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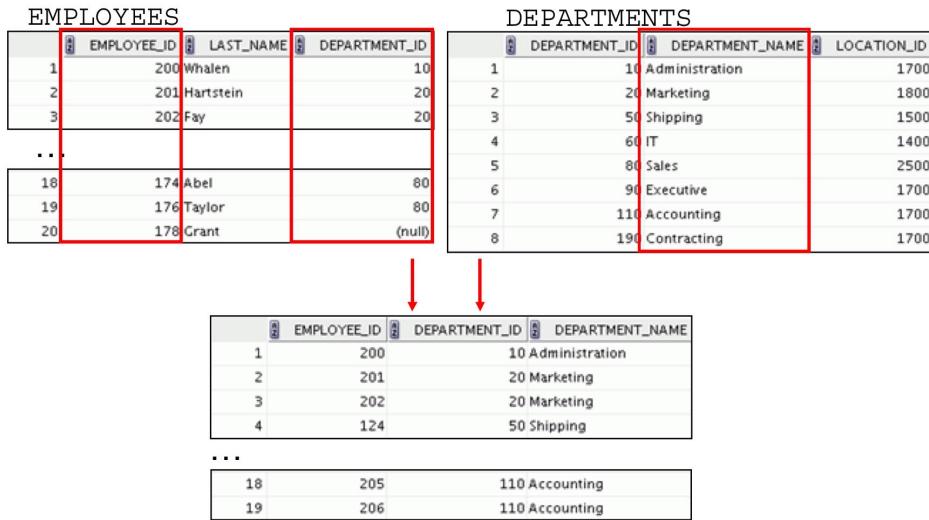
Displaying Data from Multiple Tables Using Joins



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Obtaining Data from Multiple Tables



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Sometimes you need to use data from more than one table. In the example in the slide, the report displays data from two separate tables:

- Employee IDs exist in the EMPLOYEES table.
- Department IDs exist in both the EMPLOYEES and DEPARTMENTS tables.
- Department names exist in the DEPARTMENTS table.

To produce the report, you need to link the EMPLOYEES and DEPARTMENTS tables, and access data from both of them.

Joining Tables Using SQL:1999 Syntax

Use a join to query data from more than one table:

```
SELECT    table1.column, table2.column
FROM      table1
[NATURAL JOIN table2] |
[JOIN table2 USING (column_name)] |
[JOIN table2
  ON (table1.column_name = table2.column_name)] |
[LEFT|RIGHT|FULL OUTER JOIN table2
  ON (table1.column_name = table2.column_name)] |
[CROSS JOIN table2];
```



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In the syntax:

- `table1.column` denotes the table and the column from which data is retrieved
- `NATURAL JOIN` joins two tables based on the same column name
- `JOIN table2 USING column_name` performs an equijoin based on the column name
- `JOIN table2 ON table1.column_name = table2.column_name` performs an equijoin based on the condition in the `ON` clause
- `LEFT/RIGHT/FULL OUTER` is used to perform OUTER joins
- `CROSS JOIN` returns a Cartesian product from the two tables

For more information, see the section titled “`SELECT`” in *Oracle Database SQL Language Reference* for 12c database.

Creating Natural Joins

- The NATURAL JOIN clause is based on all the columns in the two tables that have the same name.
- It selects rows from the two tables that have equal values in all matched columns.
- If the columns having the same names have different data types, an error is returned.

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You can join tables automatically based on the columns in the two tables that have matching data types and names. You do this by using the NATURAL JOIN keywords.

Note: The join can happen on only those columns that have the same names and data types in both tables. If the columns have the same name but different data types, the NATURAL JOIN syntax causes an error.

Retrieving Records with Natural Joins

```
SELECT employee_id, last_name, department_id,
       department_name
  from employees NATURAL JOIN departments;
```

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	101 Kochhar		90 Executive	
2	102 De Haan		90 Executive	
3	104 Ernst		60 IT	
4	107 Lorentz		60 IT	
5	141 Rajs		50 Shipping	
6	142 Davies		50 Shipping	
7	143 Matos		50 Shipping	
8	144 Vargas		50 Shipping	
9	174 Abel		80 Sales	
10	176 Taylor		80 Sales	
11	202 Fay		20 Marketing	
12	206 Gietz		110 Accounting	

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In the example in the slide, the DEPARTMENTS table is joined to the EMPLOYEES table by the DEPARTMENT_ID column, which is the only column of the same name in both tables. If other common columns were present, the join would have used them all.

Natural Joins with a WHERE Clause

Additional restrictions on a natural join are implemented by using a WHERE clause. The following example limits the rows of output to those with a department ID equal to 20 or 50:

```
SELECT department_id, department_name,
       location_id, city
  FROM departments
NATURAL JOIN locations
 WHERE department_id IN (20, 50);
```

	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID	CITY
1		20 Marketing		1800 Toronto
2		50 Shipping		1500 South San Francisco

Creating Joins with the USING Clause

- If several columns have the same names but the data types do not match, use the `USING` clause to specify the columns for the equijoin.
- Use the `USING` clause to match only one column when more than one column matches.
- The `NATURAL JOIN` and `USING` clauses are mutually exclusive.

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Natural joins use all columns with matching names and data types to join the tables. The `USING` clause can be used to specify only those columns that should be used for an equijoin.

Joining Column Names

EMPLOYEES

	EMPLOYEE_ID	DEPARTMENT_ID
1	200	10
2	201	20
3	202	20
4	205	110
5	206	110
6	100	90
7	101	90
8	102	90
9	103	60
10	104	60

DEPARTMENTS

	DEPARTMENT_ID	DEPARTMENT_NAME
1	10	Administration
2	20	Marketing
3	50	Shipping
4	60	IT
5	80	Sales
6	90	Executive
7	110	Accounting
8	190	Contracting

...

Foreign key

Primary key

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To determine an employee's department name, you compare the value in the DEPARTMENT_ID column in the EMPLOYEES table with the DEPARTMENT_ID values in the DEPARTMENTS table. The relationship between the EMPLOYEES and DEPARTMENTS tables is an *equijoin*; that is, values in the DEPARTMENT_ID column in both the tables must be equal. Frequently, this type of join involves primary and foreign key complements.

Note: Equijoins are also called *simple joins* or *inner joins*.

Retrieving Records with the USING Clause

```
SELECT employee_id, last_name,  
       location_id, department_id  
FROM   employees JOIN departments  
USING (department_id) ;
```

#	EMPLOYEE_ID	LAST_NAME	LOCATION_ID	DEPARTMENT_ID
1	200 Whalen		1700	10
2	201 Hartstein		1800	20
3	202 Fay		1800	20
4	144 Vargas		1500	50
5	143 Matos		1500	50
6	142 Davies		1500	50
7	141 Raji		1500	50
8	124 Mourgos		1500	50
...				
18	206 Gietz		1700	110
19	205 Higgins		1700	110



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In the example in the slide, the DEPARTMENT_ID columns in the EMPLOYEES and DEPARTMENTS tables are joined and thus the LOCATION_ID of the department where an employee works is shown.

Using Table Aliases with the USING Clause

- Do not qualify a column that is used in the USING clause.
- If the same column is used elsewhere in the SQL statement, do not alias it.

```
SELECT l.city, d.department_name
FROM   locations l JOIN departments d
USING (location_id)
WHERE  d.location_id = 1400;
```

ORA-25154: column part of USING clause cannot have qualifier
25154. 00000 - "column part of USING clause cannot have qualifier"
*Cause: Columns that are used for a named-join (either a NATURAL join or a join with a USING clause) cannot have an explicit qualifier.
*Action: Remove the qualifier.
Error at Line: 4 Column: 6



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When joining with the USING clause, you cannot qualify a column that is used in the USING clause itself. Furthermore, if that column is used anywhere in the SQL statement, you cannot alias it. For example, in the query mentioned in the slide, you should not alias the location_id column in the WHERE clause because the column is used in the USING clause. The columns that are referenced in the USING clause should not have a qualifier (table name or alias) anywhere in the SQL statement. For example, the following statement is valid:

```
SELECT l.city, d.department_name
FROM   locations l JOIN departments d USING (location_id)
WHERE  location_id = 1400;
```

The columns that are common in both the tables, but not used in the USING clause, must be prefixed with a table alias; otherwise, you get the “column ambiguously defined” error.

In the following statement, manager_id is present in both the employees and departments table; if manager_id is not prefixed with a table alias, it gives a “column ambiguously defined” error.

The following statement is valid:

```
SELECT first_name, d.department_name, d.manager_id
FROM   employees e JOIN departments d USING (department_id)
WHERE  department_id = 50;
```

Creating Joins with the ON Clause

- The join condition for the natural join is basically an equijoin of all columns with the same name.
- Use the ON clause to specify arbitrary conditions or specify columns to join.
- The join condition is separated from other search conditions.
- The ON clause makes code easy to understand.



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Use the ON clause to specify a join condition. With this, you can specify join conditions separate from any search or filter conditions in the WHERE clause.

Retrieving Records with the ON Clause

```
SELECT e.employee_id, e.last_name, e.department_id,  
       d.department_id, d.location_id  
  FROM employees e JOIN departments d  
 WHERE (e.department_id = d.department_id);
```

EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_ID_1	LOCATION_ID
1	200 Whalen	10	10	1700
2	201 Hartstein	20	20	1800
3	202 Fay	20	20	1800
4	124 Mourgos	50	50	1500
5	144 Vargas	50	50	1500
6	143 Matos	50	50	1500
7	142 Davies	50	50	1500
8	141 Rajes	50	50	1500
9	107 Lorentz	60	60	1400
10	104 Ernst	60	60	1400
11	103 Hunold	60	60	1400
...				



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In this example, the DEPARTMENT_ID columns in the EMPLOYEES and DEPARTMENTS table are joined using the ON clause. Wherever a department ID in the EMPLOYEES table equals a department ID in the DEPARTMENTS table, the row is returned. The table alias is necessary to qualify the matching column names.

You can also use the ON clause to join columns that have different names. The parenthesis around the joined columns, as in the example in the slide, (e.department_id = d.department_id) is optional. So, even ON e.department_id = d.department_id will work.

Note: When you use the Execute Statement icon to run the query, SQL Developer suffixes a '_1' to differentiate between the two department_ids.

Creating Three-Way Joins with the ON Clause

```
SELECT employee_id, city, department_name  
FROM employees e  
JOIN departments d  
ON d.department_id = e.department_id  
JOIN locations l  
ON d.location_id = l.location_id;
```

	EMPLOYEE_ID	CITY	DEPARTMENT_NAME
1	100	Seattle	Executive
2	101	Seattle	Executive
3	102	Seattle	Executive
4	103	Southlake	IT
5	104	Southlake	IT
6	107	Southlake	IT
7	124	South San Francisco	Shipping
8	141	South San Francisco	Shipping
9	142	South San Francisco	Shipping
...			

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A three-way join is a join of three tables. The optimizer decides the execution of the join as well as the order. Here, the first join to be performed is EMPLOYEES JOIN DEPARTMENTS. The first join condition can reference columns in EMPLOYEES and DEPARTMENTS but cannot reference columns in LOCATIONS. The second join condition can reference columns from all three tables.

Note: The code example in the slide can also be accomplished with the USING clause:

```
SELECT e.employee_id, l.city, d.department_name  
FROM employees e  
JOIN departments d  
USING (department_id)  
JOIN locations l  
USING (location_id);
```

Applying Additional Conditions to a Join

Use the AND clause or the WHERE clause to apply additional conditions:

```
SELECT e.employee_id, e.last_name, e.department_id,
       d.department_id, d.location_id
  FROM employees e JOIN departments d
 WHERE (e.department_id = d.department_id)
   AND e.manager_id = 149;
```

Or

```
SELECT e.employee_id, e.last_name, e.department_id,
       d.department_id, d.location_id
  FROM employees e JOIN departments d
 WHERE (e.department_id = d.department_id)
   WHERE e.manager_id = 149;
```

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You can apply additional conditions to the join.

The example shown performs a join on the EMPLOYEES and DEPARTMENTS tables and, in addition, displays only employees who have a manager ID of 149. To add additional conditions to the ON clause, you can add AND clauses. Alternatively, you can use a WHERE clause to apply additional conditions.

Both the queries produce the same output

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_ID_1	LOCATION_ID
1	174	Abel	80	80	2500
2	176	Taylor	80	80	2500

Joining a Table to Itself

EMPLOYEES (WORKER)

EMPLOYEE_ID	LAST_NAME	MANAGER_ID
200	Whalen	101
201	Hartstein	100
202	Fay	201
205	Higgins	101
206	Gietz	205
100	King	(null)
101	Kochhar	100
102	De Haan	100
103	Hunold	102
104	Ernst	103

...

EMPLOYEES (MANAGER)

EMPLOYEE_ID	LAST_NAME
200	Whalen
201	Hartstein
202	Fay
205	Higgins
206	Gietz
100	King
101	Kochhar
102	De Haan
103	Hunold
104	Ernst

...

MANAGER_ID in the WORKER table is equal to
EMPLOYEE_ID in the MANAGER table.

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Sometimes you need to join a table to itself. To find the name of each employee's manager, you need to join the EMPLOYEES table to itself, or perform a self-join. For example, to find the name of Ernst's manager, you need to:

- Find Ernst in the EMPLOYEES table by looking at the LAST_NAME column
- Find the manager number for Ernst by looking at the MANAGER_ID column. Ernst's manager number is 103.
- Find the name of the manager with EMPLOYEE_ID 103 by looking at the LAST_NAME column. Hunold's employee number is 103, so Hunold is Ernst's manager.

In this process, you look in the table twice. The first time you look in the table to find Ernst in the LAST_NAME column and the MANAGER_ID value of 103. The second time you look in the EMPLOYEE_ID column to find 103 and the LAST_NAME column to find Hunold.

Self-Joins Using the ON Clause

```
SELECT worker.last_name emp, manager.last_name mgr
FROM   employees worker JOIN employees manager
ON     (worker.manager_id = manager.employee_id);
```

	EMP	MGR
1	Hunold	De Haan
2	Fay	Hartstein
3	Gietz	Higgins
4	Lorentz	Hunold
5	Ernst	Hunold
6	Zlotkey	King
7	Mourgos	King
8	Kochhar	King

...

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The ON clause can also be used to join columns that have different names, within the same table or in a different table.

The example shown is a self-join of the EMPLOYEES table, based on the EMPLOYEE_ID and MANAGER_ID columns.

Note: The parentheses around the joined columns as in the example in the slide, (worker.manager_id = manager.employee_id) is optional. So, even ON worker.manager_id = manager.employee_id will work.

Nonequijoins

EMPLOYEES

LAST_NAME	SALARY
Whalen	4400
Hartstein	13000
Fay	6000
Higgins	12000
Gietz	8300
King	24000
Kochhar	17000
De Haan	17000
Hunold	9000
Ernst	6000
...	
Taylor	8600
Grant	7000

JOB_GRADES

GRADE_LEVEL	LOWEST_SAL	HIGHEST_SAL
A	1000	2999
B	3000	5999
C	6000	9999
D	10000	14999
E	15000	24999
F	25000	40000

The JOB_GRADES table defines the LOWEST_SAL and HIGHEST_SAL range of values for each GRADE_LEVEL. Therefore, the GRADE_LEVEL column can be used to assign grades to each employee.

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A nonequijoin is a join condition containing something other than an equality operator.

The relationship between the EMPLOYEES table and the JOB_GRADES table is an example of a nonequijoin. The SALARY column in the EMPLOYEES table ranges between the values in the LOWEST_SAL and HIGHEST_SAL columns of the JOB_GRADES table. Therefore, each employee can be graded based on their salary. The relationship is obtained using an operator other than the equality (=) operator.

Retrieving Records with Nonequijoins

```
SELECT e.last_name, e.salary, j.grade_level  
FROM   employees e JOIN job_grades j  
ON     e.salary  
      BETWEEN j.lowest_sal AND j.highest_sal;
```

#	LAST_NAME	SALARY	GRADE_LEVEL
1	Vargas	2500	A
2	Matos	2600	A
3	Davies	3100	B
4	Rajs	3500	B
5	Lorentz	4200	B
6	Whalen	4400	B
7	Mourgos	5800	B
8	Ernst	6000	C
9	Fay	6000	C
10	Grant	7000	C

...

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The example in the slide creates a nonequijoin to evaluate an employee's salary grade. The salary must be *between* any pair of the low and high salary ranges.

It is important to note that all employees appear exactly once when this query is executed. No employee is repeated in the list. There are two reasons for this:

- None of the rows in the JOB_GRADES table contain grades that overlap. That is, the salary value for an employee can lie only between the low salary and high salary values of one of the rows in the salary grade table.
- All of the employees' salaries lie within the limits provided by the job grade table. That is, no employee earns less than the lowest value contained in the LOWEST_SAL column or more than the highest value contained in the HIGHEST_SAL column.

Note: Other conditions (such as `<=` and `>=`) can be used, but `BETWEEN` is the simplest.

Remember to specify the low value first and the high value last when using the `BETWEEN` condition. The Oracle server translates the `BETWEEN` condition to a pair of `AND` conditions. Therefore, using `BETWEEN` has no performance benefits, but should be used only for logical simplicity.

Table aliases have been specified in the slide example for performance reasons, not because of possible ambiguity.

Returning Records with No Direct Match Using OUTER Joins

DEPARTMENTS

DEPARTMENT_ID	DEPARTMENT_NAME	DEPARTMENT_ID
1	Administration	10
2	Marketing	20
3	Shipping	50
4	IT	60
5	Sales	80
6	Executive	90
7	Accounting	110
8	Contracting	190

There are no employees in department 190.

Employee "Grant" has not been assigned a department ID.

Equijoin with EMPLOYEES

DEPARTMENT_ID	LAST_NAME
1	Whalen
2	Hartstein
3	Fay
4	Higgins
5	Gietz
6	King
7	Kochhar
8	De Haan
9	Hunold
10	Ernst
...	
18	Abel
19	Taylor

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If a row does not satisfy a join condition, the row does not appear in the query result.

In the slide example, a simple equijoin condition is used on the EMPLOYEES and DEPARTMENTS tables to return the result on the right. The result set does not contain the following:

- Department ID 190, because there are no employees with that department ID recorded in the EMPLOYEES table
- The employee with the last name of Grant, because this employee has not been assigned a department ID

To return the department record that does not have any employees, or employees that do not have an assigned department, you can use an OUTER join.

INNER Versus OUTER Joins

- In SQL:1999, the join of two tables returning only matched rows is called an **INNER** join.
- A join between two tables that returns the results of the **INNER** join as well as the unmatched rows from the left (or right) table is called a **left** (or **right**) **OUTER** join.
- A join between two tables that returns the results of an **INNER** join as well as the results of a **left** and **right** join is a **full** **OUTER** join.



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Joining tables with the **NATURAL JOIN**, **USING**, or **ON** clauses results in an **INNER** join. Any unmatched rows are not displayed in the output. To return the unmatched rows, you can use an **OUTER** join. An **OUTER** join returns all rows that satisfy the join condition and also returns some or all of those rows from one table for which no rows from the other table satisfy the join condition.

There are three types of **OUTER** joins:

- **LEFT OUTER**
- **RIGHT OUTER**
- **FULL OUTER**

LEFT OUTER JOIN

```
SELECT e.last_name, e.department_id, d.department_name  
FROM employees e [LEFT OUTER JOIN] departments d  
ON (e.department_id = d.department_id) ;
```

LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1 Whalen	10	Administration
2 Fay	20	Marketing
3 Hartstein	20	Marketing
4 Vargas	50	Shipping
5 Matos	50	Shipping
...		
16 Kochhar	90	Executive
17 King	90	Executive
18 Gietz	110	Accounting
19 Higgins	110	Accounting
20 Grant	(null)	(null)

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This query retrieves all the rows in the EMPLOYEES table, which is the left table, even if there is no match in the DEPARTMENTS table.

RIGHT OUTER JOIN

```
SELECT e.last_name, d.department_id, d.department_name  
FROM employees e RIGHT OUTER JOIN departments d  
ON (e.department_id = d.department_id) ;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Hartstein	20	Marketing
3	Fay	20	Marketing
4	Davies	50	Shipping
5	Vargas	50	Shipping
6	Rajs	50	Shipping
7	Mourgos	50	Shipping
8	Matos	50	Shipping
...			
18	Higgins	110	Accounting
19	Gietz	110	Accounting
20	(null)	190	Contracting

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This query retrieves all the rows in the DEPARTMENTS table, which is the table at the right, even if there is no match in the EMPLOYEES table.

FULL OUTER JOIN

```
SELECT e.last_name, d.department_id, d.department_name  
FROM employees e FULL OUTER JOIN departments d  
ON (e.department_id = d.department_id) ;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	King	90	Executive
2	Kochhar	90	Executive
3	De Haan	90	Executive
4	Hunold	60	IT
...			

15	Grant	(null)	(null)
16	Whalen	10	Administration
17	Hartstein	20	Marketing
18	Fay	20	Marketing
19	Higgins	110	Accounting
20	Gietz	110	Accounting
21	(null)	190	Contracting



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This query retrieves all rows in the EMPLOYEES table, even if there is no match in the DEPARTMENTS table. It also retrieves all rows in the DEPARTMENTS table, even if there is no match in the EMPLOYEES table.

Generating a Cartesian Product

EMPLOYEES (20 rows)

#	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	200	Whalen	10
2	201	Hartstein	20
3	202	Fay	20
4	205	Higgins	110
...			
19	176	Taylor	80
20	178	Grant	(null)

DEPARTMENTS (8 rows)

#	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID
1	10	Administration	1700
2	20	Marketing	1800
3	50	Shipping	1500
4	60	IT	1400
5	80	Sales	2500
6	90	Executive	1700
7	110	Accounting	1700
8	190	Contracting	1700

Cartesian product:
20 x 8 = 160 rows

#	EMPLOYEE_ID	DEPARTMENT_ID	LOCATION_ID
1	200	10	1700
2	201	20	1700
...			
21	200	10	1800
22	201	20	1800
...			
159	176	80	1700
160	178	(null)	1700

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A Cartesian product is generated if a join condition is omitted. The example in the slide displays the employee last name and the department name from the EMPLOYEES and DEPARTMENTS tables. Because no join condition was specified, all rows (20 rows) from the EMPLOYEES table are joined with all rows (8 rows) in the DEPARTMENTS table, thereby generating 160 rows in the output.

Creating Cross Joins

- The CROSS JOIN clause produces the cross-product of two tables.
- This is also called a Cartesian product between the two tables.

```
SELECT last_name, department_name  
FROM employees  
CROSS JOIN departments ;
```

	LAST_NAME	DEPARTMENT_NAME
1	Abel	Administration
2	Davies	Administration
3	De Haan	Administration
4	Ernst	Administration
5	Fay	Administration
...		

158	Vargas	Contracting
159	Whalen	Contracting
160	Zlotkey	Contracting

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The example in the slide produces a Cartesian product of the EMPLOYEES and DEPARTMENTS tables.

The CROSS JOIN technique can be applied to many situations usefully. For example, to return total labor cost by office by month, even if month X has no labor cost, you can do a cross join of Offices with a table of all Months.

It is a good practice to explicitly state CROSS JOIN in your SELECT when you intend to create a Cartesian product. Therefore, it is very clear that you intend for this to happen and it is not the result of missing joins.

Summary

In this lesson, you should have learned how to use joins to display data from multiple tables by using:

- Equijoins
- Nonequijoins
- OUTER joins
- Self-joins
- Cross joins
- Natural joins
- Full (or two-sided) OUTER joins



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There are multiple ways to join tables.

Types of Joins

- Equijoins
- Nonequijoins
- OUTER joins
- Self-joins
- Cross joins
- Natural joins
- Full (or two-sided) OUTER joins

Cartesian Products

A Cartesian product results in the display of all combinations of rows. This is done by either omitting the WHERE clause or specifying the CROSS JOIN clause.

Table Aliases

- Table aliases speed up database access.
- Table aliases can help to keep SQL code smaller by conserving memory.
- Table aliases are sometimes mandatory to avoid column ambiguity.