

1/50 11:17:06 ***



More SQL

Ch.8

The book cover for "Database Systems: Design, Implementation, and Management" (11th edition) by Coronel and Morris. The title is at the top, followed by a circular graphic of binary digits. Below is a world map made of binary code. The authors' names are at the bottom.

Chapter 8

Advanced SQL

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Objectives

Learning Objectives

- In this chapter, the student will learn:
 - How to use the advanced SQL JOIN operator syntax
 - About the different types of subqueries and correlated queries
 - How to use SQL functions to manipulate dates, strings, and other data
 - About the relational set operators UNION, UNION ALL, INTERSECT, and MINUS

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

2

Objectives

Learning Objectives

- In this chapter, the student will learn:
 - How to create and use views and updatable views
 - How to create and use triggers and stored procedures
 - How to create embedded SQL

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

3

The 'JOIN' operation

Recall that we looked at examples of joining - entries from **two tables**, and entries from a **single table**. These joins were based on 'join conditions'.

It is also possible to join tables using the 'JOIN' keyword..

JOIN conditions

Note that JOINs can be based on != (aka <>), >, <, >= and <= as well, in addition to equality. Eg. to list all students who will be getting a 'A' (uses two inequality comparisons indirectly):

```
//  
http://www.comp.nus.edu.sg/~ooibc/courses/sql/dml\_query\_join.htm  
SELECT a.name, a.score  
FROM student_scores a, grade_class b  
WHERE b.grade = 'A' AND a.score BETWEEN  
b.low_end AND b.high_end;
```

SQL Join Operators

- Relational join operation merges rows from two tables and returns rows with one of the following
 - Natural join - Have common values in common columns
 - Equality or inequality - Meet a given join condition
 - **Outer join**: Have common values in common columns or have no matching values
 - **Inner join**: Only rows that meet a given criterion are selected

Ways to specify JOIN conditions

Table 8.1 - SQL Join Expression Styles			
JOIN CLASSIFICATION	JOIN TYPE	SQL SYNTAX EXAMPLE	DESCRIPTION
CROSS	CROSS JOIN	SELECT * FROM T1, T2	Returns the Cartesian product of T1 and T2 (old style)
		SELECT * FROM T1 CROSS JOIN T2	Returns the Cartesian product of T1 and T2
INNER	Old-style JOIN	SELECT * FROM T1, T2 WHERE T1.C1=T2.C1	Returns only the rows that meet the join condition in the WHERE clause (old style); only rows with matching values are selected
	NATURAL JOIN	SELECT * FROM T1 NATURAL JOIN T2	Returns only the rows with matching values in the matching columns; the matching columns must have the same names and similar data types
	JOIN USING	SELECT * FROM T1 JOIN T2 USING (C1)	Returns only the rows with matching values in the columns indicated in the USING clause
	JOIN ON	SELECT * FROM T1 JOIN T2 ON T1.C1=T2.C1	Returns only the rows that meet the join condition indicated in the ON clause

Cengage Learning © 2015

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Outer vs inner vs full ('both') JOINS

Table 8.1 - SQL Join Expression Styles			
JOIN CLASSIFICATION	JOIN TYPE	SQL SYNTAX EXAMPLE	DESCRIPTION
OUTER	LEFT JOIN	SELECT * FROM T1 LEFT OUTER JOIN T2 ON T1.C1=T2.C1	Returns rows with matching values and includes all rows from the left table (T1) with unmatched values
	RIGHT JOIN	SELECT * FROM T1 RIGHT OUTER JOIN T2 ON T1.C1=T2.C1	Returns rows with matching values and includes all rows from the right table (T2) with unmatched values
	FULL JOIN	SELECT * FROM T1 FULL OUTER JOIN T2 ON T1.C1=T2.C1	Returns rows with matching values and includes all rows from both tables (T1 and T2) with unmatched values

Cengage Learning © 2015

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Full (left+right outer) JOIN example

For example, the following query lists the product code, vendor code, and vendor name for all products and includes all product rows (products without matching vendors) as well as all vendor rows (vendors without matching products):

```
SELECT P.CODE, V.CODE, V.NAME
FROM VENDOR FULL JOIN PRODUCT ON VENDOR.V_CODE = PRODUCT.V_CODE;
```

The SQL code and its results are shown in Figure 8.12.

FIGURE 8.12 FULL JOIN results

P.CODE	V.CODE	V.NAME
10000001	22500	Rudolph Systems
12345672	21345	Gomez Bros.
14-34153	21346	Damek Bros.
1545-0000	21347	Elmer J. Fudd Ltd.
1558-QWY	20110	Rabbitos Ltd.
2233	20200	Elmer Fudd Inc.
2232/0ME	20200	Elmer Fudd Inc.
2238/QPD	25595	Rudolph Systems
2345-0000	21225	Gomez Bros.
54778-21	21346	Gomez Bros.
89-00000	21225	Gomez Bros., Inc.
SH-10277	21225	Brosco, Inc.
SW-23116	21211	Dale Supply
WB/113	22547	Dome Supply
	22548	Dome Supply
	24000	Brikkman Bros.
	25541	Dwail Supplies
	25542	Dwail, Inc.
23114-AH		
P022801		
		21 rows selected.
		SQL>

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

'SELECT' subqueries

SELECT SUBQUERY EXAMPLES	EXPLANATION
INSERT INTO PRODUCT SELECT * FROM P;	Inserts all rows from Table P into the PRODUCT table. Both tables must have the same attributes. The subquery returns all rows from Table P.
UPDATE PRODUCT SET P_PRICE = (SELECT AVG(P_PRICE) FROM PRODUCT) WHERE V_CODE IN (SELECT V_CODE FROM VENDOR WHERE V_AREACODE = '615')	Updates the product price to the average product price, but only for products provided by vendors who have an area code equal to 615. The first subquery returns the average price; the second subquery returns the list of vendors with an area code equal to 615.
DELETE FROM PRODUCT WHERE V_CODE IN (SELECT V_CODE FROM VENDOR WHERE V_AREACODE = '615')	Deletes the PRODUCT table rows provided by vendors with an area code equal to 615. The subquery returns the list of vendor codes with an area code equal to 615.

Cengage Learning © 2015

Subqueries and Correlated Queries

- Subquery is a query inside another query
- Subquery can return:
 - 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
 - No value - Output of the outer query might result in an error or a null empty set

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

'WHERE' subqueries

WHERE Subqueries

- Uses inner SELECT subquery on the right side of a WHERE comparison expression
- Value generated by the subquery must be of a comparable data type
- If the query returns more than a single value, the DBMS will generate an error
- Can be used in combination with joins

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

9

WHERE subquery example

FIGURE 8.13 WHERE subquery example

```
SQL> SELECT P_CODE, P_PRICE FROM PRODUCT
  2  WHERE P_PRICE >= (SELECT AVG(P_PRICE) FROM PRODUCT);
P_CODE          P_PRICE
-----        -----
112ER/31         109.99
22232/TIV         109.92
22323/TME         95.87
80-URE-Q         255.99
UR0/TT0         119.95

SQL> SELECT DISTINCT CUS_CODE, CUS_LNAME, CUS_FNAME
  2  FROM CUSTOMER JOIN INVOICE USING (CUS_CODE)
  3           JOIN LINE USING (INV_NUMBER)
  4           JOIN PRODUCT USING (P_CODE)
  5  WHERE P_CODE IN (SELECT P_CODE FROM PRODUCT WHERE P_DESCRIFT = 'Claw hammer');
CUS_CODE CUS_LNAME      CUS_FNAME
-----  -----
10011 Dunne            Leona
10014 Orlando           Myron
```

IN, HAVING subqueries

IN and HAVING Subqueries

- IN subqueries
 - Used to compare a single attribute to a list of values
- HAVING subqueries
 - HAVING clause restricts the output of a GROUP BY query by applying conditional criteria to the grouped rows

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

'IN' subqueries

Compare against a LIST of values..

FIGURE
8.14 IN subquery example

The screenshot shows the Oracle SQL*Plus interface. The title bar says "Oracle SQL*Plus". The menu bar includes "File", "Edit", "Search", "Options", and "Help". The main area displays the following SQL query and its results:

```
SQL> SELECT DISTINCT CUS_CODE, CUS_LNAME, CUS_FNAME
  2  FROM CUSTOMER JOIN INVOICE USING (CUS_CODE)
  3  JOIN LINE USING (INV_NUMBER)
  4  JOIN PRODUCT USING (P_CODE)
  5 WHERE P_CODE IN (SELECT P_CODE FROM PRODUCT
  6   WHERE P_DESCRIP LIKE '%hammer%' OR P_DESCRIP LIKE '%saw%');

  CUS_CODE CUS_LNAME      CUS_FNAME
  -----  -----
  10011 Duane          Leona
  10012 Smith          Kathy
  10014 Orlando        Byron
  10015 O'Brian        Amy
```

The results show four customer records whose purchased products either contain the word "hammer" or "saw" in their descriptions.

'HAVING' subqueries

As we saw earlier, this restricts the results of a GROUP BY clause. Eg. here's how to list all products sold, whose totals are greater than the average quantity sold:

FIGURE 8.15 HAVING subquery example

The screenshot shows an Oracle SQL*Plus window. The query is:

```
SQL> SELECT P_CODE, SUM(LINE_UNITS)
  2  FROM LINE
  3  GROUP BY P_CODE
  4  HAVING SUM(LINE_UNITS) > (SELECT AVG(LINE_UNITS) FROM LINE);
```

The output is:

P_CODE	SUM(LINE_UNITS)
13-Q2/P2	8
23109-ID	5
54778-2T	6
PU023DRT	17
SM-18277	3
WR9/TT9	9

6 rows selected.

SQL>

ALL, ANY (inequality comparisons)

Recall that 'IN' is an equality comparison against a list. To do **inequality comparison of a value against a list of values** (eg. need to be greater than ALL, need to be less than ANY..), use ALL, ANY.

Multirow Subquery Operators: ANY and ALL

- ALL operator
 - Allows comparison of a single value with a list of values returned by the first subquery
 - Uses a comparison operator other than equals
- ANY operator
 - Allows comparison of a single value to a list of values and selects only the rows for which the value is greater than or less than any value in the list

ALL, ANY

Eg. "which products do we own [in our store], whose value is more than ALL other products's values supplied by vendors in Florida?"

FIGURE 8.16 Multirow subquery operator example

The screenshot shows an Oracle SQL*Plus window with the following content:

```

SQL> SELECT P_CODE, P_QUOH*P_PRICE
  2  FROM PRODUCT
  3 WHERE P_QUOH*P_PRICE > ALL
  4 (SELECT P_QUOH*P_PRICE FROM PRODUCT
  5 WHERE V_CODE IN (SELECT V_CODE FROM VENDOR WHERE V_STATE = 'FL'));

```

Output:

P_CODE	P_QUOH*P_PRICE
B9-WHE-Q	2820.89

Note that 'greater than ALL' is eqvt to 'greater than the largest of'. 'ALL' is used to select rows [plural in general] that comparison-succeed against all values in a list.

Another powerful operator is the ANY multirow operator (the near cousin of the ALL multirow operator). The ANY operator allows you to compare a single value to a list of values, selecting only the rows for which the inventory cost is greater than any value of the list or less than any value of the list. You could use the equal to ANY operator, which would be the equivalent of the IN operator.

'ANY' is used to select rows [plural in general] that comparison-succeed with any value in a list.

Note that ' $= \text{ANY}(\text{list of values})$ ' is equivalent to the 'IN' operator (which is itself equivalent to multiple $=$ conditions joined by ORs). So the following are all equivalent, for a given value of 'M':

(M==6) OR (M==8) OR (M==10)

M IN (6,8,10)

M = ANY (6,8,10)

So loosely speaking, ALL is equivalent to AND, and ANY is equivalent to OR.

'FROM' subqueries

A SELECT query that appears in FROM, creates a **virtual table** against which the main query can run.

FROM Subqueries

- FROM clause:
 - Specifies the tables from which the data will be drawn
 - Can use SELECT subquery

FROM subquery example

All customers who bought both specified products

FIGURE 8.17 FROM subquery example

```
+ Oracle SQL*Plus
File Edit Preferences Help
SQL> SELECT DISTINCT CUSTOMER.CUS_CODE, CUSTOMER.CUS_LNAME
  2  FROM CUSTOMER,
  3  (SELECT INVOICE.CUS_CODE
  4   FROM INVOICE
  5   WHERE INVOICE.P_CODE = '19-627-02') CP1,
  6  (SELECT INVOICE.CUS_CODE
  7   FROM INVOICE
  8   WHERE INVOICE.P_CODE = '2019-00') CP2
  9  WHERE CUSTOMER.CUS_CODE = CP1.CUS_CODE AND
10    CP1.CUS_CODE = CP2.CUS_CODE;
CUS_CODE CUS_LNAME
-----10014 Orlando
SQL> |
```

Attribute list subqueries

These subqueries determine what columns get output by the main query - they can be actual (existing) columns or computed columns or results of aggregate functions.

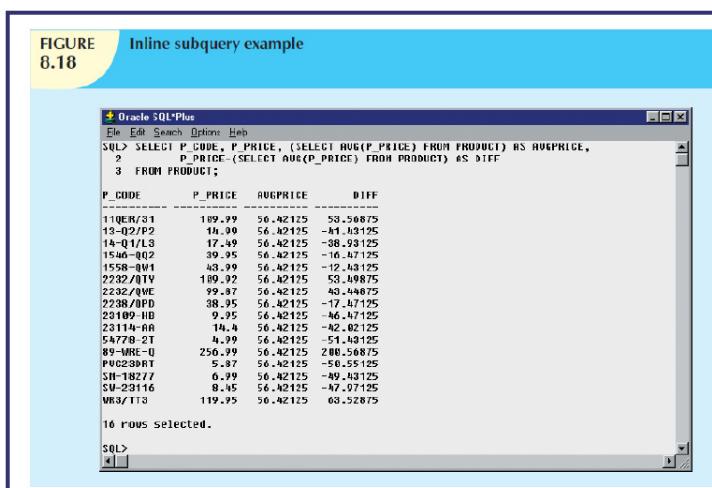
These are also known as 'column subqueries' or 'inline subqueries'.

Attribute List Subqueries

- SELECT statement uses attribute list to indicate what columns to project in the resulting set
- Inline subquery
 - Subquery expression included in the attribute list that must return one value
- Column alias cannot be used in attribute list computation if alias is defined in the same attribute list

Attribute subquery example

FIGURE 8.18 Inline subquery example



The screenshot shows the Oracle SQL*Plus interface. The command window contains the following SQL query:

```
SQL> SELECT P_CODE, P_PRICE, (SELECT AVG(P_PRICE) FROM PRODUCT) AS AVEPRICE,
2       P_PRICE-(SELECT AVG(P_PRICE) FROM PRODUCT) AS DIFF
3   FROM PRODUCT;
```

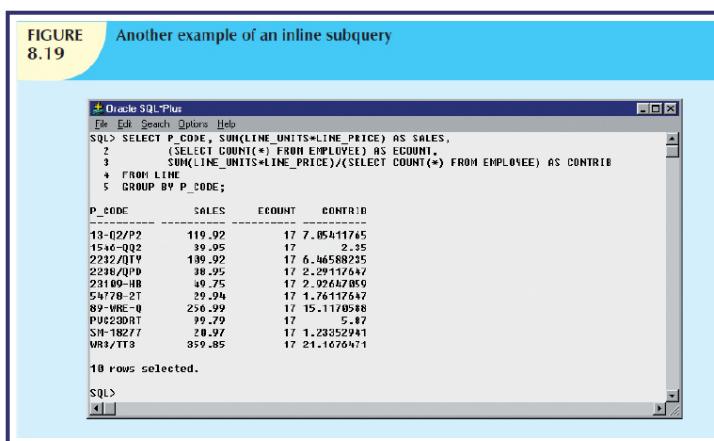
The results window displays the output of the query. The columns are P_CODE, P_PRICE, AVEPRICE, and DIFF. The data shows 16 rows selected, with various product codes and their prices relative to the average price.

P_CODE	P_PRICE	AVEPRICE	DIFF
11QEVR31	189.99	56.42125	-133.56875
13-Q2/P2	1h.90	56.42125	-A1.43125
14-Q1/L3	17.49	56.42125	-38.93125
15AB-02	39.99	56.42125	-17.47125
15AB-0011	46.99	56.42125	-19.44125
2202/01W	189.92	56.42125	-133.49875
2232/0ME	99.87	56.42125	-A3.44875
2238/0PD	38.95	56.42125	-17.47125
23109-HI	9.95	56.42125	-46.47125
23114-AA	14.4	56.42125	-42.02125
5477B-2T	4.99	56.42125	-51.43125
89-00000	250.0	56.42125	293.56875
PV0239MT	5.37	56.42125	-50.45
SII-1M2Z77	6.99	56.42125	-49.43125
SU-23116	8.15	56.42125	-47.07125
VR3/113	119.95	56.42125	63.52875

16 ROWS Selected.

Another attribute subquery example

FIGURE 8.19 Another example of an inline subquery



The screenshot shows the Oracle SQL*Plus interface with a query window. The query is:

```
SQL> SELECT P_CODE, SUM(LINE_UNITS*LINE_PRICE) AS SALES,
  2      (SELECT COUNT(*) FROM EMPLOYEE) AS ECOUNT,
  3      SUM(LINE_UNITS*LINE_PRICE)/(SELECT COUNT(*) FROM EMPLOYEE) AS CONTRIB
  4  FROM LINE
  5 GROUP BY P_CODE;
```

The output shows 10 rows of data:

P_CODE	SALES	ECOUNT	CONTRIB
13-02/P2	119.92	17	7.05411745
1546-Q02	39.95	17	2.35
2232/J01Y	119.92	17	6.46588235
2238/Q/PB	38.95	17	2.29117647
23100-HB	49.75	17	2.92627059
5478/E-0T	29.91	17	1.76117647
6939-E-0	26.99	17	15.117647
P02200RT	99.79	17	5.747
SM-1RZ77	78.97	17	1.23352941
VR3/TT3	359.85	17	21.1676471

10 rows selected.

SQL>

Correlated subqueries

Correlated Subquery

- Executes once for each row in the outer query
- Inner query references a column of the outer subquery
- Can be used with the EXISTS special operator

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

21

In a correlated subquery, the inner (sub) query is repeatedly run, for each row of the outer query! The inner is said to be (co-)related with the outer query when it references a column in the outer query's table. This is in effect, like a double (nested) 'for' loop..

Here is the Wikipedia entry on correlated subqueries. This is the example shown there [select employees who make more than the average salary for their department]:

```
SELECT employee_number, name
  FROM employees AS Bob
 WHERE salary > (
   SELECT AVG(salary)
     FROM employees
    WHERE department = Bob.department);
```

In the above, the outer query "passes in", for each employee (each row), the employee's dept. [which the inner query refers to as Bob.department]. The inner query selects all salaries for that dept., computes the average, compares it with the passed-in employee's salary; if the test passes, the outer query selects the employee's # and name.

Correlated subqueries [cont'd]

Until now, all subqueries you have learned execute independently. That is, each subquery in a command sequence executes in a serial fashion, one after another. The inner subquery executes first; its output is used by the outer query, which then executes until the last outer query executes (the first SQL statement in the code).

In contrast, a **correlated subquery** is a subquery that executes once for each row in the outer query. That process is similar to the typical nested loop in a programming language. For example:

```
FOR X = 1 TO 2
  FOR Y = 1 TO 3
    PRINT "X = "X, "Y = "Y
  END
END
```

1. It initiates the outer query.
2. For each row of the outer query result set, it executes the inner query by passing the outer row to the inner query.

That process is the opposite of that of the subqueries as you have already seen. The query is called a *correlated subquery* because the inner query is *related* to the outer query by the fact that the inner query references a column of the outer subquery.

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Correlated subquery examples

To see the correlated subquery in action, suppose that you want to know all product sales in which the units sold value is greater than the average units sold value *for that product* (as opposed to the average for *all* products). In that case, the following procedure must be completed:

1. Compute the average units sold for a product.
2. Compare the average computed in Step 1 to the units sold in each sale row, and then select only the rows in which the number of units sold is greater.

The following correlated query completes the preceding two-step process:

```
SELECT INV_NUMBER, P_CODE, LINE_UNITS
FROM LINE LS
WHERE LS.LINE_UNITS > (SELECT AVG(LINE_UNITS)
                         FROM LINE LA
                         WHERE LA.P_CODE = LS.P_CODE);
```

```
SQL> SELECT INV_NUMBER, P_CODE, LINE_UNITS
  2  FROM LINE LS
  3 WHERE LS.LINE_UNITS > (SELECT AVG(LINE_UNITS)
  4                           FROM LINE LA
  5                           WHERE LA.P_CODE = LS.P_CODE);

INV_NUMBER P_CODE      LINE_UNITS
----- ----- -----
1003 13-Q2/P2          5
1004 54778-2T          3
1004 23109-HB          2
1005 PUC23DRT          12

SQL> SELECT INV_NUMBER, P_CODE, LINE_UNITS,
  2    (SELECT AVG(LINE_UNITS) FROM LINE LX WHERE LX.P_CODE = LS.P_CODE) AS AVG
  3  FROM LINE LS
  4 WHERE LS.LINE_UNITS > (SELECT AVG(LINE_UNITS)
  5                           FROM LINE LA
  6                           WHERE LA.P_CODE = LS.P_CODE);

INV_NUMBER P_CODE      LINE_UNITS      AVG
----- ----- ----- -----
1003 13-Q2/P2          5  2.66666667
1004 54778-2T          3   2
1004 23109-HB          2   1.25
1005 PUC23DRT          12   8.5

SQL>
```

In the top query and its result in Figure 8.14, note that the LINE table is used more than once, so you must use table aliases. In this case, the inner query computes the average units sold of the product that matches the P_CODE of the outer query P_CODE. That is, the inner query runs once, using the first product code found in the outer LINE table, and returns the average sale for that product. When the number of units sold in the outer LINE row is greater than the average computed, the row is added to the output. Then the inner query runs again, this time using the second product code found in the outer LINE table. The process repeats until the inner query has run for all rows in the outer LINE table. In this case, the inner query will be repeated as many times as there are rows in the outer query.

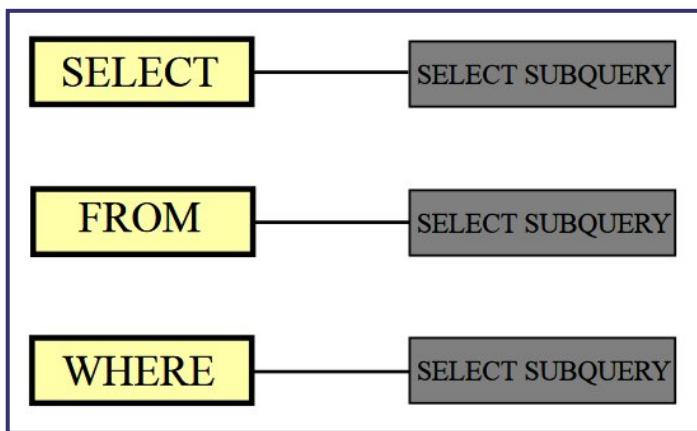
To verify the results and to provide an example of how you can combine subqueries, you can add a correlated inline subquery to the previous query. (See the second query and its results in Figure 8.14.) As you can see, the new query contains a correlated inline subquery that computes the average units sold for each product. You not only get an answer, you can also verify that the answer is correct.

In the second query above, we have TWO correlated subqueries (that are identical), both of which need to run for every row of the main query.

Queries: summary

We looked at several variations of queries and subqueries (SELECT, WHERE, HAVING, IN..).

Most interestingly, a SELECT subquery can appear at the top (SELECT), middle (FROM) or bottom (WHERE) of a parent query, which provides a flexible way to express complex logic (since such subqueries can be recursively nested):



SQL functions

SQL Functions

- Functions always use a numerical, date, or string value
- Value may be part of a command or may be an attribute located in a table
- Function may appear anywhere in an SQL statement where a value or an attribute can be used

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

24

SQL functions [cont'd]

SQL Functions

- Date and time functions
- Numeric functions
- String functions
- Conversion functions

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

UNION, INTERSECTION, DIFFERENCE

Relational Set Operators

- SQL data manipulation commands are set-oriented
 - **Set-oriented:** Operate over entire sets of rows and columns at once
- UNION, INTERSECT, and Except (MINUS) work properly when relations are union-compatible
 - **Union-compatible:** Number of attributes are the same and their corresponding data types are alike
- UNION
 - Combines rows from two or more queries without including duplicate rows

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

26

UNION, INTERSECTION, DIFFERENCE

[cont'd]

Relational Set Operators

- Syntax - query UNION query
- UNION ALL
 - Produces a relation that retains duplicate rows
 - Can be used to unite more than two queries
- INTERSECT
 - Combines rows from two queries, returning only the rows that appear in both sets
 - Syntax - query INTERSECT query

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, in whole or in part.

27

UNION, INTERSECTION, DIFFERENCE

[cont'd]

Relational Set Operators

- EXCEPT (MINUS)
 - Combines rows from two queries and returns only the rows that appear in the first set
 - Syntax
 - query EXCEPT query
 - query MINUS query
- Syntax alternatives
 - IN and NOT IN subqueries can be used in place of INTERSECT

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

28

VIEWS

Virtual Tables: Creating a View

- **View:** Virtual table based on a SELECT query
- **Base tables:** Tables on which the view is based
- **CREATE VIEW** statement: Data definition command that stores the subquery specification in the data dictionary
 - CREATE VIEW command
 - CREATE VIEW viewname AS SELECT query

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

29

VIEW example

Creating a Virtual Table with the CREATE VIEW Command

The screenshot shows a window titled "SQL Plus". Inside, the following SQL commands are run:

```
SQL> CREATE VIEW PRICEGT50 AS
  2    SELECT P_DESCRPT, P_QOH, P_PRICE
  3    FROM PRODUCT
  4   WHERE P_PRICE > 50.00;

View created.

SQL> SELECT * FROM PRICEGT50;
```

The output of the second command is a table:

P_DESCRPT	P_QOH	P_PRICE
Power painter, 15 psi., 3-nozzle	8	109.99
B&D jigsaw, 12-in. blade	8	109.92
B&D jigsaw, 8-in. blade	6	99.87
Hicut chain saw, 16 in.	11	256.99
Steel matting, 4'x8'x1/6", .5" mesh	18	119.95

At the bottom of the window, it says "Cengage Learning © 2015".

Sequences

Oracle Sequences

- Independent object in the database
- Have a name and can be used anywhere a value expected
- Not tied to a table or column
- Generate a numeric value that can be assigned to any column in any table
- Table attribute with an assigned value can be edited and modified
- Can be created and deleted any time

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

33

Sequence creation example

Figure 8.27 - Oracle Sequence

The screenshot shows the Oracle SQL Plus interface. At the top, it says "Figure 8.27 - Oracle Sequence". The SQL command window contains the following:

```
SQL> CREATE SEQUENCE CUS_CODE_SEQ START WITH 20010 NOCACHE;
Sequence created.

SQL> CREATE SEQUENCE INU_NUMBER_SEQ START WITH 4010 NOCACHE;
Sequence created.

SQL> SELECT * FROM USER_SEQUENCES;
```

A table is displayed with the following data:

SEQUENCE_NAME	MIN_VALUE	MAX_VALUE	INCREMENT_BY	CACHE_SIZE	LAST_NUMBER
CUS_CODE_SEQ	1 1.0000E+27	1	N	0	20010
INU_NUMBER_SEQ	1 1.0000E+27	1	N	0	4010

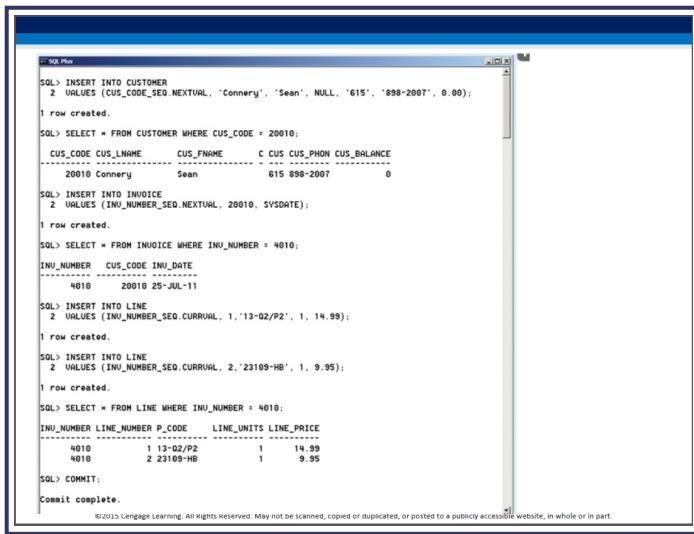
```
SQL>

INSERT INTO CUSTOMER
VALUES (CUS_CODE_SEQ.NEXTVAL, 'Connery', 'Sean', NULL, '615', '898-2007', 0.00);
```

At the bottom left, it says "©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part." At the bottom right, it says "34".

Sequence: NEXTVAL, CURRVAL

NEXTVAL returns the current value, then does ++;
CURRVAL just fetches the current value (does not ++ it).



The screenshot shows a SQL Plus window with the following session history:

```
-- SQL Plus
SQL> INSERT INTO CUSTOMER
2  VALUES (CUS_CODE_SEQ.NEXTVAL, 'Connery', 'Sean', NULL, '615', '898-2007', 0.00);
1 row created.

SQL> SELECT * FROM CUSTOMER WHERE CUS_CODE = 20010;
   CUS_CODE CUS_LNAME      CUS_FNAME      C CUS_CUS_PHON CUS_BALANCE
----- -----          -----          C-----          -----
20010 Connery        Sean           615 898-2007          0

SQL> INSERT INTO INVOICE
2  VALUES (INU_NUMBER_SEQ.NEXTVAL, 20010, SYSDATE);
1 row created.

SQL> SELECT * FROM INVOICE WHERE INU_NUMBER = 4010;
   INU_NUMBER CUS_CODE INU_DATE
----- -----          -----
4010       20010 25-JUL-11

SQL> INSERT INTO LINE
2  VALUES (INU_NUMBER_SEQ.CURRVAL, 1,'13-02/P2', 1, 14.99);
1 row created.

SQL> INSERT INTO LINE
2  VALUES (INU_NUMBER_SEQ.CURRVAL, 2,'23109-HB', 1, 9.95);
1 row created.

SQL> SELECT * FROM LINE WHERE INU_NUMBER = 4010;
   INU_NUMBER LINE_NUMBER P_CODE      LINE_UNITS LINE_PRICE
----- -----          -----          C-----          -----
4010       1 13-02/P2            1    14.99
4010       2 23109-HB           1     9.95

SQL> COMMIT;
Commit complete.
```

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Procedural Language SQL (PL/SQL)

PL/SQL involves extra (augmented) syntax that lets us do looping, branching, variable declaration and function declaration - these are of course not possible using 'plain' SQL.

PL/SQL can be used to create:

- **blocks of code** for one-time execution
- **triggers** - callbacks to invoke
- **stored procedures** - named procedures (no return values) for repeated calling
- **stored functions** - named functions (with return values) for repeated calling

Procedural SQL

- Performs a conditional or looping operation by isolating critical code and making all application programs call the shared code
 - Yields better maintenance and logic control
- **Persistent stored module (PSM):** Block of code containing:
 - Standard SQL statements
 - Procedural extensions that is stored and executed at the DBMS server

PL/SQL [cont'd]

Procedural SQL

- **Procedural Language SQL (PL/SQL)**

- Use and storage of procedural code and SQL statements within the database
- Merging of SQL and traditional programming constructs
- Procedural code is executed as a unit by DBMS when invoked by end user
- End users can use PL/SQL to create:
 - Anonymous PL/SQL blocks and triggers
 - Stored procedures and PL/SQL functions

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

37

[Unnamed] block creation example

The screenshot shows a SQL developer interface with the following content:

```
SQL> BEGIN
 2 INSERT INTO VENDOR
 3 VALUES (25678, 'Microsoft Corp.', 'Bill Gates', '765', '546-8484', 'WA', 'N');
 4 END;
 5 /
PL/SQL procedure successfully completed.

SQL> SET SERVEROUTPUT ON
SQL>
SQL> BEGIN
 2 INSERT INTO VENDOR
 3 VALUES (25772, 'Clue Store', 'Isaac Hayes', '456', '323-2009', 'VA', 'N');
 4 DBMS_OUTPUT.PUT_LINE('New Vendor Added!');
 5 END;
 6 /
New Vendor Added!
PL/SQL procedure successfully completed.

SQL> SELECT * FROM VENDOR;
U_CODE U_NAME          U_CONTACT      U_P U_PHONE U_U
----- -- -- -- -- --
25678 Microsoft Corp. Bill Gates    765 546-8484 WA N
25772 Clue Store     Isaac Hayes   615 899-0989 VA N
21225 Bellcore, Inc. Smithson      615 223-3234 TN Y
21226 SuperLoo, Inc. Flushing      904 215-8995 FL N
21231 DEE Supply     Singh         615 228-3245 TN Y
21394 Gomez Bros.  Ortega        615 888-1111 GA N
22695 Global Supply  Smith         801 555-1111 GR N
23119 Randsets Ltd. Anderson     801 678-3998 GR Y
24000 Brackman Bros. Browning     615 228-1410 TN N
24288 ORDUA, Inc.   Hakford       615 898-1234 TN Y
25494 DSK, Inc.     Smith         800 227-3234 TN N
25501 Digital Supplies Seythe       615 888-3529 TN N
25595 Rubicon Systems Orion        904 456-0092 FL Y
13 rows selected.
```

SQL>

Triggers

Triggers

- Procedural SQL code automatically invoked by RDBMS when given data manipulation event occurs
- Parts of a trigger definition
 - Triggering timing - Indicates when trigger's PL/SQL code executes
 - Triggering event - Statement that causes the trigger to execute
 - Triggering level - **Statement-** and **row-level**
 - Triggering action - PL/SQL code enclosed between the BEGIN and END keywords

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

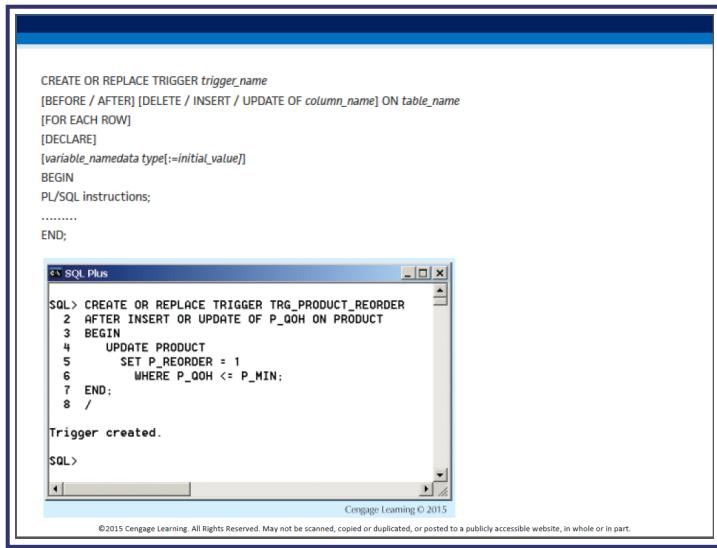
39

Triggers [cont'd]

- *The triggering timing:* BEFORE or AFTER. This timing indicates when the trigger's PL/SQL code executes—in this case, before or after the triggering statement is completed.
- *The triggering event:* The statement that causes the trigger to execute (INSERT, UPDATE, or DELETE).
- *The triggering level:* The two types of triggers are statement-level triggers and row-level triggers.
 - A **statement-level trigger** is assumed if you omit the FOR EACH ROW keywords. This type of trigger is executed once, before or after the triggering statement is completed. This is the default case.
 - A **row-level trigger** requires use of the FOR EACH ROW keywords. This type of trigger is executed once for each row affected by the triggering statement. (In other words, if you update 10 rows, the trigger executes 10 times.)
- *The triggering action:* The PL/SQL code enclosed between the BEGIN and END keywords. Each statement inside the PL/SQL code must end with a semicolon (;).

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Trigger example



The screenshot shows a computer screen with two windows. The top window is a code editor with the following PL/SQL code:

```
CREATE OR REPLACE TRIGGER trigger_name
[BEFORE / AFTER] [DELETE / INSERT / UPDATE OF column_name] ON table_name
[FOR EACH ROW]
[DECLARE]
[variable_name data_type[:>initial_value]]
BEGIN
PL/SQL instructions;
.....
END;
```

The bottom window is a SQL Plus session window titled "SQL Plus". It contains the following command and output:

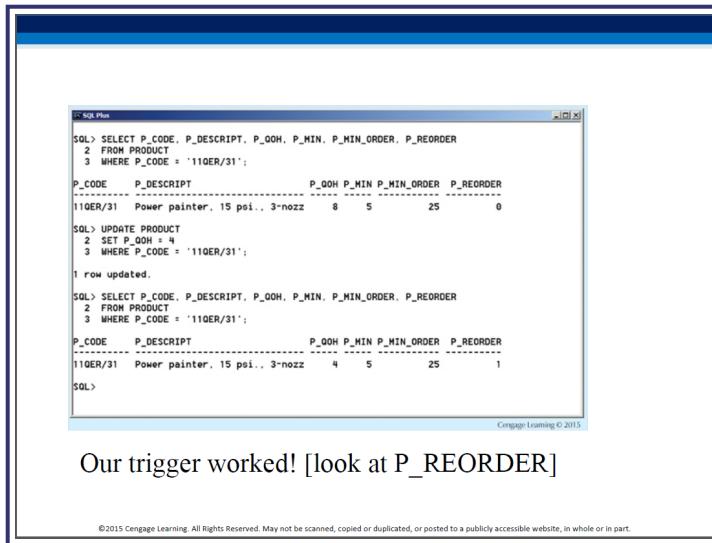
```
SQL> CREATE OR REPLACE TRIGGER TRG_PRODUCT_REORDER
2  AFTER INSERT OR UPDATE OF P_QOH ON PRODUCT
3  BEGIN
4      UPDATE PRODUCT
5          SET P_reordered = 1
6          WHERE P_QOH <= P_Min;
7  END;
8 /
```

Trigger created.

```
SQL>
```

Cengage Learning © 2015

Trigger example



The screenshot shows a SQL Plus window with the following session history:

```
SQL> SELECT P_CODE, P_DESCRIP, P_QOH, P_MIN, P_MIN_ORDER, P_REORDER
  2  FROM PRODUCT
  3 WHERE P_CODE = '11QER/31';

P_CODE      P_DESCRIP          P_QOH P_MIN P_MIN_ORDER P_REORDER
-----  -----
11QER/31  Power painter, 15 psi., 3-nozz     8      5        25          0

SQL> UPDATE PRODUCT
  2  SET P_QOH = 4
  3 WHERE P_CODE = '11QER/31';

1 row updated.

SQL> SELECT P_CODE, P_DESCRIP, P_QOH, P_MIN, P_MIN_ORDER, P_REORDER
  2  FROM PRODUCT
  3 WHERE P_CODE = '11QER/31';

P_CODE      P_DESCRIP          P_QOH P_MIN P_MIN_ORDER P_REORDER
-----  -----
11QER/31  Power painter, 15 psi.. 3-nozz     4      5        25          1

SQL>
```

Our trigger worked! [look at P_REORDER]

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Triggers [cont'd]

Triggers

- **DROP TRIGGER trigger_name command**
 - Deletes a trigger without deleting the table
- Trigger action based on DML predicates
 - Actions depend on the type of DML statement that fires the trigger

Stored procedures

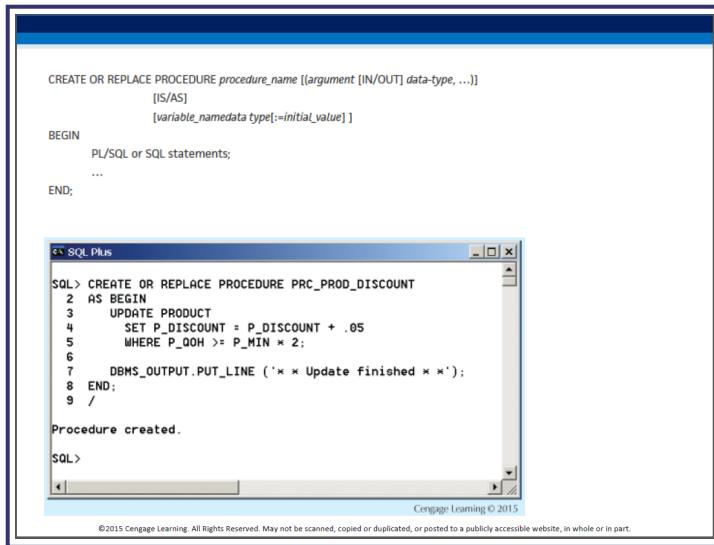
Stored Procedures

- Named collection of procedural and SQL statements
- Advantages
 - Reduce network traffic and increase performance
 - Reduce code duplication by means of code isolation and code sharing

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

44

Stored procedure example



The screenshot shows a Windows application window titled "SQL*Plus". Inside the window, PL/SQL code is being entered to create a stored procedure named "PRC_PROD_DISCOUNT". The code includes a BEGIN block containing an UPDATE statement that adds 0.05 to the product discount if quantity on hand is greater than or equal to twice the minimum quantity. It also includes a DBMS_OUTPUT.PUT_LINE call to print a message when the update is finished. The command "CREATE OR REPLACE PROCEDURE" is preceded by a multi-line comment describing the syntax for creating or replacing a procedure.

```
CREATE OR REPLACE PROCEDURE procedure_name [(argument [IN/OUT] data-type, ...)]  
[IS/AS]  
[variable_namedata type[:=initial_value]] ]  
  
BEGIN  
    PL/SQL or SQL statements;  
    ...  
END;
```

```
SQL> CREATE OR REPLACE PROCEDURE PRC_PROD_DISCOUNT  
2  AS BEGIN  
3      UPDATE PRODUCT  
4          SET P_DISCOUNT = P_DISCOUNT + .05  
5          WHERE P_QOH >= P_MIN * 2;  
6  
7      DBMS_OUTPUT.PUT_LINE ('* * Update finished * *');  
8  END;  
9 /  
  
Procedure created.  
SQL>
```

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Stored procedure example

```

SQL> SELECT P_CODE, P_DESCRIFT, P_QM, P_MIN, P_DISCOUNT FROM PRODUCT;
P_CODE P_DESCRIFT P_QM P_MIN P_DISCOUNT
11QERZ-11 Power planer, 15 pli., 3-moz 29 5 0.00
13-QZ-P7 7.2-in. per. saw blade 36 15 0.10
14-QZ-P7 7.2-in. per. saw blade 36 15 0.05
1546-QZB Hd cloth, 14-in., 2x50 15 8 0.00
1558-QZB Hd cloth, 14-in., 3x50 25 10 0.05
22Z-QTB BBD jigsaw, 12-in. blade 8 5 0.05
22Z-QTC BBD jigsaw, 8-in. blade 6 7 0.05
22Z-QTF BBD jigsaw, 12-in. blade 8 5 0.05
2310H-HS Circular saw, 12-in. 23 10 0.10
2477B-2T Ret-tail file, 1/8-in. fine 43 20 0.00
2477C-2T Ret-tail file, 1/8-in. fine 43 20 0.05
PWC-BB87 PVC pipe, 3.5-in., 8-ft 198 75 0.00
PWC-BB87 PVC pipe, 3.5-in., 8-ft 198 75 0.05
SM-1827 1.25-in. metal screw, 25 172 75 0.05
SM-1836 1.25-in. metal screw, 50 237 360 0.00
MR3-T3 Steel matting, 4'x6'x1/4", .5" 16 5 0.10

16 rows selected.

SQL> EXEC PRC_PRD_DISCOUNT;
* Update finished * *

PL/SQL procedure successfully completed.

SQL> SELECT P_CODE, P_DESCRIFT, P_QM, P_MIN, P_DISCOUNT FROM PRODUCT;
P_CODE P_DESCRIFT P_QM P_MIN P_DISCOUNT
11QERZ-11 Power planer, 15 pli., 3-moz 29 5 0.05
13-QZ-P7 7.2-in. per. saw blade 36 15 0.10
14-QZ-P7 7.2-in. per. saw blade 36 15 0.05
1546-QZB Hd cloth, 14-in., 2x50 15 8 0.00
1558-QZB Hd cloth, 14-in., 3x50 25 10 0.05
22Z-QTB BBD jigsaw, 12-in. blade 8 5 0.05
22Z-QTC BBD jigsaw, 8-in. blade 6 7 0.05
22Z-QTF BBD jigsaw, 12-in. blade 8 5 0.05
2310H-HS Circular saw, 12-in. 23 10 0.15
2477B-2T Ret-tail file, 1/8-in. fine 43 20 0.05
2477C-2T Ret-tail file, 1/8-in. fine 43 20 0.05
PWC-BB87 PVC pipe, 3.5-in., 8-ft 198 75 0.00
PWC-BB87 PVC pipe, 3.5-in., 8-ft 198 75 0.05
SM-1827 1.25-in. metal screw, 25 172 75 0.05
SM-1836 1.25-in. metal screw, 50 237 360 0.05
MR3-T3 Steel matting, 4'x6'x1/4", .5" 16 5 0.15

16 rows selected.

SQL>

```

Stored functions

Reminder - these can RETURN a value.

PL/SQL Stored Functions

- **Stored function:** Named group of procedural and SQL statements that returns a value
 - As indicated by a RETURN statement in its program code
- Can be invoked only from within stored procedures or triggers

Stored functions - syntax

```
CREATE FUNCTION function_name (argument IN data-type, ...) RETURN data-type [IS]
BEGIN
    PL/SQL statements;
    ...
    RETURN (value or expression);
END;
```

Once such a function is defined, it can be CALLED
inside triggers or in stored procedures..

©2015 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

Stored functions - example

The following is an example from
<http://www.tutorialspoint.com/plsql>.

Creating/defining a function:

```
FUNCTION findMax(x IN number, y IN number)
RETURN number
IS
    z number;
BEGIN
    IF x > y THEN
        z:= x;
    ELSE
        Z:= y;
    END IF;

    RETURN z;
END;
```

Calling/executing/running the function:

```
DECLARE
    a number;
    b number;
    c number;
BEGIN
    a:= 23;
    b:= 45;
```

```
c := findMax(a, b);
dbms_output.put_line(' Maximum of
(23,45): ' || c);
END;
/
```

Result:

```
Maximum of (23,45): 45
```