   SELECT COUNT *
   FROM EMPLOYEES;
   ```
   b.
   ```
   SELECT COUNT(EMPLOYEEID), SALARY
   FROM EMPLOYEES;
   ```
   c.
   ```
   SELECT MIN(PAYRATE), MAX(SALARY)
   FROM EMPLOYEES
   WHERE SALARY > 50000;
   ```
   d.
   ```
   SELECT COUNT(DISTINCT EMPLOYEEID) FROM EMPLOYEES;
   ```
   e.
   ```
   SELECT AVG(LASTNAME) FROM EMPLOYEES;
   ```
   f.
   ```
   SELECT AVG(CAST(ZIP AS INT)) FROM EMPLOYEES;
   ```

Exercises

1. Use the EMPLOYEES table to construct SQL statements to solve the following exercises:
   a. What is the average salary?
   b. What is the maximum pay rate for hourly employees?
   c. What are the total salaries?
   d. What is the minimum pay rate?
   e. How many rows are in the table?
2. Write a query to determine how many employees are in the company whose last names begin with a ***G***.
3. Write a query to determine the minimum and maximum salary and pay rates per city for employees.
4. Write two sets of queries to find the first employee name and last employee name when they are listed in alphabetical order.
5. Write a query to perform an AVG function on the employee names. Does the statement work? Determine why it is that you got that result.
6. Write a query to display the average value of employees' salaries that takes NULL values into account. Hint: You won't be using the AVG function.

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