

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 |          |           |         |
| 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   | Asst. Professor | 3000             | P10         | Tanweer      | 12345-7 | 042-6 | Nil      |           | Nil     |
|         |           |         |                    |                  |                 |                  | P1          | Khalid       | 12345-1 | 042-1 | R5       | Special   | B8      |
| D5      | Dr.Hafeez | Nd123   | 0321-124           | Skin/ Orthopedic | Asst. Professor | 3000             | P12         | Sohail       | 12345-9 | 042-8 | Nil      |           | Nil     |
|         |           |         |                    |                  |                 |                  | P13         | Ahmed        | 12346-0 | 042-9 | R6       | Special   | B9      |

Our task is to normalize the above given table till BCNF.

## 1NF

We notice that both phone and Department id contain multi valued attributes.

So we create a new table with only single valued attributes.

| Doc no | Name      | Address | Phone    | Departm   | Designation | Charges p | Patient n | Patient N | CNIC    | Phone | Room No. | Room Type | Bed No. |
|--------|-----------|---------|----------|-----------|-------------|-----------|-----------|-----------|---------|-------|----------|-----------|---------|
| D1     | Dr.Nadeem | Abc 123 | 0333-123 | Neurology | Professor   | 5000      | P1        | Khalid    | 12345-1 | 042-1 | R2       | Normal    | B1      |
| D1     | Dr.Nadeem | Abc 123 | 0333-123 | Neurology | Professor   | 5000      | P5        | Ahmed     | 12345-2 | 042-2 | R2       | Normal    | B1      |
| D1     | Dr.Nadeem | Abc 123 | 0333-123 | Neurology | Professor   | 5000      | P7        | Anum      | 12345-3 | 042-3 | Nil      |           | Nil     |
| D1     | Dr.Nadeem | Abc 123 | 042-123  | Neurology | Professor   | 5000      | P1        | Khalid    | 12345-1 | 042-1 | R2       | Normal    | B1      |
| D1     | Dr.Nadeem | Abc 123 | 042-123  | Neurology | Professor   | 5000      | P5        | Ahmed     | 12345-2 | 042-2 | R2       | Normal    | B1      |
| D1     | Dr.Nadeem | Abc 123 | 042-123  | Neurology | Professor   | 5000      | P7        | Anum      | 12345-3 | 042-3 | Nil      |           | Nil     |
| D2     | Dr.Nadeem | Kb13    | 0334-124 | Orthoped  | Professor   | 5000      | P4        | Mehmood   | 12345-4 | 042-4 | R2       | Normal    | B1      |
| D2     | Dr.Nadeem | Kb13    | 0334-124 | Orthoped  | Professor   | 5000      | P7        | Anum      | 12345-3 | 042-3 | R4       | Two Bed   | B5      |
| D2     | Dr.Nadeem | Kb13    | 0334-124 | Orthoped  | Professor   | 5000      | P9        | Khawar    | 12345-6 | 042-5 | R4       | Two Bed   | B7      |
| D2     | Dr.Nadeem | Kb13    | 0300-123 | Orthoped  | Professor   | 5000      | P4        | Mehmood   | 12345-4 | 042-4 | R2       | Normal    | B1      |
| D2     | Dr.Nadeem | Kb13    | 0300-123 | Orthoped  | Professor   | 5000      | P7        | Anum      | 12345-3 | 042-3 | R4       | Two Bed   | B5      |
| D2     | Dr.Nadeem | Kb13    | 0300-123 | Orthoped  | Professor   | 5000      | P9        | Khawar    | 12345-6 | 042-5 | R4       | Two Bed   | B7      |
| D4     | Dr.Erum   | Ak123   | 0321-123 | ENT       | Asst. Prof  | 3000      | P10       | Tanweer   | 12345-7 | 042-6 | Nil      |           | Nil     |
| D4     | Dr.Erum   | Ak123   | 0321-123 | ENT       | Asst. Prof  | 3000      | P1        | Khalid    | 12345-1 | 042-1 | R5       | Special   | B8      |
| D4     | Dr.Erum   | Ak123   | 0321-123 | Neurology | Asst. Prof  | 3000      | P10       | Tanweer   | 12345-7 | 042-6 | Nil      |           | Nil     |
| D4     | Dr.Erum   | Ak123   | 0321-123 | Neurology | Asst. Prof  | 3000      | P1        | Khalid    | 12345-1 | 042-1 | R5       | Special   | B8      |
| D5     | Dr.Hafeez | Nd123   | 0321-124 | Skin      | Asst. Prof  | 3000      | P12       | Sohail    | 12345-9 | 042-8 | Nil      |           | Nil     |
| D5     | Dr.Hafeez | Nd123   | 0321-124 | Skin      | Asst. Prof  | 3000      | P13       | Ahmed     | 12346-0 | 042-9 | R6       | Special   | B9      |
| D5     | Dr.Hafeez | Nd123   | 0321-124 | Orthoped  | Asst. Prof  | 3000      | P12       | Sohail    | 12345-9 | 042-8 | Nil      |           | Nil     |
| D5     | Dr.Hafeez | Nd123   | 0321-124 | Orthoped  | Asst. Prof  | 3000      | P13       | Ahmed     | 12346-0 | 042-9 | R6       | Special   | B9      |

The above table is in 1NF.

## 2NF

Now we find the functional dependencies in the given table.

Here are the functional dependencies I found.

Patient No-> Patient Name,CNIC,Phone

Doc No.,Patient No->Room No,Bed No.

Room No.->Room Type

Doc No.->Name,Address,Designation

Designation->Charges

Doc No->Designation

Phone No-> Doc No.

I have made the assumptions that there are 2 different DR. Nadeem as they have different Doc No, phone and they work on different departments.

So the candidate key was:

Doc No, Phone, Department, Patient No.

So removing the partial dependencies:-

Doc No.->Name,Address,Designation

Patient No-> Patient Name,CNIC,Phone

Doc No,Patient No->Room No,Bed No

We get the following tables

|            |            |         |             |         |  | Doc No | Phone    | Departme  | Patient No |  |  |  |  |  | Doc no | Patient No | Room No | Room Type | Bed No |
|------------|------------|---------|-------------|---------|--|--------|----------|-----------|------------|--|--|--|--|--|--------|------------|---------|-----------|--------|
|            |            |         |             |         |  | D1     | 0333-123 | Neurology | P1         |  |  |  |  |  | D1     | P1         | R2      | Normal    | B1     |
|            |            |         |             |         |  | D1     | 0333-123 | Neurology | P5         |  |  |  |  |  | D1     | P5         | R2      | Normal    | B1     |
|            |            |         |             |         |  | D1     | 0333-123 | Neurology | P7         |  |  |  |  |  | D1     | P7         | Nil     |           | Nil    |
| Doc no     | Name       | Address | Designatic  | Charges |  | D1     | 042-123  | Neurology | P1         |  |  |  |  |  | D2     | P4         | R2      | Normal    | B1     |
| D1         | Dr. Nadeem | Abc 123 | Professor   | 5000    |  | D1     | 042-123  | Neurology | P5         |  |  |  |  |  | D2     | P7         | R4      | Two Bed   | B5     |
| D2         | Dr. Nadeem | Kb13    | Professor   | 5000    |  | D1     | 042-123  | Neurology | P7         |  |  |  |  |  | D2     | P9         | R4      | Two Bed   | B7     |
| D4         | Dr. Erum   | Ak123   | Asst. Profe | 3000    |  | D2     | 0333-124 | Orthopedi | P4         |  |  |  |  |  | D4     | P10        | Nil     |           | Nil    |
| D5         | Dr. Hafeez | Nd123   | Asst. Profe | 3000    |  | D2     | 0333-124 | Orthopedi | P7         |  |  |  |  |  | D4     | P1         | R5      | Special   | B8     |
|            |            |         |             |         |  | D2     | 0333-124 | Orthopedi | P9         |  |  |  |  |  | D5     | P12        | Nil     |           | Nil    |
| Patient no | Patient No | CNIC    | Phone       |         |  | D2     | 0300-123 | Orthopedi | P4         |  |  |  |  |  | D5     | P13        | R6      | Special   | B9     |
| P1         | Khalid     | 12345-1 | 042-1       |         |  | D2     | 0300-123 | Orthopedi | P7         |  |  |  |  |  |        |            |         |           |        |
| P4         | Mehmood    | 12345-4 | 042-4       |         |  | D2     | 0300-123 | Orthopedi | P9         |  |  |  |  |  |        |            |         |           |        |
| P5         | Ahmed      | 12345-2 | 042-2       |         |  | D4     | 0321-123 | ENT       | P10        |  |  |  |  |  |        |            |         |           |        |
| P7         | Anum       | 12345-3 | 042-3       |         |  | D4     | 0321-123 | ENT       | P1         |  |  |  |  |  |        |            |         |           |        |
| P9         | Khawar     | 12345-6 | 042-5       |         |  | D4     | 0321-123 | Neurology | P10        |  |  |  |  |  |        |            |         |           |        |
| P10        | Tanweer    | 12345-7 | 042-6       |         |  | D4     | 0321-123 | Neurology | P10        |  |  |  |  |  |        |            |         |           |        |
| P12        | Sohail     | 12345-9 | 042-8       |         |  | D5     | 0321-124 | Skin      | P12        |  |  |  |  |  |        |            |         |           |        |
| P13        | Ahmed      | 12345-0 | 042-9       |         |  | D5     | 0321-124 | Skin      | P13        |  |  |  |  |  |        |            |         |           |        |
|            |            |         |             |         |  | D5     | 0321-124 | Orthopedi | P12        |  |  |  |  |  |        |            |         |           |        |
|            |            |         |             |         |  | D5     | 0321-124 | Orthopedi | P13        |  |  |  |  |  |        |            |         |           |        |

## 3NF and BCNF

Removing the partial dependencies and also making new tables such that in all partial dependencies the LHS is a super key we focus on the dependencies

Designation->Charges

Room No->Room Type

We get:-

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

Hence we have normalized the given table upto BCNF