Functional Dependencies

Functional Dependency is a relationship between attributes of a table dependent on each other. Introduced by E. F. Codd, it helps in preventing data redundancy and gets to know about bad designs.

In any relation R if there exists a set of attributes A1, A2, A3….An and an attribute B such that if any two tuples have the same value for A1, A2, A3…An then they also have the same value for B.

Then the following will represent the functional dependency between attributes A1, A2, A3 …An with an arrow sign −

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A -> B
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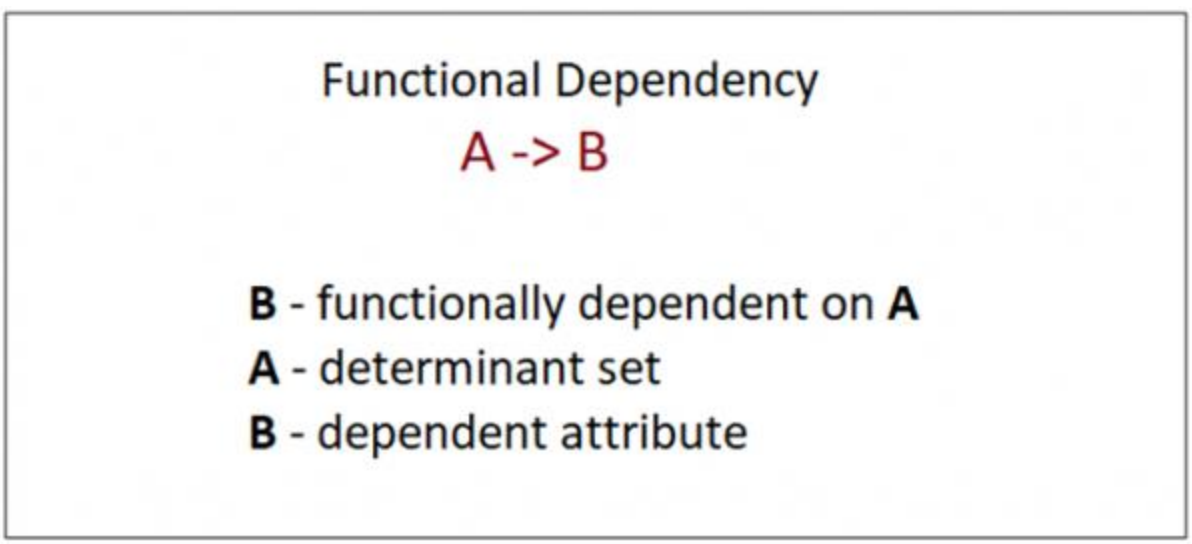
Where A represents set of attributes such as A1, A2, A3…An

This means



Functional dependency is a framework for systematic design and optimization of relational schemas. The functional dependency works upon the generalization over the keys. Functional dependency is very important in obtaining correct normalized schemas.

Functional Dependencies define properties of the schema and not of any particular tuple in the schema.

Example

The following is an example that would make it easier to understand functional dependency −

We have a **<Department>** table with two attributes − **DeptId** and **DeptName**.

DeptId = Department ID
DeptName = Department Name

The **DeptId** is our primary key. Here, **DeptId** uniquely identifies the **DeptName** attribute. This is because if you want to know the department name, then at first you need to have the **DeptId**.

DeptId	**DeptName**
001	Finance
002	Marketing
003	HR

Therefore, the above functional dependency between **DeptId** and **DeptName** can be determined as **DeptId** is functionally dependent on **DeptName** −

DeptId -> DeptName

If there is a functional Dependency **A -> B** that does not means that **B->A**

If there is a functional dependency A->B

This means that the value of B is determined by the value of A or the value of A uniquely derives B.

OR

There is a functional dependency from A->B or B is functionally dependent on A.

Example :

Consider the relation **Movies** (Title, year, length, filmtype, studio,star)

We can identify some FDs as following

{**title, Year**}->**length**

{**title, Year**} ->**studio**

However note that {**title, Year**} ->**star** is always not true.

Types of Functional Dependency

Functional Dependency has three forms −

- Trivial Functional Dependency
- Non-Trivial Functional Dependency
- Completely Non-Trivial Functional Dependency

Let us begin with Trivial Functional Dependency −

Trivial Functional Dependency

It occurs when B **is a subset** of A in −

A ->B

Example

We are considering the same **<Department>** table with two attributes to understand the concept of trivial dependency.

The following is a trivial functional dependency since **DeptId** is a subset of **DeptId** and **DeptName**

{ DeptId, DeptName } -> Dept Id

Non –Trivial Functional Dependency

It occurs when B **is not a subset** of A in −

A ->B

Example

DeptId -> DeptName

The above is a non-trivial functional dependency since DeptName is a not a subset of DeptId.

Completely Non - Trivial Functional Dependency

It occurs when **A intersection B is null** in −

A ->B

Armstrong’s Axioms Property of Functional Dependency

Armstrong’s Axioms property was developed by William Armstrong in 1974 to reason about functional dependencies.

The property suggests rules that hold true if the following are satisfied:

- **Transitivity**
  If A->B and B->C, then A->C i.e. a transitive relation.
- **Reflexivity**
  A-> B, if B is a subset of A.
- **Augmentation**
  The last rule suggests: AC->BC, if A->B

Example:

R = (A, B, C, G, H, I)

F = { $A \rightarrow B$ $A \rightarrow C$ $CG \rightarrow H$ $CG \rightarrow I$ $B \rightarrow H$} some members of F+ .

$A \rightarrow H$ by transitivity from $A \rightarrow B$ and $B \rightarrow H$

$AG \rightarrow I$ by augmenting $A \rightarrow C$ with G, to get $AG \rightarrow CG$ and then transitivity with $CG \rightarrow I$.

$CG \rightarrow HI$ from $CG \rightarrow H$ and $CG \rightarrow I$: “union rule” can be inferred from definition of functional dependencies,

or: (1) augmentation of $CG \rightarrow I$ to infer $CG \rightarrow CGI$,

(2) augmentation of $CG \rightarrow H$ to infer $CGI \rightarrow HI$,

and then (3) transitivity.