6

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 subqueries can solve
- List the types of subqueries
- Write single-row and multiple-row subqueries

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Objectives

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?

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

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 (outer query).
- The result of the subquery is used by the main query.

Subquery Syntax

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 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).

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

11000

	LAST_NAME	SALARY
1	Hartstein	13000
2	Higgins	12000
3	King	24000
4	Kochhar	17000
5	De Haan	17000

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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.

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.

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Guidelines for Using Subqueries

- A subquery must be enclosed in parentheses.
- Place the subquery on the right side of the comparison condition for readability.
- With Oracle8*i* and later releases, an `ORDER BY` clause can be used and is required in the subquery to perform Top-N analysis.
  - Before Oracle8*i*, however, subqueries could not contain an `ORDER BY` clause. Only one `ORDER BY` clause could be used for a `SELECT` statement; if specified, it had to be the last clause in the main `SELECT` statement.
- 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

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, which are queries that return more than one column from the inner `SELECT` statement. These are covered in the *Oracle Database 10g: SQL Fundamentals II* course.

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

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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
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 =                    ST_CLERK
                 (SELECT job_id
                  FROM   employees
                  WHERE  employee_id = 141)
AND    salary >                    2600
                 (SELECT salary
                  FROM   employees
                  WHERE  employee_id = 143);
```

	LAST_NAME	JOB_ID	SALARY
1	Rajs	ST_CLERK	3500
2	Davies	ST_CLERK	3100

Executing Single-Row Subqueries

A `SELECT` statement can be considered as a query block. The example in 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 that were 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);
```

2500

	LAST_NAME	JOB_ID	SALARY
1	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 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.

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
HAVING   MIN(salary) >
                        (SELECT MIN(salary)
                         FROM   employees
                         WHERE  department_id = 50);
```

2500

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

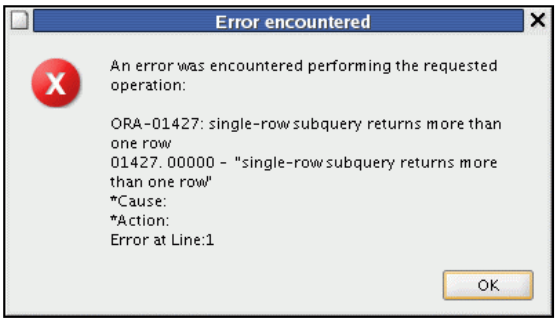
	DEPARTMENT_ID	MIN(SALARY)
1	(null)	7000
2	20	6000
3	90	17000
4	110	8300
5	80	8600
6	10	4400
7	60	4200

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);
```



Single-row operator with multiple-row subquery

Errors with Subqueries

One 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 result 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`.

Will This Statement Return Rows?

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

0 rows selected
```

Subquery returns no values.

Problems with Subqueries

A 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.

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 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
WHERE  salary < ANY
                (SELECT salary
                 FROM   employees
                 WHERE  job_id = 'IT_PROG')
AND    job_id <> 'IT_PROG';
```

9000, 6000, 4200

	EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
1	144	Vargas	ST_CLERK	2500
2	143	Matos	ST_CLERK	2600

...

9	206	Gietz	AC_ACCOUNT	8300
10	176	Taylor	SA_REP	8600

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.

Using the ALL Operator in Multiple-Row Subqueries

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

9000, 6000, 4200

	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

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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);

0 rows selected
```


Returning Nulls in the Resulting Set of a Subquery

The SQL statement in 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, therefore, 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);
```

Returning Nulls in the Resulting Set of a Subquery (continued)

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);
```

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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 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

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: Overview

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 you code the outer query.

Practice 6

1. The HR department needs a query that prompts users for an employee last name. The query then displays the last name and hire date of any employee in the same department as the employee whose name they supply (excluding that employee). For example, if the user enters `Zlotkey`, find all employees who work with Zlotkey (excluding Zlotkey).

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

2. Create a report that displays the employee number, last name, and salary of all employees who earn more than the average salary. Sort the results in ascending order by salary.

	EMPLOYEE_ID	LAST_NAME	SALARY
1	103	Hunold	9000
2	149	Zlotkey	10500
3	174	Abel	11000
4	205	Higgins	12000
5	201	Hartstein	13000
6	102	De Haan	17000
7	101	Kochhar	17000
8	100	King	24000

3. Write a query that displays the employee number and last name 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 `lab_06_03.sql`. Run your query.

	EMPLOYEE_ID	LAST_NAME
1	124	Mourgos
2	141	Rajs
3	142	Davies
4	143	Matos
5	144	Vargas
6	103	Hunold
7	104	Ernst
8	107	Lorentz

Practice 6 (continued)

4. The HR department needs a report that displays the last name, department number, and job ID of all employees whose department location ID is 1700.

	LAST_NAME	DEPARTMENT_ID	JOB_ID
1	Whalen	10	AD_ASST
2	Higgins	110	AC_MGR
3	Gietz	110	AC_ACCOUNT
4	King	90	AD_PRES
5	Kochhar	90	AD_VP
6	De Haan	90	AD_VP

Modify the query so that users are prompted for a location ID. Save this to a file named `lab_06_04.sql`.

5. Create a report for the HR department that displays the last name and salary of every employee who reports to King.

	LAST_NAME	SALARY
1	Hartstein	13000
2	Kochhar	17000
3	De Haan	17000
4	Mourgos	5800
5	Zlotkey	10500

6. Create a report for the HR department that displays the department number, last name, and job ID for every employee in the Executive department.

	DEPARTMENT_ID	LAST_NAME	JOB_ID
1	90	King	AD_PRES
2	90	Kochhar	AD_VP
3	90	De Haan	AD_VP

If you have time, complete the following exercise:

7. Modify the query in `lab_06_03.sql` to display the employee number, last name, and salary of all the employees who earn more than the average salary and who work in a department with any employee whose last name contains a *u*. Resave `lab_06_03.sql` as `lab_06_07.sql`. Run the statement in `lab_06_07.sql`.

	EMPLOYEE_ID	LAST_NAME	SALARY
1	103	Hunold	9000