



Tuple-Based Checks

Separate element of table declaration.

- Form: like attribute-based check.
- But condition can refer to any attribute of the relation.
 - Or to other relations/attributes in subqueries.
 - Again: Oracle forbids the use of subqueries.
- Checked whenever a tuple is inserted or updated.

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Example

Only graduate students can take 600 level courses

```
CREATE TABLE student (
  level CHAR(2),
  dept CHAR(4),
  coursenum CHAR(20),
  CHECK(level = 'GS' or coursenum <
  60000)
);</pre>
```

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SQL Assertions

- · Database-schema constraint.
- Not present in Oracle.
- Checked whenever a mentioned relation changes.
- Syntax:

```
CREATE ASSERTION < name>
CHECK (<condition>);
```

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Triggers

- A **trigger** is a statement that is executed automatically by the system as a side effect of a modification to the database.
- To design a trigger mechanism, we must:
 - Specify the conditions under which the trigger is to be executed.
 - Specify the actions to be taken when the trigger executes.
- Triggers introduced to SQL standard in SQL:1999, but supported even earlier using non-standard syntax by most
 - Syntax illustrated here may not work exactly on your database system; check the system manuals

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Triggering Events and Actions in SQL

- Triggering event can be insert, delete or update
- Triggers on update can be restricted to specific attributes
 - For example, after update of takes on grade
- Values of attributes before and after an update can be referenced
 - referencing old row as : for deletes and updates
 - referencing new row as : for inserts and updates
- Triggers can be activated before an event, which can serve as extra constraints. For example, convert blank grades to null.

create trigger setnull_trigger before update of takes referencing new row as nrow for each row when (nrow.grade = ' ') begin atomič set nrow.grade = null; end:

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Trigger to Maintain credits_earned value

create trigger credits_earned after update of takes on (grade)
referencing new row as nrow
referencing old row as orow
for each row
when nrow.grade <> 'F' and nrow.grade is not null
and (orow.grade = 'F' or orow.grade is null)
begin atomic
update student
set tot_cred= tot_cred +
 (select credits
 from course
 where course.course_id= nrow.course_id)
where student.id = nrow.id;
end;

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Statement Level Triggers

- Instead of executing a separate action for each affected row, a single action can be executed for all rows affected by a transaction
 - Use for each statement instead of for each row
 - Use referencing old table or referencing new table to refer to temporary tables (called transition tables) containing the affected rows
 - Can be more efficient when dealing with SQL statements that update a large number of rows

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Triggers (Oracle Version)

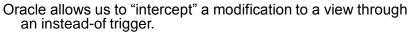
Often called event-condition-action rules.

- Event = a class of changes in the DB, e.g., "insertions into Beers."
- Condition = a test as in a where-clause for whether or not the trigger applies.
- Action = one or more SQL statements.
- Differ from checks or SQL assertions in that:
 - 1. Triggers invoked by the event; the system doesn't have to figure out when a trigger could be violated.
 - Condition not available in checks.

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Modification to Views Via **Triggers**



Example

```
Likes(drinker, beer)
Sells (bar, beer, price)
Frequents (drinker, bar)
```

CREATE VIEW Synergy AS SELECT Likes.drinker, Likes.beer, Sells.bar FROM Likes, Sells, Frequents WHERE Likes.drinker = Frequents.drinker AND Likes.beer = Sells.beer AND Sells.bar = Frequents.bar;

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```
of the same
```

```
CREATE TRIGGER ViewTrig
INSTEAD OF INSERT ON Synergy
FOR EACH ROW
BEGIN
INSERT INTO Likes VALUES(
:new.drinker, :new.beer);
INSERT INTO Sells(bar, beer)
VALUES(:new.bar, :new.beer);
INSERT INTO Frequents VALUES(
:new.drinker, :new.bar);
END;
.
run
```

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Options

- 1. Can omit OR REPLACE. But if you do, it is an error if a trigger of this name exists.
- AFTER can be BEFORE.
- 3. If the relation is a view, AFTER can be INSTEAD OF.
 - Useful for allowing "modifications" to a view; you modify the underlying relations instead.
- 4. INSERT can be DELETE or UPDATE OF <attribute>.
 - Also, several conditions like INSERT ON Sells can be connected by OR.
- 5. FOR EACH ROW can be omitted, with an important effect: the action is done once for the relation(s) consisting of all changes.

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Notes

- There are two special variables new and old, representing the new and old tuple in the change.
 - old makes no sense in an insert, and new makes no sense in a delete.
- Notice: in WHEN we use new and old without a colon, but in actions, a preceding colon is needed.
- The action is a PL/SQL statement.
 - Simplest form: surround one or more SQL statements with BEGIN and END.
 - However, select-from-where has a limited form.

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Example

Maintain a list of all the bars that raise their price for some beer by more than \$1.

```
Sells(<u>bar</u>, <u>beer</u>, price)
RipoffBars(bar)
CREATE TRIGGER PriceTrig
AFTER UPDATE OF price ON Sells
FOR EACH ROW
WHEN (new.price > old.price + 1.00)
         INSERT INTO RipoffBars
        VALUES(:new.bar);
   END;
run
```

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- Triggers are part of the database schema, like tables or views.
- Important Oracle constraint: the action cannot change the relation that triggers the action.
 - Worse, the action cannot even change a relation connected to the triggering relation by a constraint, e.g., a foreign-key constraint.

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When Not To Use Triggers

- Triggers were used earlier for tasks such as
 - Maintaining summary data (e.g., total salary of each department)
 - Replicating databases by recording changes to special relations (called **change** or **delta** relations) and having a separate process that applies the changes over to a replica
- There are better ways of doing these now:
 - Databases today provide built in materialized view facilities to maintain summary data
 - Databases provide built-in support for replication
- Encapsulation facilities can be used instead of triggers in many
 - Define methods to update fields
 - Carry out actions as part of the update methods instead of through a trigger

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When Not To Use Triggers (Cont.)

- Risk of unintended execution of triggers, for example, when
 - Loading data from a backup copy
 - Replicating updates at a remote site
 - Trigger execution can be disabled before such actions.
- Other risks with triggers:
 - Error leading to failure of critical transactions that set off the trigger
 - Cascading execution

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