

Exercise 4.1: Database Design

In this exercise set, you will see

- Functional dependencies
- Decomposition into sub-relations to avoid update anomalies
- Creating a database from a text

Exercise 1: Functional Dependencies and Normalization

Employee is a relation that describes an employee who works on a project in a laboratory:

Employee (EmpNb, LabNb, ProjNb, Emp_Name, Proj_Name, Address)

With the following functional dependencies:

(EmpNb, LabNb) → ProjNb
 EmpNb → Emp_Name
 EmpNb → Address
 ProjNb → Proj_Name

For the relation above:

- establish the minimum graph of these dependencies
- define its (their) key(s)
- identify the possible update anomalies of this relation
- define its normal form
- propose a decomposition

Exercise 2: Relational Normalization

Let **R1** be the following relation with a set of dependencies:

R1 (A, B, C, D, E, F)

{AB → C, AB → D, AB → E, AB → F, B → C, D → E, D → F}

For the relation above:

- a. Give the minimum graph of dependencies. Which is the key for **R1**?
- b. What is the normal form for **R1**?
- c. The relation **R1** is decomposed to **R11** and **R12**: **R11** (A, B, D, E, F) and **R12** (B, C). What are the normal forms of the relations **R11** and **R12**?

- d. Propose a decomposition of R11 without any update anomalies (multiple modifications, information loss, additions requiring complete information).

Exercise 3: Connectivity

PART 1

Bridge inspections are recorded by a bridge management authority. The following important functional dependencies in the system are given:

Bridge identifier (ID) → Location
 ID → Year of construction
 (ID, Date of inspection) → Bridge inspector

Regarding Table 5.1, answer the questions given below.

- (a) Which normal form does the table belong to?
- (b) What are the primary keys in the table?

Answer the following questions using tables 5.2 and 5.3.

- (c) Which normal form does this design belong to?
- (d) What are the primary keys in table 5.3?
- (e) Decompose table 5.1 into third normal form if there was only one bridge inspector per city at a time. This means that the following functional dependency is valid:

(Location, Date of inspection) → Bridge inspector

This replaces the original functional dependency ((ID, Date of inspection) → Bridge inspector)

Table 5.1 Bridge Inspections

ID	Location	Year of Construction	Date of Inspection	Bridge Inspector
1	Geneva	1979	July/1989	A
1	Geneva	1979	August/1994	B
2	Bern	1989	July/1995	B

Table 5.2 Bridges

ID	Location	Year of Construction
1	Geneva	1979
2	Bern	1989

Table 5.3 Bridge Inspections

ID	Date of Inspection	Bridge Inspector
1	July/1989	A
1	August/1994	B
2	July/1995	B

PART 2

After several years of using Table 5.1 the bridge maintenance director was changed and the new director decided to redesign the database. He asked that the database people decompose Table 5.1. Table 5.1 was split into two tables.

Table 5.4

ID	Year of Construction	Data of Inspection

Table 5.5

ID	Location	Bridge Inspector

1. Complete the tables using the information given in Table 5.1. Are all the values from Table 5.1 shown in the new tables?
2. The maintenance team then inspected a new bridge. Include the information concerning the new bridge given below in the tables above.

ID = 3
 Location = Lausanne
 Year of Construction = 1980
 Date of Inspection = 2011
 Bridge Inspector = C

3. Several months after the changes were made to the database, bridge number one showed signs of significant degradation. Therefore, the new director wished to speak with the engineer who made the last inspection. Knowing that table 5.1 is no longer valid, is it possible to identify the engineer responsible for the last inspection? What error was made?

Exercise 4: The Mechanic

A mechanic wants to create a database with the following characteristics:

- Automobiles are composed of their chassis number (ChassisNb), year of manufacture, brand, color, engine capacity and type (standard car, sports car, van,...), tire brand, warranty.

- The owner is identified by their surname, name, address, city, country and telephone number (TelNb).
- Warranty depends on the brand and has a certain duration.
- For each car repair, the type and cost of the repair is noted.
- The employee is identified the same way as the owner with an addition of her/his monthly salary, pension fund and civil status.

Question:

Define the relations, their attributes, keys and attributes that are keys in other relations.

Remark: Each point describes a new relation. It may be judicious to add attributes to some relations.

Exercise 5: The Editor

An editor wants to install a database to store the following information:

- The books are identified by their ISBN number. A book has a title and a sale price. It is written by one or several authors.
- Each book has one or several editions - dated and identified by its order (first edition, second edition, etc.)
- Each edition has a certain number of copies. A book can be awarded a prize (Pulizer, PEN/Faulkner etc.) (Independent of the edition, but the year in which the prize was given must be mentioned).
- The authors are identified by their surname and name. They may have a pen name.
- The bookstores (identified by their names and complete address) can make orders for one or several books in certain quantities.

Note that:

- Several edition numbers may exist for a single ISBN.
- The price depends on the edition number.
- Several people may have co-authored a book.

Question:

Define the relations, their attributes, keys and attributes that are keys in other relations.

Remark: Each point describes a new relation.

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