

# Assignment #4 FDs and Normal Forms

## Spring Semester 2023

### Database Systems

**Due Date:** Before the start of the class (5<sup>th</sup> April 2022)

**Instructions:**

- Use proper assignment papers for solving your assignment questions. Assignments done on diary pages, register pages, and rough pages will not be credited.
- Do not copy the work of your peers. In case cheating is detected, then your case will be referred to DC.

**Question 1:**

The relation given below shows five sample records that represent members of staff who have been allocated a car parking space. Each car park space provided by the organization is uniquely identified using a space number (space). (Note in this example, we do not include the extension number and vehicle license number data associated with staff.)

- (a) The relation is susceptible to update anomalies. Provide examples of insertion, deletion, and modification anomalies.
- (b) Identify the functional dependencies represented by the data shown in the table. State any assumptions you make about the data shown in this table.
- (c) Describe and illustrate the process of normalizing the relation to 3NF. Identify the primary key and, where appropriate, alternate and foreign keys in each table.
- (d) Demonstrate that the functional dependencies identified in part (b) are present in the 3NF tables described in part (c).

| staffNo | name             | carParkName | location | capacity | noOfFloors | spaceNo |
|---------|------------------|-------------|----------|----------|------------|---------|
| S1156   | Jane Jones       | Yellow      | Block E  | 120      | 3          | 123     |
| S2311   | Karen Gilmore    | Yellow      | Block E  | 120      | 3          | 145     |
| S1167   | Richard Blight   | Yellow      | Block E  | 120      | 3          | 156     |
| S2345   | Guy Ritchie      | Green       | Block D  | 45       | 2          | 26      |
| S3434   | Stephen Williams | Green       | Block D  | 45       | 2          | 34      |

**Question 2:** The table given below shows **staff distribution center details**

- a) The table is susceptible to update anomalies. Provide examples of insertion, deletion, and modification anomalies.
- b) Specify all the keys of the given relation for the staff distribution center.
- c) Check if the relation is in BCNF. If not, then indicate all the BCNF violations.
- d) Decompose the relation into collections of relations that are in BCNF.
- e) Indicate all the 3NF violations.
- f) Decompose the relations, as necessary, into collections of relations in 3NF.

| staffNo | name          | position  | salary | dCenterNo | dAddress                                | dTelNo       |
|---------|---------------|-----------|--------|-----------|---|--------------|
| S1500   | Tom Daniels   | Manager   | 48000  | D001      | 8 Jefferson Way, Portland, OR 97201     | 503-555-3618 |
| S0003   | Sally Adams   | Assistant | 30000  | D001      | 8 Jefferson Way, Portland, OR 97201     | 503-555-3618 |
| S0010   | Mary Martinez | Manager   | 51000  | D002      | City Center Plaza, Seattle, WA 98122    | 206-555-6756 |
| S3250   | Robert Chin   | Assistant | 33000  | D002      | City Center Plaza, Seattle, WA 98122    | 206-555-6756 |
| S2250   | Sally Stern   | Manager   | 48000  | D004      | 2 W. El Camino, San Francisco, CA 94087 | 822-555-3131 |
| S0415   | Art Peters    | Manager   | 42000  | D003      | 14 – 8th Avenue, New York, NY 10012     | 212-371-3000 |

Primary key

(fd1)

(fd2)

(fd3)

(fd4)

Table for Staff distribution center

### Question 3:

The following statement is presented to the patient (or patient representative) when the patient is discharged. Assume that each item on the bill has a unique description and that the charge for a particular item may vary from one patient to another.

Using the normalization, develop a set of BCNF relations for the patient billing system shown below.

Draw a relational schema for the BCNF relations you developed. Be sure to show the functional dependencies and referential integrity constraints.

| INVOICE      |              | INVOICE DATE: 10/24/2010<br>ACCOUNT NUMBER: 000976555<br>DUE DATE: 11/14/2010 |                 |
|--------------|--------------|---|-----------------|
| PATIENT NAME | PATIENT #    | DATE ADMITTED   | DATE DISCHARGED |
| Mary Baker   | 3249         | 10/15/2010  | 10/18/2010      |
| CODE         | DESCRIPTION  | TOTAL CHARGE  |                 |
| 200          | Room semi-pr | 1,800.00  |                 |
| 205          | Television   | 75.00   |                 |
| 307          | X-ray        | 150.00  |                 |
| 413          | Lab tests    | 200.00  |                 |
|              |              | TOTAL CHARGES DUE   | 2,225.00        |

**Question 4:** SuperX Theater produces a series of short dramas and shows them in different nationwide theaters. This summer, they are presenting 4-opera mini-series. This series has a huge cast. The owner wants a database to keep track of the characters. They hired an intern, and he built a table named Opera. It lists the characters and information about them, such as their voice part, what they have power over (fire, love, the magic sword, etc.), the name of their residence, and its address.

| Character  | Voice    | Power  | Residence          | Address             |
|------------|----------|--------|--------------------|---------------------|
| Wotan      | Baritone | Light  | Valhalla           | Rainbow Bridge      |
| Wotan      | Baritone | Air    | Valhalla           | Rainbow Bridge      |
| Erda       | Alto     | Wisdom | Middle of Universe | Fremont             |
| Erda       | Alto     | Fate   | Middle of Universe | Fremont             |
| Siegfried  | Tenor    | Sword  | Forest             | Hurricane Ridge     |
| Brunnhilde | Soprano  | Horse  | Rock               | Enchanted Fire Ring |
| Freia      | Soprano  | Love   | Valhalla           | Rainbow Bridge      |
| Loge       | Tenor    | Fire   | Valhalla           | Rainbow Bridge      |
| Hagen      | Bass     | Drink  | Hut                | Seward Park         |
| Getrune    | Soprano  | Drink  | House              | Wallingford         |

Your assignment is as follows:

- a) This table is not in BCNF. Based only on the data given above, identify the functional dependencies that violate BCNF
- a) Using the functional dependencies you identified in part a), decompose the table into BCNF. Indicate which attributes are the key(s) of the various relations, and also indicate any foreign key relationships between the tables. **Show the steps** in your decomposition that clearly show which functional dependencies you are using at each step.