4 NF and Multivalued Dependency

If two or more independent relation are kept in a single relation or we can say **multivalued dependency** occurs when the presence of one or more rows in a table implies the presence of one or more other rows in that same table. Put another way, two attributes (or columns) in a table are independent of one another, but both depend on a third attribute. A **multivalued dependency** always requires at least three attributes because it consists of at least two attributes that are dependent on a third.

Simply multivalued dependency is a relation with at least three attributes A,B,C , then for a certain value of A we are having set of values in B and for a certain value of A we are having set of values in C but B and C are not related attributes.

For a dependency A -> B, if for a single value of A, multiple value of B exists, then the table may have multi-valued dependency. The table should have at least 3 attributes and B and C should be independent for A ->> B multivalued dependency. For example,

Person	Mobile	Food_Likes
Mahesh	9893/9424	Burger / pizza
Ramesh	9191	Pizza

Person	Mobile	Food_Likes
Mahesh	9893	Burger
Mahesh	9424	Pizza
Ramesh	9191	Pizza

Person->-> mobile,

Person ->-> food_likes

This is read as “person multidetermines mobile” and “person multidetermines food_likes.”

What is 4NF?

The 4NF comes after 1NF, 2NF, 3NF, and Boyce-Codd Normal Form. It was introduced by Ronald Fagin in 1977.

To be in 4NF,

1. a relation should be in Bouce-Codd Normal Form
2. It may not contain any multi-valued dependencies.

Example

Let us see an example −

<Movie>

Movie_Name	**Shooting_Location**	**Listing**
MovieOne	UK	Comedy
MovieOne	UK	Thriller
MovieTwo	Australia	Action
MovieTwo	Australia	Crime
MovieThree	India	Drama

The above is not in 4NF, since

- More than one movie can have the same listing
- Many shooting locations can have the same movie

Let us convert the above table in 4NF −

<Movie_Shooting>

Movie_Name	Shooting_Location
MovieOne	UK
MovieOne	UK
MovieTwo	Australia
MovieTwo	Australia
MovieThree	India

<Movie_Listing>

Movie_Name	Listing
MovieOne	Comedy
MovieOne	Thriller
MovieTwo	Action
MovieTwo	Crime
MovieThree	Drama

Now the violation is removed and the tables are in 4NF.

Join dependency in DBMS

What is Join Dependency?

If a table can be recreated by joining multiple tables and each of this table have a subset of the attributes of the table, then the table is in Join

Dependency. It is a generalization of Multivalued Dependency
Join Dependency can be related to 5NF, wherein a relation is in 5NF, only if it is already in 4NF and it cannot be decomposed further.

Example

<Employee>

EmpName	**EmpSkills**	**EmpJob** (Assigned Work)
Tom	Networking	EJ001
Harry	Web Development	EJ002
Katie	Programming	EJ002

The above table can be decomposed into the following three tables; therefore it is not in 5NF:

<EmployeeSkills>

EmpName	**EmpSkills**
Tom	Networking
Harry	Web Development
Katie	Programming

<EmployeeJob>

EmpName	**EmpJob**
Tom	EJ001
Harry	EJ002

Katie	EJ002

<JobSkills>

EmpSkills	**EmpJob**
Networking	EJ001
Web Development	EJ002
Programming	EJ002

Our Join Dependency −

{(EmpName, EmpSkills), (EmpName, EmpJob), (EmpSkills, EmpJob)}

The above relations have join dependency, so they are not in 5NF. That would mean that a join relation of the above three relations is equal to our original relation **<Employee>**.

Fifth Normal Form (5NF)

The 5NF (Fifth Normal Form) is also known as project-join normal form. A relation is in Fifth Normal Form (5NF), if it is in 4NF, and won't have lossless decomposition into smaller tables.

You can also consider that a relation is in 5NF, if the candidate key implies every join dependency in it.

Example

The below relation violates the Fifth Normal Form (5NF) of

Normalization − **<Employee>**

EmpName	**EmpSkills**	**EmpJob** (Assigned Work)

David	Java	E145
John	JavaScript	E146
Jamie	jQuery	E146
Emma	Java	E147

The above relation can be decomposed into the following three tables; therefore, it is not in 5NF −

<EmployeeSkills>

EmpName	**EmpSkills**
David	Java
John	JavaScript
Jamie	jQuery
Emma	Java

The following is the <EmployeeJob> relation that displays the jobs assigned to each employee −

<EmployeeJob>

EmpName	**EmpJob**
David	E145
John	E146
Jamie	E146
Emma	E147

Here is the skills that are related to the assigned jobs −

<JobSkills>

EmpSkills	**EmpJob**

Java	E145
JavaScript	E146
jQuery	E146
Java	E147

Our Join Dependency −

{(EmpName, EmpSkills), (EmpName, EmpJob), (EmpSkills, EmpJob)}

The above relations have join dependency, so they are not in 5NF. That would mean that a join relation of the above three relations is equal to our original relation **<Employee>**.
Reference videos:

https://www.youtube.com/watch?v=mbj3HSK28Kk

https://www.youtube.com/watch?v=zb8ESEf36Zc