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1. Introduction

2. composite data types
   a. %type attribute or anchor data types
      i. %type
      ii. %row type
      User defined or temporary data types
      iii. Record type or pl/sql record
      iv. Index by table or pl/sql table or associate array

   b. User defined or permanent data types
      i. Objects
      ii. Varrays
      iii. Nested tables/ pl/sql table

3. Blocks
   i. Unnamed or anonymous block
   ii. Named or stored procedures
   iii. Labeled blocks

4. Control statements or control structures
   i. Sequential (default)
   ii. Conditional (if, case)

5. Cursors
   i. Implicit
   ii. Explicit
   iii. Ref cursor

6. Exceptions (To handle run time errors)
   i. predefine
   ii. user define
   iii. non predefine

7. stored procedure
   i. procedures
   ii. functions
   iii. packages
   iv. triggers

8. pragmas
9. no copy
10. forward declaration
11. bulk collect & bulk bind
12. mutating triggers
13. dynamic sql (execute immediate)
14. table function
15. advanced topics

- This is a procedural language or programming language
- It consist of unit blocks

- Makes the application design easy
- Provides security and is portable
- It is used to handle multiple statements
- To define our own logics we use Pl/sql
- It supports control statements like IF conditions, Loops, go to.. etc.
- By using pl/sql we can handle runtime errors
- Explicitly we can define our own cursors in pl/sql. It allows Boolean data types
- PL/SQL has tight integration with oracle data types.

Blocks:
Unnamed Blocks:-
Syntax:

```
Declare          } Optional (declarative section)
begin            }
    code;        } Mandatory (Executable Section)
Exception        }
End;             } Optional (Exception Section)
```

Declarative Section:-

* We use declarative section to define variables, constants, cursors, exceptions, etc.,
* We have to define the things in declarative section which are not understand by PL/SQL engine which is optional?

Excitable Section:-

- Here we define or we provide coding path
- Execution takes place in executable section which is mandatory
- It starts from begin to end

Exception section:-We use exception section to handle runtime errors and which is optional

Nested Blocks: Block within another block is called nested block

```
Outer block                Declare
or                         begin
Enclosing Block                Declare
                               begin
                                   code;     } Inner block
                               Exception
                               End;
                           Exception
                           End;
```

Begin

Begin

End;

End;

Example:-

1. Write a program to display the message on to the screen?

```
begin
    dbms_output.put_line('hello welcome to pl/sql');
    dbms_output.put_line('this is OracleApps88.Blogspot.com');
end;
```

Output:-

```
SQL> /
hellow welcome to pl/sql
this is Narayana Reddy

PL/SQL procedure successfully completed.
```

Using 'NULL' as a statement:-

```
Begin
    NULL;
End;
```

pl/sql procedure successfully completed

```
Begin

End;
```

o/p not coming w/o using stmt.

2 Using Constant:- We don't change modifications in entire block

```
DECLARE
   A   CONSTANT NUMBER (5, 3) := 3.142;
   B            NUMBER (5) := 100;
BEGIN
   B := 50;
   DBMS_OUTPUT.put_line (a + b);
END;
```

Output:

```
SQL> /
53.142

PL/SQL procedure successfully completed.
```

3. Change output automatically by using the program

```
Declare
A number (5): = &n;
B number (5):= &m;
Begin
Dbms_output.put_line (a+b);
```

```
End;
```

4. Write a program to calculate the area of the circle by knowing the radius

```
DECLARE
   a            NUMBER (5, 3);
   r            NUMBER (5) := &n;
   p   CONSTANT NUMBER (5, 3) := 3.142;
BEGIN
   a := p * POWER (r, 2);

   --    (or you can use p*r*r)
   DBMS_OUTPUT.put_line ('Area of the circle ' || a);
END;
/
```

Out Put:

```
SQL> /
Enter value for n: 3
old   3: r number (5) := &n;
new   3: r number (5) := 3;
Area of the circle 28.278

PL/SQL procedure successfully completed.
```

Nesting of comments is not possible

Ex:-

```
/*
Stmts
/*
Stmts
*/
stmts  */
```

2) Composite datatypes

a) %type

Ex:-Write a program to retrieve and display the employee name by providing employee number?

```
declare
vno number(5):=&n;
vname varchar2(10);
begin
select ename into vname from emp where empno = vno;
dbms_output.put_line('employee name'||vname);
end;
/
```

Output:-

```
SQL> /
Enter value for n: 7788
old   2: vno number(5):=&n;
new   2: vno number(5):=7788;
employee nameSCOTT

PL/SQL procedure successfully completed.
```

* It is used to provide column data type to a variable.
* No need to remember the column data type
* It is dynamic in nature

Syn: Variablename tablename.columnname%type;

Ex:-variable emp.ename%type;

```
DECLARE
   vno      emp.empno%TYPE := &n;
   vname    emp.ename%TYPE;
BEGIN
   SELECT ename
     INTO vname
     FROM emp
    WHERE empno = vno;

   DBMS_OUTPUT.put_line ('emplooyee name is' || vname);
END;
/
```

Output:

```
SQL> /
Enter value for n: 7788
old   2: vno emp.empno%type:=&n;
new   2: vno emp.empno%type:=7788;
emplooyee name isSCOTT

PL/SQL procedure successfully completed.
```

Disadvantage:- Not possible to store entire record

b) %row type: It assigns the entire column data types of a table. Useful to store entire record.

Syn:- Variable tablename%rowtype;

Ex:

```
DECLARE
   vno     emp.empno%TYPE := &n;
   vrow    emp%ROWTYPE;
BEGIN
   SELECT *
     INTO vrow
     FROM emp
    WHERE empno = vno;

   DBMS_OUTPUT.put_line (vrow.ename || ' ' || vrow.sal);
END;
/
```

Output:

```
SQL> /
Enter value for n: 7788
old   2: vno emp.empno%type:=&n;
new   2: vno emp.empno%type:=7788;
SCOTT 3000

PL/SQL procedure successfully completed.
```

Disadvantage:- by using %rowtype it is not possible to store table record along with user data or user information

4. CONTROL STATEMENTS

Control flow

1. if statement
2. case statement

1. If condition:

Syntax:-

```
if condition then
        Do1; (stmts)
    Else if condition then
        Do2; (stmts)
    Else do3; (stmts)
End if;
```

2. Nested if:

Syntax:-

```
If condition then
Do1;
    If condition then
      Do3;
   Else
     Do4;
   End if;
     Else
     Do2;
     End if;
```

Ex:-

```
DECLARE
   v   NUMBER (5) := &n;
BEGIN
   IF v > 1000
   THEN
      DBMS_OUTPUT.put_line ('hellow given number is > 1000');
   ELSE
      DBMS_OUTPUT.put_line ('number is < 1000');
   END IF;
END;
/
```

Output:-

```
SQL> /
Enter value for n: 1500
old   2: v number(5) :=&n;
new   2: v number(5) :=1500;
hellow given number is > 1000

PL/SQL procedure successfully completed.
```

Case:

1. Simple case
2. Search case

Syntax:

```
    Case [columns/expressions]
        When condition then
            Do1;  (stmts)
        When condition then
            Do2;  (stmts)
```

```
            When condition then
                    Do3;  (stmts)
            Else
                    Do4; (stmts)
        End case;
```

2. Search case:

Ex:-

```
SELECT sal,CASE WHEN sal =5000
THEN'A'
WHEN sal >=3000
THEN'B'
ELSE'C'
ENDCASE,job, deptno
FROMemp
```

Output:

```
  SAL C JOB       DEPTNO
----- - --------- ------
 5000 A PRESIDENT     10
 2850 C MANAGER       30
 2450 C MANAGER       10
 2975 C MANAGER       20
 3000 B ANALYST       20
 3000 B ANALYST       20
  800 C CLERK         20
 1600 C SALESMAN      30
 1250 C SALESMAN      30
 1250 C SALESMAN      30
 1500 C SALESMAN      30
 1100 C CLERK         20
  950 C CLERK         30
 1300 C CLERK         10

14 rows selected.
```

Ex:-

```
SELECTSUM(CASE
WHEN sal =5000
THEN sal
WHEN sal >=3000
THEN sal
ELSE sal
END
) sum_sal
FROMemp
```

Output:

```
SQL> /

SUM_SAL
-------
  29025
```

Ex:-

```
DECLARE
```

```
   vsal   emp.sal%TYPE;
   vno    emp.empno%TYPE := &n;
BEGIN
   SELECT sal
     INTO vsal
     FROM emp
    WHERE empno = vno;

   CASE
      WHEN vsal = 5000
      THEN
         DBMS_OUTPUT.put_line ('sal = 5000');
      WHEN vsal >= 3000
      THEN
         DBMS_OUTPUT.put_line ('sal = 3000');
      ELSE
         DBMS_OUTPUT.put_line ('sal < 3000');
   END CASE;
END;
      /
```

Output:

```
SQL> /
Enter value for n: 7788
old   3: vno emp.empno%type:=&n;
new   3: vno emp.empno%type:=7788;
sal = 3000

PL/SQL procedure successfully completed.
```

Note:- In the absence of else part if all of the conditions are false then it throws on an error i.e. case not found. (it throws err ORA-06592, pls check below o/p)

Ex:-

```
DECLARE
   vsal   emp.sal%TYPE;
   vno    emp.empno%TYPE := &n;
BEGIN
   SELECT sal
     INTO vsal
     FROM emp
    WHERE empno = vno;

   CASE
      WHEN vsal > 5000
      THEN
         DBMS_OUTPUT.put_line ('sal = 5000');
      WHEN vsal > 6000
      THEN
         DBMS_OUTPUT.put_line ('sal = 6000');
   END CASE;
END;
      /
```

Output:

```
SQL> /
Enter value for n: 7788
old   3: vno emp.empno%type:=&n;
new   3: vno emp.empno%type:=7788;
declare
*
ERROR at line 1:
ORA-06592: CASE not found while executing CASE statement
ORA-06512: at line 6
```

Simple case:- It is not allow special operators

Ex:-

```
DECLARE
   vsal    emp.sal%TYPE;
   vno     emp.empno%TYPE := &n;
BEGIN
   SELECT sal
     INTO vsal
     FROM emp
    WHERE empno = vno;

   CASE vsal
      WHEN 5000
      THEN
         DBMS_OUTPUT.put_line ('sal = 5000');
      WHEN 3000
      THEN
         DBMS_OUTPUT.put_line ('sal = 3000');
      ELSE
         DBMS_OUTPUT.put_line ('sal < 3000');
   END CASE;
END;
/
```

Output:

```
SQL> /
Enter value for n: 7788
old   3: vno emp.empno%type:=&n;
new   3: vno emp.empno%type:=7788;
sal = 3000

PL/SQL procedure successfully completed.
```

c) Iterations:

Loops:- to execute the same statement or coding for repeated times we use loops

1. Simple loop
2. While loop
3. for loop

a. Numeric for loop

b. Cursor for loop

1. **Simple loop:-** it is an infinite loop explicitly we have to stop the loop. It is uses in blocks.

Syntax:-

```
Loop
        Code;
End loop;
```

Ex:-

```
Begin
        Loop
         Exit [when condition];
        Code;
        End loop;
End;
```

Ex:- Write a program to display 1 to 10 numbers

```
declare
x number(5) :=1;
begin
loop
exit when x > 10;
dbms_output.put_line(x);
x:=x+1;
end loop;
end;
/
```

Output:

```
SQL> /
1
2
3
4
5
6
7
8
9
10

PL/SQL procedure successfully completed.
```

Ex:- To display 1 to 5 numbers

```
DECLARE
   x   NUMBER (5) := 1;
BEGIN
   LOOP
      IF x > 5
      THEN
         EXIT;
      END IF;

      DBMS_OUTPUT.put_line (x);
      x := x + 1;
   END LOOP;
END;
/
```

Output:

```
SQL> /
1
2
3
4
5

PL/SQL procedure successfully completed.
```

Ex:-

```
SELECT   deptno,SUM(NVL(sal,100)) sum_sal
FROMemp
GROUPBY deptno
HAVINGSUM(sal)>200
```

Output:

```
DEPTNO SUM_SAL
------ -------
    30    9400
    20   10875
    10    8750

SQL>
```

While loop:- It is a pre conditional loop

Syntax:- While condition loop
Code;
End loop;

Ex:- to display 1 to 10 numbers

```
declare
a number(5) := 1;
begin
while a <=10 loop
dbms_output.put_line(a);
a:=a+1;
end loop;
end;
```

Output:

```
SQL> /
1
2
3
4
5
6
7
8
9
10

PL/SQL procedure successfully completed.

SQL>
```

- Write a program to display tables from 1 to 10 by using simple loop

Ex:-

```
DECLARE
   x   NUMBER (5) := 1;
   y   NUMBER (5) := 1;
BEGIN
   LOOP
      y := 1;

      LOOP
         DBMS_OUTPUT.put_line (x || '*' || y || '=' || x * y);
         y := y + 1;
         EXIT WHEN y > 10;
      END LOOP;

      x := x + 1;
      EXIT WHEN x > 10;
   END LOOP;
END;
/
```

Output:

```
SQL> /
1*1=1
1*2=2
1*3=3
1*4=4
1*5=5
1*6=6
1*7=7
1*8=8
1*9=9
1*10=10
2*1=2
```

It will print 1 to 10 tables;

- Write a program to reverse the give string by using simple loop (without using reverse function)

For loop:

Syntax:

For var in [reverse] val1..val2 loop
Code;
End;

Ex:-Begin
For I in 1..10 loop
Dbms_output.put_line(i);
End loop;
End;

Ex:-

Begin
For I in reverse 1..10 loop
Dbms_output.put_line(i);
End loop;

End;

Continue: (11g introduced)

Syntax: Continue [When condition];

- It is a 11g feature. Which is used in loop (in any loop)
- Continue statement skips the current iteration

Ex:-

```
Begin
For I in 1..10 loop
Continue when i>5;
Dbms_output.put_line(i);
End loop;
End;
```

Ex:-

```
Begin
For I in 1..10 loop
If I <5 then
Continue;
End if;
Dbms_output.put_line(i);
End loop;
End;
```

CURSORES

- Oracle will make use of internal memory areas (implicit cursors) for sql statements to process the records
- This memory areas will be defined in a area called SGA (system global area)
- Oracle allows to provide our own memory areas (explicit cursors) to get control over each of the record

Definition:-It is a pointer pointing towards the arranged data in a context area
In explicit cursors user has to declare, open, fetch and close the cursors. Whereas in the case of impolicit cursors system has to look after all this functionalities.

Cursor functionalities:
Step 1: Declaring the cursor
Syntax:-cursor cursor_name is select …
Step 2:opening a cursor
Syntax: open cursor_name
Step 3: Fetching records into variable from cursor
Syntax: fetch cursor_name into variable;
Step 4: closing cursor
Syntax: close cursor_name

Cursor Attributes

1. Cursor_name%isopen;
2. Cursor_name%found;
3. Cursor_name%notfound;
4. Cursor_name%rowcount;
5. Cursor_name%bulk_rowcount;
6. Cursor_name%bulk_exception; (save exception 11g)

Cursor_name%isopen: returns true if cursor is opened else false
Cursor_name%found: returns true if records are found else false
Cursor_name%notfound: reverse to the found
Cursor_name%rowcount: returns number of records fetched to that state

Example for explicit cursor:

```
Declare
Cursor c is select ename for emp;
Vname c%rowtype;
Begin
Open c;
Loop
Fetch c into vname;
Exit when c%not found;
Dbms_output.put_line(vname.ename);
End loop;
End;
```

Ex:

```
Declare
Cursor c is select ename for emp;
Vname emp.ename%type;
Begin
Open c;
```

Loop
Fetch c into vname;
Exit when c%notfound;
Dbms_output.put_line(vname);
End loop;
Close c;
End;

Cursor event		%isopen	%found	%notfound	%rowcount
Open cursor	Before	F	E	E	E
	AFTER	T	N	N	O
1ST FETCH	BEFORE	T	N	N	O
	AFTER	T	T	F	I
2ND FETCH (FETCHES)	BEFORE	T	T	F	I
	AFTER	T	T	F	DD
LAST FETCH	BEFORE	T	T	F	DD
	AFTER	T	F	T	DD
CLOSE CURSOR	BEFORE	T	F	T	DD
	AFTER	F	E	E	E

E -> Exceptions DD -> data dependence
In for loops no need to open fetch and close the cursors. It happens through for loop

For loop cursors:

```
DECLARE
   CURSOR c
   IS
      SELECT ename from emp;
begin
for I in c loop
dbms_output.put_line(i.ename);
end loop;
end;
```

Parameterised Cursors:
In cursors we use "In" parameters
Ex:
Declare
Cursor c(x emp.deptno%type) is select ename from emp where deptno = x;
Vname emp.ename%type;
Vno number(5):=&n;
Begin
Open c(vno);
Loop
Fetch c into vname;
Exit when c%notfound;
Dbms_output.put_line(vname);
End loop;
Close c;

```
End;
```

Using for loop:

Ex:

```
Declare
Cursor c(x emp.deptno%type) is select ename from emp where deptno = x;
Begin
For I in c(vno) loop
Dbms_output.put_line(i.ename);
End loop;
End;
```

Static cursors:

we can open the cursor n no.of times

Ex:-

```
Declare cursor c is select ename from emp;
Vname emp.ename%type;
Begin
Open c;
Loop
Fetch c into vname;
Exit when c%notfound;
Dbms_output.put_line(vname);
End loop;
Close c;
Open c;
End;
```

a) Implicit Cursors

```
Declare
Vno emp1.deptno%type:=&n;
Begin
Delete from emp1 where deptno = vno;
If sql%rowcount >3 then
Dbms_output.put_line(sql%rowcount||'employees not possible to delete');
Rollback;
Else
Dbms_output.put_line(sql%rowcount||'employees possible to delete');
Commit;
End if;
End;
```

We use implicit cursors to find out the status of DML operations.

REF CURSOR

- Ref cursor is a datatype
- We use ref cursors to handle multiple select statements
- We can pass ref cursor variable to a parameter value

Syntax: type typename is ref cursor;

```
Var typename;
```

Ex:-

```
Declare
Type rec is refcursor;
Vrec rec;
Vemp emp.ename%type;
Vdept dept.loc%type;
Begin
Open vrec for select ename from emp;
Loop
Fetch vrec into vemp;
Exit when vrec%notfound;
Dbms_output.put_line(vemp);
End loop;
Close vrec;
Dbms_output.put_line('++++++++');
Open vrec for select dname from dept;
Loop
Fetch vrec into vdept;
Exit when vrec%notfound;
Dbms_output.put_line(vdept);
End loop;
Close vrec;
End;
```

For update cursor:

- We use for update clause to provide row level locking in a table
- Where current of cursorname
- We use current of cursorname to refer the records of a table which are processed by a cursor
- We mainly use this to simplify the coding path, without for update it is not possible to provide/refer where current of clause

Ex:

```
Declare
Cursor c is select * from emp1 where deptno = &n for update no wait;
Vrow emp1%rowtype;
Begin
Open c;
Loop
Fetch c into vrow;
Exit when c%notfound;
Update emp1 set sal = 6000 where current of c;
End loop;
End;
```

Ref cursors are two types

1. Strong ref cursors
2. Weak ref cursors

- If you restrict the ref cursor datatype with return datatype such refcursors are called "strong ref cursors"
- In strong ref cursors we have to process the only the records which are compartable to the return datatype.
- In weak refcursors there is no restrictions which means we can process records of variable data types (different data types)

Ex:-

```
Declare
```

```
Type rec is ref cursor return emp%rowtype;
Vrec rec;
Vemp emp%rowtype;
Vdept dept%rowtype;
Begin
Open vrec for select * from emp;
Loop
Fetch vrec into vemp;
Exit when vrec%notfound;
End loop;
Close vrec;
Dbms_output.put_line('++++++')
Open vrec for select * from dept;
End;
```

Cursor expressions:

EXCEPTIONS

Basically or generally errors are of two types

1. Syntactical
2. Runtime

- We will get syntactical errors ar compilation time they itself we can rectify the compilation errors
- To handle the runtime errors we use exceptions
- Types of exceptions

  User defined

  Pre-defined

  Non predefined
- In user defined exceptions user has to declared the exceptions, raise and the handle the exceptions
- We handle the errors in exception section by using exception handlers
- Whereas in the case of predefined manufacturer as to define system has to raise and user as to handle

Syntax

```
Declare
Exceptioname exception;
Begin
Raise exceptionname;
Exception
When exceptionname then
When
Exception then
End;
```

Predefined Exceptions

Ex:-

```
Declare
Vno emp.empno%type :=&n;
Vname emp.ename%type;
Begin
Select ename into vname from emp where empno = vno;
Dbms_output.put_line('hello');
Exception
When too_many_rows then
```

```
Dbms_otuput.put_line('more than one row');
When no_data_found then
Dbms_output.put_line('no such employee');
When others then
Dbms_output.put_line('other error');
End;
```

Oracle Err #	Exception name
NO_data_found	100
TOO_MANY_ROWS	-1422
CASE_NOT_FOUND	-6592
INVALID_NUMBER	-1722
VALUE_ERROR	-6502
CURSOR_ALREADY_OPEN	-6511
INVALID_CURSOR	-1001
ZERO_DIVIDED	-1476
DUP_VAL_ON_INDEX	-0001
COLLECTION_IS_NULL	-6531
SUBSCRIPT_BEYOND_COUNT	-6533
SUBSCRIPT_OUTSIDE_LIMIT	-6532
PROGRAM_ERROR	-6501
STORAGE_ERROR	-6500
LOGIN_DENIED	-1017
MEMORY_ERROR	
SELF_IS_NULL	-30625
ROWTYPE_MISMATCH	-6504
NO_DATA_NEEDED	-6548
OTHERS	

User_defined exceptions:

```
Declare
Ex exception;
Vno emp.empno%type :=&n;
Vrow emp%rowtype;
Begin
Select * into vrow from emp where empno = vno;
If vrow.comm is null then
```

CASES IN EXCEPTIONS OR EXCEPTIONAL CASES

CASE: 1

```
DECLARE
---------------;
BEGIN
---------------;
EXCEPTION
WHEN OTHERS THEN;
--------------------------------;
WHEN   EX THEN;
--------------------------------;
```

```
END;
```

NOTE: It throws an error. Others should not be at first in the list of exceptions. It should be always at last among exceptions.

CASE: 2

```
DECLARE
----------;
BEGIN
----------;
EXCEPTION
WHEN EX1 OR EX2 THEN;
-------------------------------------;
END;
```

NOTE: It is possible to mention the exception in series by separating with 'OR' operator.

CASE: 3

```
DECLARE
------------
BEGIN
------------
EXCEPTION
WHEN EX1 OR OTHERS THEN;
-----------------------------------------
END;
```

NOTE: It is not possible to mention the exception in series by separating with'OR' operator.

CASE: 4

```
DECLARE
----------;
BEGIN
----------;
EXCEPTION
WHEN EX1 AND EX2 THEN;
-------------------------------------;
END;
```

NOTE: It is not possible to mention the exception in series by separating with AND operator.

CASE: 5

```
DECLARE
----------
BEGIN
    BEGIN
RAISE EX;
    EXCEPTION;
     WHEN EX2   THEN;
     END;
EXCEPTION
WHEN EX THEN;
```

```
END;
```

NOTE: Exceptions raised in inner block can be handled in the outer block. This is called as EXCEPTION PROPAGATION.

CASE:6

```
DECLARE
----------;
BEGIN
RAISE EX2;
   BEGIN
RAISE EX;
    EXCEPTION
WHEN  EX2  THEN;
    END;
EXCEPTION
WHEN EX THEN;
END;
```

NOTE: Exception raised in outer block cannot be handled in inner block.

CASE: 7

```
DECLARE
---------------
BEGIN
            BEGIN
         RAISE EX
         EXCEPTION
         WHEN EX THEN;
         -------------------------
         RAISE
         WHEN  EX  THEN;
          ----------------------;
   END;
         EXCEPTION
         WHEN   EX THEN;
         ----------------------;
END;
```

NOTE: Exception raised in exception section cannot be handled in the same block exceptional section. But possible to handle outer bock exceptional sections which is also called as EXCEPTION PROPAGATION

CASE: 8

```
         DECLARE
--------------
    BEGIN
         DECLARE
         V  NUMBER (2):=12345
      BEGIN
        ---------------
        EXCEPTION
```

```
        WHEN VALUE_ERROR THEN
        ----------------------------------------;
      END;
        EXCEPTION
         WHEN VALUE_ERROR THEN
      ----------------------------------------;
   END;
```

NOTE: Exceptions raised in declarative section cannot be handled in same block exception sections.

TRACING AN EXCEPTION

```
        DECLARE
        BEGIN
SELECT.....;
SELECT.....;
SELECT.....;
SELECT.....;
SELECT.....;
SELECT.....;
EXCEPTION
WHEN NO_DATA_FOUND THEN
-------------------------------------------------;
END;
```

NOTE: In above case we are not able to identify in which select statement the exception has occurred. so to overcome this situation we writ as follows

```
        DECLARE
---------------- ;
BEGIN
DBMS_OUTPUT.PUT_LINE('H');
SELECT.....;
DBMS_OUTPUT.PUT_LINE('A');
SELECT.....;
DBMS_OUTPUT.PUT_LINE('R');
SELECT.....;
DBMS_OUTPUT.PUT_LINE('I');
SELECT.....;
DBMS_OUTPUT.PUT_LINE('S');
SELECT.....
DBMS_OUTPUT.PUT_LINE ('H');
EXCEPTION
WHEN NO_DATA_FOUND THEN
END;
```

NOTE:

- If we get only 'H' as output then in first select statement the exception has occurred.
- If we get 'H','A' as output then in second select statement the exception has occurred.
- If we get 'H' ,'A','R' as output then in third select statement the exception has occurred.
- If we get 'H' ,'A','R','I' as output then in fourth select statement the exception has occurred.
- If we get 'H' ,'A','R' ,I','S' as output then in third select statement the exception has occurred.
- If we get 'H' ,'A','R','S',H' as output then there are no error in select statements.

STORED PROCEDURE/ (NAMED BLOCKS)

- They are the stored programs which get stored in DB as a DB object.
- Re-usability is possible in terms reduces the redundancy.(avoids code repetetion)
- Primarily (initially) we have two types of stored procedures.

1. Application stored procedures: They are application specific.
2. Database stored procedure:

1) Procedures
2) Functions
3) Triggers
4) Packages

Mostly we use these and cursors,loops and also TCL commands.

Usages of stored procedures:-

i. Portability
ii. Security/data hiding
iii. Encapsulation
iv. Modularity
v. Scalability
vi. Easy maintenance
vii. Enhancing performance
viii. Makes application design easy
ix. Monitoring application

Tables regarding with stored procedure:-

1) User-arguments
2) User-dependencies
3) User-object
4) User-source
5) User-trigger
6) User-procedures

Procedure:-

✓ It is program unit (or) PL/SQL block which takes the parameters.
✓ In the procedure we attach header to the PL/SQL block.
✓ Procedure is a program unit which is used to execute statements.
✓ It acts as procedural statements and we use it for statements executions (more often).
✓ It is a stored program unit.
✓
✓ **A procedure has to be four sections:-**

They are:

1) Header section
2) Declarative section
3) Execution section
4) Exception section

Syntax:-create [or replace] procedure <procedure_name> (Para)[authid_user definer/current_user] is
begin

Exception

End [procedure name];

Note: -In the above syntax "is" represents standard alone procedure.

Calling procedure:-

- SQL/Plus
- SQL developer(new tool)
- Blocks
- Unix
- Front end applications(apps)
- Web applications

Parameters:-

Basically parameters of 3 types ate:

1. IN (read)
2. OUT (write)
3. INOUT (read and write)

Procedure without any parameters:-

```
create or replace procedure p is
begin
DBMS_OUTPUT.PUT_LINE('hello');
end p;
```

procedure created

```
Desc p;
Procedure p
```

Calling in SQL*plus:-

```
Exec p;
```

Calling in blocks:-

```
begin
  P;
end;
```

procedure with 'IN' parameter:-

```
Create or replace procedure p(X in number) is V number (5);
begin
v:=X+5000;
  DOCL (V);
End;
```

Note:-

Number (5) is invalid because if you define size it will throw error.

SQl*Plus:-

Calling environment:

Var a number;

We will declare this variable in executable section.

```
Exec:a:=1000;
```

Here assigning value to variable(a), from this variable(a) to I am sending value to'X'.

```
Exec p(:a);
```

Here calling the procedure.

```
declare
a number:=&n;(calling in blocks)
begin
p(a);  (this is calling environment)
end;
```

Note:-

```
x number;
x In number
```

above both two statements are same and 'In' is default parameter.

```
        Declare
vname varchar2(10):=&n;
a number(5);
        begin
        select sal into a from emp where ename=vname;
        p(a);
end;
```

```
create or replace procdure p(X number, Y number) is vname varchar2(10);
begin
select ename into vname from emp where empno=X and sal=Y;
DBMS_OUTPUT.PUT_LINE('employee name'||vname);
end;/
```

-procedure created.

```
declare
   Vno number (5):=&n;
   Vsal number (5):=&m;
begin
p(vno,vsal);
end;
```

SQL/Plus:- Calling environment

```
var a number;
var b number;
exec :a:=7839;
exec :b:=5000;
exec p(:a,:b);
```

procedure with 'OUT' parameters:-

```
Create or replace procedure p(X in number,Y out varchar) is
begin
select ename into Y from emp where empno=x;
end;
```

SQL/Plus:-

```
var a number;
var b varchar2(10);
exec :a:=7839;
exec p(:a,:b);
print b;
exec DOCL(:b);
```

blocks:-

```
declare
        a number(5):=7839;
        b varchar2(10);
begin
        p(a,b);
        DOCL(b);
end;
```

Spool concept:-

```
Sql>spool c:/gv.sql;
>select * from emp;
Sql>spool off;
Sql>spool c:/gv.sql append ; (it will append to previous one)
```

Procedure with 'IN-OUT' parameters:-

```
> create or replace procedure p(X in out number) is
begin
        select sal into X from emp where empno=x
end p;
```

SQL * Plus:-

```
var a number;
exec :a:=7788;
exec p(:a);
print a;
```

Blocks:-

```
declare
        a number(5):=&n;
begin
        p(a);
        DBMS_OUTPUT.PUT_LINE(a);
End;
```

- While creating time we will declare (arguments/parameters eg: X in number) we will call that as "formal parameters".
  EX: exec p(:a,:b) these are "actual parameters".

- We will refer the values from actual to formal in three notations:

1. Positional notation; (based on position value will be referred).

2. Named notation; (by using names (formal parameters) we can implies the value)
3. Mixed notation.

```
create or replace procedure p(X number, Y number, Z number) is
begin
   DOCL(X||' '||Y||' '||Z);
end;
/
-Procedure created.
```

Positional notations:-

```
Exec p(100,200,300);
```

Named notation:-

```
Exec p(Z=>300,Y=>200,X=>500);
```

Mixed notation:-

Note:-In mixed notation, named notation has to follow positional `

```
notation.P(100,200,Z=>300);
P(100,Y=>200,300);
P(100,Y=>300,X=>400,Z=>200);
```

In the above statements first will be valid remaining are in-valid because here we are assigning values in two times to 'X'.

- values get referred from actual to formal and formal to actual in two methods they are:

i. Reference method; (enhances performance).
ii. Copy method; (or) (pass by value method).

- By default 'In' parameter takes the values through reference method which is faster than the copy method and desirable, where as in the case of out and in out parameters values get passed through copy method. Which degrades
- the performance, so to avoid this thing we have a reserved word called 'No Copy' which is introduced from 9i onwards.

No copy:-

✓ we mention No Copy for Out and InOut parameters so, to take the values through reference method (which in turn) accelerates/alters the performance.

Note:-Mentioning NOCOPY to the 'IN' parameters throws an error.

Eg:- Create or replace procedure p(X number, Y out nocopy number) is

```
Begin
Y:=X+1000;
End p;
```

Note:- Here 'nocopy' is reserved word or key word.

SQL*Plus:-

```
Var a number;
Var b number;
Exec :a:=100;
Exec p(:a, :b);
Print b;
```

✓ Once we pass the value to 'In' parameter throughout the program we can't vary the value.

Note:- Always 'In' parameters should not be at left side of assignment operator which means 'In' parameters acts as a 'constant' in the scope of program.

Create or replace procedure p(X in number, Y out number) is

```
Begin
    X:=200;
    Y:=X+100;
    End;
```

- ✓ Exec p(100,:b)

Local subprograms:-

- ✓ They are procedures/functions which are defined in the declarative section named and unnamed blocks.
- ✓ We have to call these local programs within the scope of that block.
- ✓ It won't get stored anywhere else on by themselves.

```
Declare
        Procedure p is
 Begin                                  |   local sub programs
        DOCL('hello');
   End p;
Begin p;
End; Here we won't mention create/replace.
```

Declarative section we will handle these 8:-

- ✓ Variables, exceptions, cursors, constants, data types, programs, defining local programs.

Forward declaration:-

- ✓ Basically if you want to call a program it has to be get defined very previously.
- ✓ Whenever you call a program before defining throws an error.
- ✓ For mutual exchange purpose sometimes we have a need to call a procedure before defining.
- ✓ To fulfill this requirement we will declare the procedure very previously which is calling before defining.
- ✓ If you want to call a procedure before defining you have to declare those procedures vary previously.

```
Declare
        V number (5):=5;
        Procedure p2(Y inout number);       --forward declaration
        Procedure p1(X inout number) is
  Begin
        If X>0 then
                Docl(X);
                X:=X-1;
        P2(X);--calling
                End if;
                End p1;
                Procedure p2(Y inout number) is --defining
        Begin
                        P1(Y);
                End p2;
      Begin
P2(v);  -- calling and executable section first compiler comes here.
 First define then call any procedure without defining if
you need to make a call at least we need to declare.
 End;
```

- ✓ Create or replace procedure p3 is

```
        (1)
```

```
        End p3;
Exec p3;
```

Note:-

- ✓ A procedure can optionally contain 'return' statement but it won't through any value as in the given eg.

```
        Create or replace procedure p3 is
                V  number(5):=100;
                    Begin
                   DOCL(v);
                   Return v;
                   DBMS_OUTPUT.PUT_LINE(v);
                   End p3;
```

Functions

- ✓ They are the PL/SQL program units which allow parameters similar to that of procedures.
- ✓ But unlike procedures they return value by default.
- ✓ Functions are useful for calculation purpose and for data manipulation purpose (DML).
- ✓ Functions makes the queries simple, readable and also enhance the performance.

Note:- Providing out and inout parameters' in functions is not preferable.

Syntax:- create or replace function <function_name> (Para) return datatype
[pipelined | aggregate | parallelenabled | deterministic | authiduser] is/as
Begin
  Code;
  Return statement;
  Exception

  End[procedure name];

Calling functions:-

1. SQL/Plus
2. Blocks
3. SQl Developer
4. Apps
5. Select statement
6. Objects

Functions without any parameter:-

```
create or replace function fun return number is
v number(5):=&n;
begin
return v;  -- we can give assign value/exp/literals/collections.
end;
```

block:-

```
declare
a number(5);
begin
        a:= fun;
        DBMS_OUTPUT.PUT_LINE(a);
```

```
    End;
```

SQL/Plus:-

```
Var a number;
        Exec :a:=fun; --where 'a' holds the value
        Print a;
        Create or replace procedure p is
        B number(5);
        Begin
B:=fun;
        DBMS_OUTPUT.PUT_LINE(b);
        End p;
Create or replace function f1 return number is
Begin
  Return fun;
End f1;
Select fun from dual;
```

Note:- In the return statement we can mention value directly, expression, another function, cursor variables, index by table (collection), Boolean value, and so on…..

Function with IN parameter:-

```
Create or replace function fin(X number) return variable is Vname  emp.ename%type;
        Begin
        Select ename into vname from emp where empno:=X;
        End fin;
```

SQL/Plus:-

```
        Var a carchar2(10);
        Var b number;
        Exec :b:=7788;
        Exec :a:=fin(:b);
        Print a;
```

Blocks:-

```
                Declare
                        A varchar2(10);
                        B number(5):=&n;
                Begin
                        A:=fin(b);
                        DBMS_OUTPUT.PUT_LINE(a);
                End;
        Select fin(empno) from emp;
Create or replace function fn(X varchar2) return number is Vno number(5);
        Begin
                Select empno into vno from emp where ename=X;
        Return vno;
        End fn;
```

SQL>select fn(fin(empno)) from emp;

Function can contain 'n' no of 'return' statements but alwaya executes only one return statements.

Using multiple return statements in functions:-

```
Create or replace function f(X number) return number is v number(5):=1000;
    Begin
       If x>100 then
         Return(x);
           Else
          Return v;
           End if;
     End;
```

```
Create or replace function f return….
          Begin
Return X;
Return Y;
End;
```

- If control looks first return statement the control automatically comes out of function them it won't goes to second return statement.
- DBMS_OUTPUT.PUT_LINE won't supportsT(or) F

SQL*Plus:-

```
Var a number;
Exec :a:=F(500);
Print a;
```

Function without parameters:-

Returning Boolean value from the function:-

```
Create or replace function f return Boolean is v number(5):=100;
Begin
          Return null;
End;
```

Blocks:-

```
Declare
    A Boolean;
   Begin
     A:=f;
     DOCL('value ' | | a);
    End;
```

SQL won't supports Boolean datatype.

EX for out:-

```
Create or replace function f(X out number) return number is v number(5):=100;
Begin
          X:=v+500;
Return v;
End;
```

SQL*Plus:-

```
          var a number;
          var b number;
```

```
exec :a:=f(:b);
print a;
100
Print b;
600
```

Blocks:-

```
Declare
    A nmber(5);
    B number(5);
    Begin
    A:=f(b);
    DBMS_OUTPUT.PUT_LINE(a||' '||b);
    End;
```

SQL> select f(:b) from dual;

Note: It is not possible to call the function which are having out and in out parameters in 'select statement'.

Function with inout parameter:-

```
Create or replace function f(X inout number) return number is v umber(5):=100;
Begin
   X: =v+500+X;
   Return v;
End;
```

SQL*Plus:-

```
Var a number;
Var b number;
Exec: b: =500;
Exec: a: =f (: b);
Print a;
Print b;
```

Blocks:-

```
Declare
    A number (5);
    B number (5);
    Begin
        A: =f (b);
        DBMS_OUTPUT.PUT_LINE (a||' '||b);
    End;
```

Using functions:-

We can use the functions in the following areas

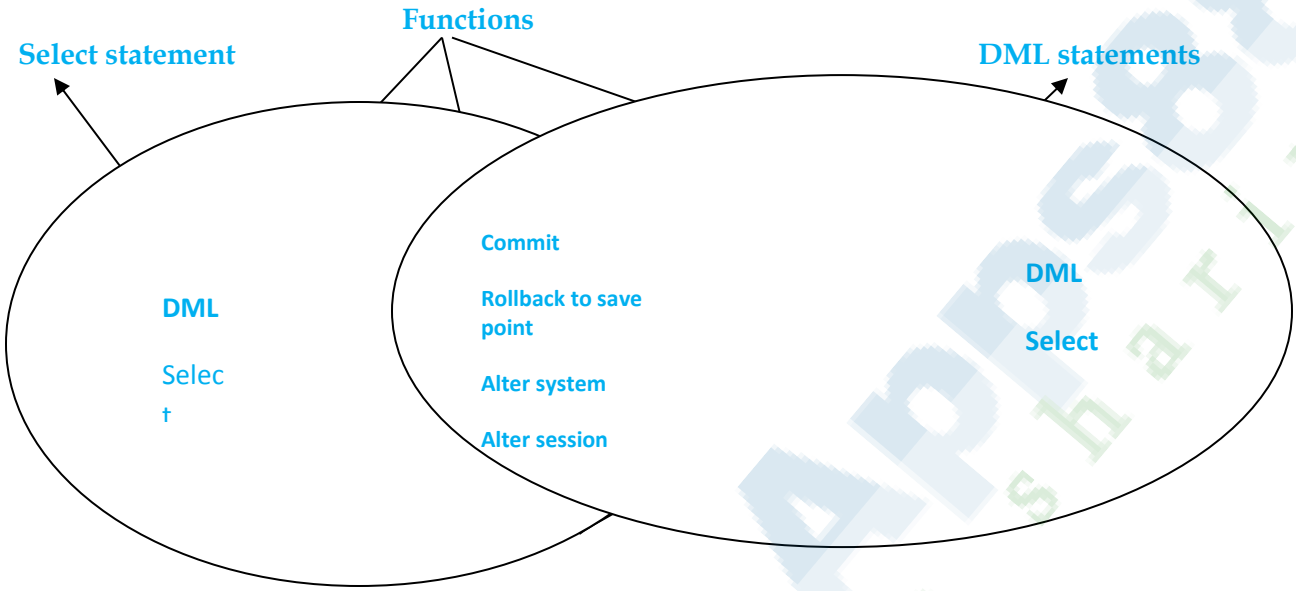
i. Where clause
ii. Start with
iii. Connect by
iv. Having
v. Group by
vi. Order by
vii. Select
viii. Update set clause

ix. Insert value clause
x. From clause

We cannot use the functions in the following areas

i. Default(alter and create)
ii. Check constraint

Restrictions of function:-



- In the above diagram select statements DML is not possibls and select is possible.
- In the DML statements DML will not possible on same function table. But it will possible on different function tables.
- In DML statements select possible on different (or) same function table.

NOTE:-

- ✓ We can use select statement in DML operations.
- ✓ Using DML operations in select statements is not passible either directly (or) indirectly.
- ✓ Functions/procedures i.e DML
- ✓ Select f (DML) from dual;
- ✓ Select f (select) --invalid
- ✓ Update t1 set val=f(DML(T1)) --invalid
- ✓ Update t2 set val =f(DML(T2)) --valid
- ✓ Generally SQL statements won't allow us to call the functions which are having DML operations. If you do so, resulting into error. If you won't to restrict the user not to provide DML operations in a function which are frequently used in select statements, we need to provide "program restrict reference" while creating a function, in this manner we will eliminate the impurities.

```
Create or replace function f return number is
    Begin
        Null;
    End f;
```

Note:-

We can define a function without return statement but at the time of calling it throws error as such in above eg.

```
Var a number;
        Exec :a:=f;      --throws an error.
```

Diff between procedure and function:-

Procedure:-

- ✓ Procedure may (or) may not return a value.
- ✓ Not passable to call in SQL statements.
- ✓ It acts as a PL/SQL statement execution (for statements execution purpose).

Functions:-

- ✓ By default function returns single value.
- ✓ It is possible to call in SQL statements.
- ✓ For calculations (or) computing purpose.
- ✓ Using functions in select statement will enhance the performance and simplifies the coding.

Forward declaration:-

- ✓ Basically if you want to call a program it has to be get defined very previously.
- ✓ Whenever you call a program before defining throws an error.
- ✓ For mutual exchange purpose sometimes we have a need to call a procedure before defining.
- ✓ To fulfill this requirement we will declare the procedure very previously which is calling before defining.
- ✓ If you want to call a procedure before defining you have to declare those procedures vary previously.

```
Declare
V number (5):=5;
Procedure p2(Y input number);        --forward declaration
Procedure p1(X input number) is
  Begin
If X>0 then
        Docl(X)
X: =X-1;
P2(X);  --calling
End if;
End p1;
Procedure p2(Y input number) is  --defining
Begin
        P1(Y);
End p2;
   Begin
P2 (v);   -- calling and executable section first compiler comes here.
First define then call any procedure without defining if You need to make a call  at least we need to declare.
 End;

Create or replace procedure p3 is
        (1)
        End p3;
Exec p3;
```

Note:-

A procedure can optionally contain 'return' statement but it won't through any value as in the given eg.

```
Create or replace procedure p3 is V  number(5):=100;
 Begin
```

```
    DOCL(v);
    Return v;
    DBMS_OUTPUT.PUT_LINE(v);
End p3;
```

Diff between procedure and function:-

Procedure:-

- Procedure may (or) may not returns a value.
- Not passable to call in SQL statements.
- It acts as a PL/SQL statement execution(for statements execution purpose).

Functions:-

- By default function returns single value.
- It is possible to call in SQL statements.
- For calculations (or) computing purpose.
- Using functions in select statement will enhance the performance and simplifies the coding.

Packages:-

- It is a container/program unit area which is useful to store related things at one place.
- It provides modularity, scalability, encapsulation, data security, portability, code analysation, debugging the code, tracing the code, profiling the code, location monitoring and so on…
  Alters/decreases the redundancy.

Note:-

Packages won't allow parameters, nesting, and calling.

Packages consist of two parts:

1. Package specification(PS)
2. Package body

Package specification:-

- It is a prototype for package body program.
- In specification we declare variables, cursors, exceptions, procedures, functions and so on…
- This is for information purpose.
- It can exist without body.
- Declaring cursor variables is not possible; defining ref cursor data type is possible.
- A package body can't exist without package specification but reverse is not so…
- Package specification and body stores in different memory areas.
- PL /SQL objects defined in package specifications are considered as global objects, won't allow coding part.

Package body:-

- It consists of program coding.
- A package body can optionally has executable section.
- Variables and programs which are defined in package body without specifying I package specification are called as local variables, local programs.
- We can drop a package body without dropping package specification
  Package specification drops.

Syntax for package specification:-

Create or replace package <package_name> is variables, cursor,exceptions,datatypes……
Declaring procedure,functions…….

End packagename;

Pragmaautonomytransaction (Tx):-

It is an independent Tx happens individually irrespective of parent Tx.

Limitations:-

- Package specification won't allow pragma; we can apply for packeged procedures and packages.

```
Create or replace procedure p is pragma autonomius_transaction;
Begin
Insert into nestab values(10);
End p;
Create table nestab(sno number(5));
Select * form nestab;
```

Calling environment:

```
Begin
Insert into nestab values(11);
P;
Insert into nestab values(12);
Rollback;
End;
```

Output: 10

- While using pragma autonomus Tx we need to mention commit, rollback as mandatory.
- DDl- autocommit commands
- DML- non-autocommit.

```
Create or replace procedure p is pragma autonomius_transaction;
Begin
Insert into nestab values(10);
Rollback;
End p;
Begin
Insert into nestab values(11);
P;
Insert into nestab values(12);
Commit;
End;
Select * from nestab;
```

Out put:-

```
11
10
12
Create or replace procedure p is
Begin insert into nestab values(10);
Rollback;
End p;
Begin insert into nestab values(11);
P;
Insert into nestab values(12);
Commit;'
End p;
```

Out put:
12
Note:-We avoiding mutating error using pragma.atonomous_transaction.

Pragma inline:- (11g)

- Which is used to including the programs(11g).
- Pragma inlining will enhance the performance.

Deff:
In lining a program means replacing the procedure call with actual executable code copy of a program.
Note:-
Programs which are having static code and frequently used programs (or) subject to the pragma inline(preferrable).
Syntax:-

```
Pragma inline('procedure name',{'yes/no'});
Declare
Stime integer;
Etime integer;
V number;
Function f(x number) return number is
Begin
Return x;
End f;
Begin
Pragma inline('f','yes');
Stime :=dbms_utility.get_time;
For I in 1..10000 loop
V:=f(i);
End loop;
Etime:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(etime-stime);
Pragma inline('f','no');
Stime:=dbms_utility.get_time;
For I in 1..10000 loop
V:=f(i);
End loop;
Etime:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(etime-stime);
End;
```

Packages:-

- It is a container/program unit area which is useful to store related things at one place.
- It provides modularity, scalability, encapsulation, data security, portability, code analysation, debugging the code, tracing the code, profiling the code, location monitoring and so on…
- Alters/decreases the redundancy.

Note:-
Packages won't allow parameters, nesting, and calling.

Some built-in packages:-
Dbms-lob-handles lob related values -- cannot call package in package

Dbms-fga(11g)-handles fine grain editing. --no parameters
Dbms-lock-to provide locks and latches
Dbms-describe-display the information regarding overload, level and arguments
Dbms-profile-profiling the code
Dbms-monitor-for application monitoring
Dbms-sql-to handle DDl commands in PL/SQL
Dbms-job-for defining and scheduling the jobs
Dbms-DDL
Dbms-transaction-to handle the transactions
Dbms-trace(11g)-tracing the code
Dbms-hprof(11g)-for hierarchical profiling
Dbmssession-session related data
Dbms-metadata-handles the metadata(data to the data)
Utl-file-for file handling
Dbms-utility-for miscellaneous
Dbms-rls-for row level security
Dbms-dependency-handles dependency objects
Dbms-revalidation-
Utl-tcp-
Dbms-output-
Dbms-result-cache (11g)-for data caching
Dbms-pipe-handles inter related session
dbms-sechdule-
dbms-warning-
dbms-debug-

Packages consist of two parts:

- Package specification(PS)
- Package body

Package specification:-

- It is a prototype for package body program.
- In specification we declare variables, cursors, exceptions, procedures, functions and so on…
- This is for information purpose.
- It can exist without body.
- Declaring cursor variables is not possible; defining ref cursor data type is possible.
- A package body can't exist without package specification but reverse is not so…
- Package specification and body stores in different memory areas.
- PL /SQL objects defined in package specifications are considered as global objects, won't allow coding part.

Package body:-

- It consists of program coding.
- A package body can optionally has executable section.
- Variables and programs which are defined in package body without specifying I package specification are called as local variables, local programs.
- We can drop a package body without dropping package specification
- Package specification drops.

Syntax for package specification:-

Create or replace package <package_name> is variables, cursor,exceptions,datatypes……

Declaring procedure, functions…….
End packagename;

Sysntax for package body:-

Create or replace package body <package_name> is variables, cursor….
Defining subprograms
Optional executable section;
End package_name;

Eg:

Crate or replace package pack is v number(5):=400;
Ex exception ;
Cursor c is select * from emp;
Procedure p(X inout number);
Function f(y in out number);
Return number;
End pack;

- Create or replace package body pack is L number(5):=500;

Function lf(Z in number)return number is lv number(5);
Begin
Lv:=Z+L;
Return lv;
End lf;
Procedure p (X inout number)is pv number(5);
Begin
Pv:=2000+lf(X);
X:=pv+5000;
End p;
Function f(Y inout number)return number is
Begin
Y:=Y+lf(v);
V:=Y+L;
Return v;
End f;

If you want to define package body first we need to define package specification.

SQL*PLUS:

SQL>var a number;
Exec :a:=1000;
Exec pack.p(:a);
Print a;

BLOCKS:

```
Declare
a number(5):=2000;
begin
pack.p(a);
DBMS_OUTPUT.PUT_LINE(a);
End;
```

FUNCTIONS:

SQL*PLUS

```
Var a number;
Var b number;
Exec :b:=4000;
Exec :a:=pack.f(:b);
```

BLOCKS:

```
Declare
A number(5);
B number(5):=1000;
Begin
A:=pack.f(:b);
DBMS_OUTPUT.PUT_LINE(a||' '||b);
End;
```

Example for Packaged Crusors:

```
declare
vrow emp%rowtype;
 begin
open pack.c;
 loop
fetch pack.c into vrow;
DBMS_OUTPUT.PUT_LINE(vrow.ename);
 If vrow.ename='scott' then
Raise pack.ex;
 End if;
 End loop;
 Exception
 When pack.ex then
 DBMS_OUTPUT.PUT_LINE('packex')
 End;
 Declare
 Vrow emp%rowtype;
 Begin
 Fetch pack.c into vrow;
 DBMS_OUTPUT.PUT_LINE(vrow.ename);
 End;
```

OutPut: Ford

NOTE:-

- If you won't close the packaged (pack's) cursor in any program then that is last for entire session.
- We can call the packaged procedures and functions outside of package which are specified in package specification(global accessing).
- Attempting to call packaged local sub programs to call outside of package throws an error.

Using cursor variable as a parameter value:

```
Create or replace package pack is type rec is ref cursor;
Procedure p(X rec);
End pack;
```

```
Create or replace package body pack is Procedure p(X rec)is vrow emp%rowtype;
Begin
Loop
Fetch X into vrow ;
DBMS_OUTPUT.PUT_LINE(vrow.ename);
Exit when X%not found;
End loop;
End p;
End pack;
```

BLOCK:

```
Declare
Type recl is ref cursor;
Vrec recl;
Begin
Open vrec for select * from emp;
Pack.p(vrec);    --calling
End;
```

Note: Defining cursor variable in package specification will not be allowed but defining ref cursor is possible.

We can use cursor variable as an 'out' parameter:

```
Create or replace package p(X out sys_refcursor) is vrec sys_refcursor;
Begin
Open vrec for select * from emp;
X:=vrec;
End p;
```

SQL*PLUS:

```
Var v refcursor;
Exec p(:v);
```

Using cursor variable in return statement of a function:

```
Create or replace function f return sys_refcursor is vrec sys_refcursor;
Begin
Open vrec for select * from emp,dept;
Return vrec;
End f;
Exec :v:=f;
Print v;
```

Note: If procedure and functions is present in specification then we go for package body otherwise no need.

Packaged Cursors:

```
Create or replace package pack is cursor c return emp%rowtype is select * from    emp;
End pack;
```

Here we are defining 'cursor' in package specification we can use this anywhere.

```
Begin
For i in pack.c
Loop
DBMS_OUTPUT.PUT_LINE(i.ename);
End loop ;
```

End;

We can hide the cursor select statement through package concept as shown in the snippent:

```
Create or replace package pack is cursor c return emp%rowtype ;
End pack;
Create or replace package body pack is cursor c return emp%rowtype is select * from emp;
End pack;
Begin
For i in pack.c
Loop
DBMS_OUTPUT.PUT_LINE(i.ename);
End loop ;
End;
```

Out Put:

Emp 14 records

- A package body can optionally contain executable section. Which is one time initialization but it should be at last in the package body if we have any sub programs.

```
Create or replace package pack is v number (5);
End pack;
Create or replace package body pack is
Begin
V: =5000;
End pack;
```

Note:-

We can also call the packaged function in select statement but that should not contain out and inout parameter.

```
Drop package <package_name>
```

- Here along with package specification, body alo will drop.
- Dropping packaged body without dropping package specification

```
Drop package body pack;
```

Polymorphism(overloading):-

- Defining multiple local subprograms with the very same name but by differing number, order and data types of parameters.

```
Create or replace package pack is Procedure p(x number);
Procedure p (x number, y number);
Procedure P(x number, y varchar2);
Procedure p(y varchar2, x number);
End pack;
```

Note:-The data types should not be same family while comparing to procedures.

```
Creating or replace package body pack is procedure p(x number) is
 Begin
 DBMS_OUTPUT.PUT_LINE(x);
 End p;

Procedure p(x nmber, y number) is
Begin
DBMS_OUTPUT.PUT_LINE(x||y);
```

```
End p;
Procedure p(x number, y varchar2) is
Begin DBMS_OUTPUT.PUT_LINE(x||''||y);
End p;
Procedure p(y varchar2, x number)is
Begin
DBMS_OUTPUT.PUT_LINE(y||''||x);
End p;
End;
```

Calling environment:-

```
SQL>exec p(100);
SQL>exec p('a',200);
SQL>exec p(200,'a');
```

Note:-Overloading is not possible for standard alone program(schema level programs).

- ✓ V$parameter=>all DB related parameters will store
- ✓ PL/SQL-optimize-level-initialization parameter.

Where level-0-ideal
Level-1
Level-2-preferrable
Level-3(11g)-aggressive much more faster.

Tuning the PL/SQL code:- optimizing the PL/SQL code:-

- We will tune the PL/SQL code based on initialisation parameter i.e PL/SQL-optimize-level in this we will set the levels from 0 to 3. Level 2 is default which allows us

1. In lining (11g) a program.
2. Avoiding the in lining program.

- Level 0 and 1 won't allow us to in lining program.
- Level 3 won't allow us to inline a program but allow us to avoid in lining program.

```
Declare
  Sdate number:=0;
  Edate number:=0;
  D_code number:=0;          --dead code no use in program
  L_r number:=0;
  Function f(x number) return number is
 Begin
 Return x;
 End f;
Begin
  Sdate:=dbms_utility.get_time; --here we are assigning to one variable
so call it as function.
  For I in 1..1000000
  Loop
  D_code:=0;
```

```
L_r:=l_r+f(i);          --calling

End loop;
Edate:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(edate_sdate);
End;
```

SQL>alter session set PLSQL_optimize_level=0;
Time:23session set PLSQL_optimize_level=1;
Time:22session set PLSQL_optimize_level=2;
Time:21session set PLSQL_optimize_level=3;
Time:9session set PLSQL_optimize_level=4;

- Dbms_utility.put_line;
- Get_time;

SQL>show parameter PLSQL_optimize_level;

Understanding the NOTNULL constraint for a PL/SQL variable:-

Providing NOT NULL constraint for a PL/SQL variable is not preferable doing so, will degrades the performance because nullity will be checked through one virtual variable created implicitly by the engine.

```
Declare
Sdate number:=0;
Edate number:=0;
V number not null:=0
Begin
Sdate:=dbms_utility.get_time;
For i in 1..100000000 loop
V:=I;
End loop;
Edate:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(edate_sdate);
End;
```

Output:
Time :- 72 minutes.

Note: Internally it takes one virtual variable and it checks v number NOT NULL(it is not preferable more time it will take if you use coading in program it is better like if v is not null).

Same as above program but variable using without NOTNULL.

Output:
Time: 44

Using pls integer is preferiable than the number since it is faster:-

```
V pls_integer:=0;        --we use these only in PL/SQL and remaining is same as above.
```

Time:-12

Using simple integer is more refereable than pls_integer:-

Simple integer is a derivate of pls_integer , but avoids overflow error and allow null values.

Note: Up to 10g every datatype allows null values but n 11g simple integer won't allow null value. Pls_integer size -2147483648 to 2147483647

Note: Pls_integer can store max of 2147483647, if you assign above of this value throws an error i.e overflow error, to overcome this error we have a datatype called "simple-integer"(11g) and even simple integer won't allow "null" values (NOTNULL datatype) .

```
Declare
  V pls_integer:=214783646;
 Begin
  V:=v+1;
  DBMS_OUTPUT.PUT_LINE(v);
  V:=v+1;
  DBMS_OUTPUT.PUT_LINE(v);
 End;
```

Out put: Numeric overflow error.

To overcome this

```
Declare
V simple_integer:=2147483646;
Begin
V:=v+1;
DBMS_OUTPUT.PUT_LINE(v);
```

```
V:=v+1;
DBMS_OUTPUT.PUT_LINE(v);
End;
```

Out put:

2147483647
-2147483648

Pragmaautonomoustransaction (Tx):-

It is an independent Tx happens individually irrespective of parent Tx.

Limitations:-

Package specification won't allow pragma; we can apply for packeged procedures and packages.

```
                Create or replace procedure p is pragma autonomous_transaction;
                Begin
Insert into nestab values(10);
End p;
                Create table nestab(sno number(5));
Select * form nestab;
```

Calling environment:

```
Begin
Insert into nstab values(11);
P;
Insert into nestab values(12);
Rollback;
End;
```

Output: 10

- While using pragma autonomus Tx we need to mention commit, rollback as mandatory.
- DDl- autocommit commands
- DML- non-autocommit.

```
Create or replace procedure p is pragma autonomius_transaction;
Begin
Insert into nestab values(10);
Rollback;
End p;
Begin
Insert into nestab values(11);
P;
Insert into nestab values(12);
Commit;
End;
Select * from nestab;
```

Out put:-

11
10
12

```
Create or replace procedure p is Begin insert into nestab values(10);
Rollback;
End p;
```

```
Begin insert into nestab values(11);
P;
Insert into nestab values(12);
Commit;
End p;
```

Out put:

12

Note: We avoiding mutating error using pragma.atonomous_transaction.

Pragma inline:- (11g)

- Which is used to including the programs(11g).
- Pragma inlining will enhance the performance.

Deff: Inlining a program means replacing the procedure call with actual executable code copy of a program.

Note: Programs which are having static code and frequently used programs (or) subject to the pragma inline(preferrable).

Syntax:

Pragma inline('procedure name',{'yes/no'});

```
Declare
Stime integer;
Etime integer;
V number;
Function f(x number) return number is
Begin
Return x;
End f;
Begin
Pragma inline('f','yes');
Stime :=dbms_utility.get_time;
For I in 1..10000 loop
V:=f(i);
End loop;
Etime:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(etime-stime);
Pragma inline('f','no');
Stime:=dbms_utility.get_time;
For I in 1..10000 loop
V:=f(i);
End loop;
Etime:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(etime-stime);
End;
```

LOB datatype:

Before of 8i if you want to store the images or huge information we opt(choose) for long datatypes but , we have so many restrictions on long datatypes to overcome this disadvantage we have LOB datatype.

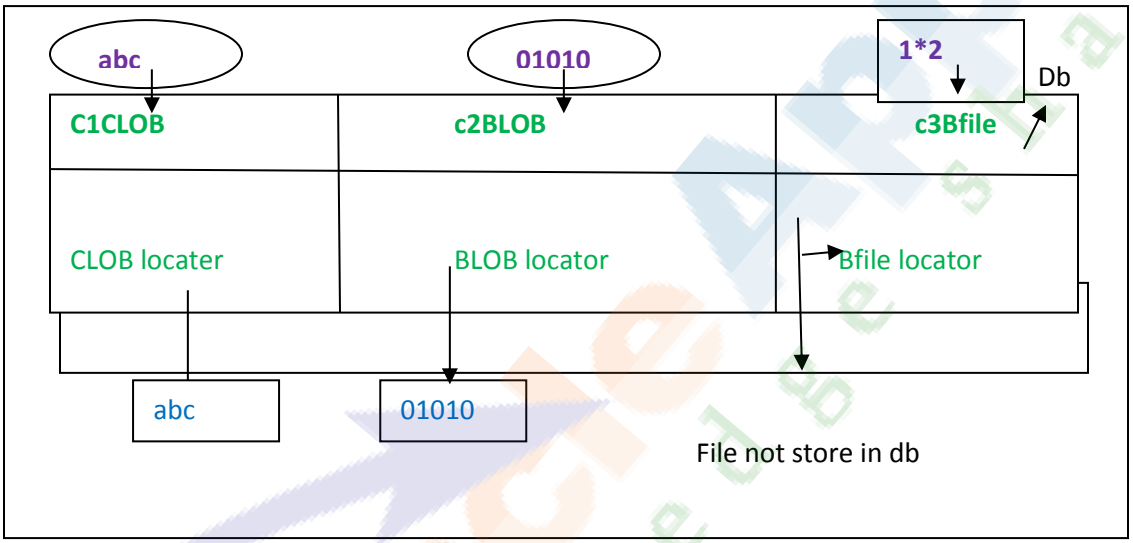
Cliassifications of LOB datatype:-

LOB datatypes can be devided as below:

- Internal
  - Persistance
  - Non-persistence(temporary)
    - BLOB

- CLOB
- NCLOB
- External
- Bfiles

CLOB: allows huge information upto 4GB from 11g onwords even it supports 8 to 128TB.
BLOB: stores binary data, allows images, audio,video files and so on…
NCLOB: it stores national database chracterset data. Supports multi languages.
Bfiles: useful to store files in the form of binary data.
Commit and rollback is not passible to provide on this data.



- We'e to make use of transactions by using locators.
- We handle LOB datatype through a package is'DBMS_LOB'
  Locator starts-null,0,empty.

Handling lob data by using DBMS_lob package:
If we are using Lob datatype's we've to make use of packages compulsoraly.

```
Declare
VCLOB clob;
Max_size integer;
Offset integer:=1;
Wdata varchar(100):='welcomw to LOB world';
Rdata varchar2(100);
Begin
Delete from clobdata;
Insert into clobtab values(10,empts_clob);
Select ccol into vclob from clobtab;
Max_size:=length(edata);
Dbms_lob.open(vclob,dbms_lob.lob_readwrite);
Dbms_lob.write(vclob,max_size,offset,wdata);
Dbms_lob.read(vclob,max_size,offset,rdata);
```

```
Dbms_lob.close(vclob);
DBMS_OUTPUT.PUT_LINE(rdata);
End;
```

Create table clobtab(sno number(5),ccol clob);
Insert into clobtab values(10,'abc');

Create table imagetab(sno number(5), image bfile);

```
Declare
Bimage bfile:=bfilename('DY','gimage.bmp');
Image_loc bfile;
Max_data integer:=60;
Offset_integer:=1;
Raw_data raw(100);
Begin
Delete from imagetab;
Insert into imagetab values(10,bimage);
Select image into image_loc from imagetab;
Dbms_lob.open(image_loc);
Dbms_lob.read(image_loc, max_data, offset,raw_data);
Dbms_lob.close(image_loc);
DBMS_OUTPUT.PUT_LINE(rawtohex(raw_data));
DBMS_OUTPUT.PUT_LINE(utl_raw.cast_to_varchar2(raw_data));
End;
```

- Create directory dy as 'c:\';
- Grant read on directory by to apps;
- Create a file with name 'gv.txt' and provide data and save in path mentioned.
  As in directory 'dy';
  Create table direction(sno number(10),dcol clob);

```
Declare
Vdir bfile:=bfilenamme('DY','gv.txt');
Colfile clob;
Max_data integer:=10;
Des_offset integer:=1;
S_ofset integer:=1;
Lang_ctx integer:=dbms_lob.default_lang_ctx;
War_mes integer;
Begin
Delete from direction;
Insert into direction values(10, empty_clob);
Selection dcol into colfile from direction;
Dbms_lob.open(colfile,dbms_lob,lob_readwrite);
Dbms_lob.open(vdir);Dbms_lob.load clob from file(colfile, vdir, dbms_lob.maxsize,
des_offset, s_offset, nls_charset_id('USTASCII'), lang_ctx, war_mes);
Dbms_lob.close(colfile);
Dbms_lob.close(vdir);
End;
```

Select * from direction;

Triggers:-

- They are the stored programs fires implicitly unlike subprograms.
- Triggers fires automatically when event occurs.

- We can't call trigger and pass parameters and can't nest (trigger with in trigger).

Usages:-

- Data auditing
- Enforcing the referential integrity
- Security
- Data replication
- Application monitoring(AM)
- Enforcing the data
- Triggers have their own name space.
- Triggers won't allow commit and rollback, but by using "pragma atonomous transaction we can mention commit and rollback in triggers.
- Basically triggers are of two types
  1.Application trigger
  2.Database triggers

Database triggers:-

1. DML triggers (table)
2. Instead of trigger(views)
3. DDL trigger(schema) -- 3 and 4 never write these in DBA level.
4. DB trigger(database)
5. Compound trigger(11g)(table)
   We will write triggers on tables, views, schema and database.

DML triggers:-

- We provide DML triggere on table
- Based on DML events execution of trigger takes place implicitly.
- This triggers are again of two types:

1.) statement level trigger (or) table level trigger
2.) row level trigger

Statement level trigger:-

This trigger executes only once for an entire table/for bunch of records execution of this trigger takes place atleast once. Even if table data won't get effected.

Rowlevel trigger:-

- this trigger executes for each of row.
- This trigger won't get executes atleast once if table data won't get effected.

Syntax of DML trigger:-

Create or replace trigger <trigger_name> (1)before/after DML operations on <table_name>[disable/enable](2)[foreach row](3)[when condition][declare]
Begin
Code;
Exception
End;

(1)-trigger timing:-

It specifies when trigger has to fire.

(2)-trigger level:-

Specifies what ever row level/statement level.if you mention for row i.e rowlevel else statement level but bydefault statement level.

(3)-trigger condition:-(not preferrable)

If further provides the additional restriction on trigger execution.in trigger conditon should always be a boolean expression statement level trigger won't allow trigger condition.

(4)-trigger body:-

It specifies what action we have to perform through trigger.

Ex for statement level trigger:-

Write a statement level trigger so not tto allow any DML operation on a table on weekends.

Create table stab(sno number(5))

```
Create or replace trigger string before insert or update or delete on stab;
Begin
If to-char(sysdate,'dy')in('thu','sun')then raise_application_error
(-20003,'DML operations are not allowed on weekends');
Else
DBMS_OUTPUT.PUT_LINE('dml operations');
End if;
End string;
```

- Trigger created.
- Insert into stab values(10); --invalid
- Select * from stab;

  No rows selected.
- Generally most of the trigges make use of 'before' instead of after. We can define a trigger name with same table name on which we are defining
- Create or replace trigger stab on stab.

Note: because trigger uses different namespaces, table uses different namespaces so possible.

Rowlevel trigger:

It will make use of pseudo records as shown in following table.

Virtual table:

	old	new
insert update delete	null	null

Here we wil represent new and old in this program i.e rowlevel trigger program.

Write a rowlevel trigger to update the salaries witch one specific value for an increment, if Any one of the existing salaries is greater than new salaries then I have to cancel all the transactions happened by trigger.

```
Create or replace trigger ustrig before update on emp1;
For each row
Begin
If :old.sal>:new.sal then
Raise_application_error(-20003,'sal cannot be decremented');
Else
DBMS_OUTPUT.PUT_LINE('icremented');end if;
End;
```

- From the trigger if we get any error, all the previous transactions will get cancelled.

Eg for trigger when condition:-

- When condition skips the execution of trigger body when 'when condition' becomes 'false'.(but insertion takes place).
- If when condition becomes true then allows trigger body to execute.
- Create or replace trigger logtrig before insert or update or delete on logtab;
  For each row
  when(to_char(sysdate,'HH')not between '05' and '08')
  begin
  DBMS_OUTPUT.PUT_LINE('login time');
  End;
- Insert into logtab values(10);
- 1 row created.
- Create table logtab(sno number(5));

Using :new and :old in when condition:-

Create or replace trigger emp1trig before insert or update or delete on emp1;
For each row
When(new.sal<old.sal)
Begin
DBMS_OUTPUT.PUT_LINE('oldsal<newsal');
End;

- In when condition we won't use :new and :old but in trigger body we can use, if you use also it throws an error.
- Update emp1 set sal=4000;

Note: Trigger when condition won't allows colons(☺ to refer old and new values.

Enforcing referential integrity:-

- Triggers can't chek the old/existing data, it checks only incoming data but where as in the case of constraints they check both incoming and existing data.
- Constraints can give guarantee for centralized data.
- Triggers are an advance of constraints.
- Create trigger contrig after insert on ltab;
  For each row
  Begin
  Insert into ptab values(:new.sno);
  End;
- Insert into ltab values(11);
- Before of constraint checking trigger execution takes place.

Order of execution:

-
- Before statement level trigger(BSLT).
- Before row level trigger(BRLT)>
- After row level trigger(ARLT).
- After statement level trigger(ASLT).

DDL triggers:-

Syntax:

Create or replace trigger <trigger_name> before/after DDL on schema
Begin

……
Exception
……
End [trigger_name]

- We write DDL on schema level(insert, update, delete).

DDL attributes:
In DDL we have more than 100 attributes but here we will go for

- Ora_sysevent
- Ora_DICT_obj_name
- Ora_DICT_obj_type

We will provide DDL commands on schema, mainly for auditing purpose.
Create trigger audtrig before create or drop on schema
Begin
Insert into audtab values (user, ora_sysevent, ora_dict_obj_name, ora_dict_obj_type, sysdate);
End audtrig;
Create table audtab(suser varchar2(10), sevent varchar2(10), sname varchar2(10), stype varchar2(10), sdate date);
Create table SAM(sno number(5));
Select * from audtab;

Suser	Sevent	Sname	Stype	Sdate
Apps	Create	Sam	Table	11-mar-13

- Drop table sam;
- Select * from audtab;

We will write DB triggers on below mentioned:-

Before	Log on	After(T)
Befor(T)	Log off	After
Before(T)	Shutdown	After
	Servererror	errornumber
before	Startup	After(T)

- Attaching the procedure to the trigger in the place of trigger body with 'call statement', so to reduce the redundancy as in the following eg.
  Create or replace procedure p is
  Begin
  DBMS_OUTPUT.PUT_LINE('hello');
  End;
  Create table RAM(sno number(5));
  Create or replace trigger protrig before insert on RAM
  Call p(don't use semicolon here, if you use you will get error)
  /

-trigger created.

- ✓ Insert into RAM values(10);
  Hello
  -1 row created.

Advanced topics in triggers⊗introduced from 11g)

- ➢ It follows reserved word or keywords followed by 11g.
- ➢ Oracle won't give gurantee for the order of trigger execution among the sametypes but, by using follows(11g) we can order the execution of triggers.

```
Create table RAM(sno number(5));
Create or replace trigger trig1 before insert on RAM
Begin
DBMS_OUTPUT.PUT_LINE('trig1');
End trig1;
        Create trigger trig2 before insert on RAM follows trig1
        Begin
DBMS_OUTPUT.PUT_LINE('trig2');
End trig2;
```

Output:-

Trig1
Trig2

Note:-

If we did not use follows we get out put like
Trig2
Trig1
Oracle won't wives guarantee for order of execution, so from 11g onwords we use 'follows'.

Disable(11g):-

- ➢ Prior to 11g we only have an option to disable an existing trigger fron 11g onwords we can disable a trigger while creating/defining.
- ➢ Create or replace trigger disable before insert on RAM disable
  Begin
  DBMS_OUTPUT.PUT_LINE('this is disable trigger');
  End disable;
- ➢ Insert into RAM values(10);
  -1 row created.
- ➢ To enable/disable the trigger we've to make use of ALTER.
- ➢ Alter trigger distrig enable;
- ➢ Insert into RAM values(10); **--this is disable trigger.**
  -1 row created.
- ➢ We can define max of 12 triggers on a table(DML).

We can write a trigger to fire when updating on specific column:-

- ➢ Create table uptab(sno number(5), loc varchar2(10));
- ➢ Create trigger updating before updating of sno on uptab
  Begin
  DBMS_OUTPUT.PUT_LINE('updating on column');
  End;
- ➢ Insert into uptabvalues(10, 'x');

- Updating utab set sno=20; **--updating on column**
  -1 row updating.

We can write trigger on multiple columns:-

```
Create trigger uptrig1 before update of sno, loc on uptab
Begin
DBMS_OUTPUT.PUT_LINE('updating on column');
End;
```

Analyzing PL/SQL code:-

- Following things are useful to analyse the PL/SQL code so to increase the performance, easy identification, identifying the code flaws, so to protect from SQL injection.
- User_object(to know the stored procedure valid/invalid)
- User_source(to know the source code of stored procedures)

Note: Deterministic➔ from the function, for eg if you call one function for every calling if it returns same value in that situation if you write deterministic, for next execution it won't executs, it acts as buffer.

- **User_objects:-**
  Which is useful to verify the status of object i.e. whether valid or invalid.
- **User_source:-**
  Which is useful to extract the source code of a stored procedure.
- **User_arguments:-**
  Gives the information regarding arguments i.e name of argument, parameter_mode, datatype, scale, precision, position of arguments.
- **User_procedure:-**
  Specifies whether the given program is deterministic, pipelined, parallel enabled, aggregate, result_cache, authid user….
- **User_identifires:-**Gives the information regarding activities of identifiers, this table automatically get populated for a program (or) for session (or) for a database when we enable the PL/SQL tool (by default disabled) with an intialisation parameter called PL/scope-settings.
- **User_trigger:-**
  Gives information regarding triggers.

- **User_dependences:-**
  To find out reflection (or) information between referenced and dependent object we use this table.

Note: It won't give information regarding remote dependenies for that we have to run a script file so to create one procedure and two tables. here deptree and ideptree are remote dependencies.

- **Dbms_metadata:-**
  To create DDL report for an object.(dbms_utility.get_ddl(emp))

- **PL/scope tool(11g):-**
  It is an utility, to get the information of identifier activites.

- **Eanblig PL/SQL tool:-**
  Syntax:-

```
Alter session set PLscpoe_setting='identifiers:all'(enable);
Alter session(or system) set PLscpoe_setting='identifiers:null'(disable);
```

Virtual private database (or) fine grained access control(FGAC):-

- Let us take eg:
- Select * from emp where 1=2;
  Note:-
  In the above eg 'where' represents the condition should be added dynamically. And '1=2' represents predicates.
- Vpd is an alias of fine grained access control(FGAC), the basic concept of FGAC is to provide the row level security(RLS) (some applications deliberately needs this process).
- Vpd provides security.
- Vpd dynamically modify the SQL statement at run time by appending (or) attaching predicate through policy function.
- Policy function is useful to return the predicate.
- We will provide a package called along with schema and object names.
- We can provide 'N' no of policy function on a single table and a single policy function can serve for multiple tables.

Definging policy function:-

```
Create or replace function pol_fun(p_schema varchar2,p_object varchar2)
Return varchar2 is l_pridicate varchar2(10);
Begin
L_proidicate:='1=2';
Return(l_pridicate);
End potfun;
```

Note:
Here while creating policy functions(p_schema and p_object) these 2 in parameters are mandatory. '1=2' this condition will append to select statement dynamically.

SQL/Plus:-

```
Var a varchar2(10);
Exec :a:=pot_fun('apps','emp');
Print a;
Exec dbms_rls.add_policy('apps','emp1','res','appa','pol_fun',select,insert,update');
Select * from emp1;
Exec.dbms_rls.drop_policy('apps','emp1','res');
```

Note:-
If you create next time with the very same name also same will be applicable.

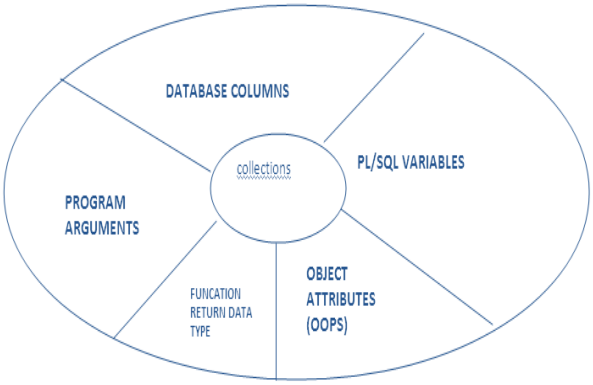
Collections:-To store data in the form of arrays we use collections.
Eg: nested table.

```
Declare
Type nes is table of varchar2(10);
Vnes nes:=nes('a','b','c','d');
-- where 'nes' is datatype  and 'vnes' is collection variable.
If vnes.limit is null then
DBMS_OUTPUT.PUT_LINE('vnes limit is limitness');
Else
DBMS_OUTPUT.PUT_LINE('vnes limit '||vnes.limit');
End if;
DBMS_OUTPUT.PUT_LINE('vnes count'||vnes.count);
DBMS_OUTPUT.PUT_LINE('vnes first'||vnes.first);
DBMS_OUTPUT.PUT_LINE('vnes last'||vnes.last);
DBMS_OUTPUT.PUT_LINE('vnes prior'||vnes.prior(2));
```

```
DBMS_OUTPUT.PUT_LINE('vnes next'||vnes.next(2));
DBMS_OUTPUT.PUT_LINE('vnes values');
For I in vnes.first..vnes.last loop
DBMS_OUTPUT.PUT_LINE('vnes values('||I||')'||vnes(I));
End loop;
if vnes.exists(2) then
dbms_output.put_line('vnes second value exists'||vnes(2));
dbms_output.put_line('vnes second value doesnot exists');
end if;
vnes.extend;
vnes.exted(2);
DBMS_OUTPUT.PUT_LINE('vnes  value after extension');
For I in vnes.first..vnes.last loop
DBMS_OUTPUT.PUT_LINE('vnes values('||I||')'||vnes(I));
End loop;
Vnes(5):='E';
Vnes(6):='F';
Vnes(7):='G';
Vnes.extend(2,3);
DBMS_OUTPUT.PUT_LINE('nes value after providing element');
For I in vnes.first..vnes.last loop
DBMS_OUTPUT.PUT_LINE('vnes values('||I||')|| vnes(I));
End loop;
vnes.trim;
vnes.trim(2);
DBMS_OUTPUT.PUT_LINE('vnes values after trim');
For I in vnes.first..vnes.last loop
DBMS_OUTPUT.PUT_LINE('vnes values('||I||')'||vnes(I));
End loop;
vnes.delete(1);
vnes.delete(2,5);
DBMS_OUTPUT.PUT_LINE('vnes values after specific deletion');
For I in vnes.first..vnes.last loop
DBMS_OUTPUT.PUT_LINE('vnes values('||I||')'||vnes(I));
End loop;
Vnes.delete;
DBMS_OUTPUT.PUT_LINE('vnes values after complete deletion');
End;
```

collection variable should not be 'NULL', to avoid that in that case we will define elements.
The function should be empty nes()(or)nes('A','B','C","D');

Usage of collections:-



Deff: To store the data in the form of arrays we use collections
Collections basically are of two types:
1.non-persistance(index by table)(temporary)
2.persistance(varrays, nested table)(permanent)

- ✓ Collections are useful to store complex/homogenous data.
- ✓ Collections defined in packages will persist for an entire session.
- ✓ Limit(is there any limit (or) not (upper boundary)) Extend(2,3);
  Where 2 represents extensions will happen. And what ever the value is present in 3 element it will return that.
  After time only we will delete, reverse is not so we delete at that time empty cell will populate.

Densely packed(with out any cops)
sparse

1	A
3	C
5	C

densely

1	A
2	B
3	C
4	C
5	D

- ✓ Extend delete(n) (or) (m,n)
  Here we can mention in three ways without paranthesis defining with number(n) .
- ✓ In index by table we can key values as var/char also.
- ✓ Key values should start with 1 and always positive values.
- ✓ Varray always densely.

Eg:

```
Declare
Type nes is table of varchar2(10) index by pls_integer;
Vnes nes:=nes();
Begin
Null;
End;
```

Error:no function name 'nes' exists in this scope.

	NESTED TABLE	VARRAYS	INDEX BY TABLE
First, Last, Next, prior, count Limit, Delete, Extend, Trim, Persistence, Subscript values, Usage SQL/PL SQL, Dense & paye, Exception, Storage	✓ Limitless (non upper boundary) ✓ ✓ ✓ Persistence Always +ve values,start with 1 SQL & PL/SQL Initially dense but may be sparse Out of line storage.	✓ Limit (exits upper bound) Specific deletion is not possible Possible within the max-limit ✓ Persistence Same as nested table.. SQL & PL/SQL DENSE INLINE	✓ LIMIT LESS ✓ × × Non-Persistance Might be with –ve, allows caharacterstics Both

Bulk bind:-

- Concept of bulk bind is a mechanism which is used to enhance the performance drastically, by decreasing the context switches.
- Bulk bind reduces the interaction between SQLand PL/SQL engine.
- We will maintain the bulk bind data through collections.

These are two types:

Bulk collect:- (clause)

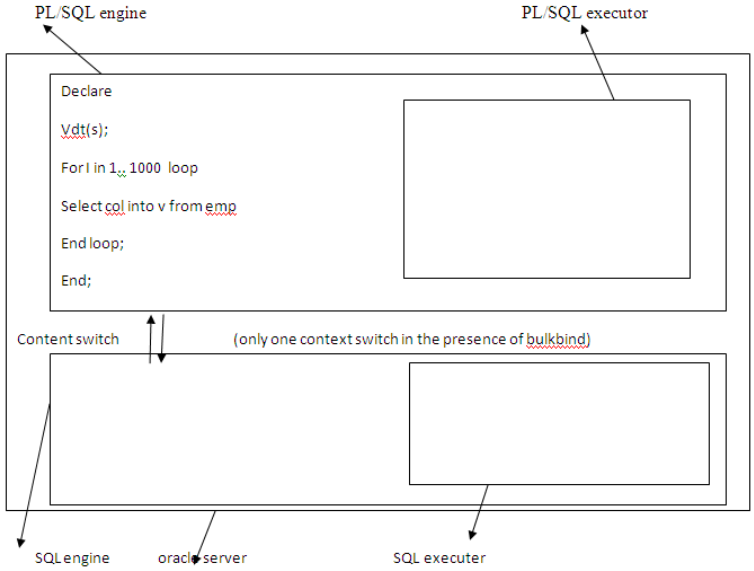
- select col bulkcollect into variable(this variable must be collection variable).
- Fetch cursor bulkcollect into variable.
- Return col bulk collect into variable(we can call out bind also).
- We can use bulk collect only above three other than this we can't.

For all statement(DML)

syntax:

```
for all: in{ var1..var2 | value of collection | indecies by collection}
[save exception](10g)DML operation;
```

- in for all statement we can perform single DML operation only.



- by using bind we can perform.
- In the presence of bulk bind 'n' no.of context switches will get compressed (or) bineoled into one single swich.

Using bulk collect in select statement:-

```
Declare
Sdate number:=0;
Edate number:=0;
Type nes is table of pls_integer;
Vnes nes:=nes();
Begin
Sdate:=dbms_utility.get_times;
For I in (select * from multab) loop
Vnes.extend; (if you don't write extend it throws an error)
Vnes(vnes.last)=i.sno;
Enol loop;
Edate:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(edate-sdate);
Sdate:=dbms_utility.get_time;
Select sno bulk collect into vnes from multabs;
Edate:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(edate-sdate);
End;
```

- While using bulk collect the variable should be collection variable.

Using bulk collect in fetch statement:-

```
Declare
Sdate number:=0;
Edate number:=0;
Type nes is table of pls_integer;
Vnes nes:=nes( );
Cursor c is select * from multab;
Begin
```

```
Open c;
Sdate:=dbms_utility.get_time;
Loop
Vnes.extend;
Fetch c into vnes(vnes.last);
Exit when c%not found;
End loop;
Close c;
Edate:=dbms_utility.get_time;
DBMS_OUTPUT.PUT_LINE(edate-sdate);
Open c;
Sdate:=dbms_utility.get_time;
Fetch c bulk collect into vnes;
Edate:=dbms_utility.get_time;
Close c;
DBMS_OUTPUT.PUT_LINE(edate-sdate);
End;
```

For the same program
Fetch c bulk collect into vnes limit 500000;
We can also mention the limit so to specify the no.of records into a collection through fetch statement limit only possible in fetch statement.

Collections:-

Note:-We won't initialize the 'index by table' datatype variable with a constructor (or) function trying to do so through an error.

Eg:-

```
Declare
Type nes is table of varchar2(10);
Vnes nes:=nes('a','b','c');
Begin
Vnes.delete(2)
DBMS_OUTPUT.PUT_LINE('vnes first'||vnes.first);
DBMS_OUTPUT.PUT_LINE('vnes last'||vnes.last);
DBMS_OUTPUT.PUT_LINE('vnes prior'||vnes.prior(3));
DBMS_OUTPUT.PUT_LINE('vnes next'||vnes.next(1));
DBMS_OUTPUT.PUT_LINE('vnes count'||vnes.count);
If vnes.exists(2) then
DBMS_OUTPUT.PUT_LINE('vnes second value exists'||vnes(2));     -- not existed
End if;
Vnes.extend;
If vnes.existts(4) then
DBMS_OUTPUT.PUT_LINE('vnes fourth value exists'||vnes(4));
Else
DBMS_OUTPUT.PUT_LINE('vnes fourth does not exists');
End if;
End;
```

Using collections as program parameters:-

```
Declare
Type nes is table of varchar2(10);
Vnes nes:=nes('a','b','c','d');
Procedure p(x nes) is
Begin
For I in x.first..x.last loop
DBMS_OUTPUT.PUT_LINE(x(i));
```

End loop;
End p;
Begin
p(vnes);
end;

using collections for return datatype:-

```
DECLARE
   TYPE nes IS TABLE OF VARCHAR2 (10);

   vnes   :=nes('a','b','c','d');
Y nes:=nes();
Function fun(x nes) return nes is
Begin
Return x;                                        --here we are returning also
End fun;
Begin
Y:=fun(vnes);
For I in Y.first..Y.last loop
DBMS_OUTPUT.PUT_LINE(Y(i));
End loop;
End;
```

Note:-

From 11g onwards for all statement allows merge command

```
DECLARE
   TYPE nes IS TABLE OF NUMBER;

   Vnes    nes := nes ();
   Sdate   NUMBER := 0;
   Edate   NUMBER := 0;
   Rdate   NUMBER := 0;
BEGIN
   SELECT sno
     BULK COLLECT INTO vnes
     FROM multab;

   EXECUTE IMMEDIATE 'truncate table multab';
Sdate:=dbms_utility.get._time;
For iin vnes.first..vnes.last loop
Insert into multab values(vnes(i));
End loop;
Edate:=dbms_utility.get_time;
Rdate:=edate_sdate;
DBMS_OUTPUT.PUT_LINE('elapsed time '||rdate);
Execute immediate 'truncate table multab;
Sdate:=dbms_utility.get_times;
For all i in vnes.first..vnes.last
Insert into multab values(vnes(i));
Edate:=dbms_utility.get_time;
Rdate:=edate-sdate;
DBMS_OUTPUT.PUT_LINE('elapsed time '||rdate);
End;
```

Output:-
Elapsed time 198
5

Upto here we never used DDL commands in executable section.

Another eg for all statement:-

```
DECLARE
   TYPE nes IS TABLE OF NUMBER;

   Vnes    nes := nes ();
   Vnes1   nes := nes ();
BEGIN
   SELECT sno
     BULK COLLECT INTO vnes
     FROM multab;

FOR all  I in vnes.first..vnes.last
Delete from multab where sno:=vnes(i);
Return sno bulk collect into vnes1;
DBMS_OUTPUT.PUT_LINE(vnes.count);
End;
```

Using save exception (10g):-

- It filters outs the error records and allows the other records to process, instead of cancelling all the records.
- Save exception saves the errors and we can retrieve the error by using '%bulk exception.'

Declare
Type nes is table of varchar2(10);
Vnes nes:=('x','a','y','b','z');
Begin
For all I in vnes.first..vnes.last
Save exception
Insert into contab values(values (i));
Exception
When others then
For I in sql%bulk_exceptions.count loop
DBMS_OUTPUT.PUT_LINE(sql%bulk_exceptions(i).error_index||' '||sql%bulk_exceptions(i).error_code);
End loop;
End;

✓ **Error-code displays the error code without '-sign'**

Indeces(index/subscript) of values of:-

Eg for "values of" clause:-

✓ Here we are comparing one collection values with another collection of indices values.

✓ Declare
Type nes is table of varchar2(10);
Vnes nes:=nes('a','b','c','d','e','f');
Type nes1 is table of pls_integer;
Vnes1 nes1:=nes1(1,3,5);
Begin
For all I in vnes values of vnes1
Insert into contab values vnes(i);
End;

Output:

Loc

A
C
C

Eg for "indecies of" clause:-

```
Declare
Type nes is table of varchar2(10);
Vnes nes:=nes('a','b','c','d','e','f');
Vnes1 nes1:=nes1(1,3,5);
Begin
For all I in vnes indices of vnes1
Insert into contab values(vnes(i));
End;
```

Output:-

Loc
A
B
C

Table function:-

- It is a function which acts as same to that of table to SQL engine with the help of table operator called 'table'.
- We provide table function in from clause of a select statement.
- SQL engine can't identify it as a function.

Note:-

- Table functions have to always return data from collections only.
- But we can't provide functions in from clause.

Eg:-

```
Create or replace function colfun return nes is
Vnes nes:=nes('a','b','c','d','e','f')
Begin
Return vnes;          -- here vnes always collection.
End;
Select * from table(col_fun);
```

Column_val -- it internally pseudo column generates, introduced from 10g

A
B
C
D
E
F

- Table function data will be displayed under a column name called column_val which is a pseudo column.

Dynamic SQl and Dynamic PL/SQL:-

- Dynamic SQL statements are the statements which are constructed (or) get framed (or) build up at the time of execution.
- When an SQL statement get framed before of compilation time those are called 'static SQL'.
- Creation of PL/SQL program at runtime is called as "dynamic PL/SQL".
- To execute dynamic SQL and PL/SQL we use

1. Execute immediate(statement).
2. DBMS_SQL(packages)

Note:-Dynamic SQL statement falls pray, to SQL injections. We can also execute immediate to execute DDL statements in the program which is normally not possible.

Syntax for execute immediate:-

Execute immediate 'string' [into {var1,var2..}]
[using[in/out/inout]] bind_variable,..];

Eg for execute immediate:-

```
Declare
V_create varchar2(100):= 'create table etab(sno number);
V number(5):=10;
Vsno number(5);
Begin
Execute immediate v_create;
Execute immediate 'insert into etab values(:1)' usingv;
Execute immediate 'select sno from etab where sno:=2' into vsno using v;
Execute immediate 'begin null; end;';
Execute immediate 'drop table etab;
DBMS_OUTPUT.PUT_LINE(vsno);
End;
```

- At runtime if you want to drop the database object, we prefer following program.

```
SQL>create or replace procedure p(X varchar2) is
Begin
Execute immediate 'drop table' ||x;
End p;
>exec p('stab');
```

- The above program is sensitive for SQL injection but by using bind arguments we'll safeguard the above program.

Using bind arguments will also enhance the performance:-

```
Create or replace procedure p(X varchar2) is
V varchar2(10);'begin
V:=x;
Execute immediate 'DROP table :a' using v;
End p;
```

SQL injection:-(safe guarding PL/SQL code from SQL injection)

- Reducing the surface attack is a preferable step to safe guard the PL/SQL code from SQL injection.
- We will reduce the attacking surface in two ways
  1. Revoking unnecessary, unintended and excess privileges from user.
  2. defining a PL/SQL program with invoker write (instead of definer write).
- Grant select on stab to u2;
- Select * from u1.stab;
- Insert into u1.stab values() **--invalid**

Defining a program with definer write:-

```
Create or replace procedure p is v number(10):=10;
Begin
Insert into u1.stab values(10);
```

Select sno into v from u1.stab where sno=v;
End p;

- Grant execute on p to u2;
- Execute u1.p
- Select * from u1.stab;

Defining a program with invoker write:-

Create or replace procedure p authid current user is v number(10):=10;
Begin
Insert into u1.stab values(v);
Select sno into v from u1.stab where sno=v;
End p;

- Grant execute on p to u2;
- Exec u1.p --insufficient privilege
- To deduce the SQL injection (or) to immunize the PL/SQL code from SQL injection better avoid dynamic SQL statements.
- Following is an eg of which specifies need to avoid dynamic SQL statements.

```
CREATE OR REPLACE PROCEDURE p (x_name VARCHAR2)
IS
   Vrec        SYS_REFCURSOR;
   V_name      VARCHAR2 (10);
   V_deptno    NUMBER (5);
BEGIN
   OPEN vrec FOR 'select ename,deptno from emp where enmae='||x_name;
-- here 'vrec' as a variable
Loop
Fetch vrec into v_name, v_deptno;
DBMS_OUTPUT.PUT_LINE(v_name||' '||v_deptno);
Exit when vrec%not found;
End loop;
Close vrec;
End;
```

Calling environment:-

SQL>exec p(‘ ‘king’ ‘);
King 10
Exec p(‘null union select ename, sal from emp’);

- Here we have a chance for attacking malicious data so, to restrict the SQL injection convert the dynamic SQL into static as shown in following eg.

```
CREATE OR REPLACE PROCEDURE p (X_name VARCHAR2)
IS
   Vrec        SYS_REFCURSOR;
   V_name      VARCHAR2 (10);
   V_deptno    NUMBER (5);
BEGIN
   OPEN vrec FOR
      SELECT ename, deptno
        FROM emp
       WHERE ename = x_name;

   LOOP
      FETCH vrec INTO v_name, v_deptno;

      DBMS_OUTPUT.PUT_LINE (v_name || ' ' ||v_deptno);
```

```
Exit when vrec%not found;
End loop;
Close vrec;
End;
```

- Exec p('king');
  King 10

- Exec p('null union select ename,sal from emp); (here getting unintended data is not possible).

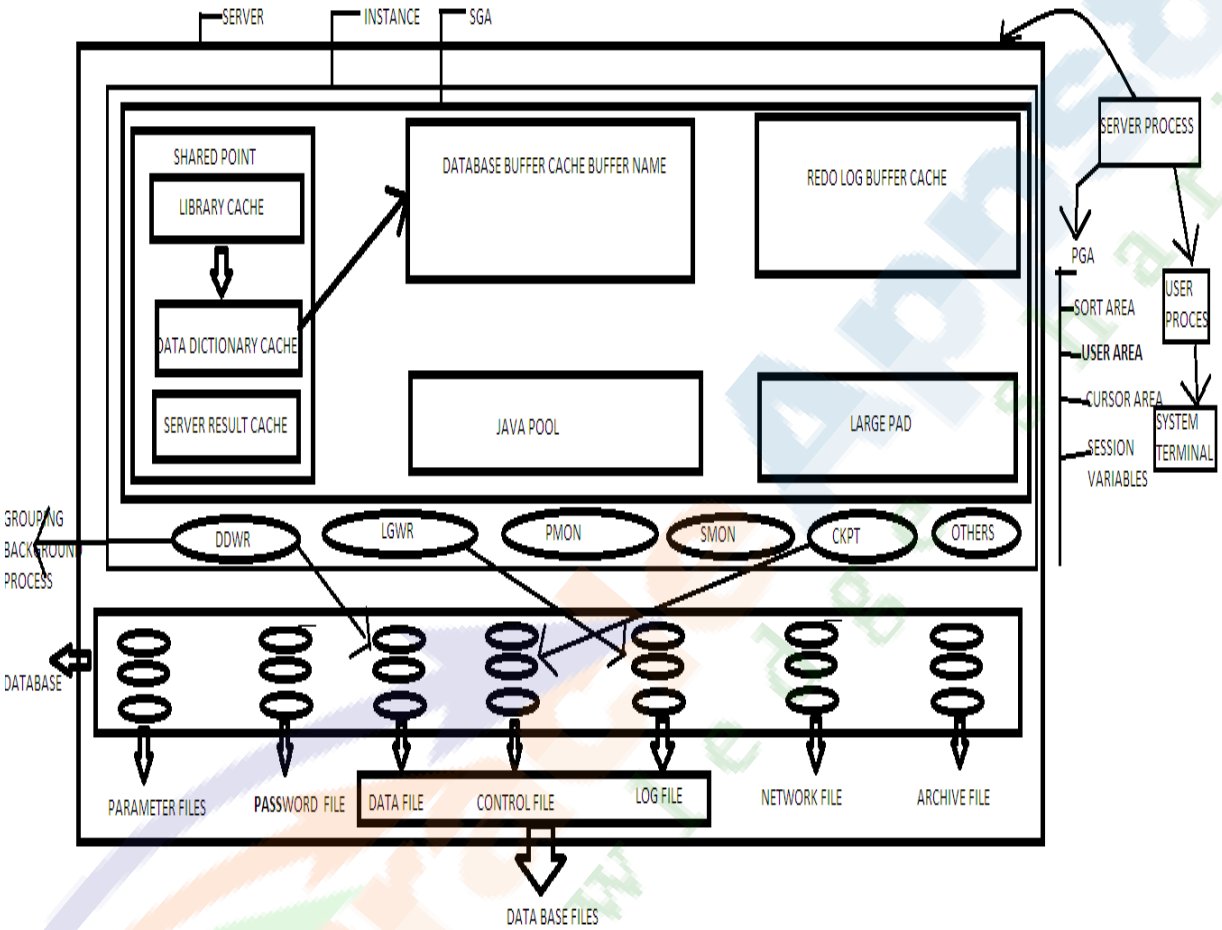
Note:-

- When we know all the SQl identifiers (column, table names) before of fraiming a statement, in that case only it is possible to convert the dynamic SQL statements into static SQl which means it is not possible to convert all the dynamic SQL statements static if this is the case then mien/mise the attacking of SQL injection by using "bind argument" as shown in the following snippet (or) eg.
- In addition with protectiong the PL/SQL code from SQL injection it also possible to enhance the performance immeyely(more effectively).
- Using bind arguments in dynamic SQL will avoid hard parsing(buffer myss) and promote soft parsing(buffer hit).
- For the above eg just change
  Begin
  Open vrec for 'select enaame, deptno from emp where ename=:' using x_name;
  Loop
  -- remaining structure is same.
- Exec p('king');
- Exec p('null union select ename,sal from emp');
- Finally we will reduce the SQL injection by sanitizing the user inputs with the help of an APL i.e DBMS_assert(package).
- While tunning the PL/SQL code avoid implicit conversion which ia a burden to the ename as server as such in the following.

Eg:-

```
DECLARE
   Stime    NUMBER := 0;
   Etime    NUMBER := 0;
   V        VARCHAR2 (10);
BEGIN
   Stime := DBMS_UTILITY.get_time;

   FOR I IN 1 .. 1000
   LOOP
      V := I;
   END LOOP;

   Etime := DBMS_UTILITY.get_time;
   DBMS_OUTPUT.PUT_LINE (edate_sdate);
END;

DECLARE
   Stime    NUMBER := 0;
   Etime    NUMBER := 0;
   V        NUMBER (5);
BEGIN
   Stime := DBMS_UTILITY.get_time;
```

```
    FOR I IN 1 .. 1000
    LOOP
       V := i;
    END LOOP;

    Ctime := DBMS_UTILITY.get_time;
    DBMS_OUTPUT.PUT_LINE (edate - sdate);
END;
```



cursor eg:-

```
DECLARE
    CURSOR c
    IS
       SELECT * FROM emp;

    --    here just defines the definition c.
    vrow    c%ROWTYPE;
BEGIN
    OPEN c;

    --here select stmt get executes and opens the memory area and gets data.
    LOOP
       FETCH c INTO vrow;                              --here fetching will happen.
```

```
        DBMS_OUTPUT.PUT_LINE (vrow.ename);

        IF c%NOTFOUND
        THEN                                                    --(1)
           EXIT;
        END IF;
    END LOOP;

    CLOSE C;
END;
```

IN case of (1) we can write

```
IF C%ROWCOUNT=3 THEN
EXIT;
END IF;
```

- If you write like this we can stop the program after 3rd record. In this case for loop is not prefereable, simple loop is prefereable.

Paramatarised cursor eg:-

Declare
Cursor c(x number) is select * from emp where deptno:=x;
Vrow emp%rowtype;
Vno number(5):=&n;
Vnol number(5):=&m;
Begin
Open c(vno);
Loop
Fetch c into vrow;
DBMS_OUTPUT.PUT_LINE(vrow.ename)
Exit when c%not found;
End loop;
Close c;
Open c(vnol);
Loop
Fetch c into vrow;
DBMS_OUTPUT.PUT_LINE(vrow.ename);
Exit when c%not found;
End loop;
Close c;

- Before 'open c':
  % is open -F
  % found -E
  % notfound -E
  % rowcount -E
- After 'open c':
  % is open -T
  % found -T
  % notfound -F
  % rowcount -0
- After fetch: (1st fetch)
  % is open -T
  % found -1

% notfound -F
% rowcount -1

- After close c:
  % is open -F
  % found -E
  % notfound -E
  % rowcount -E

We can use cursor variable as a parameter in stored procedures

- Create or replace function f return sys_refcursor is vrec sys_refcursor;
  Begin
  Open vrec for select * from emp;
  Return vrec;--return statement
  End f;
- We can also use sys_refcursor datatype for function return value (or) using cursor variable as a return value in function.
- Calling:-
  Var refvar refcursor;
  Exec :refvar:=f;
  Print refvar;--emp data:14records.

- Create or replace function f(vrec out sys_refcursor) return Boolean
  Begin
  Open vrec for select * from emp;
  Close vrec;
  Return true;
  End;
  Declare
  Vrec1 sys_refcursor;
  V Boolean;
  Vrow emp%rowtype;
  Begin
  V:=f(vrec1);
  Loop
  Fetch vrec1 into vrow;
  DBMS_OUTPUT.PUT_LINE(vrow.ename);
  Exit when vrec1%not found;
  End loop;
  End;

```
CREATE OR REPLACE FUNCTION f (vrec OUT SYS_REFCURSOR)
   RETURN BOOLEAN
IS
   Vrow   emp%ROWTYPE;
BEGIN
   OPEN vrec FOR SELECT * FROM emp;

   FETCH vrec INTO vrow;

   RETURN TRUE;
END f;
```

```
DECLARE
   Vrec1    SYS_REFCURSOR;
   V        BOOLEAN;
   Vrow     emp%ROWTYPE;
BEGIN
   V := f (vrec1);

   LOOP
      FETCH vrec1 INTO vrow;

      DBMS_OUTPUT.PUT_LINE (vrow.ename);
      EXIT WHEN vrec1%not found;
End loop;
End;
```

Output:- It will be 13 records:
Black
Clak
.
.
.

- Here points the second record in emp.
- Create or replace function f return sys_refcursor is

Vrec sys_refcursor;

```
DECLARE
   Vrec1    SYS_REFCURSOR;
BEGIN
   OPEN vrec FOR SELECT * FROM emp;

   Vrec1 := vrec;

   CLOSE vrec;

   --    --here 'close vrec' closes both the cursors.
   RETURN vrec1;
END f;

DECLARE
   Vrec2    SYS_REFCURSOR;
   Vrow     emp%ROWTYPE;
BEGIN
   Vrec2 := f;

   LOOP
      FETCH vrec2 INTO vrow;

      DBMS_OUTPUT.PUT_LINE (vrow.ename);
      EXIT WHEN vrec2%NOTFOUND;
   END LOOP;
END;
```

Analyzing PL/SQL code:-

- By using 'format-call-stack" procedure we will sequentially trace out the program calls so , to analyse the coading as shown in the following eg. (or) snippet.

- Create or replace procedure p is
  Begin
  DBMS_OUTPUT.PUT_LINE('dbms_utility.format_call_stack');
  End;

Create or replace procedure p1 is
Begin
P;
End p1;
Create or replace procedure p2 is
Begin
P1;
End p2;
Procedure created.
Begin
P2;
End;
PL/SQL call stack

Lienumber	Object
3	Procedure APPs-p
3	Procedure
3	Procedure apps.p2
2	Anonymous block

Atomics of program (or) PL/SQL program:-
Identifiers->literals->delimiters->comments
Identifiers are also derived as:
Constants, variables, packages, cursors, exceptions.

- If program is length at that time we have to know where calling happened to know the line numbers for easy identification we use above package.

/*
…….
……..
*/
Note:-
If you want to execute to multiple lines we give like this.
/*
……
……..
/*
…..
……
*/
…….
……..
*/

Note:-

We can't nest comment in comment.

Instead of trigger:-

- This trigger is for views, to perform DML operations on complex views will not be allowed directly, but by using instead of trigger it is passible.
- This trigger is always a rowlevel trigger even if you won't mention the "for each row" clause.
- Defining instead of trigger on tables ends with an error.
- Create table vtabl(sno number(5));
- Create table vtab2(loc varchar2(10);
- Create view comview as select * from vtab1, vtab2;
- Insert into comview values(10,'hyd');

Error:

Can not modify a column which maps to a non key preserved data.

```
Create or replace triggr comtrig
Instead of insert on comview;
Begin
Insert into vtab1 values(:new.sno);
Insert into vtab2 values(:new.loc);
End;
Insert into comview values(10,'hyd');--here insertion is successfully happening on view.
```

Note:-DML operation can't perform on complex views. But as in the above case trigger is inserting the values before insertion.

Mutating error:-

- We get this error when a row level trigger attempts to read or write the table from which it was raised.
- You won't get this error in statement level.
- Create or replace trigger muttrig Before update on vtab1

```
For each row
Declare
Vno number95);
Begin
Select sno into vno from vtab1 where sno=30;
End;
```

- Update vtab1 set sno=50;

Error: table apps.vtab1 is mutating, trigger/function may not see it.

✓ To Avoid Mutating Errors We Use "Pragma Atonomous Transaction" (or) we can also use "statement level trigger".