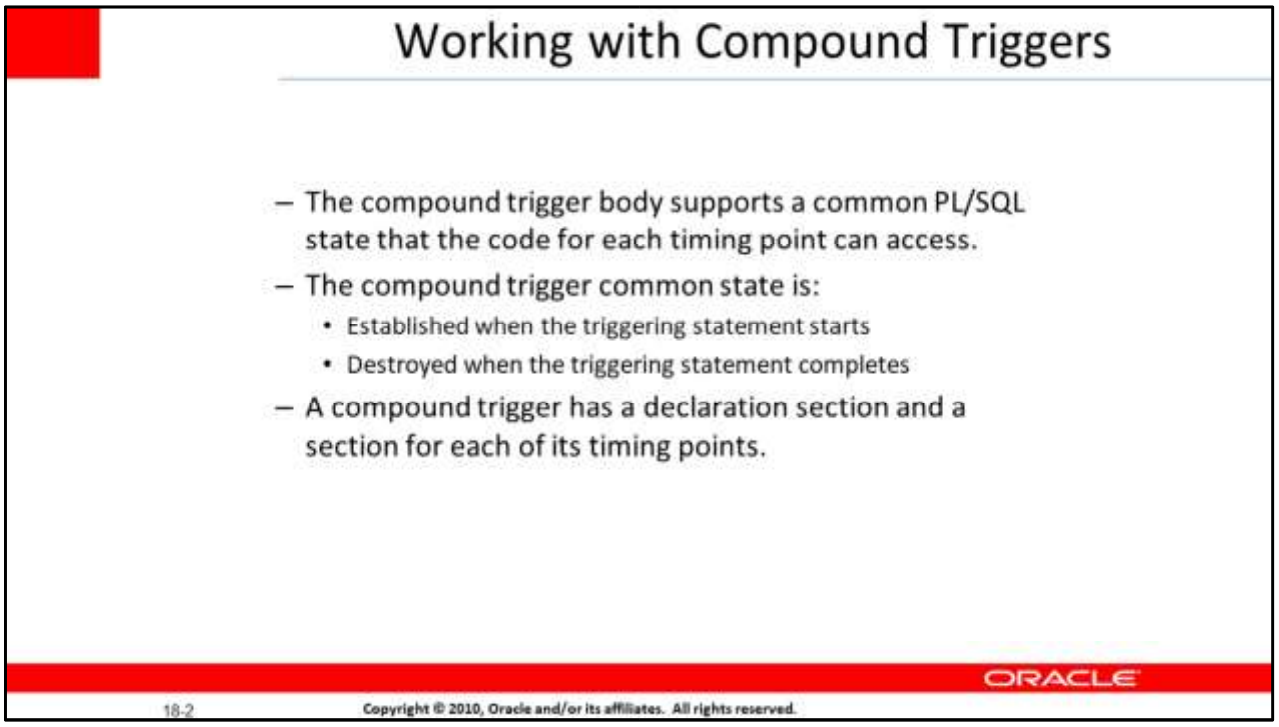


What Is a Compound Trigger?

Starting with Oracle Database 11g, you can use a compound trigger. A compound trigger is a single trigger on a table that allows you to specify actions for each of the four triggering timing points:

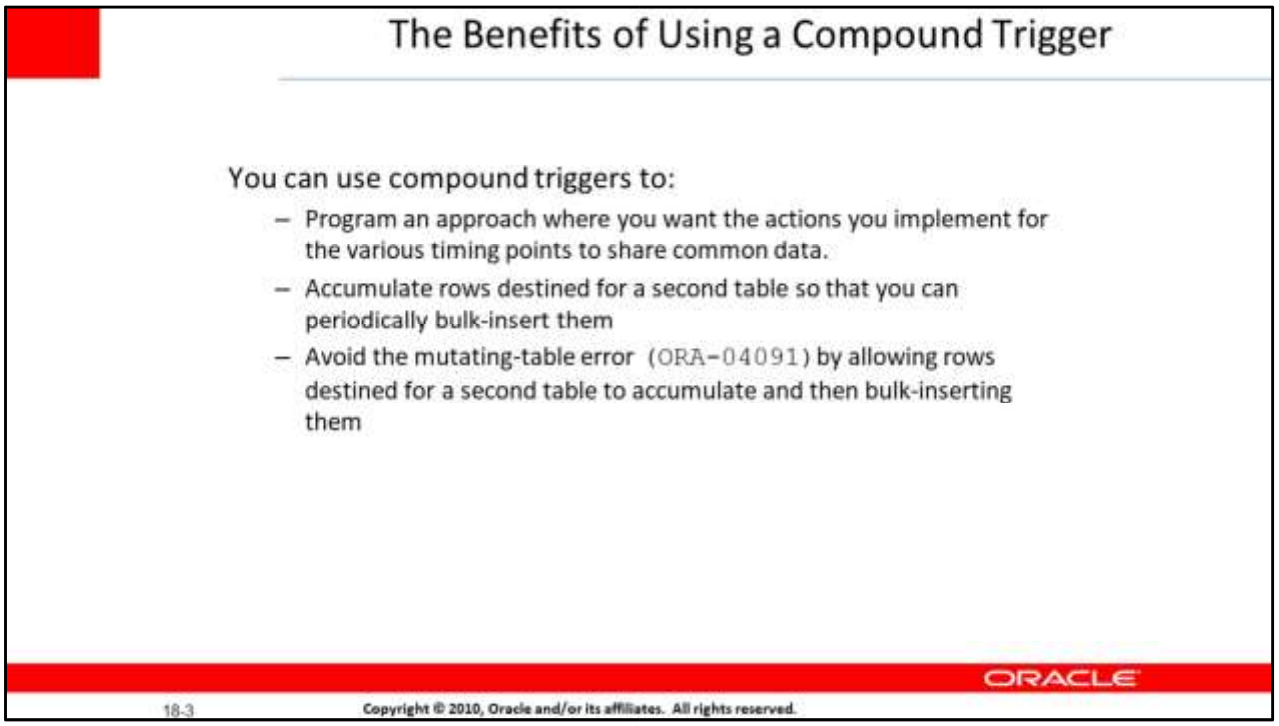
Before the firing statement
Before each row that the firing statement affects
After each row that the firing statement affects
After the firing statement

Note: For additional information about triggers, refer to the Oracle Database PL/SQL Language Reference 11g Release 2 (11.2).

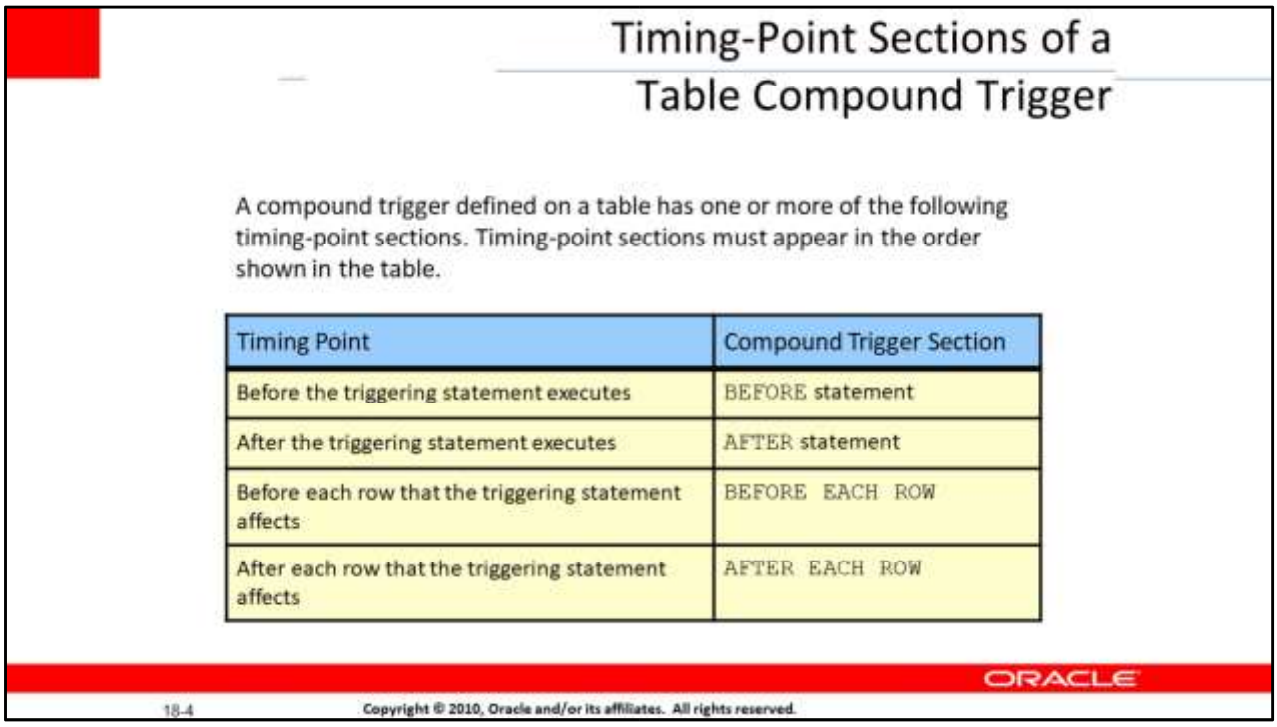
Working with Compound Triggers

The compound trigger body supports a common PL/SQL state that the code for each timing point can access. The common state is automatically destroyed when the firing statement completes, even when the firing statement causes an error. Your applications can avoid the mutating table error by allowing rows destined for a second table (such as a history table or an audit table) to accumulate and then bulk-inserting them.

Before Oracle Database 11g Release 1 (11.1), you needed to model the common state with an ancillary package. This approach was both cumbersome to

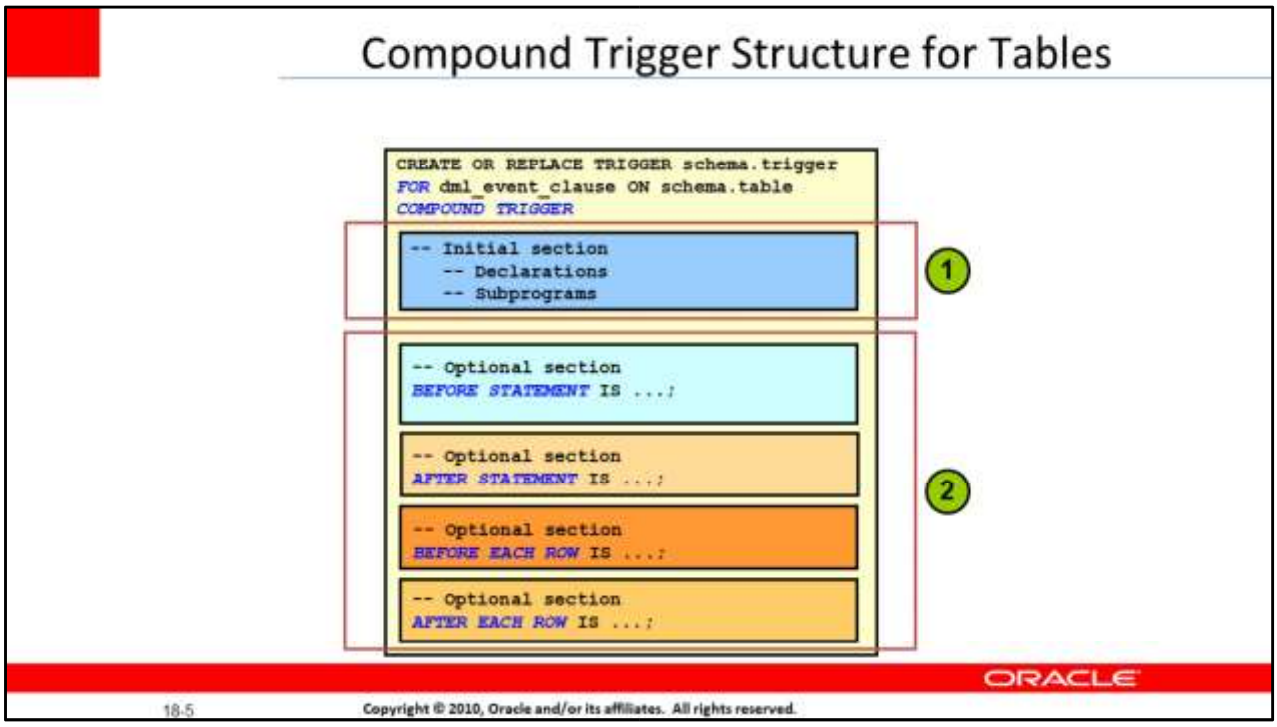


program and subject to memory leak when the firing statement caused an error and the after-statement trigger did not fire. Compound triggers make PL/SQL easier for you to use and improve run-time performance and scalability.



Note

Timing-point sections must appear in the order shown in the slide. If a timingpoint section is absent, nothing happens at its timing point.



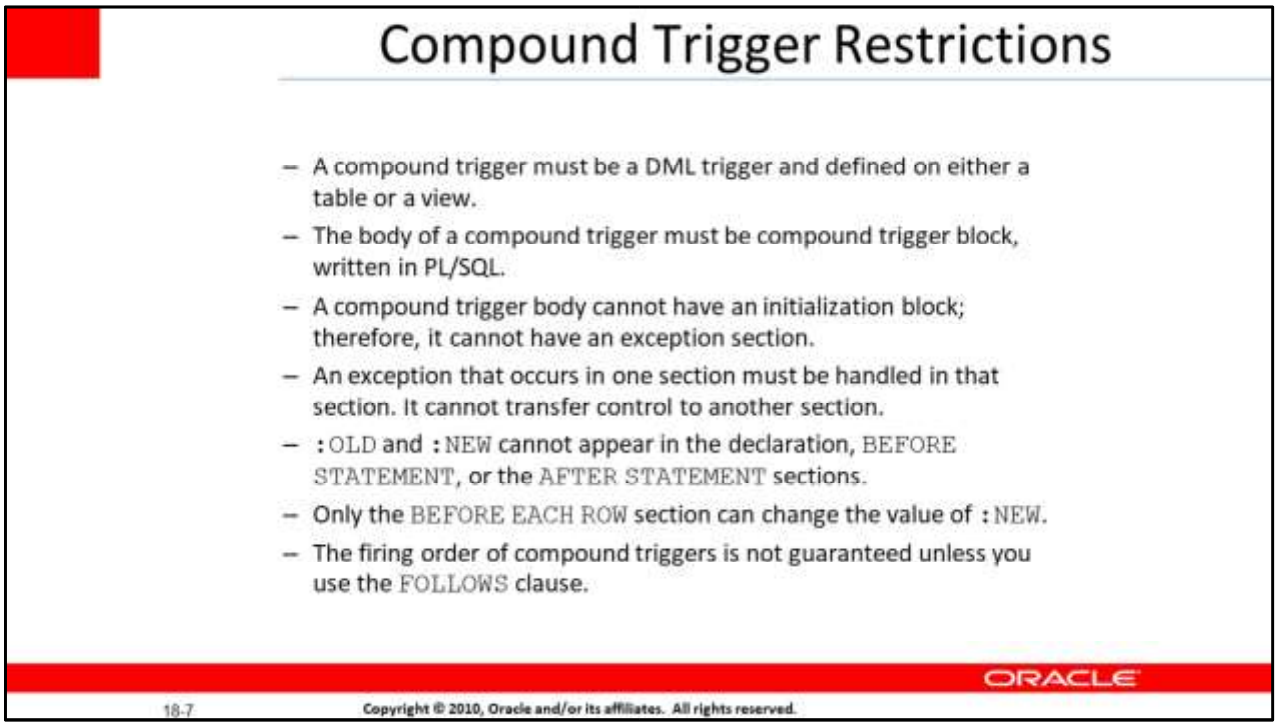
Compound Trigger Structure for Tables

A compound trigger has two main sections:

An initial section where variables and subprograms are declared. The code in this section executes before any of the code in the optional section.

An optional section that defines the code for each possible trigger point. Depending on whether you are defining a compound trigger for a table or for a view, these triggering points are different and are listed in the image shown above and on the following page. The code for the triggering points must follow the order shown above.

Note: For additional information about Compound Triggers, refer to Oracle Database PL/SQL Language Reference 11g Release 2 (11.2).



Compound Trigger Structure for Views

With views, the only allowed section is an INSTEAD OF EACH ROW clause.

Compound Trigger Restrictions

The following are some of the restrictions when working with compound triggers:

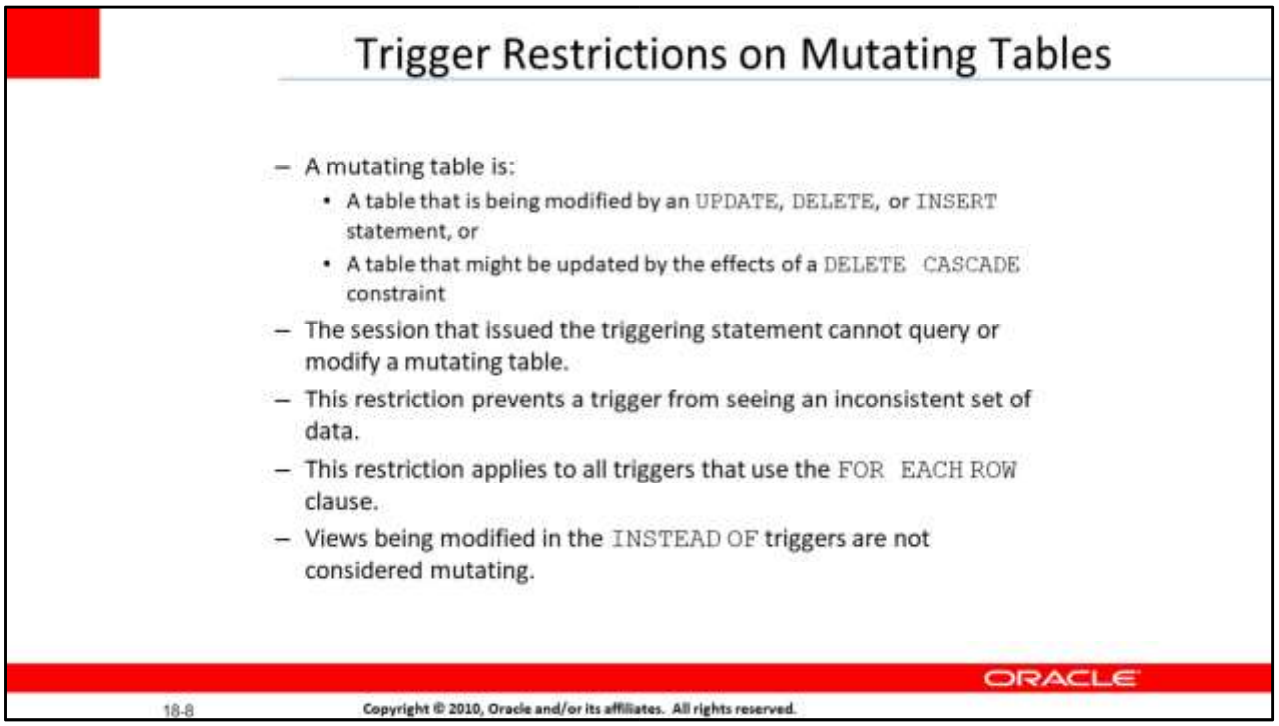
The body of a compound trigger must compound trigger block, written in PL/SQL.

A compound trigger must be a DML trigger.

A compound trigger must be defined on either a table or a view. A compound trigger body cannot have an initialization block;
therefore, it cannot have an exception section. This is not a problem, because the BEFORE STATEMENT section always executes exactly once before any other timing-point section executes.

An exception that occurs in one section must be handled in that section. It cannot transfer control to another section.

•:OLD, :NEW, and :PARENT cannot appear in the declaration section, the BEFORESTATEMENT section, or the AFTERSTATEMENT section.



The firing order of compound triggers is not guaranteed unless you use the FOLLOWS clause.

Rules Governing Triggers

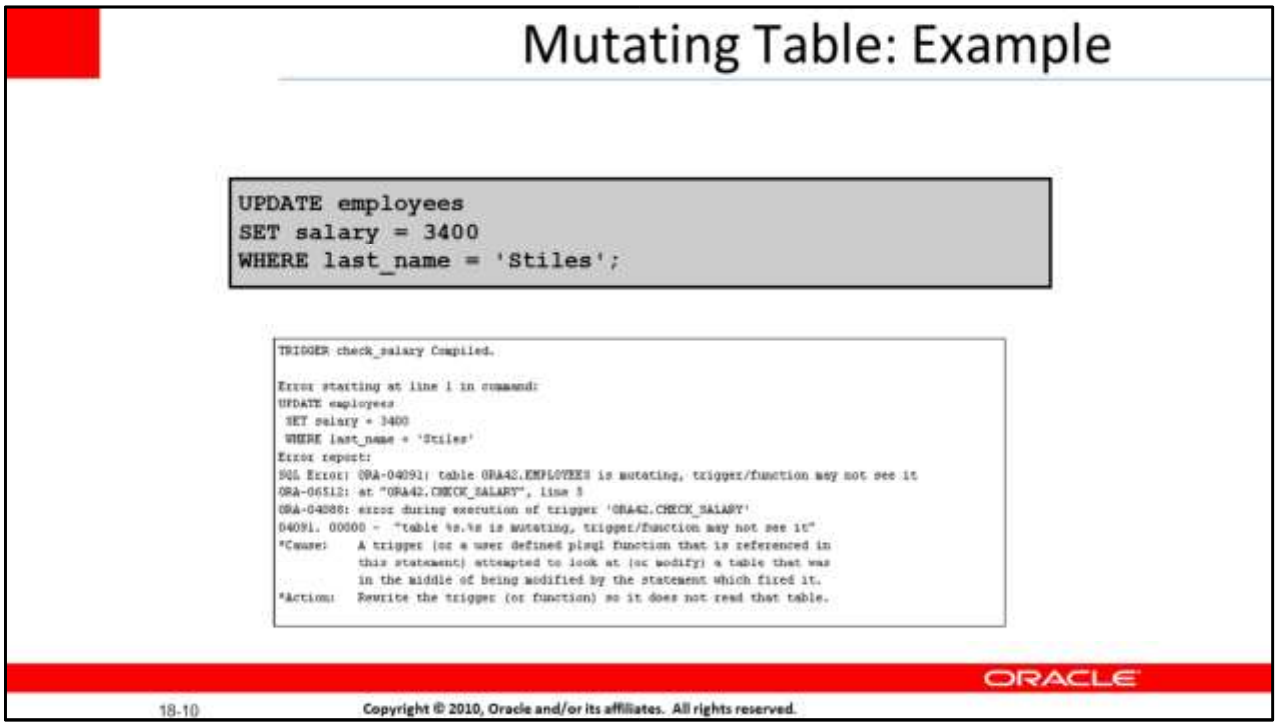
Reading and writing data using triggers is subject to certain rules. The restrictions apply only to row triggers, unless a statement trigger is fired as a result of ONDELETECASCADE.

Mutating Table

A mutating table is a table that is currently being modified by an UPDATE, DELETE, or INSERT statement, or a table that might need to be updated by the effects of a declarative DELETECASCADE referential integrity action. For STATEMENT triggers, a table is not considered a mutating table.

A mutating table error (ORA-4091) occurs when a row-level trigger attempts to change or examine a table that is already undergoing change via a DML statement.

The triggered table itself is a mutating table, as well as any table referencing it with the FOREIGNKEY constraint. This restriction prevents a row trigger from seeing an inconsistent set of data.



Mutating Table: Example

The CHECK_SALARY trigger in the slide example attempts to guarantee that whenever a new employee is added to the EMPLOYEES table or whenever an existing employee's salary or job ID is changed, the employee's salary falls within the established salary range for the employee's job.

When an employee record is updated, the CHECK_SALARY trigger is fired for each row that is updated. The trigger code queries the same table that is being updated. Therefore, it is said that the EMPLOYEES table is a mutating table.

Mutating Table: Example (continued)

In the example in the slide, the trigger code tries to read or select data from a mutating table.

If you restrict the salary within a range between the minimum existing value and the maximum existing value, then you get a run-time error. The EMPLOYEES table is mutating, or in a state of change; therefore, the trigger cannot read from it.

Remember that functions can also cause a mutating table error when they are invoked in a DML statement.

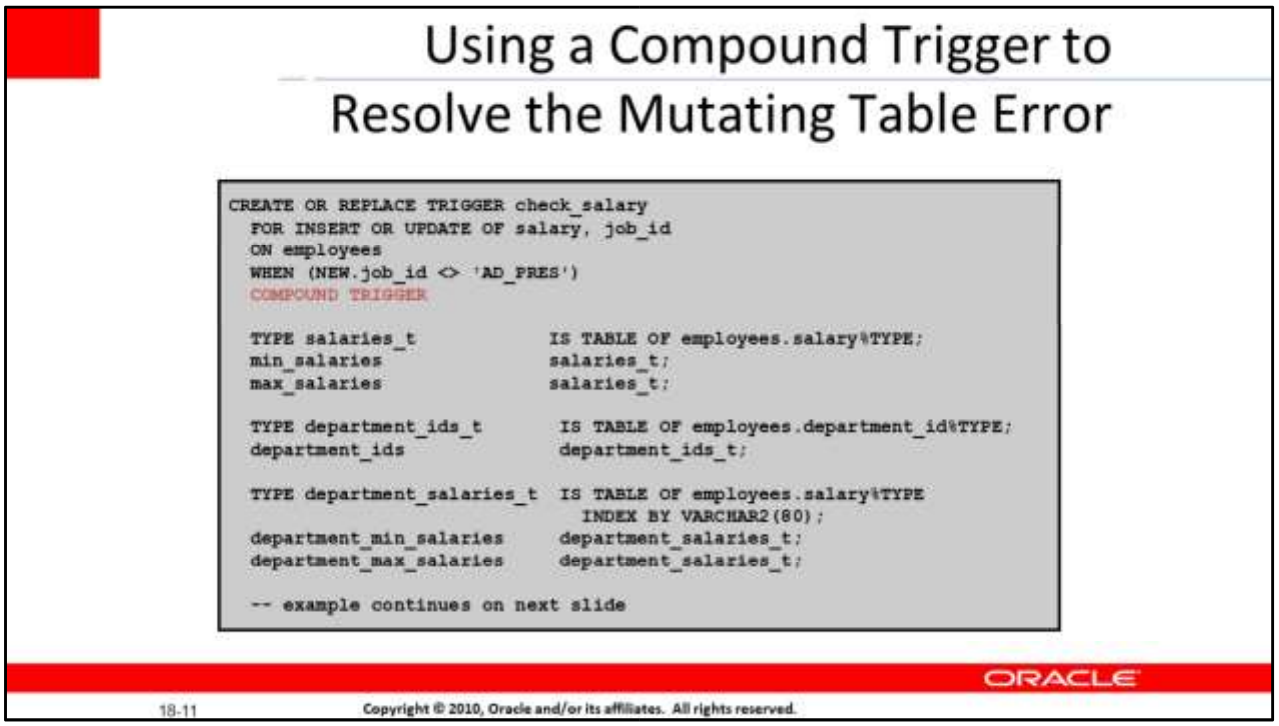
Possible Solutions

Possible solutions to this mutating table problem include the following:

Use a compound trigger as described earlier in this lesson. Store the summary data (the minimum salaries and the maximum salaries) in another summary table, which is kept up-to-date with other DML triggers.

Store the summary data in a PL/SQL package, and access the data from the package. This can be done in a BEFORE statement trigger. Depending on the nature of the problem, a solution can become more convoluted and difficult to solve. In this case, consider implementing the rules

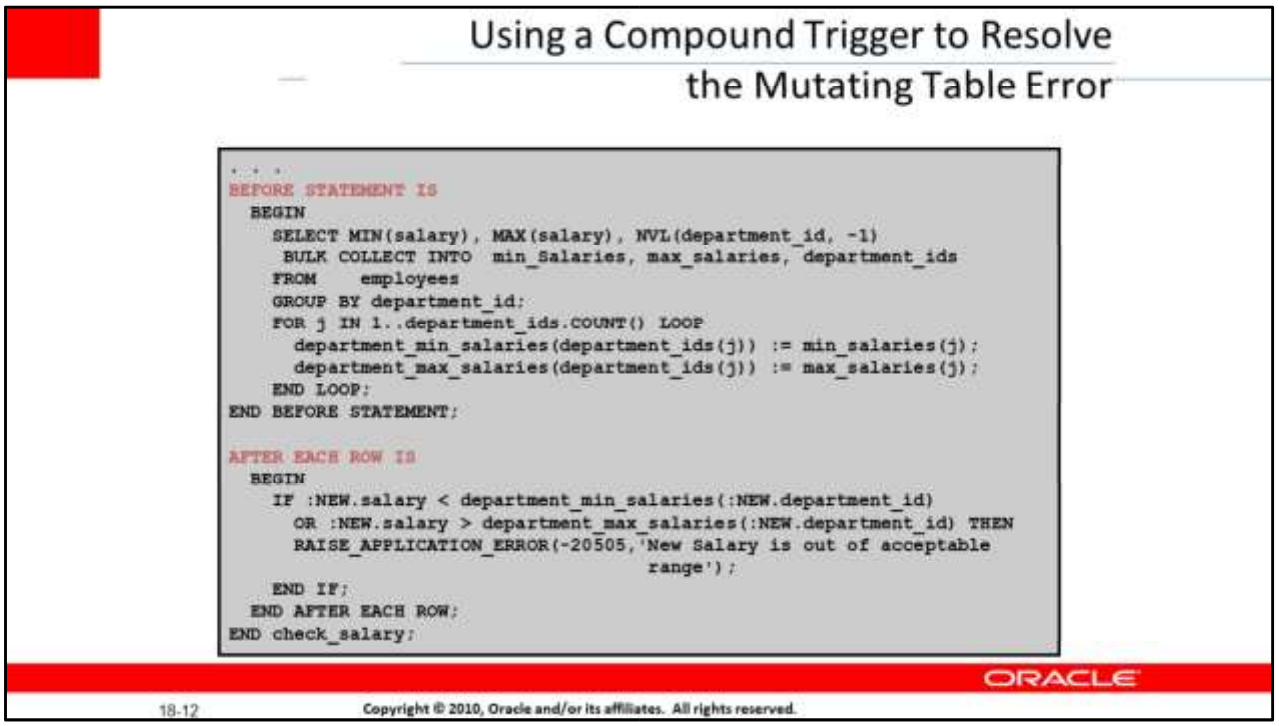
in the application or middle tier and avoid using database triggers to perform overly complex business rules. An insert statement in the code example in the slide will not generate a mutating table example.



Using a Compound Trigger to Resolve the Mutating Table Error

The CHECK_SALARY compound trigger resolves the mutating table error in the earlier example. This is achieved by storing the values in PL/SQL collections, and then performing a bulk insert/update in the "before statement" section of the compound trigger. This is a 11g only code. In the example in the slide, PL/SQL collections are used. The element types used are based on the SALARY and DEPARTMENT_ID columns from the EMPLOYEES table. To create collections, you define a collection type, and then declare variables of that type. Collections are instantiated when you enter a block or subprogram, and cease to exist when you exit. min_salaries is used to hold the minimum salary for each department and max_salaries is used to hold the maximum salary for each department. department_ids is used to hold the department IDs. If the employee who earns the minimum or maximum salary does not have an assigned department, you use the NVL function to store –1 for the department id instead of NULL. Next, you collect the minimum salary, maximum salary, and the department ID using a bulk insert into the min_salaries, max_salaries, and department_ids respectively grouped by department ID. The select statement returns 13 rows. The values of the department_ids are used as an index for the

department_min_salaries and department_max_salaries tables. Therefore, the index for those two tables (VARCHAR2) represents the actual department_ids.



Using a Compound Trigger to Resolve the Mutating Table Error (continued) After each row is added, if the new salary is less than the minimum salary for that department or greater than the department's maximum salary, then an error message is displayed.

To test the newly created compound trigger, issue the following statement:

```
UPDATE employees
SET salary = 3400
WHERE last_name = 'Stiles';
```

```
1 rows updated
```

To ensure that the salary for employee Stiles was updated, issue the following

	EMPLOYEE_ID	FIRST_NAME	LAST_NAME	JOB_ID	DEPARTMENT_ID	SALARY
1	138	Stephen	Stiles	ST_CLERK	50	3400

query using the F9 key in SQL Developer:

```
SELECT employee_id, first_name, last_name, job_id,
    department_id,                                  salary
FROM employees
WHERE last_name = 'Stiles';
```