6

Subqueries

Schedule:	Timing	Topic
	25 minutes	Lecture
	30 minutes	Practice
	55 minutes	Total

Objectives

After completing this lesson, you should be able to do the following:

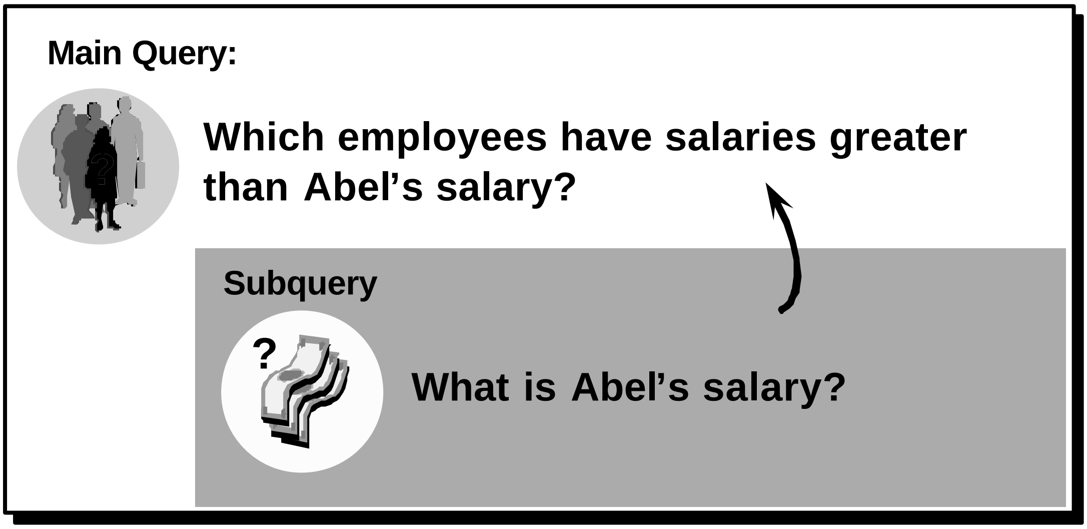
- **Describe the types of problem that subqueries can solve**
- **Define subqueries**
- **List the types of subqueries**
- **Write single-row and multiple-row subqueries**

Lesson Aim

In this lesson, you learn about more advanced features of the `SELECT` statement. You can write subqueries in the `WHERE` clause of another SQL statement to obtain values based on an unknown conditional value. This lesson covers single-row subqueries and multiple-row subqueries.

Using a Subquery to Solve a Problem

Who has a salary greater than Abel's?



Main Query:

Which employees have salaries greater than Abel's salary?

Subquery

What is Abel's salary?

Using a Subquery to Solve a Problem

Suppose you want to write a query to find out who earns a salary greater than Abel's salary.

To solve this problem, you need *two* queries: one to find what Abel earns, and a second query to find who earns more than that amount.

You can solve this problem by combining the two queries, placing one query *inside* the other query.

The inner query or the *subquery* returns a value that is used by the outer query or the main query. Using a subquery is equivalent to performing two sequential queries and using the result of the first query as the search value in the second query.

Instructor Note

This lesson concentrates on noncorrelated subqueries.

Subquery Syntax

```
SELECT   select_list
FROM     table
WHERE    expr operator
                    (SELECT     select_list
                     FROM       table);
```

- **The subquery (inner query) executes once before the main query.**
- **The result of the subquery is used by the main query (outer query).**

Subqueries

A subquery is a `SELECT` statement that is embedded in a clause of another `SELECT` statement. You can build powerful statements out of simple ones by using subqueries. They can be very useful when you need to select rows from a table with a condition that depends on the data in the table itself.

You can place the subquery in a number of SQL clauses, including:

- The `WHERE` clause
- The `HAVING` clause
- The `FROM` clause

In the syntax:

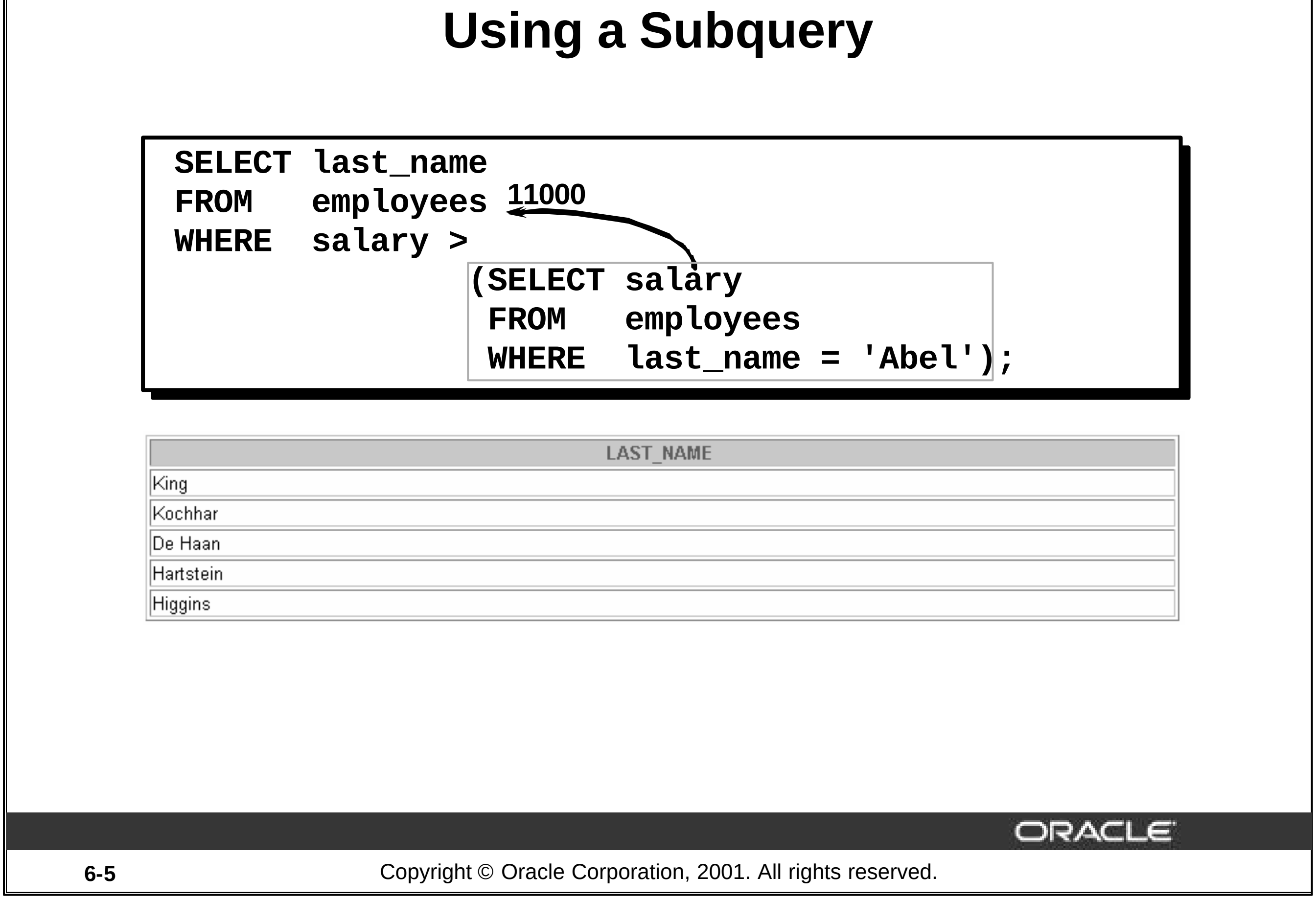
`operator` includes a comparison condition such as >, =, or `IN`

Note: Comparison conditions fall into two classes: single-row operators (>, =, >=, <, <>, <=) and multiple-row operators (`IN`, `ANY`, `ALL`).

The subquery is often referred to as a nested `SELECT`, sub-`SELECT`, or inner `SELECT` statement. The subquery generally executes first, and its output is used to complete the query condition for the main or outer query.

Instructor Note

Additionally, subqueries can be placed in the `CREATE VIEW` statement, `CREATE TABLE` statement, `UPDATE` statement, `INTO` clause of an `INSERT` statement, and `SET` clause of an `UPDATE` statement.



Using a Subquery

```
SELECT last_name
FROM   employees 11000
WHERE  salary >
                (SELECT salary
                 FROM   employees
                 WHERE  last_name = 'Abel');
```

LAST_NAME
King
Kochhar
De Haan
Hartstein
Higgins

Using a Subquery

In the slide, the inner query determines the salary of employee Abel. The outer query takes the result of the inner query and uses this result to display all the employees who earn more than this amount.

Instructor Note

Execute the subquery (inner query) on its own first to show the value that the subquery returns. Then execute the outer query using the result returned by the inner query. Finally, execute the entire query (containing the subquery), and show that the result is the same.

Guidelines for Using Subqueries

- **Enclose subqueries in parentheses.**
- **Place subqueries on the right side of the comparison condition.**
- **The `ORDER BY` clause in the subquery is not needed unless you are performing Top-N analysis.**
- **Use single-row operators with single-row subqueries and use multiple-row operators with multiple-row subqueries.**

Guidelines for Using Subqueries

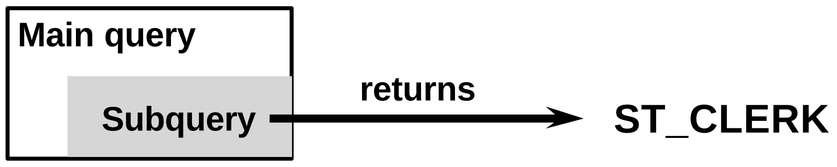
- A subquery must be enclosed in parentheses.
- Place the subquery on the right side of the comparison condition for readability.
- Prior to release Oracle8*i*, subqueries could not contain an `ORDER BY` clause. Only one `ORDER BY` clause can be used for a `SELECT` statement, and if specified it must be the last clause in the main `SELECT` statement. Starting with release Oracle8*i*, an `ORDER BY` clause can be used and is required in the subquery to perform Top-N analysis.
- Two classes of comparison conditions are used in subqueries: single-row operators and multiple-row operators.

Instructor Note

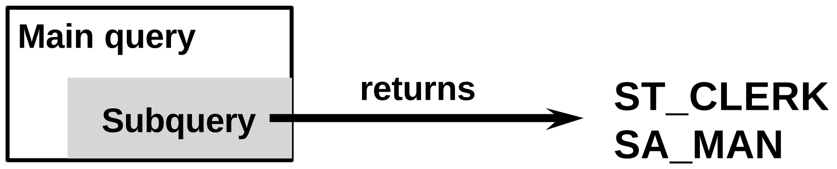
A subquery can execute multiple times in correlated subqueries. Students may ask how many subqueries can be written. The Oracle server imposes no limit on the number of subqueries; the limit is related to the buffer size that the query uses.

Types of Subqueries

- **Single-row subquery**



- **Multiple-row subquery**



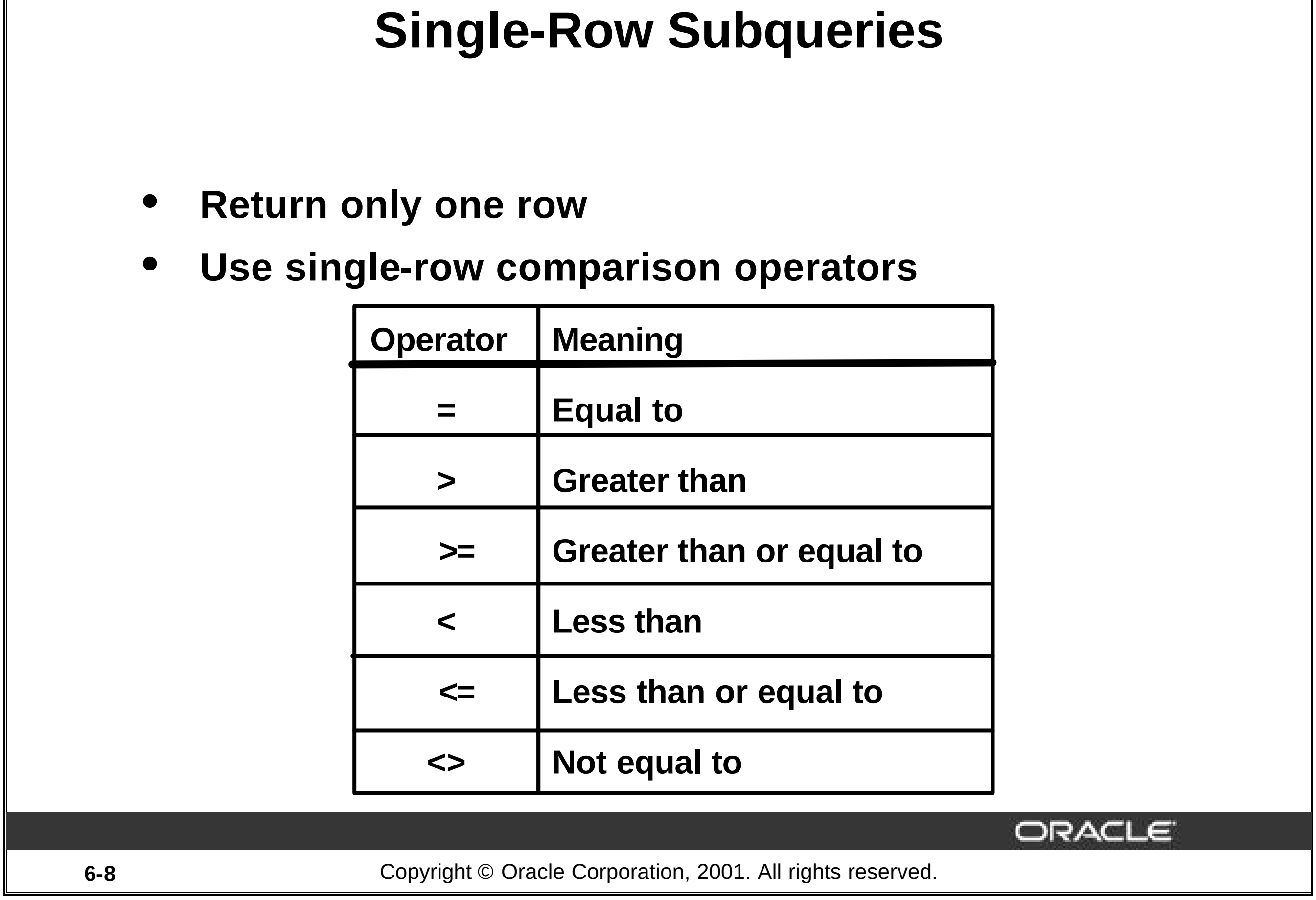
Types of Subqueries

- Single-row subqueries: Queries that return only one row from the inner `SELECT` statement
- Multiple-row subqueries: Queries that return more than one row from the inner `SELECT` statement

Note: There are also multiple-column subqueries: Queries that return more than one column from the inner `SELECT` statement.

Instructor Note

Multiple column subqueries are also available.



Single-Row Subqueries

- Return only one row
- Use single-row comparison operators

Operator	Meaning
=	Equal to
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
<>	Not equal to

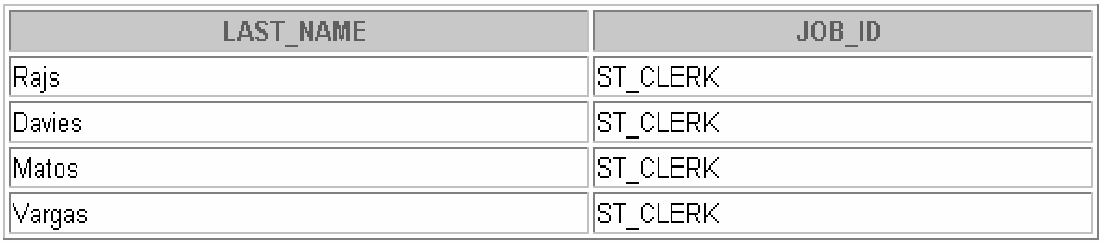
Single-Row Subqueries

A single-row subquery is one that returns one row from the inner `SELECT` statement. This type of subquery uses a single-row operator. The slide gives a list of single-row operators.

Example

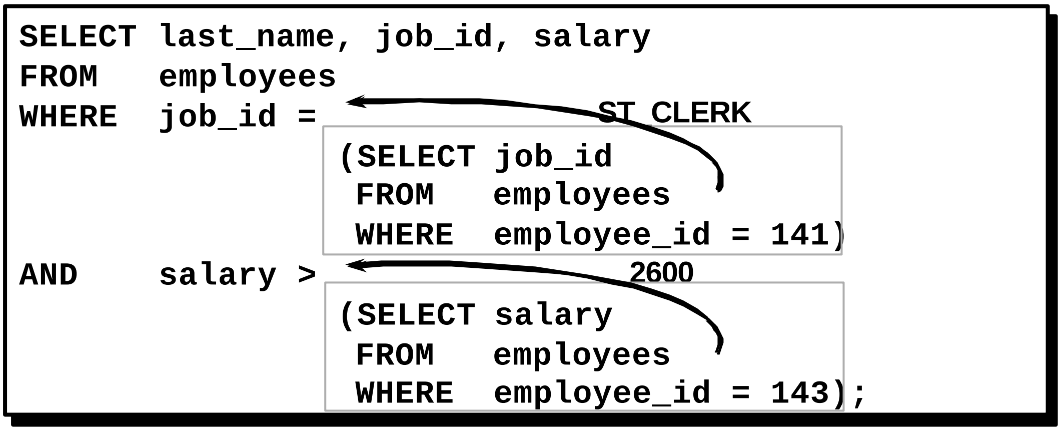
Display the employees whose job ID is the same as that of employee 141.

```
SELECT last_name, job_id
FROM   employees
WHERE  job_id =
                (SELECT job_id
                 FROM   employees
                 WHERE  employee_id = 141);
```



LAST_NAME	JOB_ID
Rajs	ST_CLERK
Davies	ST_CLERK
Matos	ST_CLERK
Vargas	ST_CLERK

Executing Single-Row Subqueries



```
SELECT last_name, job_id, salary
FROM   employees
WHERE  job_id =
                (SELECT job_id
                 FROM   employees
                 WHERE  employee_id = 141)
AND    salary >
                (SELECT salary
                 FROM   employees
                 WHERE  employee_id = 143);
```

LAST_NAME	JOB_ID	SALARY
Rajs	ST_CLERK	3500
Davies	ST_CLERK	3100

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Executing Single-Row Subqueries

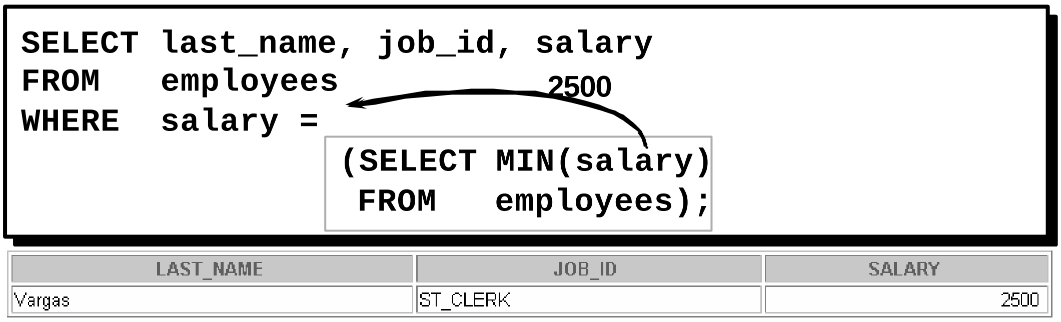
A SELECT statement can be considered as a query block. The example on the slide displays employees whose job ID is the same as that of employee 141 and whose salary is greater than that of employee 143.

The example consists of three query blocks: the outer query and two inner queries. The inner query blocks are executed first, producing the query results ST_CLERK and 2600, respectively. The outer query block is then processed and uses the values returned by the inner queries to complete its search conditions.

Both inner queries return single values (ST_CLERK and 2600, respectively), so this SQL statement is called a single-row subquery.

Note: The outer and inner queries can get data from different tables.

Using Group Functions in a Subquery



```
SELECT last_name, job_id, salary
FROM   employees
WHERE  salary =
                (SELECT MIN(salary)
                 FROM   employees);
```

LAST_NAME	JOB_ID	SALARY
Vargas	ST_CLERK	2500

Using Group Functions in a Subquery

You can display data from a main query by using a group function in a subquery to return a single row. The subquery is in parentheses and is placed after the comparison condition.

The example on the slide displays the employee last name, job ID, and salary of all employees whose salary is equal to the minimum salary. The `MIN` group function returns a single value (2500) to the outer query.

The **HAVING** Clause with Subqueries

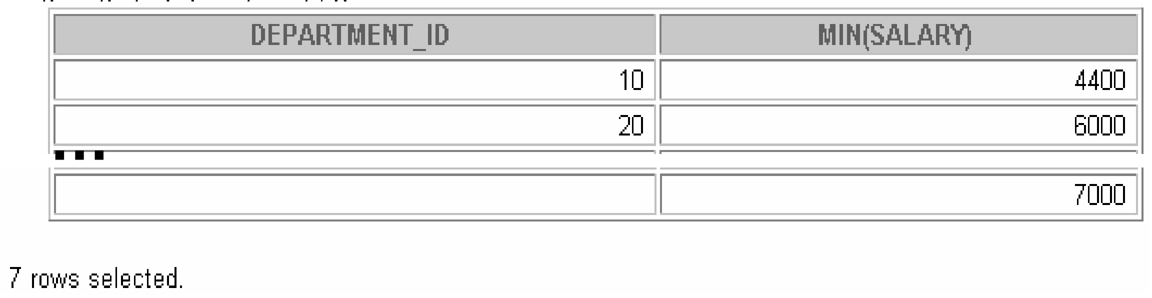
- The Oracle server executes subqueries first.
- The Oracle server returns results into the `HAVING` clause of the main query.

```
SELECT   department_id, MIN(salary)
FROM     employees
GROUP BY department_id                  2500
HAVING   MIN(salary) >
                        (SELECT MIN(salary)
                         FROM   employees
                         WHERE  department_id = 50);
```

The HAVING Clause with Subqueries

You can use subqueries not only in the `WHERE` clause, but also in the `HAVING` clause. The Oracle server executes the subquery, and the results are returned into the `HAVING` clause of the main query.

The SQL statement on the slide displays all the departments that have a minimum salary greater than that of department 50.



DEPARTMENT_ID	MIN(SALARY)
10	4400
20	6000
...	
	7000

7 rows selected.

Example

Find the job with the lowest average salary.

```
SELECT   job_id, AVG(salary)
FROM     employees
GROUP BY job_id
HAVING   AVG(salary) = (SELECT   MIN(AVG(salary))
                        FROM     employees
                        GROUP BY job_id);
```

What is Wrong with this Statement?

```
SELECT employee_id, last_name
FROM   employees
WHERE  salary =
                (SELECT   MIN(salary)
                 FROM     employees
                 GROUP BY department_id);
```

```
ERROR at line 4:
ORA-01427: single-row subquery returns more than
one row
```

Single-row operator with multiple-row subquery

Errors with Subqueries

One common error with subqueries is more than one row returned for a single-row subquery.

In the SQL statement on the slide, the subquery contains a `GROUP BY` clause, which implies that the subquery will return multiple rows, one for each group it finds. In this case, the result of the subquery will be 4400, 6000, 2500, 4200, 7000, 17000, and 8300.

The outer query takes the results of the subquery (4400, 6000, 2500, 4200, 7000, 17000, 8300) and uses these results in its `WHERE` clause. The `WHERE` clause contains an equal (=) operator, a single-row comparison operator expecting only one value. The `=` operator cannot accept more than one value from the subquery and therefore generates the error.

To correct this error, change the `=` operator to `IN`.

Will this Statement Return Rows?

```
SELECT last_name, job_id
FROM   employees
WHERE  job_id =
                (SELECT job_id
                 FROM   employees
                 WHERE  last_name = 'Haas');
```

```
no rows selected
```

Subquery returns no values

Problems with Subqueries

A common problem with subqueries is no rows being returned by the inner query.

In the SQL statement on the slide, the subquery contains a `WHERE` clause. Presumably, the intention is to find the employee whose name is Haas. The statement is correct but selects no rows when executed.

There is no employee named Haas. So the subquery returns no rows. The outer query takes the results of the subquery (null) and uses these results in its `WHERE` clause. The outer query finds no employee with a job ID equal to null, and so returns no rows. If a job existed with a value of null, the row is not returned because comparison of two null values yields a null, therefore the `WHERE` condition is not true.

Multiple-Row Subqueries

- **Return more than one row**
- **Use multiple-row comparison operators**

Operator	Meaning
`IN`	Equal to any member in the list
`ANY`	Compare value to each value returned by the subquery
`ALL`	Compare value to every value returned by the subquery

Multiple-Row Subqueries

Subqueries that return more than one row are called multiple-row subqueries. You use a multiple-row operator, instead of a single-row operator, with a multiple-row subquery. The multiple-row operator expects one or more values.

```
SELECT last_name, salary, department_id
FROM   employees
WHERE  salary IN (SELECT   MIN(salary)
                  FROM     employees
                  GROUP BY department_id);
```

Example

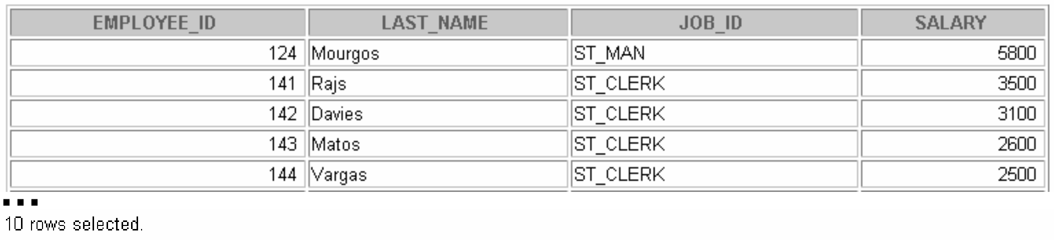
Find the employees who earn the same salary as the minimum salary for each department.

The inner query is executed first, producing a query result. The main query block is then processed and uses the values returned by the inner query to complete its search condition. In fact, the main query would appear to the Oracle server as follows:

```
SELECT last_name, salary, department_id
FROM   employees
WHERE  salary IN (2500, 4200, 4400, 6000, 7000, 8300, 8600,
17000);
```

Using the ANY Operator in Multiple-Row Subqueries

```
SELECT employee_id, last_name, job_id, salary
FROM   employees    9000, 6000, 4200
WHERE  salary < ANY
                    (SELECT salary
                     FROM   employees
                     WHERE  job_id = 'IT_PROG')
AND    job_id <> 'IT_PROG';
```



EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
124	Mourgos	ST_MAN	5800
141	Rajs	ST_CLERK	3500
142	Davies	ST_CLERK	3100
143	Matos	ST_CLERK	2600
144	Vargas	ST_CLERK	2500

...
10 rows selected.

Multiple-Row Subqueries (continued)

The `ANY` operator (and its synonym, the `SOME` operator) compares a value to *each* value returned by a subquery. The slide example displays employees who are not IT programmers and whose salary is less than that of any IT programmer. The maximum salary that a programmer earns is $9,000.

<`ANY` means less than the maximum. >`ANY` means more than the minimum. =`ANY` is equivalent to `IN`.

<`ALL` means less than the maximum. >`ALL` means more than the minimum.

Instructor Note

When using `SOME` or `ANY`, you often use the `DISTINCT` keyword to prevent rows from being selected several times.

Using the ALL Operator in Multiple-Row Subqueries

```
SELECT employee_id, last_name, job_id, salary
FROM   employees
WHERE  salary < ALL                    9000, 6000, 4200
                      (SELECT salary
                       FROM   employees
                       WHERE  job_id = 'IT_PROG')
AND    job_id <> 'IT_PROG';
```

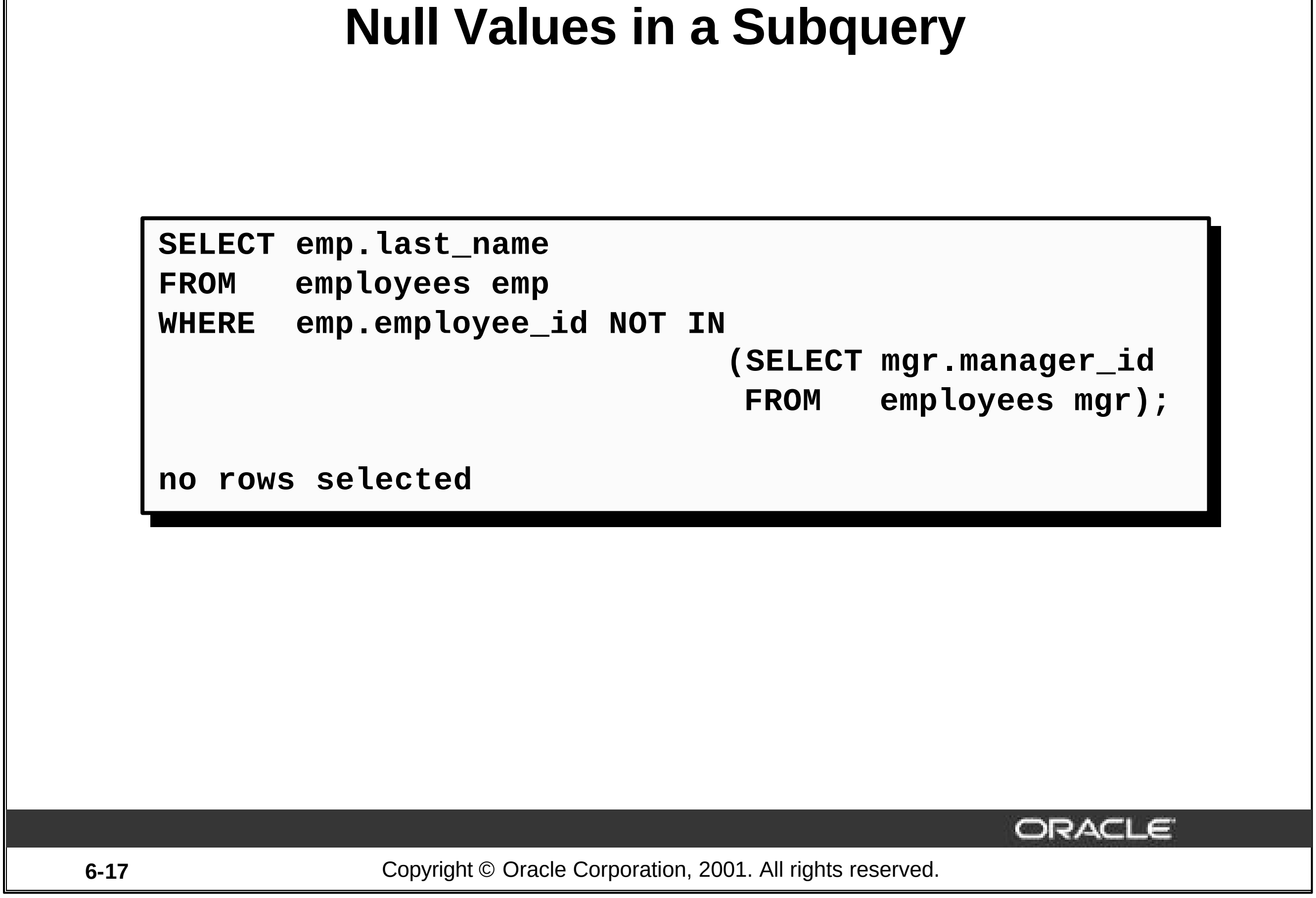
EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
141	Rajs	ST_CLERK	3500
142	Davies	ST_CLERK	3100
143	Matos	ST_CLERK	2600
144	Vargas	ST_CLERK	2500

Multiple-Row Subqueries (continued)

The `ALL` operator compares a value to *every* value returned by a subquery. The slide example displays employees whose salary is less than the salary of all employees with a job ID of IT_PROG and whose job is not IT_PROG.

`>ALL` means more than the maximum, and `<ALL` means less than the minimum.

The `NOT` operator can be used with `IN`, `ANY`, and `ALL` operators.



Null Values in a Subquery

```
SELECT emp.last_name
FROM   employees emp
WHERE  emp.employee_id NOT IN
                             (SELECT mgr.manager_id
                              FROM   employees mgr);

no rows selected
```

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Returning Nulls in the Resulting Set of a Subquery

The SQL statement on the slide attempts to display all the employees who do not have any subordinates. Logically, this SQL statement should have returned 12 rows. However, the SQL statement does not return any rows. One of the values returned by the inner query is a null value, and hence the entire query returns no rows. The reason is that all conditions that compare a null value result in a null. So whenever null values are likely to be part of the results set of a subquery, do not use the `NOT IN` operator. The `NOT IN` operator is equivalent to `<> ALL`.

Notice that the null value as part of the results set of a subquery is not a problem if you use the `IN` operator. The `IN` operator is equivalent to `=ANY`. For example, to display the employees who have subordinates, use the following SQL statement:

```
SELECT emp.last_name
FROM   employees emp
WHERE  emp.employee_id  IN
                         (SELECT mgr.manager_id
                          FROM   employees mgr);
```

Alternatively, a `WHERE` clause can be included in the subquery to display all employees who do not have any subordinates:

```
SELECT last_name FROM employees
WHERE  employee_id NOT IN
                       (SELECT manager_id
                        FROM   employees
                        WHERE  manager_id IS NOT NULL);
```

Summary

In this lesson, you should have learned how to:

- **Identify when a subquery can help solve a question**
- **Write subqueries when a query is based on unknown values**

```
SELECT   select_list
FROM     table
WHERE    expr operator
                   (SELECT select_list
                    FROM   table);
```

Summary

In this lesson, you should have learned how to use subqueries. A subquery is a `SELECT` statement that is embedded in a clause of another SQL statement. Subqueries are useful when a query is based on a search criteria with unknown intermediate values.

Subqueries have the following characteristics:

- Can pass one row of data to a main statement that contains a single-row operator, such as =, <>, >, >=, <, or <=
- Can pass multiple rows of data to a main statement that contains a multiple-row operator, such as `IN`
- Are processed first by the Oracle server, and the `WHERE` or `HAVING` clause uses the results
- Can contain group functions

Practice 6 Overview

This practice covers the following topics:

- Creating subqueries to query values based on unknown criteria
- Using subqueries to find out which values exist in one set of data and not in another

Practice 6

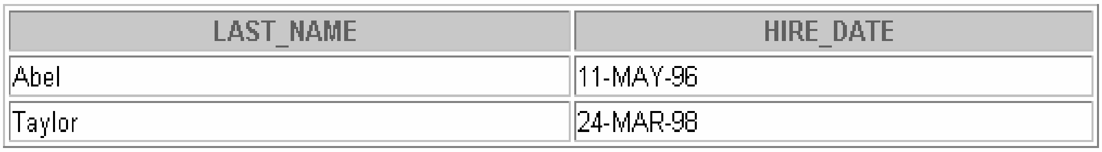
In this practice, you write complex queries using nested `SELECT` statements.

Paper-Based Questions

You may want to create the inner query first for these questions. Make sure that it runs and produces the data that you anticipate before coding the outer query.

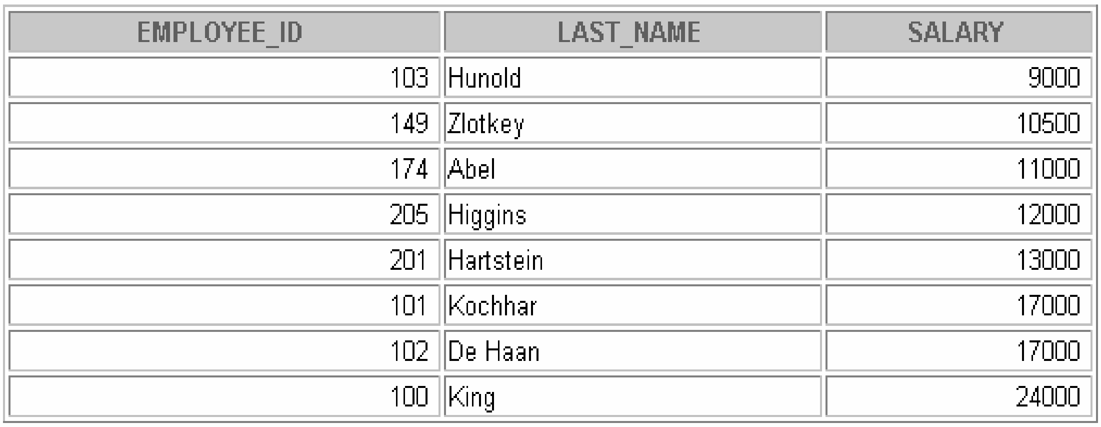
Practice 6

1. Write a query to display the last name and hire date of any employee in the same department as Zlotkey. Exclude Zlotkey.



LAST_NAME	HIRE_DATE
Abel	11-MAY-96
Taylor	24-MAR-98

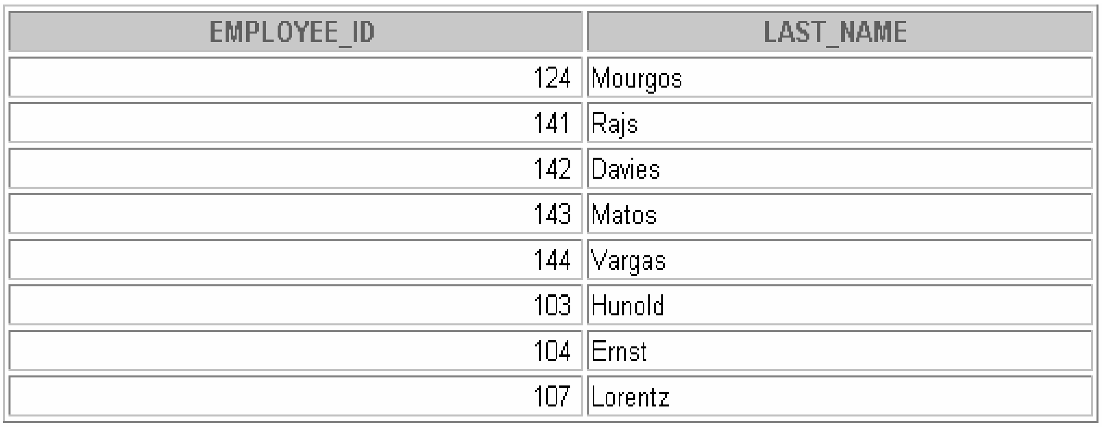
2. Create a query to display the employee numbers and last names of all employees who earn more than the average salary. Sort the results in ascending order of salary.



EMPLOYEE_ID	LAST_NAME	SALARY
103	Hunold	9000
149	Zlotkey	10500
174	Abel	11000
205	Higgins	12000
201	Hartstein	13000
101	Kochhar	17000
102	De Haan	17000
100	King	24000

8 rows selected.

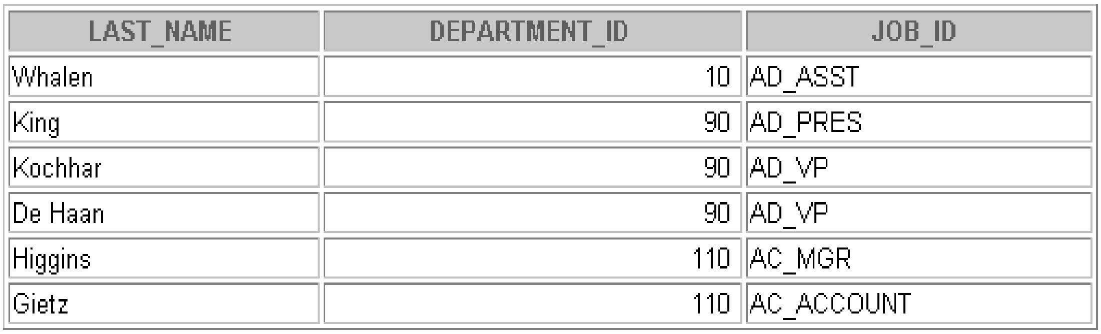
3. Write a query that displays the employee numbers and last names of all employees who work in a department with any employee whose last name contains a *u*. Place your SQL statement in a text file named `lab6_3.sql`. Run your query.



EMPLOYEE_ID	LAST_NAME
124	Mourgos
141	Rajs
142	Davies
143	Matos
144	Vargas
103	Hunold
104	Ernst
107	Lorentz

8 rows selected.

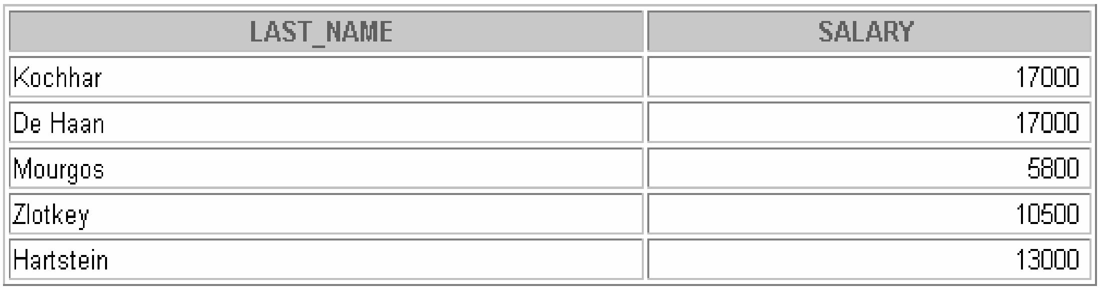
4. Display the last name, department number, and job ID of all employees whose department location ID is 1700.



LAST_NAME	DEPARTMENT_ID	JOB_ID
Whalen	10	AD_ASST
King	90	AD_PRES
Kochhar	90	AD_VP
De Haan	90	AD_VP
Higgins	110	AC_MGR
Gietz	110	AC_ACCOUNT

6 rows selected.

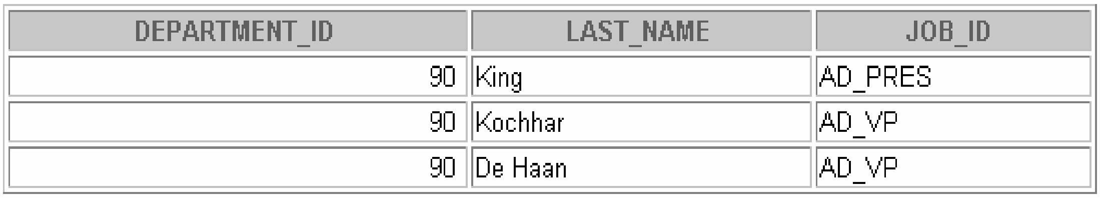
5. Display the last name and salary of every employee who reports to King.



LAST_NAME	SALARY
Kochhar	17000
De Haan	17000
Mourgos	5800
Zlotkey	10500
Hartstein	13000

6.

department.

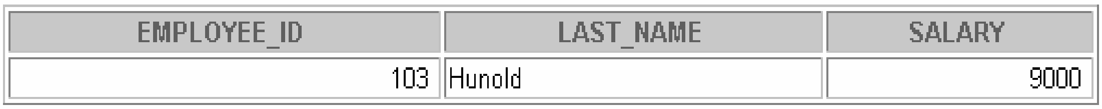


DEPARTMENT_ID	LAST_NAME	JOB_ID
90	King	AD_PRES
90	Kochhar	AD_VP
90	De Haan	AD_VP

If yo

7.

salaries of all employees who earn more than the average salary and who work in a department with any employee with a *u* in their name. Resave `lab6_3.sql` to `lab6_7.sql`. Run the statement in `lab6_7.sql`.



EMPLOYEE_ID	LAST_NAME	SALARY
103	Hunold	9000