More on normalization

Case 1

Consider the following table; definitely, it is not in 1NF

TABLE_PRODUCT

ProductID	Color	Price
1	red, green	15.99
2	yellow	23.99
3	green	17.50
4	yellow, blue	9.99
5	red	29.99

If we expand the second column, it would be

ProductID	Color	Price
1	red	15.99
1	green	15.99
2	yellow	23.99
3	green	17.50
4	yellow	9.99
4	blue	9.99
5	red	29.99

It is in 1NF, but not in 2NF, since it has the partial dependency (ProductID -> Price).
It is not in 4NF, either, since it has the multivalued dependency (ProductID ->->Color).

Through the normalization process, we have the following two tables

Product_Color

ProductID	Color
1	red
1	green
2	yellow
3	green
4	yellow
4	blue
5	red

Product_Price

ProductID	Price
1	15.99
2	23.99
3	17.50
4	9.99
5	29.99

Case 2

This case is a little different.

Consider the following table

Pizza_Delivery

Restaurant	Pizza Variety	Delivery Area
A1 Pizza	Thick Crust, Stuffed Crust	Springfield, Shelbyville, Capital City
Elite Pizza	Thin Crust, Stuffed Crust	Capital City
Vincenzo's Pizza	Thick Crust, Thin Crust	Springfield, Shelbyville

Again, it is not in 1NF obviously. After expanding the two columns, we can have

Pizza_Delivery_Permutations

Restaurant	Pizza Variety	Delivery Area
A1 Pizza	Thick Crust	Springfield
A1 Pizza	Thick Crust	Shelbyville
A1 Pizza	Thick Crust	Capital City
A1 Pizza	Stuffed Crust	Springfield
A1 Pizza	Stuffed Crust	Shelbyville
A1 Pizza	Stuffed Crust	Capital City
Elite Pizza	Thin Crust	Capital City
Elite Pizza	Stuffed Crust	Capital City
Vincenzo's Pizza	Thick Crust	Springfield
Vincenzo's Pizza	Thick Crust	Shelbyville
Vincenzo's Pizza	Thin Crust	Springfield
Vincenzo's Pizza	Thin Crust	Shelbyville

Now, the table is in 2NF (no partial dependency), 3NF (no transitive dependency), and BCNF (all determinants are candidate key). In fact, the primary key of the table is the composite key (Restaurant, Pizza Variety, Delivery Area).

However, the table is not in 4NF, since it has the following multivalued dependencies

Restaurant ->-> Pizza Variety

Restaurant ->-> Delivery Area

Therefore, we put the multivalued dependencies in separate tables

Varieties By Restaurant

Restaurant	Pizza Variety
A1 Pizza	Thick Crust
A1 Pizza	Stuffed Crust
Elite Pizza	Thin Crust
Elite Pizza	Stuffed Crust
Vincenzo's Pizza	Thick Crust
Vincenzo's Pizza	Thin Crust

Delivery Areas By Restaurant

Restaurant	Delivery Area
A1 Pizza	Springfield
A1 Pizza	Shelbyville
A1 Pizza	Capital City
Elite Pizza	Capital City
Vincenzo's Pizza	Springfield
Vincenzo's Pizza	Shelbyville