# PL/SQL - Cursors

Oracle creates a memory area, known as the context area, for processing an SQL statement, which contains all the information needed for processing the statement; for example, the number of rows processed, etc.

A **cursor** is a pointer to this context area. PL/SQL controls the context area through a cursor. A cursor holds the rows (one or more) returned by a SQL statement. The set of rows the cursor holds is referred to as the **active set**.

You can name a cursor so that it could be referred to in a program to fetch and process the rows returned by the SQL statement, one at a time. There are two types of cursors −

* Implicit cursors
* Explicit cursors

## Implicit Cursors

Implicit cursors are automatically created by Oracle whenever an SQL statement is executed, when there is no explicit cursor for the statement. Programmers cannot control the implicit cursors and the information in it.

Whenever a DML statement (INSERT, UPDATE and DELETE) is issued, an implicit cursor is associated with this statement. For INSERT operations, the cursor holds the data that needs to be inserted. For UPDATE and DELETE operations, the cursor identifies the rows that would be affected.

In PL/SQL, you can refer to the most recent implicit cursor as the **SQL cursor**, which always has attributes such as **%FOUND, %ISOPEN, %NOTFOUND**, and **%ROWCOUNT**. The SQL cursor has additional attributes, **%BULK\_ROWCOUNT** and **%BULK\_EXCEPTIONS**, designed for use with the **FORALL** statement. The following table provides the description of the most used attributes −

|  |  |
| --- | --- |
| **S.No** | **Attribute & Description** |
| 1 | **%FOUND**  Returns TRUE if an INSERT, UPDATE, or DELETE statement affected one or more rows or a SELECT INTO statement returned one or more rows. Otherwise, it returns FALSE. |
| 2 | **%NOTFOUND**  The logical opposite of %FOUND. It returns TRUE if an INSERT, UPDATE, or DELETE statement affected no rows, or a SELECT INTO statement returned no rows. Otherwise, it returns FALSE. |
| 3 | **%ISOPEN**  Always returns FALSE for implicit cursors, because Oracle closes the SQL cursor automatically after executing its associated SQL statement. |
| 4 | **%ROWCOUNT**  Returns the number of rows affected by an INSERT, UPDATE, or DELETE statement, or returned by a SELECT INTO statement. |

Any SQL cursor attribute will be accessed as **sql%attribute\_name** as shown below in the example.

### Example

We will be using the CUSTOMERS table we had created and used in the previous chapters.

Select \* from customers;

+----+----------+-----+-----------+----------+

| ID | NAME | AGE | ADDRESS | SALARY |

+----+----------+-----+-----------+----------+

| 1 | Ramesh | 32 | Ahmedabad | 2000.00 |

| 2 | Khilan | 25 | Delhi | 1500.00 |

| 3 | kaushik | 23 | Kota | 2000.00 |

| 4 | Chaitali | 25 | Mumbai | 6500.00 |

| 5 | Hardik | 27 | Bhopal | 8500.00 |

| 6 | Komal | 22 | MP | 4500.00 |

+----+----------+-----+-----------+----------+

The following program will update the table and increase the salary of each customer by 500 and use the **SQL%ROWCOUNT** attribute to determine the number of rows affected −

DECLARE

total\_rows number(2);

BEGIN

UPDATE customers

SET salary = salary + 500;

IF sql%notfound THEN

dbms\_output.put\_line('no customers selected');

ELSIF sql%found THEN

total\_rows := sql%rowcount;

dbms\_output.put\_line( total\_rows || ' customers selected ');

END IF;

END;

/

When the above code is executed at the SQL prompt, it produces the following result −

6 customers selected

PL/SQL procedure successfully completed.

If you check the records in customers table, you will find that the rows have been updated −

Select \* from customers;

+----+----------+-----+-----------+----------+

| ID | NAME | AGE | ADDRESS | SALARY |

+----+----------+-----+-----------+----------+

| 1 | Ramesh | 32 | Ahmedabad | 2500.00 |

| 2 | Khilan | 25 | Delhi | 2000.00 |

| 3 | kaushik | 23 | Kota | 2500.00 |

| 4 | Chaitali | 25 | Mumbai | 7000.00 |

| 5 | Hardik | 27 | Bhopal | 9000.00 |

| 6 | Komal | 22 | MP | 5000.00 |

+----+----------+-----+-----------+----------+

## Explicit Cursors

Explicit cursors are programmer-defined cursors for gaining more control over the **context area**. An explicit cursor should be defined in the declaration section of the PL/SQL Block. It is created on a SELECT Statement which returns more than one row.

The syntax for creating an explicit cursor is −

CURSOR cursor\_name IS select\_statement;

Working with an explicit cursor includes the following steps −

* Declaring the cursor for initializing the memory
* Opening the cursor for allocating the memory
* Fetching the cursor for retrieving the data
* Closing the cursor to release the allocated memory

## Declaring the Cursor

Declaring the cursor defines the cursor with a name and the associated SELECT statement. For example −

CURSOR c\_customers IS

SELECT id, name, address FROM customers;

## Opening the Cursor

Opening the cursor allocates the memory for the cursor and makes it ready for fetching the rows returned by the SQL statement into it. For example, we will open the above defined cursor as follows −

OPEN c\_customers;

## Fetching the Cursor

Fetching the cursor involves accessing one row at a time. For example, we will fetch rows from the above-opened cursor as follows −

FETCH c\_customers INTO c\_id, c\_name, c\_addr;

## Closing the Cursor

Closing the cursor means releasing the allocated memory. For example, we will close the above-opened cursor as follows −

CLOSE c\_customers;

### Example

Following is a complete example to illustrate the concepts of explicit cursors &minua;

DECLARE

c\_id customers.id%type;

c\_name customerS.name%type;

c\_addr customers.address%type;

CURSOR c\_customers is

SELECT id, name, address FROM customers;

BEGIN

OPEN c\_customers;

LOOP

FETCH c\_customers into c\_id, c\_name, c\_addr;

EXIT WHEN c\_customers%notfound;

dbms\_output.put\_line(c\_id || ' ' || c\_name || ' ' || c\_addr);

END LOOP;

CLOSE c\_customers;

END;

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When the above code is executed at the SQL prompt, it produces the following result −

1 Ramesh Ahmedabad

2 Khilan Delhi

3 kaushik Kota

4 Chaitali Mumbai

5 Hardik Bhopal

6 Komal MP

PL/SQL procedure successfully completed.

**Trigger**

Triggers are stored programs, which are automatically executed or fired when some events occur. Triggers are, in fact, written to be executed in response to any of the following events −

* A **database manipulation (DML)** statement (DELETE, INSERT, or UPDATE)
* A **database definition (DDL)** statement (CREATE, ALTER, or DROP).
* A **database operation** (SERVERERROR, LOGON, LOGOFF, STARTUP, or SHUTDOWN).

Triggers can be defined on the table, view, schema, or database with which the event is associated.

### Benefits of Triggers

Triggers can be written for the following purposes −

* Generating some derived column values automatically
* Enforcing referential integrity
* Event logging and storing information on table access
* Auditing
* Synchronous replication of tables
* Imposing security authorizations
* Preventing invalid transactions

## Creating Triggers

The syntax for creating a trigger is −

CREATE [OR REPLACE ] TRIGGER trigger\_name

{BEFORE | AFTER | INSTEAD OF }

{INSERT [OR] | UPDATE [OR] | DELETE}

[OF col\_name]

ON table\_name

[REFERENCING OLD AS o NEW AS n]

[FOR EACH ROW]

WHEN (condition)

DECLARE

Declaration-statements

BEGIN

Executable-statements

EXCEPTION

Exception-handling-statements

END;

Where,

* CREATE [OR REPLACE] TRIGGER trigger\_name − Creates or replaces an existing trigger with the *trigger\_name*.
* {BEFORE | AFTER | INSTEAD OF} − This specifies when the trigger will be executed. The INSTEAD OF clause is used for creating trigger on a view.
* {INSERT [OR] | UPDATE [OR] | DELETE} − This specifies the DML operation.
* [OF col\_name] − This specifies the column name that will be updated.
* [ON table\_name] − This specifies the name of the table associated with the trigger.
* [REFERENCING OLD AS o NEW AS n] − This allows you to refer new and old values for various DML statements, such as INSERT, UPDATE, and DELETE.
* [FOR EACH ROW] − This specifies a row-level trigger, i.e., the trigger will be executed for each row being affected. Otherwise the trigger will execute just once when the SQL statement is executed, which is called a table level trigger.
* WHEN (condition) − This provides a condition for rows for which the trigger would fire. This clause is valid only for row-level triggers.

### Example

To start with, we will be using the CUSTOMERS table we had created and used in the previous chapters −

Select \* from customers;

+----+----------+-----+-----------+----------+

**| ID | NAME | AGE | ADDRESS | SALARY |**

**+----+----------+-----+-----------+----------+**

**| 1 | Ramesh | 32 | Ahmedabad | 2000.00 |**

**| 2 | Khilan | 25 | Delhi | 1500.00 |**

**| 3 | kaushik | 23 | Kota | 2000.00 |**

**| 4 | Chaitali | 25 | Mumbai | 6500.00 |**

**| 5 | Hardik | 27 | Bhopal | 8500.00 |**

**| 6 | Komal | 22 | MP | 4500.00 |**

**+----+----------+-----+-----------+----------+**

The following program creates a **row-level** trigger for the customers table that would fire for INSERT or UPDATE or DELETE operations performed on the CUSTOMERS table. This trigger will display the salary difference between the old values and new values −

CREATE OR REPLACE TRIGGER display\_salary\_changes

BEFORE DELETE OR INSERT OR UPDATE ON customers

FOR EACH ROW

WHEN (NEW.ID > 0)

DECLARE

sal\_diff number;

BEGIN

sal\_diff := :NEW.salary - :OLD.salary;

dbms\_output.put\_line('Old salary: ' || :OLD.salary);

dbms\_output.put\_line('New salary: ' || :NEW.salary);

dbms\_output.put\_line('Salary difference: ' || sal\_diff);

END;

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When the above code is executed at the SQL prompt, it produces the following result −

Trigger created.

The following points need to be considered here −

* OLD and NEW references are not available for table-level triggers, rather you can use them for record-level triggers.
* If you want to query the table in the same trigger, then you should use the AFTER keyword, because triggers can query the table or change it again only after the initial changes are applied and the table is back in a consistent state.
* The above trigger has been written in such a way that it will fire before any DELETE or INSERT or UPDATE operation on the table, but you can write your trigger on a single or multiple operations, for example BEFORE DELETE, which will fire whenever a record will be deleted using the DELETE operation on the table.

## Triggering a Trigger

Let us perform some DML operations on the CUSTOMERS table. Here is one INSERT statement, which will create a new record in the table −

INSERT INTO CUSTOMERS (ID,NAME,AGE,ADDRESS,SALARY)

VALUES (7, 'Kriti', 22, 'HP', 7500.00 );

When a record is created in the CUSTOMERS table, the above create trigger, **display\_salary\_changes** will be fired and it will display the following result −

Old salary:

New salary: 7500

Salary difference:

Because this is a new record, old salary is not available and the above result comes as null. Let us now perform one more DML operation on the CUSTOMERS table. The UPDATE statement will update an existing record in the table −

UPDATE customers

SET salary = salary + 500

WHERE id = 2;

When a record is updated in the CUSTOMERS table, the above create trigger, **display\_salary\_changes** will be fired and it will display the following result −

Old salary: 1500

New salary: 2000

Salary difference: 500