CS4221: Database Design

Tutorial 1: The Relational Model – Functional Dependency

5 February 2015

Note: Due to the time constraint, we will only discuss some of the questions.

1. Information of a hospital database system is shown in Figure 1.

PATIENT

Code	Surname	FirstName
A102	Harris	Lucy
B372	Rossini	Peter
B543	Johnson	Nadia
B444	Johnson	Luigi
S555	Rose	Jean

ADMISSION

Patient	Admitted	Discharged	Ward
A102	2/05/94	9/05/94	A
A102	2/12/94	2/01/95	A
S555	5/10/94	3/12/94	B
B444	1/12/94	1/01/95	B
S555	5/10/95	1/11/95	A

DOCTOR

Number	Surname	FirstName	Ward
203	Black	Peter	A
574	Bisi	Mavis	B
461	Boyne	Steve	B
530	Clark	Nicola	C
405	Mizzi	Nicola	A
501	Mount	Mavis	A

WARD

Code	Name	Head
A	Surgical	203
B	Paediatric	574
C	Medical	530

Figure 1. A database instance for Question 1.

Find functional dependencies, keys and referential constraints that exist in the database. You may make some reasonable assumptions.

Highlight attributes on which they could be reasonable to admit null values.

Does the database schema satisfy the Universal Relation Assumption? If not, modify the schema so that the database will satisfy the Universal Relation Assumption.

2. The table (i.e. relation) in Figure 2 lists sample dentist/patient appointment data. A patient is given an appointment at a specific time and date with a dentist located for a particular surgery.

   (a) Identify the functional dependencies represented by the attributes shown in the table of Figure 2. State any assumptions you make about the data and the attributes shown in this table.

   (b) The table shown in Figure 2 is susceptible to update anomalies. Provide examples of insertion, deletion, and update anomalies.

   (c) Describe and illustrate the process of normalizing the table shown in Figure 2 to 3NF relations using the decomposition method. Identify the primary, alternate, and foreign keys in your 3NF relations.

staffNo	dentistName	patNo	patName	appointment date	time	surgeryNo
S1011	Tony Smith	P100	Gillian White	12-Sep-08	10.00	S15
S1011	Tony Smith	P105	Jill Bell	12-Sep-08	12.00	S15
S1024	Helen Pearson	P108	Ian MacKay	12-Sep-08	10.00	S10
S1024	Helen Pearson	P108	Ian MacKay	14-Sep-08	14.00	S10
S1032	Robin Plevin	P105	Jill Bell	14-Sep-08	16.30	S15
51032	Robin Plevin	P110	John Walker	15-Sep-08	18.00	S13

Figure 2. Table displaying sample dentist/patient appointment data.

3. Consider the following relational schema:

   Car (make, model, year, color, dealer)

   Each tuple in relation *Car* specifies that one or more cars of a particular make, model, and year in a particular color are available at a particular dealer. For example, the tuple

   (Honda, Civic, 2010, Blue, Fred's Friendly Folks)

   indicates that 2010 Honda Civics in blue are available at the Fred's Friendly Folks car dealer.

   For each of the 2 following English statements, write one nontrivial functional that best captures the statement.

   (a) The model name for a car is trademarked by its make, i.e., no two makes can use the same model name.

   (b) Each dealer sells only one model of each make of car.

   What are the keys of the relation *Car*?

4. Consider the relation shown in Figure 3, which represents information on the products of a carpentry firm and their components. The following are given: the type of component of a product (attribute TypeOfC), the quantity of the component necessary for a certain product (attribute Quantity), the unit price of the component of a certain product (attribute PriceOfC), the supplier of the component (attribute Supplier) and the price of the each product (attribute PriceOfP).

Product	TypeOfC	Component	Quantity	PriceOfC	Supplier	PriceOfP
Bookcase	Wood	Walnut	5	10.00	Smith	400
Bookcase	Screw	B212	200	0.10	Brown	400
Bookcase	Glass	Crystal	3	5.00	Jones	400
Seat	Wood	Oak	5	15.00	Smith	300
Seat	Screw	B212	250	0.10	Brown	300
Seat	Screw	B412	150	0.30	Brown	300
Desk	Wood	Walnut	10	8.00	Quasimodo	250
Desk	Handle	H621	10	20.00	Brown	250
Table	Wood	Walnut	4	10.00	Smith	200

Figure 3. A relation instance containing data of a carpentry firm.

(a) Identify the functional dependencies and the key(s) for this relation.

(b) Consider the following update operations:

- Insertion of a new product;
- Deletion of a product;
- Addition of a component in a product;
- Modification of the price of a product.

Discuss the types of updating anomalies that can be caused by these operations.

(c) Describe the redundancies present and identify a decomposition of the relation that removes these redundancies. Show the schema obtained. Then verify that it is possible to reconstruct the original table from this schema.

5. Design a database to organize the information of a company that has employees (each with Social Security Number – to identify a person in US and it is similar to Singapore's NRIC, last name, first name, date of birth, his/her highest qualification which includes degree, university, and year), and branches (each with a unique code, branch name, and branch manager who is also an employee). Each employee works for a branch.

   Indicate the functional dependencies in the schema. Design a good database schema for the database. What are the keys and foreign keys in the relations?

   Show an instance of the database and check that it satisfies the constraints.

6. Design a car registration database for the Registrar of Vehicles of Singapore. The database stores information about registered cars such as car make, car model, color, engine size, car Open Market Value (OMV), Registration Fee ($140), Additional Registration Fee (ARF, from 100% to 180% of OMV), Excise (Import) Duty (20% of OMV), Certificate of Entitlement (COE), date of registration of the car, car owner information, car road tax information, and car insurance information, etc.

   What are the attributes? What are the functional dependencies?

   Note: Information on tax structure for cars in Singapore can be found from

   http://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/owning-a-vehicle/costs-of-owning-a-vehicle/tax-structure-for-cars.html