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# Database Programming with PL/SQL

## 13-2
## Creating DML Triggers: Part I

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# Objectives

This lesson covers the following objectives:

- Create a DML trigger
- List the DML trigger components
- Create a statement-level trigger
- Describe the trigger firing sequence options

# Purpose

- Suppose you want to keep an automatic record of the history of changes to employees' salaries.
- This is not only important for business reasons, but is a legal requirement in many countries.
- To do this, you create a DML trigger.
- DML triggers are the most common type of trigger in most Oracle databases.
- In this and the next lesson, you learn how to create and use database DML triggers.

# What Is a DML Trigger?

- A DML trigger is a trigger that is automatically fired (executed) whenever an SQL DML statement (INSERT, UPDATE, or DELETE) is executed.
- You classify DML triggers in two ways:
  - By when they execute: BEFORE, AFTER, or INSTEAD OF the triggering DML statement.
  - By how many times they execute: Once for the whole DML statement (a statement trigger), or once for each row affected by the DML statement (a row trigger).

# Creating DML Statement Triggers

The sections of a CREATE TRIGGER statement that need to be considered before creating a trigger:

```
CREATE [OR REPLACE] TRIGGER trigger_name
  timing
  event1 [OR event2 OR event3] ON object_name
trigger_body
```

- timing: When the trigger fires in relation to the triggering event.
- Values are BEFORE, AFTER, or INSTEAD OF.
- event: Which DML operation causes the trigger to fire. Values are INSERT, UPDATE [OF column], and DELETE.

# Creating DML Statement Triggers

```
CREATE [OR REPLACE] TRIGGER trigger_name
  timing
  event1 [OR event2 OR event3] ON object_name
trigger_body
```

- `object_name`: The table or view associated with the trigger.
- `trigger_body`: The action(s) performed by the trigger are defined in an anonymous block.

# Statement Trigger Timing

- When should the trigger fire?
- BEFORE: Execute the trigger body before the triggering DML event on a table.
- AFTER: Execute the trigger body after the triggering DML event on a table.
- INSTEAD OF: Execute the trigger body instead of the triggering DML event on a view.
- Programming requirements will dictate which one will be used.

# Trigger Timings and Events Examples

- The first trigger executes immediately before an employee's salary is updated:

```
CREATE OR REPLACE TRIGGER sal_upd_trigg
BEFORE UPDATE OF salary ON employees
BEGIN ...   END;
```

- The second trigger executes immediately after an employee is deleted:

```
CREATE OR REPLACE TRIGGER emp_del_trigg
AFTER DELETE ON employees
BEGIN ...   END;
```

# Trigger Timings and Events Examples

- You can restrict an UPDATE trigger to updates of a specific column or columns:

```
CREATE OR REPLACE TRIGGER sal_upd_trigg
BEFORE UPDATE OF salary, commission_pct ON employees
BEGIN ...   END;
```

- A trigger can have more than one triggering event:

```
CREATE OR REPLACE TRIGGER emp_del_trigg
AFTER INSERT OR DELETE OR UPDATE ON employees
BEGIN ...   END;
```

# How Often Does a Statement Trigger Fire?

A statement trigger:

- Fires only once for each execution of the triggering statement (even if no rows are affected)
- Is the default type of DML trigger
- Fires once even if no rows are affected
- Useful if the trigger body does not need to process column values from affected rows

```
CREATE OR REPLACE TRIGGER log_emp_changes
AFTER UPDATE ON employees BEGIN
  INSERT INTO log_emp_table (who, when)
    VALUES (USER, SYSDATE);
END;
```

# How Often Does a Statement Trigger Fire?

- Now an UPDATE statement is executed:

```
UPDATE employees SET ... WHERE ...;
```

- How many times does the trigger fire, if the UPDATE statement modifies three rows?
- Ten rows?
- One row?
- No rows?

# And When Does the Statement Trigger Fire?

This slide shows the firing sequence for a statement trigger associated with the event `INSERT INTO departments`:

```
INSERT INTO departments
  (department_id,department_name, location_id)
VALUES (400, 'CONSULTING', 2500);
```

**Triggering action**

| DEPARTMENT_ID | DEPARTMENT_NAME | LOCATION_ID |
|---|---|---|
| 10 | Administration | 1700 |
| 20 | Marketing | 1800 |
| 50 | Shipping | 1500 |
| 400 | CONSULTING | 2500 |

→ **BEFORE statement trigger**

→ **AFTER statement trigger**

# Trigger-Firing Sequence

A statement trigger fires only once even if the triggering DML statement affects many rows:

```
UPDATE employees
  SET salary = salary * 1.1
  WHERE department_id = 50;
```

| EMPLOYEE_ID | LAST_NAME | DEPARTMENT_ID |
|---|---|---|
| 124 | Mourgos | 50 |
| 141 | Rajs | 50 |
| 142 | Davies | 50 |
| 143 | Matos | 50 |

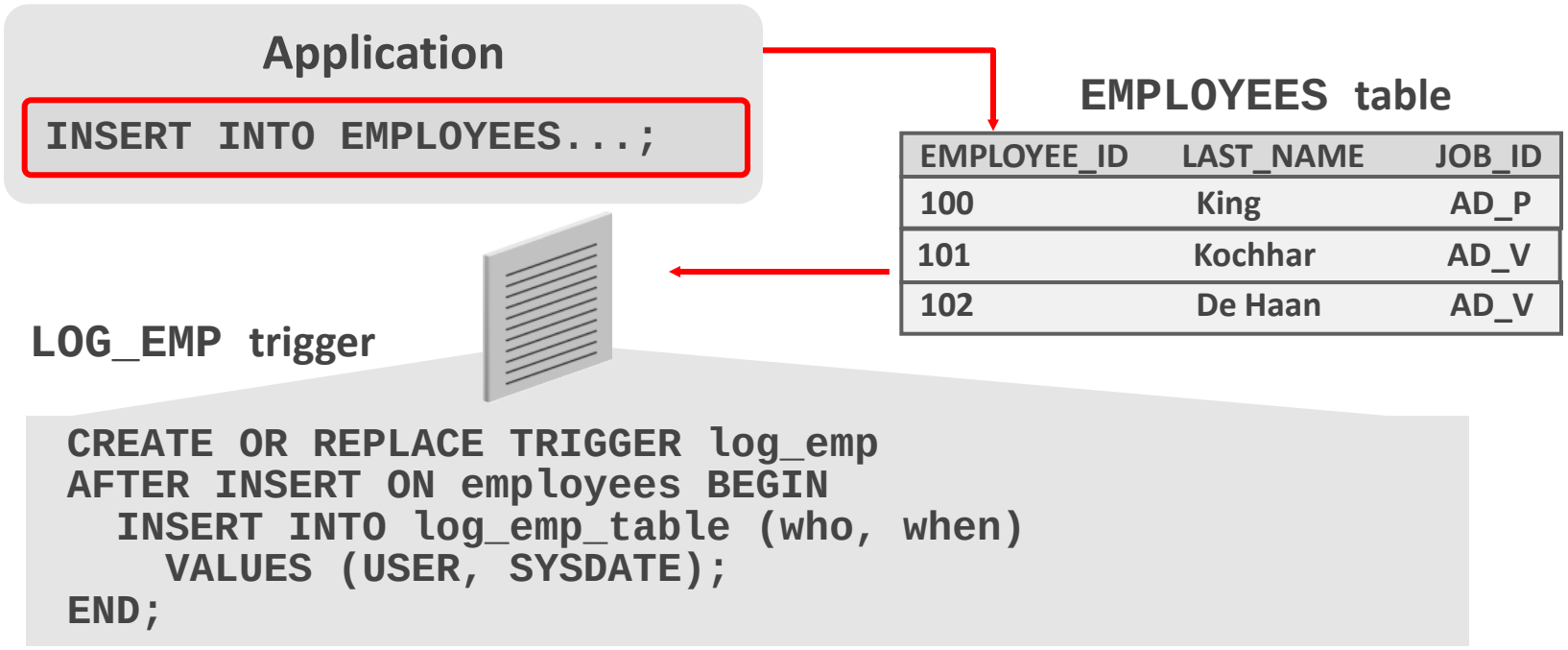
→ **BEFORE statement trigger**

| | | |
|---|---|---|
| 144 | Vargas | 50 |

→ **AFTER statement trigger**

# DML Statement Triggers Example 1

This statement trigger automatically inserts a row into a logging table every time one or more rows are successfully inserted into EMPLOYEES.



# DML Statement Triggers Example 2

This statement trigger automatically inserts a row into a logging table every time a DML operation is successfully executed on the DEPARTMENTS table.

```
CREATE OR REPLACE TRIGGER log_dept_changes
AFTER INSERT OR UPDATE OR DELETE ON DEPARTMENTS
BEGIN
  INSERT INTO log_dept_table (which_user, when_done)
    VALUES (USER, SYSDATE);
END;
```

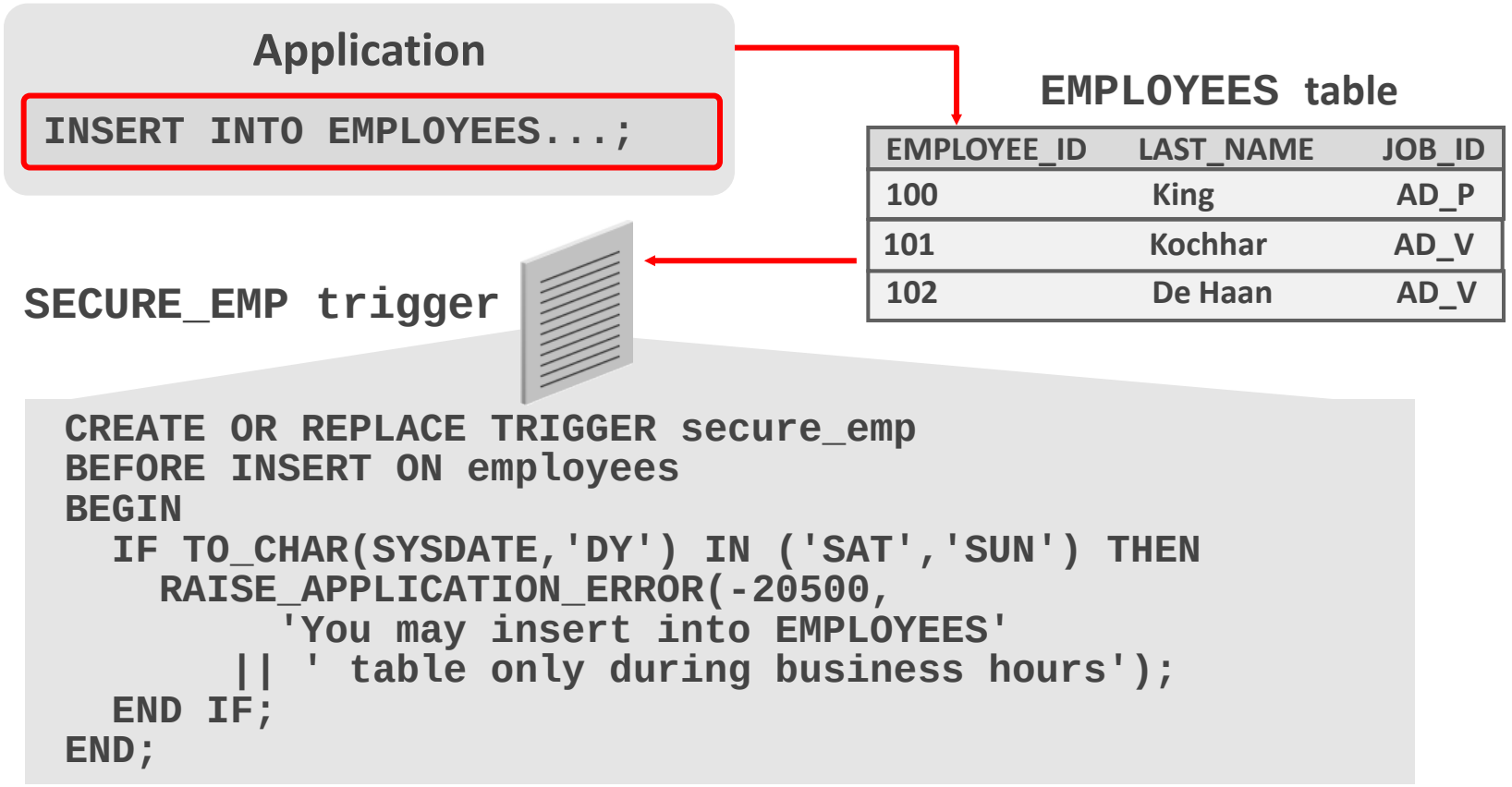
# DML Statement Triggers Example 3

- This example shows how you can use a DML trigger to enforce complex business rules that cannot be enforced by a constraint.
- You want to allow `INSERT`s into the `EMPLOYEES` table during normal working days (Monday through Friday), but prevent `INSERT`s on the weekend (Saturday and Sunday).

# DML Statement Triggers Example

- If a user attempts to insert a row into the EMPLOYEES table during the weekend, then the user sees an error message, the trigger fails, and the triggering statement is rolled back.
- The next slide shows the trigger code needed for this example.

# DML Statement Triggers: Example 3



# Testing SECURE_EMP

A user tries to INSERT a row on the weekend:

```
INSERT INTO employees (employee_id, last_name, first_name,
    email, hire_date, job_id, salary, department_id)
  VALUES (300, 'Smith', 'Rob', 'RSMITH', SYSDATE,'IT_PROG',
    4500, 60);
```

```
ORA-20500:  You may insert into EMPLOYEES table only
    during business hours.
ORA-06512:  at “USVA_TEST_SQL01_T01.SECURE_EMP”, line 4
ORA_04088:  error during execution of trigger
‘USVA_TEST_SQL01_T01.SECURE_EMP’ 2.  VALUES (300,
‘Smith’, ‘Rob’, ‘RSMITH’, SYSDATE, ‘IT_PROG’, 4500, 60);
```

# A Final Example

- This trigger does not compile successfully.
- Why not?

```
CREATE OR REPLACE TRIGGER log_dept_changes
AFTER INSERT OR UPDATE OR DELETE ON DEPARTMENTS
BEGIN
  INSERT INTO log_dept_table (which_user, when_done)
    VALUES (USER, SYSDATE);
  COMMIT;
END;
```

# Terminology

Key terms used in this lesson included:

- DML trigger
- Row trigger
- Statement trigger

# Summary

In this lesson, you should have learned how to:

- Create a DML trigger
- List the DML trigger components
- Create a statement-level trigger
- Describe the trigger firing sequence options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