



Database Programming with SQL

10-3

Multiple-Row Subqueries



Objectives

This lesson covers the following objectives:

- Correctly use the comparison operators IN, ANY, and ALL in multiple-row subqueries
- Construct and execute a multiple-row subquery in the WHERE clause or HAVING clause
- Describe what happens if a multiple-row subquery returns a null value
- Understand when multiple-row subqueries should be used, and when it is safe to use a single-row subquery

Objectives

This lesson covers the following objectives:

- Distinguish between pair-wise and non-pair-wise subqueries
- Create a query using the EXISTS and NOT EXISTS operators to test for returned rows from the subquery

Purpose

- A subquery is designed to find information you don't know so that you can find information you want to know.
- However, single-row subqueries can return only one row. What if you need to find information based on several rows and several values?
- The subquery will need to return several rows.
- We achieve this using multiple-row subqueries and the three comparison operators: IN, ANY, and ALL.

Query Comparison

- Whose salary is equal to the salary of an employee in department 20 ?
- This example returns an error because more than one employee exists in department 20, the subquery returns multiple rows.
- We call this a multiple-row subquery.

LAST_NAME	DEPT_ID	SALARY
Hartstein	20	13000
Fay	20	6000

```
SELECT first_name, last_name
FROM employees
WHERE salary =
  (SELECT salary
   FROM employees
   WHERE department_id = 20);
```



ORA-01427: single-row subquery returns more than one row

Query Comparison

- The problem is the equal sign (=) in the WHERE clause of the outer query.
- How can one value be equal to (or not equal to) more than one value at a time?
- It's a silly question, isn't it?

```
SELECT first_name, last_name
FROM employees
WHERE salary =
  (SELECT salary
   FROM employees
   WHERE department_id = 20);
```



ORA-01427: single-row subquery returns more than one row

IN, ANY, and ALL

- Subqueries that return more than one value are called multiple-row subqueries.
- Because we cannot use the single-row comparison operators (=, <, and so on), we need different comparison operators for multiple-row subqueries.
- The multiple-row operators are:
 - IN,
 - ANY
 - ALL
- The NOT operator can be used with any of these three operators.

IN

- The IN operator is used within the outer query WHERE clause to select only those rows which are IN the list of values returned from the inner query.
- For example, we are interested in all the employees that were hired the same year as an employee in department 90.

```
SELECT last_name, hire_date
FROM employees
WHERE EXTRACT(YEAR FROM hire_date) IN
      (SELECT EXTRACT(YEAR FROM hire_date)
       FROM employees
       WHERE department_id=90);
```

LAST_NAME	HIRE_DATE
Whalen	17/Sep/1987
King	17/Jun/1987
Kochhar	21/Sep/1989
De Haan	13/Jan/1993

IN

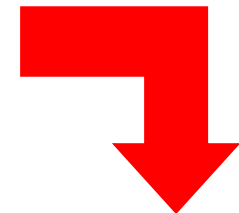
- The inner query will return a list of the years that employees in department 90 were hired.
- The outer query will then return any employee that was hired the same year as any year in the inner query list.

```
SELECT last_name, hire_date
FROM employees
WHERE EXTRACT(YEAR FROM hire_date) IN
      (SELECT EXTRACT(YEAR FROM hire_date)
       FROM employees
       WHERE department_id=90);
```

LAST_NAME	HIRE_DATE
Whalen	17/Sep/1987
King	17/Jun/1987
Kochhar	21/Sep/1989
De Haan	13/Jan/1993

ANY

- The ANY operator is used when we want the outer-query WHERE clause to select the rows which match the criteria (<, >, =, etc.) of **at least** one value in the subquery result set.
- The example shown will return any employee whose year hired is less than at least one year hired of employees in department 90.



Year Hired
1987
1989
1993

```
SELECT last_name, hire_date
FROM employees
WHERE EXTRACT(YEAR FROM hire_date) < ANY
      (SELECT EXTRACT(YEAR FROM hire_date)
       FROM employees
       WHERE department_id=90);
```

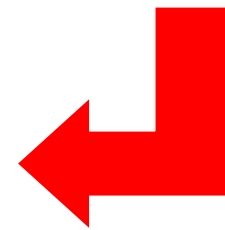
LAST_NAME	HIRE_DATE
Whalen	17/Sep/1987
King	17/Jun/1987
Kochhar	21/Sep/1989
Hunold	03/Jan/1990
Ernst	21/May/1991

ALL

- The ALL operator is used when we want the outer-query WHERE clause to select the rows which match the criteria (<, >, =, etc.) of **all** of the values in the subquery result set.
- The ALL operator compares a value to every value returned by the inner query.
- As no employee was hired before 1987, no rows are returned.

```
SELECT last_name, hire_date
FROM employees
WHERE EXTRACT(YEAR FROM hire_date) < ALL
      (SELECT EXTRACT(YEAR FROM hire_date)
       FROM employees
       WHERE department_id=90);
```

no data found



Year Hired
1987
1989
1993

NULL Values

- Suppose that one of the values returned by a multiple-row subquery is null, but other values are not.
- If IN or ANY are used, the outer query will return rows which match the non-null values.

```
SELECT last_name, employee_id
FROM employees
WHERE employee_id IN
  (SELECT manager_id
   FROM employees);
```

MANAGER_ID
(null)
100
100
102
103
103
100
124

Result of subquery

LAST_NAME	EMPLOYEE_ID
King	100
Kochhar	101
De Haan	102
Hunold	103
Mourgos	124



NULL Values

- If ALL is used, the outer query returns no rows because ALL compares the outer query row with every value returned by the subquery, including the null.
- And comparing anything with null results in null.

```
SELECT last_name, employee_id
FROM employees
WHERE employee_id <= ALL
      (SELECT manager_id
       FROM employees);
```

no data found

GROUP BY and HAVING

- As you might suspect, the GROUP BY clause and the HAVING clause can also be used with multiple-row subqueries.
- What if you wanted to find the departments whose minimum salary is less than the salary of any employee who works in department 10 or 20?

LAST_NAME	DEPT_ID	SALARY
Whalen	10	4400
Hartstein	20	13000
Fay	20	6000

DEPARTMENT_ID	MIN(SALARY)
10	4400
20	6000
50	2500
60	4200
80	8600
110	8300
(null)	7000

GROUP BY and HAVING

- We need a multiple-row subquery which returns the salaries of employees in departments 10 and 20.
- The outer query will use a group function (MIN) so we need to GROUP the outer query BY department_id.

LAST_NAME	DEPT_ID	SALARY
Whalen	10	4400
Hartstein	20	13000
Fay	20	6000

DEPARTMENT_ID	MIN(SALARY)
10	4400
20	6000
50	2500
60	4200
80	8600
110	8300
(null)	7000

GROUP BY and HAVING

- Here is the SQL statement:

```
SELECT department_id, MIN(salary)
FROM employees
GROUP BY department_id
HAVING MIN(salary) < ANY
  (SELECT salary
   FROM employees
   WHERE department_id IN (10,20))
ORDER BY department_id;
```

LAST_NAME	DEPT_ID	SALARY
Whalen	10	4400
Hartstein	20	13000
Fay	20	6000

Result of subquery

DEPARTMENT_ID	MIN(SALARY)
10	4400
20	6000
50	2500
60	4200
80	8600
110	8300
(null)	7000

Multiple-Column Subqueries

- Subqueries can use one or more columns.
- If they use more than one column, they are called multiple-column subqueries.
- A multiple-column subquery can be either pair-wise comparisons or non-pair-wise comparisons.

```
SELECT employee_id, manager_id, department_id
FROM employees
WHERE (manager_id, department_id) IN
      (SELECT manager_id, department_id
       FROM employees
       WHERE employee_id IN (149, 174))
AND employee_id NOT IN (149, 174)
```

EMPLOYEE_ID	MANAGER_ID	DEPARTMENT_ID
176	149	80

Multiple-Column Subqueries

- The example below shows a multiple-column pair-wise subquery with the subquery highlighted in red and the result in the table below.
- The query lists the employees whose manager and departments are the same as the manager and department of employees 149 or 174.

```
SELECT employee_id, manager_id, department_id
FROM employees
WHERE (manager_id, department_id) IN
      (SELECT manager_id, department_id
       FROM employees
       WHERE employee_id IN (149, 174))
AND employee_id NOT IN (149, 174)
```

EMPLOYEE_ID	MANAGER_ID	DEPARTMENT_ID
176	149	80

Multiple-Column Subqueries

- A non-pair-wise multiple-column subquery also uses more than one column in the subquery, but it compares them one at a time, so the comparisons take place in different subqueries.

```
SELECT  employee_id,  
        manager_id,  
        department_id  
FROM    employees  
WHERE   manager_id IN  
        (SELECT  manager_id  
         FROM    employees  
         WHERE   employee_id IN  
                (149,174))  
AND     department_id IN  
        (SELECT  department_id  
         FROM    employees  
         WHERE   employee_id IN  
                (149,174))  
AND     employee_id NOT IN(149,174);
```

EMPLOYEE_ID	MANAGER_ID	DEPARTMENT_ID
176	149	80

Multiple-Column Subqueries

- You will need to write one subquery per column you want to compare against when performing non-pair-wise multiple column subqueries.
- The example on the right shows a multiple-column non-pair-wise subquery with the subqueries highlighted in red.

```
SELECT  employee_id,  
        manager_id,  
        department_id  
FROM    employees  
WHERE   manager_id IN  
        (SELECT  manager_id  
         FROM    employees  
         WHERE   employee_id IN  
                (149,174))  
AND     department_id IN  
        (SELECT  department_id  
         FROM    employees  
         WHERE   employee_id IN  
                (149,174))  
AND     employee_id NOT IN(149,174);
```

EMPLOYEE_ID	MANAGER_ID	DEPARTMENT_ID
176	149	80

Multiple-Column Subqueries

- This query is listing the employees who have the same `manager_id` and `department_id` as employees 149 or 174.

Result of 1st subquery

MANAGER_ID
100
149

Result of 2nd subquery

DEPARTMENT_ID
80
80

```
SELECT  employee_id,
        manager_id,
        department_id
FROM    employees
WHERE   manager_id IN
        (SELECT  manager_id
         FROM    employees
         WHERE   employee_id IN
                (149,174))
AND     department_id IN
        (SELECT  department_id
         FROM    employees
         WHERE   employee_id IN
                (149,174))
AND     employee_id NOT IN(149,174);
```

EMPLOYEE_ID	MANAGER_ID	DEPARTMENT_ID
176	149	80

EXISTS & NOT EXISTS in Subqueries

- EXISTS, and its opposite NOT EXISTS, are two clauses that can be used when testing for matches in subqueries.
- EXISTS tests for a TRUE, or a matching result in the subquery.
- To answer the question: "Which employees are not managers?"
 - You first have to ask, "Who are the managers?"
 - And then ask, "Who does NOT EXIST on the managers list?"

EXISTS & NOT EXISTS in Subqueries

- In this example, the subquery is selecting the employees that are managers.
- The outer query then returns the rows from the employee table that do NOT EXIST in the subquery.

```
SELECT last_name AS "Not a Manager"  
FROM   employees emp  
WHERE  NOT EXISTS  
       (SELECT *  
        FROM employees mgr  
        WHERE mgr.manager_id = emp.employee_id);
```

Not a Manager
Abel
Davies
Ernst
Fay
Gietz
Grant
Lorentz
Matos
Rajs
Taylor
Vargas
Whalen

EXISTS & NOT EXISTS in Subqueries

- If the same query is executed with a NOT IN instead of NOT EXISTS, the result is very different.
- The result of this query suggests there are no employees who are also not managers, so all employees are managers, which we already know is not true.

```
SELECT last_name AS "Not a Manager"  
FROM   employees emp  
WHERE  emp.employee_id NOT IN  
       (SELECT mgr.manager_id  
        FROM employees mgr);
```

no data found

EXISTS & NOT EXISTS in Subqueries

- The cause of the strange result is due to the NULL value returned by the subquery.
- One of the rows in the employees table does not have a manager, and this makes the entire result wrong.
- Subqueries can return three values: TRUE, FALSE, and UNKNOWN.
- A NULL in the subquery result set will return an UNKNOWN, which Oracle cannot evaluate, so it doesn't.

```
SELECT last_name AS "Not a Manager"  
FROM   employees emp  
WHERE  emp.employee_id NOT IN  
       (SELECT mgr.manager_id  
        FROM employees mgr);
```

no data found

EXISTS & NOT EXISTS in Subqueries

- BEWARE of NULLS in subqueries when using IN or NOT IN.
- If you are unsure whether or not a subquery will include a null value, either eliminate the null by using IS NOT NULL in a WHERE clause.
- For example: WHERE emp.manager_id IS NOT NULL or use NOT EXISTS to be safe.

One Last Point About Subqueries

- Some subqueries may return a single row or multiple rows, depending on the data values in the rows.
- If even the slightest possibility exists of returning multiple rows, make sure you write a multiple-row subquery.

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

FIRST_NAME	LAST_NAME	JOB_ID
Bruce	Ernst	IT_PROG
Alexander	Hunold	IT_PROG
Diana	Lorentz	IT_PROG

FIRST_NAME	LAST_NAME	JOB_ID
Bruce	Ernst	IT_PROG

Result of subquery

One Last Point About Subqueries

- For example: Who has the same job_id as Ernst?
- This single-row subquery works correctly because there is only one Ernst in the table.
- But what if later, the business hires a new employee named Susan Ernst?

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

FIRST_NAME	LAST_NAME	JOB_ID
Bruce	Ernst	IT_PROG
Alexander	Hunold	IT_PROG
Diana	Lorentz	IT_PROG

FIRST_NAME	LAST_NAME	JOB_ID
Bruce	Ernst	IT_PROG

Result of subquery

One Last Point About Subqueries

- It would be better to write a multiple-row subquery.
- The multiple-row subquery syntax will still work even if the subquery returns a single row.
- If in doubt, write a multiple-row subquery!

```
SELECT first_name, last_name, job_id
FROM employees
WHERE job_id IN
  (SELECT job_id
   FROM employees
   WHERE last_name = 'Ernst');
```

FIRST_NAME	LAST_NAME	JOB_ID
Bruce	Ernst	IT_PROG
Alexander	Hunold	IT_PROG
Diana	Lorentz	IT_PROG
Susan	Ernst	SA_MAN
Eleni	Zlotkey	SA_MAN

FIRST_NAME	LAST_NAME	JOB_ID
Bruce	Ernst	IT_PROG
Susan	Ernst	SA_MAN

Result of subquery
There are 2 people with last name 'Ernst'

Terminology

Key terms used in this lesson included:

- EXIST and NOT EXIST
- Non-pair-wise multiple column subquery
- Pair-wise multiple column subquery

Summary

In this lesson, you should have learned how to:

- Correctly use the comparison operators IN, ANY, and ALL in multiple-row subqueries
- Construct and execute a multiple-row subquery in the WHERE clause or HAVING clause
- Describe what happens if a multiple-row subquery returns a null value
- Understand when multiple-row subqueries should be used, and when it is safe to use a single-row subquery

Summary

In this lesson, you should have learned how to:

- Distinguish between pair-wise and non-pair-wise subqueries
- Create a query using the EXISTS and NOT EXISTS operators to test for returned rows from the subquery

