Database Systems: Design, Implementation, and Management

UNIT 4

Advanced SQL

SQL Join Operators

- Join operation merges rows from two tables and returns the rows with one of the following:
  - *Inner Join*
    - Have common values in common columns
      - Natural join
    - Meet a given join condition
      - Equality or inequality
  - *Outer join*
    - Have common values in common columns or have no matching value
  - *Cross join*
    - Returns same result as the Cartesian product of two sets

SQL Join Operators

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
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

Cross Join

- Performs relational product of two tables
  - Also called Cartesian product
- Syntax:

  SELECT column-list FROM table1 CROSS JOIN table2
- Perform a cross join that yields specified attributes

```
SELECT INVOICE.INV_NUMBER, CUS_CODE, INV_DATE, P_CODE
FROM INVOICE CROSS JOIN LINE;
```

OR

```
FROM INVOICE, LINE;
```

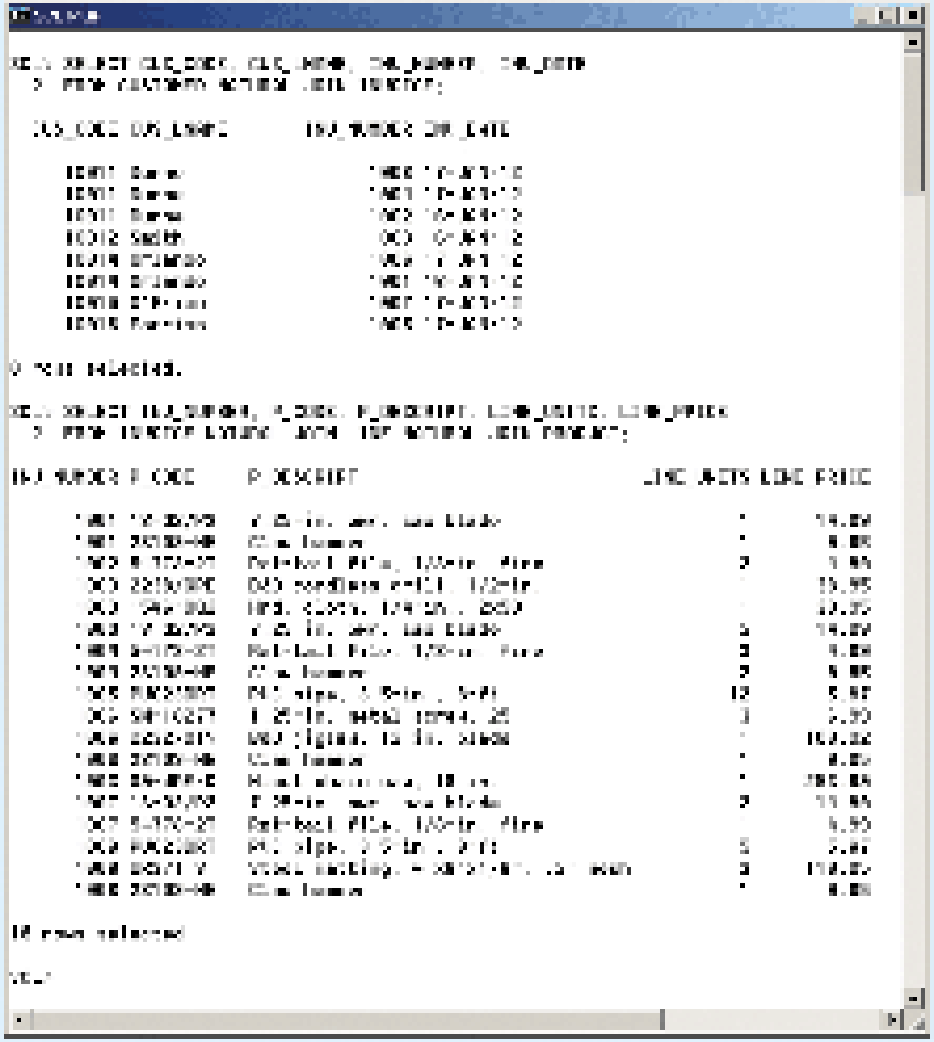
Natural Join

- Not available in MS SQL – use JOIN ON
- Returns all rows with matching values in the matching columns
  - Determines the common attribute(s) by looking for attributes with identical names and compatible data types
  - Select only the rows with common values in the common attribute(s)
  - If there are no common attributes, return the relational product of the two tables
  - Eliminates duplicate columns
- Used when tables share one or more common attributes with common names
- Syntax:

```
SELECT column-list FROM table1 NATURAL JOIN table2
```

Natural Join

FIGURE 8.1 NATURAL JOIN results



JOIN USING Clause

- Returns only rows with matching values in the column indicated in the USING clause
  - The column must exist in both tables
- Syntax:

  SELECT column-list FROM table1 JOIN table2 USING (common-column)
- JOIN USING operand does not require table qualifiers
  - Oracle returns error if table name is specified

JOIN USING Clause

FIGURE 8.2 JOIN USING results

```
SQL> SELECT INV_NUMBER, P_CODE, P_DESCRIPT, LINE_UNITS, LINE_PRICE
  2  FROM INVOICE JOIN LINE USING (INV_NUMBER)
  3       JOIN PRODUCT USING (P_CODE);

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

18 rows selected.

SQL>
```

SOURCE: Course Technology/Cengage Learning

JOIN ON Clause

- Used when tables have no common attributes
- Returns only rows that meet the join condition
  - Typically includes equality comparison expression of two columns
  - Column names need not be the same but they must be the same data type
- Syntax:

  SELECT column-list FROM table1 JOIN table2 ON join-condition

JOIN ON Clause

FIGURE 8.3 JOIN ON results

```
SQL> SELECT INVOICE.INV_NUMBER, PRODUCT.P_CODE, P_DESCRIPT, LINE_UNITS, LINE_PRICE
  2  FROM INVOICE JOIN LINE ON INVOICE.INV_NUMBER = LINE.INV_NUMBER
  3       JOIN PRODUCT ON LINE.P_CODE = PRODUCT.P_CODE;

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

18 rows selected.

SQL>
```

SOURCE: Course Technology/Cengage Learning

JOIN ON Clause

- The following query will generate a list of all employees with the managers' names

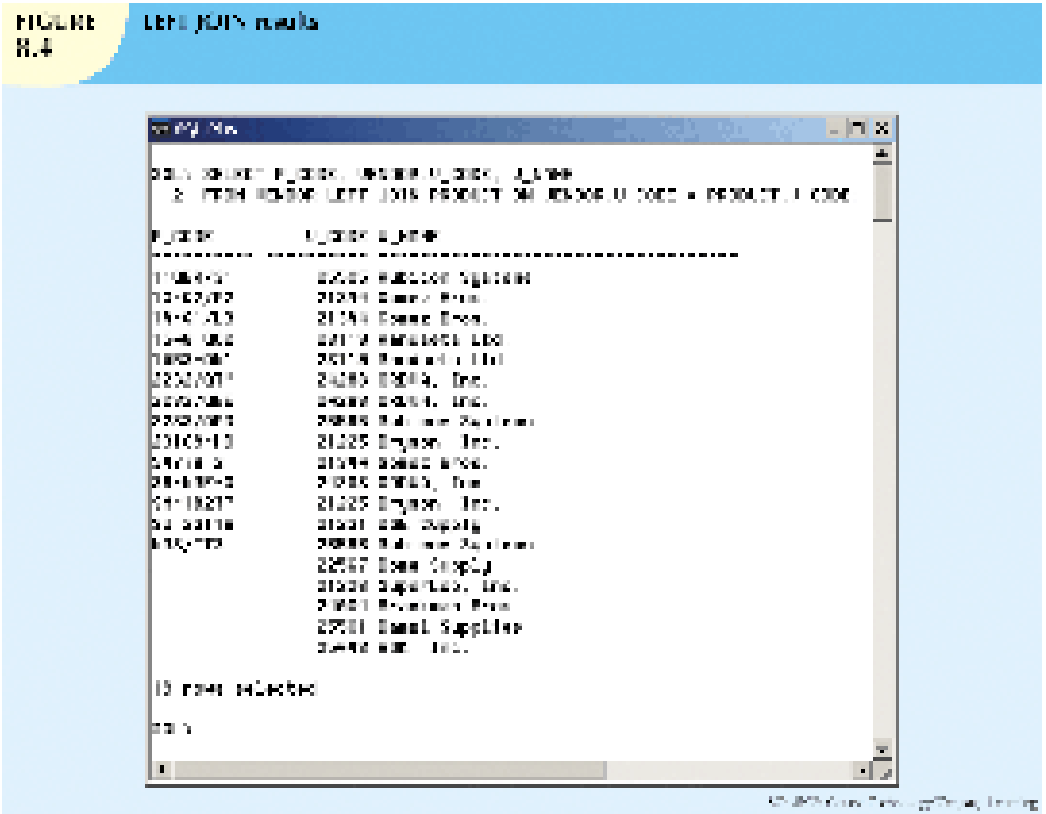
```
SELECT E.EMP_MGR, M.EMP_LNAME, E.EMP_NUM, E.EMP_LNAME
FROM   EMP E JOIN EMP M ON E.EMP_MGR = M.EMP_NUM
ORDER  BY E.EMP_MGR
```

Outer Joins

- Returns rows matching the join condition
- Also returns rows with unmatched attribute values for tables to be joined
- Three types
  - Left
  - Right
  - Full
- Left and right designate order in which tables are processed

Outer Joins (cont'd.)

- Left outer join
  - Returns rows matching the join condition
  - Returns rows in left side table with unmatched values
  - Syntax: SELECT column-list FROM table1 LEFT [OUTER] JOIN table2 ON join-condition



Outer Joins (cont'd.)

- Right outer join
  - Returns rows matching join condition
  - Returns rows in right side table with unmatched values

FIGURE 8.5 RIGHT JOIN results

```
SQL> SELECT P_CODE, VENDOR.V_CODE, V_NAME
  2  FROM VENDOR RIGHT JOIN PRODUCT ON VENDOR.V_CODE = PRODUCT.V_CODE;

P_CODE         V_CODE V_NAME
---------- ---------- ----------------------------------
SM-18277        21225 Bryson, Inc.
23109-HB        21225 Bryson, Inc.
SW-23116        21231 D&E Supply
54778-2T        21344 Gomez Bros.
14-Q1/L3        21344 Gomez Bros.
13-Q2/P2        21344 Gomez Bros.
1558-QW1        23119 Randsets Ltd.
1546-QQ2        23119 Randsets Ltd.
89-WRE-Q        24288 ORDVA, Inc.
2232/QWE        24288 ORDVA, Inc.
2232/QTY        24288 ORDVA, Inc.
WR3/TT3         25595 Rubicon Systems
2238/QPD        25595 Rubicon Systems
11QER/31        25595 Rubicon Systems
PVC23DRT
23114-AA

16 rows selected.

SQL>
```

SOURCE: Course Technology/Cengage Learning

Outer Joins (cont'd.)

- Full outer join
  - Returns rows matching join condition
  - Returns all rows with unmatched values in either side table
  - Syntax:

```
SELECT   column-list
FROM  table1 FULL [OUTER] JOIN table2
        ON join-condition
```

FIGURE 8.6 **FULL JOIN results**

```
SQL Plus

SQL> SELECT P_CODE, VENDOR.V_CODE, V_NAME
  2  FROM VENDOR FULL JOIN PRODUCT ON VENDOR.V_CODE = PRODUCT.V_CODE;

P_CODE         V_CODE V_NAME
---------- ---------- ----------------------------------
11QER/31        25595 Rubicon Systems
13-Q2/P2        21344 Gomez Bros.
14-Q1/L3        21344 Gomez Bros.
1546-QQ2        23119 Randsets Ltd.
1558-QW1        23119 Randsets Ltd.
2232/QTY        24288 ORDVA, Inc.
2232/QWE        24288 ORDVA, Inc.
2238/QPD        25595 Rubicon Systems
23109-HB        21225 Bryson, Inc.
23114-AA
54778-2T        21344 Gomez Bros.
89-WRE-Q        24288 ORDVA, Inc.
PVC23DRT
SM-18277        21225 Bryson, Inc.
SW-23116        21231 D&E Supply
WR3/TT3         25595 Rubicon Systems
                22567 Dome Supply
                21226 SuperLoo, Inc.
                24004 Brackman Bros.
                25501 Damal Supplies
                25443 B&K, Inc.

21 rows selected.

SQL>
```

SOURCE: Course Technology/Cengage Learning

Relational Set Operators

- UNION
- INTERSECT
- MINUS
- Work properly if relations are union-compatible
  - Names of relation attributes must be the same and their data types must be identical

UNION

- Combines rows from two or more queries without including duplicate rows
  - Example:

```
SELECT   CUS_LNAME, CUS_FNAME,
   CUS_INITIAL, CUS_AREACODE,
FROM     CUSTOMER
UNION
SELECT   CUS_LNAME, CUS_FNAME,
   CUS_INITIAL, CUS_AREACODE,
FROM     CUSTOMER_2
```

- Can be used to unite more than two queries

UNION

FIGURE 8.16 UNION query results

Database name: CH08_SaleCo

Table name: CUSTOMER

CUS_CODE	CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE	CUS_BALANCE
10010	Ramas	Alex	A	615	844-2573	0.00
10011	Dunne	Leona	K	713	894-1238	0.00
10012	Smith	Kathy	W	615	894-2285	345.86
10013	Olowski	Paul	F	615	894-2180	536.75
10014	Orlando	Myron		615	222-1672	0.00
10015	O'Brian	Amy	B	713	442-3381	0.00
10016	Brown	James	G	615	297-1228	221.19
10017	Williams	George		615	290-2556	768.93
10018	Farriss	Anne	G	713	382-7185	216.55
10019	Smith	Olette	K	615	297-3809	0.00

Table name: CUSTOMER_2

CUS2_CODE	CUS2_LNAME	CUS2_FNAME	CUS2_INITIAL	CUS2_AREACODE	CUS2_PHONE
345	Terrell	Justine	H	615	322-9870
347	Olowski	Paul	F	615	894-2180
351	Hernandez	Carlos	J	723	123-7654
352	McDougall	George		723	123-7789
355	Tripp	Khaleed	G	723	123-8876
358	Lewis	Maria	J	734	332-1789
359	Dunne	Leona	K	713	894-1238

Query name: qryUNION-of-CUSTOMER-and-CUSTOMER_2

CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE
Brown	James	G	615	297-1228
Dunne	Leona	K	713	894-1238
Farriss	Anne	G	713	382-7185
Hernandez	Carlos	J	723	123-7654
Lewis	Maria	J	734	332-1789
McDougall	George		723	123-7789
O'Brian	Amy	B	713	442-3381
Olowski	Paul	F	615	894-2180
Orlando	Myron		615	222-1672
Ramas	Alex	A	615	844-2573
Smith	Kathy	W	615	894-2285
Smith	Olette	K	615	297-3809
Terrell	Justine	H	615	322-9870
Tripp	Khaleed	G	723	123-8876
Williams	George		615	290-2556

SOURCE: Course Technology/Cengage Learning

UNION ALL

- Produces a relation that retains duplicate rows
  - Example query:

```
SELECT  CUS_LNAME, CUS_FNAME,
 CUS_INITIAL, CUS_AREACODE, FROM    CUSTOMER
 UNION ALL
 SELECT  CUS_LNAME, CUS_FNAME,
 CUS_INITIAL, CUS_AREACODE, FROM
 CUSTOMER_2;
```

- Can be used to unite more than two queries

UNION ALL

FIGURE 8.17 UNION ALL query results

Database name: CH08_SaleCo

Table name: CUSTOMER

CUS_CODE	CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE	CUS_BALANCE
10010	Ramas	Alfred	A	615	844-2573	0.00
10011	Dunne	Leona	K	713	894-1238	0.00
10012	Smith	Kathy	W	615	894-2285	345.86
10013	Olowski	Paul	F	615	894-2180	536.75
10014	Orlando	Myron		615	222-1672	0.00
10015	O'Brian	Amy	B	713	442-3381	0.00
10016	Brown	James	G	615	297-1228	221.19
10017	Williams	George		615	290-2556	768.93
10018	Farriss	Anne	G	713	382-7185	216.55
10019	Smith	Olette	K	615	297-3809	0.00

Table name: CUSTOMER_2

CUS_CODE	CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE
345	Terrell	Justine	H	615	322-5672
347	Olowski	Paul	F	615	894-2180
351	Hernandez	Carlos	J	723	123-7654
352	McDowell	George		723	123-7755
355	Tirpin	Khaled	G	723	123-8873
356	Lewis	Marie	J	734	222-1789
358	Dunne	Leona	K	713	894-1238

Query name: qryUNION-ALL-of-CUSTOMER-and-CUSTOMER_2

CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE
Ramas	Alfred	A	615	844-2573
Dunne	Leona	K	713	894-1238
Smith	Kathy	W	615	894-2285
Olowski	Paul	F	615	894-2180
Orlando	Myron		615	222-1672
O'Brian	Amy	B	713	442-3381
Brown	James	G	615	297-1228
Williams	George		615	290-2556
Farriss	Anne	G	713	382-7185
Smith	Olette	K	615	297-3809
Terrell	Justine	H	615	322-5672
Olowski	Paul	F	615	894-2180
Hernandez	Carlos	J	723	123-7654
McDowell	George		723	123-7755
Tirpin	Khaled	G	723	123-8873
Lewis	Marie	J	734	222-1789
Dunne	Leona	K	713	894-1238

SOURCE: Course Technology/Cengage Learning

INTERSECT

- Combines rows from two queries, returning only the rows that appear in both sets
- Syntax: query INTERSECT query
  - Example query:

```
SELECT   CUS_LNAME, CUS_FNAME,
  CUS_INITIAL, CUS_AREACODE, FROM
  CUSTOMER
  INTERSECT
  SELECT  CUS_LNAME, CUS_FNAME,
  CUS_INITIAL, CUS_AREACODE, FROM
  CUSTOMER_2
```

FIGURE 8.18 INTERSECT query results

```
SQL> SELECT CUS_LNAME, CUS_FNAME, CUS_INITIAL, CUS_AREACODE, CUS_PHONE FROM CUSTOMER
  2  INTERSECT
  3  SELECT CUS_LNAME, CUS_FNAME, CUS_INITIAL, CUS_AREACODE, CUS_PHONE FROM CUSTOMER_2;

CUS_LNAME       CUS_FNAME       C CUS CUS_PHON
--------------- --------------- - --- --------
Dunne           Leona           K 713 894-1238
Olowski         Paul            F 615 894-2180

SQL> SELECT CUS_CODE FROM CUSTOMER WHERE CUS_AREACODE = '615'
  2  INTERSECT
  3  SELECT DISTINCT CUS_CODE FROM INVOICE;

  CUS_CODE
----------
     10012
     10014

SQL>
```

SOURCE: Course Technology/Cengage Learning

MINUS

- Combines rows from two queries
  - Returns only the rows that appear in the first set but not in the second
- Syntax: query MINUS query (MS SQL uses EXCEPT)
  - Example:

```
SELECT CUS_LNAME, CUS_FNAME, CUS_INITIAL, CUS_AREACODE, FROM
 CUSTOMER
 MINUS
SELECT  CUS_LNAME, CUS_FNAME, CUS_INITIAL, CUS_AREACODE,
 FROM CUSTOMER_2
```

MINUS

FIGURE 8.19 MINUS query results

```
SQL> SELECT CUS_LNAME, CUS_FNAME, CUS_INITIAL, CUS_AREACODE, CUS_PHONE FROM CUSTOMER
  2  MINUS
  3  SELECT CUS_LNAME, CUS_FNAME, CUS_INITIAL, CUS_AREACODE, CUS_PHONE FROM CUSTOMER_2;

CUS_LNAME       CUS_FNAME       C CUS CUS_PHON
--------------- --------------- - --- --------
Brown           James           G 615 297-1228
Farriss         Anne            G 713 382-7185
O'Brian         Amy             B 713 442-3381
Orlando         Myron             615 222-1672
Ramas           Alfred          A 615 844-2573
Smith           Kathy           W 615 894-2285
Smith           Olette          K 615 297-3809
Williams        George            615 290-2556

8 rows selected.

SQL> SELECT CUS_LNAME, CUS_FNAME, CUS_INITIAL, CUS_AREACODE, CUS_PHONE FROM CUSTOMER_2
  2  MINUS
  3  SELECT CUS_LNAME, CUS_FNAME, CUS_INITIAL, CUS_AREACODE, CUS_PHONE FROM CUSTOMER;

CUS_LNAME       CUS_FNAME       C CUS CUS_PHON
--------------- --------------- - --- --------
Hernandez       Carlos          J 723 123-7654
Lewis           Marie           J 734 332-1789
McDowell        George            723 123-7768
Terrell         Justine         H 615 322-9870
Tirpin          Khaleed         G 723 123-9876

SQL> SELECT CUS_CODE FROM CUSTOMER WHERE CUS_AREACODE = '615'
  2  MINUS
  3  SELECT DISTINCT CUS_CODE FROM INVOICE;

  CUS_CODE
----------
     10010
     10013
     10016
     10017
     10019

SQL>
```

SOURCE: Course Technology/Cengage Learning

Syntax Alternatives

- IN and NOT IN subqueries can be used in place of INTERSECT or MINUS

  Example: INTERSECT

```
SELECT    CUS_CODE FROM CUSTOMER
WHERE     CUS_AREACODE = '615' AND
          CUS_CODE IN
(SELECT DISTINCT CUS_CODE FROM INVOICE);
```

- MINUS would use NOT IN

Subqueries and Correlated Queries

- Often necessary to process data based on other processed data
- Subquery is a query inside a query, normally inside parentheses
- First query is the outer query
  - Inside query is the inner query
- Inner query is executed first
- Output of inner query is used as input for outer query
- Sometimes referred to as a nested query

Subqueries and Correlated Queries

TABLE 8.2 SELECT Subquery Examples

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.

WHERE Subqueries

- Most common type uses inner SELECT subquery on right side of WHERE comparison
  - Requires a subquery that returns only one single value
- Value generated by subquery must be of comparable data type
- Can be used in combination with joins

FIGURE 8.7 WHERE subquery examples

```
SQL> SELECT P_CODE, P_PRICE FROM PRODUCT
  2  WHERE P_PRICE >= (SELECT AVG(P_PRICE) FROM PRODUCT);

P_CODE        P_PRICE
---------- ----------
11QER/31       109.99
2232/QTY       109.92
2232/QWE        99.87
89-WRE-Q       256.99
WR3/TT3        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 = (SELECT P_CODE FROM PRODUCT WHERE P_DESCRIPT = 'Claw hammer');

  CUS_CODE CUS_LNAME       CUS_FNAME
---------- --------------- ---------------
     10011 Dunne           Leona
     10014 Orlando         Myron

SQL>
```

SOURCE: Course Technology/Cengage Learning

IN Subqueries

- Used when comparing a single attribute to a list of values

FIGURE 8.8 IN subquery example

```
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_DESCRIPT LIKE '%hammer%' OR P_DESCRIPT LIKE '%saw%');

  CUS_CODE CUS_LNAME       CUS_FNAME
---------- --------------- ---------------
     10012 Smith           Kathy
     10011 Dunne           Leona
     10014 Orlando         Myron
     10015 O'Brian         Amy

SQL>
```

SOURCE: Course Technology/Cengage Learning

HAVING Subqueries

- HAVING clause restricts the output of a GROUP BY query
  - Applies conditional criterion to the grouped rows

FIGURE 8.9 HAVING subquery example

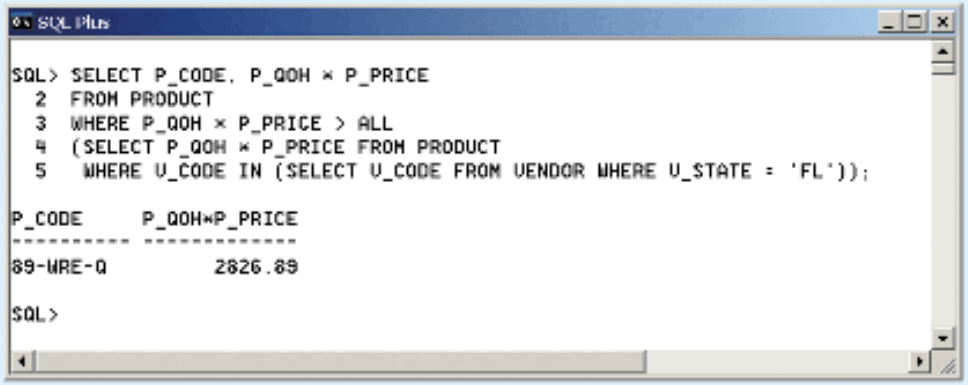
```
SQL> SELECT P_CODE, SUM(LINE_UNITS)
  2  FROM LINE
  3  GROUP BY P_CODE
  4  HAVING SUM(LINE_UNITS) > (SELECT AVG(LINE_UNITS) FROM LINE);

P_CODE     SUM(LINE_UNITS)
---------- ---------------
23109-HB                 5
WR3/TT3                  3
54778-2T                 6
SM-18277                 3
13-Q2/P2                 8
PVC23DRT                17

6 rows selected.

SQL>
```

SOURCE: Course Technology/Cengage Learning

Multirow Subquery Operators: ANY and ALL

- Allows comparison of single value with a list of values using inequality comparison
  - “Greater than ALL” equivalent to “greater than the highest in list”
  - “Less than ALL” equivalent to “less than lowest”
  - Using equal to ANY operator equivalent to IN operator
  - In the query below we compare a single value (P_QOH*P_PRICE) with a list of values returned by the first subquery
  - For a row to appear in the resultset, it has to meet the criterion P_QOH*P_PRICE>ALL of the individual values returned by the first subquery

FIGURE 8.10 Multirow subquery operator example



SOURCE: Course Technology/Cengage Learning

```
SELECT V_CODE FROM VENDOR WHERE V_STATE='FL';
V_CODE
21226
25443
25595

SELECT P_QOH*P_PRICE FROM PRODUCT
WHERE V_CODE IN (SELECT V_CODE FROM VENDOR WHERE V_STATE='FL');
QOH*PRICE
879.92
467.4
2159.1

SELECT P_CODE, P_QOH*P_PRICE, V_STATE
FROM PRODUCT JOIN VENDOR ON PRODUCT.V_CODE=VENDOR.V_CODE
WHERE P_QOH*P_PRICE > ALL
(SELECT P_QOH*P_PRICE FROM PRODUCT
WHERE V_CODE IN (SELECT V_CODE FROM VENDOR WHERE V_STATE='FL'));
P_CODE        QOH*PRICE    V_STATE
89-WRE-Q2826.89    TN
```

FROM Subqueries

- Specifies the tables from which the data will be drawn
- Can use SELECT subquery in the FROM clause
  - View name can be used anywhere a table is expected

FIGURE 8.11 FROM subquery example

```
SQL> SELECT DISTINCT CUSTOMER.CUS_CODE, CUSTOMER.CUS_LNAME
  2  FROM CUSTOMER,
  3       (SELECT INVOICE.CUS_CODE FROM INVOICE NATURAL JOIN LINE WHERE P_CODE = '13-Q2/P2') CP1,
  4       (SELECT INVOICE.CUS_CODE FROM INVOICE NATURAL JOIN LINE WHERE P_CODE = '23109-HB') CP2
  5  WHERE CUSTOMER.CUS_CODE = CP1.CUS_CODE AND
  6        CP1.CUS_CODE = CP2.CUS_CODE;

  CUS_CODE CUS_LNAME
---------- ---------------
     10014 Orlando

SQL>
```

SOURCE: Course Technology/Cengage Learning

Attribute List Subqueries

- SELECT statement uses attribute list to indicate columns to project resulting set
  - Columns can be attributes of base tables
  - Result of aggregate function
- Attribute list can also include subquery expression: inline subquery
  - Must return one single value

Attribute List Subqueries

- Cannot use an alias in the attribute list
  - You can not write P_PRICE-AVGPRICE in line 2

FIGURE 8.12 Inline subquery example

SQL Plus

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

P_CODE        P_PRICE   AVGPRICE       DIFF
---------- ---------- ---------- ----------
11QER/31       109.99   56.42125   53.56875
13-Q2/P2        14.99   56.42125  -41.43125
14-Q1/L3        17.49   56.42125  -38.93125
1546-QQ2        39.95   56.42125  -16.47125
1558-QW1        43.99   56.42125  -12.43125
2232/QTY       109.92   56.42125   53.49875
2232/QWE        99.87   56.42125   43.44875
2238/QPD        38.95   56.42125  -17.47125
23109-HB         9.95   56.42125  -46.47125
23114-AA         14.4   56.42125  -42.02125
54778-2T         4.99   56.42125  -51.43125
89-WRE-Q       256.99   56.42125  200.56875
PVC23DRT         5.87   56.42125  -50.55125
SM-18277         6.99   56.42125  -49.43125
SW-23116         8.45   56.42125  -47.97125
WR3/TT3        119.95   56.42125   63.52875

16 rows selected.

SQL>
```

SOURCE: Course Technology/Cengage Learning

Correlated Subqueries

- Subquery that executes once for each row in the outer query
- Correlated because inner query is related to the outer query
  - Inner query references column of outer subquery
  - Works like a nested loop

```
for x=1 to 2
  for y=1 to 3
   print “x=“ x “y=“ y
```

as x holds steady with 1, y loops from 1 to 3

- Can also be used with the EXISTS special operator

Correlated Subqueries

FIGURE 8.14 Correlated subquery examples

```
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 PVC23DRT           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 PVC23DRT           12        8.5

SQL>
```

LS.P_CODE is fixed, the inner query finds the average LINE_UNITS for that code and the outer query lists the row information if the LINE_UNITS for an individual INV_NUMBER is greater than the average LINE_UNITS for all INV_NUMBERs with that P_CODE

The second query validates the information listed in the first by showing the LINE_UNITS for the INV_NUMBER as before and the AVG LINE_UNITS for that P_CODE

SOURCE: Course Technology/Cengage Learning

EXISTS Correlated Subquery

FIGURE 8.15 EXISTS correlated subquery examples

```
SQL> SELECT CUS_CODE, CUS_LNAME, CUS_FNAME
  2  FROM CUSTOMER
  3  WHERE EXISTS (SELECT CUS_CODE FROM INVOICE
  4                WHERE INVOICE.CUS_CODE = CUSTOMER.CUS_CODE);

  CUS_CODE CUS_LNAME       CUS_FNAME
---------- --------------- ---------------
     10014 Orlando         Myron
     10011 Dunne           Leona
     10012 Smith           Kathy
     10013 Farriss         Anne
     10015 O'Brian         Amy

SQL> SELECT V_CODE, V_NAME FROM VENDOR
  2  WHERE EXISTS (SELECT * FROM PRODUCT
  3                WHERE P_QOH < P_MIN * 2 AND
  4                      VENDOR.V_CODE = PRODUCT.V_CODE);

    V_CODE V_NAME
---------- ----------------------------------
     21344 Gomez Bros.
     23119 Randsets Ltd.
     24288 ORDVA, Inc.
     25595 Rubicon Systems

SQL>
```

The first query shows the names of all customers who have at least one order in the INVOICE table

The second query shows the vendor info for those products who QOH is less than twice the minimum quantity

SOURCE: Course Technology/Cengage Learning

SQL Functions

- Generating information from data often requires many data manipulations
- SQL functions are similar to functions in programming languages
- Functions always use numerical, date, or string value
- Value may be part of a command or attribute in a table
- Function may appear anywhere in an SQL statement

Date and Time Functions

- All SQL-standard DBMSs support date and time functions
- Date functions take one parameter and return a value
- Date/time data types are implemented differently by different DBMS vendors
- ANSI SQL standard defines date data types, but not how data types are stored

TABLE 8.3 Selected MS Access and SQL Server Date/Time Functions

FUNCTION	EXAMPLE(S)
YEAR Returns a four-digit year Syntax: YEAR(date_value)	Lists all employees born in 1966: SELECT EMP_LNAME, EMP_FNAME, EMP_DOB, YEAR(EMP_DOB) AS YEAR FROM EMPLOYEE WHERE YEAR(EMP_DOB) = 1966;
MONTH Returns a two-digit month code Syntax: MONTH(date_value)	Lists all employees born in November: SELECT EMP_LNAME, EMP_FNAME, EMP_DOB, MONTH(EMP_DOB) AS MONTH FROM EMPLOYEE WHERE MONTH(EMP_DOB) = 11;
DAY Returns the number of the day Syntax: DAY(date_value)	Lists all employees born on the 14th day of the month: SELECT EMP_LNAME, EMP_FNAME, EMP_DOB, DAY(EMP_DOB) AS DAY FROM EMPLOYEE WHERE DAY(EMP_DOB) = 14;
DATE() MS Access **GETDATE() SQL Server** Returns today's date	Lists how many days are left until Christmas: SELECT #25-Dec-2012# – DATE(); Note two features: • There is no FROM clause, which is acceptable in MS Access. • The Christmas date is enclosed in number signs (#) because you are doing date arithmetic. In MS SQL Server: Use GETDATE() to get the current system date. To compute the difference between dates, use the DATEDIFF function (see below).
DATEADD SQL Server Adds a number of selected time periods to a date Syntax: **DATEADD(datepart, number, date)**	Adds a number of dateparts to a given date. Dateparts can be minutes, hours, days, weeks, months, quarters, or years. For example: SELECT DATEADD(day,90, P_INDATE) AS DueDate FROM PRODUCT; The preceding example adds 90 days to P_INDATE. In MS Access, use the following: SELECT P_INDATE+90 AS DueDate FROM PRODUCT;
DATEDIFF SQL Server Subtracts two dates Syntax: **DATEDIFF(datepart, startdate, enddate)**	Returns the difference between two dates expressed in a selected datepart. For example: SELECT DATEDIFF(day, P_INDATE, GETDATE()) AS DaysAgo FROM PRODUCT; In MS Access, use the following: SELECT DATE() - P_INDATE AS DaysAgo FROM PRODUCT;

Numeric Functions

- Grouped in different ways
  - Algebraic, trigonometric, logarithmic, etc.
- Do not confuse with aggregate functions
  - Aggregate functions operate over sets
  - Numeric functions operate over single row
- Numeric functions take one numeric parameter and return one value

TABLE 8.5 **Selected Numeric Functions**

FUNCTION	EXAMPLE(S)
ABS Returns the absolute value of a number Syntax: ABS(numeric_value)	In Oracle, use the following: SELECT 1.95, -1.93, ABS(1.95), ABS(-1.93) FROM DUAL; In MS Access and SQL Server, use the following: SELECT 1.95, -1.93, ABS(1.95), ABS(-1.93);
ROUND Rounds a value to a specified precision (number of digits) Syntax: ROUND(numeric_value, p) p = precision	Lists the product prices rounded to one and zero decimal places: SELECT P_CODE, P_PRICE, ROUND(P_PRICE,1) AS PRICE1, ROUND(P_PRICE,0) AS PRICE0 FROM PRODUCT;
CEIL/CEILING/FLOOR Returns the smallest integer greater than or equal to a number or returns the largest integer equal to or less than a number, respectively Syntax: CEIL(numeric_value) Oracle CEILING(numeric_value) SQL Server FLOOR(numeric_value)	Lists the product price, the smallest integer greater than or equal to the product price, and the largest integer equal to or less than the product price. In Oracle, use the following: SELECT P_PRICE, CEIL(P_PRICE), FLOOR(P_PRICE) FROM PRODUCT; In SQL Server, use the following: SELECT P_PRICE, CEILING(P_PRICE), FLOOR(P_PRICE) FROM PRODUCT; MS Access does not support these functions.

String Functions

- String manipulations are the most used functions in programming
- String manipulation function examples:
  - Concatenation
  - Printing in uppercase
  - Finding length of an attribute

Conversion Functions

- Take a value of given data type and convert it to the equivalent value in another data type
- Oracle conversion functions:
  - TO_CHAR: takes a date value, converts to character string
  - TO_DATE: takes character string representing a date, converts it to actual date in Oracle format

SQL Conversion Functions

- SQL Server uses CAST and CONVERT functions
  - Numeric to Character
    - CAST(numeric as varchar(length))
    - CONVERT(varchar(length), numeric)
  - Date to Character
    - CAST(date as varchar(length))
    - CONVERT(varchar(length), date)
  - String to Number
    - CAST(‘-123.99’ AS NUMERIC(8,2))
  - String to Date
    - CONVERT(DATETIME,'01/JAN/1970')
    - CAST('01-JAN-1970' AS DATETIME)

Virtual Tables: Creating a View

- View
  - Virtual table based on a SELECT query
- Base tables
- Tables on which the view is based
- CREATE VIEW viewname AS SELECT query

```
create view v_empname as
select emp_lname, emp_fname, emp_initial
from emp;
```

Aggregate Functions

TABLE 7.8 **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