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```
void main()  
{  
  int no;  
  clrscr();  
  printf("%d\n", no);  
}
```

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# SQL & PLSQL

## INTRODUCTION

SQL is divided into the following

- Data Definition Language (DDL)
- Data Manipulation Language (DML)
- Data Retrieval Language (DRL)
- Transaction Control Language (TCL)
- Data Control Language (DCL)

DDL -- create, alter, drop, truncate, rename

DML -- insert, update, delete

DRL -- select

TCL -- commit, rollback, savepoint

DCL -- grant, revoke

### CREATE TABLE SYNTAX

Create table <table\_name> (col1 datatype1, col2 datatype2 ...coln datatype<sub>n</sub>);

Ex:

```
SQL> create table student (no number (2), name varchar (10), marks number (3));
```

### INSERT

This will be used to insert the records into table.

We have two methods to insert.

- By value method
- By address method

#### a) USING VALUE METHOD

Syntax:

```
insert into <table_name> values (value1, value2, value3 .... Valuen);
```

Ex:

```
SQL> insert into student values (1, 'sudha', 100);  
SQL> insert into student values (2, 'saketh', 200);
```

To insert a new record again you have to type entire insert command, if there are lot of records this will be difficult.

This will be avoided by using address method.

#### b) USING ADDRESS METHOD

Syntax:

```
insert into <table_name> values (&col1, &col2, &col3 .... &coln);
```

This will prompt you for the values but for every insert you have to use forward slash.

Ex:

```
SQL> insert into student values (&no, '&name', &marks);
```

Enter value for no: 1

Enter value for name: Jagan

Enter value for marks: 300

old 1: insert into student values(&no, '&name', &marks)

new 1: insert into student values(1, 'Jagan', 300)

```
SQL> /
```

Enter value for no: 2

Enter value for name: Naren

Enter value for marks: 400

old 1: insert into student values(&no, '&name', &marks)

new 1: insert into student values(2, 'Naren', 400)

#### c) INSERTING DATA INTO SPECIFIED COLUMNS USING VALUE METHOD

Syntax:

```
insert into <table_name>(col1, col2, col3 ... Coln) values (value1, value2, value3 ....  
Valuen);
```

Ex:

```
SQL> insert into student (no, name) values (3, 'Ramesh');  
SQL> insert into student (no, name) values (4, 'Madhu');
```

#### d) INSERTING DATA INTO SPECIFIED COLUMNS USING ADDRESS METHOD

Syntax:

```
insert into <table_name>(col1, col2, col3 ... coln) values (&col1, &col2, &col3 .... &coln);  
This will prompt you for the values but for every insert you have to use forward slash.
```

Ex:

```
SQL> insert into student (no, name) values (&no, '&name');  
Enter value for no: 5  
Enter value for name: Visu  
old 1: insert into student (no, name) values(&no, '&name')  
new 1: insert into student (no, name) values(5, 'Visu')  
  
SQL> /  
Enter value for no: 6  
Enter value for name: Rattu  
old 1: insert into student (no, name) values(&no, '&name')  
new 1: insert into student (no, name) values(6, 'Rattu')
```

#### SELECTING DATA

Syntax:

```
Select * from <table_name>;          -- here * indicates all columns  
or  
Select col1, col2, ... coln from <table_name>;
```

Ex:

```
SQL> select * from student;
```

```
NO NAME      MARKS  
----  
-----
```

1	Sudha	100
2	Saketh	200
1	Jagan	300
2	Naren	400
3	Ramesh	
4	Madhu	
5	Visu	
6	Rattu	

SQL> select no, name, marks from student;

NO	NAME	MARKS
1	Sudha	100
2	Saketh	200
1	Jagan	300
2	Naren	400
3	Ramesh	
4	Madhu	
5	Visu	
6	Rattu	

SQL> select no, name from student;

NO	NAME
1	Sudha
2	Saketh
1	Jagan
2	Naren
3	Ramesh
4	Madhu
5	Visu
6	Rattu

## CONDITIONAL SELECTIONS AND OPERATORS

We have two clauses used in this

- Where
- Order by

### USING WHERE

Syntax:

```
select * from <table_name> where <condition>;
```

the following are the different types of operators used in where clause.

- ❖ Arithmetic operators
- ❖ Comparison operators
- ❖ Logical operators

❖ Arithmetic operators      -- highest precedence

+, -, \*, /

❖ Comparison operators

- =, !=, >, <, >=, <=, <>
- between, not between
- in, not in
- null, not null
- like

❖ Logical operators

- And
- Or                              -- lowest precedence
- not

a) USING =, >, <, >=, <=, !=, <>

Ex:

```
SQL> select * from student where no = 2;
```

NO	NAME	MARKS
2	Saketh	200
2	Naren	400

SQL> select \* from student where no < 2;

NO	NAME	MARKS
1	Sudha	100
1	Jagan	300

SQL> select \* from student where no > 2;

NO	NAME	MARKS
3	Ramesh	
4	Madhu	
5	Visu	
6	Rattu	

SQL> select \* from student where no <= 2;

NO	NAME	MARKS
1	Sudha	100
2	Saketh	200
1	Jagan	300
2	Naren	400

SQL> select \* from student where no >= 2;

NO	NAME	MARKS
2	Saketh	200

```
2 Naren      400
3 Ramesh
4 Madhu
5 Visu
6 Rattu
```

SQL> select \* from student where no != 2;

```
NO NAME      MARKS
--- -
1  Sudha      100
1  Jagan      300
3  Ramesh
4  Madhu
5  Visu
6  Rattu
```

SQL> select \* from student where no <> 2;

```
NO NAME      MARKS
--- -
1  Sudha      100
1  Jagan      300
3  Ramesh
4  Madhu
5  Visu
6  Rattu
```

## b) USING AND

This will gives the output when all the conditions become true.

### Syntax:

```
select * from <table_name> where <condition1> and <condition2> and .. <conditionn>;
```

Ex:

```
SQL> select * from student where no = 2 and marks >= 200;
```

NO	NAME	MARKS
2	Saketh	200
2	Naren	400

c) USING OR

This will give the output when either of the conditions become true.

Syntax:

```
select * from <table_name> where <condition1> and <condition2> or .. <conditionn>;
```

Ex:

```
SQL> select * from student where no = 2 or marks >= 200;
```

NO	NAME	MARKS
2	Saketh	200
1	Jagan	300
2	Naren	400

d) USING BETWEEN

This will give the output based on the column and its lower bound, upperbound.

Syntax:

```
select * from <table_name> where <col> between <lower bound> and <upper bound>;
```

Ex:

```
SQL> select * from student where marks between 200 and 400;
```

NO	NAME	MARKS
2	Saketh	200
1	Jagan	300
2	Naren	400

e) USING NOT BETWEEN

This will gives the output based on the column which values are not in its lower bound, upperbound.

Syntax:

```
select * from <table_name> where <col> not between <lower bound> and <upper bound>;
```

Ex:

```
SQL> select * from student where marks not between 200 and 400;
```

NO	NAME	MARKS
1	Sudha	100

f) USING IN

This will gives the output based on the column and its list of values specified.

Syntax:

```
select * from <table_name> where <col> in ( value1, value2, value3 ... valuen);
```

Ex:

```
SQL> select * from student where no in (1, 2, 3);
```

NO	NAME	MARKS
1	Sudha	100

2	Saketh	200
1	Jagan	300
2	Naren	400
3	Ramesh	

g) USING NOT IN

This will gives the output based on the column which values are not in the list of values specified.

Syntax:

```
select * from <table_name> where <col> not in ( value1, value2, value3 ... valuen);
```

Ex:

```
SQL> select * from student where no not in (1, 2, 3);
```

NO	NAME	MARKS
4	Madhu	
5	Visu	
6	Rattu	

h) USING NULL

This will gives the output based on the null values in the specified column.

Syntax:

```
select * from <table_name> where <col> is null;
```

Ex:

```
SQL> select * from student where marks is null;
```

NO	NAME	MARKS
3	Ramesh	

- 4 Madhu
- 5 Visu
- 6 Rattu

i) USING NOT NULL

This will gives the output based on the not null values in the specified column.

Syntax:

```
select * from <table_name> where <col> is not null;
```

Ex:

```
SQL> select * from student where marks is not null;
```

NO	NAME	MARKS
1	Sudha	100
2	Saketh	200
1	Jagan	300
2	Naren	400

j) USING LIKE

This will be used to search through the rows of database column based on the pattern you specify.

Syntax:

```
select * from <table_name> where <col> like <pattern>;
```

Ex:

i) This will give the rows whose marks are 100.

```
SQL> select * from student where marks like 100;
```

NO	NAME	MARKS
----	------	-------

1	Sudha	100
---	-------	-----

ii) This will give the rows whose name start with 'S'.

```
SQL> select * from student where name like 'S%';
```

NO	NAME	MARKS
1	Sudha	100
2	Saketh	200

iii) This will give the rows whose name ends with 'h'.

```
SQL> select * from student where name like '%h';
```

NO	NAME	MARKS
2	Saketh	200
3	Ramesh	

iV) This will give the rows whose name's second letter start with 'a'.

```
SQL> select * from student where name like '_a%';
```

NO	NAME	MARKS
2	Saketh	200
1	Jagan	300
2	Naren	400
3	Ramesh	
4	Madhu	
6	Rattu	

V) This will give the rows whose name's third letter start with 'd'.

```
SQL> select * from student where name like '__d%';
```

NO	NAME	MARKS
1	Sudha	100
4	Madhu	

Vi) This will give the rows whose name's second letter start with 't' from ending.

```
SQL> select * from student where name like '%_t%';
```

NO	NAME	MARKS
2	Saketh	200
6	Rattu	

Vii) This will give the rows whose name's third letter start with 'e' from ending.

```
SQL> select * from student where name like '%e__%';
```

NO	NAME	MARKS
2	Saketh	200
3	Ramesh	

Viii) This will give the rows whose name cotains 2 a's.

```
SQL> select * from student where name like '%a% a %';
```

NO	NAME	MARKS
1	Jagan	300

\* You have to specify the patterns in *like* using underscore ( \_ ).

## USING ORDER BY

This will be used to ordering the columns data (ascending or descending).

### Syntax:

```
Select * from <table_name> order by <col> desc;
```

By default oracle will use ascending order.

If you want output in descending order you have to use *desc* keyword after the column.

### Ex:

```
SQL> select * from student order by no;
```

NO	NAME	MARKS
1	Sudha	100
1	Jagan	300
2	Saketh	200
2	Naren	400
3	Ramesh	
4	Madhu	
5	Visu	
6	Rattu	

```
SQL> select * from student order by no desc;
```

NO	NAME	MARKS
6	Rattu	
5	Visu	
4	Madhu	
3	Ramesh	
2	Saketh	200
2	Naren	400
1	Sudha	100
1	Jagan	300

## USING DML

### USING UPDATE

This can be used to modify the table data.

#### Syntax:

```
Update <table_name> set <col1> = value1, <col2> = value2 where <condition>;
```

#### Ex:

```
SQL> update student set marks = 500;
```

If you are not specifying any condition this will update entire table.

```
SQL> update student set marks = 500 where no = 2;
```

```
SQL> update student set marks = 500, name = 'Venu' where no = 1;
```

### USING DELETE

This can be used to delete the table data temporarily.

#### Syntax:

```
Delete <table_name> where <condition>;
```

#### Ex:

```
SQL> delete student;
```

If you are not specifying any condition this will delete entire table.

```
SQL> delete student where no = 2;
```

## USING DDL

### USING ALTER

This can be used to add or remove columns and to modify the precision of the datatype.

#### a) ADDING COLUMN

Syntax:

```
alter table <table_name> add <col datatype>;
```

Ex:

```
SQL> alter table student add sdob date;
```

#### b) REMOVING COLUMN

Syntax:

```
alter table <table_name> drop <col datatype>;
```

Ex:

```
SQL> alter table student drop column sdob;
```

#### c) INCREASING OR DECREASING PRECISION OF A COLUMN

Syntax:

```
alter table <table_name> modify <col datatype>;
```

Ex:

```
SQL> alter table student modify marks number(5);
```

\* To decrease precision the column should be empty.

#### d) MAKING COLUMN UNUSED

Syntax:

```
alter table <table_name> set unused column <col>;
```

Ex:

```
SQL> alter table student set unused column marks;
```

Even though the column is unused still it will occupy memory.

#### d) DROPPING UNUSED COLUMNS

Syntax:

```
alter table <table_name> drop unused columns;
```

Ex:

```
SQL> alter table student drop unused columns;
```

\* You can not drop individual unused columns of a table.

#### e) RENAMING COLUMN

Syntax:

```
alter table <table_name> rename column <old_col_name> to <new_col_name>;
```

Ex:

```
SQL> alter table student rename column marks to smarks;
```

#### USING TRUNCATE

This can be used to delete the entire table data permanently.

Syntax:

```
truncate table <table_name>;
```

Ex:

```
SQL> truncate table student;
```

#### USING DROP

This will be used to drop the database object;

**Syntax:**

```
Drop table <table_name>;
```

**Ex:**

```
SQL> drop table student;
```

**USING RENAME**

This will be used to rename the database object;

**Syntax:**

```
rename <old_table_name> to <new_table_name>;
```

**Ex:**

```
SQL> rename student to stud;
```

## USING TCL

### USING COMMIT

This will be used to save the work.

Commit is of two types.

- Implicit
- Explicit

#### a) IMPLICIT

This will be issued by oracle internally in two situations.

- When any DDL operation is performed.
- When you are exiting from SQL \* PLUS.

#### b) EXPLICIT

This will be issued by the user.

#### Syntax:

Commit or commit work;

\* When ever you committed then the transaction was completed.

### USING ROLLBACK

This will undo the operation.

This will be applied in two methods.

- Upto previous commit
- Upto previous rollback

#### Syntax:

Roll or roll work;

Or

Rollback or rollback work;

\* While process is going on, if suddenly power goes then oracle will rollback the transaction.

## USING SAVEPOINT

You can use savepoints to rollback portions of your current set of transactions.

### Syntax:

```
Savepoint <savepoint_name>;
```

### Ex:

```
SQL> savepoint s1;
SQL> insert into student values(1, 'a', 100);
SQL> savepoint s2;
SQL> insert into student values(2, 'b', 200);
SQL> savepoint s3;
SQL> insert into student values(3, 'c', 300);
SQL> savepoint s4;
SQL> insert into student values(4, 'd', 400);
```

### Before rollback

```
SQL> select * from student;
```

NO	NAME	MARKS
1	a	100
2	b	200
3	c	300
4	d	400

```
SQL> rollback to savepoint s3;
```

Or

```
SQL> rollback to s3;
```

This will rollback last two records.

```
SQL> select * from student;
```

NO	NAME	MARKS
1	a	100
2	b	200

## USING DCL

DCL commands are used to granting and revoking the permissions.

### USING GRANT

This is used to grant the privileges to other users.

#### Syntax:

```
Grant <privileges> on <object_name> to <user_name> [with grant option];
```

#### Ex:

```
SQL> grant select on student to sudha;    -- you can give individual privilege
SQL> grant select, insert on student to sudha;    -- you can give set of privileges
SQL> grant all on student to sudha;        -- you can give all privileges
```

The sudha user has to use dot method to access the object.

```
SQL> select * from saketh.student;
```

The sudha user can not grant permission on student table to other users. To get this type of option use the following.

```
SQL> grant all on student to sudha with grant option;
```

Now sudha user also grant permissions on student table.

### USING REVOKE

This is used to revoke the privileges from the users to which you granted the privileges.

#### Syntax:

```
Revoke <privileges> on <object_name> from <user_name>;
```

#### Ex:

```
SQL> revoke select on student form sudha;    -- you can revoke individual privilege
SQL> revoke select, insert on student from sudha;    -- you can revoke set of privileges
SQL> revoke all on student from sudha;    -- you can revoke all privileges
```

## USING ALIASES

### CREATE WITH SELECT

We can create a table using existing table [along with data].

#### Syntax:

```
Create table <new_table_name> [col1, col2, col3 ... coln] as select * from  
    <old_table_name>;
```

#### Ex:

```
SQL> create table student1 as select * from student;
```

Creating table with your own column names.

```
SQL> create table student2(sno, sname, smarks) as select * from student;
```

Creating table with specified columns.

```
SQL> create table student3 as select no,name from student;
```

Creating table with out table data.

```
SQL> create table student2(sno, sname, smarks) as select * from student where 1 = 2;
```

In the above where clause give any condition which does not satisfy.

### INSERT WITH SELECT

Using this we can insert existing table data to a another table in a single trip. But the table structure should be same.

#### Syntax:

```
Insert into <table1> select * from <table2>;
```

#### Ex:

```
SQL> insert into student1 select * from student;
```

Inserting data into specified columns

```
SQL> insert into student1(no, name) select no, name from student;
```

## COLUMN ALIASES

### Syntax:

```
Select <original_col> <alias_name> from <table_name>;
```

### Ex:

```
SQL> select no sno from student;
```

or

```
SQL> select no "sno" from student;
```

## TABLE ALIASES

If you are using table aliases you can use dot method to the columns.

### Syntax:

```
Select <alias_name>.<col1>, <alias_name>.<col2> ... <alias_name>.<coln> from  
<table_name> <alias_name>;
```

### Ex:

```
SQL> select s.no, s.name from student s;
```

## USING MERGE

### MERGE

You can use merge command to perform insert and update in a single command.

Ex:

```
SQL> Merge into student1 s1
      Using (select *From student2) s2
      On(s1.no=s2.no)
      When matched then
      Update set marks = s2.marks
      When not matched then
      Insert (s1.no,s1.name,s1.marks)
      Values(s2.no,s2.name,s2.marks);
```

In the above the two tables are with the same structure but we can merge different structured tables also but the datatype of the columns should match.

Assume that student1 has columns like no,name,marks and student2 has columns like no, name, hno, city.

```
SQL> Merge into student1 s1
      Using (select *From student2) s2
      On(s1.no=s2.no)
      When matched then
      Update set marks = s2.hno
      When not matched then
      Insert (s1.no,s1.name,s1.marks)
      Values(s2.no,s2.name,s2.hno);
```

## MULTIPLE INSERTS

We have table called DEPT with the following columns and data

DEPTNO	DNAME	LOC
10	accounting	new york
20	research	dallas
30	sales	Chicago
40	operations	boston

### a) CREATE STUDENT TABLE

```
SQL> Create table student(no number(2),name varchar(2),marks number(3));
```

### b) MULTI INSERT WITH ALL FIELDS

```
SQL> Insert all  
  Into student values(1,'a',100)  
  Into student values(2,'b',200)  
  Into student values(3,'c',300)  
  Select *from dept where deptno=10;
```

-- This inserts 3 rows

### c) MULTI INSERT WITH SPECIFIED FIELDS

```
SQL> insert all  
  Into student (no,name) values(4,'d')  
  Into student(name,marks) values('e',400)  
  Into student values(3,'c',300)  
  Select *from dept where deptno=10;
```

-- This inserts 3 rows

d) MULTI INSERT WITH DUPLICATE ROWS

```
SQL> insert all
  Into student values(1,'a',100)
  Into student values(2,'b',200)
  Into student values(3,'c',300)
  Select *from dept where deptno > 10;
```

-- This inserts 9 rows because in the select statement retrieves 3 records (3 inserts for each row retrieved)

e) MULTI INSERT WITH CONDITIONS BASED

```
SQL> Insert all
  When deptno > 10 then
  Into student1 values(1,'a',100)
  When dname = 'SALES' then
  Into student2 values(2,'b',200)
  When loc = 'NEW YORK' then
  Into student3 values(3,'c',300)
  Select *from dept where deptno>10;
```

-- This inserts 4 rows because the first condition satisfied 3 times, second condition satisfied once and the last none.

f) MULTI INSERT WITH CONDITIONS BASED AND ELSE

```
SQL> Insert all
  When deptno > 100 then
  Into student1 values(1,'a',100)
  When dname = 'S' then
  Into student2 values(2,'b',200)
  When loc = 'NEW YORK' then
  Into student3 values(3,'c',300)
  Else
  Into student values(4,'d',400)
```

```
Select *from dept where deptno>10;
```

-- This inserts 3 records because the else satisfied 3 times

g) MULTI INSERT WITH CONDITIONS BASED AND FIRST

```
SQL> Insert first
```

```
When deptno = 20 then  
Into student1 values(1,'a',100)  
When dname = 'RESEARCH' then  
Into student2 values(2,'b',200)  
When loc = 'NEW YORK' then  
Into student3 values(3,'c',300)  
Select *from dept where deptno=20;
```

-- This inserts 1 record because the first clause avoid to check the remaining conditions once the condition is satisfied.

h) MULTI INSERT WITH CONDITIONS BASED, FIRST AND ELSE

```
SQL> Insert first
```

```
When deptno = 30 then  
Into student1 values(1,'a',100)  
When dname = 'R' then  
Into student2 values(2,'b',200)  
When loc = 'NEW YORK' then  
Into student3 values(3,'c',300)  
Else  
Into student values(4,'d',400)  
Select *from dept where deptno=20;
```

-- This inserts 1 record because the else clause satisfied once

i) MULTI INSERT WITH MULTIPLE TABLES

```
SQL> Insert all  
  Into student1 values(1,'a',100)  
  Into student2 values(2,'b',200)  
  Into student3 values(3,'c',300)  
  Select *from dept where deptno=10;
```

-- This inserts 3 rows

\*\* You can use multi tables with specified fields, with duplicate rows, with conditions, with first and else clauses.

## FUNCTIONS

Functions can be categorized as follows.

- Single row functions
- Group functions

### SINGLE ROW FUNCTIONS

Single row functions can be categorized into five. These will be applied for each row and produces individual output for each row.

- Numeric functions
- String functions
- Date functions
- Miscellaneous functions
- Conversion functions

### NUMERIC FUNCTIONS

- Abs
- Sign
- Sqrt
- Mod
- Nvl
- Power
- Exp
- Ln
- Log
- Ceil
- Floor
- Round
- Trunk
- Bitand
- Greatest
- Least
- Coalesce

a) ABS

Absolute value is the measure of the magnitude of value.  
Absolute value is always a positive number.

Syntax: `abs (value)`

Ex:

```
SQL> select abs(5), abs(-5), abs(0), abs(null) from dual;
```

ABS(5)	ABS(-5)	ABS(0)	ABS(NULL)
5	-5	0	

b) SIGN

Sign gives the sign of a value.

Syntax: `sign (value)`

Ex:

```
SQL> select sign(5), sign(-5), sign(0), sign(null) from dual;
```

SIGN(5)	SIGN(-5)	SIGN(0)	SIGN(NULL)
1	-1	0	

c) SQRT

This will give the square root of the given value.

Syntax: `sqrt (value)` -- here value must be positive.

Ex:

```
SQL> select sqrt(4), sqrt(0), sqrt(null), sqrt(1) from dual;
```

SQRT(4)	SQRT(0)	SQRT(NULL)	SQRT(1)
2	0		1

d) MOD

This will give the remainder.

Syntax: mod (value, divisor)

Ex:

```
SQL> select mod(7,4), mod(1,5), mod(null,null), mod(0,0), mod(-7,4) from dual;
```

MOD(7,4)	MOD(1,5)	MOD(NULL,NULL)	MOD(0,0)	MOD(-7,4)
3	1		0	-3

e) NVL

This will substitutes the specified value in the place of null values.

Syntax: nvl (null\_col, replacement\_value)

Ex:

```
SQL> select * from student; -- here for 3rd row marks value is null
```

NO	NAME	MARKS
1	a	100
2	b	200
3	c	

```
SQL> select no, name, nvl(marks,300) from student;
```

```
NO NAME NVL(MARKS,300)
```

```
-----
```

1	a	100
2	b	200
3	c	300

```
SQL> select nvl(1,2), nvl(2,3), nvl(4,3), nvl(5,4) from dual;
```

```
NVL(1,2) NVL(2,3) NVL(4,3) NVL(5,4)
```

```
-----
```

1	2	4	5
---	---	---	---

```
SQL> select nvl(0,0), nvl(1,1), nvl(null,null), nvl(4,4) from dual;
```

```
NVL(0,0) NVL(1,1) NVL(null,null) NVL(4,4)
```

```
-----
```

0	1		4
---	---	--	---

f) POWER

Power is the ability to raise a value to a given exponent.

**Syntax:** power (value, exponent)

**Ex:**

```
SQL> select power(2,5), power(0,0), power(1,1), power(null,null), power(2,-5) from dual;
```

```
POWER(2,5) POWER(0,0) POWER(1,1) POWER(NULL,NULL) POWER(2,-5)
```

```
-----
```

32	1	1		.03125
----	---	---	--	--------

g) EXP

This will raise e value to the give power.

Syntax: `exp (value)`

Ex:

```
SQL> select exp(1), exp(2), exp(0), exp(null), exp(-2) from dual;
```

EXP(1)	EXP(2)	EXP(0)	EXP(NULL)	EXP(-2)
2.71828183	7.3890561	1		.135335283

h) LN

This is based on natural or base e logarithm.

Syntax: `ln (value)` -- here value must be greater than zero which is positive only.

Ex:

```
SQL> select ln(1), ln(2), ln(null) from dual;
```

LN(1)	LN(2)	LN(NULL)
0	.693147181	

Ln and Exp are reciprocal to each other.

$EXP(3) = 20.0855369$

$LN(20.0855369) = 3$

i) LOG

This is based on 10 based logarithm.

Syntax: `log (10, value)` -- here value must be greater than zero which is positive only.

Ex:

```
SQL> select log(10,100), log(10,2), log(10,1), log(10,null) from dual;
```

```
LOG(10,100) LOG(10,2) LOG(10,1) LOG(10,NULL)
-----
2          .301029996      0
```

LN (value) = LOG (EXP(1), value)

SQL> select ln(3), log(exp(1),3) from dual;

```
LN(3)      LOG(EXP(1),3)
-----
1.09861229 1.09861229
```

### j) CEIL

This will produce a whole number that is greater than or equal to the specified value.

Syntax: ceil (value)

Ex:

SQL> select ceil(5), ceil(5.1), ceil(-5), ceil(-5.1), ceil(0), ceil(null) from dual;

```
CEIL(5) CEIL(5.1) CEIL(-5) CEIL(-5.1) CEIL(0) CEIL(NULL)
-----
5        6         -5        -5         0
```

### k) FLOOR

This will produce a whole number that is less than or equal to the specified value.

Syntax: floor (value)

Ex:

SQL> select floor(5), floor(5.1), floor(-5), floor(-5.1), floor(0), floor(null) from dual;

```
FLOOR(5) FLOOR(5.1) FLOOR(-5) FLOOR(-5.1) FLOOR(0) FLOOR(NULL)
-----
5         5         -5        -6         0
```

I) ROUND

This will rounds numbers to a given number of digits of precision.

Syntax: round (value, precision)

Ex:

```
SQL> select round(123.2345), round(123.2345,2), round(123.2354,2) from dual;
```

```
ROUND(123.2345) ROUND(123.2345,0) ROUND(123.2345,2) ROUND(123.2354,2)
-----
123             123             123.23             123.24
```

```
SQL> select round(123.2345,-1), round(123.2345,-2), round(123.2345,-3),
round(123.2345,-4) from dual;
```

```
ROUND(123.2345,-1) ROUND(123.2345,-2) ROUND(123.2345,-3) ROUND(123.2345,-4)
-----
120                 100                 0                 0
```

```
SQL> select round(123,0), round(123,1), round(123,2) from dual;
```

```
ROUND(123,0) ROUND(123,1) ROUND(123,2)
-----
123         123         123
```

```
SQL> select round(-123,0), round(-123,1), round(-123,2) from dual;
```

```
ROUND(-123,0) ROUND(-123,1) ROUND(-123,2)
-----
-123         -123         -123
```

```
SQL> select round(123,-1), round(123,-2), round(123,-3), round(-123,-1), round(-123,-2), round(-123,-3) from dual;
```

```
ROUND(123,-1) ROUND(123,-2) ROUND(123,-3) ROUND(-123,-1) ROUND(-123,-2)
ROUND(-123,-3)
```

```
-----
      120      100      0      -120      -100      0
```

```
SQL> select round(null,null), round(0,0), round(1,1), round(-1,-1), round(-2,-2) from dual;
```

```
ROUND(NULL,NULL) ROUND(0,0) ROUND(1,1) ROUND(-1,-1) ROUND(-2,-2)
```

```
-----
                        0      1      0      0
```

m) TRUNC

This will truncates or chops off digits of precision from a number.

**Syntax:** `trunc (value, precision)`

**Ex:**

```
SQL> select trunc(123.2345), trunc(123.2345,2), trunc(123.2354,2) from dual;
```

```
TRUNC(123.2345) TRUNC(123.2345,2) TRUNC(123.2354,2)
```

```
-----
      123      123.23      123.23
```

```
SQL> select trunc(123.2345,-1), trunc(123.2345,-2), trunc(123.2345,-3),
trunc(123.2345,-4) from dual;
```

```
TRUNC(123.2345,-1) TRUNC(123.2345,-2) TRUNC(123.2345,-3) TRUNC(123.2345,-4)
```

```
-----
      120      100      0      0
```

```
SQL> select trunc(123,0), trunc(123,1), trunc(123,2) from dual;
```

```
TRUNC(123,0) TRUNC(123,1) TRUNC(123,2)
-----
123          123          123
```

```
SQL> select trunc(-123,0), trunc(-123,1), trunc(-123,2) from dual;
```

```
TRUNC(-123,0) TRUNC(-123,1) TRUNC(-123,2)
-----
-123          -123          -123
```

```
SQL> select trunc(123,-1), trunc(123,-2), trunc(123,-3), trunc(-123,-1), trunc(-123,2),
trunc(-123,-3) from dual;
```

```
TRUNC(123,-1) TRUNC(123,-2) TRUNC(123,-3) TRUNC(-123,-1) TRUNC(-123,2) TRUNC(-
123,-3)
-----
120          100          0          -120          -123          0
```

```
SQL> select trunc(null,null), trunc(0,0), trunc(1,1), trunc(-1,-1), trunc(-2,-2) from dual;
```

```
TRUNC(NULL,NULL) TRUNC(0,0) TRUNC(1,1) TRUNC(-1,-1) TRUNC(-2,-2)
-----
0          1          0          0
```

#### n) BITAND

This will perform bitwise and operation.

**Syntax:** bitand (value1, value2)

**Ex:**

```
SQL> select bitand(2,3), bitand(0,0), bitand(1,1), bitand(null,null), bitand(-2,-3) from
dual;
```

```
BITAND(2,3) BITAND(0,0) BITAND(1,1) BITAND(NULL,NULL) BITAND(-2,-3)
-----
                2          0          1                               -4
```

**o) GREATEST**

This will give the greatest number.

**Syntax:** greatest (*value1, value2, value3 ... valuen*)

**Ex:**

```
SQL> select greatest(1, 2, 3), greatest(-1, -2, -3) from dual;
```

```
GREATEST(1,2,3) GREATEST(-1,-2,-3)
-----
                3          -1
```

- If all the values are zeros then it will display zero.
- If all the parameters are nulls then it will display nothing.
- If any of the parameters is null it will display nothing.

**p) LEAST**

This will give the least number.

**Syntax:** least (*value1, value2, value3 ... valuen*)

**Ex:**

```
SQL> select least(1, 2, 3), least(-1, -2, -3) from dual;
```

```
LEAST(1,2,3)    LEAST(-1,-2,-3)
-----
                1          -3
```

- If all the values are zeros then it will display zero.
- If all the parameters are nulls then it will display nothing.
- If any of the parameters is null it will display nothing.

q) COALESCE

This will return first non-null value.

**Syntax:** coalesce (*value1, value2, value3 ... valuen*)

**Ex:**

```
SQL> select coalesce(1,2,3), coalesce(null,2,null,5) from dual;
```

```
COALESCE(1,2,3) COALESCE(NULL,2,NULL,5)
-----
1                2
```

STRING FUNCTIONS

- Initcap
- Upper
- Lower
- Length
- Rpad
- Lpad
- Ltrim
- Rtrim
- Trim
- Translate
- Replace
- Soundex
- Concat ( ' || ' Concatenation operator)
- Ascii
- Chr
- Substr
- Instr
- Decode
- Greatest
- Least
- Coalesce

a) INITCAP

This will capitalize the initial letter of the string.

Syntax: `initcap (string)`

Ex:

```
SQL> select initcap('computer') from dual;
```

```
INITCAP  
-----  
Computer
```

b) UPPER

This will convert the string into uppercase.

Syntax: `upper (string)`

Ex:

```
SQL> select upper('computer') from dual;
```

```
UPPER  
-----  
COMPUTER
```

c) LOWER

This will convert the string into lowercase.

Syntax: `lower (string)`

Ex:

```
SQL> select lower('COMPUTER') from dual;
```

```
LOWER
-----
computer
```

d) LENGTH

This will give length of the string.

Syntax: length (*string*)

Ex:

```
SQL> select length('computer') from dual;
```

```
LENGTH
-----
      8
```

e) RPAD

This will allows you to pad the right side of a column with any set of characters.

Syntax: rpad (*string*, *length* [, *padding\_char*])

Ex:

```
SQL> select rpad('computer',15,'*'), rpad('computer',15,'*#') from dual;
```

```
RPAD('COMPUTER' RPAD('COMPUTER'
-----
computer***** computer*#*#*#*#*
```

-- Default padding character was blank space.

f) LPAD

This will allows you to pad the left side of a column with any set of characters.

**Syntax:** lpad (*string*, *length* [, *padding\_char*])

**Ex:**

```
SQL> select lpad('computer',15,'*'), lpad('computer',15,'*#') from dual;
```

```
LPAD('COMPUTER' LPAD('COMPUTER'  
-----  
*****computer *#*#*#*computer
```

-- Default padding character was blank space.

### g) LTRIM

This will trim off unwanted characters from the left end of string.

**Syntax:** ltrim (*string* [,*unwanted\_chars*])

**Ex:**

```
SQL> select ltrim('computer','co'), ltrim('computer','com') from dual;
```

```
LTRIM( LTRIM  
-----  
mputer puter
```

```
SQL> select ltrim('computer','puter'), ltrim('computer','omputer') from dual;
```

```
LTRIM('C LTRIM('C  
-----  
computer computer
```

-- If you haven't specify any unwanted characters it will display entire string.

### h) RTRIM

This will trim off unwanted characters from the right end of string.

**Syntax:** rtrim (*string* [, *unwanted\_chars*])

**Ex:**

```
SQL> select rtrim('computer','er'), rtrim('computer','ter') from dual;
      RTRIM( RTRIM
      -----
      comput  compu
```

```
SQL> select rtrim('computer','comput'), rtrim('computer','compute') from dual;
```

```
      RTRIM('C RTRIM('C
      -----
      computer  computer
```

-- If you haven't specify any unwanted characters it will display entire string.

#### i) TRIM

This will trim off unwanted characters from the both sides of string.

**Syntax:** trim (*unwanted\_chars* from *string*)

**Ex:**

```
SQL> select trim( 'i' from 'indiani') from dual;
```

```
      TRIM(
      -----
      ndian
```

```
SQL> select trim( leading'i' from 'indiani') from dual;      -- this will work as LTRIM
```

```
      TRIM(L
      -----
      ndiani
```

```
SQL> select trim( trailing'i' from 'indiani') from dual;      -- this will work as RTRIM
```

```
TRIM(T  
-----  
Indian
```

#### j) TRANSLATE

This will replace the set of characters, character by character.

**Syntax:** translate (*string, old\_chars, new\_chars*)

**Ex:**

```
SQL> select translate('india','in','xy') from dual;
```

```
TRANS  
-----  
xydxa
```

#### k) REPLACE

This will replace the set of characters, string by string.

**Syntax:** replace (*string, old\_chars [, new\_chars]*)

**Ex:**

```
SQL> select replace('india','in','xy'), replace('india','in') from dual;
```

```
REPLACE  REPLACE  
-----  -----  
Xydia    dia
```

#### l) SOUNDEX

This will be used to find words that sound like other words, exclusively used in where clause.

Syntax: `soundex (string)`

Ex:

```
SQL> select * from emp where soundex(ename) = soundex('SMIT');
```

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	DEPTNO
7369	SMITH	CLERK	7902	17-DEC-80	500	20

m) `CONCAT`

This will be used to combine two strings only.

Syntax: `concat (string1, string2)`

Ex:

```
SQL> select concat('computer',' operator') from dual;
```

```
CONCAT('COMPUTER'  
-----  
computer operator
```

If you want to combine more than two strings you have to use concatenation operator (`||`).

```
SQL> select 'how' || ' are' || ' you' from dual;
```

```
'HOW' || 'ARE  
-----  
how are you
```

n) `ASCII`

This will return the decimal representation in the database character set of the first character of the string.

Syntax: `ascii (string)`

Ex:

```
SQL> select ascii('a'), ascii('apple') from dual;
```

```
ASCII('A') ASCII('APPLE')
-----
          97          97
```

o) CHR

This will return the character having the binary equivalent to the string in either the database character set or the national character set.

Syntax: `chr (number)`

Ex:

```
SQL> select chr(97) from dual;
```

```
CHR
----
a
```

p) SUBSTR

This will be used to extract substrings.

Syntax: `substr (string, start_chr_count [, no_of_chars])`

Ex:

```
SQL> select substr('computer',2), substr('computer',2,5), substr('computer',3,7) from
dual;
```

```
SUBSTR( SUBST SUBSTR
-----
computer oput mputer
```

- If *no\_of\_chars* parameter is negative then it will display nothing.
- If both parameters except *string* are null or zeros then it will display nothing.
- If *no\_of\_chars* parameter is greater than the length of the string then it ignores and calculates based on the original string length.
- If *start\_chr\_count* is negative then it will extract the substring from right end.

1	2	3	4	5	6	7	8
C	O	M	P	U	T	E	R
-8	-7	-6	-5	-4	-3	-2	-1

q) INSTR

This will allow you for searching through a string for set of characters.

**Syntax:** instr (*string*, *search\_str* [, *start\_chr\_count* [, *occurrence*] ])

**Ex:**

```
SQL> select instr('information','o',4,1), instr('information','o',4,2) from dual;
```

```
INSTR('INFORMATION','O',4,1) INSTR('INFORMATION','O',4,2)
-----
                4                10
```

- If you are not specifying *start\_chr\_count* and *occurrence* then it will start search from the beginning and finds first occurrence only.
- If both parameters *start\_chr\_count* and *occurrence* are null, it will display nothing.

r) DECODE

Decode will act as value by value substitution.

For every value of field, it will check for a match in a series of if/then tests.

**Syntax:** decode (*value*, *if1*, *then1*, *if2*, *then2*, ..... *else*);

**Ex:**

```
SQL> select sal, decode(sal,500,'Low',5000,'High','Medium') from emp;
```

SAL	DECODE
500	Low
2500	Medium
2000	Medium
3500	Medium
3000	Medium
5000	High
4000	Medium
5000	High
1800	Medium
1200	Medium
2000	Medium
2700	Medium
2200	Medium
3200	Medium

```
SQL> select decode(1,1,3), decode(1,2,3,4,4,6) from dual;
```

DECODE(1,1,3)	DECODE(1,2,3,4,4,6)
3	6

- If the number of parameters are odd and different then decode will display nothing.
- If the number of parameters are even and different then decode will display last value.
- If all the parameters are null then decode will display nothing.
- If all the parameters are zeros then decode will display zero.

### s) GREATEST

This will give the greatest string.

**Syntax:** greatest (*strng1, string2, string3 ... stringn*)

Ex:

```
SQL> select greatest('a', 'b', 'c'), greatest('satish','srinu','saketh') from dual;
```

```
GREAT GREAT
-----
c      srinu
```

- If all the parameters are nulls then it will display nothing.
- If any of the parameters is null it will display nothing.

t) LEAST

This will give the least string.

**Syntax:** `greatest (strng1, string2, string3 ... stringn)`

Ex:

```
SQL> select least('a', 'b', 'c'), least('satish','srinu','saketh') from dual;
```

```
LEAST LEAST
-----
a      saketh
```

- If all the parameters are nulls then it will display nothing.
- If any of the parameters is null it will display nothing.

u) COALESCE

This will gives the first non-null string.

**Syntax:** `coalesce (strng1, string2, string3 ... stringn)`

Ex:

```
SQL> select coalesce('a','b','c'), coalesce(null,'a',null,'b') from dual;
```

## COALESCE COALESCE

-----  
a a

### DATE FUNCTIONS

- Sysdate
- Current\_date
- Current\_timestamp
- Systimestamp
- Localtimestamp
- Dbtimezone
- Sessiontimezone
- To\_char
- To\_date
- Add\_months
- Months\_between
- Next\_day
- Last\_day
- Extract
- Greatest
- Least
- Round
- Trunc
- New\_time
- Coalesce

Oracle default date format is DD-MON-YY.

We can change the default format to our desired format by using the following command.

```
SQL> alter session set nls_date_format = 'DD-MONTH-YYYY';
```

But this will expire once the session was closed.

#### a) SYSDATE

This will give the current date and time.

Ex:

```
SQL> select sysdate from dual;
```

```
SYSDATE
-----
24-DEC-06
```

b) CURRENT\_DATE

This will returns the current date in the session's timezone.

Ex:

```
SQL> select current_date from dual;
```

```
CURRENT_DATE
-----
24-DEC-06
```

c) CURRENT\_TIMESTAMP

This will returns the current timestamp with the active time zone information.

Ex:

```
SQL> select current_timestamp from dual;
```

```
CURRENT_TIMESTAMP
-----
24-DEC-06 03.42.41.383369 AM +05:30
```

d) SYSTIMESTAMP

This will returns the system date, including fractional seconds and time zone of the database.

Ex:

```
SQL> select systimestamp from dual;
```

SYSTIMESTAMP

-----  
24-DEC-06 03.49.31.830099 AM +05:30

e) LOCALTIMESTAMP

This will returns local timestamp in the active time zone information, with no time zone information shown.

Ex:

SQL> select localtimestamp from dual;

LOCALTIMESTAMP  
-----  
24-DEC-06 03.44.18.502874 AM

f) DBTIMEZONE

This will returns the current database time zone in UTC format. (Coordinated Universal Time)

Ex:

SQL> select dbtimezone from dual;

DBTIMEZONE  
-----  
-07:00

g) SESSIONTIMEZONE

This will returns the value of the current session's time zone.

Ex:

SQL> select sessiontimezone from dual;

SESSIONTIMEZONE  
-----  
+05:30

## h) TO\_CHAR

This will be used to extract various date formats.

The available date formats as follows.

**Syntax:** to\_char (date, format)

### DATE FORMATS

D	--	No of days in week
DD	--	No of days in month
DDD	--	No of days in year
MM	--	No of month
MON	--	Three letter abbreviation of month
MONTH	--	Fully spelled out month
RM	--	Roman numeral month
DY	--	Three letter abbreviated day
DAY	--	Fully spelled out day
Y	--	Last one digit of the year
YY	--	Last two digits of the year
YYY	--	Last three digits of the year
YYYY	--	Full four digit year
SYYYY	--	Signed year
I	--	One digit year from ISO standard
IY	--	Two digit year from ISO standard
IYY	--	Three digit year from ISO standard
IYYY	--	Four digit year from ISO standard
Y, YYY	--	Year with comma
YEAR	--	Fully spelled out year
CC	--	Century
Q	--	No of quarters
W	--	No of weeks in month
WW	--	No of weeks in year
IW	--	No of weeks in year from ISO standard
HH	--	Hours
MI	--	Minutes

SS	--	Seconds
FF	--	Fractional seconds
AM or PM	--	Displays AM or PM depending upon time of day
A.M or P.M	--	Displays A.M or P.M depending upon time of day
AD or BC	--	Displays AD or BC depending upon the date
A.D or B.C	--	Displays AD or BC depending upon the date
FM	--	Prefix to month or day, suppresses padding of month or day
TH	--	Suffix to a number
SP	--	suffix to a number to be spelled out
SPTH	--	Suffix combination of TH and SP to be both spelled out
THSP	--	same as SPTH

Ex:

```
SQL> select to_char(sysdate,'dd month yyyy hh:mi:ss am dy') from dual;
```

```
TO_CHAR(SYSDATE,'DD MONTH YYYYHH:MI
```

```
-----
```

```
24 december 2006 02:03:23 pm sun
```

```
SQL> select to_char(sysdate,'dd month year') from dual;
```

```
TO_CHAR(SYSDATE,'DDMONTHYEAR')
```

```
-----
```

```
24 december two thousand six
```

```
SQL> select to_char(sysdate,'dd fmmmonth year') from dual;
```

```
TO_CHAR(SYSDATE,'DD FMMONTH YEAR')
```

```
-----
```

```
24 december two thousand six
```

```
SQL> select to_char(sysdate,'ddth DDTH') from dual;
```

```
TO_CHAR(S  
-----  
24th 24TH
```

```
SQL> select to_char(sysdate,'ddspth DDSPTH') from dual;
```

```
TO_CHAR(SYSDATE,'DDSPHDDSPTH  
-----  
twenty-fourth TWENTY-FOURTH
```

```
SQL> select to_char(sysdate,'ddsp Ddsp DDSP ') from dual;
```

```
TO_CHAR(SYSDATE,'DDSPDDSPDDSP')  
-----  
twenty-four Twenty-Four TWENTY-FOUR
```

#### i) TO\_DATE

This will be used to convert the string into data format.

**Syntax:** to\_date (date)

**Ex:**

```
SQL> select to_char(to_date('24/dec/2006','dd/mon/yyyy'), 'dd * month * day') from  
dual;
```

```
TO_CHAR(TO_DATE('24/DEC/20  
-----  
24 * december * Sunday
```

-- If you are not using to\_char oracle will display output in default date format.

#### j) ADD\_MONTHS

This will add the specified months to the given date.

**Syntax:** `add_months (date, no_of_months)`

**Ex:**

```
SQL> select add_months(to_date('11-jan-1990','dd-mon-yyyy'), 5) from dual;
```

```
ADD_MONTHS
-----
11-JUN-90
```

```
SQL> select add_months(to_date('11-jan-1990','dd-mon-yyyy'), -5) from dual;
```

```
ADD_MONTH
-----
11-AUG-89
```

- If *no\_of\_months* is zero then it will display the same date.
- If *no\_of\_months* is null then it will display nothing.

#### K) MONTHS\_BETWEEN

This will give difference of months between two dates.

**Syntax:** `months_between (date1, date2)`

**Ex:**

```
SQL> select months_between(to_date('11-aug-1990','dd-mon-yyyy'), to_date('11-jan-1990','dd-mon-yyyy')) from dual;
```

```
MONTHS_BETWEEN(TO_DATE('11-AUG-1990','DD-MON-YYYY'),TO_DATE('11-JAN-1990','DD-MON-YYYY'))
```

```
-----
```

7

```
SQL> select months_between(to_date('11-jan-1990','dd-mon-yyyy'), to_date('11-aug-1990','dd-mon-yyyy')) from dual;
```

```
MONTHS_BETWEEN(TO_DATE('11-JAN-1990','DD-MON-YYYY'),TO_DATE('11-AUG-1990','DD-MON-YYYY'))
```

-----  
-7

#### l) NEXT\_DAY

This will produce next day of the given day from the specified date.

**Syntax:** next\_day (date, day)

**Ex:**

```
SQL> select next_day(to_date('24-dec-2006','dd-mon-yyyy'),'sun') from dual;
```

```
      NEXT_DAY(  
      -----  
      31-DEC-06
```

-- If the day parameter is null then it will display nothing.

#### m) LAST\_DAY

This will produce last day of the given date.

**Syntax:** last\_day (date)

**Ex:**

```
SQL> select last_day(to_date('24-dec-2006','dd-mon-yyyy'),'sun') from dual;
```

```
      LAST_DAY(  
      -----  
      31-DEC-06
```

n) EXTRACT

This is used to extract a portion of the date value.

**Syntax:** `extract ((year | month | day | hour | minute | second), date)`

**Ex:**

```
SQL> select extract(year from sysdate) from dual;
      EXTRACT(YEARFROMSYSDATE)
-----
                2006
```

-- You can extract only one value at a time.

o) GREATEST

This will give the greatest date.

**Syntax:** `greatest (date1, date2, date3 ... daten)`

**Ex:**

```
SQL> select greatest(to_date('11-jan-90','dd-mon-yy'),to_date('11-mar-90','dd-mon-yy'),to_date('11-apr-90','dd-mon-yy')) from dual;
      GREATEST(
-----
      11-APR-90
```

p) LEAST

This will give the least date.

**Syntax:** `least (date1, date2, date3 ... daten)`

**Ex:**

```
SQL> select least(to_date('11-jan-90','dd-mon-yy'),to_date('11-mar-90','dd-mon-yy'),to_date('11-apr-90','dd-mon-yy')) from dual;
```

```
LEAST(  
-----  
11-JAN-90
```

#### q) ROUND

Round will rounds the date to which it was equal to or greater than the given date.

**Syntax:** round (*date*, (*day* | *month* | *year*))

If the second parameter was *year* then round will checks the month of the given date in the following ranges.

```
JAN  --  JUN  
JUL  --  DEC
```

If the month falls between JAN and JUN then it returns the first day of the current year.

If the month falls between JUL and DEC then it returns the first day of the next year.

If the second parameter was *month* then round will checks the day of the given date in the following ranges.

```
1    --    15  
16   --    31
```

If the day falls between 1 and 15 then it returns the first day of the current month.

If the day falls between 16 and 31 then it returns the first day of the next month.

If the second parameter was *day* then round will checks the week day of the given date in the following ranges.

```
SUN  --  WED  
THU  --  SUN
```

If the week day falls between SUN and WED then it returns the previous sunday.

If the weekday falls between THU and SUN then it returns the next sunday.

- If the second parameter was null then it returns nothing.
- If the you are not specifying the second parameter then round will resets the time to the begining of the current day in case of user specified date.
- If the you are not specifying the second parameter then round will resets the time to the begining of the next day in case of sysdate.

Ex:

```
SQL> select round(to_date('24-dec-04','dd-mon-yy'),'year'), round(to_date('11-mar-06','dd-mon-yy'),'year') from dual;
```

```
ROUND(TO_ ROUND(TO_
-----
01-JAN-05  01-JAN-06
```

```
SQL> select round(to_date('11-jan-04','dd-mon-yy'),'month'), round(to_date('18-jan-04','dd-mon-yy'),'month') from dual;
```

```
ROUND(TO_ ROUND(TO_
-----
01-JAN-04  01-FEB-04
```

```
SQL> select round(to_date('26-dec-06','dd-mon-yy'),'day'), round(to_date('29-dec-06','dd-mon-yy'),'day') from dual;
```

```
ROUND(TO_ ROUND(TO_
-----
24-DEC-06  31-DEC-06
```

```
SQL> select to_char(round(to_date('24-dec-06','dd-mon-yy')), 'dd mon yyyy hh:mi:ss am') from dual;
```

```
TO_CHAR(ROUND(TO_DATE('
-----
24 dec 2006 12:00:00 am
```

r) TRUNC

Trunc will chop off the date to which it was equal to or less than the given date.

**Syntax:** trunc (*date*, (*day* | *month* | *year*))

- If the second parameter was *year* then it always returns the first day of the current year.
- If the second parameter was *month* then it always returns the first day of the current month.
- If the second parameter was *day* then it always returns the previous sunday.
- If the second parameter was null then it returns nothing.
- If the you are not specifying the second parameter then trunk will resets the time to the begining of the current day.

**Ex:**

```
SQL> select trunc(to_date('24-dec-04','dd-mon-yy'),'year'), trunc(to_date('11-mar-06','dd-mon-yy'),'year') from dual;
```

```
TRUNC(TO_ TRUNC(TO_
-----
01-JAN-04  01-JAN-06
```

```
SQL> select trunc(to_date('11-jan-04','dd-mon-yy'),'month'), trunc(to_date('18-jan-04','dd-mon-yy'),'month') from dual;
```

```
TRUNC(TO_ TRUNC(TO_
-----
01-JAN-04  01-JAN-04
```

```
SQL> select trunc(to_date('26-dec-06','dd-mon-yy'),'day'), trunc(to_date('29-dec-06','dd-mon-yy'),'day') from dual;
```

```
TRUNC(TO_ TRUNC(TO_
-----
24-DEC-06 24-DEC-06
```

```
SQL> select to_char(trunc(to_date('24-dec-06','dd-mon-yy')), 'dd mon yyyy hh:mi:ss am')
        from dual;
```

```
TO_CHAR(TRUNC(TO_DATE('
-----
24 dec 2006 12:00:00 am
```

s) **NEW\_TIME**

This will give the desired timezone's date and time.

**Syntax:** *new\_time (date, current\_timezone, desired\_timezone)*

Available timezones are as follows.

**TIMEZONES**

AST/ADT	--	Atlantic standard/day light time
BST/BDT	--	Bering standard/day light time
CST/CDT	--	Central standard/day light time
EST/EDT	--	Eastern standard/day light time
GMT	--	Greenwich mean time
HST/HDT	--	Alaska-Hawaii standard/day light time
MST/MDT	--	Mountain standard/day light time
NST	--	Newfoundland standard time
PST/PDT	--	Pacific standard/day light time
YST/YDT	--	Yukon standard/day light time

**Ex:**

```
SQL> select to_char(new_time(sysdate,'gmt','yst'),'dd mon yyyy hh:mi:ss am') from dual;
```

```
TO_CHAR(NEW_TIME(SYSDAT
-----
24 dec 2006 02:51:20 pm
```

```
SQL> select to_char(new_time(sysdate,'gmt','est'),'dd mon yyyy hh:mi:ss am') from dual;
```

```
TO_CHAR(NEW_TIME(SYSDAT
-----
24 dec 2006 06:51:26 pm
```

t) COALESCE

This will give the first non-null date.

**Syntax:** coalesce (date1, date2, date3 ... daten)

**Ex:**

```
SQL> select coalesce('12-jan-90','13-jan-99'), coalesce(null,'12-jan-90','23-mar-98',null)
from dual;
```

```
COALESCE( COALESCE(
-----
12-jan-90 12-jan-90
```

MISCELLANEOUS FUNCTIONS

- Uid
- User
- Vsize
- Rank
- Dense\_rank

a) UID

This will returns the integer value corresponding to the user currently logged in.

**Ex:**

```
SQL> select uid from dual;
```

```
UID
-----
319
```

b) USER

This will returns the login's user name.

Ex:

```
SQL> select user from dual;
```

```
USER
-----
SAKETH
```

c) VSIZE

This will returns the number of bytes in the expression.

Ex:

```
SQL> select vsize(123), vsize('computer'), vsize('12-jan-90') from dual;
```

```
VSIZE(123) VSIZE('COMPUTER') VSIZE('12-JAN-90')
-----
3          8                  9
```

d) RANK

This will give the non-sequential ranking.

Ex:

```
SQL> select rownum,sal from (select sal from emp order by sal desc);
```

```
ROWNUM  SAL
-----
1       5000
2       3000
3       3000
4       2975
```

5	2850
6	2450
7	1600
8	1500
9	1300
10	1250
11	1250
12	1100
13	1000
14	950
15	800

SQL> select rank(2975) within group(order by sal desc) from emp;

RANK(2975)WITHINGROUP(ORDERBYSALDESC)

-----

4

#### d) DENSE\_RANK

This will give the sequential ranking.

Ex:

SQL> select dense\_rank(2975) within group(order by sal desc) from emp;

DENSE\_RANK(2975)WITHINGROUP(ORDERBYSALDESC)

-----

3

#### CONVERSION FUNCTIONS

- Bin\_to\_num
- Chartorowid
- Rowidtochar
- To\_number
- To\_char
- To\_date

a) BIN\_TO\_NUM

This will convert the binary value to its numerical equivalent.

Syntax: `bin_to_num( binary_bits)`

Ex:

```
SQL> select bin_to_num(1,1,0) from dual;
```

```
      BIN_TO_NUM(1,1,0)
-----
                6
```

- If all the bits are zero then it produces zero.
- If all the bits are null then it produces an error.

b) CHARTOROWID

This will convert a character string to act like an internal oracle row identifier or rowid.

c) ROWIDTOCHAR

This will convert an internal oracle row identifier or rowid to character string.

d) TO\_NUMBER

This will convert a char or varchar to number.

e) TO\_CHAR

This will convert a number or date to character string.

f) TO\_DATE

This will convert a number, char or varchar to a date.

## GROUP FUNCTIONS

- Sum
- Avg
- Max
- Min
- Count

Group functions will be applied on all the rows but produces single output.

### a) SUM

This will give the sum of the values of the specified column.

**Syntax:** `sum (column)`

**Ex:**

```
SQL> select sum(sal) from emp;
```

```
SUM(SAL)
-----
38600
```

### b) AVG

This will give the average of the values of the specified column.

**Syntax:** `avg (column)`

**Ex:**

```
SQL> select avg(sal) from emp;
```

```
AVG(SAL)
-----
2757.14286
```

c) MAX

This will give the maximum of the values of the specified column.

Syntax: `max (column)`

Ex:

```
SQL> select max(sal) from emp;
```

```
MAX(SAL)
-----
5000
```

d) MIN

This will give the minimum of the values of the specified column.

Syntax: `min (column)`

Ex:

```
SQL> select min(sal) from emp;
```

```
MIN(SAL)
-----
500
```

e) COUNT

This will give the count of the values of the specified column.

Syntax: `count (column)`

Ex:

```
SQL> select count(sal),count(*) from emp;
```

```
COUNT(SAL)  COUNT(*)
-----  -----
14          14
```

## CONSTRAINTS

Constraints are categorized as follows.

### Domain integrity constraints

- ✓ Not null
- ✓ Check

### Entity integrity constraints

- ✓ Unique
- ✓ Primary key

### Referential integrity constraints

- ✓ Foreign key

Constraints are always attached to a column not a table.

We can add constraints in three ways.

- ✓ Column level      -- along with the column definition
- ✓ Table level        -- after the table definition
- ✓ Alter level        -- using alter command

While adding constraints you need not specify the name but the type only, oracle will internally name the constraint.

If you want to give a name to the constraint, you have to use the constraint clause.

### NOT NULL

This is used to avoid null values.

We can add this constraint in column level only.

Ex:

```
SQL> create table student(no number(2) not null, name varchar(10), marks number(3));
SQL> create table student(no number(2) constraint nn not null, name varchar(10), marks
number(3));
```

## CHECK

This is used to insert the values based on specified condition.

We can add this constraint in all three levels.

Ex:

### COLUMN LEVEL

```
SQL> create table student(no number(2) , name varchar(10), marks number(3) check  
    (marks > 300));
```

```
SQL> create table student(no number(2) , name varchar(10), marks number(3) constraint ch  
    check(marks > 300));
```

### TABLE LEVEL

```
SQL> create table student(no number(2) , name varchar(10), marks number(3), check  
    (marks > 300));
```

```
SQL> create table student(no number(2) , name varchar(10), marks number(3), constraint  
    ch check(marks > 300));
```

### ALTER LEVEL

```
SQL> alter table student add check(marks>300);
```

```
SQL> alter table student add constraint ch check(marks>300);
```

## UNIQUE

This is used to avoid duplicates but it allow nulls.

We can add this constraint in all three levels.

Ex:

### COLUMN LEVEL

```
SQL> create table student(no number(2) unique, name varchar(10), marks number(3));
```

```
SQL> create table student(no number(2) constraint un unique, name varchar(10), marks  
    number(3));
```

#### TABLE LEVEL

```
SQL> create table student(no number(2) , name varchar(10), marks number(3),  
    unique(no));
```

```
SQL> create table student(no number(2) , name varchar(10), marks number(3), constraint  
    un unique(no));
```

#### ALTER LEVEL

```
SQL> alter table student add unique(no);
```

```
SQL> alter table student add constraint un unique(no);
```

#### PRIMARY KEY

This is used to avoid duplicates and nulls. This will work as combination of unique and not null. Primary key always attached to the parent table.

We can add this constraint in all three levels.

Ex:

#### COLUMN LEVEL

```
SQL> create table student(no number(2) primary key, name varchar(10), marks number(3));
```

```
SQL> create table student(no number(2) constraint pk primary key, name varchar(10),  
    marks number(3));
```

#### TABLE LEVEL

```
SQL> create table student(no number(2) , name varchar(10), marks number(3),  
    primary key(no));
```

```
SQL> create table student(no number(2) , name varchar(10), marks number(3), constraint  
    pk primary key(no));
```

#### ALTER LEVEL

```
SQL> alter table student add primary key(no);
```

```
SQL> alter table student add constraint pk primary key(no);
```

## FOREIGN KEY

This is used to reference the parent table primary key column which allows duplicates.

Foreign key always attached to the child table.

We can add this constraint in table and alter levels only.

Ex:

### TABLE LEVEL

```
SQL> create table emp(empno number(2), ename varchar(10), deptno number(2),
    primary key(empno), foreign key(deptno) references dept(deptno));
SQL> create table emp(empno number(2), ename varchar(10), deptno number(2),
    constraint pk primary key(empno), constraint fk foreign key(deptno) references
    dept(deptno));
```

### ALTER LEVEL

```
SQL> alter table emp add foreign key(deptno) references dept(deptno);
SQL> alter table emp add constraint fk foreign key(deptno) references dept(deptno);
```

Once the primary key and foreign key relationship has been created then you can not remove any parent record if the dependent childs exists.

## USING ON DELTE CASCADE

By using this clause you can remove the parent record even it childs exists.

Because when ever you remove parent record oracle automatically removes all its dependent records from child table, if this clause is present while creating foreign key constraint.

Ex:

### TABLE LEVEL

```
SQL> create table emp(empno number(2), ename varchar(10), deptno number(2),
    primary key(empno), foreign key(deptno) references dept(deptno) on delete cascade);
SQL> create table emp(empno number(2), ename varchar(10), deptno number(2),
    constraint pk primary key(empno), constraint fk foreign key(deptno) references
    dept(deptno) on delete cascade);
```

#### ALTER LEVEL

```
SQL> alter table emp add foreign key(deptno) references dept(deptno) on delete cascade;
SQL> alter table emp add constraint fk foreign key(deptno) references dept(deptno) on
delete cascade;
```

#### COMPOSITE KEYS

A composite key can be defined on a combination of columns.

We can define composite keys on entity integrity and referential integrity constraints.

Composite key can be defined in table and alter levels only.

Ex:

#### UNIQUE (TABLE LEVEL)

```
SQL> create table student(no number(2) , name varchar(10), marks number(3),
unique(no,name));
SQL> create table student(no number(2) , name varchar(10), marks number(3), constraint
un unique(no,name));
```

#### UNIQUE (ALTER LEVEL)

```
SQL> alter table student add unique(no,name);
SQL> alter table student add constraint un unique(no,name);
```

#### PRIMARY KEY (TABLE LEVEL)

```
SQL> create table student(no number(2) , name varchar(10), marks number(3),
primary key(no,name));
SQL> create table student(no number(2) , name varchar(10), marks number(3), constraint
pk primary key(no,name));
```

#### PRIMARY KEY (ALTER LEVEL)

```
SQL> alter table student add primary key(no,name);
SQL> alter table student add constraint pk primary key(no,name);
```

#### FOREIGN KEY (TABLE LEVEL)

```
SQL> create table emp(empno number(2), ename varchar(10), deptno number(2), dname  
    varchar(10), primary key(empno), foreign key(deptno,dname) references  
    dept(deptno,dname));
```

```
SQL> create table emp(empno number(2), ename varchar(10), deptno number(2), dname  
    varchar(10), constraint pk primary key(empno), constraint fk foreign  
    key(deptno,dname) references dept(deptno,dname));
```

#### FOREIGN KEY (ALTER LEVEL)

```
SQL> alter table emp add foreign key(deptno,dname) references dept(deptno,dname);
```

```
SQL> alter table emp add constraint fk foreign key(deptno,dname) references  
    dept(deptno,dname);
```

#### DEFERRABLE CONSTRAINTS

Each constraint has two additional attributes to support deferred checking of constraints.

- Deferred initially immediate
- Deferred initially deferred

Deferred initially immediate checks for constraint violation at the time of insert.

Deferred initially deferred checks for constraint violation at the time of commit.

Ex:

```
SQL> create table student(no number(2), name varchar(10), marks number(3), constraint  
    un unique(no) deferred initially immediate);
```

```
SQL> create table student(no number(2), name varchar(10), marks number(3), constraint  
    un unique(no) deferred initially deferred);
```

```
SQL> alter table student add constraint un unique(no) deferrable initially deferred;
```

```
SQL> set constraints all immediate;
```

This will enable all the constraints violations at the time of inserting.

```
SQL> set constraints all deferred;
```

This will enable all the constraints violations at the time of commit.

## OPERATIONS WITH CONSTRAINTS

Possible operations with constraints as follows.

- Enable
- Disable
- Enforce
- Drop

### ENABLE

This will enable the constraint. Before enable, the constraint will check the existing data.

Ex:

```
SQL> alter table student enable constraint un;
```

### DISABLE

This will disable the constraint.

Ex:

```
SQL> alter table student enable constraint un;
```

### ENFORCE

This will enforce the constraint rather than enable for future inserts or updates.

This will not check for existing data while enforcing data.

Ex:

```
SQL> alter table student enforce constraint un;
```

### DROP

This will remove the constraint.

Ex:

```
SQL> alter table student drop constraint un;
```

Once the table is dropped, constraints automatically will drop.

## CASE AND DEFAULT

### CASE

Case is similar to decode but easier to understand while going through coding

Ex:

```
SQL> Select sal,  
       Case sal  
         When 500 then 'low'  
         When 5000 then 'high'  
         Else 'medium'  
       End case  
       From emp;
```

SAL	CASE
500	low
2500	medium
2000	medium
3500	medium
3000	medium
5000	high
4000	medium
5000	high
1800	medium
1200	medium
2000	medium
2700	medium
2200	medium
3200	medium

## DEFAULT

*Default* can be considered as a substitute behavior of *not null* constraint when applied to new rows being entered into the table.

When you define a column with the *default* keyword followed by a value, you are actually telling the database that, on insert if a row was not assigned a value for this column, use the default value that you have specified.

Default is applied only during insertion of new rows.

Ex:

```
SQL> create table student(no number(2) default 11,name varchar(2));
```

```
SQL> insert into student values(1,'a');
```

```
SQL> insert into student(name) values('b');
```

```
SQL> select * from student;
```

NO	NAME
1	a
11	b

```
SQL> insert into student values(null, 'c');
```

```
SQL> select * from student;
```

NO	NAME
1	a
11	b
	c

-- Default can not override nulls.

## ABSTRACT DATA TYPES

Some times you may want type which holds all types of data including numbers, chars and special characters something like this. You can not achieve this using pre-defined types. You can define custom types which holds your desired data.

Ex:

Suppose in a table we have address column which holds hno and city information. We will define a custom type which holds both numeric as well as char data.

### CREATING ADT

```
SQL> create type addr as object(hno number(3),city varchar(10)); /
```

### CREATING TABLE BASED ON ADT

```
SQL> create table student(no number(2),name varchar(2),address addr);
```

### INSERTING DATA INTO ADT TABLES

```
SQL> insert into student values(1,'a',addr(111,'hyd'));
SQL> insert into student values(2,'b',addr(222,'bang'));
SQL> insert into student values(3,'c',addr(333,'delhi'));
```

### SELECTING DATA FROM ADT TABLES

```
SQL> select * from student;
```

```
NO NAME ADDRESS(HNO, CITY)
```

```
-----
1    a    ADDR(111, 'hyd')
2    b    ADDR(222, 'bang')
3    c    ADDR(333, 'delhi')
```

```
SQL> select no,name,s.address.hno,s.address.city from student s;
```

```
NO NAME ADDRESS.HNO ADDRESS.CITY
```

```
-----  
1      a      111      hyd  
2      b      222      bang  
3      c      333      delhi
```

UPDATE WITH ADT TABLES

```
SQL> update student s set s.address.city = 'bombay' where s.address.hno = 333;
```

```
SQL> select no,name,s.address.hno,s.address.city from student s;
```

```
NO NAME ADDRESS.HNO ADDRESS.CITY
```

```
-----  
1      a      111      hyd  
2      b      222      bang  
3      c      333      bombay
```

DELETE WITH ADT TABLES

```
SQL> delete student s where s.address.hno = 111;
```

```
SQL> select no,name,s.address.hno,s.address.city from student s;
```

```
NO NAME ADDRESS.HNO ADDRESS.CITY
```

```
-----  
2      b      222      bang  
3      c      333      bombay
```

DROPPING ADT

```
SQL> drop type addr;
```

## OBJECT VIEWS AND METHODS

### OBJECT VIEWS

If you want to implement objects with the existing table, object views come into picture. You define the object and create a view which relates this object to the existing table nothing but *object view*.

Object views are used to relate the user defined objects to the existing table.

Ex:

- 1) Assume that the table student has already been created with the following columns

```
SQL> create table student(no number(2),name varchar(10),hno number(3),city
      varchar(10));
```

- 2) Create the following types

```
SQL> create type addr as object(hno number(2),city varchar(10));/
SQL> create type stud as object(name varchar(10),address addr);/
```

- 3) Relate the objects to the student table by creating the object view

```
SQL> create view student_ov(no,stud_info) as select no,stud(name,addr(hno,city)) from
      student;
```

- 4) Now you can insert data into student table in two ways

- a) By regular insert

```
SQL> Insert into student values(1,'sudha',111,'hyd');
```

- b) By using object view

```
SQL> Insert into student_ov values(1,stud('sudha',addr(111,'hyd')));
```

### METHODS

You can define methods which are nothing but functions in types and apply in the tables which holds the types;

Ex:

- 1) Defining methods in types

```
SQL> Create type stud as object(name varchar(10),marks number(3),
      Member function makrs_f(marks in number) return number,
```

```
Pragma restrict_references(marks_f,wnds,rnds,wnps,fnps));/
```

## 2) Defining type body

```
SQL> Create type body stud as
Member function marks_f(marks in number) return number is
Begin
Return (marks+100);
End marks_f;
End;/
```

## 3) Create a table using stud type

```
SQL> Create table student(no number(2),info stud);
```

## 4) Insert some data into student table

```
SQL> Insert into student values(1,stud('sudha',100));
```

## 5) Using method in select

```
SQL> Select s.info.marks_f(s.info.marks) from student s;
```

-- Here we are using the pragma restrict\_references to avoid the writes to the database.

## VARRAYS AND NESTED TABLES

### VARRAYS

A varying array allows you to store repeating attributes of a record in a single row but with limit.

Ex:

1) We can create varrays using oracle types as well as user defined types.

a) Varray using pre-defined types

```
SQL> Create type va as varray(5) of varchar(10);/
```

b) Varrays using user defined types

```
SQL> Create type addr as object(hno number(3),city varchar(10));/
```

```
SQL> Create type va as varray(5) of addr;/
```

2) Using varray in table

```
SQL> Create table student(no number(2),name varchar(10),address va);
```

3) Inserting values into varray table

```
SQL> Insert into student values(1,'sudha',va(addr(111,'hyd')));
```

```
SQL> Insert into student values(2,'jagan',va(addr(111,'hyd'),addr(222,'bang')));
```

4) Selecting data from varray table

```
SQL> Select * from student;
```

```
-- This will display varray column data along with varray and adt;
```

```
SQL> Select no,name, s.* from student s1, table(s1.address) s;
```

```
-- This will display in general format
```

5) Instead of s.\* you can specify the columns in varray

```
SQL> Select no,name, s.hno,s.city from student s1,table(s1.address) s;
```

```
-- Update and delete not possible in varrays.
```

```
-- Here we used table function which will take the varray column as input for producing output excluding varray and types.
```

## NESTED TABLES

A nested table is, as its name implies, a table within a table. In this case it is a table that is represented as a column within another table.

Nested table has the same effect of varrays but has no limit.

Ex:

1) We can create nested tables using oracle types and user defined types which has no limit

a) Nested tables using pre-defined types

```
SQL> Create type nt as table of varchar(10);/
```

b) Nested tables using user defined types

```
SQL> Create type addr as object(hno number(3),city varchar(10));/
```

```
SQL> Create type nt as table of addr;/
```

2) Using nested table in table

```
SQL> Create table student(no number(2),name varchar(10),address nt) nested table  
address store as student_temp;
```

3) Inserting values into table which has nested table

```
SQL> Insert into student values (1,'sudha',nt(addr(111,'hyd')));
```

```
SQL> Insert into student values (2,'jagan',nt(addr(111,'hyd'),addr(222,'bang')));
```

4) Selecting data from table which has nested table

```
SQL> Select * from student;
```

```
-- This will display nested table column data along with nested table and adt;
```

```
SQL> Select no,name, s.* from student s1, table(s1.address) s;
```

```
-- This will display in general format
```

5) Instead of s.\* you can specify the columns in nested table

```
SQL> Select no,name, s.hno,s.city from student s1,table(s1.address) s;
```

6) Inserting nested table data to the existing row

```
SQL> Insert into table(select address from student where no=1)  
values(addr(555,'chennai'));
```

7) Update in nested tables

```
SQL> Update table(select address from student where no=2) s set s.city='bombay' where  
s.hno = 222;
```

8) Delete in nested table

```
SQL> Delete table(select address from student where no=3) s where s.hno=333;
```

## DATA MODEL

- ALL\_COLL\_TYPES
- ALL\_TYPES
- DBA\_COLL\_TYPES
- DBA\_TYPES
- USER\_COLL\_TYPES
- USER\_TYPES

## FLASHBACK QUERY

Used to retrieve the data which has been already committed with out going for recovery.

Flashbacks are of two types

- Time base flashback
- SCN based flashback (SCN stands for System Change Number)

Ex:

### 1) Using time based flashback

- a) SQL> Select \*from student;  
-- This will display all the rows
- b) SQL> Delete student;
- c) SQL> Commit; -- this will commit the work.
- d) SQL> Select \*from student;  
-- Here it will display nothing
- e) Then execute the following procedures  
SQL> Exec dbms\_flashback.enable\_at\_time(sysdate-2/1440)
- f) SQL> Select \*from student;  
-- Here it will display the lost data  
-- The lost data will come but the current system time was used
- g) SQL> Exec dbms\_flashback.disable  
-- Here we have to disable the flashback to enable it again

### 2) Using SCN based flashback

- a) Declare a variable to store SCN  
SQL> Variable s number
- b) Get the SCN  
SQL> Exec :s := exec dbms\_flashback.get\_system\_change\_number
- c) To see the SCN  
SQL> Print s
- d) Then execute the following procedures  
SQL> Exec dbms\_flashback.enable\_at\_system\_change\_number(:s)  
SQL> Exec dbms\_flashback.disable

## EXTERNAL TABLES

You can use external table feature to access external files as if they are tables inside the database.

When you create an external table, you define its structure and location within Oracle.

When you query the table, Oracle reads the external table and returns the results just as if the data had been stored within the database.

### ACCESSING EXTERNAL TABLE DATA

To access external files from within Oracle, you must first use the create directory command to define a directory object pointing to the external file location.

Users who will access the external files must have the read and write privilege on the directory.

Ex:

### CREATING DIRECTORY AND OS LEVEL FILE

```
SQL> Sqlplus system/manager
SQL> Create directory saketh_dir as '/Visdb/visdb/9.2.0/external';
SQL> Grant all on directory saketh_dir to saketh;
SQL> Conn saketh/saketh
SQL> Spool dept.lst
SQL> Select deptno || ',' || dname || ',' || loc from dept;
SQL> Spool off
```

### CREATING EXTERNAL TABLE

```
SQL> Create table dept_ext
      (deptno number(2),
       Dname varchar(14),
       Loc varchar(13))
      Organization external ( type oracle_loader
                             Default directory saketh_dir
                             Access parameters
```

```
( records delimited by newline  
Fields terminated by ","  
( deptno number(2),  
Dname varchar(14),  
Loc varchar(13)))  
Location ('/Visdb/visdb/9.2.0/dept.lst');
```

#### SELECTING DATA FROM EXTERNAL TABLE

```
SQL> select * from dept_ext;
```

This will read from dept.lst which is a operating system level file.

#### LIMITATIONS ON EXTERNAL TABLES

- a) You can not perform insert, update, and delete operations
- a) Indexing not possible
- b) Constraints not possible

#### BENEFITS OF EXTERNAL TABLES

- a) Queries of external tables complete very quickly even though a full table scan is required with each access
- b) You can join external tables to each other or to standard tables

## REF Deref VALUE

### REF

- The ref function allows referencing of existing row objects.
- Each of the row objects has an object id value assigned to it.
- The object id assigned can be seen by using ref function.

### DEREF

- The deref function performs opposite action.
- It takes a reference value of object id and returns the value of the row objects.

### VALUE

- Even though the primary table is object table, still it displays the rows in general format.
- To display the entire structure of the object, this will be used.

### Ex:

#### 1) create vendot\_adt type

```
SQL> Create type vendor_adt as object (vendor_code number(2), vendor_name  
      varchar(2), vendor_address varchar(10));/
```

#### 2) create object tables vendors and vendors1

```
SQL> Create table vendors of vendor_adt;  
SQL> Create table vendors1 of vendor_adt;
```

#### 3) insert the data into object tables

```
SQL> insert into vendors values(1, 'a', 'hyd');  
SQL> insert into vendors values(2, 'b', 'bang');  
SQL> insert into vendors1 values(3, 'c', 'delhi');  
SQL> insert into vendors1 values(4, 'd', 'chennai');
```

#### 4) create another table orders which holds the vendor\_adt type also.

```
SQL> Create table orders (order_no number(2), vendor_info ref vendor_adt);
```

Or

```
SQL> Create table orders (order_no number(2), vendor_info ref vendor_adt with rowid);
```

5) insert the data into orders table

The vendor\_info column in the following syntaxes will store object id of any table which is referenced by vendor\_adt object ( both vendors and vendors1).

```
SQL> insert into orders values(11,(select ref(v) from vendors v where vendor_code = 1));
```

```
SQL> insert into orders values(12,(select ref(v) from vendors v where vendor_code = 2));
```

```
SQL> insert into orders values(13,(select ref(v1) from vendors1 v1 where vendor_code = 1));
```

```
SQL> insert into orders values(14,(select ref(v1) from vendors1 v1 where vendor_code = 1));
```

6) To see the object ids of vendor table

```
SQL> Select ref(V) from vendors v;
```

7) If you see the vendor\_info of orders it will show only the object ids not the values, to see the values

```
SQL> Select deref(o.vendor_info) from orders o;
```

8) Even though the vendors table is object table it will not show the adt along with data, to see the data along with the adt

```
SQL>Select * from vendors;
```

This will give the data without adt.

```
SQL>Select value(v) from vendors v;
```

This will give the columns data along with the type.

## REF CONSTRAINTS

Ref can also acts as constraint.

Even though vendors1 also holding vendor\_adt, the orders table will store the object ids of vendors only because it is constrained to that table only.

The vendor\_info column in the following syntaxes will store object ids of vendors only.

```
SQL> Create table orders (order_no number(2), vendor_info ref vendor_adt scope is vendors);
```

Or

```
SQL> Create table orders (order_no number(2), vendor_info ref vendor_adt constraint fk references vendors);
```

## OBJECT VIEWS WITH REFERENCES

To implement the objects and the ref constraints to the existing tables, what we can do? Simply drop the both tables and recreate with objects and ref constrains.

But you can achieve this with out dropping the tables and without losing the data by creating object views with references.

Ex:

**a) Create the following tables**

```
SQL> Create table student1(no number(2) primary key,name varchar(2),marks  
    number(3));
```

```
SQL> Create table student2(no number(2) primary key,hno number(3),city varchar(10),id  
    number(2),foreign Key(id) references student1(no));
```

**b) Insert the records into both tables**

```
SQL> insert into student1(1,'a',100);
```

```
SQL> insert into student1(2,'b',200);
```

```
SQL> insert into student2(11,111,'hyd',1);
```

```
SQL> insert into student2(12,222,'bang',2);
```

```
SQL> insert into student2(13,333,'bombay',1);
```

**c) Create the type**

```
SQL> create or replace type stud as object(no number(2),name varchar(2),marks  
    number(3));/
```

**d) Generating OIDs**

```
SQL> Create or replace view student1_ov of stud with object identifier(or id) (no) as  
    Select * from Student1;
```

**e) Generating references**

```
SQL> Create or replace view student2_ov as select no,hno,city,make_ref(student1_ov,id)  
    id from Student2;
```

**d) Query the following**

```
SQL> select *from student1_ov;
```

```
SQL> select ref(s) from student1_ov s;
```

```
SQL> select values(s) from student1_ov;
```

```
SQL> select *from student2_ov;
```

```
SQL> select deref(s.id) from student2_ov s;
```

## PARTITIONS

A single logical table can be split into a number of physically separate pieces based on ranges of key values. Each of the parts of the table is called a partition.

A non-partitioned table can not be partitioned later.

### TYPES

- Range partitions
- List partitions
- Hash partitions
- Sub partitions

### ADVANTAGES

- Reducing downtime for scheduled maintenance, which allows maintenance operations to be carried out on selected partitions while other partitions are available to users.
- Reducing downtime due to data failure, failure of a particular partition will no way affect other partitions.
- Partition independence allows for concurrent use of the various partitions for various purposes.

### ADVANTAGES OF PARTITIONS BY STORING THEM IN DIFFERENT TABLESPACES

- Reduces the possibility of data corruption in multiple partitions.
- Back up and recovery of each partition can be done independently.

### DISADVANTAGES

- Partitioned tables cannot contain any columns with long or long raw datatypes, LOB types or object types.

## RANGE PARTITIONS

### a) Creating range partitioned table

```
SQL> Create table student(no number(2),name varchar(2)) partition by range(no) (partition
p1 values less than(10), partition p2 values less than(20), partition p3 values less
than(30),partition p4 values less than(maxvalue));
```

\*\* if you are using maxvalue for the last partition, you can not add a partition.

### b) Inserting records into range partitioned table

```
SQL> Insert into student values(1,'a'); -- this will go to p1
SQL> Insert into student values(11,'b'); -- this will go to p2
SQL> Insert into student values(21,'c'); -- this will go to p3
SQL> Insert into student values(31,'d'); -- this will go to p4
```

### c) Retrieving records from range partitioned table

```
SQL> Select *from student;
SQL> Select *from student partition(p1);
```

### d) Possible operations with range partitions

- ❖ Add
- ❖ Drop
- ❖ Truncate
- ❖ Rename
- ❖ Split
- ❖ Move
- ❖ Exchange

### e) Adding a partition

```
SQL> Alter table student add partition p5 values less than(40);
```

### f) Dropping a partition

```
SQL> Alter table student drop partition p4;
```

### g) Renaming a partition

```
SQL> Alter table student rename partition p3 to p6;
```

### h) Truncate a partition

```
SQL> Alter table student truncate partition p6;
```

### i) Splitting a partition

```
SQL> Alter table student split partition p2 at(15) into (partition p21,partition p22);
```

### j) Exchanging a partition

```
SQL> Alter table student exchange partition p1 with table student2;
```

**k) Moving a partition**

```
SQL> Alter table student move partition p21 tablespace saketh_ts;
```

**LIST PARTITIONS**

**a) Creating list partitioned table**

```
SQL> Create table student(no number(2),name varchar(2)) partition by list(no) (partition p1 values(1,2,3,4,5), partition p2 values(6,7,8,9,10),partition p3 values(11,12,13,14,15), partition p4 values(16,17,18,19,20));
```

**b) Inserting records into list partitioned table**

```
SQL> Insert into student values(1,'a'); -- this will go to p1  
SQL> Insert into student values(6,'b'); -- this will go to p2  
SQL> Insert into student values(11,'c'); -- this will go to p3  
SQL> Insert into student values(16,'d'); -- this will go to p4
```

**c) Retrieving records from list partitioned table**

```
SQL> Select *from student;  
SQL> Select *from student partition(p1);
```

**d) Possible operations with list partitions**

- ❖ Add
- ❖ Drop
- ❖ Truncate
- ❖ Rename
- ❖ Move
- ❖ Exchange

**e) Adding a partition**

```
SQL> Alter table student add partition p5 values(21,22,23,24,25);
```

**f) Dropping a partition**

```
SQL> Alter table student drop partition p4;
```

**g) Renaming a partition**

```
SQL> Alter table student rename partition p3 to p6;
```

**h) Truncate a partition**

```
SQL> Alter table student truncate partition p6;
```

**i) Exchanging a partition**

```
SQL> Alter table student exchange partition p1 with table student2;
```

j) Moving a partition

```
SQL> Alter table student move partition p2 tablespace saketh_ts;
```

## HASH PARTITIONS

a) Creating hash partitioned table

```
SQL> Create table student(no number(2),name varchar(2)) partition by hash(no) partitions  
5;
```

Here oracle automatically gives partition names like

```
SYS_P1  
SYS_P2  
SYS_P3  
SYS_P4  
SYS_P5
```

b) Inserting records into hash partitioned table

it will insert the records based on hash function calculated by taking the partition key

```
SQL> Insert into student values(1,'a');  
SQL> Insert into student values(6,'b');  
SQL> Insert into student values(11,'c');  
SQL> Insert into student values(16,'d');
```

c) Retrieving records from hash partitioned table

```
SQL> Select *from student;  
SQL> Select *from student partition(sys_p1);
```

d) Possible operations with hash partitions

- ❖ Add
- ❖ Truncate
- ❖ Rename
- ❖ Move
- ❖ Exchange

e) Adding a partition

```
SQL> Alter table student add partition p6 ;
```

f) Renaming a partition

```
SQL> Alter table student rename partition p6 to p7;
```

g) Truncate a partition

```
SQL> Alter table student truncate partition p7;
```

h) Exchanging a partition

```
SQL> Alter table student exchange partition sys_p1 with table student2;
```

i) Moving a partition

```
SQL> Alter table student move partition sys_p2 tablespace saketh_ts;
```

SUB-PARTITIONS WITH RANGE AND HASH

Subpartitions clause is used by hash only. We can not create subpartitions with list and hash partitions.

a) Creating subpartitioned table

```
SQL> Create table student(no number(2),name varchar(2),marks number(3))  
Partition by range(no) subpartition by hash(name) subpartitions 3  
(Partition p1 values less than(10),partition p2 values less than(20));
```

This will create two partitions p1 and p2 with three subpartitions for each partition

```
P1 – SYS_SUBP1  
      SYS_SUBP2  
      SYS_SUBP3  
P2 – SYS_SUBP4  
      SYS_SUBP5  
      SYS_SUBP6
```

\*\* if you are using maxvalue for the last partition, you can not add a partition.

b) Inserting records into subpartitioned table

```
SQL> Insert into student values(1,'a'); -- this will go to p1  
SQL> Insert into student values(11,'b'); -- this will go to p2
```

c) Retrieving records from subpartitioned table

```
SQL> Select *from student;  
SQL> Select *from student partition(p1);  
SQL> Select *from student subpartition(sys_subp1);
```

d) Possible operations with subpartitions

- ❖ Add
- ❖ Drop
- ❖ Truncate
- ❖ Rename
- ❖ Split

e) Adding a partition

```
SQL> Alter table student add partition p3 values less than(30);
```

f) Dropping a partition

```
SQL> Alter table student drop partition p3;
```

g) Renaming a partition

```
SQL> Alter table student rename partition p2 to p3;
```

h) Truncate a partition

```
SQL> Alter table student truncate partition p1;
```

i) Splitting a partition

```
SQL> Alter table student split partition p3 at(15) into (partition p31,partition p32);
```

DATA MODEL

- ALL\_IND\_PARTITIONS
- ALL\_IND\_SUBPARTITIONS
- ALL\_TAB\_PARTITIONS
- ALL\_TAB\_SUBPARTITIONS
- DBA\_IND\_PARTITIONS
- DBA\_IND\_SUBPARTITIONS
- DBA\_TAB\_PARTITIONS
- DBA\_TAB\_SUBPARTITIONS
- USER\_IND\_PARTITIONS
- USER\_IND\_SUBPARTITIONS
- USER\_TAB\_PARTITIONS
- USER\_TAB\_SUBPARTITIONS

## GROUP BY AND HAVING

### GROUP BY

Using group by, we can create groups of related information.

Columns used in select must be used with group by, otherwise it was not a group by expression.

Ex:

```
SQL> select deptno, sum(sal) from emp group by deptno;
```

DEPTNO	SUM(SAL)
10	8750
20	10875
30	9400

```
SQL> select deptno,job,sum(sal) from emp group by deptno,job;
```

DEPTNO	JOB	SUM(SAL)
10	CLERK	1300
10	MANAGER	2450
10	PRESIDENT	5000
20	ANALYST	6000
20	CLERK	1900
20	MANAGER	2975
30	CLERK	950
30	MANAGER	2850
30	SALESMAN	5600

### HAVING

This will work as where clause which can be used only with group by because of absence of where clause in group by.

Ex:

```
SQL> select deptno,job,sum(sal) tsal from emp group by deptno,job having sum(sal) > 3000;
```

DEPTNO	JOB	TSAL
10	PRESIDENT	5000
20	ANALYST	6000
30	SALESMAN	5600

```
SQL> select deptno,job,sum(sal) tsal from emp group by deptno,job having sum(sal) > 3000  
order by job;
```

DEPTNO	JOB	TSAL
20	ANALYST	6000
10	PRESIDENT	5000
30	SALESMAN	5600

## ORDER OF EXECUTION

- Group the rows together based on group by clause.
- Calculate the group functions for each group.
- Choose and eliminate the groups based on the having clause.
- Order the groups based on the specified column.

## ROLLUP GROUPING CUBE

These are the enhancements to the group by feature.

### USING ROLLUP

This will give the salaries in each department in each job category along with the total salary for individual departments and the total salary of all the departments.

```
SQL> Select deptno,job,sum(sal) from emp group by rollup(deptno,job);
```

DEPTNO	JOB	SUM(SAL)
10	CLERK	1300
10	MANAGER	2450
10	PRESIDENT	5000
10		8750
20	ANALYST	6000
20	CLERK	1900
20	MANAGER	2975
20		10875
30	CLERK	950
30	MANAGER	2850
30	SALESMAN	5600
30		9400
		29025

### USING GROUPING

In the above query it will give the total salary of the individual departments but with a blank in the job column and gives the total salary of all the departments with blanks in deptno and job columns.

To replace these blanks with your desired string grouping will be used

```
SQL> select decode(grouping(deptno),1,'All Depts',deptno),decode(grouping(job),1,'All
```

```
jobs',job),sum(sal) from emp group by rollup(deptno,job);
```

DECODE(GROUPING(DEPTNO),1,'ALLDEPTS',DEP	DECODE(GR	SUM(SAL)
10	CLERK	1300
10	MANAGER	2450
10	PRESIDENT	5000
10	All jobs	8750
20	ANALYST	6000
20	CLERK	1900
20	MANAGER	2975
20	All jobs	10875
30	CLERK	950
30	MANAGER	2850
30	SALESMAN	5600
30	All jobs	9400
All Depts	All jobs	29025

Grouping will return 1 if the column which is specified in the grouping function has been used in rollup.

Grouping will be used in association with decode.

### USING CUBE

This will give the salaries in each department in each job category, the total salary for individual departments, the total salary of all the departments and the salaries in each job category.

```
SQL> select decode(grouping(deptno),1,'All Depts',deptno),decode(grouping(job),1,'All Jobs',job),sum(sal) from emp group by cube(deptno,job);
```

DECODE(GROUPING(DEPTNO),1,'ALLDEPTS',DEP	DECODE(GR	SUM(SAL)
10	CLERK	1300
10	MANAGER	2450

10	PRESIDENT	5000
10	All Jobs	8750
20	ANALYST	6000
20	CLERK	1900
20	MANAGER	2975
20	All Jobs	10875
30	CLERK	950
30	MANAGER	2850
30	SALESMAN	5600
30	All Jobs	9400
All Depts	ANALYST	6000
All Depts	CLERK	4150
All Depts	MANAGER	8275
All Depts	PRESIDENT	5000
All Depts	SALESMAN	5600
All Depts	All Jobs	29025

## SET OPERATORS

### TYPES

- Union
- Union all
- Intersect
- Minus

### UNION

This will combine the records of multiple tables having the same structure.

Ex:

```
SQL> select * from student1 union select * from student2;
```

### UNION ALL

This will combine the records of multiple tables having the same structure but including duplicates.

Ex:

```
SQL> select * from student1 union all select * from student2;
```

### INTERSECT

This will give the common records of multiple tables having the same structure.

Ex:

```
SQL> select * from student1 intersect select * from student2;
```

### MINUS

This will give the records of a table whose records are not in other tables having the same structure.

Ex:

```
SQL> select * from student1 minus select * from student2;
```

## VIEWS

A view is a database object that is a logical representation of a table. It is delivered from a table but has no storage of its own and often may be used in the same manner as a table.

A view takes the output of the query and treats it as a table, therefore a view can be thought of as a stored query or a virtual table.

### TYPES

- Simple view
- Complex view

Simple view can be created from one table where as complex view can be created from multiple tables.

### WHY VIEWS?

- Provides additional level of security by restricting access to a predetermined set of rows and/or columns of a table.
- Hide the data complexity.
- Simplify commands for the user.

### VIEWS WITHOUT DML

- Read only view
- View with group by
- View with aggregate functions
- View with rownum
- Partition view
- View with distinct

### Ex:

```
SQL> Create view dept_v as select *from dept with read only;
SQL> Create view dept_v as select deptno, sum(sal) t_sal from emp group by deptno;
SQL> Create view stud as select rownum no, name, marks from student;
SQL> Create view student as select *from student1 union select *from student2;
SQL> Create view stud as select distinct no,name from student;
```

## VIEWS WITH DML

- View with not null column -- insert with out not null column not possible
  - update not null column to null is not possible
  - delete possible
- View with out not null column which was in base table -- insert not possible
  - update, delete possible
- View with expression -- insert , update not possible
  - delete possible
- View with functions (except aggregate) -- insert, update not possible
  - delete possible
- View was created but the underlying table was dropped then we will get the message like " view has errors " .
- View was created but the base table has been altered but still the view was with the initial definition, we have to replace the view to affect the changes.
- Complex view (view with more than one table) -- insert not possible
  - update, delete possible (not always)

## CREATING VIEW WITHOUT HAVING THE BASE TABLE

```
SQL> Create force view stud as select *From student;  
-- Once the base table was created then the view is validated.
```

## VIEW WITH CHECK OPTION CONSTRAINT

```
SQL> Create view stud as select *from student where marks = 500 with check option constraint  
Ck;  
- Insert possible with marks value as 500  
- Update possible excluding marks column  
- Delete possible
```

## DROPPING VIEWS

```
SQL> drop view dept_v;
```

## SYNONYM AND SEQUENCE

### SYNONYM

A synonym is a database object, which is used as an alias for a table, view or sequence.

#### TYPES

- Private
- Public

Private synonym is available to the particular user who creates.

Public synonym is created by DBA which is available to all the users.

#### ADVANTAGES

- Hide the name and owner of the object.
- Provides location transparency for remote objects of a distributed database.

#### CREATE AND DROP

```
SQL> create synonym s1 for emp;
```

```
SQL> create public synonym s2 for emp;
```

```
SQL> drop synonym s1;
```

### SEQUENCE

A sequence is a database object, which can generate unique, sequential integer values.

It can be used to automatically generate primary key or unique key values.

A sequence can be either in an ascending or descending order.

#### Syntax:

```
Create sequence <seq_name> [increment by n] [start with n] [maxvalue n] [minvalue n]  
[cycle/nocycle] [cache/nocache];
```

By default the sequence starts with 1, increments by 1 with minvalue of 1 and with nocycle, nocache.

Cache option pre-allocates a set of sequence numbers and retains them in memory for faster access.

Ex:

```
SQL> create sequence s;  
SQL> create sequence s increment by 10 start with 100 minvalue 5 maxvalue 200 cycle  
cache 20;
```

#### USING SEQUENCE

```
SQL> create table student(no number(2),name varchar(10));  
SQL> insert into student values(s.nextval, 'saketh');
```

- Initially currval is not defined and nextval is starting value.
- After that nextval and currval are always equal.

#### CREATING ALPHA-NUMERIC SEQUENCE

```
SQL> create sequence s start with 111234;  
SQL> Insert into student values (s.nextval || translate  
(s.nextval,'1234567890','abcdefghij'));
```

#### ALTERING SEQUENCE

We can alter the sequence to perform the following.

- Set or eliminate minvalue or maxvalue.
- Change the increment value.
- Change the number of cached sequence numbers.

Ex:

```
SQL> alter sequence s minvalue 5;  
SQL> alter sequence s increment by 2;  
SQL> alter sequence s cache 10;
```

#### DROPPING SEQUENCE

```
SQL> drop sequence s;
```

## JOINS

The purpose of a join is to combine the data across tables.

A join is actually performed by the where clause which combines the specified rows of tables.

If a join involves in more than two tables then oracle joins first two tables based on the joins condition and then compares the result with the next table and so on.

### TYPES

- ✚ Equi join
- ✚ Non-equi join
- ✚ Self join
- ✚ Natural join
- ✚ Cross join
- ✚ Outer join
  - Left outer
  - Right outer
  - Full outer
- ✚ Inner join
- ✚ Using clause
- ✚ On clause

Assume that we have the following tables.

```
SQL> select * from dept;
```

DEPTNO	DNAME	LOC
10	mkt	hyd
20	fin	bang
30	hr	bombay

```
SQL> select * from emp;
```

EMPNO	ENAME	JOB	MGR	DEPTNO
111	saketh	analyst	444	10

222	sudha	clerk	333	20
333	jagan	manager	111	10
444	madhu	engineer	222	40

### EQUI JOIN

A join which contains an '=' operator in the joins condition.

Ex:

```
SQL> select empno,ename,job,dname,loc from emp e,dept d where e.deptno=d.deptno;
```

EMPNO	ENAME	JOB	DNAME	LOC
111	saketh	analyst	mkt	hyd
333	jagan	manager	mkt	hyd
222	sudha	clerk	fin	bang

### USING CLAUSE

```
SQL> select empno,ename,job ,dname,loc from emp e join dept d using(deptno);
```

EMPNO	ENAME	JOB	DNAME	LOC
111	saketh	analyst	mkt	hyd
333	jagan	manager	mkt	hyd
222	sudha	clerk	fin	bang

### ON CLAUSE

```
SQL> select empno,ename,job,dname,loc from emp e join dept d on(e.deptno=d.deptno);
```

EMPNO	ENAME	JOB	DNAME	LOC
111	saketh	analyst	mkt	hyd
333	jagan	manager	mkt	hyd

222      sudha    clerk    fin      bang

### NON-EQUI JOIN

A join which contains an operator other than '=' in the joins condition.

Ex:

```
SQL> select empno,ename,job,dname,loc from emp e,dept d where e.deptno > d.deptno;
```

EMPNO	ENAME	JOB	DNAME	LOC
222	sudha	clerk	mkt	hyd
444	madhu	engineer	mkt	hyd
444	madhu	engineer	fin	bang
444	madhu	engineer	hr	bombay

### SELF JOIN

Joining the table itself is called self join.

Ex:

```
SQL> select e1.empno,e2.ename,e1.job,e2.deptno from emp e1,emp e2 where e1.empno=e2.mgr;
```

EMPNO	ENAME	JOB	DEPTNO
111	jagan	analyst	10
222	madhu	clerk	40
333	sudha	manager	20
444	saketh	engineer	10

### NATURAL JOIN

Natural join compares all the common columns.

Ex:

```
SQL> select empno,ename,job,dname,loc from emp natural join dept;
```

EMPNO	ENAME	JOB	DNAME	LOC
111	saketh	analyst	mkt	hyd
333	jagan	manager	mkt	hyd
222	sudha	clerk	fin	bang

### CROSS JOIN

This will gives the cross product.

Ex:

```
SQL> select empno,ename,job,dname,loc from emp cross join dept;
```

EMPNO	ENAME	JOB	DNAME	LOC
111	saketh	analyst	mkt	hyd
222	sudha	clerk	mkt	hyd
333	jagan	manager	mkt	hyd
444	madhu	engineer	mkt	hyd
111	saketh	analyst	fin	bang
222	sudha	clerk	fin	bang
333	jagan	manager	fin	bang
444	madhu	engineer	fin	bang
111	saketh	analyst	hr	bombay
222	sudha	clerk	hr	bombay
333	jagan	manager	hr	bombay
444	madhu	engineer	hr	bombay

### OUTER JOIN

Outer join gives the non-matching records along with matching records.

LEFT OUTER JOIN

This will display the all matching records and the records which are in left hand side table those that are not in right hand side table.

Ex:

```
SQL> select empno,ename,job,dname,loc from emp e left outer join dept d  
on(e.deptno=d.deptno);
```

Or

```
SQL> select empno,ename,job,dname,loc from emp e,dept d where e.deptno=d.deptno(+);
```

EMPNO	ENAME	JOB	DNAME	LOC
111	saketh	analyst	mkt	hyd
333	jagan	manager	mkt	hyd
222	sudha	clerk	fin	bang
444	madhu	engineer		

RIGHT OUTER JOIN

This will display the all matching records and the records which are in right hand side table those that are not in left hand side table.

Ex:

```
SQL> select empno,ename,job,dname,loc from emp e right outer join dept d  
on(e.deptno=d.deptno);
```

Or

```
SQL> select empno,ename,job,dname,loc from emp e,dept d where e.deptno(+) = d.deptno;
```

EMPNO	ENAME	JOB	DNAME	LOC
111	saketh	analyst	mkt	hyd
333	jagan	manager	mkt	hyd
222	sudha	clerk	fin	bang
			hr	bombay

### FULL OUTER JOIN

This will display the all matching records and the non-matching records from both tables.

Ex:

```
SQL> select empno,ename,job,dname,loc from emp e full outer join dept d  
on(e.deptno=d.deptno);
```

EMPNO	ENAME	JOB	DNAME	LOC
333	jagan	manager	mkt	hyd
111	saketh	analyst	mkt	hyd
222	sudha	clerk	fin	bang
444	madhu	engineer	hr	bombay

### INNER JOIN

This will display all the records that have matched.

Ex:

```
SQL> select empno,ename,job,dname,loc from emp inner join dept using(deptno);
```

EMPNO	ENAME	JOB	DNAME	LOC
111	saketh	analyst	mkt	hyd
333	jagan	manager	mkt	hyd
222	sudha	clerk	fin	bang

## SUBQUERIES AND EXISTS

### SUBQUERIES

Nesting of queries, one within the other is termed as a subquery.

A statement containing a subquery is called a parent query.

Subqueries are used to retrieve data from tables that depend on the values in the table itself.

### TYPES

- Single row subqueries
- Multi row subqueries
- Multiple subqueries
- Correlated subqueries

### SINGLE ROW SUBQUERIES

In single row subquery, it will return one value.

Ex:

```
SQL> select * from emp where sal > (select sal from emp where empno = 7566);
```

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7788	SCOTT	ANALYST	7566	19-APR-87	3000		20
7839	KING	PRESIDENT		17-NOV-81	5000		10
7902	FORD	ANALYST	7566	03-DEC-81	3000		20

### MULTI ROW SUBQUERIES

In multi row subquery, it will return more than one value. In such cases we should include operators like any, all, in or not in between the comparison operator and the subquery.

Ex:

```
SQL> select * from emp where sal > any (select sal from emp where sal between 2500 and 4000);
```

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7566	JONES	MANAGER	7839	02-APR-81	2975		20
7788	SCOTT	ANALYST	7566	19-APR-87	3000		20
7839	KING	PRESIDENT		17-NOV-81	5000		10
7902	FORD	ANALYST	7566	03-DEC-81	3000		20

```
SQL> select * from emp where sal > all (select sal from emp where sal between 2500 and 4000);
```

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7839	KING	PRESIDENT		17-NOV-81	5000		10

#### MULTIPLE SUBQUERIES

There is no limit on the number of subqueries included in a where clause. It allows nesting of a query within a subquery.

Ex:

```
SQL> select * from emp where sal = (select max(sal) from emp where sal < (select max(sal) from emp));
```

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7788	SCOTT	ANALYST	7566	19-APR-87	3000		20
7902	FORD	ANALYST	7566	03-DEC-81	3000		20

#### CORRELATED SUBQUERIES

A subquery is evaluated once for the entire parent statement where as a correlated subquery is evaluated once for every row processed by the parent statement.

Ex:

```
SQL> select distinct deptno from emp e where 5 <= (select count(ename) from emp where e.deptno = deptno);
```

```
DEPTNO
-----
20
30
```

## EXISTS

Exists function is a test for existence. This is a logical test for the return of rows from a query.

Ex:

Suppose we want to display the department numbers which has more than 4 employees.

```
SQL> select deptno,count(*) from emp group by deptno having count(*) > 4;
```

```
DEPTNO  COUNT(*)
-----  -
20      5
30      6
```

From the above query can you want to display the names of employees?

```
SQL> select deptno,ename, count(*) from emp group by deptno,ename having count(*) > 4;
```

no rows selected

The above query returns nothing because combination of deptno and ename never return more than one count.

The solution is to use exists which follows.

```
SQL> select deptno,ename from emp e1 where exists (select * from emp e2 where e1.deptno=e2.deptno group by e2.deptno having count(e2.ename) > 4) order by deptno,ename;
```

DEPTNO	ENAME
20	ADAMS
20	FORD
20	JONES
20	SCOTT
20	SMITH
30	ALLEN
30	BLAKE
30	JAMES
30	MARTIN
30	TURNER
30	WARD

NOT EXISTS

```
SQL> select deptno,ename from emp e1 where not exists (select * from emp e2
where e1.deptno=e2.deptno group by e2.deptno having count(e2.ename) > 4) order by
deptno,ename;
```

DEPTNO	ENAME
10	CLARK
10	KING
10	MILLER

## WALKUP TREES AND INLINE VIEW

### WALKUP TREES

Using hierarchical queries, you can retrieve data based on a natural hierarchical relationship between rows in a table. However, where a hierarchical relationship exists between the rows of a table, a process called tree walking enables the hierarchy to be constructed.

Ex:

```
SQL> select ename || '==>' || prior ename, level from emp start with ename = 'KING'
       connect by prior empno=mgr;
```

ENAME  '==>'  PRI ORENAM	LEVEL
KING==>	1
JONES==>KING	2
SCOTT==>JONES	3
ADAMS==>SCOTT	4
FORD==>JONES	3
SMITH==>FORD	4
BLAKE==>KING	2
ALLEN==>BLAKE	3
WARD==>BLAKE	3
MARTIN==>BLAKE	3
TURNER==>BLAKE	3
JAMES==>BLAKE	3
CLARK==>KING	2
MILLER==>CLARK	3

In the above

Start with clause specifies the root row of the table.

Level pseudo column gives the 1 for root , 2 for child and so on.

Connect by prior clause specifies the columns which has parent-child relationship.

## INLINE VIEW OR TOP-N ANALYSIS

In the select statement instead of table name, replacing the select statement is known as inline view.

Ex:

```
SQL> Select ename, sal, rownum rank from (select *from emp order by sal);
```

ENAME	SAL	RANK
SMITH	800	1
JAMES	950	2
ADAMS	1100	3
WARD	1250	4
MARTIN	1250	5
MILLER	1300	6
TURNER	1500	7
ALLEN	1600	8
CLARK	2450	9
BLAKE	2850	10
JONES	2975	11
SCOTT	3000	12
FORD	3000	13
KING	5000	14

## LOCKS

Locks are the mechanisms used to prevent destructive interaction between users accessing same resource simultaneously. Locks provides high degree of data concurrency.

### TYPES

- Row level locks
- Table level locks

### ROW LEVEL LOCKS

In the row level lock a row is locked exclusively so that other cannot modify the row until the transaction holding the lock is committed or rolled back. This can be done by using select..for update clause.

Ex:

```
SQL> select * from emp where sal > 3000 for update of comm.;
```

### TABLE LEVEL LOCKS

A table level lock will protect table data thereby guaranteeing data integrity when data is being accessed concurrently by multiple users. A table lock can be held in several modes.

- Share lock
- Share update lock
- Exclusive lock

### SHARE LOCK

A share lock locks the table allowing other users to only query but not insert, update or delete rows in a table. Multiple users can place share locks on the same resource at the same time.

Ex:

```
SQL> lock table emp in share mode;
```

### SHARE UPDATE LOCK

It locks rows that are to be updated in a table. It permits other users to concurrently query, insert, update or even lock other rows in the same table. It prevents the other users from updating the row that has been locked.

Ex:

```
SQL> lock table emp in share update mode;
```

### EXCLUSIVE LOCK

Exclusive lock is the most restrictive of tables locks. When issued by any user, it allows the other user to only query. It is similar to share lock but only one user can place exclusive lock on a table at a time.

Ex:

```
SQL> lock table emp in share exclusive mode;
```

### NOWAIT

If one user locked the table without nowait then another user trying to lock the same table then he has to wait until the user who has initially locked the table issues a commit or rollback statement. This delay could be avoided by appending a nowait clause in the lock table command.

Ex:

```
SQL> lock table emp in exclusive mode nowait.
```

### DEADLOCK

A deadlock occurs when two users have a lock each on separate object, and they want to acquire a lock on the each other's object. When this happens, the first user has to wait for the second user to release the lock, but the second user will not release it until the lock on the first user's object is freed. In such a case, oracle detects the deadlock automatically and solves the problem by aborting one of the two transactions.

## INDEXES

Index is typically a listing of keywords accompanied by the location of information on a subject. We can create indexes explicitly to speed up SQL statement execution on a table. The index points directly to the location of the rows containing the value.

### WHY INDEXES?

Indexes are most useful on larger tables, on columns that are likely to appear in where clauses as simple equality.

### TYPES

- Unique index
- Non-unique index
- Btree index
- Bitmap index
- Composite index
- Reverse key index
- Function-based index
- Descending index
- Domain index
- Object index
- Cluster index
- Text index
- Index organized table
- Partition index
  - ❖ Local index
    - ✓ Local prefixed
    - ✓ Local non-prefixed
  - ❖ Global index
    - ✓ Global prefixed
    - ✓ Global non-prefixed

## UNIQUE INDEX

Unique indexes guarantee that no two rows of a table have duplicate values in the columns that define the index. Unique index is automatically created when primary key or unique constraint is created.

Ex:

```
SQL> create unique index stud_ind on student(sno);
```

## NON-UNIQUE INDEX

Non-Unique indexes do not impose the above restriction on the column values.

Ex:

```
SQL> create index stud_ind on student(sno);
```

## BTREE INDEX or ASCENDING INDEX

The default type of index used in an oracle database is the btree index. A btree index is designed to provide both rapid access to individual rows and quick access to groups of rows within a range. The btree index does this by performing a succession of value comparisons. Each comparison eliminates many of the rows.

Ex:

```
SQL> create index stud_ind on student(sno);
```

## BITMAP INDEX

This can be used for low cardinality columns: that is columns in which the number of distinct values is small when compared to the number of the rows in the table.

Ex:

```
SQL> create bitmap index stud_ind on student(sex);
```

## COMPOSITE INDEX

A composite index also called a concatenated index is an index created on multiple columns of a table. Columns in a composite index can appear in any order and need not be adjacent columns of the table.

Ex:

```
SQL> create bitmap index stud_ind on student(sno, sname);
```

## REVERSE KEY INDEX

A reverse key index when compared to standard index, reverses each byte of the column being indexed while keeping the column order. When the column is indexed in reverse mode then the column values will be stored in an index in different blocks as the starting value differs. Such an arrangement can help avoid performance degradations in indexes where modifications to the index are concentrated on a small set of blocks.

Ex:

```
SQL> create index stud_ind on student(sno, reverse);
```

We can rebuild a reverse key index into normal index using the noreverse keyword.

Ex:

```
SQL> alter index stud_ind rebuild noreverse;
```

## FUNCTION BASED INDEX

This will use result of the function as key instead of using column as the value for the key.

Ex:

```
SQL> create index stud_ind on student(upper(sname));
```

## DESCENDING INDEX

The order used by B-tree indexes has been ascending order. You can categorize data in B-tree index in descending order as well. This feature can be useful in applications where sorting operations are required.

Ex:

```
SQL> create index stud_ind on student(sno desc);
```

## TEXT INDEX

Querying text is different from querying data because words have shades of meaning, relationships to other words, and opposites. You may want to search for words that are near each other, or words that are related to theirs. These queries would be extremely difficult if all you had available was the standard relational operators. By extending SQL to include text indexes, Oracle Text permits you to ask very complex questions about the text.

To use Oracle Text, you need to create a *text index* on the column in which the text is stored. Text index is a collection of tables and indexes that store information about the text stored in the column.

## TYPES

There are several different types of indexes available in Oracle 9i. The first, CONTEXT is supported in Oracle 8i as well as Oracle 9i. As of Oracle 9i, you can use the CTXCAT text index to further enhance your text index management and query capabilities.

- CONTEXT
- CTXCAT
- CTXRULE

The CTXCAT index type supports the transactional synchronization of data between the base table and its text index. With CONTEXT indexes, you need to manually tell Oracle to update the values in the text index after data changes in the base table. CTXCAT index types do not generate score values during the text queries.

## HOW TO CREATE TEXT INDEX?

You can create a text index via a special version of the create index command. For context index, specify the `ctxsys.context` index type and for `ctxcat` index, specify the `ctxsys.ctxcat` index type.

### Ex:

Suppose you have a table called `BOOKS` with the following columns  
Title, Author, Info.

```
SQL> create index book_index on books(info) indextype is ctxsys.context;
```

```
SQL> create index book_index on books(info) indextype is ctxsys.ctxcat;
```

## TEXT QUERIES

Once a text index is created on the `info` column of `BOOKS` table, text-searching capabilities increase dynamically.

## CONTAINS & CATSEARCH

`CONTAINS` function takes two parameters – the column name and the search string.

### Syntax:

```
Contains(indexed_column, search_str);
```

If you create a `CTXCAT` index, use the `CATSEARCH` function in place of `CONTAINS`. `CATSEARCH` takes three parameters – the column name, the search string and the index set.

### Syntax:

```
Contains(indexed_column, search_str, index_set);
```

## HOW A TEXT QUERY WORKS?

When a function such as `CONTAINS` or `CATSEARCH` is used in query, the text portion of the query is processed by Oracle Text. The remainder of the query is processed just like a regular query within the database. The result of the text query processing and the regular query processing are merged to return a single set of records to the user.

#### SEARCHING FOR AN EXACT MATCH OF A WORD

The following queries will search for a word called 'property' whose score is greater than zero.

```
SQL> select * from books where contains(info, 'property') > 0;
SQL> select * from books where catsearch(info, 'property', null) > 0;
```

Suppose if you want to know the score of the 'property' in each book, if score values for individual searches range from 0 to 10 for each occurrence of the string within the text then use the score function.

```
SQL> select title, score(10) from books where contains(info, 'property', 10) > 0;
```

#### SEARCHING FOR AN EXACT MATCH OF MULTIPLE WORDS

The following queries will search for two words.

```
SQL> select * from books where contains(info, 'property AND harvests') > 0;
SQL> select * from books where catsearch(info, 'property AND harvests', null) > 0;
```

Instead of using AND you could have used an ampersand(&). Before using this method, set define off so the & character will not be seen as part of a variable name.

```
SQL> set define off
SQL> select * from books where contains(info, 'property & harvests') > 0;
SQL> select * from books where catsearch(info, 'property harvests', null) > 0;
```

The following queries will search for more than two words.

```
SQL> select * from books where contains(info, 'property AND harvests AND workers') > 0;
SQL> select * from books where catsearch(info, 'property harvests workers', null) > 0;
```

The following queries will search for either of the two words.

```
SQL> select * from books where contains(info, 'property OR harvests') > 0;
```

Instead of OR you can use a vertical line (|).

```
SQL> select * from books where contains(info, 'property | harvests') > 0;  
SQL> select * from books where catsearch(info, 'property | harvests', null) > 0;
```

In the following queries the ACCUM(accumulate) operator adds together the scores of the individual searches and compares the accumulated score to the threshold value.

```
SQL> select * from books where contains(info, 'property ACCUM harvests') > 0;  
SQL> select * from books where catsearch(info, 'property ACCUM harvests', null) > 0;
```

Instead of OR you can use a comma(,).

```
SQL> select * from books where contains(info, 'property , harvests') > 0;  
SQL> select * from books where catsearch(info, 'property , harvests', null) > 0;
```

In the following queries the MINUS operator subtracts the score of the second term's search from the score of the first term's search.

```
SQL> select * from books where contains(info, 'property MINUS harvests') > 0;  
SQL> select * from books where catsearch(info, 'property NOT harvests', null) > 0;
```

Instead of MINUS you can use – and instead of NOT you can use ~.

```
SQL> select * from books where contains(info, 'property - harvests') > 0;  
SQL> select * from books where catsearch(info, 'property ~ harvests', null) > 0;
```

#### SEARCHING FOR AN EXACT MATCH OF A PHRASE

The following queries will search for the phrase. If the search phrase includes a reserved word within oracle text, the you must use curly braces ({} ) to enclose text.

```
SQL> select * from books where contains(info, 'transactions {and} finances') > 0;  
SQL> select * from books where catsearch(info, 'transactions {and} finances', null) > 0;
```

You can enclose the entire phrase within curly braces, in which case any reserved words within the phrase will be treated as part of the search criteria.

```
SQL> select * from books where contains(info, '{ transactions and finances}') > 0;  
SQL> select * from books where catsearch(info, '{ transactions and finances}', null) > 0;
```

#### SEARCHING FOR WORDS THAT ARE NEAR EACH OTHER

The following queries will search for the words that are in between the search terms.

```
SQL> select * from books where contains(info, 'workers NEAR harvests') > 0;
```

Instead of NEAR you can use ;.

```
SQL> select * from books where contains(info, 'workers ; harvests') > 0;
```

In CONTEXT index queries, you can specify the maximum number of words between the search terms.

```
SQL> select * from books where contains(info, 'NEAR((workers, harvests),10)' > 0;
```

#### USING WILDCARDS DURING SEARCHES

You can use wildcards to expand the list of valid search terms used during your query. Just as in regular text-string wildcard processing, two wildcards are available.

% - percent sign; multiple-character wildcard  
\_ - underscore; single-character wildcard

```
SQL> select * from books where contains(info, 'worker%') > 0;  
SQL> select * from books where contains(info, 'work_____') > 0;
```

#### SEARCHING FOR WORDS THAT SHARE THE SAME STEM

Rather than using wildcards, you can use stem-expansion capabilities to expand the list of text strings. Given the 'stem' of a word, oracle will expand the list of words to search for to include all words having the same stem. Sample expansions are show here.

Play - plays playing played playful

```
SQL> select * from books where contains(info, '$manage') > 0;
```

#### SEARCHING FOR FUZZY MATCHES

A fuzzy match expands the specified search term to include words that are spelled similarly but that do not necessarily have the same word stem. Fuzzy matches are most helpful when the text contains misspellings. The misspellings can be either in the searched text or in the search string specified by the user during the query.

The following queries will not return anything because its search does not contain the word 'hardest'.

```
SQL> select * from books where contains(info, 'hardest') > 0;
```

It does, however, contain the word 'harvest'. A fuzzy match will return the books containing the word 'harvest' even though 'harvest' has a different word stem than the word used as the search term.

To use a fuzzy match, precede the search term with a question mark, with no space between the question mark and the beginning of the search term.

```
SQL> select * from books where contains(info, '?hardest') > 0;
```

#### SEARCHING FOR WORDS THAT SOUND LIKE OTHER WORDS

SOUNDEX, expands search terms based on how the word sounds. The SOUNDEX expansion method uses the same text-matching logic available via the SOUNDEX function in SQL.

To use the SOUNDEX option, you must precede the search term with an exclamation mark(!).

```
SQL> select * from books where contains(info, '!grate') > 0;
```

#### INDEX SYNCHRONIZATION

When using CONTEXT indexes, you need to manage the text index contents; the text indexes are not updated when the base table is updated. When the table was updated, its text index is out

of sync with the base table. To sync of the index, execute the SYNC\_INDEX procedure of the CTX\_DDL package.

```
SQL> exec CTX_DDL.SYNC_INDEX('book_index');
```

## INDEX SETS

Historically, problems with queries of text indexes have occurred when other criteria are used alongside text searches as part of the where clause. To improve the mixed query capability, oracle features index sets. The indexes within the index set may be structured relational columns or on text columns.

To create an index set, use the CTX\_DDL package to create the index set and add indexes to it. When you create a text index, you can then specify the index set it belongs to.

```
SQL> exec CTX_DDL.CREATE_INDEX_SET('books_index_set');
```

The add non-text indexes.

```
SQL> exec CTX_DDL.ADD_INDEX('books_index_set', 'title_index');
```

Now create a CTXCAT text index. Specify ctxsys.ctxcat as the index type, and list the index set in the parameters clause.

```
SQL> create index book_index on books(info) indextype is ctxsys.ctxcat parameters('index set books_index_set');
```

## INDEX-ORGANIZED TABLE

An index-organized table keeps its data sorted according to the primary key column values for the table. Index-organized tables store their data as if the entire table was stored in an index. An index-organized table allows you to store the entire table's data in an index.

Ex:

```
SQL> create table student (sno number(2),sname varchar(10),smarks number(3) constraint pk primary key(sno) organization index;
```

## PARTITION INDEX

Similar to partitioning tables, oracle allows you to partition indexes too. Like table partitions, index partitions could be in different tablespaces.

### LOCAL INDEXES

- Local keyword tells oracle to create a separate index for each partition.
- In the local prefixed index the partition key is specified on the left prefix. When the underlying table is partitioned based on, say two columns then the index can be prefixed on the first column specified.
- Local prefixed indexes can be unique or non unique.
- Local indexes may be easier to manage than global indexes.

Ex:

```
SQL> create index stud_index on student(sno) local;
```

### GLOBAL INDEXES

- A global index may contain values from multiple partitions.
- An index is global prefixed if it is partitioned on the left prefix of the index columns.
- The global clause allows you to create a non-partitioned index.
- Global indexes may perform uniqueness checks faster than local (partitioned) indexes.
- You cannot create global indexes for hash partitions or subpartitions.

Ex:

```
SQL> create index stud_index on student(sno) global;
```

Similar to table partitions, it is possible to move them from one device to another. But unlike table partitions, movement of index partitions requires individual reconstruction of the index or each partition (only in the case of global index).

Ex:

```
SQL> alter index stud_ind rebuild partition p2
```

- Index partitions cannot be dropped manually.
- They are dropped implicitly when the data they refer to is dropped from the partitioned table.

## MONITORING USE OF INDEXES

Once you turned on the monitoring the use of indexes, then we can check whether the table is hitting the index or not.

To monitor the use of index use the following syntax.

**Syntax:**

```
alter index index_name monitoring usage;
```

then check for the details in V\$OBJECT\_USAGE view.

If you want to stop monitoring use the following.

**Syntax:**

```
alter index index_name nomonitoring usage;
```

## DATA MODEL

- ALL\_INDEXES
- DBA\_INDEXES
- USER\_INDEXES
- ALL\_IND-COLUMNS
- DBA-IND\_COLUMNS
- USER\_IND\_COLUMNS
- ALL\_PART\_INDEXES
- DBA\_PART\_INDEXES
- USER\_PART\_INDEXES
- V\$OBJECT\_USAGE

## SQL\*PLUS COMMANDS

These commands does not require statement terminator and applicable to the sessions , those will be automatically cleared when session was closed.

### BREAK

This will be used to breakup the data depending on the grouping.

#### Syntax:

Break or bre [on <column\_name> on report]

### COMPUTE

This will be used to perform group functions on the data.

#### Syntax:

Compute or comp [group\_function of column\_name on breaking\_column\_name or report]

### TTITLE

This will give the top title for your report. You can on or off the ttitle.

#### Syntax:

Ttitle or ttit [left | center | right] title\_name skip n other\_characters  
Ttitle or ttit [on or off]

### BTITLE

This will give the bottom title for your report. You can on or off the btitle.

#### Syntax:

Btitle or btit [left | center | right] title\_name skip n other\_characters  
Btitle or btit [on or off]

Ex:

```
SQL> bre on deptno skip 1 on report
SQL> comp sum of sal on deptno
SQL> comp sum of sal on report
SQL> tttitle center 'EMPLOYEE DETAILS' skip1 center '-----'
SQL> bttitle center '** THANKQ **'
SQL> select * from emp order by deptno;
```

Output:

EMPLOYEE DETAILS							
EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7782	CLARK	MANAGER	7839	09-JUN-81	2450		10
7839	KING	PRESIDENT		17-NOV-81	5000		
7934	MILLER	CLERK	7782	23-JAN-82	1300		
					-----	*****	
					8750		sum
7369	SMITH	CLERK	7902	17-DEC-80	800		20
7876	ADAMS	CLERK	7788	23-MAY-87	1100		
7902	FORD	ANALYST	7566	03-DEC-81	3000		
7788	SCOTT	ANALYST	7566	19-APR-87	3000		
7566	JONES	MANAGER	7839	02-APR-81	2975		
					-----	*****	
					10875		sum
7499	ALLEN	SALESMAN	7698	20-FEB-81	1600	300	30
7698	BLAKE	MANAGER	7839	01-MAY-81	2850		
7654	MARTIN	SALESMAN	7698	28-SEP-81	1250	1400	
7900	JAMES	CLERK	7698	03-DEC-81	950		
7844	TURNER	SALESMAN	7698	08-SEP-81	1500	0	
7521	WARD	SALESMAN	7698	22-FEB-81	1250	500	

```
-----          *****
          9400          sum
-----
sum          29025

** THANKQ **
```

## CLEAR

This will clear the existing buffers or break or computations or columns formatting.

### Syntax:

```
Clear or cle buffer | bre | comp | col;
```

### Ex:

```
SQL> clear buffer
      Buffer cleared
SQL> clear bre
      Breaks cleared
SQL> clear comp
      Computes cleared
SQL> clear col
      Columns cleared
```

## CHANGE

This will be used to replace any strings in SQL statements.

### Syntax:

```
Change or c/old_string/new_string
```

If the *old\_string* repeats many times then *new\_string* replaces the first string only.

### Ex:

```
SQL> select * from det;
```

```
select * from det
      *
```

```
ERROR at line 1:
ORA-00942: table or view does not exist
```

```
SQL> c/det/dept
1* select * from dept
SQL> /
```

DEPTNO	DNAME	LOC
10	ACCOUNTING	NEW YORK
20	RESEARCH	ALLAS
30	SALES	CHICAGO
40	OPERATIONS	BOSTON

## COLUMN

This will be used to increase or decrease the width of the table columns.

### Syntax:

Column or col <column\_name> format <num\_format|text\_format>

### Ex:

```
SQL> col deptno format 999
SQL> col dname format a10
```

## SAVE

This will be used to save your current SQL statement as SQL Script file.

### Syntax:

Save or sav <file\_name>.[extension] replace or rep

If you want to save the filename with existing filename the you have to use replace option. By default it will take *sql* as the extension.

Ex:

```
SQL> save ss
      Created file ss.sql
SQL> save ss replace
      Wrote file ss.sql
```

## EXECUTE

This will be used to execute stored subprograms or packaged subprograms.

Syntax:

```
Execute or exec <subprogram_name>
```

Ex:

```
SQL> exec sample_proc
```

## SPOOL

This will record the data when you spool on, upto when you say spool off. By default it will give *lst* as extension.

Syntax:

```
Spool on | off | out | <file_name>.[Extension]
```

Ex:

```
SQL> spool on
SQL> select * from dept;
```

DEPTNO	DNAME	LOC
10	ACCOUNTING	NEW YORK
20	RESEARCH	DALLAS
30	SALES	CHICAGO
40	OPERATIONS	BOSTON

```
SQL> spool off
```

```
SQL> ed on.lst
```

```
SQL> select * from dept;
```

DEPTNO	DNAME	LOC
10	ACCOUNTING	NEW YORK
20	RESEARCH	DALLAS
30	SALES	CHICAGO
40	OPERATIONS	BOSTON

```
SQL> spool off
```

## LIST

This will give the current SQL statement.

### Syntax:

```
List or li [start_line_number] [end_line_number]
```

### Ex:

```
SQL> select
```

```
2 *
```

```
3 from
```

```
4 dept;
```

```
SQL> list
```

```
1 select
```

```
2 *
```

```
3 from
```

```
4* dept
```

```
SQL> list 1
```

```
1* select
```

```
SQL> list 3
```

```
3* from
```

```
SQL> list 1 3
1 select
2 *
3* from
```

## INPUT

This will insert the new line to the current SQL statement.

### Syntax:

Input or in *<string>*

### Ex:

```
SQL> select *
SQL> list
1* select *
SQL> input from dept
SQL> list
1 select *
2* from dept
```

## APPEND

This will adds a new string to the existing string in the SQL statement without any space.

### Syntax:

Append or app *<string>*

### Ex:

```
SQL> select *
SQL> list
1* select *
SQL> append from dept
1* select * from dept
```

```
SQL> list
1* select * from dept
```

## DELETE

This will delete the current SQL statement lines.

### Syntax:

Delete or del <start\_line\_number> [<end\_line\_number>]

### Ex:

```
SQL> select
2 *
3 from
4 dept
5 where
6 deptno
7 >10;
SQL> list
1 select
2 *
3 from
4 dept
5 where
6 deptno
7* >10
SQL> del 1
SQL> list
1 *
2 from
3 dept
4 where
5 deptno
6* >10
SQL> del 2
```

```
SQL> list
  1 *
  2 dept
  3 where
  4 deptno
  5* >10
SQL> del 2 4
SQL> list
  1 *
  2* >10
SQL> del
SQL> list
  1 *
```

## VARIABLE

This will be used to declare a variable.

### Syntax:

```
Variable or var <variable_name> <variable_type>
```

### Ex:

```
SQL> var dept_name varchar(15)
SQL> select dname into dept_name from dept where deptno = 10;
```

## PRINT

This will be used to print the output of the variables that will be declared at SQL level.

### Syntax:

```
Print <variable_name>
```

### Ex:

```
SQL> print dept_name
```

```
DEPT_NAME  
-----  
ACCOUNTING
```

## START

This will be used to execute SQL scripts.

### Syntax:

```
start <filename_name>.sql
```

### Ex:

```
SQL> start ss.sql  
SQL> @ss.sql      -- this will execute sql script files only.
```

## HOST

This will be used to interact with the OS level from SQL.

### Syntax:

```
Host [operation]
```

### Ex:

```
SQL> host  
SQL> host dir
```

## SHOW

Using this, you can see several commands that use the set command and status.

### Syntax:

```
Show all | <set_command>
```

### Ex:

```
SQL> show all  
appinfo is OFF and set to "SQL*Plus"
```

```
arraysize 15
autocommit OFF
autoprint OFF
autorecovery OFF
autotrace OFF
blockterminator "." (hex 2e)
btitle OFF and is the first few characters of the next SELECT statement
cmdsep OFF
colsep " "
compatibility version NATIVE
concat "." (hex 2e)
copycommit 0
COPYTYPECHECK is ON
define "&" (hex 26)
describe DEPTH 1 LINENUM OFF INDENT ON
echo OFF
editfile "afiedt.buf"
embedded OFF
escape OFF
FEEDBACK ON for 6 or more rows
flagger OFF
flush ON

SQL> sho verify
verify OFF
```

## RUN

This will runs the command in the buffer.

## Syntax:

```
Run | /
```

## Ex:

```
SQL> run
SQL> /
```

## STORE

This will save all the set command statuses in a file.

### Syntax:

```
Store set <filename>.[extension] [create] | [replace] | [append]
```

### Ex:

```
SQL> store set my_settings.scmd  
Created file my_settings.scmd  
SQL> store set my_settings.cmd replace  
Wrote file my_settings.cmd  
SQL> store set my_settings.cmd append  
Appended file to my_settings.cmd
```

## FOLD\_AFTER

This will fold the columns one after the other.

### Syntax:

```
Column <column_name> fold_after [no_of_lines]
```

### Ex:

```
SQL> col deptno fold_after 1  
SQL> col dname fold_after 1  
SQL> col loc fold_after 1  
SQL> set heading off  
SQL> select * from dept;
```

```
      10  
ACCOUNTING  
NEW YORK
```

```
      20  
RESEARCH  
DALLAS
```

```
30
SALES
CHICAGO
```

```
40
OPERATIONS
BOSTON
```

### FOLD\_BEFORE

This will fold the columns one before the other.

#### Syntax:

```
Column <column_name> fold_before [no_of_lines]
```

### DEFINE

This will give the list of all the variables currently defined.

#### Syntax:

```
Define [variable_name]
```

#### Ex:

```
SQL> define
DEFINE _DATE          = "16-MAY-07" (CHAR)
DEFINE _CONNECT_IDENTIFIER = "oracle" (CHAR)
DEFINE _USER          = "SCOTT" (CHAR)
DEFINE _PRIVILEGE     = "" (CHAR)
DEFINE _SQLPLUS_RELEASE = "1001000200" (CHAR)
DEFINE _EDITOR        = "Notepad" (CHAR)
DEFINE _O_VERSION     = "Oracle Database 10g Enterprise Edition Release 10.1.0.2.0 –
                        Production With the Partitioning, OLAP and Data Mining
                        options" (CHAR)
DEFINE _O_RELEASE     = "1001000200" (CHAR)
```

## SET COMMANDS

These commands does not require statement terminator and applicable to the sessions , those will be automatically cleared when session was closed.

### LINESIZE

This will be used to set the linesize. Default linesize is 80.

#### Syntax:

Set linesize <value>

#### Ex:

```
SQL> set linesize 100
```

### PAGESIZE

This will be used to set the pagesize. Default pagesize is 14.

#### Syntax:

Set pagesize <value>

#### Ex:

```
SQL> set pagesize 30
```

### DESCRIBE

This will be used to see the object's structure.

#### Syntax:

Describe or desc <object\_name>

#### Ex:

```
SQL> desc dept
```

Name	Null?	Type
DEPTNO	NOT NULL	NUMBER(2)
DNAME		VARCHAR2(14)
LOC		VARCHAR2(13)

### PAUSE

When the displayed data contains hundreds or thousands of lines, when you select it then it will automatically scrolls and displays the last page data. To prevent this you can use this pause option. By using this it will display the data corresponding to the pagesize with a break which will continue by hitting the return key. By default this will be off.

#### Syntax:

Set pause on | off

#### Ex:

```
SQL> set pause on
```

### FEEDBACK

This will give the information regarding howmany rows you selected the object. By default the feedback message will be displayed, only when the object contains more than 5 rows.

#### Syntax:

Set feedback <value>

#### Ex:

```
SQL> set feedback 4
```

```
SQL> select * from dept;
```

DEPTNO	DNAME	LOC
10	ACCOUNTING	NEW YORK
20	RESEARCH	DALLAS

```
30 SALES          CHICAGO
40 OPERATIONS    BOSTON
```

4 rows selected.

## HEADING

If you want to display data without headings, then you can achieve with this. By default heading is on.

### Syntax:

```
Set heading on | off
```

### Ex:

```
SQL> set heading off
SQL> select * from dept;
```

```
10 ACCOUNTING    NEW YORK
20 RESEARCH      DALLAS
30 SALES          CHICAGO
40 OPERATIONS    BOSTON
```

## SERVEROUTPUT

This will be used to display the output of the PL/SQL programs. By default this will be off.

### Syntax:

```
Set serveroutput on | off
```

### Ex:

```
SQL> set serveroutput on
```

## TIME

This will be used to display the time. By default this will be off.

**Syntax:**

Set time on | off

**Ex:**

```
SQL> set time on
19:56:33 SQL>
```

**TIMING**

This will give the time taken to execute the current SQL statement. By default this will be off.

**Syntax:**

Set timing on | off

**Ex:**

```
SQL> set timing on
SQL> select * from dept;
```

DEPTNO	DNAME	LOC
10	ACCOUNTING	NEW YORK
20	RESEARCH	DALLAS
30	SALES	CHICAGO
40	OPERATIONS	BOSTON

Elapsed: 00:00:00.06

**SQLPROMPT**

This will be used to change the SQL prompt.

**Syntax:**

Set sqlprompt <prompt>

Ex:

```
SQL> set sqlprompt 'ORACLE>'
ORACLE>
```

## SQLCASE

This will be used to change the case of the SQL statements. By default the case is mixed.

Syntax:

```
Set sqlcase upper | mixed | lower
```

Ex:

```
SQL> set sqlcase upper
```

## SQLTERMINATOR

This will be used to change the terminator of the SQL statements. By default the terminator is ;.

Syntax:

```
Set sqlterminator <termination_character>
```

Ex:

```
SQL> set sqlterminator :
SQL> select * from dept:
```

## DEFINE

By default if the & character finds then it will treat as bind variable and ask for the input. Suppose you want to treat it as a normal character while inserting data, then you can prevent this by using the define option. By default this will be on

Syntax:

```
Set define on | off
```

Ex:

```
SQL> insert into dept values(50,'R&D','HYD');
```

Enter value for d:

```
old 1: insert into dept values(50,'R&D','HYD')
```

```
new 1: INSERT INTO DEPT VALUES(50,'R','HYD')
```

```
SQL> set define off
```

```
SQL>insert into dept values(50,'R&D','HYD');      -- here it won't ask for value
```

## NEWPAGE

This will shows how many blank lines will be left before the report. By default it will leave one blank line.

### Syntax:

```
Set newpage <value>
```

### Ex:

```
SQL> set newpage 10
```

The zero value for newpage does not produce zero blank lines instead it switches to a special property which produces a top-of-form character (hex 13) just before the date on each page. Most modern printers respond to this by moving immediately to the top of the next page, where the printing of the report will begin.

## HEADSEP

This allow you to indicate where you want to break a page title or a column heading that runs longer than one line. The default heading separator is vertical bar (|).

### Syntax:

```
Set headsep <separation_char>
```

### Ex:

```
SQL> select * from dept;
```

```
DEPTNO  DNAME      LOC
-----
    10  ACCOUNTING  NEW YORK
    20  RESEARCH    DALLAS
    30  SALES        CHICAGO
    40  OPERATIONS  BOSTON
```

```
SQL> set headsetp !
SQL> col dname heading 'DEPARTMENT ! NAME'
SQL> /
```

```
          DEPARTMENT
DEPTNO  NAME      LOC
-----
    10  ACCOUNTING  NEW YORK
    20  RESEARCH    DALLAS
    30  SALES        CHICAGO
    40  OPERATIONS  BOSTON
```

## ECHO

When using a bind variable, the SQL statement is maintained by echo. By default this is off.

### Syntax:

```
Set echo on | off
```

## VERIFY

When using a bind variable, the old and new statements will be maintained by verify. By default this is on.

### Syntax:

```
Set verify on | off
```

Ex:

```
SQL> select * from dept where deptno = &dno;
Enter value for dno: 10
old 1: select * from dept where deptno = &dno
new 1: select * from dept where deptno = 10
```

```
DEPTNO  DNAME      LOC
-----
10      ACCOUNTING  NEW YORK
```

```
SQL> set verify off
SQL> select * from dept where deptno = &dno;
Enter value for dno: 20
```

```
DEPTNO  DNAME      LOC
-----
20      RESEARCH   DALLAS
```

PNO

This will give displays the page numbers. By default the value would be zero.

Ex:

```
SQL> col hiredate new_value xtoday noprint format a1 trunc
SQL> ttitle left xtoday right 'page' sql.pno
SQL> select * from emp where deptno = 10;
```

```
09-JUN-81                                     page      1
```

```
EMPNO  ENAME      JOB          MGR      SAL  COMM  DEPTNO
-----
7782  CLARK      MANAGER      7839     2450         10
7839  KING       PRESIDENT           5000         10
7934  MILLER     CLERK        7782     1300         10
```

In the above noprint tells SQLPLUS not to display this column when it prints the results of the SQL statement. Dates that have been reformatted by TO\_CHAR get a default width of about 100 characters. By changing the format to a1 trunc, you minimize this effect. NEW\_VALUE inserts contents of the column retrieved by the SQL statement into a variable called xtoday.

## SPECIAL FILES

### LOGIN.sql

If you would like SQLPLUS to define your own environmental settings, put all the required commands in a file named login.sql. This is a special filename that SQLPLUS always looks for whenever it starts up. If it finds login.sql, it executes any commands in it as if you had entered them by hand. You can put any command in login.sql that you can use in SQLPLUS, including SQLPLUS commands and SQL statements. All of them executed before SQLPLUS gives you the SQL> prompt.

## IMP QUERIES

### 1) To find the nth row of a table

```
SQL> Select *from emp where rowid = (select max(rowid) from emp where rownum <= 4);
```

Or

```
SQL> Select *from emp where rownum <= 4 minus select *from emp where rownum <= 3;
```

### 2) To find duplicate rows

```
SQL> Select *from emp where rowid in (select max(rowid) from emp group by empno,  
    ename, mgr, job, hiredate, comm, deptno, sal);
```

Or

```
SQL> Select empno,ename,sal,job,hiredate,comm , count(*) from emp group by  
    empno,ename,sal,job,hiredate,comm having count(*) >=1;
```

### 3) To delete duplicate rows

```
SQL> Delete emp where rowid in (select max(rowid) from emp group by  
    empno,ename,mgr,job,hiredate,sal,comm,deptno);
```

### 4) To find the count of duplicate rows

```
SQL> Select ename, count(*) from emp group by ename having count(*) >= 1;
```

5) How to display alternative rows in a table?

```
SQL> select *from emp where (rowid,0) in (select rowid,mod(rownum,2) from emp);
```

6) Getting employee details of each department who is drawing maximum sal?

```
SQL> select *from emp where (deptno,sal) in  
    ( select deptno,max(sal) from emp group by deptno);
```

7) How to get number of employees in each department , in which department is having more than 2500 employees?

```
SQL> Select deptno,count(*) from emp group by deptno having count(*) >2500;
```

9) To reset the time to the beginning of the day

```
SQL> Select to_char(trunc(sysdate),'dd-mon-yyyy hh:mi:ss am') from dual;
```

10) To find nth maximum sal

```
SQL> Select *from emp where sal in (select max(sal) from (select *from emp order by sal)  
    where rownum <= 5);
```

## INTRODUCTION

### CHARACTERSTICS

- Highly structured, readable and accessible language.
- Standard and Protable language.
- Embedded language.
- Improved execution authority.

### 10g FEATURES

- *Optimized compiler.*

To change the optimizer settings for the entire database, set the database parameter PLSQL\_OPTIMIZE\_LEVEL. Valid settings are as follows

0	-	No optimization
1	-	Moderate optimization
2	-	Aggressive optimization

These settings are also modifiable for the current session.

```
SQL> alter session set plsql_optimize_level=2;
```

Oracle retains optimizer settings on a module-by-module basis. When you recompile a particular module with nondefault settings, the settings will stick allowing you to recompile later on using REUSE SETTINGS.

```
SQL> Alter procedure proc compile plsql_optimize_level=1;
```

```
SQL> Alter procedure proc compile reuse settings;
```

- *Compile-time warnings.*

Starting with oracle database 10g release 1 you can enable additional compile-time warnings to help make your programs more robust. The compiler can detect potential

runtime problems with your code, such as identifying lines of code that will never be run. This process, also known as *lint checking*.

To enable these warnings for the entire database, set the database parameter `PLSQL_WARNINGS`.

These settings are also modifiable for the current session.

```
SQL> alter session set plsql_warnings = 'enable:all';
```

The above can be achieved using the built-in package `DBMS_WARNING`.

➤ *Conditional compilation.*

Conditional compilation allows the compiler to allow to compile selected parts of a program based on conditions you provide with the `$IF` directive.

➤ *Support for non-sequential collections in FORALL.*

➤ *Improved datatype support.*

➤ *Backtrace an exception to its line number.*

When handling an error, how can you find the line number on which the error was originally raised?

In earlier release, the only way to do this was allow you exception to go unhandled and then view the full error trace stack.

Now you can call `DBMS_UTILITY.FORMAT_ERROR_BACKTRACE` function to obtain that stack and manipulate it programmatically within your program.

➤ *Set operators for nested tables.*

➤ *Support for regular expressions.*

Oracle database 10g supports the use of regular expressions inside PL/SQL code via four new built-in functions.

- ✓ `REGEXP_LIKE`
- ✓ `REGEXP_INSTR`
- ✓ `REGEXP_SUBSTR`
- ✓ `REGEXP_REPLACE`

➤ *Programmer-defined quoting mechanism.*

Starting with oracle database 10g release 1, you can define your own quoting mechanism for string literals in both SQL and PL/SQL.

Use the characters q'(q followed by a single quote) to note the programmer-defined deliemeter for you string literal.

Ex:

```
DECLARE
    v varchar(10) := 'computer';
BEGIN
    dbms_output.put_line(q'*v = *' || v);
    dbms_output.put_line(q'$v = $' || v);
END;
```

Output:

```
v = computer
v = computer
```

➤ *Many new built-in packages.*

DBMS\_SCHEDULER

Represents a major update to DBMS\_JOB. DBMS\_SCHEDULER provides much improved functionality for scheduling and executing jobs defined via stored procedures.

DBMS\_CRYPTO

Offers the ability to encrypt and decrypt common oracle datatype, including RAWs, BLOBs, and CLOBs. It also provides globalization support for encrypting data across different charactersets.

DBMS\_MONITOR

Provides an API to control additional tracing and statistics gathering of sessions.

DBMS\_WARNING

Provides an API into the PL/SQL compiler warnings module, allowing you to read and change settings that control which warnings are suppressed, displayed, or treated as errors.

STANDARD PACKAGE

Oracle has defined in this special package. Oracle defines quite a few identifiers in this package, including built-in exceptions, functions and subtypes.

You can reference the built-in form by prefixing it with STANDARD.

The basic unit in any PL/SQL program is block. All PL/SQL programs are composed of blocks which can occur sequentially or nested.

## BLOCK STRUCTURE

```
Declare
-- declarative section
Begin
-- executable section
Exception
-- exception section
End;
```

In the above declarative and exception sections are optional.

## BLOCK TYPES

- Anonymous blocks
- Named blocks
  - ✓ Labeled blocks
  - ✓ Subprograms
  - ✓ Triggers

## ANONYMOUS BLOCKS

Anonymous blocks implies basic block structure.

Ex:

```
BEGIN
  Dbms_output.put_line('My first program');
END;
```

## LABELED BLOCKS

Labeled blocks are anonymous blocks with a label which gives a name to the block.

Ex:

```
<<my_block>>  
BEGIN  
    Dbms_output.put_line('My first program');  
END;
```

## SUBPROGRAMS

Subprograms are procedures and functions. They can be stored in the database as stand-alone objects, as part of package or as methods of an object type.

## TRIGGERS

Triggers consists of a PL/SQL block that is associated with an event that occur in the database.

## NESTED BLOCKS

A block can be nested within the executable or exception section of an outer block.

## IDENTIFIERS

Identifiers are used to name PL/SQL objects, such as variables, cursors, types and subprograms. Identifiers consists of a letter, optionally followed by any sequence of characters, including letters, numbers, dollar signs, underscores, and pound signs only. The maximum length for an identifier is 30 characters.

## QUOTED IDENTIFIERS

If you want to make an identifier case sensitive, include characters such as spaces or use a reserved word, you can enclose the identifier in double quotation marks.

Ex:

```
DECLARE  
    "a" number := 5;
```

```
"A" number := 6;  
BEGIN  
  dbms_output.put_line('a = ' || a);  
  dbms_output.put_line('A = ' || A);  
END;
```

### Output:

```
a = 6  
A = 6
```

## COMMENTS

Comments improve readability and make your program more understandable. They are ignored by the PL/SQL compiler. There are two types of comments available.

- Single line comments
- Multiline comments

### SINGLE LINE COMMENTS

A single-line comment can start any point on a line with two dashes and continues until the end of the line.

Ex:

```
BEGIN  
  Dbms_output.put_line('hello');           -- sample program  
END;
```

### MULTILINE COMMENTS

Multiline comments start with the /\* delimiter and ends with \*/ delimiter.

Ex:

```
BEGIN  
  Dbms_output.put_line('hello');           /* sample program */  
END;
```

## VARIABLE DECLERATIONS

Variables can be declared in declarative section of the block;

Ex:

```
DECLARE
  a number;
  b number := 5;
  c number default 6;
```

### CONSTANT DECLERATIONS

To declare a constant, you include the `CONSTANT` keyword, and you must supply a default value.

Ex:

```
DECLARE
  b constant number := 5;
  c constant number default 6;
```

### NOT NULL CLAUSE

You can also specify that the variable must be not null.

Ex:

```
DECLARE
  b constant number not null:= 5;
  c number not null default 6;
```

### ANCHORED DECLERATIONS

PL/SQL offers two kinds of anchoring.

- Scalar anchoring
- Record anchoring

### SCALAR ANCHORING

Use the `%TYPE` attribute to define your variable based on table's column of some other PL/SQL scalar variable.

Ex:

```
DECLARE
  dno dept.deptno% type;
  Subtype t_number is number;
  a t_number;
```

```
Subtype t_sno is student.sno% type;  
V_sno t_sno;
```

#### RECORD ANCHORING

Use the %ROWTYPE attribute to define your record structure based on a table.

Ex:

```
DECLARE  
    V_dept dept%rowtype;
```

#### BENEFITS OF ANCHORED DECLARATIONS

- Synchronization with database columns.
- Normalization of local variables.

#### PROGRAMMER-DEFINED TYPES

With the SUBTYPE statement, PL/SQL allows you to define your own subtypes or aliases of predefined datatypes, sometimes referred to as abstract datatypes.

There are two kinds of subtypes.

- Constrained
- Unconstrained

#### CONSTRAINED SUBTYPE

A subtype that restricts or constrains the values normally allowed by the datatype itself.

Ex:

```
Subtype positive is binary_integer range 1..2147483647;
```

In the above declaration a variable that is declared as positive can store only integer greater than zero even though binary\_integer ranges from -2147483647..+2147483647.

#### UNCONSTRAINED SUBTYPE

A subtype that does not restrict the values of the original datatype in variables declared with the subtype.

Ex:

Subtype float is number;

## DATATYPE CONVERSIONS

PL/SQL can handle conversions between different families among the datatypes.

Conversion can be done in two ways.

- Explicit conversion
- Implicit conversion

### EXPLICIT CONVERSION

This can be done using the built-in functions available.

### IMPLICIT CONVERSION

PL/SQL will automatically convert between datatype families when possible.

Ex:

```
DECLARE
    a varchar(10);
BEGIN
    select deptno into a from dept where dname='ACCOUNTING';
END;
```

In the above variable a is char type and deptno is number type even though, oracle will automatically converts the numeric data into char type assigns to the variable.

PL/SQL can automatically convert between

- Characters and numbers
- Characters and dates

## VARIABLE SCOPE AND VISIBILITY

The scope of a variable is the portion of the program in which the variable can be accessed. For PL/SQL variables, this is from the variable declaration until the end of the block. When a variable goes out of scope, the PL/SQL engine will free the memory used to store the variable.

The visibility of a variable is the portion of the program where the variable can be accessed without having to qualify the reference. The visibility is always within the scope. If it is out of scope, it is not visible.

Ex1:

```
DECLARE
    a number;    -- scope of a
BEGIN
-----
    DECLARE
        b number;    -- scope of b
    BEGIN
        -----
        END;
    -----
END;
```

Ex2:

```
DECLARE
    a number;
    b number;
BEGIN
    -- a , b available here
    DECLARE
        b char(10);
    BEGIN
        -- a and char type b is available here
    END;
    -----
END;
```

Ex3:

```
<<my_block>>
DECLARE
    a number;
    b number;
BEGIN
    -- a , b available here
    DECLARE
        b char(10);
```

```
BEGIN
    -- a and char type b is available here
    -- number type b is available using <<my_block>>.b
END;
-----
END;
```

## PL/SQL CONTROL STRUCTURES

PL/SQL has a variety of control structures that allow you to control the behaviour of the block as it runs. These structures include conditional statements and loops.

- If-then-else
- Case
  - ✓ Case with no else
  - ✓ Labeled case
  - ✓ Searched case
- Simple loop
- While loop
- For loop
- Goto and Labels

## IF-THEN-ELSE

### Syntax:

```
If <condition1> then
    Sequence of statements;
Elsif <condition1> then
    Sequence of statements;
.....
Else
    Sequence of statements;
End if;
```

### Ex:

```
DECLARE
```

```
    dno number(2);  
BEGIN  
    select deptno into dno from dept where dname = 'ACCOUNTING';  
    if dno = 10 then  
        dbms_output.put_line('Location is NEW YORK');  
    elsif dno = 20 then  
        dbms_output.put_line('Location is DALLAS');  
    elsif dno = 30 then  
        dbms_output.put_line('Location is CHICAGO');  
    else  
        dbms_output.put_line('Location is BOSTON');  
    end if;  
END;
```

**Output:**

```
Location is NEW YORK
```

**CASE**

**Syntax:**

```
Case test-variable  
    When value1 then sequence of statements;  
    When value2 then sequence of statements;  
    .....  
    When valuen then sequence of statements;  
    Else sequence of statements;  
End case;
```

**Ex:**

```
DECLARE  
    dno number(2);  
BEGIN  
    select deptno into dno from dept where dname = 'ACCOUNTING';  
    case dno  
        when 10 then  
            dbms_output.put_line('Location is NEW YORK');  
        when 20 then
```

```
        dbms_output.put_line('Location is DALLAS');
    when 30 then
        dbms_output.put_line('Location is CHICAGO');
    else
        dbms_output.put_line('Location is BOSTON');
    end case;
END;
```

Output:

```
Location is NEW YORK
```

### CASE WITHOUT ELSE

Syntax:

```
Case test-variable
    When value1 then sequence of statements;
    When value2 then sequence of statements;
    .....
    When valuen then sequence of statements;
End case;
```

Ex:

```
DECLARE
    dno number(2);
BEGIN
    select deptno into dno from dept where dname = 'ACCOUNTING';
    case dno
        when 10 then
            dbms_output.put_line('Location is NEW YORK');
        when 20 then
            dbms_output.put_line('Location is DALLAS');
        when 30 then
            dbms_output.put_line('Location is CHICAGO');
        when 40 then
            dbms_output.put_line('Location is BOSTON');
    end case;
END;
```

Output:

Location is NEW YORK

## LABELED CASE

Syntax:

```
<<label>>  
Case test-variable  
    When value1 then sequence of statements;  
    When value2 then sequence of statements;  
    .....  
    When valuen then sequence of statements;  
End case;
```

Ex:

```
DECLARE  
    dno number(2);  
BEGIN  
    select deptno into dno from dept where dname = 'ACCOUNTING';  
    <<my_case>>  
    case dno  
        when 10 then  
            dbms_output.put_line('Location is NEW YORK');  
        when 20 then  
            dbms_output.put_line('Location is DALLAS');  
        when 30 then  
            dbms_output.put_line('Location is CHICAGO');  
        when 40 then  
            dbms_output.put_line('Location is BOSTON');  
    end case my_case;  
END;
```

Output:

Location is NEW YORK

## SEARCHED CASE

**Syntax:**

```
Case
  When <condition1> then sequence of statements;
  When <condition2> then sequence of statements;
  .....
  When <conditionn> then sequence of statements;
End case;
```

**Ex:**

```
DECLARE
  dno number(2);
BEGIN
  select deptno into dno from dept where dname = 'ACCOUNTING';
  case dno
    when dno = 10 then
      dbms_output.put_line('Location is NEW YORK');
    when dno = 20 then
      dbms_output.put_line('Location is DALLAS');
    when dno = 30 then
      dbms_output.put_line('Location is CHICAGO');
    when dno = 40 then
      dbms_output.put_line('Location is BOSTON');
  end case;
END;
```

**Output:**

```
Location is NEW YORK
```

**SIMPLE LOOP**

**Syntax:**

```
Loop
  Sequence of statements;
Exit when <condition>;
End loop;
```

In the syntax exit when <condition> is equivalent to

```
If <condition> then  
    Exit;  
End if;
```

Ex:

```
DECLARE  
    i number := 1;  
BEGIN  
    loop  
        dbms_output.put_line('i = ' || i);  
        i := i + 1;  
        exit when i > 5;  
    end loop;  
END;
```

Output:

```
i = 1  
i = 2  
i = 3  
i = 4  
i = 5
```

## WHILE LOOP

Syntax:

```
While <condition> loop  
    Sequence of statements;  
End loop;
```

Ex:

```
DECLARE  
    i number := 1;  
BEGIN  
    While i <= 5 loop  
        dbms_output.put_line('i = ' || i);  
        i := i + 1;  
    end loop;  
END;
```

Output:

```
i = 1  
i = 2  
i = 3  
i = 4  
i = 5
```

FOR LOOP

Syntax:

```
For <loop_counter_variable> in low_bound..high_bound loop  
Sequence of statements;  
End loop;
```

Ex1:

```
BEGIN  
  For i in 1..5 loop  
    dbms_output.put_line('i = ' || i);  
  end loop;  
END;
```

Output:

```
i = 1  
i = 2  
i = 3  
i = 4  
i = 5
```

Ex2:

```
BEGIN  
  For i in reverse 1..5 loop  
    dbms_output.put_line('i = ' || i);  
  end loop;  
END;
```

Output:

```
i = 5  
i = 4
```

```
i = 3  
i = 2  
i = 1
```

## NULL STATEMENT

Usually when you write a statement in a program, you want it to do something. There are cases, however, when you want to tell PL/SQL to do absolutely nothing, and that is where the NULL comes.

The NULL statement does nothing except pass control to the next executable statement.

You can use NULL statement in the following situations.

- Improving program readability.  
Sometimes, it is helpful to avoid any ambiguity inherent in an IF statement that doesn't cover all possible cases. For example, when you write an IF statement, you do not have to include an ELSE clause.
- Nullifying a raised exception.  
When you don't want to write any special code to handle an exception, you can use the NULL statement to make sure that a raised exception halts execution of the current PL/SQL block but does not propagate any exceptions to enclosing blocks.
- Using null after a label.  
In some cases, you can pair NULL with GOTO to avoid having to execute additional statements. For example, I use a GOTO statement to quickly move to the end of my program if the state of my data indicates that no further processing is required. Because I do not have to do anything at the termination of the program, I place a NULL statement after the label because at least one executable statement is required there. Even though NULL does nothing, it is still an executable statement.

## GOTO AND LABELS

**Syntax:**

```
Goto label;
```

Where *label* is a label defined in the PL/SQL block. Labels are enclosed in double angle brackets. When a goto statement is evaluated, control immediately passes to the statement identified by the label.

**Ex:**

```
BEGIN
  For i in 1..5 loop
    dbms_output.put_line('i = ' || i);
    if i = 4 then
      goto exit_loop;
    end if;
  end loop;
  <<exit_loop>>
Null;
END;
```

**Output:**

```
i = 1
i = 2
i = 3
i = 4
```

**RESTRICTIONS ON GOTO**

- It is illegal to branch into an inner block, loop.
- At least one executable statement must follow.
- It is illegal to branch into an if statement.
- It is illegal to branch from one if statement to another if statement.
- It is illegal to branch from exception block to the current block.

**PRAGMAS**

Pragmas are compiler directives. They serve as instructions to the PL/SQL compiler. The compiler will act on the pragma during the compilation of the block.

**Syntax:**

`PRAGMA instruction_to_compiler.`

PL/SQL offers several pragmas:

- AUTONOMOUS\_TRANSACTION
- EXCEPTION\_INIT
- RESTRICT\_REFERENCES
- SERIALLY\_REUSABLE

## SUBPROGRAMS

### PROCEDURES

A procedure is a module that performs one or more actions.

#### Syntax:

```
Procedure [schema.]name [(parameter1 [,parameter2 ...])]
    [authid definer | current_user] is
    -- [declarations]
Begin
    -- executable statements
[Exception
    -- exception handlers]
End [name];
```

In the above *authid* clause defines whether the procedure will execute under the authority of the definer of the procedure or under the authority of the current user.

### FUNCTIONS

A function is a module that returns a value.

#### Syntax:

```
Function [schema.]name [(parameter1 [,parameter2 ...])]
    Return return_datatype
    [authid definer | current_user]
    [deterministic]
    [parallel_enable] is
    -- [declarations]
Begin
```

```
-- executable statements  
[Exception  
  -- exception handlers]  
End [name];
```

In the above *authid* clause defines whether the procedure will execute under the authority of the definer of the procedure or under the authority of the current user.

*Deterministic* clause defines, an optimization hint that lets the system use a saved copy of the function's return result, if available. The query optimizer can choose whether to use the saved copy or re-call the function.

*Parallel\_enable* clause defines, an optimization hint that enables the function to be executed in parallel when called from within SELECT statement.

## PARAMETER MODES

- ❖ In (Default)
- ❖ Out
- ❖ In out

## IN

In parameter will act as *pl/sql constant*.

## OUT

- Out parameter will act as *uninitialized variable*.
- You cannot provide a default value to an *out* parameter.
- Any assignments made to *out* parameter are rolled back when an exception is raised in the program.
- An actual parameter corresponding to an *out* formal parameter must be a variable.

## IN OUT

- In out parameter will act as *initialized variable*.
- An actual parameter corresponding to an *in out* formal parameter must be a variable.

## DEFAULT PARAMETERS

Default Parameters will not allow in the *beginning* and *middle*.

*Out* and *In Out* parameters can not have default values.

Ex:

```
procedure p(a in number default 5, b in number default 6, c in number default 7) – valid
procedure p(a in number, b in number default 6, c in number default 7) – valid
procedure p(a in number, b in number, c in number default 7) – valid
procedure p(a in number, b in number default 6, c in number) – invalid
procedure p(a in number default 5, b in number default 6, c in number) – invalid
procedure p(a in number default 5, b in number, c in number) – invalid
```

## NOTATIONS

Notations are of two types.

- Positional notation
- Name notation

We can combine positional and name notation but positional notation can not be followed by the name notation.

Ex:

Suppose we have a procedure `proc(a number,b number,c number)` and we have one anonymous block which contains `v1,v2, and v3`;

```
SQL> exec proc (v1,v2,v3)           -- Positional notation
SQL> exec proc (a=>v1,b=>v2,c=>v3)  -- Named notation
```

## FORMAL AND ACTUAL PARAMETERS

- Parametes which are in calling subprogram are *actual parameters*.
- Parametes which are in called subprogram are *formal parameters*.
- If any subprogram was called, once the call was completed then the values of formal parameters are copied to the actual parameters.

**Ex1:**

```
CREATE OR REPLACE PROCEDURE SAMPLE(a in number,b out number,c in out number) is
BEGIN
    dbms_output.put_line('After call');
    dbms_output.put_line('a = ' || a ||' b = ' || b || ' c = ' || c);
    b := 10;
    c := 20;
    dbms_output.put_line('After assignment');
    dbms_output.put_line('a = ' || a ||' b = ' || b || ' c = ' || c);
END SAMPLE;

DECLARE
    v1 number := 4;
    v2 number := 5;
    v3 number := 6;
BEGIN
    dbms_output.put_line('Before call');
    dbms_output.put_line('v1 = ' || v1 || ' v2 = ' || v2 || ' v3 = ' || v3);
    sample(v1,v2,v3);
    dbms_output.put_line('After completion of call');
    dbms_output.put_line('v1 = ' || v1 || ' v2 = ' || v2 || ' v3 = ' || v3);
END;
```

**Output:**

```
Before call
v1 = 4 v2 = 5 v3 = 6
After call
a = 4 b = c = 6
After assignment
a = 4 b = 10 c = 20
After completion of call
v1 = 4 v2 = 10 v3 = 20
```

Ex2:

```
CREATE OR REPLACE FUN(a in number,b out number,c in out number) return number IS
BEGIN
    dbms_output.put_line('After call');
    dbms_output.put_line('a = ' || a || ' b = ' || b || ' c = ' || c);
    dbms_output.put_line('Before assignement Result = ' || (a*nvl(b,1)*c));
    b := 5;
    c := 7;
    dbms_output.put_line('After assignment');
    dbms_output.put_line('a = ' || a || ' b = ' || b || ' c = ' || c);
    return (a*b*c);
END FUN;

DECLARE
    v1 number := 1;
    v2 number := 2;
    v3 number := 3;
    v number;
BEGIN
    dbms_output.put_line('Before call');
    dbms_output.put_line('v1 = ' || v1 || ' v2 = ' || v2 || ' v3 = ' || v3);
    v := fun(v1,v2,v3);
    dbms_output.put_line('After call completed');
    dbms_output.put_line('v1 = ' || v1 || ' v2 = ' || v2 || ' v3 = ' || v3);
    dbms_output.put_line('Result = ' || v);
END;
```

Output:

```
Before call
v1 = 1 v2 = 2 v3 = 3
After call
a = 1 b = c = 3
Before assignement Result = 3
After assignment
a = 1 b = 5 c = 7
After call completed
v1 = 1 v2 = 5 v3 = 7
```

Result = 35

## RESTRICTIONS ON FORMAL PARAMETERS

- By declaring with specified size in actual parameters.
- By declaring formal parameters with % type specifier.

## USING NOCOPY

- *Nocopy* is a hint, not a command. This means that the compiler might silently decide that it can't fulfill your request for a *nocopy* parameter.
- The copying from formal to actual can be restricted by issuing *nocopy* qualifier.
- To pass the out and in out parameters by reference use *nocopy* qualifier.

Ex:

```
CREATE OR REPLACE PROCEDURE PROC(a in out nocopy number) IS
BEGIN
----
END PROC;
```

## CALL AND EXEC

Call is a SQL statement, which can be used to execute subprograms like exec.

Syntax:

```
Call subprogram_name([argument_list]) [into host_variable];
```

- The parantheses are always required, even if the subprogram takes no arguments.
- We can not use call with *out* and *in out* parameters.
- Call is a SQL statement, it is not valid inside a PL/SQL block;
- The INTO clause is used for the output variables of functions only.
- We can not use 'exec' with *out* or *in out* parameters.
- Exec is not valid inside a PL/SQL block;

Ex1:

```
CREATE OR REPLACE PROC IS
BEGIN
    dbms_output.put_line('hello world');
END PROC;
```

Output:

```
SQL> call proc();
    hello world
```

Ex2:

```
CREATE OR REPLACE PROC(a in number,b in number) IS
BEGIN
    dbms_output.put_line('a = ' || a || ' b = ' || b);
END PROC;
```

Output:

```
SQL> call proc(5,6);
    a = 5 b = 6
```

Ex3:

```
CREATE OR REPLACE FUNCTION FUN RETURN VARCHAR IS
BEGIN
    return 'hello world';
END FUN;
```

Output:

```
SQL> variable v varchar(20)
SQL> call fun() into :v;
SQL> print v
    hello world
```

## CALL BY REFERENCE AND CALL BY VALUE

- In parameters by default *call by reference* where as out and in out *call by value*.
- When parameter passed by reference, a pointer to the actual parameter is passed to the corresponding formal parameter.
- When parameter passed by value it copies the value of the actual parameter to the formal parameter.
- Call by reference is faster than the call by value because it avoids the copying.

## SUBPROGRAMS OVERLOADING

- Possible with different number of parameters.
- Possible with different types of data.
- Possible with same type with objects.
- Can not be possible with different types of modes.
- We can overload local subprograms also.

Ex:

```
SQL> create or replace type t1 as object(a number);/  
SQL> create or replace type t1 as object(a number);/
```

```
DECLARE  
    i t1 := t1(5);  
    j t2 := t2(5);  
    PROCEDURE P(m t1) IS  
    BEGIN  
        dbms_output.put_line('a = ' || m.a);  
    END P;  
    PROCEDURE P(n t2) IS  
    BEGIN  
        dbms_output.put_line('b = ' || n.b);  
    END P;  
    PROCEDURE PRODUCT(a number,b number) IS  
    BEGIN  
        dbms_output.put_line('Product of a,b = ' || a * b);  
    END PRODUCT;  
    PROCEDURE PRODUCT(a number,b number,c number) IS  
    BEGIN  
        dbms_output.put_line('Product of a,b = ' || a * b * c);  
    END PRODUCT;  
BEGIN  
    p(i);  
    p(j);  
    product(4,5);  
    product(4,5,6);  
END;
```

Output:

a = 5

b = 5

Product of a,b = 20

Product of a,b = 120

### BENEFITS OF OVERLOADING

- Supporting many data combinations
- Fitting the program to the user.

### RESTRICTIONS ON OVERLOADING

- Overloaded programs with parameter lists that differ only by name must be called using named notation.
- The parameter list of overloaded programs must differ by more than parameter mode.
- All of the overloaded programs must be defined within the same PL/SQL scope or block.
- Overloaded functions must differ by more than their return type.

### IMPORTANT POINTS ABOUT SUBPROGRAMS

- When a stored subprogram is created, it is stored in the *data dictionary*.
- The subprogram is stored in compile form which is known as *p-code* in addition to the source text.
- The p-code has all of the references in the subprogram evaluated, and the source code is translated into a form that is easily readable by PL/SQL engine.
- When the subprogram is called, the p-code is read from the disk, if necessary, and executed.
- Once it reads from the disk, the p-code is stored in the shared pool portion of the system global area (SGA), where it can be accessed by multiple users as needed.
- Like all of the contents of the shared pool, p-code is aged out of the shared pool according to a least recently used (LRU) algorithm.
- Subprograms can be *local*.
- Local subprograms must be declared in the declarative section of PL/SQL block and called from the executable section.
- Subprograms can not have the declarative section separately.
- Stored subprograms can have local subprograms;

- Local subprograms also can have local subprograms.
- If the subprogram contains a variable with the same name as the column name of the table then use the dot method to differentiate (*subprogram\_name.sal*).
- Subprograms can be invalidated.

## PROCEDURES V FUNCTIONS

- Procedures may return through out and in out parameters where as function must return.
- Procedures can not have return clause where as functions must.
- We can use call statement directly for executing procedure where as we need to declare a variable in case of functions.
- Functions can use in select statements where as procedures can not.
- Functions can call from reports environment where as procedures can not.
- We can use exec for executing procedures where as functions can not.
- Function can be used in dbms\_output where as procedure can not.
- Procedure call is a standalone executable statement where as function call is a part of an executable statement.

## STORED V LOCAL SUBPROGRAMS

- The stored subprogram is stored in compiled p-code in the database, when the procedure is called it does not have to be compiled.  
The local subprogram is compiled as part of its containing block. If the containing block is anonymous and is run multiple times, the subprogram has to be compiled each time.
- Stored subprograms can be called from any block submitted by a user who has execute privileges on the subprogram.  
Local subprograms can be called only from the block containing the subprogram.
- By keeping the stored subprogram code separate from the calling block, the calling block is shorter and easier to understand.  
The local subprogram and the calling block are one and the same, which can lead to part confusion. If a change to the calling block is made, the subprogram will be recompiled as of the recompilation of the containing block.
- The compiled p-code can be pinned in the shared pool using the DBMS\_SHARED\_POOL Package. This can improve performance.  
Local subprograms cannot be pinned in the shared pool by themselves.

- Stand alone stored subprograms can not be overloaded, but packaged subprograms can be overloaded within the same package.
- Local subprograms can be overloaded within the same block.

Ex1:

```
CREATE OR REPLACE PROCEDURE P IS
BEGIN
    dbms_output.put_line('Stored subprogram');
END;
```

Output:

```
SQL> exec p
Stored subprogram
```

Ex2:

```
DECLARE
    PROCEDURE P IS
    BEGIN
        dbms_output.put_line('Local subprogram');
    END;
BEGIN
    p;
END;
```

Output:

```
Local subprogram
```

## COMPILING SUBPROGRAMS

- SQL> Alter procedure P1 compile;
- SQL> Alter function F1 compile;

## SUBPROGRAMS DEPENDENCIES

- A stored subprogram is marked as invalid in the data dictionary if it has compile errors.
- A stored subprogram can also become invalid if a DDL operation is performed on one of its dependent objects.

- If a subprogram is invalidated, the PL/SQL engine will automatically attempt to recompile in the next time it is called.
- If we have two procedures like P1 and P2 in which P1 depends on P2. If we compile P2 then P1 is invalidated.

### SUBPROGRAMS DEPENDENCIES IN REMOTE DATABASES

- We will call remote subprogram using connect string like P1@ORACLE;
- If we have two procedures like P1 and P2 in which P1 depends on P2 but P2 was in remote database. If we compile P2 it will not invalidate P1 immediately because the data dictionary does not track remote dependencies.
- Instead the validity of remote objects is checked at runtime. When P1 is called, the remote data dictionary is queried to determine the status of P2.
- P1 and P2 are compared to see if P1 needs to be recompiled, there are two different methods of comparison
  - ✓ Timestamp Model
  - ✓ Signature Model

### TIMESTAMP MODEL

- This is the default model used by oracle.
- With this model, the timestamps of the last modifications of the two objects are compared.
- The *last\_ddl\_time* field of *user\_objects* contains the timestamp.
- If the base object has a newer timestamp than the dependent object, the dependent object will be recompiled.

### ISSUES WITH THIS MODEL

- If the objects are in different time zones, the comparison is invalid.
- When P1 is in a client side PL/SQL engine such as oracle forms, in this case it may not be possible to recompile P1, because the source for it may not be included with the forms.

### SIGNATURE MODEL

- When a procedure is created, a signature is stored in the data dictionary in addition to the p-code.
- The signature encodes the types and order of the parameters.
- When P1 is compiled the first time, the signature of P2 is included. Thus, P1 only needs to be recompiled when the signature of P2 changes.
- In order to use the signature model, the parameter `REMOTE_DEPENDENCIES_MODE` must be set to `SIGNATURE`. This is a parameter in the database initialization file.

#### THREE WAYS OF SETTING THIS MODE

- Add the line `REMOTE_DEPENDENCIES_MODE=SIGNATURE` to the database initialization file. The next time the database is started, the mode will be set to `SIGNATURE` for all sessions.
- `Alter system set remote_dependencies_mode = signature;`  
This will affect the entire database (all sessions) from the time the statement is issued. You must have the `ALTER SYSTEM` privilege to issue this command.
- `Alter session set remote_dependencies_mode = signature;`  
This will only affect your session

#### ISSUES WITH THIS MODEL

- Signatures don't get modified if the default values of formal parameters are changed.
- Suppose P2 has a default value for one of its parameters, and P1 is using this default value. If the default in the specification for P2 is changed, P1 will not be recompiled by default. The old value for the default parameter will still be used until P1 is manually recompiled.
- If P1 is calling a packaged procedure P2, and a new overloaded version of P2 is added to the remote package, the signature is not changed. P1 will still use the old version (not the new overloaded one) until P1 is recompiled manually.

#### FORWARD DECLARATION

Before going to use the procedure in any other subprogram or other block, you must declare the prototype of the procedure in declarative section.

Ex1:

```
DECLARE
```

```
PROCEDURE P1 IS
BEGIN
    dbms_output.put_line('From procedure p1');
    p2;
END P1;
PROCEDURE P2 IS
BEGIN
    dbms_output.put_line('From procedure p2');
    p3;
END P2;
PROCEDURE P3 IS
BEGIN
    dbms_output.put_line('From procedure p3');
END P3;
BEGIN
    p1;
END;
```

Output:

```
p2;
*
ERROR at line 5:
ORA-06550: line 5, column 1:
PLS-00313: 'P2' not declared in this scope
ORA-06550: line 5, column 1:
PL/SQL: Statement ignored
ORA-06550: line 10, column 1:
PLS-00313: 'P3' not declared in this scope
ORA-06550: line 10, column 1:
PL/SQL: Statement ignored
```

Ex2:

```
DECLARE
    PROCEDURE P2; -- forward declaration
    PROCEDURE P3;
    PROCEDURE P1 IS
    BEGIN
        dbms_output.put_line('From procedure p1');
```

```
        p2;
END P1;
PROCEDURE P2 IS
BEGIN
    dbms_output.put_line('From procedure p2');
    p3;
END P2;
PROCEDURE P3 IS
BEGIN
    dbms_output.put_line('From procedure p3');
END P3;
BEGIN
    p1;
END;
```

**Output:**

```
From procedure p1
From procedure p2
From procedure p3
```

## PRIVILEGES AND STORED SUBPROGRAMS

### EXECUTE PRIVILEGE

- For stored subprograms and packages the relevant privilege is EXECUTE.
- If user A had the procedure called emp\_proc then user A grants execute privilege on procedure to user B with the following command.  
SQL> Grant execute on emp\_proc to user B.
- Then user B can run the procedure by issuing  
SQL> Exec user A.emp\_proc

userA created the following procedure

```
CREATE OR REPLACE PROCEDURE P IS
    cursor is select *from student1;
BEGIN
    for v in c loop
        insert into student2 values(v.no,v.name,v.marks);
    end loop;
```

```
END P;
```

userA granted execute privilege to userB using

```
SQL> grant execute on p to userB
```

Then userB executed the procedure

```
SQL> Exec userA.p
```

If suppose userB also having student2 table then which table will populate whether userA's or userB's.

The answer is userA's student2 table only because by default the procedure will execute under the privilege set of its owner.

The above procedure is known as definer's procedure.

#### HOW TO POPULATE USER B's TABLE

- Oracle introduces *Invoker's and Definer's rights*.
- By default it will use the definer's rights.
- An invoker's rights routine can be created by using AUTHID clause to populate the userB's table.
- It is valid for stand-alone subprograms, package specifications, and object type specifications only.

userA created the following procedure

```
CREATE OR REPLACE PROCEDURE P
AUTHID CURRENT_USER IS
    cursor is select *from student1;
BEGIN
    for v in c loop
        insert into student2 values(v.no,v.name,v.marks);
    end loop;
END P;
```

Then grant execute privilege on p to userB.

Executing the procedure by userB, which populates userB's table.

The above procedure is called invoker's procedure.

Instead of current\_user of authid clause, if you use definer then it will be called definer's procedure.

## STORED SUBPROGRAMS AND ROLES

we have two users saketh and sudha in which saketh has student table and sudha does not. Sudha is going to create a procedure based on student table owned by saketh. Before doing this saketh must grant the permissions on this table to sudha.

```
SQL> conn saketh/saketh
SQL> grant all on student to sudha;
then sudha can create procedure
SQL> conn sudha/sudha

CREATE OR REPLACE PROCEDURE P IS
  cursor c is select *from saketh.student;
BEGIN
  for v in c loop
    dbms_output.put_line('No = ' || v.no);
  end loop;
END P;
```

here procedure will be created.

If the same privilege was granted through a role it wont create the procedure. Examine the following code

```
SQL> conn saketh/saketh
SQL> create role saketh_role;
SQL> grant all on student to saketh_role;
SQL> grant saketh_role to sudha;
then conn sudha/sudha

CREATE OR REPLACE PROCEDURE P IS
  cursor c is select *from saketh.student;
BEGIN
  for v in c loop
    dbms_output.put_line('No = ' || v.no);
  end loop;
END P;
```

The above code will raise error instead of creating procedure .

This is because of early binding which PL/SQL uses by default in which references are evaluated in compile time but when you are using a role this will affect immediately.

#### ISSUES WITH INVOKER'S RIGHTS

- In an invoker's rights routine, external references in SQL statements will be resolved using the caller's privilege set.
- But references in PL/SQL statements are still resolved under the owner's privilege set.

#### TRIGGERS, VIEWS AND INVOKER'S RIGHTS

- A database trigger will always be executed with definer's rights and will execute under the privilege set of the schema that owns the triggering table.
- This is also true for PL/SQL function that is called from a view. In this case, the function will execute under the privilege set of the view's owner.

## PACKAGES

A *package* is a container for related objects. It has specification and body. Each of them is stored separately in data dictionary.

### PACKAGE SYNTAX

Create or replace package *<package\_name>* is

-- package specification includes subprograms signatures, cursors and global or public variables.

End *<package\_name>*;

Create or replace package body *<package\_name>* is

-- package body includes body for all the subprograms declared in the spec, private Variables and cursors.

Begin

-- initialization section

Exception

-- Exception handling section

End *<package\_name>*;

### IMPORTANT POINTS ABOUT PACKAGES

- The first time a packaged subprogram is called or any reference to a packaged variable or type is made, the package is instantiated.
- Each session will have its own copy of packaged variables, ensuring that two sessions executing subprograms in the same package use different memory locations.
- In many cases initialization needs to be run the first time the package is instantiated within a session. This can be done by adding initialization section to the package body after all the objects.
- Packages are stored in the data dictionary and can not be local.

- Packaged subprograms has an advantage over stand alone subprogram.
- When ever any reference to package, the whole package p-code was stored in shared pool of SGA.
- Package may have local subprograms.
- You can include authid clause inside the package spec not in the body.
- The execution section of a package is know as initialization section.
- You can have an exception section at the bottom of a package body.
- Packages subprograms are not invalidated.

### COMPILING PACKAGES

- SQL> Alter package PKG compile;
- SQL> Alter package PKG compile specification;
- SQL> Alter package PKG compile body;

### PACKAGE DEPENDENCIES

- The package body depends on the some objects and the package header.
- The package header does not depend on the package body, which is an advantage of packages.
- We can change the package body with out changing the header.

### PACKAGE RUNTIME STATE

Package runtime state is differ for the following packages.

- Serially reusable packages
- Non serially reusable packages

### SERIALLY REUSABLE PACKAGES

To force the oracle to use serially reusable version then include `PRAGMA SERIALLY_REUSABLE` in both package spec and body, Examine the following package.

```
CREATE OR REPLACE PACKAGE PKG IS
    pragma serially_reusable;
    procedure emp_proc;
```

```
END PKG;
```

```
CREATE OR REPLACE PACKAGE BODY PKG IS
```

```
    pragma serially_reusable;
```

```
    cursor c is select ename from emp;
```

```
PROCEDURE EMP_PROC IS
```

```
    v_ename emp.ename% type;
```

```
    v_flag boolean := true;
```

```
    v_numrows number := 0;
```

```
BEGIN
```

```
    if not c%isopen then
```

```
        open c;
```

```
    end if;
```

```
    while v_flag loop
```

```
        fetch c into v_ename;
```

```
        v_numrows := v_numrows + 1;
```

```
        if v_numrows = 5 then
```

```
            v_flag := false;
```

```
        end if;
```

```
        dbms_output.put_line('Ename = ' || v_ename);
```

```
    end loop;
```

```
END EMP_PROC;
```

```
END PKG;
```

```
SQL> exec pkg.emp_proc
```

```
    Ename = SMITH
```

```
    Ename = ALLEN
```

```
    Ename = WARD
```

```
    Ename = JONES
```

```
    Ename = MARTIN
```

```
SQL> exec pkg.emp_proc
```

```
    Ename = SMITH
```

```
    Ename = ALLEN
```

```
    Ename = WARD
```

```
    Ename = JONES
```

```
    Ename = MARTIN
```

- The above package displays the same output for each execution even though the cursor is not closed.
- Because the serially reusable version resets the state of the cursor each time it was called.

#### NON SERIALLY REUSABLE PACKAGES

This is the default version used by the oracle, examine the following package.

```
CREATE OR REPLACE PACKAGE PKG IS
    procedure emp_proc;
END PKG;

CREATE OR REPLACE PACKAGE BODY IS
    cursor c is select ename from emp;
PROCEDURE EMP_PROC IS
    v_ename emp.ename% type;
    v_flag boolean := true;
    v_numrows number := 0;
BEGIN
    if not c%isopen then
        open c;
    end if;
    while v_flag loop
        fetch c into v_ename;
        v_numrows := v_numrows + 1;
        if v_numrows = 5 then
            v_flag := false;
        end if;
        dbms_output.put_line('Ename = ' || v_ename);
    end loop;
END EMP_PROC;
END PKG;
```

```
SQL> exec pkg.emp_proc
Ename = SMITH
```

```
Ename = ALLEN  
Ename = WARD  
Ename = JONES  
Ename = MARTIN
```

```
SQL> exec pkg.emp_proc  
Ename = BLAKE  
Ename = CLARK  
Ename = SCOTT  
Ename = KING  
Ename = TURNER
```

- The above package displays the different output for each execution even though the cursor is not closed.
- Because the non-serially reusable version remains the state of the cursor over database calls.

#### DEPENDENCIES OF PACKAGE RUNTIME STATE

Dependencies can exist between package state and anonymous blocks.

Examine the following program

Create this package in first session

```
CREATE OR REPLACE PACKAGE PKG IS  
    v number := 5;  
    procedure p;  
END PKG;  
  
CREATE OR REPLACE PACKAGE BODY PKG IS  
    PROCEDURE P IS  
    BEGIN  
        dbms_output.put_line('v = ' || v);  
        v := 10;  
        dbms_output.put_line('v = ' || v);  
    END P;  
END PKG;
```

Connect to second session, run the following code.

```
BEGIN
    pkg.p;
END;
```

The above code will work.

Go back to first session and recreate the package using create.

Then connect to second session and run the following code again.

```
BEGIN
    pkg.p;
END;
```

This above code will not work because of the following.

- The anonymous block depends on pkg. This is compile time dependency.
- There is also a runtime dependency on the packaged variables, since each session has its own copy of packaged variables.
- Thus when pkg is recompiled the runtime dependency is followed, which invalidates the block and raises the oracle error.
- Runtime dependencies exist only on package state. This includes variables and cursors declared in a package.
- If the package had no global variables, the second execution of the anonymous block would have succeeded.

## PURITY LEVELS

In general, calls to subprograms are procedural, they cannot be called from SQL statements. However, if a stand-alone or packaged function meets certain restrictions, it can be called during execution of a SQL statement.

User-defined functions are called the same way as built-in functions but it must meet different restrictions. These restrictions are defined in terms of purity levels.

There are four types of purity levels.

WNDS      --      Writes No Database State

```
RNDS      --      Reads No Database State
WNPS      --      Writes No Package State
RNPS      --      Reads No Package State
```

In addition to the preceding restrictions, a user-defined function must also meet the following requirements to be called from a SQL statement.

- The function has to be stored in the database, either stand-alone or as part of a package.
- The function can take only in parameters.
- The formal parameters must use only database types, not PL/SQL types such as boolean or record.
- The return type of the function must also be a database type.
- The function must not end the current transaction with commit or rollback, or rollback to a savepoint prior to the function execution.
- It also must not issue any alter session or alter system commands.

#### RESTRICT\_REFERENCES

For packaged functions, however, the RESTRICT\_REFERENCES pragma is required to specify the purity level of a given function.

#### Syntax:

```
PRAGMA RESTRICT_REFERENCES(subprogram_name or package_name, WNDS [,WNPS] [,RNDS]
                           [,RNPS]);
```

#### Ex:

```
CREATE OR REPLACE PACKAGE PKG IS
    function fun1 return varchar;
    pragma restrict_references(fun1,wnds);
    function fun2 return varchar;
    pragma restrict_references(fun2,wnds);
END PKG;
```

```
CREATE OR REPLACE PACKAGE BODY PKG IS
    FUNCTION FUN1 return varchar IS
    BEGIN
        update dept set deptno = 11;
```

```
        return 'hello';
    END FUN1;
    FUNCTION FUN2 return varchar IS
    BEGIN
        update dept set dname ='aa';
        return 'hello';
    END FUN2;
END PKG;
```

The above package body will not created, it will give the following erros.

PLS-00452: Subprogram 'FUN1' violates its associated pragma

PLS-00452: Subprogram 'FUN2' violates its associated pragma

```
CREATE OR REPLACE PACKAGE BODY PKG IS
    FUNCTION FUN1 return varchar IS
    BEGIN
        return 'hello';
    END FUN1;
    FUNCTION FUN2 return varchar IS
    BEGIN
        return 'hello';
    END FUN2;
END PKG;
```

Now the package body will be created.

#### DEFAULT

If there is no RESTRICT\_REFERENCES pragma associated with a given packaged function, it will not have any purity level asserted. However, you can change the default purity level for a package. The DEFAULT keyword is used instead of the subprogram name in the pragma.

Ex:

```
CREATE OR REPLACE PACKAGE PKG IS
    pragma restrict_references(default,wnds);
    function fun1 return varchar;
    function fun2 return varchar;
END PKG;
```

```
CREATE OR REPLACE PACKAGE BODY PKG IS
  FUNCTION FUN1 return varchar IS
  BEGIN
    update dept set deptno = 11;
    return 'hello';
  END FUN1;
  FUNCTION FUN2 return varchar IS
  BEGIN
    update dept set dname = 'aa';
    return 'hello';
  END FUN2;
END PKG;
```

The above package body will not be created, it will give the following errors because the pragma will apply to all the functions.

PLS-00452: Subprogram 'FUN1' violates its associated pragma

PLS-00452: Subprogram 'FUN2' violates its associated pragma

```
CREATE OR REPLACE PACKAGE BODY PKG IS
  FUNCTION FUN1 return varchar IS
  BEGIN
    return 'hello';
  END FUN1;
  FUNCTION FUN2 return varchar IS
  BEGIN
    return 'hello';
  END FUN2;
END PKG;
```

Now the package body will be created.

## TRUST

If the TRUST keyword is present, the restrictions listed in the pragma are not enforced. Rather, they are trusted to be true.

Ex:

```
CREATE OR REPLACE PACKAGE PKG IS
  function fun1 return varchar;
```

```
        pragma restrict_references(fun1,wnds,trust);
        function fun2 return varchar;
        pragma restrict_references(fun2,wnds,trust);
END PKG;

CREATE OR REPLACE PACKAGE BODY PKG IS
    FUNCTION FUN1 return varchar IS
    BEGIN
        update dept set deptno = 11;
        return 'hello';
    END FUN1;
    FUNCTION FUN2 return varchar IS
    BEGIN
        update dept set dname = 'aa';
        return 'hello';
    END FUN2;
END PKG;
```

The above package will be created successfully.

#### IMPORTANT POINTS ABOUT RESTRICT\_REFERENCES

- This pragma can appear anywhere in the package specification, after the function declaration.
- It can apply to only one function definition.
- For overload functions, the pragma applies to the nearest definition prior to the pragma.
- This pragma is required only for packages functions not for stand-alone functions.
- The Pragma can be declared only inside the package specification.
- The pragma is checked at compile time, not runtime.
- It is possible to specify without any purity levels when trust or combination of default and trust keywords are present.

#### PINNING IN THE SHARED POOL

The *shared pool* is the portion of the SGS that contains, among other things, the p-code of compiled subprograms as they are run. The first time a stored a store subprogram is called, the p-code is loaded from disk into the shared pool. Once the object is no longer referenced, it is free to be aged out. Objects are aged out of the shared pool using an LRU(Least Recently Used) algorithm.

The DBMS\_SHARED\_POOL package allows you to pin objects in the shared pool. When an object is pinned, it will never be aged out until you request it, no matter how full the pool gets or how often the object is accessed. This can improve performance, as it takes time to reload a package from disk.

DBMS\_SHARED\_POOL has four procedures

- KEEP
- UNKEEP
- SIZES
- ABORTED\_REQUEST\_THRESHOLD

#### KEEP

The DBMS\_SHARED\_POOL.KEEP procedure is used to pin objects in the pool.

#### Syntax:

```
PROCEDURE KEEP(object_name varchar2,flag char default 'P');
```

Here the flag represents different types of flag values for different types of objects.

P	--	Package, function or procedure
Q	--	Sequence
R	--	Trigger
C	--	SQL Cursor
T	--	Object type
JS	--	Java source
JC	--	Java class
JR	--	Java resource
JD	--	Java shared data

#### UNKEEP

UNKEEP is the only way to remove a kept object from the shared pool, without restarting the database. Kept objects are never aged out automatically.

**Syntax:**

```
PROCEDURE UNKEEP(object_name varchar2, flag char default 'P');
```

**SIZES**

SIZES will echo the contents of the shared pool to the screen.

**Syntax:**

```
PROCEDURE SIZES(minsize number);
```

Objects with greater than the *minsize* will be returned. SIZES uses DBMS\_OUTPUT to return the data.

**ABORTED\_REQUEST\_THRESHOLD**

When the database determines that there is not enough memory in the shared pool to satisfy a given request, it will begin aging objects out until there is enough memory. If enough objects are aged out, this can have a performance impact on other database sessions. The ABORTED\_REQUEST\_THRESHOLD can be used to remedy this.

**Syntax:**

```
PROCEDURE ABORTED_REQUEST_THRESHOLD(threshold_size number);
```

Once this procedure is called, oracle will not start aging objects from the pool unless at least *threshold\_size* bytes is needed.

**DATA MODEL FOR SUBPROGRAMS AND PACKAGES**

- USER\_OBJECTS
- USER\_SOURCE
- USER\_ERRORS

## CURSORS

*Cursor* is a pointer to memory location which is called as *context area* which contains the information necessary for processing, including the number of rows processed by the statement, a pointer to the parsed representation of the statement, and the *active set* which is the set of rows returned by the query.

### Cursor contains two parts

- ✓ Header
- ✓ Body

Header includes cursor name, any parameters and the type of data being loaded.

Body includes the select statement.

Ex:

Cursor c(dno in number) return dept%rowtype is select \*from dept;

In the above

**Header** – cursor c(dno in number) return dept%rowtype

**Body** – select \*from dept

## CURSOR TYPES

- Implicit (SQL)
- Explicit
  - ✓ Parameterized cursors
  - ✓ REF cursors

## CURSOR STAGES

- Open
- Fetch
- Close

## CURSOR ATTRIBUTES

- %found
- %notfound
- %rowcount
- %isopen
- %bulk\_rowcount
- %bulk\_exceptions

## CURSOR DECLARATION

Syntax:

Cursor <cursor\_name> is select statement;

Ex:

Cursor c is select \*from dept;

## CURSOR LOOPS

- Simple loop
- While loop
- For loop

## SIMPLE LOOP

### Syntax:

```
Loop
  Fetch <cursor_name> into <record_variable>;
  Exit when <cursor_name> % notfound;
  <statements>;
End loop;
```

### Ex:

```
DECLARE
  cursor c is select * from student;
  v_stud student%rowtype;
BEGIN
  open c;
  loop
    fetch c into v_stud;
    exit when c%notfound;
    dbms_output.put_line('Name = ' || v_stud.name);
  end loop;
  close c;
END;
```

### Output:

```
Name = saketh
Name = srinu
Name = satish
Name = sudha
```

## WHILE LOOP

### Syntax:

```
While <cursor_name> % found loop
  Fetch <cursor_name> into <record_variable>;
  <statements>;
End loop;
```

Ex:

```
DECLARE
  cursor c is select * from student;
  v_stud student%rowtype;
BEGIN
  open c;
  fetch c into v_stud;
  while c%found loop
    fetch c into v_stud;
    dbms_output.put_line('Name = ' || v_stud.name);
  end loop;
  close c;
END;
```

Output:

```
Name = saketh
Name = srinu
Name = satish
Name = sudha
```

FOR LOOP

Syntax:

```
for <record_variable> in <cursor_name> loop
  <statements>;
End loop;
```

Ex:

```
DECLARE
  cursor c is select * from student;
BEGIN
  for v_stud in c loop
    dbms_output.put_line('Name = ' || v_stud.name);
  end loop;
END;
```

Output:

```
Name = saketh
```

Name = srinu  
Name = satish  
Name = sudha

## PARAMETARIZED CURSORS

- This was used when you are going to use the cursor in more than one place with different values for the same where clause.
- Cursor parameters must be *in* mode.
- Cursor parameters may have default values.
- The scope of cursor parameter is within the select statement.

Ex:

```
DECLARE
  cursor c(dno in number) is select * from dept where deptno = dno;
  v_dept dept%rowtype;
BEGIN
  open c(20);
  loop
    fetch c into v_dept;
    exit when c%notfound;
    dbms_output.put_line('Dname = ' || v_dept.dname || ' Loc = ' || v_dept.loc);
  end loop;
  close c;
END;
```

Output:

```
Dname = RESEARCH Loc = DALLAS
```

## PACKAGED CURSORS WITH HEADER IN SPEC AND BODY IN PACKAGE BODY

- cursors declared in packages will not close automatically.
- In packaged cursors you can modify the select statement without making any changes to the cursor header in the package specification.
- Packaged cursors with must be defined in the package body itself, and then use it as global for the package.

- You can not define the packaged cursor in any subprograms.
- Cursor declaration in package with out body needs the return clause.

Ex:

```
CREATE OR REPLACE PACKAGE PKG IS
    cursor c return dept%rowtype is select * from dept;
    procedure proc is
END PKG;
```

```
CREATE OR REPLACE PAKCAGE BODY PKG IS
    cursor c return dept%rowtype is select * from dept;
PROCEDURE PROC IS
BEGIN
    for v in c loop
        dbms_output.put_line('Deptno = ' || v.deptno || ' Dname = ' || v.dname || '
                               Loc = ' || v.loc);
    end loop;
END PROC;
END PKG;
```

Output:

```
SQL> exec pkg.proc
    Deptno = 10 Dname = ACCOUNTING Loc = NEW YORK
    Deptno = 20 Dname = RESEARCH Loc = DALLAS
    Deptno = 30 Dname = SALES Loc = CHICAGO
    Deptno = 40 Dname = OPERATIONS Loc = BOSTON
CREATE OR REPLACE PAKCAGE BODY PKG IS
    cursor c return dept%rowtype is select * from dept where deptno > 20;
PROCEDURE PROC IS
BEGIN
    for v in c loop
        dbms_output.put_line('Deptno = ' || v.deptno || ' Dname = ' || v.dname || '
                               Loc = ' || v.loc);
    end loop;
END PROC;
END PKG;
```

Output:

```
SQL> exec pkg.proc
    Deptno = 30 Dname = SALES Loc = CHICAGO
    Deptno = 40 Dname = OPERATIONS Loc = BOSTON
```

## REF CURSORS AND CURSOR VARIABLES

- This is unconstrained cursor which will return different types depends upon the user input.
- Ref cursors can not be closed implicitly.
- Ref cursor with return type is called *strong cursor*.
- Ref cursor with out return type is called *weak cursor*.
- You can declare ref cursor type in package spec as well as body.
- You can declare ref cursor types in local subprograms or anonymous blocks.
- Cursor variables can be assigned from one to another.
- You can declare a cursor variable in one scope and assign another cursor variable with different scope, then you can use the cursor variable even though the assigned cursor variable goes out of scope.
- Cursor variables can be passed as a parameters to the subprograms.
- Cursor variables modes are in or out or in out.
- Cursor variables can not be declared in package spec and package body (excluding subprograms).
- You can not user remote procedure calls to pass cursor variables from one server to another.
- Cursor variables can not use for update clause.
- You can not assign nulls to cursor variables.
- You can not compare cursor variables for equality, inequality and nullity.

Ex:

```
CREATE OR REPLACE PROCEDURE REF_CURSOR(TABLE_NAME IN VARCHAR) IS
  type t is ref cursor;
  c t;
  v_dept dept%rowtype;
  type r is record(ename emp.ename% type,job emp.job% type,sal emp.sal% type);
  v_emp r;
  v_stud student.name% type;
BEGIN
  if table_name = 'DEPT' then
    open c for select * from dept;
  elsif table_name = 'EMP' then
    open c for select ename,job,sal from emp;
```

```
elseif table_name = 'STUDENT' then
  open c for select name from student;
end if;
loop
  if table_name = 'DEPT' then
    fetch c into v_dept;
    exit when c%notfound;
    dbms_output.put_line('Deptno = ' || v_dept.deptno || ' Dname = ' ||
v_dept.dname || ' Loc = ' || v_dept.loc);
  elseif table_name = 'EMP' then
    fetch c into v_emp;
    exit when c%notfound;
    dbms_output.put_line('Ename = ' || v_emp.ename || ' Job = ' || v_emp.job || ' Sal
= ' || v_emp.sal);
  elseif table_name = 'STUDENT' then
    fetch c into v_stud;
    exit when c%notfound;
    dbms_output.put_line('Name = ' || v_stud);
  end if;
end loop;
close c;
END;
```

**Output:**

```
SQL> exec ref_cursor('DEPT')
```

```
Deptno = 10 Dname = ACCOUNTING Loc = NEW YORK
Deptno = 20 Dname = RESEARCH LOC = DALLAS
Deptno = 30 Dname = SALES LOC = CHICAGO
Deptno = 40 Dname = OPERATIONS LOC = BOSTON
```

```
SQL> exec ref_cursor('EMP')
```

```
Ename = SMITH Job = CLERK Sal = 800
Ename = ALLEN Job = SALESMAN Sal = 1600
Ename = WARD Job = SALESMAN Sal = 1250
```

Ename = JONES Job = MANAGER Sal = 2975  
Ename = MARTIN Job = SALESMAN Sal = 1250  
Ename = BLAKE Job = MANAGER Sal = 2850  
Ename = CLARK Job = MANAGER Sal = 2450  
Ename = SCOTT Job = ANALYST Sal = 3000  
Ename = KING Job = PRESIDENT Sal = 5000  
Ename = TURNER Job = SALESMAN Sal = 1500  
Ename = ADAMS Job = CLERK Sal = 1100  
Ename = JAMES Job = CLERK Sal = 950  
Ename = FORD Job = ANALYST Sal = 3000  
Ename = MILLER Job = CLERK Sal = 1300

SQL> exec ref\_cursor('STUDENT')

Name = saketh  
Name = srinu  
Name = satish  
Name = sudha

## CURSOR EXPRESSIONS

- You can use cursor expressions in explicit cursors.
- You can use cursor expressions in dynamic SQL.
- You can use cursor expressions in REF cursor declarations and variables.
- You can not use cursor expressions in implicit cursors.
- Oracle opens the nested cursor defined by a cursor expression implicitly as soon as it fetches the data containing the cursor expression from the parent or outer cursor.
- Nested cursor closes if you close explicitly.
- Nested cursor closes whenever the outer or parent cursor is executed again or closed or canceled.
- Nested cursor closes whenever an exception is raised while fetching data from a parent cursor.
- Cursor expressions can not be used when declaring a view.

- Cursor expressions can be used as an argument to table function.
- You can not perform bind and execute operations on cursor expressions when using the cursor expressions in dynamic SQL.

#### USING NESTED CURSORS OR CURSOR EXPRESSIONS

Ex:

```
DECLARE
  cursor c is select ename,cursor(select dname from dept d where e.empno = d.deptno)
  from emp e;
  type t is ref cursor;
  c1 t;
  c2 t;
  v1 emp.ename% type;
  v2 dept.dname% type;
BEGIN
  open c;
  loop
    fetch c1 into v1;
    exit when c1%notfound;
    fetch c2 into v2;
    exit when c2%notfound;
    dbms_output.put_line('Ename = ' || v1 || ' Dname = ' || v2);
  end loop;
end loop;
close c;
END;
```

#### CURSOR CLAUSES

- Return
- For update
- Where current of
- Bulk collect

#### RETURN

```
Cursor c return dept%rowtype is select *from dept;
```

Or

```
Cursor c1 is select *from dept;
```

```
Cursor c return c1%rowtype is select *from dept;
```

Or

```
Type t is record(deptno dept.deptno% type, dname dept.dname% type);
```

```
Cursor c return t is select deptno, dname from dept;
```

## FOR UPDATE AND WHERE CURRENT OF

Normally, a select operation will not take any locks on the rows being accessed. This will allow other sessions connected to the database to change the data being selected. The result set is still consistent. At open time, when the active set is determined, oracle takes a snapshot of the table. Any changes that have been committed prior to this point are reflected in the active set. Any changes made after this point, even if they are committed, are not reflected unless the cursor is reopened, which will evaluate the active set again.

However, if the FOR UPDATE clause is present, exclusive row locks are taken on the rows in the active set before the open returns. These locks prevent other sessions from changing the rows in the active set until the transaction is committed or rolled back. If another session already has locks on the rows in the active set, then SELECT ... FOR UPDATE operation will wait for these locks to be released by the other session. There is no time-out for this waiting period. The SELECT...FOR UPDATE will hang until the other session releases the lock. To handle this situation, the NOWAIT clause is available.

### Syntax:

```
Select ...from ... for update of column_name [wait n];
```

If the cursor is declared with the FOR UPDATE clause, the WHERE CURRENT OF clause can be used in an update or delete statement.

### Syntax:

```
Where current of cursor;
```

### Ex:

```
DECLARE
```

```
        cursor c is select * from dept for update of dname;
BEGIN
    for v in c loop
        update dept set dname = 'aa' where current of c;
        commit;
    end loop;
END;
```

## BULK COLLECT

- This is used for array fetches
- With this you can retrieve multiple rows of data with a single roundtrip.
- This reduces the number of context switches between the pl/sql and sql engines.
- Reduces the overhead of retrieving data.
- You can use bulk collect in both dynamic and static sql.
- You can use bulk collect in select, fetch into and returning into clauses.
- SQL engine automatically initializes and extends the collections you reference in the bulk collect clause.
- Bulk collect operation empties the collection referenced in the into clause before executing the query.
- You can use the limit clause of bulk collect to restrict the no of rows retrieved.
- You can fetch into multiple collections with one column each.
- Using the returning clause we can return data to the another collection.

## BULK COLLECT IN FETCH

Ex:

```
DECLARE
    Type t is table of dept%rowtype;
    nt t;
    Cursor c is select * from dept;
BEGIN
    Open c;
    Fetch c bulk collect into nt;
    Close c;
    For i in nt.first..nt.last loop
```

```
        dbms_output.put_line('Dname = ' || nt(i).dname || ' Loc = ' || nt(i).loc);
    end loop;
END;
```

**Output:**

```
Dname = ACCOUNTING Loc = NEW YORK
Dname = RESEARCH LOC = DALLAS
Dname = SALES Loc = CHICAGO
Dname = OPERATIONS LOC = BOSTON
```

**BULK COLLECT IN SELECT**

**Ex:**

```
DECLARE
    Type t is table of dept%rowtype;
    Nt t;
BEGIN
    Select * bulk collect into nt from dept;
    for i in nt.first..nt.last loop
        dbms_output.put_line('Dname = ' || nt(i).dname || ' Loc = ' || nt(i).loc);
    end loop;
END;
```

**Output:**

```
Dname = ACCOUNTING Loc = NEW YORK
Dname = RESEARCH LOC = DALLAS
Dname = SALES Loc = CHICAGO
Dname = OPERATIONS LOC = BOSTON
```

**LIMIT IN BULK COLLECT**

**Ex:**

```
DECLARE
    Type t is table of dept%rowtype;
    nt t;
    Cursor c is select *from dept;
BEGIN
```

```
Open c;  
Fetch c bulk collect into nt;  
Close c;  
For i in nt.first..nt.last loop  
    dbms_output.put_line('Dname = ' || nt(i).dname || ' Loc = ' || nt(i).loc);  
end loop;  
END;
```

**Output:**

```
Dname = ACCOUNTING Loc = NEW YORK  
Dname = RESEARCH LOC = DALLAS
```

**MULTIPLE FETCHES IN INTO CLAUSE**

**Ex1:**

```
DECLARE  
    Type t is table of dept.dname% type;  
    nt t;  
    Type t1 is table of dept.loc% type;  
    nt1 t;  
    Cursor c is select dname,loc from dept;  
BEGIN  
    Open c;  
    Fetch c bulk collect into nt,nt1;  
    Close c;  
    For i in nt.first..nt.last loop  
        dbms_output.put_line('Dname = ' || nt(i));  
    end loop;  
    For i in nt1.first..nt1.last loop  
        dbms_output.put_line('Loc = ' || nt1(i));  
    end loop;  
END;
```

**Output:**

```
Dname = ACCOUNTING  
Dname = RESEARCH  
Dname = SALES
```

```
Dname = OPERATIONS  
Loc = NEW YORK  
Loc = DALLAS  
Loc = CHICAGO  
Loc = BOSTON
```

Ex2:

```
DECLARE  
  type t is table of dept.dname% type;  
  type t1 is table of dept.loc% type;  
  nt t;  
  nt1 t1;  
BEGIN  
  Select dname,loc bulk collect into nt,nt1 from dept;  
  for i in nt.first..nt.last loop  
    dbms_output.put_line('Dname = ' || nt(i));  
  end loop;  
  for i in nt1.first..nt1.last loop  
    dbms_output.put_line('Loc = ' || nt1(i));  
  end loop;  
END;
```

Output:

```
Dname = ACCOUNTING  
Dname = RESEARCH  
Dname = SALES  
Dname = OPERATIONS  
Loc = NEW YORK  
Loc = DALLAS  
Loc = CHICAGO  
Loc = BOSTON
```

RETURNING CLAUSE IN BULK COLLECT

```
declare  
type t is table of number(2);
```

```
nt t := t(1,2,3,4);
type t1 is table of varchar(2);
nt1 t1;
type t2 is table of student%rowtype;
nt2 t2;
begin
select name bulk collect into nt1 from student;
forall v in nt1.first..nt1.last
update student set no = nt(v) where name = nt1(v) returning no,name,marks bulk collect
into nt2;
for v in nt2.first..nt2.last loop
dbms_output.put_line('Marks = ' || nt2(v));
end loop;
end;
```

#### POINTS TO REMEMBER

- Cursor name can be up to 30 characters in length.
- Cursors declared in anonymous blocks or subprograms closes automatically when that block terminates execution.
- %bulk\_rowcount and %bulk\_exceptions can be used only with forall construct.
- Cursor declarations may have expressions with column aliases.
- These expressions are called virtual columns or calculated columns.

## SQL IN PL/SQL

The only statements allowed directly in pl/sql are DML and TCL.

### BINDING

Binding a variable is the process of identifying the storage location associated with an identifier in the program.

#### Types of binding

- Early binding
- Late binding
- Binding during the compiled phase is early binding.
- Binding during the runtime phase is late binding.
- In early binding compile phase will take longer because of binding work but the execution is faster.
- In late binding it will shorten the compile phase but lengthens the execution time.
- PL/sql by default uses early binding.
- Binding also involves checking the database for permissions to access the object Referenced.

### DYNAMIC SQL

If you use DDL in pl/sql it validates the permissions and existence if requires during compile time which makes invalid.

We can avoid this by using Dynamic SQL.

Dynamic SQL allows you to create a SQL statement dynamically at runtime.

Two techniques are available for Dynamic SQL.

- Native Dynamic SQL
- DBMS\_SQL package

### USING NATIVE DYNAMIC SQL

#### Using execute immediate

Begin

```
Execute immediate 'create table student(no number(2),name varchar(10))';
```

or

```
Execute immediate ('create table student(no number(2),name varchar(10))');
```

End;

#### Using execute immediate with pl/sql variables

declare

```
v varchar(100);
```

begin

```
v := 'create table student(no number(2),name varchar(10))';
```

```
execute immediate v;
```

end;

#### Using execute immediate with bind variables and using clause

declare

```
v varchar(100);
```

begin

```
v := 'insert into student values(:v1,;v2,;v3)';
```

```
execute immediate v using 6,'f',600;
```

end;

#### Executing queries with open for and using clause

create or replace procedure p(smarks in number) is

```
s varchar(100) := 'select *from student where marks > :m';
```

```
type t is ref cursor;
```

```
c t;
```

```
v student%rowtype;
```

begin

```
open c for s using smarks;
```

```
loop
fetch c into v;
exit when c%notfound;
dbms_output.put_line('Student Marks = ' || v.marks);
end loop;
close c;
end;
```

### Queries with execute immediate

```
declare
d_name dept.dname% type;
lc dept.loc% type;
v varchar(100);
begin
v := 'select dname from dept where deptno = 10';
execute immediate v into d_name;
dbms_output.put_line('Dname = ' || d_name);
v := 'select loc from dept where dname = :dn';
execute immediate v into lc using d_name;
dbms_output.put_line('Loc = ' || lc);
end;
```

### Bind variables

```
Declare
V number := 500;
Begin
Update student set marks = v where;      -- here v is bind variable
End;
```

### Variable Names

```
Declare
Marks number(3) := 100;
Begin
Delete student where marks = marks;      -- this will delete all the rows in the student table
End;
```

This can be avoided by using the labeled blocks.

```
<<my_block>>
```

```
Declare
```

```
Marks number(3) := 100;
```

```
Begin
```

```
Delete student where marks = my_block.marks; -- delete rows which has a marks of 100
```

```
End;
```

### Getting data into pl/sql variables

```
Declare
```

```
V1 number;
```

```
V2 varchar(2);
```

```
Begin
```

```
Select no,name into v1,v2 from student where marks = 100;
```

```
End;
```

### DML and Records

```
create or replace procedure p(srow in student%rowtype) is
```

```
begin
```

```
insert into student values srow;
```

```
end p;
```

```
declare
```

```
s student%rowtype;
```

```
begin
```

```
s.no := 11;
```

```
s.name := 'aa';
```

```
s.marks := 100;
```

```
p(s);
```

```
end;
```

### Record based inserts

```
declare
```

```
srow student%rowtype;
```

```
begin
srow.no := 7;
srow.name := 'cc';
srow.marks := 500;
insert into student values srow;
end;
```

### Record based updates

```
declare
srow student%rowtype;
begin
srow.no := 6;
srow.name := 'cc';
srow.marks := 500;
update student set row=srow where no = srow.no;
end;
```

### Using records with returning clause

```
declare
srow student%rowtype;
sreturn student%rowtype;
begin
srow.no := 8;
srow.name := 'dd';
srow.marks := 500;
insert into student values srow returning no,name,marks into sreturn;
dbms_output.put_line('No = ' || sreturn.no);
dbms_output.put_line('No = ' || sreturn.name);
dbms_output.put_line('No = ' || sreturn.marks);
end;
```

### Forall with non-sequential arrays

```
declare
type t is table of student.no% type index by binary_integer;
ibt t;
```

```
begin
ibt(1) := 1;
ibt(10) := 2;
forall i in ibt.first..ibt.last
update student set marks = 900 where no = ibt(i);
end;
```

The above program will give error like 'element at index [2] does not exists.

Usage of indices of to avoid the above error

```
declare
type t is table of student.no% type index by binary_integer;
ibt t;
type t1 is table of boolean index by binary_integer;
ibt1 t1;
begin
ibt(1) := 1;
ibt(10) := 2;
ibt(100) := 3;
ibt1(1) := true;
ibt1(10) := true;
ibt1(100) := true;
forall i in indices of ibt1
update student set marks = 900 where no = ibt(i);
end;
```

```
declare
type t is table of student.no% type index by binary_integer;
ibt t;
type t1 is table of pls_integer index by binary_integer;
ibt1 t1;
begin
ibt(1) := 1;
ibt(10) := 2;
```

```
ibt(100) := 3;
ibt1(11) := 1;
ibt1(15) := 10;
ibt1(18) := 100;
forall i in values of ibt1
update student set marks = 567 where no = ibt(i);
end;
```

### Bulk Binds

- Passing the entire pl/sql table to the SQL engine in one step is known as bulk bind.
- Bulk binds are done using the forall statement.
- If there is an error processing one of the rows in bulk DML operation, only that row is rolled back.

### Returning clause

- This will be used only with DML statements to return data into pl/sql variables.
- This will be useful in situations like , when performing insert or update or delete if you want to know the data of the table which has been effected by the DML.
- With out going for another SELECT using RETURNING clause we will get the data which will avoid a call to RDBMS kernel.

## COLLECTIONS

Collections are also composite types, in that they allow you to treat several variables as a unit. A collection combines variables of the same type.

### TYPES

- Varrays

- Nested tables
- Index - by tables

## VARRAYS

A varray is datatype very similar to an array. A varray has a fixed limit on its size, specified as part of the declaration. Elements are inserted into varray starting at index 1, up to maximum length declared in the varray type. The maximum size of the varray is 2 giga bytes.

### Syntax:

Type `<type_name>` is varray | varying array (`<limit>`) of `<element_type>`;

### Ex1:

```
DECLARE
    type t is varray(10) of varchar(2);
    va t := t('a','b','c','d');
    flag boolean;
BEGIN
    dbms_output.put_line('Limit = ' || va.limit);
    dbms_output.put_line('Count = ' || va.count);
    dbms_output.put_line('First Index = ' || va.first);
    dbms_output.put_line('Last Index = ' || va.last);
    dbms_output.put_line('Next Index = ' || va.next(2));
    dbms_output.put_line('Previous Index = ' || va.prior(3));
    dbms_output.put_line('VARRAY ELEMENTS');
    for i in va.first..va.last loop
        dbms_output.put_line('va[' || i || '] = ' || va(i));
    end loop;
    flag := va.exists(3);
    if flag = true then
        dbms_output.put_line('Index 3 exists with an element ' || va(3));
    else
        dbms_output.put_line('Index 3 does not exists');
    end if;
    va.extend;
    dbms_output.put_line('After extend of one index, Count = ' || va.count);
    flag := va.exists(5);
```

```
if flag = true then
    dbms_output.put_line('Index 5 exists with an element ' || va(5));
else
    dbms_output.put_line('Index 5 does not exists');
end if;
flag := va.exists(6);
if flag = true then
    dbms_output.put_line('Index 6 exists with an element ' || va(6));
else
    dbms_output.put_line('Index 6 does not exists');
end if;
va.extend(2);
dbms_output.put_line('After extend of two indexes, Count = ' || va.count);
dbms_output.put_line('VARRAY ELEMENTS');
for i in va.first..va.last loop
    dbms_output.put_line('va[' || i || '] = ' || va(i));
end loop;
va(5) := 'e';
va(6) := 'f';
va(7) := 'g';
dbms_output.put_line('AFTER ASSINGNING VALUES TO EXTENDED ELEMENTS,
                      VARRAY ELEMENTS');
for i in va.first..va.last loop
    dbms_output.put_line('va[' || i || '] = ' || va(i));
end loop;
va.extend(3,2);
dbms_output.put_line('After extend of three indexes, Count = ' || va.count);
dbms_output.put_line('VARRAY ELEMENTS');
for i in va.first..va.last loop
    dbms_output.put_line('va[' || i || '] = ' || va(i));
end loop;
va.trim;
dbms_output.put_line('After trim of one index, Count = ' || va.count);
va.trim(3);
dbms_output.put_line('After trim of three indexs, Count = ' || va.count);
```

```
dbms_output.put_line('AFTER TRIM, VARRAY ELEMENTS');
for i in va.first..va.last loop
    dbms_output.put_line('va[ ' || i || ' ] = ' || va(i));
end loop;
va.delete;
dbms_output.put_line('After delete of entire varray, Count = ' || va.count);
END;
```

**Output:**

```
Limit = 10
Count = 4
First Index = 1
Last Index = 4
Next Index = 3
Previous Index = 2
VARRAY ELEMENTS
va[1] = a
va[2] = b
va[3] = c
va[4] = d
Index 3 exists with an element c
After extend of one index, Count = 5
Index 5 exists with an element
Index 6 does not exists
After extend of two indexes, Count = 7
VARRAY ELEMENTS
va[1] = a
va[2] = b
va[3] = c
va[4] = d
va[5] =
va[6] =
va[7] =
AFTER ASSINGNING VALUES TO EXTENDED ELEMENTS, VARRAY ELEMENTS
va[1] = a
va[2] = b
```

va[3] = c

va[4] = d

va[5] = e

va[6] = f

va[7] = g

After extend of three indexes, Count = 10

VARRAY ELEMENTS

va[1] = a

va[2] = b

va[3] = c

va[4] = d

va[5] = e

va[6] = f

va[7] = g

va[8] = b

va[9] = b

va[10] = b

After trim of one index, Count = 9

After trim of three indexes, Count = 6

AFTER TRIM, VARRAY ELEMENTS

va[1] = a

va[2] = b

va[3] = c

va[4] = d

va[5] = e

va[6] = f

After delete of entire varray, Count = 0

Ex2:

DECLARE

type t is varray(4) of student%rowtype;

va t := t(null,null,null,null);

BEGIN

for i in 1..va.count loop

select \* into va(i) from student where sno = i;

dbms\_output.put\_line('Sno = ' || va(i).sno || ' Sname = ' || va(i).sname);

end loop;

```
END;
```

**Output:**

```
Sno = 1 Sname = saketh  
Sno = 2 Sname = srinu  
Sno = 3 Sname = divya  
Sno = 4 Sname = manogni
```

**Ex3:**

```
DECLARE  
  type t is varray(4) of student.smarks% type;  
  va t := t(null,null,null,null);  
BEGIN  
  for i in 1..va.count loop  
    select smarks into va(i) from student where sno = i;  
    dbms_output.put_line('Smarks = ' || va(i));  
  end loop;  
END;
```

**Output:**

```
Smarks = 100  
Smarks = 200  
Smarks = 300  
Smarks = 400
```

**Ex4:**

```
DECLARE  
  type r is record(c1 student.sname% type,c2 student.smarks% type);  
  type t is varray(4) of r;  
  va t := t(null,null,null,null);  
BEGIN  
  for i in 1..va.count loop  
    select sname,smarks into va(i) from student where sno = i;  
    dbms_output.put_line('Sname = ' || va(i).c1 || ' Smarks = ' || va(i).c2);  
  end loop;  
END;
```

Output:

```
Sname = saketh Smarks = 100  
Sname = srinu Smarks = 200  
Sname = divya Smarks = 300  
Sname = manogni Smarks = 400
```

Ex5:

```
DECLARE  
  type t is varray(1) of addr;  
  va t := t(null);  
  cursor c is select * from employ;  
  i number := 1;  
BEGIN  
  for v in c loop  
    select address into va(i) from employ where ename = v.ename;  
    dbms_output.put_line('Hno = ' || va(i).hno || ' City = ' || va(i).city);  
  end loop;  
END;
```

Output:

```
Hno = 11 City = hyd  
Hno = 22 City = bang  
Hno = 33 City = kochi
```

Ex6:

```
DECLARE  
  type t is varray(5) of varchar(2);  
  va1 t;  
  va2 t := t();  
BEGIN  
  if va1 is null then  
    dbms_output.put_line('va1 is null');  
  else
```

```
        dbms_output.put_line('va1 is not null');
    end if;
    if va2 is null then
        dbms_output.put_line('va2 is null');
    else
        dbms_output.put_line('va2 is not null');
    end if;
END;
```

**Output:**

```
va1 is null
va2 is not null
```

**NESTED TABLES**

A nested table is thought of a database table which has no limit on its size. Elements are inserted into nested table starting at index 1. The maximum size of the varray is 2 giga bytes.

**Syntax:**

```
Type <type_name> is table of <table_type>;
```

**Ex1:**

```
DECLARE
    type t is table of varchar(2);
    nt t := t('a','b','c','d');
    flag boolean;
BEGIN
    if nt.limit is null then
        dbms_output.put_line('No limit to Nested Tables');
    else
        dbms_output.put_line('Limit = ' || nt.limit);
    end if;
    dbms_output.put_line('Count = ' || nt.count);
    dbms_output.put_line('First Index = ' || nt.first);
    dbms_output.put_line('Last Index = ' || nt.last);
    dbms_output.put_line('Next Index = ' || nt.next(2));
```

```
dbms_output.put_line('Previous Index = ' || nt.prior(3));
dbms_output.put_line('NESTED TABLE ELEMENTS');
for i in 1..nt.count loop
    dbms_output.put_line('nt[' || i || '] = ' || nt(i));
end loop;
flag := nt.exists(3);
if flag = true then
    dbms_output.put_line('Index 3 exists with an element ' || nt(3));
else
    dbms_output.put_line('Index 3 does not exists');
end if;
nt.extend;
dbms_output.put_line('After extend of one index, Count = ' || nt.count);
flag := nt.exists(5);
if flag = true then
    dbms_output.put_line('Index 5 exists with an element ' || nt(5));
else
    dbms_output.put_line('Index 5 does not exists');
end if;
flag := nt.exists(6);
if flag = true then
    dbms_output.put_line('Index 6 exists with an element ' || nt(6));
else
    dbms_output.put_line('Index 6 does not exists');
end if;
nt.extend(2);
dbms_output.put_line('After extend of two indexes, Count = ' || nt.count);
dbms_output.put_line('NESTED TABLE ELEMENTS');
for i in 1..nt.count loop
    dbms_output.put_line('nt[' || i || '] = ' || nt(i));
end loop;
nt(5) := 'e';
nt(6) := 'f';
nt(7) := 'g';
dbms_output.put_line('AFTER ASSINGNING VALUES TO EXTENDED ELEMENTS, NESTED TABLE
ELEMENTS');
```

```
for i in 1..nt.count loop
    dbms_output.put_line('nt[' || i || '] = ' || nt(i));
end loop;
nt.extend(5,2);
dbms_output.put_line('After extend of five indexes, Count = ' || nt.count);
dbms_output.put_line('NESTED TABLE ELEMENTS');
for i in 1..nt.count loop
    dbms_output.put_line('nt[' || i || '] = ' || nt(i));
end loop;
nt.trim;
dbms_output.put_line('After trim of one index, Count = ' || nt.count);
nt.trim(3);
dbms_output.put_line('After trim of three indexes, Count = ' || nt.count);
dbms_output.put_line('AFTER TRIM, NESTED TABLE ELEMENTS');
for i in 1..nt.count loop
    dbms_output.put_line('nt[' || i || '] = ' || nt(i));
end loop;
nt.delete(1);
dbms_output.put_line('After delete of first index, Count = ' || nt.count);
dbms_output.put_line('NESTED TABLE ELEMENTS');
for i in 2..nt.count+1 loop
    dbms_output.put_line('nt[' || i || '] = ' || nt(i));
end loop;
nt.delete(4);
dbms_output.put_line('After delete of fourth index, Count = ' || nt.count);
dbms_output.put_line('NESTED TABLE ELEMENTS');
for i in 2..3 loop
    dbms_output.put_line('nt[' || i || '] = ' || nt(i));
end loop;
for i in 5..nt.count+2 loop
    dbms_output.put_line('nt[' || i || '] = ' || nt(i));
end loop;
nt.delete;
dbms_output.put_line('After delete of entire nested table, Count = ' || nt.count);
END;
```

Output:

No limit to Nested Tables

Count = 4

First Index = 1

Last Index = 4

Next Index = 3

Previous Index = 2

NESTED TABLE ELEMENTS

nt[1] = a

nt[2] = b

nt[3] = c

nt[4] = d

Index 3 exists with an element c

After extend of one index, Count = 5

Index 5 exists with an element

Index 6 does not exists

After extend of two indexes, Count = 7

NESTED TABLE ELEMENTS

nt[1] = a

nt[2] = b

nt[3] = c

nt[4] = d

nt[5] =

nt[6] =

nt[7] =

AFTER ASSINGNING VALUES TO EXTENDED ELEMENTS, NESTED TABLE ELEMENTS

nt[1] = a

nt[2] = b

nt[3] = c

nt[4] = d

nt[5] = e

nt[6] = f

nt[7] = g

After extend of five indexes, Count = 12

NESTED TABLE ELEMENTS

nt[1] = a  
nt[2] = b  
nt[3] = c  
nt[4] = d  
nt[5] = e  
nt[6] = f  
nt[7] = g  
nt[8] = b  
nt[9] = b  
nt[10] = b  
nt[11] = b  
nt[12] = b

After trim of one index, Count = 11

After trim of three indexes, Count = 8

AFTER TRIM, NESTED TABLE ELEMENTS

nt[1] = a  
nt[2] = b  
nt[3] = c  
nt[4] = d  
nt[5] = e  
nt[6] = f  
nt[7] = g  
nt[8] = b

After delete of first index, Count = 7

NESTED TABLE ELEMENTS

nt[2] = b  
nt[3] = c  
nt[4] = d  
nt[5] = e  
nt[6] = f  
nt[7] = g  
nt[8] = b

After delete of fourth index, Count = 6

NESTED TABLE ELEMENTS

nt[2] = b

```
nt[3] = c
nt[5] = e
nt[6] = f
nt[7] = g
nt[8] = b
After delete of entire nested table, Count = 0
```

Ex2:

```
DECLARE
  type t is table of student%rowtype;
  nt t := t(null,null,null,null);
BEGIN
  for i in 1..nt.count loop
    select * into nt(i) from student where sno = i;
    dbms_output.put_line('Sno = ' || nt(i).sno || ' Sname = ' || nt(i).sname);
  end loop;
END;
```

Output:

```
Sno = 1 Sname = saketh
Sno = 2 Sname = srinu
Sno = 3 Sname = divya
Sno = 4 Sname = manogni
```

Ex3:

```
DECLARE
  type t is table of student.smarks% type;
  nt t := t(null,null,null,null);
BEGIN
  for i in 1..nt.count loop
    select smarks into nt(i) from student where sno = i;
    dbms_output.put_line('Smarks = ' || nt(i));
  end loop;
END;
```

Output:

```
Smarks = 100
```

```
Smarks = 200  
Smarks = 300  
Smarks = 400
```

**Ex4:**

```
DECLARE  
  type r is record(c1 student.sname%type,c2 student.smarks%type);  
  type t is table of r;  
  nt t := t(null,null,null,null);  
BEGIN  
  for i in 1..nt.count loop  
    select sname,smarks into nt(i) from student where sno = i;  
    dbms_output.put_line('Sname = ' || nt(i).c1 || ' Smarks = ' || nt(i).c2);  
  end loop;  
END;
```

**Output:**

```
Sname = saketh Smarks = 100  
Sname = srinu Smarks = 200  
Sname = divya Smarks = 300  
Sname = manogni Smarks = 400
```

**Ex5:**

```
DECLARE  
  type t is table of addr;  
  nt t := t(null);  
  cursor c is select * from employ;  
  i number := 1;  
BEGIN  
  for v in c loop  
    select address into nt(i) from employ where ename = v.ename;  
    dbms_output.put_line('Hno = ' || nt(i).hno || ' City = ' || nt(i).city);  
  end loop;  
END;
```

**Output:**

```
Hno = 11 City = hyd  
Hno = 22 City = bang
```

Hno = 33 City = Kochi

Ex6:

```
DECLARE
  type t is varray(5) of varchar(2);
  nt1 t;
  nt2 t := t();
BEGIN
  if nt1 is null then
    dbms_output.put_line('nt1 is null');
  else
    dbms_output.put_line('nt1 is not null');
  end if;
  if nt2 is null then
    dbms_output.put_line('nt2 is null');
  else
    dbms_output.put_line('nt2 is not null');
  end if;
END;
```

Output:

```
nt1 is null
nt2 is not null
```

## INDEX-BY TABLES

An index-by table has no limit on its size. Elements are inserted into index-by table whose index may start non-sequentially including negative integers.

Syntax:

```
Type <type_name> is table of <table_type> index by binary_integer;
```

Ex:

```
DECLARE
```

```
type t is table of varchar(2) index by binary_integer;
ibt t;
flag boolean;
BEGIN
  ibt(1) := 'a';
  ibt(-20) := 'b';
  ibt(30) := 'c';
  ibt(100) := 'd';
  if ibt.limit is null then
    dbms_output.put_line('No limit to Index by Tables');
  else
    dbms_output.put_line('Limit = ' || ibt.limit);
  end if;
  dbms_output.put_line('Count = ' || ibt.count);
  dbms_output.put_line('First Index = ' || ibt.first);
  dbms_output.put_line('Last Index = ' || ibt.last);
  dbms_output.put_line('Next Index = ' || ibt.next(2));
  dbms_output.put_line('Previous Index = ' || ibt.prior(3));
  dbms_output.put_line('INDEX BY TABLE ELEMENTS');
  dbms_output.put_line('ibt[-20] = ' || ibt(-20));
  dbms_output.put_line('ibt[1] = ' || ibt(1));
  dbms_output.put_line('ibt[30] = ' || ibt(30));
  dbms_output.put_line('ibt[100] = ' || ibt(100));
  flag := ibt.exists(30);
  if flag = true then
    dbms_output.put_line('Index 30 exists with an element ' || ibt(30));
  else
    dbms_output.put_line('Index 30 does not exists');
  end if;
  flag := ibt.exists(50);
  if flag = true then
    dbms_output.put_line('Index 50 exists with an element ' || ibt(30));
  else
    dbms_output.put_line('Index 50 does not exists');
  end if;
  ibt.delete(1);
```

```
dbms_output.put_line('After delete of first index, Count = ' || ibt.count);
ibt.delete(30);
dbms_output.put_line('After delete of index thirty, Count = ' || ibt.count);
dbms_output.put_line('INDEX BY TABLE ELEMENTS');
dbms_output.put_line('ibt[-20] = ' || ibt(-20));
dbms_output.put_line('ibt[100] = ' || ibt(100));
ibt.delete;
dbms_output.put_line('After delete of entire index-by table, Count = ' || ibt.count);
END;
```

**Output:**

```
No limit to Index by Tables
Count = 4
First Index = -20
Last Index = 100
Next Index = 30
Previous Index = 1
INDEX BY TABLE ELEMENTS
ibt[-20] = b
ibt[1] = a
ibt[30] = c
ibt[100] = d
Index 30 exists with an element c
Index 50 does not exists
After delete of first index, Count = 3
After delete of index thirty, Count = 2
INDEX BY TABLE ELEMENTS
ibt[-20] = b
ibt[100] = d
After delete of entire index-by table, Count = 0
```

**DIFFERENCES AMONG COLLECTIONS**

- Varrays has limit, nested tables and index-by tables has no limit.

- Varrays and nested tables must be initialized before assignment of elements, in index-by tables we can directly assign elements.
- Varrays and nested tables stored in database, but index-by tables can not.
- Nested tables and index-by tables are PL/SQL tables, but varrays can not.
- Keys must be positive in case of nested tables and varrays, in case of index-by tables keys can be positive or negative.
- Referencing nonexistent elements raises `SUBSCRIPT_BEYOND_COUNT` in both nested tables and varrays, but in case of index-by tables `NO_DATA_FOUND` raises.
- Keys are sequential in both nested tables and varrays, non-sequential in index-by tables.
- Individual indexes can be deleted in both nested tables and index-by tables, but in varrays can not.
- Individual indexes can be trimmed in both nested tables and varrays, but in index-by tables can not.
- Individual indexes can be extended in both nested tables and varrays, but in index-by tables can not.

## MULTILEVEL COLLECTIONS

Collections of more than one dimension which is a collection of collections, known as multilevel collections.

### Syntax:

```
Type <type_name1> is table of <table_type> index by binary_integer;  
Type <type_name2> is varray(<limit>) | table | of <type_name1> / index by  
binary_integer;
```

### Ex1:

```
DECLARE  
    type t1 is table of varchar(2) index by binary_integer;  
    type t2 is varray(5) of t1;  
    va t2 := t2();  
    c number := 97;  
    flag boolean;  
BEGIN  
    va.extend(4);  
    dbms_output.put_line('Count = ' || va.count);
```

```
dbms_output.put_line('Limit = ' || va.limit);
for i in 1..va.count loop
    for j in 1..va.count loop
        va(i)(j) := chr(c);
        c := c + 1;
    end loop;
end loop;
dbms_output.put_line('VARRAY ELEMENTS');
for i in 1..va.count loop
    for j in 1..va.count loop
        dbms_output.put_line('va[' || i || '][' || j || '] = ' || va(i)(j));
    end loop;
end loop;
dbms_output.put_line('First index = ' || va.first);
dbms_output.put_line('Last index = ' || va.last);
dbms_output.put_line('Next index = ' || va.next(2));
dbms_output.put_line('Previous index = ' || va.prior(3));
flag := va.exists(2);
if flag = true then
    dbms_output.put_line('Index 2 exists');
else
    dbms_output.put_line('Index 2 exists');
end if;
va.extend;
va(1)(5) := 'q';
va(2)(5) := 'r';
va(3)(5) := 's';
va(4)(5) := 't';
va(5)(1) := 'u';
va(5)(2) := 'v';
va(5)(3) := 'w';
va(5)(4) := 'x';
va(5)(5) := 'y';
dbms_output.put_line('After extend of one index, Count = ' || va.count);
dbms_output.put_line('VARRAY ELEMENTS');
```

```
for i in 1..va.count loop
    for j in 1..va.count loop
        dbms_output.put_line('va[' || i || '][' || j || '] = ' || va(i)(j));
    end loop;
end loop;
va.trim;
dbms_output.put_line('After trim of one index, Count = ' || va.count);
va.trim(2);
dbms_output.put_line('After trim of two indexes, Count = ' || va.count);
dbms_output.put_line('VARRAY ELEMENTS');
for i in 1..va.count loop
    for j in 1..va.count loop
        dbms_output.put_line('va[' || i || '][' || j || '] = ' || va(i)(j));
    end loop;
end loop;
va.delete;
dbms_output.put_line('After delete of entire varray, Count = ' || va.count);
END;
```

**Output:**

```
Count = 4
Limit = 5
VARRAY ELEMENTS
va[1][1] = a
va[1][2] = b
va[1][3] = c
va[1][4] = d
va[2][1] = e
va[2][2] = f
va[2][3] = g
va[2][4] = h
va[3][1] = i
va[3][2] = j
va[3][3] = k
va[3][4] = l
va[4][1] = m
```

va[4][2] = n

va[4][3] = o

va[4][4] = p

First index = 1

Last index = 4

Next index = 3

Previous index = 2

Index 2 exists

After extend of one index, Count = 5

VARRAY ELEMENTS

va[1][1] = a

va[1][2] = b

va[1][3] = c

va[1][4] = d

va[1][5] = q

va[2][1] = e

va[2][2] = f

va[2][3] = g

va[2][4] = h

va[2][5] = r

va[3][1] = i

va[3][2] = j

va[3][3] = k

va[3][4] = l

va[3][5] = s

va[4][1] = m

va[4][2] = n

va[4][3] = o

va[4][4] = p

va[4][5] = t

va[5][1] = u

va[5][2] = v

va[5][3] = w

va[5][4] = x

va[5][5] = y

After trim of one index, Count = 4  
After trim of two indexes, Count = 2  
VARRAY ELEMENTS  
va[1][1] = a  
va[1][2] = b  
va[2][1] = e  
va[2][2] = f  
After delete of entire varray, Count = 0

Ex2:

```
DECLARE
    type t1 is table of varchar(2) index by binary_integer;
    type t2 is table of t1;
    nt t2 := t2();
    c number := 65;
    v number := 1;
    flag boolean;
BEGIN
    nt.extend(4);
    dbms_output.put_line('Count = ' || nt.count);
    if nt.limit is null then
        dbms_output.put_line('No limit to Nested Tables');
    else
        dbms_output.put_line('Limit = ' || nt.limit);
    end if;
    for i in 1..nt.count loop
        for j in 1..nt.count loop
            nt(i)(j) := chr(c);
            c := c + 1;
            if c = 91 then
                c := 97;
            end if;
        end loop;
    end loop;
    dbms_output.put_line('NESTED TABLE ELEMENTS');
    for i in 1..nt.count loop
```

```
    for j in 1..nt.count loop
        dbms_output.put_line('nt[' || i || '][' || j || '] = ' || nt(i)(j));
    end loop;
end loop;
dbms_output.put_line('First index = ' || nt.first);
dbms_output.put_line('Last index = ' || nt.last);
dbms_output.put_line('Next index = ' || nt.next(2));
dbms_output.put_line('Previous index = ' || nt.prior(3));
flag := nt.exists(2);
if flag = true then
    dbms_output.put_line('Index 2 exists');
else
    dbms_output.put_line('Index 2 exists');
end if;
nt.extend(2);
nt(1)(5) := 'Q';
nt(1)(6) := 'R';
nt(2)(5) := 'S';
nt(2)(6) := 'T';
nt(3)(5) := 'U';
nt(3)(6) := 'V';
nt(4)(5) := 'W';
nt(4)(6) := 'X';
nt(5)(1) := 'Y';
nt(5)(2) := 'Z';
nt(5)(3) := 'a';
nt(5)(4) := 'b';
nt(5)(5) := 'c';
nt(5)(6) := 'd';
nt(6)(1) := 'e';
nt(6)(2) := 'f';
nt(6)(3) := 'g';
nt(6)(4) := 'h';
nt(6)(5) := 'i';
nt(6)(6) := 'j';
```

```
dbms_output.put_line('After extend of one index, Count = ' || nt.count);
dbms_output.put_line('NESTED TABLE ELEMENTS');
for i in 1..nt.count loop
    for j in 1..nt.count loop
        dbms_output.put_line('nt[' || i || '][' || j || '] = ' || nt(i)(j));
    end loop;
end loop;
nt.trim;
dbms_output.put_line('After trim of one index, Count = ' || nt.count);
nt.trim(2);
dbms_output.put_line('After trim of two indexes, Count = ' || nt.count);
dbms_output.put_line('NESTED TABLE ELEMENTS');
for i in 1..nt.count loop
    for j in 1..nt.count loop
        dbms_output.put_line('nt[' || i || '][' || j || '] = ' || nt(i)(j));
    end loop;
end loop;
nt.delete(2);
dbms_output.put_line('After delete of second index, Count = ' || nt.count);
dbms_output.put_line('NESTED TABLE ELEMENTS');
loop
    exit when v = 4;
    for j in 1..nt.count+1 loop
        dbms_output.put_line('nt[' || v || '][' || j || '] = ' || nt(v)(j));
    end loop;
    v := v + 1;
    if v = 2 then
        v := 3;
    end if;
end loop;
nt.delete;
dbms_output.put_line('After delete of entire nested table, Count = ' || nt.count);
END;
```

**Output:**

Count = 4

No limit to Nested Tables

NESTED TABLE ELEMENTS

nt[1][1] = A

nt[1][2] = B

nt[1][3] = C

nt[1][4] = D

nt[2][1] = E

nt[2][2] = F

nt[2][3] = G

nt[2][4] = H

nt[3][1] = I

nt[3][2] = J

nt[3][3] = K

nt[3][4] = L

nt[4][1] = M

nt[4][2] = N

nt[4][3] = O

nt[4][4] = P

First index = 1

Last index = 4

Next index = 3

Previous index = 2

Index 2 exists

After extend of one index, Count = 6

NESTED TABLE ELEMENTS

nt[1][1] = A

nt[1][2] = B

nt[1][3] = C

nt[1][4] = D

nt[1][5] = Q

nt[1][6] = R

nt[2][1] = E

nt[2][2] = F

nt[2][3] = G

nt[2][4] = H

nt[2][5] = S  
nt[2][6] = T  
nt[3][1] = I  
nt[3][2] = J  
nt[3][3] = K  
nt[3][4] = L  
nt[3][5] = U  
nt[3][6] = V  
nt[4][1] = M  
nt[4][2] = N  
nt[4][3] = O  
nt[4][4] = P  
nt[4][5] = W  
nt[4][6] = X  
nt[5][1] = Y  
nt[5][2] = Z  
nt[5][3] = a  
nt[5][4] = b  
nt[5][5] = c  
nt[5][6] = d  
nt[6][1] = e  
nt[6][2] = f  
nt[6][3] = g  
nt[6][4] = h  
nt[6][5] = i  
nt[6][6] = j

After trim of one index, Count = 5

After trim of two indexes, Count = 3

#### NESTED TABLE ELEMENTS

nt[1][1] = A  
nt[1][2] = B  
nt[1][3] = C  
nt[2][1] = E  
nt[2][2] = F  
nt[2][3] = G

```
nt[3][1] = I
nt[3][2] = J
nt[3][3] = K
After delete of second index, Count = 2
NESTED TABLE ELEMENTS
nt[1][1] = A
nt[1][2] = B
nt[1][3] = C
nt[3][1] = I
nt[3][2] = J
nt[3][3] = K
After delete of entire nested table, Count = 0
```

**Ex3:**

```
DECLARE
  type t1 is table of varchar(2) index by binary_integer;
  type t2 is table of t1 index by binary_integer;
  ibt t2;
  flag boolean;
BEGIN
  dbms_output.put_line('Count = ' || ibt.count);
  if ibt.limit is null then
    dbms_output.put_line('No limit to Index-by Tables');
  else
    dbms_output.put_line('Limit = ' || ibt.limit);
  end if;
  ibt(1)(1) := 'a';
  ibt(4)(5) := 'b';
  ibt(5)(1) := 'c';
  ibt(6)(2) := 'd';
  ibt(8)(3) := 'e';
  ibt(3)(4) := 'f';
  dbms_output.put_line('INDEX-BY TABLE ELEMENTS');
  dbms_output.put_line('ibt([1][1] = ' || ibt(1)(1));
  dbms_output.put_line('ibt([4][5] = ' || ibt(4)(5));
  dbms_output.put_line('ibt([5][1] = ' || ibt(5)(1));
```

```
dbms_output.put_line('ibt([6][2] = ' || ibt(6)(2));
dbms_output.put_line('ibt([8][3] = ' || ibt(8)(3));
dbms_output.put_line('ibt([3][4] = ' || ibt(3)(4));
dbms_output.put_line('First Index = ' || ibt.first);
dbms_output.put_line('Last Index = ' || ibt.last);
dbms_output.put_line('Next Index = ' || ibt.next(3));
dbms_output.put_line('Prior Index = ' || ibt.prior(8));
ibt(1)(2) := 'g';
ibt(1)(3) := 'h';
ibt(1)(4) := 'i';
ibt(1)(5) := 'k';
ibt(1)(6) := 'l';
ibt(1)(7) := 'm';
ibt(1)(8) := 'n';
dbms_output.put_line('Count = ' || ibt.count);
dbms_output.put_line('INDEX-BY TABLE ELEMENTS');
for i in 1..8 loop
    dbms_output.put_line('ibt[1][' || i || '] = ' || ibt(1)(i));
end loop;
dbms_output.put_line('ibt([4][5] = ' || ibt(4)(5));
dbms_output.put_line('ibt([5][1] = ' || ibt(5)(1));
dbms_output.put_line('ibt([6][2] = ' || ibt(6)(2));
dbms_output.put_line('ibt([8][3] = ' || ibt(8)(3));
dbms_output.put_line('ibt([3][4] = ' || ibt(3)(4));
flag := ibt.exists(3);
if flag = true then
    dbms_output.put_line('Index 3 exists');
else
    dbms_output.put_line('Index 3 exists');
end if;
ibt.delete(1);
dbms_output.put_line('After delete of first index, Count = ' || ibt.count);
ibt.delete(4);
dbms_output.put_line('After delete of fourth index, Count = ' || ibt.count);
dbms_output.put_line('INDEX-BY TABLE ELEMENTS');
```

```
dbms_output.put_line('ibt([5][1] = ' || ibt(5)(1));  
dbms_output.put_line('ibt([6][2] = ' || ibt(6)(2));  
dbms_output.put_line('ibt([8][3] = ' || ibt(8)(3));  
dbms_output.put_line('ibt([3][4] = ' || ibt(3)(4));  
ibt.delete;  
dbms_output.put_line('After delete of entire index-by table, Count = ' || ibt.count);  
END;
```

**Output:**

```
Count = 0  
No limit to Index-by Tables  
INDEX-BY TABLE ELEMENTS  
ibt([1][1] = a  
ibt([4][5] = b  
ibt([5][1] = c  
ibt([6][2] = d  
ibt([8][3] = e  
ibt([3][4] = f  
First Index = 1  
Last Index = 8  
Next Index = 4  
Prior Index = 6  
Count = 6  
INDEX-BY TABLE ELEMENTS  
ibt[1][1] = a  
ibt[1][2] = g  
ibt[1][3] = h  
ibt[1][4] = i  
ibt[1][5] = k  
ibt[1][6] = l  
ibt[1][7] = m  
ibt[1][8] = n  
ibt([4][5] = b  
ibt([5][1] = c  
ibt([6][2] = d  
ibt([8][3] = e
```

```
ibt([3][4] = f
Index 3 exists
After delete of first index, Count = 5
After delete of fourth index, Count = 4
INDEX-BY TABLE ELEMENTS
ibt([5][1] = c
ibt([6][2] = d
ibt([8][3] = e
ibt([3][4] = f
After delete of entire index-by table, Count = 0
```

Ex3:

```
DECLARE
    type t1 is table of varchar(2) index by binary_integer;
    type t2 is table of t1 index by binary_integer;
    type t3 is table of t2;
    nt t3 := t3();
    c number := 65;
BEGIN
    nt.extend(2);
    dbms_output.put_line('Count = ' || nt.count);
    for i in 1..nt.count loop
        for j in 1..nt.count loop
            for k in 1..nt.count loop
                nt(i)(j)(k) := chr(c);
                c := c + 1;
            end loop;
        end loop;
    end loop;
    dbms_output.put_line('NESTED TABLE ELEMENTS');
    for i in 1..nt.count loop
        for j in 1..nt.count loop
            for k in 1..nt.count loop
                dbms_output.put_line('nt[' || i || '][' || j || '][' || k || '] = ' ||
                    nt(i)(j)(k));
            end loop;
        end loop;
    end loop;
```

```
        end loop;  
    end loop;  
END;
```

Output:

```
Count = 2  
NESTED TABLE ELEMENTS  
nt[1][1][1] = A  
nt[1][1][2] = B  
nt[1][2][1] = C  
nt[1][2][2] = D  
nt[2][1][1] = E  
nt[2][1][2] = F  
nt[2][2][1] = G  
nt[2][2][2] = H
```

OBJECTS USED IN THE EXAMPLES

```
SQL> select * from student;
```

SNO	SNAME	SMARKS
1	saketh	100
2	srinu	200
3	divya	300
4	manogni	400

```
SQL> create or replace type addr as object(hno number(2),city varchar(10));/
```

```
SQL> select * from employ;
```

ENAME	JOB	ADDRESS(HNO, CITY)
Ranjit	clerk	ADDR(11, 'hyd')
Satish	manager	ADDR(22, 'bang')

```
Srinu    engineer    ADDR(33, 'kochi')
```

## ERROR HANDLING

PL/SQL implements error handling with exceptions and exception handlers. Exceptions can be associated with oracle errors or with your own user-defined errors. By using exceptions and exception handlers, you can make your PL/SQL programs robust and able to deal with both unexpected and expected errors during execution.

### ERROR TYPES

- Compile-time errors
- Runtime errors

Errors that occur during the compilation phase are detected by the PL/SQL engine and reported back to the user, we have to correct them.

Runtime errors are detected by the PL/SQL runtime engine which can programmatically raise and caught by exception handlers.

Exceptions are designed for run-time error handling, rather than compile-time error handling.

## HANDLING EXCEPTIONS

When exception is raised, control passes to the exception section of the block. The exception section consists of handlers for some or all of the exceptions. An exception handler contains the code that is executed when the error associated with the exception occurs, and the exception is raised.

### Syntax:

```
EXCEPTION
    When exception_name then
        Sequence_of_statements;
    When exception_name then
        Sequence_of_statements;
    When others then
        Sequence_of_statements;
END;
```

## EXCEPTION TYPES

- Predefined exceptions
- User-defined exceptions

## PREDEFINED EXCEPTIONS

Oracle has predefined several exceptions that corresponds to the most common oracle errors. Like the predefined types, the identifiers of these exceptions are defined in the STANDARD

package. Because of this, they are already available to the program, it is not necessary to declare them in the declarative section.

Ex1:

```
DECLARE
    a number;
    b varchar(2);
    v_marks number;
    cursor c is select * from student;
    type t is varray(3) of varchar(2);
    va t := t('a','b');
    va1 t;
BEGIN
    -- NO_DATA_FOUND
    BEGIN
        select smarks into v_marks from student where sno = 50;
    EXCEPTION
        when no_data_found then
            dbms_output.put_line('Invalid student number');
    END;
    -- CURSOR_ALREADY_OPEN
    BEGIN
        open c;
        open c;
    EXCEPTION
        when cursor_already_open then
            dbms_output.put_line('Cursor is already opened');
    END;
    -- INVALID_CURSOR
    BEGIN
        close c;
        open c;
        close c;
        close c;
    EXCEPTION
        when invalid_cursor then
            dbms_output.put_line('Cursor is already closed');
```

```
END;
-- TOO_MANY_ROWS
BEGIN
    select smarks into v_marks from student where sno > 1;
EXCEPTION
    when too_many_rows then
        dbms_output.put_line('Too many values are coming to marks variable');
END;
-- ZERO_DIVIDE
BEGIN
    a := 5/0;
EXCEPTION
    when zero_divide then
        dbms_output.put_line('Divided by zero - invalid operation');
END;
-- VALUE_ERROR
BEGIN
    b := 'saketh';
EXCEPTION
    when value_error then
        dbms_output.put_line('Invalid string length');
END;
-- INVALID_NUMBER
BEGIN
    insert into student values('a','srinu',100);
EXCEPTION
    when invalid_number then
        dbms_output.put_line('Invalid number');
END;
-- SUBSCRIPT_OUTSIDE_LIMIT
BEGIN
    va(4) := 'c';
EXCEPTION
    when subscript_outside_limit then
        dbms_output.put_line('Index is greater than the limit');
END;
-- SUBSCRIPT_BEYOND_COUNT
BEGIN
    va(3) := 'c';
EXCEPTION
```

```
        when subscript_beyond_count then
            dbms_output.put_line('Index is greater than the count');
END;
-- COLLECTION_IS_NULL
BEGIN
    va1(1) := 'a';
EXCEPTION
    when collection_is_null then
        dbms_output.put_line('Collection is empty');
END;
--
END;
```

**Output:**

```
Invalid student number
Cursor is already opened
Cursor is already closed
Too many values are coming to marks variable
Divided by zero - invalid operation
Invalid string length
Invalid number
Index is greater than the limit
Index is greater than the count
Collection is empty
```

**Ex2:**

```
DECLARE
    c number;
BEGIN
    c := 5/0;
EXCEPTION
    when zero_divide then
        dbms_output.put_line('Invalid Operation');
    when others then
        dbms_output.put_line('From OTHERS handler: Invalid Operation');
END;
```

Output:

Invalid Operation

## USER-DEFINED EXCEPTIONS

A user-defined exception is an error that is defined by the programmer. User-defined exceptions are declared in the declarative section of a PL/SQL block. Just like variables, exceptions have a type `EXCEPTION` and scope.

## RAISING EXCEPTIONS

User-defined exceptions are raised explicitly via the `RAISE` statement.

Ex:

```
DECLARE
    e exception;
BEGIN
    raise e;
EXCEPTION
    when e then
        dbms_output.put_line('e is raised');
END;
```

Output:

e is raised

## BUILT-IN ERROR FUNCTIONS

### SQLCODE AND SQLERRM

`SQLCODE` returns the current error code, and `SQLERRM` returns the current error message text; For user-defined exception `SQLCODE` returns 1 and `SQLERRM` returns "user-defined exception". `SQLERRM` will take only negative value except 100. If any positive value other than 100 returns non-oracle exception.

Ex1:

```
DECLARE
    e exception;
    v_dname varchar(10);
BEGIN
```

```
-- USER-DEFINED EXCEPTION
BEGIN
    raise e;
EXCEPTION
    when e then
        dbms_output.put_line(SQLCODE || ' ' || SQLERRM);
END;

-- PREDEFINED EXCEPTION
BEGIN
    select dname into v_dname from dept where deptno = 50;
EXCEPTION
    when no_data_found then
        dbms_output.put_line(SQLCODE || ' ' || SQLERRM);
END;
END;
```

**Output:**

```
1 User-Defined Exception
100 ORA-01403: no data found
```

**Ex2:**

```
BEGIN
    dbms_output.put_line(SQLERRM(100));
    dbms_output.put_line(SQLERRM(0));
    dbms_output.put_line(SQLERRM(1));
    dbms_output.put_line(SQLERRM(-100));
    dbms_output.put_line(SQLERRM(-500));
    dbms_output.put_line(SQLERRM(200));
    dbms_output.put_line(SQLERRM(-900));
END;
```

**Output:**

```
ORA-01403: no data found
ORA-0000: normal, successful completion
User-Defined Exception
ORA-00100: no data found
ORA-00500: Message 500 not found; product=RDBMS; facility=ORA
-200: non-ORACLE exception
```

## ORA-00900: invalid SQL statement

### DBMS\_UTILITY.FORMAT\_ERROR\_STACK

The built-in function, like SQLERRM, returns the message associated with the current error.

It differs from SQLERRM in two ways:

Its length is not restricted; it will return the full error message string.

You can not pass an error code number to this function; it cannot be used to return the message for a random error code.

Ex:

```
DECLARE
    v number := 'ab';
BEGIN
    null;
EXCEPTION
    when others then
        dbms_output.put_line(dbms_utility.format_error_stack);
END;
```

Output:

```
declare
*
ERROR at line 1:
ORA-06502: PL/SQL: numeric or value error: character to number conversion error
ORA-06512: at line 2
```

### DBMS\_UTILITY.FORMAT\_CALL\_STACK

This function returns a formatted string showing the execution call stack inside your PL/SQL application. Its usefulness is not restricted to error management; you will also find its handy for tracing the execution of your code. You may not use this function in exception block.

Ex:

```
BEGIN
    dbms_output.put_line(dbms_utility.format_call_stack);
END;
```

Output:

```
----- PL/SQL Call Stack -----
Object_handle   line_number  object_name
```

69760478                    2                    anonymous block

**DBMS\_UTILITY.FORMAT\_ERROR\_BACKTRACE**

It displays the execution stack at the point where an exception was raised. Thus , you can call this function with an exception section at the top level of your stack and still find out where the error was raised deep within the call stack.

**Ex:**

```
CREATE OR REPLACE PROCEDURE P1 IS
BEGIN
    dbms_output.put_line('from procedure 1');
    raise value_error;
END P1;

CREATE OR REPLACE PROCEDURE P2 IS
BEGIN
    dbms_output.put_line('from procedure 2');
    p1;
END P2;

CREATE OR REPLACE PROCEDURE P3 IS
BEGIN
    dbms_output.put_line('from procedure 3');
    p2;
EXCEPTION
    when others then
        dbms_output.put_line(dbms_utility.format_error_backtrace);
END P3;
```

**Output:**

```
SQL> exec p3

from procedure 3
from procedure 2
from procedure 1
ORA-06512: at "SAKETH.P1", line 4
ORA-06512: at "SAKETH.P2", line 4
ORA-06512: at "SAKETH.P3", line 4
```

## EXCEPTION\_INIT PRAGMA

Using this you can associate a named exception with a particular oracle error. This gives you the ability to trap this error specifically, rather than via an OTHERS handler.

### Syntax:

```
PRAGMA EXCEPTION_INIT(exception_name, oracle_error_number);
```

### Ex:

```
DECLARE
    e exception;
    pragma exception_init(e,-1476);
    c number;
BEGIN
    c := 5/0;
EXCEPTION
    when e then
        dbms_output.put_line('Invalid Operation');
END;
```

### Output:

```
Invalid Operation
```

## RAISE\_APPLICATION\_ERROR

You can use this built-in function to create your own error messages, which can be more descriptive than named exceptions.

### Syntax:

```
RAISE_APPLICATION_ERROR(error_number, error_message, [keep_errors_flag]);
```

The Boolean parameter *keep\_errors\_flag* is optional. If it is TRUE, the new error is added to the list of errors already raised. If it is FALSE, which is default, the new error will replace the current list of errors.

### Ex:

```
DECLARE
    c number;
BEGIN
    c := 5/0;

EXCEPTION
```

```
        when zero_divide then
            raise_application_error(-20222,'Invalid Operation');
END;
```

Output:

```
DECLARE
*
ERROR at line 1:
ORA-20222: Invalid Operation
ORA-06512: at line 7
```

## EXCEPTION PROPAGATION

Exceptions can occur in the declarative, the executable, or the exception section of a PL/SQL block.

### EXCEPTION RAISED IN THE EXECUTABLE SECTION

Exceptions raised in executable section can be handled in current block or outer block.

Ex1:

```
DECLARE
    e exception;
BEGIN
    BEGIN
        raise e;
    END;
EXCEPTION
    when e then
        dbms_output.put_line('e is raised');
END;
```

Output:

```
e is raised
```

Ex2:

```
DECLARE
    e exception;
BEGIN
    BEGIN
        raise e;
```

```
END;  
END;
```

Output:

```
ERROR at line 1:  
ORA-06510: PL/SQL: unhandled user-defined exception  
ORA-06512: at line 5
```

EXCEPTION RAISED IN THE DECLARATIVE SECTION

Exceptions raised in the declarative section must be handled in the outer block.

Ex1:

```
DECLARE  
    c number(3) := 'abcd';  
BEGIN  
    dbms_output.put_line('Hello');  
EXCEPTION  
    when others then  
        dbms_output.put_line('Invalid string length');  
END;
```

Output:

```
ERROR at line 1:  
ORA-06502: PL/SQL: numeric or value error: character to number conversion error  
ORA-06512: at line 2
```

Ex2:

```
BEGIN  
    DECLARE  
        c number(3) := 'abcd';  
    BEGIN  
        dbms_output.put_line('Hello');  
    EXCEPTION  
        when others then  
            dbms_output.put_line('Invalid string length');  
    END;  
EXCEPTION  
    when others then  
        dbms_output.put_line('From outer block: Invalid string length');
```

```
END;
```

Output:

```
From outer block: Invalid string length
```

EXCEPTION RAISED IN THE EXCEPTION SECTION

Exceptions raised in the declarative section must be handled in the outer block.

Ex1:

```
DECLARE
    e1 exception;
    e2 exception;
BEGIN
    raise e1;
EXCEPTION
    when e1 then
        dbms_output.put_line('e1 is raised');
        raise e2;
    when e2 then
        dbms_output.put_line('e2 is raised');
END;
```

Output:

```
e1 is raised
DECLARE
*
ERROR at line 1:
ORA-06510: PL/SQL: unhandled user-defined exception
ORA-06512: at line 9
ORA-06510: PL/SQL: unhandled user-defined exception
```

Ex2:

```
DECLARE
    e1 exception;
    e2 exception;
BEGIN
    BEGIN
```

```
        raise e1;
    EXCEPTION
        when e1 then
            dbms_output.put_line('e1 is raised');
            raise e2;
        when e2 then
            dbms_output.put_line('e2 is raised');
    END;
EXCEPTION
    when e2 then
        dbms_output.put_line('From outer block: e2 is raised');
END;
```

Output:

```
e1 is raised
From outer block: e2 is raised
```

Ex3:

```
DECLARE
    e exception;
BEGIN
    raise e;
EXCEPTION
    when e then
        dbms_output.put_line('e is raised');
        raise e;
END;
```

Output:

```
e is raised
DECLARE
*
ERROR at line 1:
ORA-06510: PL/SQL: unhandled user-defined exception
ORA-06512: at line 8
ORA-06510: PL/SQL: unhandled user-defined exception
```

## RESTRICTIONS

You can not pass exception as an argument to a subprogram.

## DATABASE TRIGGERS

Triggers are similar to procedures or functions in that they are named PL/SQL blocks with declarative, executable, and exception handling sections. A trigger is executed implicitly whenever the triggering event happens. The act of executing a trigger is known as firing the trigger.

### RESTRICTIONS ON TRIGGERES

- Like packages, triggers must be stored as stand-alone objects in the database and cannot be local to a block or package.
- A trigger does not accept arguments.

## USE OF TRIGGERS

- Maintaining complex integrity constraints not possible through declarative constraints enable at table creation.
- Auditing information in a table by recording the changes made and who made them.
- Automatically signaling other programs that action needs to take place when changes are made to a table.
- Perform validation on changes being made to tables.
- Automate maintenance of the database.

## TYPES OF TRIGGERS

- DML Triggers
- Instead of Triggers
- DDL Triggers
- System Triggers
- Suspend Triggers

## CATEGORIES

Timing      --      Before or After

Level        --      Row or Statement

Row level trigger fires once for each row affected by the triggering statement. Row level trigger is identified by the FOR EACH ROW clause.

Statement level trigger fires once either before or after the statement.

## DML TRIGGER SYNTAX

Create or replace trigger <trigger\_name>

Before | after on insert or update or delete

[For each row]

Begin

    -- trigger body

End <trigger\_name>;

## DML TRIGGERS

A DML trigger is fired on an INSERT, UPDATE, or DELETE operation on a database table. It can be fired either before or after the statement executes, and can be fired once per affected row, or once per statement.

The combination of these factors determines the types of the triggers. These are a total of 12 possible types (3 statements \* 2 timing \* 2 levels).

### ORDER OF DML TRIGGER FIRING

- Before statement level
- Before row level
- After row level
- After statement level

Ex:

Suppose we have a following table.

```
SQL> select * from student;
```

NO	NAME	MARKS
1	a	100
2	b	200
3	c	300
4	d	400

Also we have triggering\_firing\_order table with firing\_order as the field.

```
CREATE OR REPLACE TRIGGER TRIGGER1
before insert on student
BEGIN
insert into trigger_firing_order values('Before Statement Level');
END TRIGGER1;

CREATE OR REPLACE TRIGGER TRIGGER2
before insert on student
```

```
        for each row
BEGIN
    insert into trigger_firing_order values('Before Row Level');
END TRIGGER2;

CREATE OR REPLACE TRIGGER TRIGGER3
    after insert on student
BEGIN
    insert into trigger_firing_order values('After Statement Level');
END TRIGGER3;

CREATE OR REPLACE TRIGGER TRIGGER4
    after insert on student
    for each row
BEGIN
    insert into trigger_firing_order values('After Row Level');
END TRIGGER4;
```

**Output:**

```
SQL> select * from trigger_firing_order;
```

```
no rows selected
```

```
SQL> insert into student values(5,'e',500);
```

```
1 row created.
```

```
SQL> select * from trigger_firing_order;
```

```
FIRING_ORDER
```

```
-----
```

```
Before Statement Level
```

```
Before Row Level
```

```
After Row Level
```

```
After Statement Level
```

```
SQL> select * from student;
```

NO	NAME	MARKS
1	a	100
2	b	200
3	c	300
4	d	400
5	e	500

### CORRELATION IDENTIFIERS IN ROW-LEVEL TRIGGERS

Inside the trigger, you can access the data in the row that is currently being processed. This is accomplished through two correlation identifiers - :old and :new.

A *correlation identifier* is a special kind of PL/SQL bind variable. The colon in front of each indicates that they are bind variables, in the sense of host variables used in embedded PL/SQL, and indicates that they are not regular PL/SQL variables. The PL/SQL compiler will treat them as records of type

Triggering\_table%ROWTYPE.

Although syntactically they are treated as records, in reality they are not. :old and :new are also known as *pseudorecords*, for this reason.

TRIGGERING STATEMENT	:OLD	:NEW
INSERT	all fields are NULL.	values that will be inserted When the statement is completed.
UPDATE	original values for the row before the update.	new values that will be updated when the statement is completed.
DELETE	original values before the row is deleted.	all fields are NULL.

Ex:

Suppose we have a table called marks with fields no, old\_marks, new\_marks.

```
CREATE OR REPLACE TRIGGER OLD_NEW
  before insert or update or delete on student
  for each row
BEGIN
  insert into marks values(:old.no,:old.marks,:new.marks);
END OLD_NEW;
```

Output:

```
SQL> select * from student;
```

NO	NAME	MARKS
1	a	100
2	b	200
3	c	300
4	d	400
5	e	500

```
SQL> select * from marks;
```

no rows selected

```
SQL> insert into student values(6,'f',600);
```

1 row created.

```
SQL> select * from student;
```

NO	NAME	MARKS
1	a	100
2	b	200
3	c	300

4	d	400
5	e	500
6	f	600

SQL> select \* from marks;

NO	OLD_MARKS	NEW_MARKS
		600

SQL> update student set marks=555 where no=5;

1 row updated.

SQL> select \* from student;

NO	NAME	MARKS
1	a	100
2	b	200
3	c	300
4	d	400
5	e	555
6	f	600

SQL> select \* from marks;

NO	OLD_MARKS	NEW_MARKS
		600
5	500	555

SQL> delete student where no = 2;

1 row deleted.

```
SQL> select * from student;
```

NO	NAME	MARKS
1	a	100
3	c	300
4	d	400
5	e	555
6	f	600

```
SQL> select * from marks;
```

NO	OLD_MARKS	NEW_MARKS
		600
5	500	555
2	200	

#### REFERENCING CLAUSE

If desired, you can use the REFERENCING clause to specify a different name for :old and :new. This clause is found after the triggering event, before the WHEN clause.

#### Syntax:

```
REFERENCING [old as old_name] [new as new_name]
```

#### Ex:

```
CREATE OR REPLACE TRIGGER REFERENCE_TRIGGER
before insert or update or delete on student
referencing old as old_student new as new_student
for each row
BEGIN
insert into marks
values(:old_student.no,:old_student.marks,:new_student.marks);
END REFERENCE_TRIGGER;
```

#### WHEN CLAUSE

WHEN clause is valid for row-level triggers only. If present, the trigger body will be executed only for those rows that meet the condition specified by the WHEN clause.

**Syntax:**

```
WHEN trigger_condition;
```

Where *trigger\_condition* is a Boolean expression. It will be evaluated for each row. The *:new* and *:old* records can be referenced inside *trigger\_condition* as well, but like REFERENCING, the colon is not used there. The colon is only valid in the trigger body.

**Ex:**

```
CREATE OR REPLACE TRIGGER WHEN_TRIGGER  
  before insert or update or delete on student  
  referencing old as old_student new as new_student  
  for each row  
  when (new_student.marks > 500)  
BEGIN  
  insert into marks  
    values (:old_student.no, :old_student.marks, :new_student.marks);  
END WHEN_TRIGGER;
```

**TRIGGER PREDICATES**

There are three Boolean functions that you can use to determine what the operation is. The predicates are

- INSERTING
- UPDATING
- DELETING

**Ex:**

```
CREATE OR REPLACE TRIGGER PREDICATE_TRIGGER  
  before insert or update or delete on student  
BEGIN  
  if inserting then  
    insert into predicates values ('I');
```

```
    elsif updating then
        insert into predicates values('U');
    elsif deleting then
        insert into predicates values('D');
    end if;
END PREDICATE_TRIGGER;
```

**Output:**

```
SQL> delete student where no=1;
```

1 row deleted.

```
SQL> select * from predicates;
```

MSG

-----

D

```
SQL> insert into student values(7,'g',700);
```

1 row created.

```
SQL> select * from predicates;
```

MSG

-----

D

I

```
SQL> update student set marks = 777 where no=7;
```

1 row updated.

```
SQL> select * from predicates;
```

MSG

-----

D

I

U

## INSTEAD-OF TRIGGERS

Instead-of triggers fire instead of a DML operation. Also, instead-of triggers can be defined only on views. Instead-of triggers are used in two cases:

- To allow a view that would otherwise not be modifiable to be modified.
- To modify the columns of a nested table column in a view.