Homework 4

Prepare your answers using either a word processor or by neatly sketching diagrams and then scanning them into a single digital document (e.g., scan them into a word processing document and then create a pdf file of the word processing document). When the two normal form problems say "describe and illustrate the process of normalizing", I want to see three sets of relations--the 1st NF, 2nd NF, and 3rd NF relations--**and the functional dependencies you used to go from 1st NF to 2nd NF and then from 2nd NF to 3rd NF**.

1. 14.14. You may need to read parts of the Wellmeadows Hospital case study in Appendix B. You may make the following assumptions:
   a. A drug's dosage and method of administration is determined by its drug no
   b. Each ward has unique bed numbers, but they may not be unique throughout the hospital (i.e., the bed number may be replicated in another ward).
   c. The relation only stores patients currently registered at the hospital and hence each patient will be in at most one bed and one ward

   Use reasonable assumptions about the remaining fields on the form. Make sure that you look at the fields at the top of the form, such as full name and patient number, and not just at the fields in the table.

   ANSWERS

   a) Identify the functional dependencies represented by the attributes shown in the form in Figure 14.18. State any assumptions that you make about the data and the attributes shown in this form.

   i. patientNo → fullName, wardNo, bedNo

   ii. wardNo → wardName

   iii. wardName → wardNo

   iv. drugNo → name, description, dosage, methodOfAdmin

   v. patientNo, drugNo, startDate → unitsPerDay, finishDate

   b) Describe and illustrate the process of normalizing the attributes shown in Figure 14. 18 to produce a set of well-designed 3NF relations.

   i. 1NF

   Relations:
   - PatientMedication(patientNo, drugNo, startDate, fullName, wardNo, wardName, bedNo, name, description, dosage, methodOfAdmin, unitsPerday, finishDate)

   ii. 2NF

   1NF → 2NF (partial dependencies used):

- drugNo → name, description, dosage, methodOfAdmin
- patientNo → fullName, wardNo, bedNo

Relations:
- PatientMedication(patientNo, drugNo, startDate, unitsPerDay, finishDate)
- DrugInformation(drugNo, name, description, dosage, methodOfAdmin)
- PatientInformation(patientNo, fullName, wardNo, wardName, bedNo)

iii. 3NF

2NF → 3NF (transitive dependencies used):
- wardNo → wardName

Relations:
- PatientMedication(patientNo, drugNo, startDate, unitsPerDay, finishDate)
- DrugInformation(drugNo, name, description, dosage, methodOfAdmin)
- PatientInformation(patientNo, fullName, wardNo, bedNo)
- WardName(wardNo, wardName)

c) Identify the primary, alternate, and foreign keys in your 3NF relations.

i. Primary, alternate (i.e., candidate keys not selected as primary key)**, and foreign keys in 3NF relations**

- **PatientMedication**
  - Primary keys: (patientNo, drugNo, startDate)
  - Alternate keys: (patientNo, drugNo, finishDate)
  - Foreign keys: patientNo; drugNo

- **DrugInformation**
  - Primary keys: drugNo
  - Alternate keys: name [this assumes name == generic/brand drug name which is required to be unique by law so one drug doesn't get confused with another: https://www.merckmanuals.com/home/drugs/brand-name-and-generic-drugs/overview-of-generic-drugs-and-drug-naming#:~:text=As%20a%20result%2C%20the%20same,prescribed%20and%20prescriptions%20are%20dispensed.]

    NOTE TO GRADER: Dr. VZ's assumption "a" makes me believe that he's implying that (dosage, methodOfAdmin) could be unique as well, thus a candidate key. However, it seems perfectly

reasonable to me that two different drugNo could possibly have the same dosage and methodOfAdmin. For this reason, I'm omitting (dosage, methodOfAdmin) as an alternate key.

- Foreign keys: N/A

- **PatientInformation**

  - Primary keys: patNo
  - Alternate keys: (wardNo, bedNo) [based on Dr. VZ's assumption "c" meaning that a (wardNo, bedNo) pair uniquely identifies a currently registered patient. After all, two registered patients can't be in the same physical bed simultaneously. If so, someone needs to investigate that hospital for illegal practices 😉]
  - Foreign keys: wardNo

- **WardName**

  - Primary keys: (wardNo)
  - Alternate keys: wardName [because of **wardNo → wardName** and **wardName → wardNo** dependencies. This shows that wardName and wardNo mutally have ONE TO ONE correspondence with each other, (i.e., meaning a particular wardName would never have two or more wardNo's and vice versa)]
  - Foreign keys: N/A

2. 14.15. Assume that this appointments relation not only contains information about the appointments, but is also the only repository of information about the dentists in the practice, and the patients in the practice. Assume that surgeries has another relation which is referenced by the surgery number and contains information about the surgeries. You may make the following assumptions:
   a. When the book says "assigned to a surgery" the book is talking about the location (e.g., such as a building or clinic) in which the operation is to be performed, not the operation itself.
   b. a patient can be registered for only one surgery (i.e., clinic). You will note that patients may have multiple appointments but are registered for the same surgery at each appointment. The book makes this assumption as well in its solution.
   c. a patient may have multiple appointments on the same day.

ANSWERS

a) The table shown in Figure 14.19 is susceptible to update anomalies. Provide examples of insertion, deletion, and update anomalies.

i. Insertion [primary key == (staffNo, appointment)]:

- If a new dentist needed to be inserted without an appointment , then appointment attributes would be assigned NULL which is not allowed because they are part of the primary key, (staffNo, appointment)
- If a new patient is needed to be inserted with an appointment, but a dentist couldn't be assigned yet, then appointment would be NULL which is not allowed because it's part of the primary key, (staffNo, appointment)

ii. Deletion [primary key == (staffNo, appointment)]:

- If all information about a particular patient and/or dentist is deleted from this relation, then that information is completely lost because it is stored nowhere else. For example, a dentist may only be working on one patient, but if all associated appointments were suddenly canceled and associated rows deleted from this relation, then all information about that dentist and patient would be lost.

iii. Update [primary key == (staffNo, appointment)]:

- If a dentist and/or patient changes their name, then this could need updates in several locations (dentistName and patName, respectively).
- If a patient changes surgeryNo's for an appointment, then that could need updating in several places if there are multiple appointments rows for that patient.

b) Identify the functional dependencies represented by the attributes shown in the table of Figure 14.19. State any assumption you make about the data and the attributes shown in this table.

i. Functional Dependencies

- staffNo → dentistName
- (staffNo, appointment) → patNo
- patNo → patName, surgeryNo

NOTE TO GRADER:
patNo → surgeryNo dependency is based Dr. VZ's assumption "b". I'm interpreting "a patient can be registered for only one surgery (i.e., clinic)" to mean that a patNo will never be in the relation with more than one associated surgeryNo. Honestly, this does not sound realistic to me (what if the patient comes back for another, separate surgery in a different surgeryNo? Surely that's possible…), but I think his statement is pretty clear on the issue.

c) Describe and illustrate the process of normalizing the table shown in Figure 14.19 to 3NF relations. Identify the primary, alternate, and foreign keys in your 3NF relations.

i. 1NF

Relations:

- DentistPatientAppointment(staffNo, appointment, patNo dentistName, patName, surgeryNo)

ii. 2NF

1NF → 2NF (partial dependencies used):

- staffNo → dentistName

Relations:

- DentistPatientAppointment(staffNo, appointment, patNo, patName, surgeryNo)
- StaffInformation(staffNo, dentistName)

iii. 3NF

2NF → 3NF (transitive dependencies used):

- patNo → patName, surgeryNo

Relations:

- DentistPatientAppointment(staffNo, appointment, patNo)
- StaffInformation(staffNo, dentistName)
- PatientSurgeryInformation(patNo, patName, surgeryNo)

iv. Primary, alternate (i.e., candidate keys not selected as primary key)**, and foreign keys in 3NF relations**

- **DentistPatientAppointment**
  - Primary keys: (staffNo, appointment)
  - Alternate keys: (patNo, appointment)
  - Foreign keys: staffNo; patNo
- **StaffInformation**
  - Primary keys: staffNo
  - Alternate keys: N/A
  - Foreign keys: N/A
- **PatientSurgeryInformation**
  - Primary keys: patNo
  - Alternate keys: N/A

NOTE TO GRADER:
There are no alternative keeps because it is possible, though rare, for two different patients (i.e., different patNo's) with the same patName to be appointed to the same surgeryNo . Also, surgeryNo is not unique as you can see in the table provided in the problem (e.g., S15 is associated with two patNo's resulting in S15 showing up two times in PatientSurgeryInformation == not unique).

- Foreign keys: surgeryNo