Normalization

Is a scientific or step by step formal process to arrive at the correct set of tables in a database.

Reduces redundancy

What is redundancy? Unnecessary repeatation of same data in multiple locations

Update Anamolies

What is update anamolies? If you repeat same data in many locations, we may update them inconsistently. Example, In attendance table, if we have trainer name, it may be updated differently in different rows.

Functional Dependency

It is based on a column depends on another column or whole entity.

For example, In Candidate table, phone number is based on candidate. But State is based on city, not on candidate.

Large table split into multiple tables, with relationship like primary key of one table is foreign key of another table, this is what we do when we do normalization. If we split tables, we do normalization. If we merge tables, we do de-normalization.

Step by Step normalization:

1st Normal Form

2nd Normal Form

3rd Normal Form

Boyce Codd Normal Form

Example Unnormalized Database

An unnormalized table has multiple values within a single field, as well as redundant information in the worst case.

For example:

managerID	managerName	area	employeeID	employeeName	sectorID	sectorName
1	Adam A.	East	1	David D.	4	Finance
			2	Eugene E.	3	IT
2	Betty B.	West	3	George G.	2	Security
			4	Henry H.	1	Administration
			5	Ingrid I.	4	Finance
3	Carl C.	North	6	James J.	1	Administration
			7	Katy K.	4	Finance

First Normal Form:

A table is said to be in 1st Normal form if every cell in the table contains precisely only 1 data.

Ex:

SNO	NAME	ADDRESS
1	Raja	12, Main road, Chennai 600002
2	Siva	14, Raja street, Coimbatore 641002

The above table has a column address, which contains many data. So if it is like

SNO	NAME®	ADDRESS1	CITY	PINCODE
1	Raja	12, Main road,	Chennai	600002
2	Siva	14, Raja street,	Coimbatore	641002

Step 1: First Normal Form 1NF

To rework the database table into the 1NF, values within a single field must be atomic. All complex entities in the table divide into new rows or columns.

The information in the columns **managerID**, **managerName**, and **area** repeat for each employee to ensure no loss of information.

managerID	managerName	area	employeeID	employeeName	sectorID	sectorName
1	Adam A.	East	1	David D.	4	Finance
1	Adam A.	East	2	Eugene E.	3	IT
2	Betty B.	West	3	George G.	2	Security
2	Betty B.	West	4	Henry H.	1	Administration
2	Betty B.	West	5	Ingrid I.	4	Finance
3	Carl C.	North	6	James J.	1	Administration
3	Carl C.	North	7	Katy K.	4	Finance

Second Normal Form:

A table is said to be in 2nd Normal form, if it is already in 1st normal form and every field in that table is dependent on whole key (entity).

Step 1: First Normal Form 1NF

To rework the database table into the 1NF, values within a single field must be atomic. All complex entities in the table divide into new rows or columns.

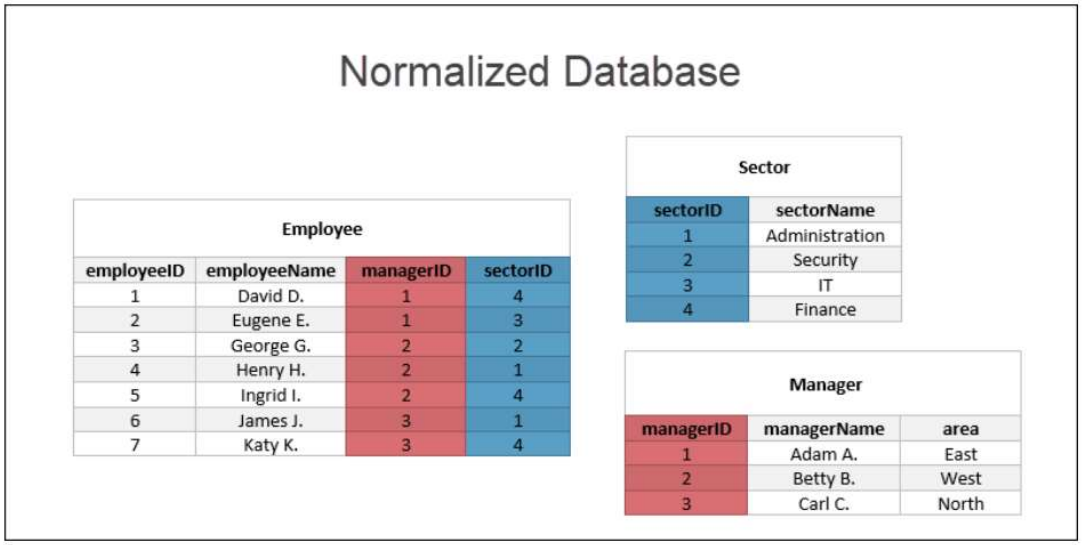
The information in the columns **managerID**, **managerName**, and **area** repeat for each employee to ensure no loss of information.

managerID	managerName	area	employeeID	employeeName	sectorID	sectorName
1	Adam A.	East	1	David D.	4	Finance
1	Adam A.	East	2	Eugene E.	3	IT
2	Betty B.	West	3	George G.	2	Security
2	Betty B.	West	4	Henry H.	1	Administration
2	Betty B.	West	5	Ingrid I.	4	Finance
3	Carl C.	North	6	James J.	1	Administration
3	Carl C.	North	7	Katy K.	4	Finance

Third Normal Form:

A table is said to be in 3rd Normal form, if it is already in 2nd normal form and every field is dependent on the primary key.

The database is currently in third normal form with three relations in total. The final structure is:



At this point, the database is **normalized**. Any further normalization steps depend on the use case of the data.

Activity:

Identify

First, Second and Third normal forms

<u>Design patterns</u>

Creational

Structural

Behavioral

SOLID principles

Single Responsibility Principle

Open – Closed Principle

Liskov Substitution Principle

Interface Segregation Principle

Dependency Inversion Principle

1) Single Responsibility Principle

A class should implement only one functionality.

2) Open – Close Principle

Open for Extension, Closed for Modification.

3) Liskov Substitution Principle

If a method has an argument of type A, then we can substitute that with B or C or D, provided B, C, D are sub classes of A

4) Interface Seggregation Principle

Instead of declaring an object of class, it is always good to declare ref var of an interface

List<Integer> marks=new ArrayList<Integer>(); //this is better than

ArrayList<Integer> marks=new ArrayList<Integer>();

5) Dependency Inversion Principle

```
class Car1
{
        Sony sony;
}

class Car2
{
        Jbl jbl;
}
```

The above car classes have tightly coupled audio systems.

```
class Car3
{
        Audio audio;                    //Audio is an interface
}

interface Audio
{}
```

```
class Sony implements Audio
{}

class Jbl implements Audio
{}
```

Reminder:

- Creational
- Structural
- Behavioural

Stored Procedures

What is PLSQL?

Procedural Language Extension to SQL

SQL Statements are executed by sqL Engine.
PLSQL statements are executed by plsql engine.

In PLSQL

- We can declare variables
- We can use programming constructs like
  - Conditions and Looping

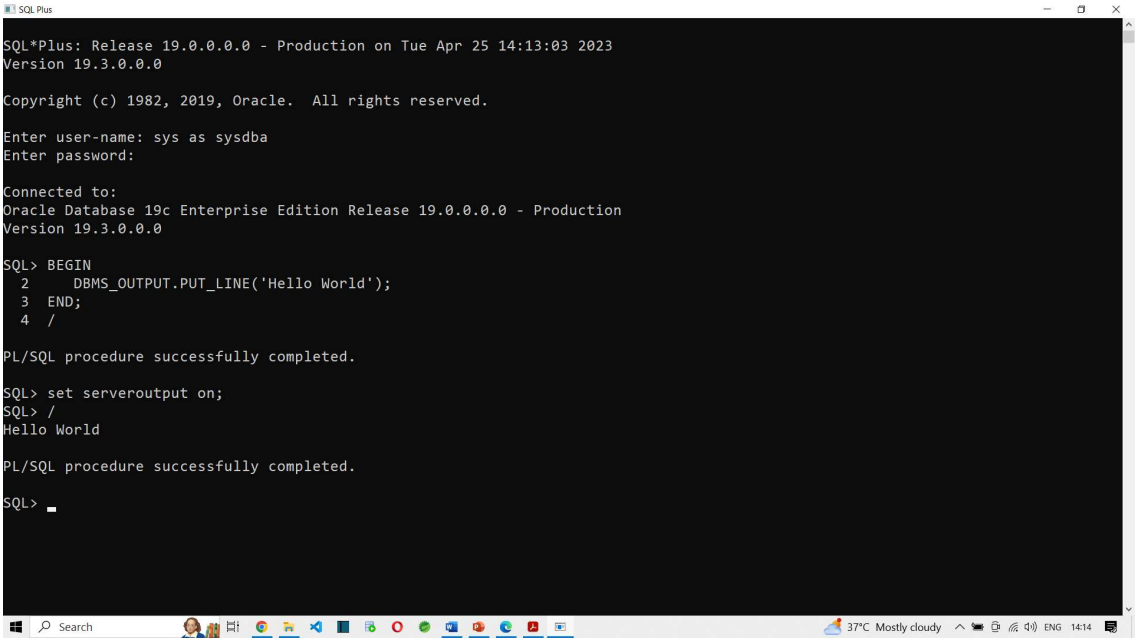
Every PLSQL program has a block structure

```
[DECLARE]
BEGIN
[EXCEPTION]
END
```

It is understood that a plsql program always have

```
BEGIN
END;
```

```
set serveroutput on;
```



How to declare variables in PLSQL?
You can declare variables only in the DECLARE block

SQL Worksheet

```
1  DECLARE
2      X INT:=2;
3  BEGIN
4      X:=200;
5      DBMS_OUTPUT.PUT_LINE(X*X);
6  END;
```

Can we run SQL statements inside PLSQL program?
Of course.

```
DECLARE
   X INT;
BEGIN
        SELECT 2*3 INTO X FROM DUAL;
        DBMS_OUTPUT.PUT_LINE(X);
END;

--

DECLARE
   X INT;
BEGIN
        SELECT SALARY INTO X FROM HR.EMPLOYEES;      --More than 1 row
is retrieved, so we cannot store it in a scalar variable
        DBMS_OUTPUT.PUT_LINE(X);
END;

ORA-01422: exact fetch returns more than requested number of rows ORA-
06512: at line 4


DECLARE
   X INT;
BEGIN
        SELECT SALARY INTO X FROM HR.EMPLOYEES WHERE
EMPLOYEE_ID=100;
        DBMS_OUTPUT.PUT_LINE(X);
END;

Statement processed.
24000



These are PLSQL programs. Also called as Anonymous programs.
Because these programs do not have a name. Hence they are not stored in
database.


How to use IF conditions in PLSQL?
DECLARE
   X INT;
BEGIN
        SELECT SALARY INTO X FROM HR.EMPLOYEES WHERE
EMPLOYEE_ID=100;
        IF X>20000 THEN
                DBMS_OUTPUT.PUT_LINE('NOT ELIGIBLE FOR BONUS');
        ELSIF X>10000 THEN
      DBMS_OUTPUT.PUT_LINE('ELIGIBLE FOR 10% BONUS');
        ELSE
      DBMS_OUTPUT.PUT_LINE('ELIGIBLE FOR 50% BONUS');
    END IF;
        DBMS_OUTPUT.PUT_LINE(X);
```

END;

```
DECLARE
    JID HR.EMPLOYEES.JOB_ID%TYPE;
BEGIN
    SELECT JOB_ID INTO JID FROM HR.EMPLOYEES WHERE EMPLOYEE_ID=101;
    CASE JID
        WHEN 'AC_ACCOUNT' THEN DBMS_OUTPUT.PUT_LINE('Accountant');
        WHEN 'AC_MGR' THEN DBMS_OUTPUT.PUT_LINE('Accounts Manager');
        WHEN 'AD_VP' THEN DBMS_OUTPUT.PUT_LINE('Vice President');
        ELSE    DBMS_OUTPUT.PUT_LINE('Some other designation');
    END CASE;
END;
```

We can also do Looping:

```
DECLARE
   JID HR.EMPLOYEES.JOB_ID%TYPE;
        I INT:=100;
BEGIN
        LOOP
        DBMS_OUTPUT.PUT_LINE(I);
                I:=I+1;
                IF I>110 THEN
         EXIT;
      END IF;
   END LOOP;
END;
```

```
Statement processed.
100
101
102
103
104
105
106
107
108
109
110
```

```
DECLARE
    FNAME HR.EMPLOYEES.FIRST_NAME%TYPE;
    I INT:=100;
BEGIN
    LOOP
        SELECT FIRST_NAME INTO FNAME FROM HR.EMPLOYEES
            WHERE EMPLOYEE_ID=I;
        DBMS_OUTPUT.PUT_LINE(FNAME);
        I:=I+1;
        IF I>110 THEN
            EXIT;
        END IF;
    END LOOP;
END;
```

```
Statement processed.
Steven
Neena
Lex
Alexander
Bruce
David
Valli
Diana
Nancy
Daniel
John
```

```
DECLARE
    FNAME HR.EMPLOYEES.FIRST_NAME%TYPE;
    I INT:=100;
BEGIN
    WHILE I<=110
    LOOP
        SELECT FIRST_NAME INTO FNAME FROM HR.EMPLOYEES
            WHERE EMPLOYEE_ID=I;
        DBMS_OUTPUT.PUT_LINE(FNAME);
        I:=I+1;
        -- IF I>110 THEN
  --            EXIT;
  --       END IF;
    END LOOP;
END;
```

Same output. But we earlier used BASIC LOOP, now we use WHILE LOOP

Shall we use FOR LOOP now.

```
DECLARE
    FNAME HR.EMPLOYEES.FIRST_NAME%TYPE;
    -- I INT:=100;
BEGIN
    FOR I IN 100 .. 110
    LOOP
        SELECT FIRST_NAME INTO FNAME FROM HR.EMPLOYEES
            WHERE EMPLOYEE_ID=I;
        DBMS_OUTPUT.PUT_LINE(FNAME);
        -- I:=I+1;
        -- IF I>110 THEN
  --            EXIT;
  --       END IF;
    END LOOP;
END;
```

Notice that FOR loop variable need not be declared. If I is already declared, then it ignores that I and use Local loop variable I inside loop.

```
DECLARE
    X HR.EMPLOYEES%ROWTYPE;
BEGIN
    FOR I IN 100 .. 110
    LOOP
        SELECT * INTO X FROM HR.EMPLOYEES
            WHERE EMPLOYEE_ID=I;
        DBMS_OUTPUT.PUT_LINE(X.EMPLOYEE_ID || ' ' || X.FIRST_NAME );
    END LOOP;
END;
```

PROCEDURES

They are named PLSQL programs
They are stored in the database as object.

We can call the procedure from
- A plsql program (or from)
- Another procedure (or from)
- A function (or from)
- A trigger

Etc

Procedure is like a void method in java.

I am going to modify the PLSQL program we did above into a procedure.

```
CREATE OR REPLACE procedure PROC1
AS
    X HR.EMPLOYEES%ROWTYPE;
BEGIN
    FOR I IN 100 .. 110
    LOOP
        SELECT * INTO X FROM HR.EMPLOYEES
            WHERE EMPLOYEE_ID=I;
        DBMS_OUTPUT.PUT_LINE(X.EMPLOYEE_ID || ' ' || X.FIRST_NAME );
    END LOOP;
END;
```

```
Procedure created.
```

To call this procedure:
We can call this proc from a plsql program

```
BEGIN
      proc1;
END;
```

```
Statement processed.
100 Steven
101 Neena
102 Lex
103 Alexander
104 Bruce
105 David
106 Valli
107 Diana
108 Nancy
109 Daniel
110 John
```

PROCEDURES, can have parameters.

```
CREATE OR REPLACE procedure PROC1(M INT, N INT)
AS
   X HR.EMPLOYEES%ROWTYPE;
```

```
BEGIN
   FOR I IN M .. N
        LOOP
        SELECT * INTO X FROM HR.EMPLOYEES
                WHERE EMPLOYEE_ID=I;
        DBMS_OUTPUT.PUT_LINE(X.EMPLOYEE_ID || ' ' || X.FIRST_NAME );
   END LOOP;
END;
```

To call this procedure:

```
DECLARE
   X INT;
        Y INT;
BEGIN
   X:=100;
        Y:=106;
        PROC1(X,Y);
END;
```

Procedures can have
IN
OUT
IN OUT
Parameters.

```
Collections.sort(arr);
Sqr(2,x);               x=4
Cube(2,x)               x=8
Sqrt(4,x)               x=2
```

Here, in above examples, x is OUT parameter, because the procedure fills output in that parameter.

```
CREATE OR REPLACE PROCEDURE PRCAJAY(X INT, Y OUT INT)
AS
BEGIN
   Y:=X*X;
END;
```

We call this procedure using PLSQL program:

```
DECLARE
   X INT:=2;
        Y INT;
BEGIN
   PRCAJAY(2,Y);
        DBMS_OUTPUT.PUT_LINE(Y);
```

```
END;
```

Output is 4

```
CREATE OR REPLACE PROCEDURE PRCSQR(X IN OUT INT)
AS
BEGIN
   X:=X*X;
END;
```

The above is IN OUT

```
DECLARE
   X INT:=4;
BEGIN
   PRCSQR(X);
        DBMS_OUTPUT.PUT_LINE(X);
END;
```

Lets create a PLSQL Function.

```
CREATE OR REPLACE FUNCTION fnKalyan
RETURN INT
AS
BEGIN
   RETURN 200;
END;
```

How to call the function?
A function can be called from

- A plsql program
- Another function
- A procedure
- SQL Statements
  - SELECT fnKalyan() FROM DUAL;

```
DECLARE
   x INT;
BEGIN
   x:=fnKalyan();
        DBMS_OUTPUT.PUT_LINE(x);
END;
```

Demo:
Single row functions (scalar)

```
CREATE OR REPLACE FUNCTION  fnBonus(SAL INT)
RETURN INT
AS
BEGIN
   RETURN SAL+SAL*2;
END;
```

Lets use this in our EMPLOYEES table

```
select first_name, salary, fnBonus(salary) as Bonus
from hr.employees;
```

Task:
Create a plsql function that accepts employee id as input and returns the salary as output.

Task:
Create a plsql function that accepts employee id as input and returns the entire row as output.

```
create or replace function fn2(id1 INT)
return HR.EMPLOYEES%ROWTYPE
as
   emprec HR.EMPLOYEES%ROWTYPE;
begin
   SELECT * INTO emprec FROM HR.EMPLOYEES WHERE EMPLOYEE_ID=id1;
        return emprec;
end;

DECLARE
   result HR.EMPLOYEES%ROWTYPE;
BEGIN
   result:=fn2(101);
        DBMS_OUTPUT.PUT_LINE(result.FIRST_NAME || ' ' || result.LAST_NAME);
END;
```