CIS 363 MySQL

Chapter 19 Database Triggers
Ch. 19 Triggers

- A trigger is a database object that is associated with a table and that is defined to activate when a particular kind of event occurs for that table.
- A trigger provides a means to execute an SQL statement or set of statements when you insert, update or delete rows in a table.
- Triggers provide the following benefits:
  - A trigger can examine row values to be inserted or updated, and it can determine what values were deleted or what they were updated to.
  - A trigger can change values before they are inserted into a table or used to update a table.
  - A trigger can help to modify how INSERT, DELETE, or UPDATE work.
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Trigger Concepts

- A trigger is an object that belongs to a database. Each trigger within the database must have a different name.
- A trigger is defined to activate when a particular kind of event occurs for a given table. The events for which trigger can be defined are INSERT, DELETE, and UPDATE. A given trigger is defined for only one of these events, but you can define multiple triggers for a table, **one trigger per type of event.**
- Triggers can be defined to activate either **BEFORE** or **after** the event. This means there can be two triggers per event. (There are 6 triggers max. for a table.)
- Triggers may be used to supplement integrity constraints, enforce complex business rules, or to audit changes to the database. Triggers should be used to enforce rules that CANNOT be enforced through referential integrity.
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Valid Trigger Types:
BEFORE INSERT row
AFTER INSERT row
BEFORE UPDATE row
AFTER UPDATE row
BEFORE DELETE row
AFTER DELETE row

ORDER OF TRIGGER FIRING:
Before Row
Execute of SQL Statement.
After Row
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Trigger Syntax

```
mysql> CREATE TRIGGER trigger_name
    {BEFORE|AFTER} {INSERT|DELETE|UPDATE}
    ON table_name
    FOR EACH ROW
    BEGIN
    Statements;
    End;
```

- The triggered statement must be a single statement, but if necessary you can use a BEGIN/END compound statement to create a block and include multiple statements within the block. Each statement must be terminated by semicolon character (‘;’) within the block.
- If you are using the mysql client to create such a trigger, you must redefine the statement delimiter.
Example:

mysql> CREATE TABLE debit_balance_report (action_dt TIMESTAMP, customer_number INT);

/* debit_balance: retrieve customer balance.
   @author: rtimlin
   @original: 06-Mar-2001
   @updated:
Table:
   @version: 1.0
   **** Modification History ****
   Date   User    Description
===================================================
3/6/01  rtimlin  Original.
3/8/01  flast    Added Exception handler.
*/
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mysql> DELIMITER //

mysql> CREATE TRIGGER debit_balance
    BEFORE UPDATE ON customer
    FOR EACH ROW
    BEGIN
    IF (new.balance > new.credit_limit)
    THEN INSERT INTO debit_balance_report (action_dt, customer_number)
       VALUES (SYSDATE(), new.customer_number);
    END IF;
    END IF;
    END; //

mysql> DELIMITER ;
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Using a trigger to stop an invalid transaction:

- Your business rule on the above may be that we will allow over credit limit amounts to 110% of credit limit, but not higher. In order to stop the SQL statement that caused the trigger in the first place, the trigger must SIGNAL and exception. The SQL 2003 standard defines a procedure called SIGNAL to do just this. Oracle uses a command called RAISE_APPLICATION_ERROR.

- Unfortunately the current version of MySQL does not yet support SIGNAL, version 5.2 is set to start this support. It is possible to write our own SIGNAL procedure, but it is sort of a hack job.
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-- This version also doesn't work in MySQL 5.1

mysql> DELIMITER $$

mysql> DROP PROCEDURE IF EXISTS `test`.`my_signal` $$
CREATE DEFINER=`root`@`localhost` PROCEDURE `my_signal`(in_errorText VARCHAR(255))
BEGIN
SET @sql=CONCAT('UPDATE `', in_errorText, '` SET x=1');
PREPARE my_signal_stmt FROM @sql;
EXECUTE my_signal_stmt;
DEALLOCATE PREPARE my_signal_stmt;
END $$

mysql> DELIMITER ;
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-- This version will work in MySQL 5.1

```sql
mysql> DELIMITER //
mysql> CREATE DEFINER=`root`@`localhost` PROCEDURE `my_signal`(in_errorText VARCHAR(255))
BEGIN
    update junk set nothing = in_errortext;
END//
mysql> DELIMITER //
mysql> CREATE TRIGGER debit_balance
BEFORE UPDATE ON customer
FOR EACH ROW
BEGIN
    IF (new.balance > new.credit_limit) THEN INSERT INTO debit_balance_report (action_dt, customer_number) VALUES (SYSDATE(), new.customer_number);
    -- If the Amount over the credit limit is greater than 10%, Then Raise an Exception
    IF ((new.balance - new.credit_limit)/new.credit_limit > .1) THEN
        CALL my_signal ('Over Credit Limit Amount is TOO High');
        END IF;
    END IF;
END; //
```

mysql> DELIMITER ;
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- All your MySQL functions, procedures and triggers must have an exception handler or you will receive one full letter grade deduction and your work will be returned to be fixed.
- Note the indentation above, failure to indent for readability will result in one full letter grade deduction and your work being returned to you to fix. Also I will not help you with any program that is NOT readable.
- All your MySQL functions, procedures and triggers must have comments similar to the above or you will receive one full letter grade deduction and your work will be returned to be fixed.

- The RAISE_APPLICATION_ERROR procedure takes two input parameters: The error number (which must be between -20001 and -20999) and the error message to be displayed.

SQL> UPDATE customer SET balance = 1101 WHERE customer_number = 124;

SQL> select trigger_name, table_name from user_triggers; -- Information on triggers;
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An example for OLD and New Column Values  (p.310)

mysql> delimiter //

mysql> CREATE TRIGGER Capital_bu
       BEFORE UPDATE
       ON Capital
       FOR EACH ROW
       BEGIN
           SET @country = OLD.Country;
           SET @capital_old = OLD.Capital;
           SET @capital_new = NEW.Capital;
       End; //

mysql> delimiter ;
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Referring to OLD and NEW column Values

Within a trigger definition, you can refer to columns of the row being inserted, updated, or deleted. This enables you to examine column values, or to change values before they are used for an insert or update.

To refer to a given column, prefix the column name with a qualifier of OLD to refer to a value from the original row or NEW to refer to a value in the new row. OLD and NEW must be used appropriately, because the triggering event determines which of them are allowable:

- In an INSERT trigger, NEW.col_name indicates a column value to be inserted into a new row. OLD is not allowable.
- In a DELETE trigger, OLD.col_name indicates the value of a column in a row to be deleted. NEW is not allowable.
- In an UPDATE trigger, OLD.col_name and NEW.col_name refer to the value of the column in a row before and after the row is updated, respectively.

OLD must be used in read-only fashion. NEW can be used to read or change column values.
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Restrictions on Triggers

The current trigger implementation in MySQL has become limitations:

- You can NOT use the CALL statement
- You can NOT begin or end transactions
- You can NOT create a trigger for a TEMPORARY table or a view.
- Trigger creation is subject to the same restrictions placed on stored routine creation.
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Using a TRIGGER to log changes

mysql> DELIMITER $$

mysql> CREATE TRIGGER tg_update_customer
    AFTER UPDATE ON customer
    FOR EACH ROW
    BEGIN
    INSERT INTO customer_history (customer_number, lname, fname, street, city, state, zip_code, credit_limit, balance, user_name, action, stamp) VALUES
    (OLD.customer_number, OLD.lname, OLD.fname, OLD.street, OLD.city, OLD.state, OLD.zip_code, OLD.credit_limit, OLD.balance, CURRENT_USER, 'UPDATE', SYSDATE());
    END; $$

mysql> DELIMITER ;
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```sql
mysql> select * from customer_history;
Empty set (0.00 sec)

mysql> update customer set balance = 1750 where customer_number=5;
ERROR 1336 (0A000): Dynamic SQL is not allowed in stored function or trigger

mysql> select * from customer_history;
Empty set (0.00 sec)

mysql> update customer set balance = 1501 where customer_number=5;
Query OK, 1 row affected (0.05 sec) Rows matched: 1 Changed: 1 Warnings: 0

mysql> select * from customer_history;
```

<table>
<thead>
<tr>
<th>customer_number</th>
<th>lname</th>
<th>fname</th>
<th>street</th>
<th>city</th>
<th>state</th>
<th>zip_code</th>
<th>balance</th>
<th>credit_limit</th>
<th>slsrep_number</th>
<th>last_update</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test</td>
<td>Bob</td>
<td>123 Bankrupt</td>
<td>Las Vegas</td>
<td>NV</td>
<td>59321</td>
<td>0.00</td>
<td>1500.00</td>
<td>NULL</td>
<td>2008-04-01</td>
</tr>
</tbody>
</table>

1 row in set (0.00 sec)
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mysql> select * from customer;

<table>
<thead>
<tr>
<th>customer_number</th>
<th>lname</th>
<th>fname</th>
<th>street</th>
<th>city</th>
<th>state</th>
<th>zip_code</th>
<th>balance</th>
<th>credit_limit</th>
<th>slsrep_number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adams</td>
<td>John</td>
<td>123 Main</td>
<td>Alameda</td>
<td>CA</td>
<td>94501</td>
<td>1001.00</td>
<td>1000.00</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Bentson</td>
<td>Lloyd</td>
<td>12 Main</td>
<td>Reno</td>
<td>NV</td>
<td>54321</td>
<td>750.00</td>
<td>1500.00</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Tiger</td>
<td>Scott</td>
<td>1 Oracle Way</td>
<td>Redwood Shores</td>
<td>CA</td>
<td>94123</td>
<td>750.00</td>
<td>1500.00</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Wilde</td>
<td>Paul</td>
<td>3 Market</td>
<td>San Francisco</td>
<td>CA</td>
<td>94103</td>
<td>750.00</td>
<td>7000.00</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Test</td>
<td>Bob</td>
<td>123 Bankrupt</td>
<td>Las Vegas</td>
<td>NV</td>
<td>54321</td>
<td>1501.00</td>
<td>1500.00</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Test</td>
<td>John</td>
<td>123 Bankrupt</td>
<td>Las Vegas</td>
<td>NV</td>
<td>54321</td>
<td>1500.00</td>
<td>1500.00</td>
<td>12</td>
</tr>
</tbody>
</table>

mysql> select * from debit_balance_report;

<table>
<thead>
<tr>
<th>action_dt</th>
<th>customer_number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-03-26 09:39:46</td>
<td>1</td>
</tr>
<tr>
<td>2008-03-30 15:46:17</td>
<td>1</td>
</tr>
<tr>
<td>2008-03-30 16:10:24</td>
<td>3</td>
</tr>
<tr>
<td>2008-04-02 12:22:45</td>
<td>5</td>
</tr>
<tr>
<td>2008-04-02 12:30:46</td>
<td>5</td>
</tr>
<tr>
<td>2008-04-02 12:32:56</td>
<td>5</td>
</tr>
<tr>
<td>2008-04-02 12:34:36</td>
<td>5</td>
</tr>
<tr>
<td>2008-04-02 12:34:50</td>
<td>5</td>
</tr>
<tr>
<td>2008-04-02 12:45:00</td>
<td>5</td>
</tr>
<tr>
<td>2008-04-02 12:45:24</td>
<td>5</td>
</tr>
</tbody>
</table>
What about modifying the current table? Say I want to store the username in the current table as well.

```sql
mysql> ALTER TABLE customer ADD (user_name VARCHAR(50));
mysql> CREATE TRIGGER tg_update_customer
    AFTER UPDATE ON customer
    FOR EACH ROW
    BEGIN
        INSERT INTO customer_history (customer_number, lname, fname, street,
        city, state, zip_code, credit_limit, balance, user_name, action) VALUES
        (OLD.customer_number, OLD.lname, OLD.fname, OLD.street, OLD.city,
        OLD.state, OLD.zip_code, OLD.credit_limit, OLD.balance, CURRENT_USER,
        'UPDATE');
        SET NEW.user_name = CURRENT_USER;
    END; $$
```

ERROR 1362 (HY000): Updating of NEW row is not allowed in after trigger
You can only change the NEW image of the record in a BEFORE trigger NOT and AFTER trigger. The reason being AFTER executes after the SQL statement completes and then it is too late to change the NEW image.

```sql
mysql> CREATE TRIGGER tg_update_customer
    -> BEFORE UPDATE ON customer
    -> FOR EACH ROW
    -> BEGIN
    ->    INSERT INTO customer_history (customer_number, lname, fname, street, city, state, zip_code, credit_limit, balance, user_name, action) VALUES
    ->        (OLD.customer_number, OLD.lname, OLD.fname, OLD.street, OLD.city, OLD.state, OLD.zip_code, OLD.credit_limit, OLD.balance, CURRENT_USER, 'UPDATE');
    ->    SET NEW.user_name = CURRENT_USER;
    -> END; $$
```

ERROR 1235 (42000): This version of MySQL doesn't yet support 'multiple triggers with the same action time and event for one table'

```sql
mysql> DELIMITER ;
```
OOP's, we already have a BEFORE UPDATE TRIGGER ON Customer table. We will need to merge the two.

```
mysql> DROP TRIGGER tg_update_customer;
mysql> DROP TRIGGER debit_balance;
mysql> DELIMITER $$
mysql> CREATE TRIGGER tg_update_customer
    BEFORE UPDATE ON customer
    FOR EACH ROW
    BEGIN
        IF (new.balance > new.credit_limit) THEN
            INSERT INTO debit_balance_report (action_dt, customer_number)
                VALUES (SYSDATE(), new.customer_number);
        END IF;

        -- If the Amount over the credit limit is greater than 10%, Then Raise an Exception
        IF ((new.balance - new.credit_limit)/new.credit_limit > .1) THEN
            CALL my_signal ('Over Credit Limit Amount is TOO High');
        END IF;

        INSERT INTO customer_history (customer_number, lname, fname, street, city, state, zip_code, credit_limit, balance, user_name, action, stamp) VALUES (OLD.customer_number, OLD.lname, OLD.fname, OLD.street, OLD.city, OLD.state, OLD.zip_code, OLD.credit_limit, OLD.balance, CURRENT_USER, 'UPDATE', SYSDATE());
        SET NEW.user_name = CURRENT_USER;
        SET NEW.updated = SYSDATE();
    END; $$
```

mysql> DELIMITER ;
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mysql> UPDATE customer SET balance = 1550 WHERE customer_number=6;
Query OK, 1 row affected (0.03 sec) Rows matched: 1 Changed: 1 Warnings: 0

mysql> SELECT * FROM customer WHERE customer_number = 6;

```
+----------+-------+--------+----------+--------+--------+--------+----------+---------+-----------+----------+----------+----------+
| customer_number | lname | fname  | street   | city    | state  | zip_code | balance  | credit_limit | slsrep_number | user_name | host     |
+----------+-------+--------+----------+--------+--------+--------+--------+----------+-----------+----------+----------+
| 6        | Test  | John   | 123 Bankrupt | Las Vegas | NV     | 54321   | 1550.00  | 1500.00    | 12        | root@local |
+----------+-------+--------+----------+--------+--------+--------+--------+----------+-----------+----------+----------+
1 row in set (0.00 sec)
```
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mysql> SELECT * FROM customer_history WHERE customer_number = 6;

<table>
<thead>
<tr>
<th>customer_number</th>
<th>lname</th>
<th>fname</th>
<th>street</th>
<th>city</th>
<th>state</th>
<th>zip_code</th>
<th>balance</th>
<th>credit_limit</th>
<th>slsrep_number</th>
<th>last_update</th>
<th>user_name</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Test</td>
<td>John</td>
<td>123 Bankrup:</td>
<td>Las Vegas</td>
<td>NV</td>
<td>54321</td>
<td>1500.00</td>
<td>1500.00</td>
<td>NULL</td>
<td>2008-04-0 2 12:57:49</td>
<td>root@localhost</td>
<td>UPDATE</td>
</tr>
</tbody>
</table>

1 row in set (0.00 sec)

mysql> SELECT * FROM debit_balance_report WHERE customer_number = 6;

<table>
<thead>
<tr>
<th>action_dt</th>
<th>customer_number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-04-02 12:57:49</td>
<td>6</td>
</tr>
</tbody>
</table>

1 row in set (0.00 sec)
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Destroying a Trigger

- To destroy a trigger, use the DROP TRIGGER statement.

```
DROP TRIGGER WORLD.Capital_bi;
```

- Drop trigger destroys a trigger explicitly. Triggers also are destroyed implicitly under some circumstances. When you drop a table that has triggers associated with it, MySQL drops the triggers as well. When you drop a database, doing so causes tables in the databases to be dropped, and thus also drops any triggers for those tables.

```
If your default database is “World”,
you can also write syntax like:

DROP TRIGGER Capital.Bi;
```