6. PL/SQL Programming

PL/SQL Introduction

PL/SQL is a block structured language that enables developers to combine the power of SQL with procedural statements. All the statements of a block are passed to oracle engine all at once which increases processing speed and decreases the traffic.

## **Advantages of PL/SQL**

PL/SQL has the following advantages −

* SQL is the standard database language and PL/SQL is strongly integrated with SQL. PL/SQL supports both static and dynamic SQL. Static SQL supports DML operations and transaction control from PL/SQL block. In Dynamic SQL, SQL allows embedding DDL statements in PL/SQL blocks.
* PL/SQL allows sending an entire block of statements to the database at one time. This reduces network traffic and provides high performance for the applications.
* PL/SQL gives high productivity to programmers as it can query, transform, and update data in a database.
* PL/SQL saves time on design and debugging by strong features, such as exception handling, encapsulation, data hiding, and object-oriented data types.

**Disadvantages of SQL:**

* SQL doesn’t provide the programmers with a technique of condition checking, looping and branching.
* SQL statements are passed to Oracle engine one at a time which increases traffic and decreases speed.
* SQL has no facility of error checking during manipulation of data.

**Features of PL/SQL:**

1. PL/SQL is basically a procedural language, which provides the functionality of decision making, iteration and many more features of procedural programming languages.
2. PL/SQL can execute a number of queries in one block using single command.
3. One can create a PL/SQL unit such as procedures, functions, packages, triggers, and types, which are stored in the database for reuse by applications.
4. PL/SQL provides a feature to handle the exception which occurs in PL/SQL block known as exception handling block.
5. Applications written in PL/SQL are portable to computer hardware or operating system where Oracle is operational.
6. PL/SQL Offers extensive error checking.
7. **Differences between SQL and PL/SQL:**

|  |  |
| --- | --- |
| **SQL** | **PL/SQL** |
| SQL is a single query that is used to perform DML and DDL operations. | PL/SQL is a block of codes that used to write the entire program blocks/ procedure/ function, etc. |
| It is declarative, that defines what needs to be done, rather than how things need to be done. | PL/SQL is procedural that defines how the things needs to be done. |
| Execute as a single statement. | Execute as a whole block. |
| Mainly used to manipulate data. | Mainly used to create an application. |
| Cannot contain PL/SQL code in it. | It is an extension of SQL, so it can contain SQL inside it. |

**Structure of PL/SQL Block:**

PL/SQL extends SQL by adding constructs found in procedural languages, resulting in a structural language that is more powerful than SQL. The basic unit in PL/SQL is a block. All PL/SQL programs are made up of blocks, which can be nested within each other.



Typically, each block performs a logical action in the program. A block has the following structure:

**DECLARE**

 declaration statements;

**BEGIN**

 executable statements

**EXCEPTIONS**

 exception handling statements

**END;**

* Declare section starts with **DECLARE** keyword in which variables, constants, records as cursors can be declared which stores data temporarily. It basically consists definition of PL/SQL identifiers. This part of the code is optional.
* Execution section starts with **BEGIN** and ends with **END** keyword. This is a mandatory section and here the program logic is written to perform any task like loops and conditional statements. It supports all [DML](https://en.wikipedia.org/wiki/Data_manipulation_language) commands, [DDL](https://en.wikipedia.org/wiki/Data_definition_language) commands and SQL\*PLUS built-in functions as well.
* Exception section starts with **EXCEPTION** keyword. This section is optional which contains statements that are executed when a run-time error occurs. Any exceptions can be handled in this section.
* **PL/SQL Execution Environment:**
* The PL/SQL engine resides in the Oracle engine. The Oracle engine can process not only single SQL statement but also block of many statements. The call to Oracle engine needs to be made only once to execute any number of SQL statements if these SQL statements are bundled inside a PL/SQL block.

**PL/SQL Data types:-**

|  |  |
| --- | --- |
| **S.No** | **Category & Description** |
| 1 | **Scalar**Single values with no internal components, such as a **NUMBER, DATE,** or **BOOLEAN**. |
| 2 | **Large Object (LOB)**Pointers to large objects that are stored separately from other data items, such as text, graphic images, video clips, and sound waveforms. |
| 3 | **Composite**Data items that have internal components that can be accessed individually. For example, collections and records. |
| 4 | **Reference**Pointers to other data items. |

 The PL/SQL variables, constants and parameters must have a valid data type, which specifies a storage format, constraints, and a valid range of values.

## **PL/SQL Scalar Data Types and Subtypes**

PL/SQL Scalar Data Types and Subtypes come under the following categories −

|  |  |
| --- | --- |
| **S.No** | **Date Type & Description** |
| 1 | **Numeric**Numeric values on which arithmetic operations are performed. |
| 2 | **Character**Alphanumeric values that represent single characters or strings of characters. |
| 3 | **Boolean**Logical values on which logical operations are performed. |
| 4 | **Datetime**Dates and times. |

PL/SQL provides subtypes of data types. For example, the data type NUMBER has a subtype called INTEGER. You can use the subtypes in your PL/SQL program to make the data types compatible with data types in other programs while embedding the PL/SQL code in another program, such as a Java program.

## **PL/SQL Numeric Data Types and Subtypes**

Following table lists out the PL/SQL pre-defined numeric data types and their sub-types −

|  |  |
| --- | --- |
| **S.No** | **Data Type & Description** |
| 1 | **PLS\_INTEGER**Signed integer in range -2,147,483,648 through 2,147,483,647, represented in 32 bits |
| 2 | **BINARY\_INTEGER**Signed integer in range -2,147,483,648 through 2,147,483,647, represented in 32 bits |
| 3 | **BINARY\_FLOAT**Single-precision IEEE 754-format floating-point number |
| 4 | **BINARY\_DOUBLE**Double-precision IEEE 754-format floating-point number |
| 5 | **NUMBER(prec, scale)**Fixed-point or floating-point number with absolute value in range 1E-130 to (but not including) 1.0E126. A NUMBER variable can also represent 0 |
| 6 | **DEC(prec, scale)**ANSI specific fixed-point type with maximum precision of 38 decimal digits |
| 7 | **DECIMAL(prec, scale)**IBM specific fixed-point type with maximum precision of 38 decimal digits |
| 8 | **NUMERIC(pre, secale)**Floating type with maximum precision of 38 decimal digits |
| 9 | **DOUBLE PRECISION**ANSI specific floating-point type with maximum precision of 126 binary digits (approximately 38 decimal digits) |
| 10 | **FLOAT**ANSI and IBM specific floating-point type with maximum precision of 126 binary digits (approximately 38 decimal digits) |
| 11 | **INT**ANSI specific integer type with maximum precision of 38 decimal digits |
| 12 | **INTEGER**ANSI and IBM specific integer type with maximum precision of 38 decimal digits |
| 13 | **SMALLINT**ANSI and IBM specific integer type with maximum precision of 38 decimal digits |
| 14 | **REAL**Floating-point type with maximum precision of 63 binary digits (approximately 18 decimal digits) |

Following is a valid declaration −

DECLARE

 num1 INTEGER;

 num2 REAL;

 num3 DOUBLE PRECISION;

BEGIN

 null;

END;

/

When the above code is compiled and executed, it produces the following result −

PL/SQL procedure successfully completed

## **PL/SQL Character Data Types and Subtypes**

Following is the detail of PL/SQL pre-defined character data types and their sub-types −

|  |  |
| --- | --- |
| **S.No** | **Data Type & Description** |
| 1 | **CHAR**Fixed-length character string with maximum size of 32,767 bytes |
| 2 | **VARCHAR2**Variable-length character string with maximum size of 32,767 bytes |
| 3 | **RAW**Variable-length binary or byte string with maximum size of 32,767 bytes, not interpreted by PL/SQL |
| 4 | **NCHAR**Fixed-length national character string with maximum size of 32,767 bytes |
| 5 | **NVARCHAR2**Variable-length national character string with maximum size of 32,767 bytes |
| 6 | **LONG**Variable-length character string with maximum size of 32,760 bytes |
| 7 | **LONG RAW**Variable-length binary or byte string with maximum size of 32,760 bytes, not interpreted by PL/SQL |
| 8 | **ROWID**Physical row identifier, the address of a row in an ordinary table |
| 9 | **UROWID**Universal row identifier (physical, logical, or foreign row identifier) |

## **PL/SQL Boolean Data Types**

The **BOOLEAN** data type stores logical values that are used in logical operations. The logical values are the Boolean values **TRUE** and **FALSE** and the value **NULL**.

However, SQL has no data type equivalent to BOOLEAN. Therefore, Boolean values cannot be used in −

* SQL statements
* Built-in SQL functions (such as **TO\_CHAR**)
* PL/SQL functions invoked from SQL statements

## **PL/SQL Datetime and Interval Types**

The **DATE** datatype is used to store fixed-length datetimes, which include the time of day in seconds since midnight. Valid dates range from January 1, 4712 BC to December 31, 9999 AD.

The default date format is set by the Oracle initialization parameter NLS\_DATE\_FORMAT. For example, the default might be 'DD-MON-YY', which includes a two-digit number for the day of the month, an abbreviation of the month name, and the last two digits of the year. For example, 01-OCT-12.

Each DATE includes the century, year, month, day, hour, minute, and second. The following table shows the valid values for each field −

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Valid Datetime Values** | **Valid Interval Values** |
| YEAR | -4712 to 9999 (excluding year 0) | Any nonzero integer |
| MONTH | 01 to 12 | 0 to 11 |
| DAY | 01 to 31 (limited by the values of MONTH and YEAR, according to the rules of the calendar for the locale) | Any nonzero integer |
| HOUR | 00 to 23 | 0 to 23 |
| MINUTE | 00 to 59 | 0 to 59 |
| SECOND | 00 to 59.9(n), where 9(n) is the precision of time fractional seconds | 0 to 59.9(n), where 9(n) is the precision of interval fractional seconds |
| TIMEZONE\_HOUR | -12 to 14 (range accommodates daylight savings time changes) | Not applicable |
| TIMEZONE\_MINUTE | 00 to 59 | Not applicable |
| TIMEZONE\_REGION | Found in the dynamic performance view V$TIMEZONE\_NAMES | Not applicable |
| TIMEZONE\_ABBR | Found in the dynamic performance view V$TIMEZONE\_NAMES | Not applicable |

## **PL/SQL Large Object (LOB) Data Types**

Large Object (LOB) data types refer to large data items such as text, graphic images, video clips, and sound waveforms. LOB data types allow efficient, random, piecewise access to this data. Following are the predefined PL/SQL LOB data types −

|  |  |  |
| --- | --- | --- |
| **Data Type** | **Description** | **Size** |
| BFILE | Used to store large binary objects in operating system files outside the database. | System-dependent. Cannot exceed 4 gigabytes (GB). |
| BLOB | Used to store large binary objects in the database. | 8 to 128 terabytes (TB) |
| CLOB | Used to store large blocks of character data in the database. | 8 to 128 TB |
| NCLOB | Used to store large blocks of NCHAR data in the database. | 8 to 128 TB |

## **PL/SQL User-Defined Subtypes**

A subtype is a subset of another data type, which is called its base type. A subtype has the same valid operations as its base type, but only a subset of its valid values.

PL/SQL predefines several subtypes in package **STANDARD**. For example, PL/SQL predefines the subtypes **CHARACTER** and **INTEGER** as follows −

SUBTYPE CHARACTER IS CHAR;

SUBTYPE INTEGER IS NUMBER(38,0);

You can define and use your own subtypes. The following program illustrates defining and using a user-defined subtype −

DECLARE

 SUBTYPE name IS char(20);

 SUBTYPE message IS varchar2(100);

 salutation name;

 greetings message;

BEGIN

 salutation := 'Reader ';

 greetings := 'Welcome to the World of PL/SQL';

 dbms\_output.put\_line('Hello ' || salutation || greetings);

END;

/

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

Hello Reader Welcome to the World of PL/SQL

PL/SQL procedure successfully completed.

## **NULLs in PL/SQL**

PL/SQL NULL values represent **missing** or **unknown data** and they are not an integer, a character, or any other specific data type. Note that **NULL** is not the same as an empty data string or the null character value **'\0'**. A null can be assigned but it cannot be equated with anything, including itself.

## **PL/SQL Variables**

A variable is a reserved memory area for storing the data of a particular datatype. It is an **identifier** which is identifies memory locations where data is stored.

### **Rules for declaring a Variable in PL/SQL**

Following are some important rules to keep in mind while defining and using a variable in PL/SQL:

1. A variable name is user-defined. It should begin with a character and can be followed by maximum of 29 characters.
2. Keywords (i.e, reserved words ) of PL/SQL cannot be used as variable name.
3. Multiple variables can be declared in a single line provided they must be separated from each other by at least one space and comma.

For eg: a,b,c int;

1. Variable names containing two words should not contain space between them. It must be covered by underscore instead.

For eg: Roll\_no

1. A variable name is case sensitive, which means a\_var is not same as A\_var

## **Variable Declaration in PL/SQL**

PL/SQL variables must be declared in the declaration section or in a package as a global variable. When you declare a variable, PL/SQL allocates memory for the variable's value and the storage location is identified by the variable name.

**Syntax for declaration of a variable:**

Variable\_name datatype(size);

Let's take a simple example of how we can define a variable in PL/SQL,

roll\_no NUMBER(2);

a int;

And if we want to assign some value to the variable at the time of declaration itself, the syntax would be,

Variable\_name datatype(size) NOT NULL:=value;

Let's take a simple example for this too,

eid NUMBER(2) NOT NULL := 5;

In the PL/SQL code above, we have defined a variable with name eid which is of datatype NUMBER and can hold a number of length **2** bytes, which means it can hold a number upto **99**(because 100 onwards we have 3 digits) and the default value for this variable is **5**.

The keyword **NOT NULL** indicates that eid cannot be a blank field.

Here, := is an **assignment operator** used to assign a value to a variable.

* Some valid variable declarations along with their definition are shown below −

sales number(10, 2);

pi CONSTANT double precision := 3.1415;

name varchar2(25);

address varchar2(100);

* When you provide a size, scale or precision limit with the data type, it is called a **constrained declaration**. Constrained declarations require less memory than unconstrained declarations. For example −

sales number(10, 2);

name varchar2(25);

address varchar2(100);

## **Initializing Variables in PL/SQL**

Whenever you declare a variable, PL/SQL assigns it a default value of NULL. If you want to initialize a variable with a value other than the NULL value, you can do so during the declaration, using either of the following −

* The **DEFAULT** keyword
* The **assignment** operator

For example −

counter binary\_integer := 0;

greetings varchar2(20) DEFAULT 'Have a Good Day';

You can also specify that a variable should not have a **NULL** value using the **NOT NULL** constraint. If you use the NOT NULL constraint, you must explicitly assign an initial value for that variable.

It is a good programming practice to initialize variables properly otherwise, sometimes programs would produce unexpected results. Try the following example which makes use of various types of variables −

DECLARE

 a integer := 10;

 b integer := 20;

 c integer;

 f real;

BEGIN

 c := a + b;

 dbms\_output.put\_line('Value of c: ' || c);

 f := 70.0/3.0;

 dbms\_output.put\_line('Value of f: ' || f);

END;

/

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

Value of c: 30

Value of f: 23.333333333333333333

PL/SQL procedure successfully completed.

PL/SQL allows the nesting of blocks, i.e., each program block may contain another inner block. If a variable is declared within an inner block, it is not accessible to the outer block. However, if a variable is declared and accessible to an outer block, it is also accessible to all nested inner blocks. There are two types of variable scope −

* **Local variables** − Variables declared in an inner block and not accessible to outer blocks.
* **Global variables** − Variables declared in the outermost block or a package.

Following example shows the usage of **Local** and **Global** variables in its simple form −

DECLARE

 -- Global variables

 num1 number := 95;

 num2 number := 85;

BEGIN

 dbms\_output.put\_line('Outer Variable num1: ' || num1);

 dbms\_output.put\_line('Outer Variable num2: ' || num2);

 DECLARE

 -- Local variables

 num1 number := 195;

 num2 number := 185;

 BEGIN

 dbms\_output.put\_line('Inner Variable num1: ' || num1);

 dbms\_output.put\_line('Inner Variable num2: ' || num2);

 END;

END;

/

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

Outer Variable num1: 95

Outer Variable num2: 85

Inner Variable num1: 195

Inner Variable num2: 185

PL/SQL procedure successfully completed.

## **Assigning SQL Query Results to PL/SQL Variables**

You can use the **SELECT INTO** statement of SQL to assign values to PL/SQL variables. For each item in the **SELECT list**, there must be a corresponding, type-compatible variable in the **INTO list**. The following example illustrates the concept. Let us create a table named CUSTOMERS −

(**For SQL statements, please refer to the**[SQL tutorial](https://www.tutorialspoint.com/sql/index.htm))

CREATE TABLE CUSTOMERS(

 ID INT NOT NULL,

 NAME VARCHAR (20) NOT NULL,

 AGE INT NOT NULL,

 ADDRESS CHAR (25),

 SALARY DECIMAL (18, 2),

 PRIMARY KEY (ID)

);

Table Created

Let us now insert some values in the table −

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

VALUES (1, 'Ramesh', 32, 'Ahmedabad', 2000.00 );

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

VALUES (2, 'Khilan', 25, 'Delhi', 1500.00 );

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

VALUES (3, 'kaushik', 23, 'Kota', 2000.00 );

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

VALUES (4, 'Chaitali', 25, 'Mumbai', 6500.00 );

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

VALUES (5, 'Hardik', 27, 'Bhopal', 8500.00 );

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

VALUES (6, 'Komal', 22, 'MP', 4500.00 );

The following program assigns values from the above table to PL/SQL variables using the **SELECT INTO clause** of SQL −

DECLARE

 c\_id customers.id%type := 1;

 c\_name customers.name%type;

 c\_addr customers.address%type;

 c\_sal customers.salary%type;

BEGIN

 SELECT name, address, salary INTO c\_name, c\_addr, c\_sal

 FROM customers

 WHERE id = c\_id;

 dbms\_output.put\_line

 ('Customer ' ||c\_name || ' from ' || c\_addr || ' earns ' || c\_sal);

END;

/

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

Customer Ramesh from Ahmedabad earns 2000

PL/SQL procedure completed successfully

## **PL/SQL Constants**

Constants are those values which when declared remain fixed throughout the PL/SQL block. For declaring constants, a constant keyword is used.

**Syntax for declaring constants**:

Constant\_Name constant Datatype(size) := value;

Let's take a simple code example,

school\_name constant VARCHAR2(20) := "DPS";

In the above code example, constant name is user defined followed by a keyword constant and then we have declared its value, which once declared cannot be changed.

Below we have a simple program to demonstrate the use of constants in PL/SQL,

set serveroutput on;

DECLARE

 school\_name constant varchar2(20) := "DPS";

BEGIN

 dbms\_output.put\_line('I study in '|| school\_name);

END;

I study in DPS

PL/SQL Procedure successfully completed.

# Control Structures

PL/SQL Control Structures are used to control flow of execution.  PL/SQL provides different kinds of statements to provide such type of procedural capabilities.These statements are almost same as that of provided by other languages.
 The flow of control statements can be classified into the following categories:

* Conditional Control
* Iterative Control
* Sequential Control

#### **1.Conditional Control :-**

PL/SQL allows the use of an IF statement to control the execution of a block of code.
 In PL/SQL, the IF -THEN - ELSIF - ELSE - END IF construct in code blocks allow specifying certain conditions under which a specific block of code should be executed.

### ***Syntax:***

IF < Condition > THEN

  < Action >

ELSIF <Condition> THEN

 < Action >

ELSE < Action >

END IF;

### ***Example:***

create file named "condi.sql"

DECLARE

   a Number := 30;       b Number;

BEGIN

       IF a > 40 THEN

      b := a - 40;

    DBMS\_OUTPUT.PUT\_LINE('b=' || b);

  elseif a = 30 then

  b := a + 40;

  DBMS\_OUTPUT.PUT\_LINE('b=' || b);

    ELSE

    b := 0;

  DBMS\_OUTPUT.PUT\_LINE('b=' || b);

  END IF;

END;

/

### ***Output:***

Run SQL Command Line

SQL>set serveroutput on

SQL>start d://condi.sql
b=70

PL/SQL successfully completed.

### **Simple CASE Statement**

The simple CASE statement has this structure:

CASE *selector*

WHEN *selector\_value\_1* THEN *statements\_1*

WHEN *selector\_value\_2* THEN *statements\_2*

...

WHEN *selector\_value\_*n THEN *statements\_*n

[ ELSE

 *else\_statements* ]

END CASE;]

The *selector* is an expression (typically a single variable). Each *selector\_value* can be either a literal or an expression.

The simple CASE statement runs the first *statements* for which *selector\_value* equals *selector*. Remaining conditions are not evaluated. If no *selector\_value* equals *selector*, the CASE statement runs *else\_statements* if they exist and raises the predefined exception CASE\_NOT\_FOUND otherwise.

 ***Simple CASE Statement***

DECLARE

 grade CHAR(1);

BEGIN

 grade := 'B';

 **CASE grade**

 **WHEN 'A' THEN** DBMS\_OUTPUT.PUT\_LINE('Excellent');

 **WHEN 'B' THEN** DBMS\_OUTPUT.PUT\_LINE('Very Good');

 **WHEN 'C' THEN** DBMS\_OUTPUT.PUT\_LINE('Good');

 **WHEN 'D' THEN** DBMS\_OUTPUT.PUT\_LINE('Fair');

 **WHEN 'F' THEN** DBMS\_OUTPUT.PUT\_LINE('Poor');

 **ELSE** DBMS\_OUTPUT.PUT\_LINE('No such grade');

 **END CASE;**

END;

/

Result:

Very Good

### **Searched CASE Statement**

The searched CASE statement has this structure:

CASE

WHEN *condition\_1* THEN *statements\_1*

WHEN *condition\_2* THEN *statements\_2*

...

WHEN *condition\_*n THEN *statements\_*n

[ ELSE

 *else\_statements* ]

END CASE;]

The searched CASE statement runs the first *statements* for which *condition* is true. Remaining conditions are not evaluated. If no *condition* is true, the CASE statement runs *else\_statements* if they exist and raises the predefined exception CASE\_NOT\_FOUND otherwise. (For complete syntax, see "[CASE Statement](https://docs.oracle.com/database/121/LNPLS/case_statement.htm#GUID-F4251A23-0284-4990-A156-00A92F83BC35)".)

The searched CASE statement is logically equivalent to the simple CASE statement .

***Searched CASE Statement***

DECLARE

 grade CHAR(1);

BEGIN

 grade := 'B';

 **CASE**

 **WHEN grade = 'A' THEN** DBMS\_OUTPUT.PUT\_LINE('Excellent');

 **WHEN grade = 'B' THEN** DBMS\_OUTPUT.PUT\_LINE('Very Good');

 **WHEN grade = 'C'** THEN DBMS\_OUTPUT.PUT\_LINE('Good');

 **WHEN grade = 'D'** THEN DBMS\_OUTPUT.PUT\_LINE('Fair');

 **WHEN grade = 'F'** THEN DBMS\_OUTPUT.PUT\_LINE('Poor');

 **ELSE** DBMS\_OUTPUT.PUT\_LINE('No such grade');

 **END CASE;**

END;

/

Result:

Very Good

***EXCEPTION Instead of ELSE Clause in CASE Statement***

DECLARE

 grade CHAR(1);

BEGIN

 grade := 'B';

 CASE

 WHEN grade = 'A' THEN DBMS\_OUTPUT.PUT\_LINE('Excellent');

 WHEN grade = 'B' THEN DBMS\_OUTPUT.PUT\_LINE('Very Good');

 WHEN grade = 'C' THEN DBMS\_OUTPUT.PUT\_LINE('Good');

 WHEN grade = 'D' THEN DBMS\_OUTPUT.PUT\_LINE('Fair');

 WHEN grade = 'F' THEN DBMS\_OUTPUT.PUT\_LINE('Poor');

 END CASE;

**EXCEPTION**

 **WHEN CASE\_NOT\_FOUND THEN**

 **DBMS\_OUTPUT.PUT\_LINE('No such grade');**

END;

/

Result:

Very Good

#### **2.Iterative Control :-**

 Iterative control indicates the ability to repeat or skip sections of a code block.
 A **loop** marks a sequence of statements that has to be repeated. The keyword loop has to be placed before the first statement in the sequence of statements to be repeated, while the keyword end loop is placed immediately after the last statement in the sequence.
Once a loop begins to execute, it will go on forever. Hence a conditional statement that controls the number of times a loop is executed always accompanies loops.
 PL/SQL supports the following structures for iterative control:

##### Simple loop :

In simple loop, the key word loop should be placed before the first statement in the sequence and the keyword end loop should be written at the end of the sequence to end the loop.

### ***Syntax:***

**Loop**

**< Sequence of statements >**

 **End loop;**

### ***Example:***

create file named it.sql

**DECLARE**

**i number := 0;**

**BEGIN**

**LOOP**

**dbms\_output.put\_line ('i = '||i);**

**i:=i+1;**

**EXIT WHEN i>=11;**

**END LOOP;**

**END;**

**/**

### ***Output:***

Run SQL Command Line

SQL>set serveroutput on

SQL>start d://it.sql
i = 0
i = 1
i = 2
i = 3
i = 4
i = 5
i = 6
i = 7
i = 8
i = 9
i = 10
PL/SQL successfully completed.

##### WHILE loop

The **while** loop executes commands in its body as long as the condtion remains true

### ***Syntax :***

**WHILE < condition >**

**LOOP**

 **< Action >**

**END LOOP**

### ***Example :***

find reverse of given number using while loop

**DECLARE**

**num Number(3) :=123;**

**ans Number(3) :=0;**

**i Number(3) :=0;**

 **BEGIN**

**WHILE num != 0**

**LOOP**

 **i:=mod(num,10);**

**ans:=(ans \* 10 ) + i;**

**num:=floor(num/10);**

**END LOOP;**

 **dbms\_output.put\_line('reverse of given number is: ' || ans);**

**END;**

**/**

### ***Output :***

Run SQL Command Line

SQL>set serveroutput on

SQL>start d://rev.sql

reverse of given number is: 321
PL/SQL successfully completed.

##### The FOR Loop

The  **FOR** loop can be used when the number of iterations to be executed are known.

### ***Syntax :***

FOR variable IN [REVERSE] start..end

 LOOP

 < Action >

 END LOOP;

The variable in the For Loop need not be declared. Also the increment value cannot be specified. The For Loop variable is always incremented by 1.

### ***Example :***

**DECLARE**

**i number ;**

 **BEGIN**

**FOR i IN 1 .. 10**

**LOOP**

 **dbms\_output.put\_line ('i = '||i);**

**END LOOP;**

 **END;**

 **/**

### ***Output :***

Run SQL Command Line

SQL>set serveroutput on

SQL>start d://it.sql
i = 1
i = 2
i = 3
i = 4
i = 5
i = 6
i = 7
i = 8
i = 9
i = 10
PL/SQL successfully completed.

#### **3.Sequential Control :-**

##### The GOTO Statement

The GOTO statement changes the flow of control within a PL/SQL block. This statement allows execution of a section of code, which is not in the normal flow of control. The entry point into such a block of code is marked using the tags «userdefined name». The GOTO statement can then make use of this user-defined name to jump into that block of code for execution.

### ***Syntax :***

GOTO jump;

....

<<jump>>

### ***Example :***

**DECLARE**

 **BEGIN**

 **dbms\_output.put\_line ('code starts');**

 **dbms\_output.put\_line ('before GOTO statement');**

**GOTO down;**

**dbms\_output.put\_line ('statement will not get executed..');**

 **<<down>>**

 **dbms\_output.put\_line ('flow of execution jumped here.');**

 **END;**

 **/**

### ***Output :***

Run SQL Command Line

SQL>set serveroutput on

SQL>start d://a.sql
code starts
before gotostatements
flow of execution jumped here.

PL/SQL successfully completed.

**Exception Handling:-**

An exception is an error condition during a program execution. PL/SQL supports programmers to catch such conditions using **EXCEPTION** block in the program and an appropriate action is taken against the error condition. There are two types of exceptions −

* System-defined exceptions
* User-defined exceptions

## **Syntax for Exception Handling**

The general syntax for exception handling is as follows. Here you can list down as many exceptions as you can handle. The default exception will be handled using ***WHEN others THEN*** –

DECLARE

 <declarations section>

BEGIN

 <executable command(s)>

EXCEPTION

 <exception handling goes here >

 WHEN exception1 THEN

 exception1-handling-statements

 WHEN exception2 THEN

 exception2-handling-statements

 WHEN exception3 THEN

 exception3-handling-statements

 ........

 WHEN others THEN

 exception3-handling-statements

END;

### **Example**

Let us write a code to illustrate the concept. We will be using the CUSTOMERS table −

DECLARE

 c\_id customers.id%type := 8;

 c\_name customerS.Name%type;

 c\_addr customers.address%type;

BEGIN

 SELECT name, address INTO c\_name, c\_addr

 FROM customers

 WHERE id = c\_id;

 DBMS\_OUTPUT.PUT\_LINE ('Name: '|| c\_name);

 DBMS\_OUTPUT.PUT\_LINE ('Address: ' || c\_addr);

EXCEPTION

 WHEN no\_data\_found THEN

 dbms\_output.put\_line('No such customer!');

 WHEN others THEN

 dbms\_output.put\_line('Error!');

END;

/

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

No such customer!

PL/SQL procedure successfully completed.

The above program displays the name and address of a customer whose ID is given. Since there is no customer with ID value 8 in our database, the program raises the run-time exception **NO\_DATA\_FOUND**, which is captured in the **EXCEPTION block**.

## **Guidelines for Avoiding and Handling PL/SQL Errors and Exceptions**

Because reliability is crucial for database programs, use both error checking and exception handling to ensure your program can handle all possibilities:

* Add exception handlers whenever errors can occur.

Errors are especially likely during arithmetic calculations, string manipulation, and database operations. Errors can also occur at other times, for example if a hardware failure with disk storage or memory causes a problem that has nothing to do with your code; but your code still must take corrective action.

* Add error-checking code whenever bad input data can cause an error.

Expect that at some time, your code will be passed incorrect or null parameters, that your queries will return no rows or more rows than you expect.

Test your code with different combinations of bad data to see what potential errors arise.

* Make your programs robust enough to work even if the database is not in the state you expect.

For example, perhaps a table you query will have columns added or deleted, or their types changed. You can avoid such problems by declaring individual variables with %TYPE qualifiers, and declaring records to hold query results with %ROWTYPE qualifiers.

* Handle named exceptions whenever possible, instead of using WHEN OTHERS in exception handlers.

Learn the names and causes of the predefined exceptions. If your database operations might cause particular ORA-*n* errors, associate names with these errors so you can write handlers for them. (You will learn how to do that later in this chapter.)

* Write out debugging information in your exception handlers.

You might store such information in a separate table. If so, do it by invoking a subprogram declared with the PRAGMA AUTONOMOUS\_TRANSACTION, so that you can commit your debugging information, even if you roll back the work that the main subprogram was doing.

* Carefully consider whether each exception handler should commit the transaction, roll it back, or let it continue.

No matter how severe the error is, you want to leave the database in a consistent state and avoid storing any bad data.

## **Raising Exceptions:-**

Exceptions are raised by the database server automatically whenever there is any internal database error, but exceptions can be raised explicitly by the programmer by using the command **RAISE**. Following is the simple syntax for raising an exception −

DECLARE

 exception\_name EXCEPTION;

BEGIN

 IF condition THEN

 RAISE exception\_name;

 END IF;

EXCEPTION

 WHEN exception\_name THEN

 statement;

END;

**1.User defined exceptions:**This type of users can create their own exceptions according to the need and to raise these exceptions explicitly ***raise*** command is used.

*Example:*

* Divide non-negative integer x by y such that the result is greater than or equal to 1.

From the given question we can conclude that there exist two exceptions

* + Division be zero.
	+ If result is greater than or equal to 1 means y is less than or equal to x.

|  |
| --- |
| DECLARE   x int:=&x; /\*taking value at run time\*/    y int:=&y;    div\_r float;    exp1 EXCEPTION;    exp2 EXCEPTION;   BEGIN   IF y=0 then       raise exp1;      ELSEIF y > x then      raise exp2;      ELSE      div\_r:= x / y;       dbms\_output.put\_line('the result is '||div\_r);      END IF;   EXCEPTION    WHEN exp1 THEN      dbms\_output.put\_line('Error');       dbms\_output.put\_line('division by zero not allowed');      WHEN exp2 THEN      dbms\_output.put\_line('Error');       dbms\_output.put\_line('y is greater than x please check the input');   END;  |

Input 1: x = 20

 y = 10

Output: the result is 2

Input 2: x = 20

 y = 0

Output:

Error

division by zero not allowed

Input 3: x=20

 y = 30

Output:

Error

y is greater than x please check the input

***RAISE\_APPLICATION\_ERROR****:
It is used to display user-defined error messages with error number whose range is in between -20000 and -20999. When RAISE\_APPLICATION\_ERROR executes it returns error message and error code which looks****same as Oracle built-in error.***

***Example:***

|  |
| --- |
| DECLARE    myex EXCEPTION;     n NUMBER :=10;   BEGIN    FOR i IN 1..n LOOP     dbms\_output.put\_line(i\*i);         IF i\*i=36 THEN        RAISE myex;         END IF;     END LOOP;   EXCEPTION     WHEN myex THEN        RAISE\_APPLICATION\_ERROR(-20015, 'Welcome');   END;  |

*Output:*

*Error report:*

*ORA-20015: Welcome*

*ORA-06512: at line 13*

*1*

*4*

*9*

*16*

*25*

*36*

**2.System defined exceptions:**
These exceptions are predefined in PL/SQL which get raised WHEN certain **database rule is violated.**
System-defined exceptions are further divided into two categories:

1. Named system exceptions.
2. Unnamed system exceptions.
* **Named system exceptions:** They have a predefined name by the system like ACCESS\_INTO\_NULL, DUP\_VAL\_ON\_INDEX, LOGIN\_DENIED etc. the list is quite big.

So we will discuss some of the most commonly used exceptions:

Lets create a table student.

create table student (s\_id int , s\_name varchar(20), marks int);

insert into student values(1, 'Suraj',100);

insert into student values(2, 'Praveen',97);

insert into student values(3, 'Jessie', 99);



1. **NO\_DATA\_FOUND**: It is raised WHEN a SELECT INTO statement returns *no* rows. For eg:

|  |
| --- |
| DECLARE   temp varchar(20);   BEGIN   SELECT s\_id into temp from student where s\_name='Ravi';   exception    WHEN no\_data\_found THEN      dbms\_output.put\_line('ERROR');       dbms\_output.put\_line('there is no name as');       dbms\_output.put\_line('Ravi in student table'); end;  |

Output:

ERROR

there is no name as Ravi in student table

**2.TOO\_MANY\_ROWS**:It is raised WHEN a SELECT INTO statement returns *more* than one row.

|  |
| --- |
| DECLARE   temp varchar(20);   BEGIN  -- raises an exception as SELECT  -- into trying to return too many rows    SELECT s\_name into temp from student;    dbms\_output.put\_line(temp);   EXCEPTION    WHEN too\_many\_rows THEN      dbms\_output.put\_line('error trying to SELECT too many rows');   end;  |

Output:

error trying to SELECT too many rows

**3.VALUE\_ERROR**:This error is raised WHEN a statement is executed that resulted in an arithmetic, numeric, string, conversion, or constraint error. This error mainly results from programmer error or invalid data input.

|  |
| --- |
| DECLARE   temp number;      BEGIN   SELECT s\_name  into temp from student where s\_name='Suraj';    dbms\_output.put\_line('the s\_name is '||temp);   EXCEPTION    WHEN value\_error THEN   dbms\_output.put\_line('Error');    dbms\_output.put\_line('Change data type of temp to varchar(20)');   END;  |

Output:

Error

Change data type of temp to varchar(20)

**4.ZERO\_DIVIDE** = raises exception WHEN dividing with zero.

|  |
| --- |
| DECLARE   a int:=10;    b int:=0;    answer int;   BEGIN   answer:=a/b;    dbms\_output.put\_line('the result after division is'||answer);   exception    WHEN zero\_divide THEN      dbms\_output.put\_line('dividing by zero please check the values again');       dbms\_output.put\_line('the value of a is '||a);       dbms\_output.put\_line('the value of b is '||b); END;  |

Output:

dividing by zero please check the values again

the value of a is 10

the value of b is 0

* **Unnamed system exceptions:**Oracle doesn’t provide name for some system exceptions called unnamed system exceptions.These exceptions *don’t* occur frequently.These exceptions have two parts *code and an associated message*.
The way to handle to these exceptions is to *assign name* to them using **Pragma EXCEPTION\_INIT**
Syntax:
* PRAGMA EXCEPTION\_INIT(exception\_name, -error\_number);

error\_number are pre-defined and have negative integer range from -20000 to -20999.

**Example:**

|  |
| --- |
| DECLARE   exp exception;    pragma exception\_init (exp, -20015);    n int:=10;   BEGIN    FOR i IN 1..n LOOP       dbms\_output.put\_line(i\*i);          IF i\*i=36 THEN            RAISE exp;          END IF;    END LOOP;   EXCEPTION    WHEN exp THEN      dbms\_output.put\_line('Welcome');   END;  |

Output:

1

4

9

16

25

36

Welcome

 ***Scope rules in exception handling****:*

1. *We can’t DECLARE an exception twice but we can DECLARE the same exception in****two dIFferent blocks.***
2. *Exceptions DECLAREd inside a block are local to that block and global to all its sub-blocks.*

*As a block can reference only local or global exceptions, enclosing blocks cannot reference exceptions DECLAREd in a sub-block.
If we reDECLARE a global exception in a sub-block, the local declaration prevails i.e. the scope of local is more.*

***Example:***

|  |
| --- |
| DECLARE   sample EXCEPTION;    age NUMBER:=16; BEGIN     --  sub-block BEGINs     DECLARE                     -- this declaration prevails        sample  EXCEPTION;         age NUMBER:=22;        BEGIN      IF age > 16 THEN         RAISE sample; /\* this is not handled\*/       END IF;         END;              -- sub-block ends   EXCEPTION   -- Does not handle raised exception    WHEN sample THEN    DBMS\_OUTPUT.PUT\_LINE       ('Handling  sample exception.');       WHEN OTHERS THEN    DBMS\_OUTPUT.PUT\_LINE       ('Could not recognize exception sample  in this scope.'); END;  |

*Output:*

*Could not recognize exception sample in this scope.*

***Advantages:***

* *Exception handling is very useful for error handling, without it we have to issue the command at every point to check for execution errors:****Example:***
* *Select ..*
* *.. check for 'no data found' error*
* *Select ..*
* *.. check for 'no data found' error*
* *Select ..*
* *.. check for 'no data found' error*

*Here we can see that it is not****robust****as error processing is not separated from normal processing and IF we miss some line in the code than it may lead to some other kind of error.*

* *With exception handling we handle errors without writing statements multiple times and we can even handle****dIFferent****types of errors in one exception block:****Example:***
* *BEGIN*
* *SELECT ...*
* *SELECT ...*
* *SELECT ...*
* *.*
* *.*
* *.*
* *exception*
* *WHEN NO\_DATA\_FOUND THEN /\* catches all 'no data found' errors \*/*
* *...*
* *WHEN ZERO\_DIVIDE THEN /\* different types of \*/*
* *WHEN value\_error THEN /\* errors handled in same block \*/*
* *...*

*From above code we can conclude that exception handling*

1. *Improves****readability****by letting us isolate error-handling routines and thus providing robustness.*
2. *Provides****reliability****, instead of checking for dIFferent types of errors at every point we can simply write them in exception block and IF error exists exception will be raised thus helping the programmer to find out the type of error and eventually resolve it.*

***Uses****: One of the real lIFe use of exception can be found in online train reservation system.
While filling the station code to book the ticket IF we input wrong code it shows us the exception that the code doesn’t exist in database.*

**Cursor:-**

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.

**Use of Cursor**
The major function of a cursor is to retrieve data, one row at a time, from a result set, unlike the SQL commands which operate on all the rows in the result set at one time. Cursors are used when the user needs to update records in a singleton fashion or in a row by row manner, in a database table.
The Data that is stored in the Cursor is called the *Active Data Set*. Oracle DBMS has another predefined area in the main memory Set, within which the cursors are opened. Hence the size of the cursor is limited by the size of this pre-defined area.


**Cursor Actions**

* **Declare Cursor:** A cursor is declared by defining the SQL statement that returns a result set.
* **Open:** A Cursor is opened and populated by executing the SQL statement defined by the cursor.
* **Fetch:** When the cursor is opened, rows can be fetched from the cursor one by one or in a block to perform data manipulation.
* **Close:** After data manipulation, close the cursor explicitly.
* **Deallocate:** Finally, delete the cursor definition and release all the system resources associated with the cursor.

**Types of Cursors:-**

Cursors are classified depending on the circumstances in which they are opened.

* **Implicit Cursor:** If the Oracle engine opened a cursor for its internal processing it is known as an Implicit Cursor. It is created “automatically” for the user by Oracle when a query is executed and is simpler to code.
* **Explicit Cursor:** A Cursor can also be opened for processing data through a PL/SQL block, on demand. Such a user-defined cursor is known as an Explicit Cursor.

## **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.

|  |  |
| --- | --- |
| **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. |

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 −

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.

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 customer.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;

/

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.

## **PL/SQL cursor FOR LOOP statement**

The cursor FOR LOOP statement is an elegant extension of the numeric [FOR LOOP](https://www.oracletutorial.com/plsql-tutorial/plsql-for-loop/) statement.

The numeric [FOR LOOP](https://www.oracletutorial.com/plsql-tutorial/plsql-for-loop/) executes the body of a loop once for every integer value in a specified range.  Similarly, the cursor FOR LOOP executes the body of the loop once for each row returned by the [query](https://www.oracletutorial.com/oracle-basics/oracle-select/) associated with the cursor.

A nice feature of the cursor FOR LOOP statement is that it allows you to fetch every row from a cursor without manually managing the execution cycle i.e.,  OPEN, FETCH, and CLOSE.

The cursor FOR LOOP implicitly creates its loop index as a [record](https://www.oracletutorial.com/plsql-tutorial/plsql-record/) variable with the row type in which the cursor returns and then opens the cursor.

In each loop iteration, the cursor FOR LOOP statement fetches a row from the result set into its loop index. If there is no row to fetch, the cursor FOR LOOP closes the cursor.

The cursor is also closed if a statement inside the loop transfers control outside the loop, e.g., EXIT and [GOTO](https://www.oracletutorial.com/plsql-tutorial/plsql-goto/), or [raises an exception](https://www.oracletutorial.com/plsql-tutorial/plsql-raise/).

The following illustrates the syntax of the cursor FOR LOOP statement:

FOR record IN cursor\_name

LOOP

 process\_record\_statements;

**END** **LOOP**;

**1) record**

The record is the name of the index that the cursor FOR LOOP statement declares implicitly as a %ROWTYPE record variable of the type of the cursor.

The record variable is local to the cursor FOR LOOP statement. It means that you can only reference it inside the loop, not outside. After the cursor FOR LOOP statement execution ends, the record variable becomes undefined.

**2) cursor\_name**

The cursor\_name is the name of an explicit cursor that is not opened when the loop starts.

Note that besides the cursor name, you can use a [SELECT](https://www.oracletutorial.com/oracle-basics/oracle-select/) statement as shown below:

FOR record IN (select\_statement)

LOOP

 process\_record\_statements;

**END** **LOOP**;

In this case, the cursor FOR LOOP declares, opens, fetches from, and closes an implicit cursor. However, the implicit cursor is internal; therefore, you cannot reference it.

Note that Oracle Database automatically optimizes a cursor FOR LOOP to work similarly to a BULK COLLECT query. Although your code looks as if it fetched one row at a time, Oracle Database fetches multiple rows at a time and allows you to process each row individually.

## **PL/SQL cursor FOR LOOP examples**

Let’s look at some examples of using the cursor FOR LOOP statement to see how it works.

### **A) PL/SQL cursor FOR LOOP example**

The following example declares an explicit cursor and uses it in the cursor FOR LOOP statement.

**DECLARE**

 **CURSOR** c\_product **IS** **SELECT** product\_name,list\_price **FROM** products **ORDER** **BY** list\_price **DESC**;

**BEGIN**

 **FOR** r\_product **IN** c\_product

 **LOOP**

 dbms\_output.put\_line( r\_product.product\_name || ': $' || r\_product.list\_price );

 **END** **LOOP**;

**END**;

In this example, the SELECT statement of the cursor retrieves data from the products table. The FOR LOOP statement opened, fetched each row in the result set, displayed the product information, and closed the cursor.

### **B) Cursor FOR LOOP with a SELECT statement example**

The following example is equivalent to the example above but uses a query in a cursor FOR LOOP statement.

**BEGIN**

 **FOR** r\_product **IN** (**SELECT** product\_name, list\_price **FROM** products **ORDER** **BY** list\_price **DESC**)

 **LOOP**

 dbms\_output.put\_line( r\_product.product\_name ||

 ': $' ||

 r\_product.list\_price );

 **END** **LOOP**;

**END**;

* **Parameterized cursor:-**

An [explicit cursor](https://www.oracletutorial.com/plsql-tutorial/plsql-cursor/) may accept a list of parameters. Each time you open the cursor, you can pass different arguments to the cursor, which results in different result sets.

The following shows the syntax of a declaring a cursor with parameters:

CURSOR cursor\_name (parameter\_list)

IS

cursor\_query;

In the cursor query, each parameter in the parameter list can be used anywhere which a constant is used. The cursor parameters cannot be referenced outside of the cursor query.

To open a cursor with parameters, you use the following syntax:

OPEN cursor\_name (value\_list);

In this syntax, you passed arguments corresponding to the parameters of the cursor.

Cursors with parameters are also known as parameterized cursors.

## **PL/SQL cursor with parameters example**

The following example illustrates how to use a cursor with parameters:

**DECLARE**

 r\_product products%rowtype;

 CURSOR c\_product (low\_price NUMBER, high\_price NUMBER)

 IS

 **SELECT** \*

 **FROM** products

 **WHERE** list\_price **BETWEEN** low\_price **AND** high\_price;

**BEGIN**

 *-- show mass products*

 dbms\_output.put\_line('Mass products: ');

 OPEN c\_product(50,100);

 LOOP

 FETCH c\_product INTO r\_product;

 EXIT WHEN c\_product%notfound;

 dbms\_output.put\_line(r\_product.product\_name || ': ' ||r\_product.list\_price);

 **END** **LOOP**;

 CLOSE c\_product;

 *-- show luxury products*

 dbms\_output.put\_line('Luxury products: ');

 OPEN c\_product(800,1000);

 LOOP

 FETCH c\_product INTO r\_product;

 EXIT WHEN c\_product%notfound;

 dbms\_output.put\_line(r\_product.product\_name || ': ' ||r\_product.list\_price);

 **END** **LOOP**;

 CLOSE c\_product;

**END**;

/

In this example:

* First, declare a cursor that accepts two parameters low price and high price. The cursor retrieves products whose prices are between the low and high prices.
* Second, open the cursor and pass the low and high prices as 50 and 100 respectively. Then fetch each row in the cursor and show the product’s information, and close the cursor.
* Third, open the cursor for the second time but with different arguments, 800 for the low price and 100 for the high price. Then the rest is fetching data, printing out product’s information, and closing the cursor.

## **PL/SQL parameterized cursor with default values**

A parameterized cursor can have default values for its parameters as shown below:

CURSOR cursor\_name (

 parameter\_name datatype := default\_value,

 parameter\_name datatype := default\_value,

 ...

) IS

 cursor\_query;

If you open the parameterized cursor without passing any argument, the cursor will use the default values for its parameters.

The following example shows how to use a parameterized cursor with default values.

**DECLARE**

 **CURSOR** c\_revenue (in\_year NUMBER :=2017 , in\_customer\_id NUMBER := 1)

 **IS**

 **SELECT** **SUM**(quantity \* unit\_price) revenue

 **FROM** order\_items

 **INNER** **JOIN** orders **USING** (order\_id)

 **WHERE** **status** = 'Shipped' **AND** **EXTRACT**( **YEAR** **FROM** order\_date) = in\_year

 **GROUP** **BY** customer\_id

 **HAVING** customer\_id = in\_customer\_id;

 r\_revenue c\_revenue%rowtype;

**BEGIN**

 **OPEN** c\_revenue;

 LOOP

 FETCH c\_revenue INTO r\_revenue;

 EXIT WHEN c\_revenue%notfound;

 *-- show the revenue*

 dbms\_output.put\_line(r\_revenue.revenue);

 **END** **LOOP**;

 CLOSE c\_revenue;

**END**;

In this example, we declared a parameterized cursor with default values. When we opened the cursor, we did not pass any arguments; therefore, the cursor used the default values, 2017 for  in\_yearand 1 for in\_customer\_id.

PL/SQL **Procedures and Functions:-**

Procedures and Functions are the subprograms which can be created and saved in the database as database objects. They can be called or referred inside the other blocks also.

## Terminologies in PL/SQL Subprograms

Before we learn about PL/SQL subprograms, we will discuss the various terminologies that are the part of these subprograms. Below are the terminologies that we are going to discuss.

### **Parameter:**

The parameter is variable or placeholder of any valid PL/SQL datatype through which the PL/SQL subprogram exchange the values with the main code. This parameter allows to give input to the subprograms and to extract from these subprograms.

* These parameters should be defined along with the subprograms at the time of creation.
* These parameters are included n the calling statement of these subprograms to interact the values with the subprograms.
* The datatype of the parameter in the subprogram and the calling statement should be same.
* The size of the datatype should not mention at the time of parameter declaration, as the size is dynamic for this type.

Based on their purpose parameters are classified as

1. IN Parameter
2. OUT Parameter
3. IN OUT Parameter

### **IN Parameter:**

* This parameter is used for giving input to the subprograms.
* It is a read-only variable inside the subprograms. Their values cannot be changed inside the subprogram.
* In the calling statement, these parameters can be a variable or a literal value or an expression, for example, it could be the arithmetic expression like '5\*8' or 'a/b' where 'a' and 'b' are variables.
* By default, the parameters are of IN type.

### **OUT Parameter:**

* This parameter is used for getting output from the subprograms.
* It is a read-write variable inside the subprograms. Their values can be changed inside the subprograms.
* In the calling statement, these parameters should always be a variable to hold the value from the current subprograms.

### **IN OUT Parameter:**

* This parameter is used for both giving input and for getting output from the subprograms.
* It is a read-write variable inside the subprograms. Their values can be changed inside the subprograms.
* In the calling statement, these parameters should always be a variable to hold the value from the subprograms.

These parameter type should be mentioned at the time of creating the subprograms.

### **RETURN**

RETURN is the keyword that instructs the compiler to switch the control from the subprogram to the calling statement. In subprogram RETURN simply means that the control needs to exit from the subprogram. Once the controller finds RETURN keyword in the subprogram, the code after this will be skipped.

Normally, parent or main block will call the subprograms, and then the control will shift from those parent block to the called subprograms. RETURN in the subprogram will return the control back to their parent block. In the case of functions RETURN statement also returns the value. The datatype of this value is always mentioned at the time of function declaration. The datatype can be of any valid PL/SQL data type.

## **What is Procedure in PL/SQL?**

A Procedure is a subprogram unit that consists of a group of PL/SQL statements. Each procedure in Oracle has its own unique name by which it can be referred. This subprogram unit is stored as a database object. Below are the characteristics of this subprogram unit.

**Note:** Subprogram is nothing but a procedure, and it needs to be created manually as per the requirement. Once created they will be stored as database objects.

* Procedures are standalone blocks of a program that can be stored in the database.
* Call to these procedures can be made by referring to their name, to execute the PL/SQL statements.
* It is mainly used to execute a process in PL/SQL.
* It can have nested blocks, or it can be defined and nested inside the other blocks or packages.
* It contains declaration part (optional), execution part, exception handling part (optional).
* The values can be passed into the procedure or fetched from the procedure through parameters.
* These parameters should be included in the calling statement.
* Procedure can have a RETURN statement to return the control to the calling block, but it cannot return any values through the RETURN statement.
* Procedures cannot be called directly from SELECT statements. They can be called from another block or through EXEC keyword.

#### Syntax:

CREATE OR REPLACE PROCEDURE

<procedure\_name>

 (

 <parameterl IN/OUT <datatype>

 ..

 .

 )

[ IS | AS ]

 <declaration\_part>

BEGIN

 <execution part>

EXCEPTION

 <exception handling part>

END;

* CREATE PROCEDURE instructs the compiler to create new procedure. Keyword 'OR REPLACE' instructs the compile to replace the existing procedure (if any) with the current one.
* Procedure name should be unique.
* Keyword 'IS' will be used, when the procedure is nested into some other blocks. If the procedure is standalone then 'AS' will be used. Other than this coding standard, both have the same meaning.

**Example1: Creating Procedure and calling it using EXEC**

In this example, we are going to create a procedure that takes the name as input and prints the welcome message as output. We are going to use EXEC command to call procedure.

CREATE OR REPLACE PROCEDURE welcome\_msg (p\_name IN VARCHAR2)

IS

BEGIN

dbms\_output.put\_line (‘Welcome '|| p\_name);

END;

/

EXEC welcome\_msg (‘STUDENTS’);

**Code Explanation:**

* **Code line 1**: Creating the procedure with name 'welcome\_msg' and with one parameter 'p\_name' of 'IN' type.
* **Code line 4**: Printing the welcome message by concatenating the input name.
* Procedure is compiled successfully.
* **Code line 7**: Calling the procedure using EXEC command with the parameter 'STUDENTS'. Procedure is executed, and the message is printed out as "Welcome STUDENTS".

## What is Function?

Functions is a standalone PL/SQL subprogram. Like PL/SQL procedure, functions have a unique name by which it can be referred. These are stored as PL/SQL database objects. Below are some of the characteristics of functions.

* Functions are a standalone block that is mainly used for calculation purpose.
* Function use RETURN keyword to return the value, and the datatype of this is defined at the time of creation.
* A Function should either return a value or raise the exception, i.e. return is mandatory in functions.
* Function with no DML statements can be directly called in SELECT query whereas the function with DML operation can only be called from other PL/SQL blocks.
* It can have nested blocks, or it can be defined and nested inside the other blocks or packages.
* It contains declaration part (optional), execution part, exception handling part (optional).
* The values can be passed into the function or fetched from the procedure through the parameters.
* These parameters should be included in the calling statement.
* Function can also return the value through OUT parameters other than using RETURN.
* Since it will always return the value, in calling statement it always accompanies with assignment operator to populate the variables.

#### Syntax

CREATE OR REPLACE FUNCTION

<Function\_name>

(

<parameterl IN/OUT <datatype>

)

RETURN <datatype>

[ IS | AS ]

<declaration\_part>

BEGIN

<execution part>

EXCEPTION

<exception handling part>

END;

* CREATE FUNCTION instructs the compiler to create a new function. Keyword 'OR REPLACE' instructs the compiler to replace the existing function (if any) with the current one.
* The Function name should be unique.
* RETURN datatype should be mentioned.
* Keyword 'IS' will be used, when the procedure is nested into some other blocks. If the procedure is standalone then 'AS' will be used. Other than this coding standard, both have the same meaning.

**Example1: Creating Function and calling it using Anonymous Block**

In this program, we are going to create a function that takes the name as input and returns the welcome message as output. We are going to use anonymous block and select statement to call the function.

CREATE OR REPLACE FUNCTION welcome\_msgJune ( p\_name IN VARCHAR2)

RETURN VARCHAR2

IS

BEGIN

RETURN (‘Welcome ‘|| p\_name);

END;

/

DECLARE

lv\_msg VARCHAR2(250);

BEGIN

lv\_msg := welcome\_msg\_func (‘STUDENTS’);

dbms\_output.put\_line(lv\_msg);

END;

SELECT welcome\_msg\_func(‘STUDENTS’) FROM DUAL;

**Code Explanation:**

* **Code line 1**: Creating the function with name 'welcome\_msg\_func' and with one parameter 'p\_name' of 'IN' type.
* **Code line 2**: declaring the return type as VARCHAR2
* **Code line 5**: Returning the concatenated value 'Welcome' and the parameter value.
* **Code line 8**: Anonymous block to call the above function.
* **Code line 9**: Declaring the variable with datatype same as the return datatype of the function.
* **Code line 11**: Calling the function and populating the return value to the variable 'lv\_msg'.
* **Code line 12**: Printing the variable value. The output you will get here is "Welcome STUDENTS"
* **Code line 14**: Calling the same function through SELECT statement. The return value is directed to the standard output directly.

## Similarities between Procedure and Function

* Both can be called from other PL/SQL blocks.
* If the exception raised in the subprogram is not handled in the subprogram exception handling section, then it will propagate to the calling block.
* Both can have as many parameters as required.
* Both are treated as database objects in PL/SQL.

## Procedure Vs. Function: Key Differences

|  |  |
| --- | --- |
| **Procedure** | **Function** |
| * Used mainly to a execute certain process
 | * Used mainly to perform some calculation
 |
| * Cannot call in SELECT statement
 | * A Function that contains no DML statements can be called in SELECT statement
 |
| * Use OUT parameter to return the value
 | * Use RETURN to return the value
 |
| * It is not mandatory to return the value
 | * It is mandatory to return the value
 |
| * RETURN will simply exit the control from subprogram.
 | * RETURN will exit the control from subprogram and also returns the value
 |
| * Return datatype will not be specified at the time of creation
 | * Return datatype is mandatory at the time of creation
 |

## **Creating a Function**

A standalone function is created using the **CREATE FUNCTION** statement. The simplified syntax for the **CREATE OR REPLACE PROCEDURE** statement is as follows −

CREATE [OR REPLACE] FUNCTION function\_name

[(parameter\_name [IN | OUT | IN OUT] type [, ...])]

RETURN return\_datatype

{IS | AS}

BEGIN

 < function\_body >

END [function\_name];

Where,

* *function-name* specifies the name of the function.
* [OR REPLACE] option allows the modification of an existing function.
* The optional parameter list contains name, mode and types of the parameters. IN represents the value that will be passed from outside and OUT represents the parameter that will be used to return a value outside of the procedure.
* The function must contain a **return** statement.
* The *RETURN* clause specifies the data type you are going to return from the function.
* *function-body* contains the executable part.
* The AS keyword is used instead of the IS keyword for creating a standalone function.

### **Example**

The following example illustrates how to create and call a standalone function. This function returns the total number of CUSTOMERS in the customers table.

# We will use the CUSTOMERS table

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 |

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

CREATE OR REPLACE FUNCTION totalCustomers

RETURN number

IS

 total number(2) := 0;

BEGIN

 SELECT count(\*) into total

 FROM customers;

 RETURN total;

END;

/

When the above code is executed using the SQL prompt, it will produce the following result −

Total no. of Customers: 6

PL/SQL procedure successfully completed.

### **Example**

The following example demonstrates Declaring, Defining, and Invoking a Simple PL/SQL Function that computes and returns the maximum of two values.

DECLARE

 a number;

 b number;

 c number;

FUNCTION findMax(x IN number, y IN number)

RETURN number

IS

 z number;

BEGIN

 IF x > y THEN

 z:= x;

 ELSE

 Z:= y;

 END IF;

 RETURN z;

END;

BEGIN

 a:= 23;

 b:= 45;

 c := findMax(a, b);

 dbms\_output.put\_line(' Maximum of (23,45): ' || c);

END;

/

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

Maximum of (23,45): 45

PL/SQL procedure successfully completed.

## **PL/SQL Recursive Functions**

We have seen that a program or subprogram may call another subprogram. When a subprogram calls itself, it is referred to as a recursive call and the process is known as **recursion**.

To illustrate the concept, let us calculate the factorial of a number. Factorial of a number n is defined as −

n! = n\*(n-1)!

 = n\*(n-1)\*(n-2)!

 ...

 = n\*(n-1)\*(n-2)\*(n-3)... 1

The following program calculates the factorial of a given number by calling itself recursively −

DECLARE

 num number;

 factorial number;

FUNCTION fact(x number)

RETURN number

IS

 f number;

BEGIN

 IF x=0 THEN

 f := 1;

 ELSE

 f := x \* fact(x-1);

 END IF;

RETURN f;

END;

BEGIN

 num:= 6;

 factorial := fact(num);

 dbms\_output.put\_line(' Factorial '|| num || ' is ' || factorial);

END;

/

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

Factorial 6 is 720

PL/SQL procedure successfully completed.

## **Removing a function:-**

The DROP FUNCTION deletes a function from the Oracle Database. The syntax for removing a function is straightforward:

**DROP** **FUNCTION** function\_name;

Followed by the DROP FUNCTION keywords is the function name that you want to drop.

For example, the following statement drops the GET\_TOTAL\_SALES function:

**DROP** **FUNCTION** GET\_TOTAL\_SALES;

Oracle issued a message indicating that the function GET\_TOTAL\_SALES has been dropped:

Function GET\_TOTAL\_SALES dropped.

**Advantages of function:-**

1. We can make a single call to the database to run a block of statements thus it improves the performance against running SQL multiple times. This will reduce the number of calls between the database and the application.
2. We can divide the overall work into small modules which becomes quite manageable also enhancing the readability of the code.
3. It promotes reusability.
4. It is secure since the code stays inside the database thus hiding internal database details from the application (user). The user only makes a call to the PL/SQL functions. Hence security and data hiding is ensured.

Advantages of stored procedures:

* Since stored procedures are compiled and stored, whenever you call a procedure the response is quick.
* you can group all the required SQL statements in a procedure and execute them at once.
* Since procedures are stored on the database server which is faster than client. You can execute all the complicated quires using it, which will be faster.
* Using procedures, you can avoid repetition of code moreover with these you can use additional SQL functionalities like calling stored functions.
* Once you compile a stored procedure you can use it in any number of applications. If any changes are needed you can just change the procedures without touching the application code.

**Triggers in PL/SQL:-**

A trigger is a named PL/SQL block stored in the Oracle Database and executed automatically when a triggering event takes place.

These events can be:

* DDL statements (CREATE, ALTER, DROP, TRUNCATE) These triggers are often used for auditing purposes to record changes of the schema.
* DML statements (INSERT, SELECT, UPDATE, DELETE) For example, if you define a trigger that fires before an INSERT statement on the customers table, the trigger will fire once before a new row is inserted into the customers table.
* Database operation like connecting or disconnecting to oracle (LOGON, LOGOFF, SHUTDOWN)
* The act of executing a trigger is also known as firing a trigger. We say that the trigger is fired.
* Triggers are automatically and repeatedly called upon by oracle engine on satisfying certain condition.
* Triggers can be activated or deactivated depending on the requirements.
* If triggers are activated then they are executed implicitly by oracle engine and if triggers are deactivated then they are executed explicitly by oracle engine.

## **Oracle trigger usages**

Oracle triggers are useful in many cases such as the following:

* Enforcing complex business rules that cannot be established using integrity constraint such as [UNIQUE](https://www.oracletutorial.com/oracle-basics/oracle-unique-constraint/), [NOT NULL](https://www.oracletutorial.com/oracle-basics/oracle-not-null/), and [CHECK](https://www.oracletutorial.com/oracle-basics/oracle-check-constraint/).
* Preventing invalid transactions.
* Gathering statistical information on table accesses.
* Generating value automatically for derived columns.
* Auditing sensitive data.

## **PL/SQL: Parts of a Trigger**

Whenever a trigger is created, it contains the following three sequential parts:

* **Triggering Event or Statement:** The statements due to which a trigger occurs is called triggering event or statement. Such statements can be DDL statements, DML statements or any database operation, executing which gives rise to a trigger.
* **Trigger Restriction:** The condition or any limitation applied on the trigger is called trigger restriction. Thus, if such a condition is **TRUE** then trigger occurs otherwise it does not occur.
* **Trigger Action:** The body containing the executable statements that is to be executed when trigger occurs that is with the execution of Triggering statement and upon evaluation of Trigger restriction as **True** is called Trigger Action.

## **PL/SQL: Types of Triggers**

The above diagram clearly indicated that Triggers can be classified into three categories:

1. Level Triggers
2. Event Triggers
3. Timing Triggers

**which are further divided into different parts.**

### **Level Triggers**

There are 2 different types of level triggers, they are:

1. **ROW LEVEL TRIGGERS**
	* It fires for every record that got affected with the execution of DML statements like INSERT, UPDATE, DELETE etc.
	* It always use a FOR EACH ROW clause in a triggering statement.
2. **STATEMENT LEVEL TRIGGERS**
	* It fires once for each statement that is executed.

### **Event Triggers**

There are 3 different types of event triggers, they are:

1. **DDL EVENT TRIGGER**
	* It fires with the execution of every DDL statement(CREATE, ALTER, DROP, TRUNCATE).
2. **DML EVENT TRIGGER**
	* It fires with the execution of every DML statement(INSERT, UPDATE, DELETE).
3. **DATABASE EVENT TRIGGER**
	* It fires with the execution of every database operation which can be LOGON, LOGOFF, SHUTDOWN, SERVERERROR etc.

### **Timing Triggers**

There are 2 different types of timing triggers, they are:

* **BEFORE TRIGGER**
	+ It fires before executing DML statement.
	+ Triggering statement may or may not executed depending upon the before condition block.
* **AFTER TRIGGER**
	+ It fires after executing DML statement.

### **Syntax for creating Triggers**

Following is the syntax for creating a trigger:

CREATE OR REPLACE TRIGGER <trigger\_name>

BEFORE/AFTER/INSTEAD OF

 INSERT/DELETE/UPDATE ON <table\_name>

REFERENCING (OLD AS O, NEW AS N)

 FOR EACH ROW WHEN (test\_condition)

DECLARE

 -- Variable declaration;

BEGIN

 -- Executable statements;

EXCEPTION

 -- Error handling statements;

END <trigger\_name>;

END;

where,

CREATE OR REPLACE TRIGGER is a keyword used to create a trigger and **<trigger\_name>** is user-defined where a trigger can be given a name.

BEFORE/AFTER/INSTEAD OF specify the timing of the trigger's occurance. INSTEAD OF is used when a view is created.

**INSERT/UPDATE/DELETE** specify the DML statement.

**<table\_name>** specify the name of the table on which DML statement is to be applied.

REFERENCING is a keyword used to provide reference to old and new values for DML statements.

FOR EACH ROW is the clause used to specify row level tigger.

WHEN is a clause used to specify condition to be applied and is only applicable for row-level trigger.

DECLARE, BEGIN, EXCEPTION, END are the different sections of PL/SQL code block containing variable declaration, executable statements, error handling statements and marking end of PL/SQL block respectively where DECLARE and EXCEPTION part are optional.

### **Example!**

Below we have a simple program to demonstrate the use of Triggers in PL/SQL code block.

CREATE OR REPLACE TRIGGER CheckAge

BEFORE

INSERT OR UPDATE ON student

FOR EACH ROW

BEGIN

 IF :new.Age>30 THEN

 raise\_application\_error(-20001, 'Age should not be greater than 30');

 END IF;

END;

Trigger created.

Following is the STUDENT table,

|  |  |  |  |
| --- | --- | --- | --- |
| **ROLLNO** | **SNAME** | **AGE** | **COURSE** |
| 11 | Anu | 20 | BSC |
| 12 | Asha | 21 | BCOM |
| 13 | Arpit | 18 | BCA |
| 14 | Chetan | 20 | BCA |
| 15 | Nihal | 19 | BBA |

After initializing the trigger CheckAge, whenever we will insert any new values or update the existing values in the above table STUDENT our trigger will check the **age** before executing INSERT or UPDATE statements and according to the result of triggering restriction or condition it will execute the statement.

Let's take a few examples and try to understand this,

**Example 1:**

INSERT into STUDENT values(16, 'Saina', 32, 'BCOM');

Age should not be greater than 30

**Example 2:**

INSERT into STUDENT values(17, 'Anna', 22, 'BCOM');

1 row created

**Example 3:**

UPDATE STUDENT set age=31 where ROLLNO=12;

Age should not be greater than 30

**Example 4:**

 UPDATE STUDENT set age=23 where ROLLNO=12;

1 row updated.