

Please read 15 – 15.4 of the textbook and then answer the following, trying not to look at your notes or at the textbook. Quiz #5, on Wednesday 21st March, will consist of questions taken or inspired from Part I and Part II of this homework.

## Part I — Questions

1. What is insertion anomaly? Give an example.
2. Why should we avoid attributes whose value will often be **NULL**? Can the usage of **NULL** be completely avoided?
3. Consider the following relation:  
STUDENT(SSN, Name, ..., Sibling\_On\_Campus)  
Why is it a poor design to have a “Sibling\_On\_Campus” attribute in such a relation? How should we store this information?
4. Consider the following relational database schema:  
STUDENT(Login, Name, ..., Major, Major\_Head)  
DEPARTMENT(Code, Name, Major\_Head)  
Assuming that “Major” is a foreign key referencing “DEPARTMENT.Code”, what is the problem with that schema? How could you address it?
5. Consider the relation  $R(A, B, C, D, E, F)$  and the following functional dependencies:
  1.  $F \rightarrow \{D, C\}, D \rightarrow \{B, E\}, \{B, E\} \rightarrow A$
  2.  $\{A, B\} \rightarrow \{C, D\}, \{B, E\} \rightarrow F$
  3.  $A \rightarrow \{C, D\}, E \rightarrow F, D \rightarrow B$For each set of functional dependency, give a key for  $R$ . We want a key, so it has to be minimal.
6. Consider the relation  $R(A, B, C, D)$  and answer the following:
  1. If  $\{A, B\}$  is the only key, is  $\{A, B\} \rightarrow \{C, D\}, \{B, C\} \rightarrow D$  a 2NF? List the nonprime attributes and justify.
  2. If  $\{A, B, C\}$  is the only key, is  $A \rightarrow \{B, D\}, \{A, B, C\} \rightarrow D$  a 2NF? List the nonprime attributes and justify.
7. Consider the relation  $R(A, B, C, D, E, F)$  with candidate keys  $\{A, B\}$  and  $C$ . Answer the following:
  1. What are the prime attributes in  $R$ ?
  2. Is  $\{C, D\} \rightarrow E$  a fully functional dependency?
  3. Write a set of functional dependencies containing at least one transitive dependency, and justify your answer.
8. Consider the relation  $R(A, B, C, D)$  and answer the following:
  1. If  $A$  is the only key, is  $A \rightarrow \{B, C, D\}, \{A, B\} \rightarrow C, \{B, C\} \rightarrow D$  a 3NF? List the nonprime attributes and justify.
  2. If  $B$  is the only key, is  $B \rightarrow \{A, C, D\}, A \rightarrow \{C, D\}, \{A, C\} \rightarrow D$  a 3NF? List the nonprime attributes and justify.

## Part II — Problems

This part will help you in assessing your level of understanding of this lecture, and give you an idea of the kind of problem you will be asked to solve during the exams. I'll assume that you will have successfully completed those two problems by the time Homework #6 is released (Wednesday 21st March), so don't wait and let me know if you had difficulties solving them.

### Problem 1

This problem asks you to convert business statements into dependencies. Consider the following relation:

BIKE(Serial\_no, Manufacturer, Model, Batch, Wheel\_size, Retailer)

Each tuple in the relation BIKE contains information about a bike with a serial number, made by a manufacturer, with a particular model number, released in a certain batch, which has a certain wheel size, and is sold by a certain retailer.

- Write each of the following dependencies as a functional dependency (I give you the first one as an example):
  1. A retailer can't have two bikes of the same model from different batches.  
*solution:* {Retailer, Model} → Batch
  2. The manufacturer and serial number uniquely identifies the bike and where it is sold.
  3. A model number is registered by a manufacturer and therefore can't be used by another manufacturer.
  4. All bikes in a particular batch are of the same model.
  5. All bikes of a certain model have the same wheel size.
- Based on those statements, what could be a key for this relation?
- Assuming all those functional dependencies hold, and taking the primary key you identified at the previous step, what is the degree of normality of this relation? Justify your answer.

### Problem 2

Consider the relations  $R$  and  $T$  below, and their functional dependencies (on top of the one induced by the primary keys):

$R(\underline{\text{EventId}}, \underline{\text{Email}}, \text{Time}, \text{Date}, \text{Location}, \text{Status})$

$T(\underline{\text{Invno}}, \text{Subtotal}, \text{Tax}, \text{Total}, \text{Email}, \text{Lname}, \text{Fname}, \text{Phone})$

{EventId, Email} → Status

EventId → {Time, Date, Location}

Invno → {Subtotal, Tax, Total, Email}

Email → {Fname, Lname, Phone}

Normalize the relations to 2NF and 3NF. Show all relations at each stage (2NF and 3NF) of the normalization process.

### Problem 3

Consider the following relation for published books:

BOOK (Book\_title, Book\_type, Author\_name, List\_price, Author\_affil, Publisher)

Suppose we have the following dependencies:

Book\_title → { Publisher, Book\_type }  
Book\_type → List\_price  
Author\_name → Author\_affil

- What would be a suitable key for this relation?
- How could this relation not be in first normal form? Explain your answer.
- This relation is not in second normal form: explain why and normalize it.
- Is the relations you obtained at the previous step in third normal form? Explain why, and normalize them if needed.

