Using Subqueries to Solve Queries

Objectives

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

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

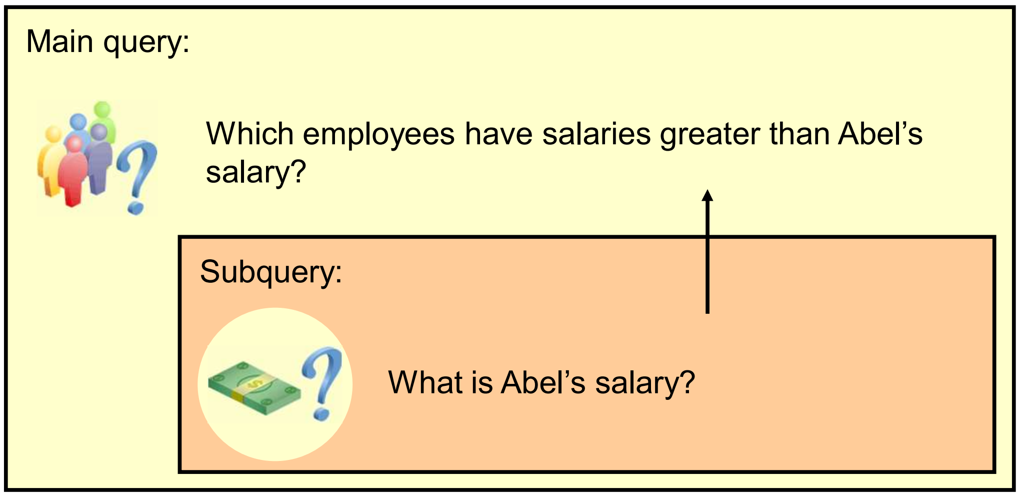
In this lesson, you learn about the more advanced features of the `SELECT` statement. You can write subqueries in the `WHERE` clause of another SQL statement to obtain values based on an unknown conditional value. This lesson also covers single-row subqueries and multiple-row subqueries.

Lesson Agenda

- Subquery: Types, syntax, and guidelines
- Single-row subqueries:
  - Group functions in a subquery
  - `HAVING` clause with subqueries
- Multiple-row subqueries
  - Use `ALL` or `ANY` operator.
- Using the `EXISTS` operator
- Null values in a subquery

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?

The inner query (or *subquery*) returns a value that is used by the outer query (or *main query*).

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 how much 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 execution plan of the query depends on the optimizer's decision on the structure of the subquery.

Subquery Syntax

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

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

- You can place the subquery in a number of SQL clauses, including the following:
  - `WHERE` clause
  - `HAVING` clause
  - `FROM` clause

A subquery is a `SELECT` statement that is embedded in the 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 following:

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

In the syntax:

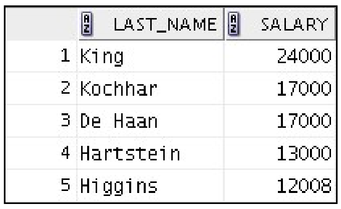
`operator` includes a comparison condition such as `>`, `=`, or `IN`

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

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.

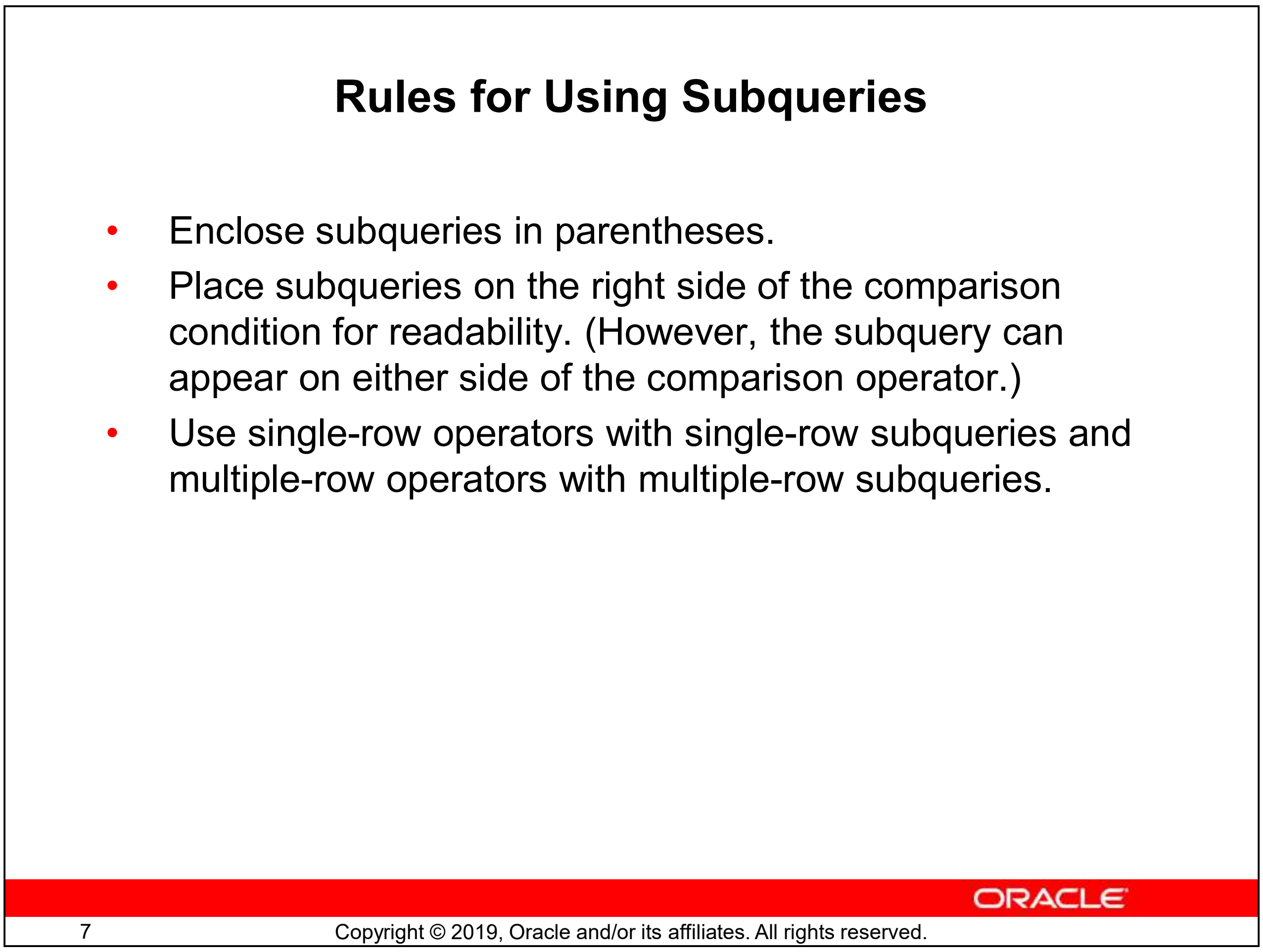
Using a Subquery

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



	LAST_NAME	SALARY
1	King	24000
2	Kochhar	17000
3	De Haan	17000
4	Hartstein	13000
5	Higgins	12008

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 employee Abel.



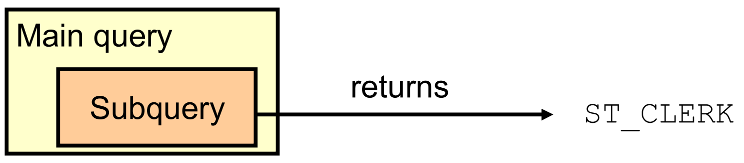
Rules for Using Subqueries

- Enclose subqueries in parentheses.
- Place subqueries on the right side of the comparison condition for readability. (However, the subquery can appear on either side of the comparison operator.)
- Use single-row operators with single-row subqueries and multiple-row operators with multiple-row subqueries.

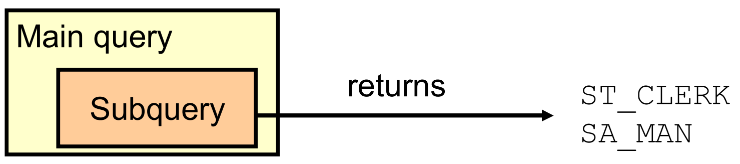
- A subquery must be enclosed in parentheses.
- Place the subquery on the right side of the comparison condition for readability. However, the subquery can appear on either side of the comparison operator.
- Two classes of comparison conditions are used in subqueries: single-row operators and multiple-row operators.

Types of Subqueries

- Single-row subquery

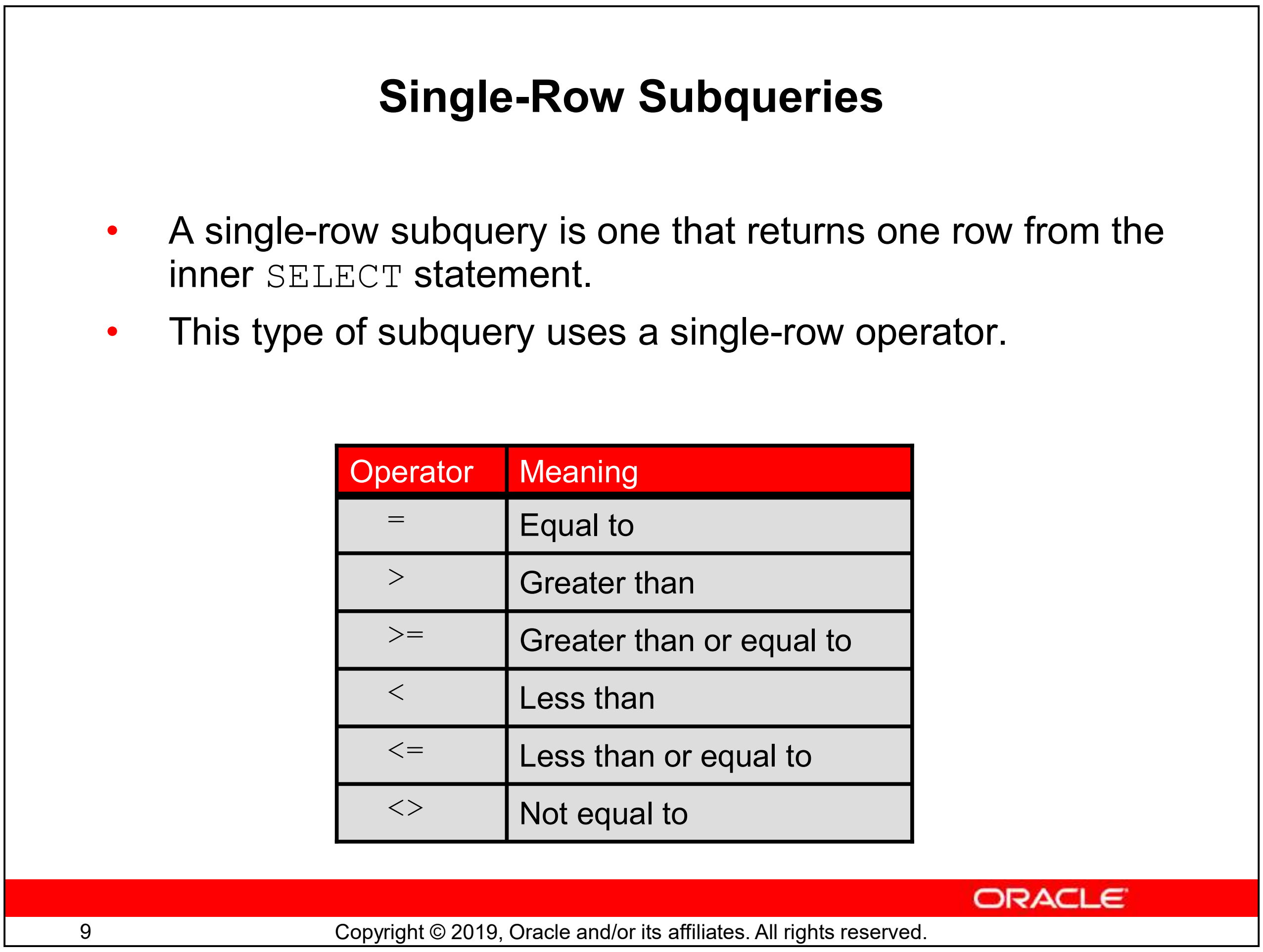


- Multiple-row subquery



- **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, which are queries that return more than one column from the inner `SELECT` statement.



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.

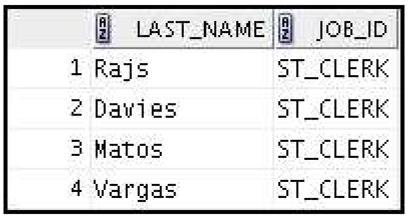
Operator	Meaning
=	Equal to
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
<>	Not equal to

The slide gives a list of single-row operators.

Example

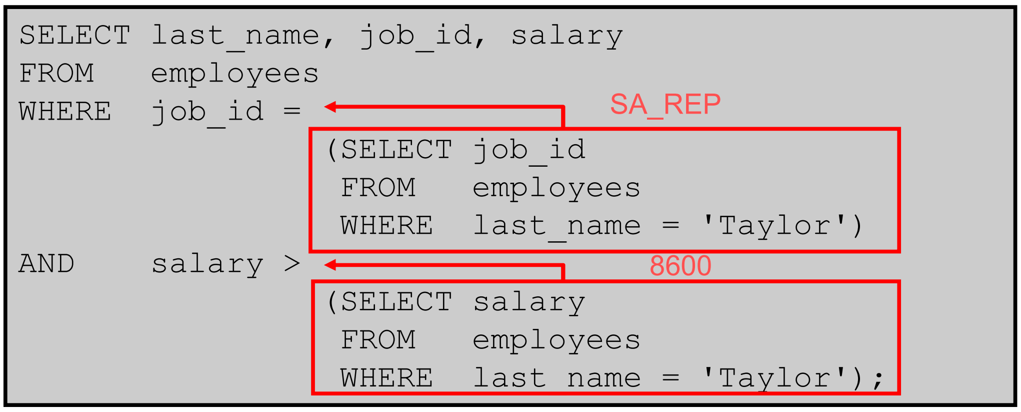
Display the employees whose job `ID` is the same as that of employee 141:

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

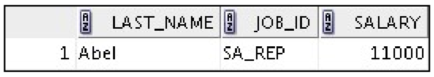


	LAST_NAME	JOB_ID
1	Rajs	ST_CLERK
2	Davies	ST_CLERK
3	Matos	ST_CLERK
4	Vargas	ST_CLERK

Executing Single-Row Subqueries



```
SELECT last_name, job_id, salary
FROM   employees
WHERE  job_id =
                 (SELECT job_id
                  FROM   employees
                  WHERE  last_name = 'Taylor')
AND    salary >
                 (SELECT salary
                  FROM   employees
                  WHERE  last_name = 'Taylor');
```



	LAST_NAME	JOB_ID	SALARY
1	Abel	SA_REP	11000

A `SELECT` statement can be considered as a query block. The example in the slide displays employees who do the same job as “Taylor,” but earn more salary than him.

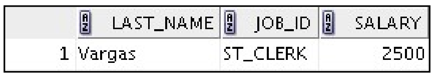
The example consists of three query blocks: the outer query and two inner queries. The inner query blocks are executed first, producing the query results `SA_REP` and `8600`, respectively. The outer query block is then processed and uses the values that were returned by the inner queries to complete its search conditions.

Both inner queries return single values (`SA_REP` and `8600`, 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 =                   2500
                (SELECT MIN(salary)
                 FROM   employees);
```



	LAST_NAME	JOB_ID	SALARY
1	Vargas	ST_CLERK	2500

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 in 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.

HAVING Clause with Subqueries

- The Oracle server executes the 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
HAVING    MIN(salary)  >
                                  (SELECT MIN(salary)
                                   FROM   employees
                                   WHERE  department_id = 50);
```

2500

	DEPARTMENT_ID	MIN(SALARY)
1	(null)	7000
2	90	17000
3	20	6000
4	110	8300
5	80	8600
6	60	4200
7	10	4400

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.

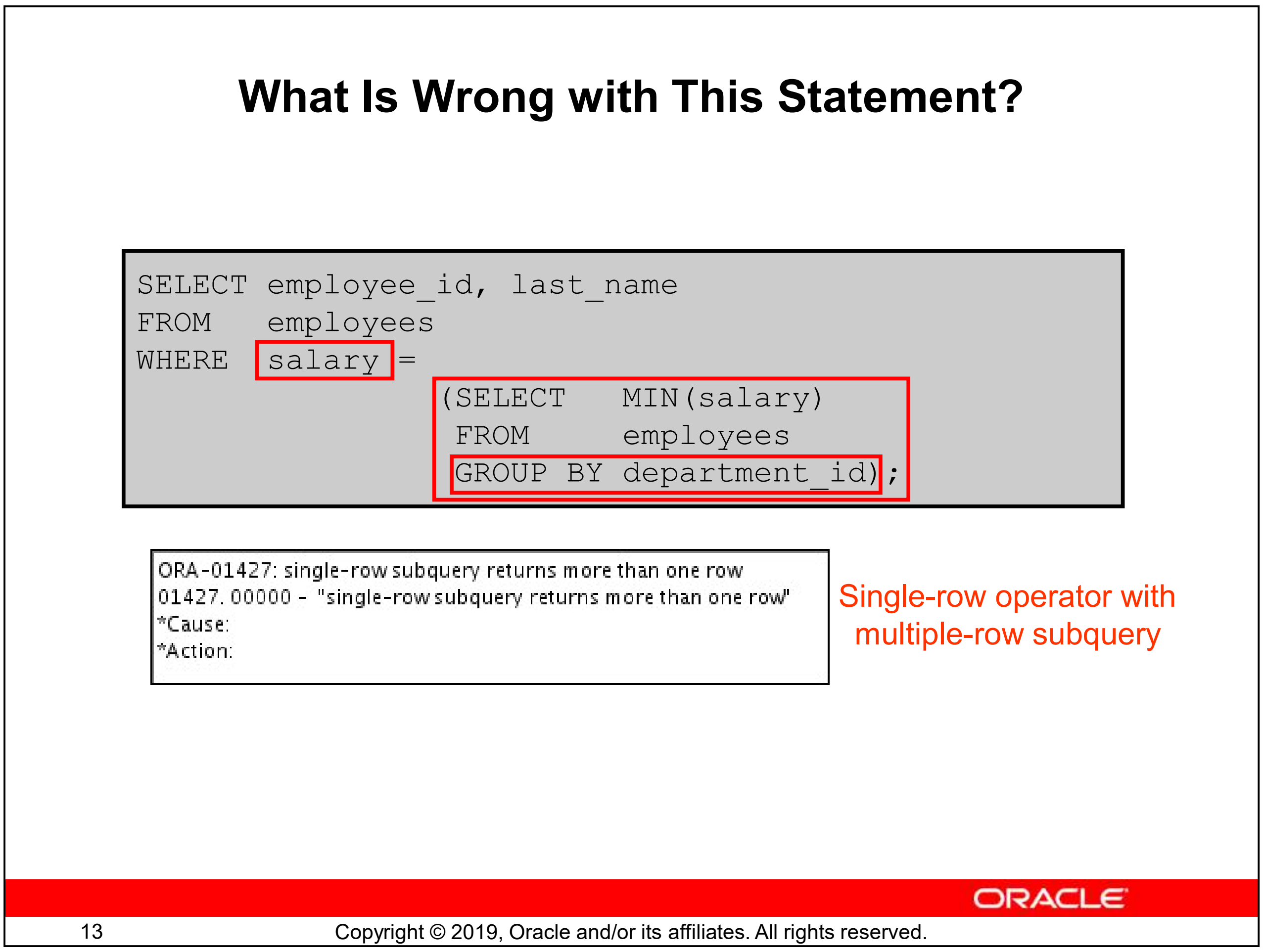
The SQL statement in the slide displays all the departments that have a minimum salary greater than that of department 50.

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);
```

	JOB_ID	AVG(SALARY)
1	ST_CLERK	2925



What Is Wrong with This Statement?

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

```
ORA-01427: single-row subquery returns more than one row
01427. 00000 -  "single-row subquery returns more than one row"
*Cause:
*Action:
```

Single-row operator with multiple-row subquery

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

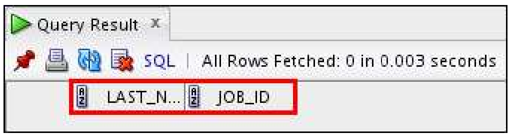
In the SQL statement in the slide, the subquery contains a `GROUP BY` clause, which implies that the subquery will return multiple rows, one for each group that it finds. In this case, the results of the subquery are `4400`, `6000`, `2500`, `4200`, `7000`, `17000`, and `8300`.

The outer query takes those results and uses them in its `WHERE` clause. The `WHERE` clause contains an equal (=) operator, a single-row comparison operator that expects 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`.

No Rows Returned by the Inner Query

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

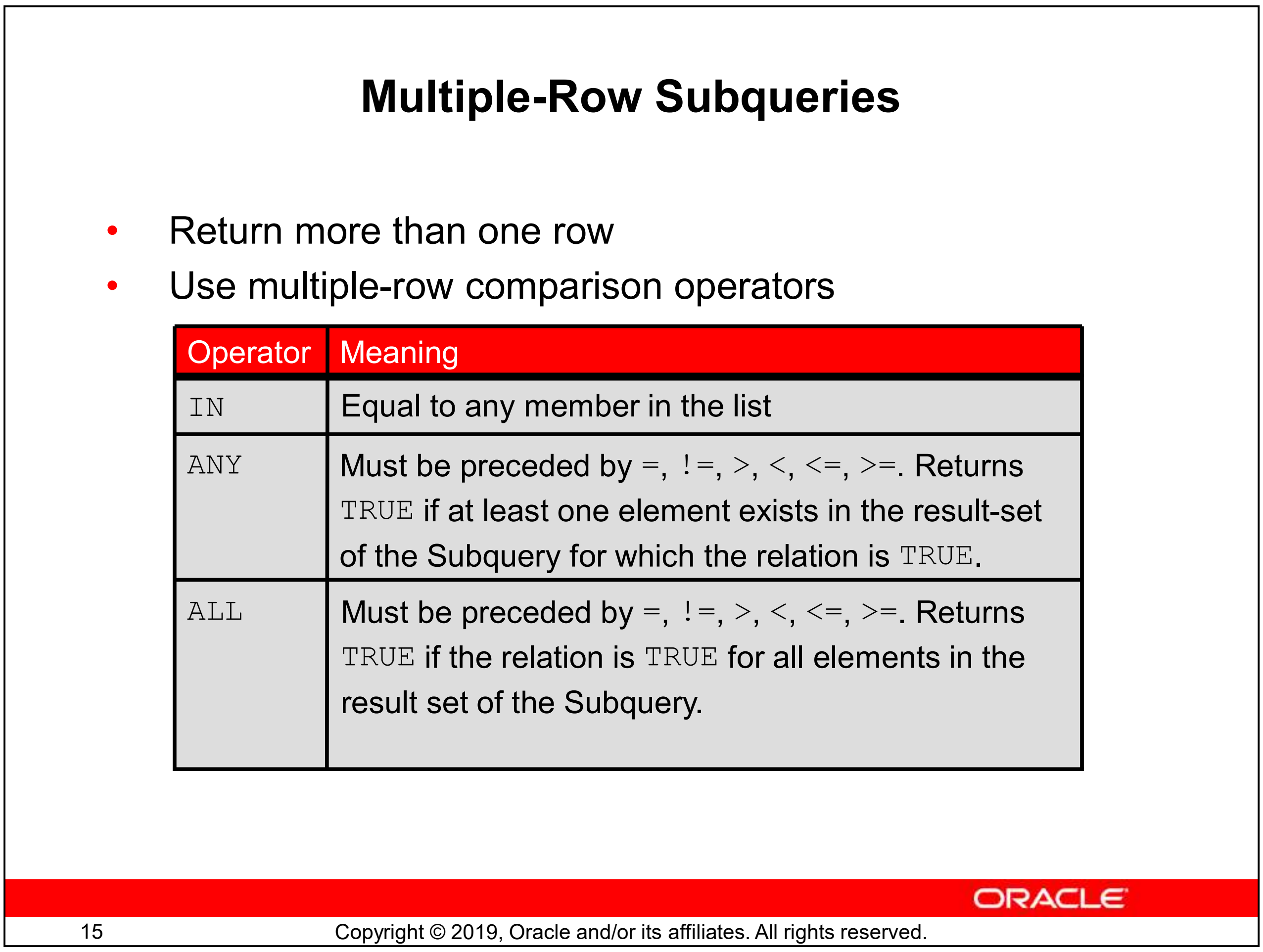


Subquery returns no rows because there is no employee named “Haas.”

Another common problem with subqueries occurs when no rows are returned by the inner query.

In the SQL statement in 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 because there is no employee named Haas. Therefore, 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`	Must be preceded by =, !=, >, <, <=, >=. Returns `TRUE` if at least one element exists in the result-set of the Subquery for which the relation is `TRUE`.
`ALL`	Must be preceded by =, !=, >, <, <=, >=. Returns `TRUE` if the relation is `TRUE` for all elements in the result set of the Subquery.

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:

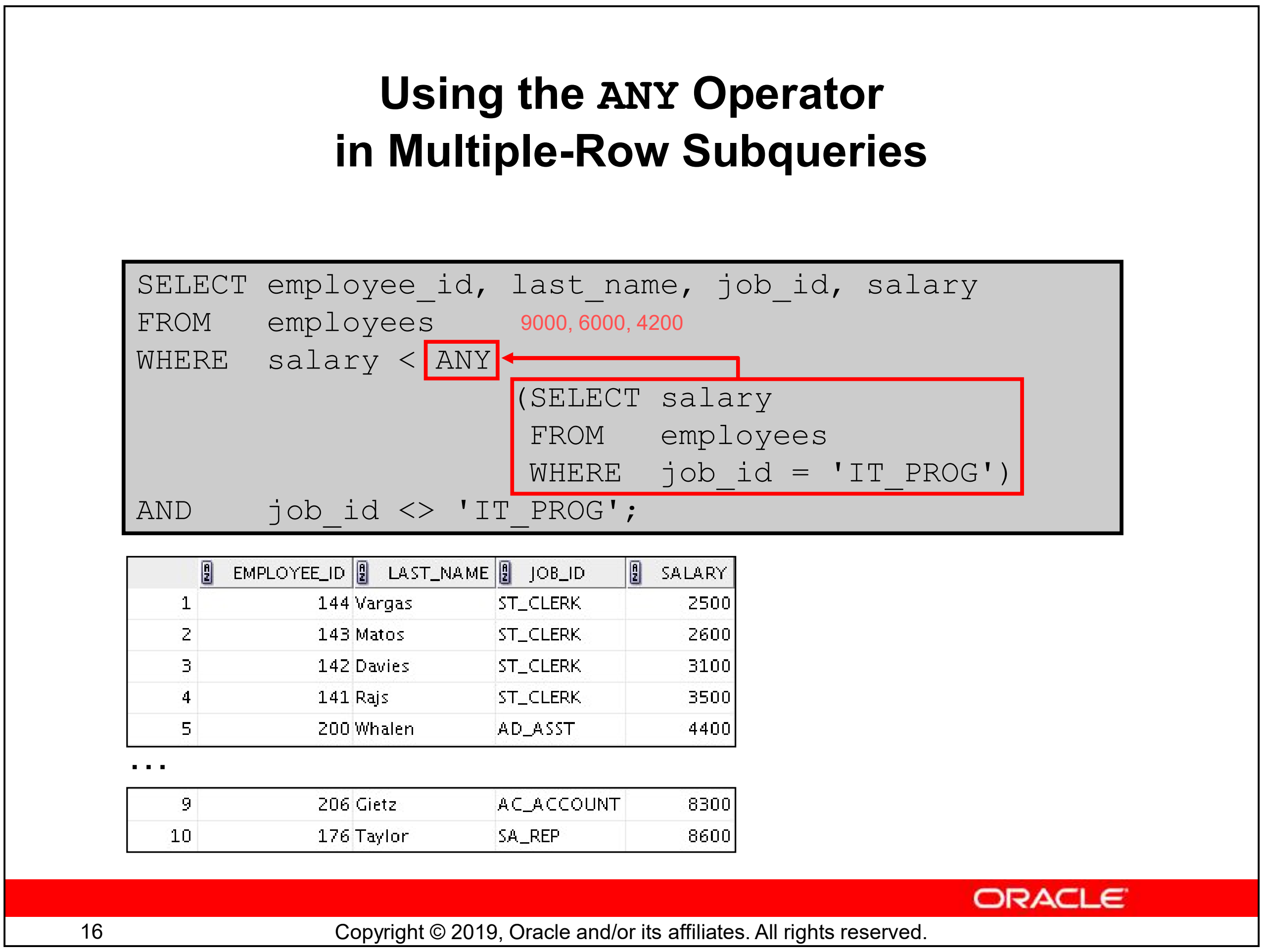
```
SELECT last_name, salary, department_id
FROM   employees
WHERE  salary IN (SELECT   MIN(salary)
                  FROM     employees
                  GROUP BY department_id);
```

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 that were returned by the inner query to complete its search condition. In fact, the main query appears 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
1	144	Vargas	ST_CLERK	2500
2	143	Matos	ST_CLERK	2600
3	142	Davies	ST_CLERK	3100
4	141	Rajs	ST_CLERK	3500
5	200	Whalen	AD_ASST	4400

...

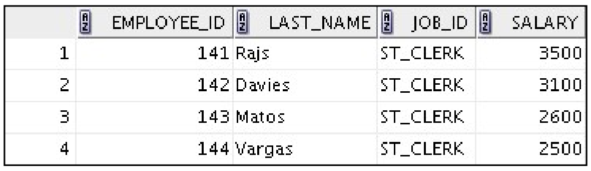
9	206	Gietz	AC_ACCOUNT	8300
10	176	Taylor	SA_REP	8600

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.

Using the `ALL` Operator in Multiple-Row Subqueries

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



	EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
1	141	Rajs	ST_CLERK	3500
2	142	Davies	ST_CLERK	3100
3	143	Matos	ST_CLERK	2600
4	144	Vargas	ST_CLERK	2500

The `ALL` operator compares a value to *every* value returned by a subquery. The example in the slide 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`.

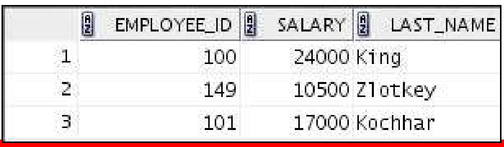
`>ALL` means more than the maximum and `<ALL` means less than the minimum.

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

Using the `EXISTS` Operator

- The `EXISTS` operator is used in queries where the query result depends on whether or not certain rows exist in a table.
- It evaluates to `TRUE` if the subquery returns at least one row.
- The example displays managers in the `EMPLOYEES` table who earns a salary more than 10000. For each row in `EMPLOYEES` table, the condition is checked whether there exists a manager_id who earns a salary more than 10000.

```
SELECT employee_id,salary,last_name FROM employees M
WHERE EXISTS
(SELECT employee_id FROM employees W
 WHERE (W.manager_id=M.employee_id) AND W.salary > 10000);
```

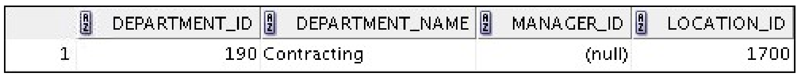


	EMPLOYEE_ID	SALARY	LAST_NAME
1	100	24000	King
2	149	10500	Zlotkey
3	101	17000	Kochhar

Using the EXISTS Operator

- The example displays departments that have no employees. For each row in the DEPARTMENTS table, the condition is checked whether there exists a row in the EMPLOYEES table that has the same department ID.
- In case no such row exists, the condition is satisfied for the row under consideration and it is selected.
- If there exists a corresponding row in the EMPLOYEES table, the row is not selected.

```
SELECT * FROM departments
WHERE NOT EXISTS
(SELECT * FROM employees
 WHERE employees.department_id=departments.department_id);
```

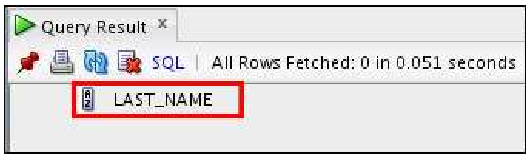


	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	190	Contracting	(null)	1700

Null Values in a Subquery

- The SQL statement 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, therefore, the entire query returns no rows.
- The reason is that all conditions that compare a null value result in a null.

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



Query Result ×

SQL | All Rows Fetched: 0 in 0.051 seconds

LAST_NAME

Subquery returns no rows because one of the values returned by a subquery is Null.

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);
```

Quiz

Using a subquery is equivalent to performing two sequential queries and using the result of the first query as the search values in the second query.

a. True

b. False

Answer: a

Summary

In this lesson, you should have learned how to:

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

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

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In this lesson, you should have learned how to use subqueries. A subquery is a `SELECT` statement that is embedded in the clause of another SQL statement. Subqueries are useful when a query is based on a search criterion 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, after which the `WHERE` or `HAVING` clause uses the results
- Can contain group functions