

CS4221: Database Design

Tutorial 3: The Relational Model

5 March 2015

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

1. Consider the following relational schema:

UnivInfo (studID, studName, course, profID, profName, office)

Each tuple in relation UnivInfo records the fact that the student with the given studID and name took the given course from the professor with the given profID and office. Assume that students have unique studIDs but not necessarily unique names, and professors have unique profIDs but not necessarily unique offices. Each student has one name (studName); each professor has one name (profName) and one office.

- (a) Specify a set of completely non-trivial functional dependencies for relation UnivInfo that captures the assumptions described above and no additional assumptions.

Based on your functional dependencies given in part (a), find all keys for relation UnivInfo.

Is UnivInfo in 3NF and Boyce-Codd Normal Form (BCNF)? If not, give a decomposition of UnivInfo into BCNF. Is your decomposition dependency preserving?

- (b) Now add the following two assumptions: (1) No student takes two different courses from the same professor; (2) No course is taught by more than one professor (but a professor may teach more than one course). Specify additional functional dependencies to take these new assumptions into account.

Based on your functional dependencies for parts (a) and (b) together, find all keys for relation UnivInfo.

Is UnivInfo in 3NF and BCNF according to your functional dependencies for (a) and (b)? If not, give a decomposition of UnivInfo into BCNF. Is your decomposition dependency preserving?

2. Consider the following relational schema:

Sale (clerk, store, city, date, item, size, color)

// a clerk sold an item on a particular day

Item (item, size, color, price) // prices and available sizes and colors for items

Make the following assumptions, and only these assumptions, about the real world being modeled:

- Each clerk works in one store.
- Each store is in one city.
- A given item always has the same price, regardless of size or color.
- Each item is available in all combinations of different sizes and different colors for that item.

Sale does not contain duplicates: If a clerk sells more than one of a given item in a given size and color on a given day, still only one tuple appears in relation Sale to record that fact.

- (a) Specify a set of completely nontrivial functional dependencies and nontrivial multi-valued dependencies for relations Sale and Item that captures the assumptions described above and no additional assumptions. Do not include multi-valued dependencies that also are functional dependencies.
- (b) Based on your functional and multi-valued dependencies in part (a), find all keys for relations Sale and Item.
- (c) Is the schema in Boyce-Codd Normal Form (BCNF) and 4NF according to your answers to (a) and (b)? If not, give a decomposition into 4NF. Is your decomposition dependency preserving?

3. Consider the following three relational schemas and sets of functional dependencies:

(a) R1 (A, B, C, D, E) with functional dependencies $D \rightarrow B$, $CE \rightarrow A$

(b) R2 (A, B, C, D, E) with functional dependencies $A \rightarrow E$, $BC \rightarrow A$, $DE \rightarrow B$

(c) R3 (A, B, C, D) with functional dependencies $AB \rightarrow C$, $C \rightarrow D$, $D \rightarrow A$

For each of the three schemas, decompose the relation, as necessary, into collections of relations that are in BCNF. Show which is the relation that you are decomposing, what functional dependency do you apply, and which are the two resulting relations. Are the decompositions dependency preserving?

Hint: You also need to consider BCNF violations caused by derived FDs and not just by the given FDs.

4. The Pittsburgh area shoe distributor called “Foot-Gloves” maintains a simple database containing information about shoes (brands, models, etc.), and retail shoe stores around Pittsburgh supplied by Foot-Gloves. The database has a single relation:

Shoes (retailer, brand, model, laces_type, num_in_stock, price)

An example tuple is <TenToes, Reebok, SuperStarCruiser, athletic-style, 17, 149>. The following functional dependencies are known to hold over this relation:

- (i) A retailer has a single price and num_in_stock for each model made by each brand.
 - (ii) To avoid being sued, no two brands use the same model name.
 - (iii) A given brand uses the same type of laces for all of its models.
- (a) List all functional dependencies and candidate keys for the relation Shoes.
- (b) What normal form is the relation Shoes in? 3NF, BCNF, or neither?
- (c) Decompose the relation into BCNF (if it is not already in BCNF). Show the steps.
- (d) Is your answer for part (c) a dependency preserving decomposition?

5. Find **all** non-trivial functional dependencies and non-trivial multivalued dependencies satisfied by the following relation instance.

A	B	C
a2	b2	c1
a1	b1	c2
a1	b1	c3
a2	b3	c1