N&N Hospital is facing problems in its data organization. As database analyst, you have to normalize following N&N Hospital data up to **4NF**. Elaborate each step you perform with logic and state clearly any other **VALID** assumption that you make.

Doc no.	Name	Address	Phone	Department Id	Designation	Charges Per hour	Patient No.	Patient Name	CNIC	Phone	Room No.	Room Type	Bed No.
D1	Dr.Nadeem	Abc 123	0333-123, 042-123	Neurology	Professor	5000	P1	Kahlid	12345-1	042-1	R2	Normal	B1
							P5	Ahmed	12345-2	042-2			
							P7	Anum	12345-3	042-3	Nill		Nill
D2	Dr.Nadeem	Kb13	0334-124, 0300-123	Orthopedic	Professor	5000	P4	Mehmood	12345-4	042-4	R2	Normal	B1
							P7	Anum	12345-3	042-3	R4	Two bed	B5
							P9	Khawar	12345-6	042-5			B7
D4	Dr.Erum	Ak123	0321-123	ENT/ Neurology	Astt. Professor	3000	P10	Tanweer	12345-7	042-6	Nill		Nill
							P1	Khalid	12345-1	042-1	R5	Special	B8
D5	Dr.Hafeez	Nd123	0321-124	Skin/ Orthopedic	Astt. Professor	3000	P12	Sohail	12345-9	042-8	Nill		Nill
							P13	Ahmed	12346-0	042-9	R6	Special	B9

a) 1NF:

changes required -

1. change 'Name' to: (Salutaion, FName)
2. change multiple phone number to Phone_1 & Phone_2. If a doctor has only one number we put Null in Phone_2.
3. Also keep the multivalued attribures like PatientNo., PAtirentName, CNIC, Phone, RoomNo., RoomType, BedNo. in separate tupples. (change the 'Phone' (of the patient) to 'P_Phone' to avoid confusion)
4. Assumption – the 'Nill' or empty values in RoomNo., RoomType or BedNo. are assumed to be 'NoRoom', 'NoType', 'NoBed'.

The functional dependencies in the given data are ->

FD1: (DocNo.) -> (Salutaion, FName, Address,Phone_1, Phone_2, Dept.Id, Designation, Charges per hour)

FD2: (Patient No.) -> (PatientName, CNIC, P_Phone)

FD3: (DocNo., PatientNo.) -> (RoomNo., RoomType, BedNo)

FD4: (RoomNo.) -> (RoomType)

The table will look like the following after applying above changes:

Doc no.	Salutation	FName	Address	Phone_1	Phone_2	Department Id	Designation	Charges Per hour	Patient No.	Patient Name	CNIC	P_Phone	RoomNo.	RoomType	BedNo
D1	Dr.	Nadeem	Abc123	0333-123	042-123	Neurology	Professor	5000	P1	Khalid	12345-1	042-1	R2	Normal	B1
D1	Dr.	Nadeem	Abc123	0333-123	042-123	Neurology	Professor	5000	P5	Ahmed	12345-2	042-2	R2	Normal	B1
D1	Dr.	Nadeem	Abc123	0333-123	042-123	Neurology	Professor	5000	P7	Anum	12345-3	042-3	NoRoom	NoType	NoBed
D2	Dr.	Nadeem	Kb13	0334-124	0300-123	Orthopedic	Professor	5000	P4	Mehmood	12345-4	042-4	R2	Normal	B1
D2	Dr.	Nadeem	Kb13	0334-124	0300-123	Orthopedic	Professor	5000	P7	Anum	12345-3	042-3	R4	Two Bed	B5
D2	Dr.	Nadeem	Kb13	0334-124	0300-123	Orthopedic	Professor	5000	P9	Khawar	12345-6	042-5	R4	Two Bed	B7
D4	Dr.	Erum	Ak123	0321-123	Null	ENT/Neurology	Astt. Professor	3000	P10	Tanweer	12345-1	042-6	NoRoom	NoType	NoBed
D4	Dr.	Erum	Ak123	0321-123	Null	ENT/Neurology	Astt. Professor	3000	P1	Khalid	12345-6	042-1	R5	special	B8
D5	Dr.	Hafeez	Nd123	0321-124	Null	Skin/Orthopedic	Astt. Professor	3000	P12	Sohali	12345-9	042-8	NoRoom	NoType	NoBed
D5	Dr.	Hafeez	Nd123	0321-124	Null	Skin/Orthopedic	Astt. Professor	3000	P13	Ahmed	12346-0	042-9	R6	Special	B9

b) 2NF:

In above table the Primary key is : (DocNo.+PatientNo)

But the Relation is not in 2NF as there are partial dependencies on the primary key (Candidate key) due to functional dependies FD1 and FD2 listed above.

So we split the above table as shown:

Original Table : T(Doc no., Desgnation, FName, Address, Phone, Department Id, Designation, Charges Per hour, Patient No., Patient Name, CNIC, P_Phone, RoomNo., RoomType, BedNo)

New Tables : T1(Doc no., Desgnation, FName, Address, Phone_1, Phone_2, Department Id, Designation, Charges Per hour**);**

T2(Patient No., Patient Name, CNIC, P_Phone**) ;**

T3: (Doc no , Patient No., RoomNo., RoomType, BedNo)**;**

T1:

Doc no.	Salutation	FName	Address	Phone_1	Phone_2	Department Id	Designation
D1	Dr.	Nadeem	Abc123	0333-123	042-123	Neurology	Professor
D2	Dr.	Nadeem	Kb13	0334-124	0300-123	Orthopedic	Professor
D4	Dr.	Erum	Ak123	0321-123	Null	ENT/Neurology	Astt. Professor
D5	Dr.	Hafeez	Nd123	0321-124	Null	Skin/Orthopedic	Astt. Professor

T2:

Patient No.	Patient Name	CNIC	P_Phone
P1	Khalid	12345-1	042-1
P5	Ahmed	12345-2	042-2
P7	Anum	12345-3	042-3
P1	Khalid	12345-1	042-1
P5	Ahmed	12345-2	042-2
P7	Anum	12345-3	042-3
P4	Mehmood	12345-4	042-4
P7	Anum	12345-3	042-3
P9	Khawar	12345-6	042-5
P4	Mehmood	12345-4	042-4
P7	Anum	12345-3	042-3
P9	Khawar	12345-6	042-5
P10	Tanweer	12345-1	042-6
P1	Khalid	12345-1	042-1
P12	Sohali	12345-9	042-8
P13	Ahmed	12346-0	042-9

T3:

Doc no.	Patient No.	RoomNo.	RoomType	BedNo
D1	P1	R2	Normal	B1
D1	P5	R2	Normal	B1
D1	P7	NoRoom	NoType	NoBed
D2	P4	R2	Normal	B1
D2	P7	R4	Two Bed	B5
D2	P9	R4	Two Bed	B7
D4	P10	NoRoom	NoType	NoBed
D4	P1	R5	special	B8
D5	P12	NoRoom	NoType	NoBed
D5	P13	R6	Special	B9

c) 3NF:

There should be no transitive dependencies in 3NF & relation should be in 2NF.

Tables T1 & T2 have no transitive dependencies so they are in 3NF.

It states that for a dependency A->B, A should be a super key or B should be a prime attribute.

Now, due to **FD4 in** table which states that (RoomNo.) -> (RoomType) there is a transitive dependency.

So we modify T3 and make a new relation T4 as shown –

T3: (Doc no , Patient No., RoomNo., BedNo)**;**

T4: (RoomNo., RoomType,)**;**

T3(modified):

Doc no.	Patient No.	RoomNo.	RoomType	BedNo
D1	P1	R2	Normal	B1
D1	P5	R2	Normal	B1
D1	P7	NoRoom	NoType	NoBed
D2	P4	R2	Normal	B1
D2	P7	R4	Two Bed	B5
D2	P9	R4	Two Bed	B7
D4	P10	NoRoom	NoType	NoBed
D4	P1	R5	special	B8
D5	P12	NoRoom	NoType	NoBed
D5	P13	R6	Special	B9

T4:

RoomNo.	RoomType
R2	Normal
R4	Two Bed
R5	Special
R6	Special
NoRoom	NoType

d) BCNF:

It states that for each dependency A->B, A should be a super key. And the relations should be 3NF.

Clearly, all the dependencies are in BCNF. So finally we have following relations for N&N Hospital Data:

T1: (Doc no., Desgnation, FName, Address, Phone_1, Phone_2, Department Id, Designation, Charges Per hour**);**

T2: (Patient No., Patient Name, CNIC, P_Phone**) ;**

T3: (Doc no , Patient No., RoomNo., BedNo)**;**

T4: (RoomNo., RoomType,)**;**