CS411 Database Systems
Spring 2007

HW #1
Due: 11:30am CST, 2/15/07

Note: Print your name and NetID in the upper right corner of every page of your submission. Handin your homework to Trisha Benson in 4322 SC.

Problem 1 ER diagram

Consider the following information about a company database:

- Employees have an Employee ID, a name and a phone number
- An employee may have more than one email address
- Projects have a project number and a project budget
- Departments have a department number, a department name, and a main building
- No employee works in more than one department at a time
- An employee may work on more than one project at a time, and for each project that they work on, a time percentage is associated

Design and draw an ER diagram that captures the information about the company. Be sure to indicate any key and participation constraints (multiplicity constraints).

Problem 2 ER diagram– cont'd

Modify your solution for Problem 1 above, by introducing managers and interns into the system:

- Managers and interns are employees
- Each intern has a starting date and an ending date
- Each manager has an office and may have one senior manager
- Each department is always run by one manager
- No manager can lead more than one project at a time

Update your ER diagram for Problem 1 to reflect the information given above. Be sure to indicate any key, participation constraints (multiplicity constraints) and roles.

Problem 3 Schema Design

a) Convert the E/R diagram of Problem 1 to a relational database schema. Don't forget to indicate the keys for each relation.

b) Convert the manager, intern, employee subclass relationship in Problem 2 into relational schema, using the following three approaches: ER approach, Object-Oriented approach, Null approach. Don't forget to indicate the keys for each relation. (Assume an intern could be a manager)

Problem 4 Basic Concepts

a) Describe the concept of

- Functional Dependency
- Multivalued Dependency

in relational data model and use your own example, including relational schema and data in tabular form to illustrate the usage of these two. Explain how the two concepts differ.

b) Briefly describe the concept of

- Key
- Primary key
- Superkey

Problem 5 Functional Dependency

Consider a relation with schema R(A,B,C,D) and FD's $A \rightarrow C, BC \rightarrow D$, $D \rightarrow C$ and $AD \rightarrow B$.

(a) Find the closures for subsets B, AC and AD respectively.
(b) List all nontrivial FD's that follow from the given FD's. (*Note*: List only the ones with single attributes on the right side, *e.g.*, $BC \rightarrow D$.)
(c) What are all the keys? Explain your answer.
(d) Briefly describe the concept of *dependency-preserving decomposition*.

Problem 6 Normalization and Schema Design

Consider a relation with schema R(A,B,C,D,E) and FD's $AB \rightarrow C$, $C \rightarrow B$, and $C \rightarrow D$.

(a) What are all the keys?

(b) Indicate all the BCNF violations. Do not forget to consider FD's that are not in the given set, but follow from them. However, it is not necessary to give violations that have more than one attribute on the right side.

(c) Decompose the relations, if necessary, into collections of relations that are in BCNF. (*Note*: (1) At every step, indicate which violating FD you are decomposing on; (2) Highlight the final schema at the end of your answer.)

(d) Indicate all the 3NF violations.

(e) Decompose the relations, if necessary, into collections of relations that are in 3NF. (*Note*: (1) At every step, indicate which violating FD you are decomposing on; (2) Highlight the final schema at the end of your answer.)

Problem 7 Normal Forms

The relationship between 3NF, BCNF, 4NF could be illustrated by the following figure. That is, all the relations that are in 4NF are also in BCNF, and all the relations that are in BCNF are also in 3NF.

(a) Use your own example to show relations that are in 3NF but not in BCNF.

- Show the schema (including the keys) and the data in tabular form.
- List all the FDs.
- Justify your example by explaining why it satisfies the normal form requirements for 3NF, but not BCNF.

(b) Give a 3-column schema example that violates 4NF, but not BCNF.

- Show the schema (including the keys) and the data in tabular form.
- List all the FDs and MVDs.
- Justify your example by explaining why it satisfies the normal form requirements for BCNF, but not 4NF.

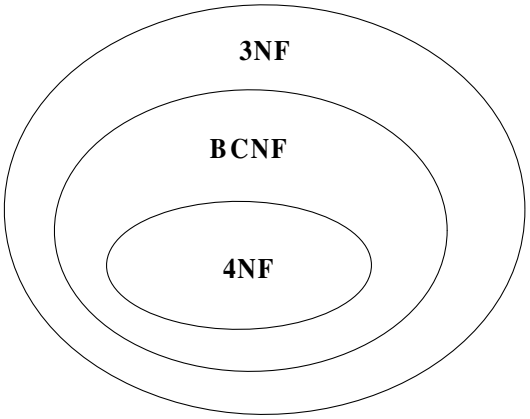

Figure 1: Normal Forms

Problem 8 Functional Dependency and Normal Forms

Given a relation R and a set of functional dependencies (all the other functional dependencies could be derived from this set), can we always decide whether relation R is in BCNF by just checking whether there are any BCNF violations in the given set of functional dependencies, without checking other functional dependencies that could be derived from the given set of functional dependencies?

If your answer is yes, try to prove it. In order to prove, you need to consider two cases: when none of the given FDs violates BCNF; and when some of them violate BCNF.

If your answer is no, try to come up with a counter example.