

## Database and Information Systems

### Homework 3

September 25, 2003; Due October 2 at 1:30 PM

**Problem 1:** The CIS department frequent fliers have been complaining to the officials at the Philadelphia International Airport about the bad organization. As a result the officials have decided to organize all the information related to the airport in a DBMS and you have been hired to design the database. Your first task is to organize the information about the planes stationed and maintained at the airport. The relevant information is as follows:

- Every airplane has a registration number and is of a specific model.
- The airport accomodates a number of airplane models and each model is identified by a model number and has a capacity and a weight.
- A number of technicians work at the airport. You need to store the name, SSN, address, phone number and salary of each technician.
- Each technician is an expert on one or more plane model(s), and his or her expertise may overlap with that of other technicians. This information about technicians must also be recorded.
- Traffic controllers must have an annual medical exam. For each traffic controller you must store the date of the most recent exam.
- All airport employees(including technicians) belong to a union. You must store the union membership number of each employee. You can assume that each employee is uniquely identified by the SSN.
- The airport has a number of tests that are used periodically to ensure that the planes are still airworthy. Each test has a Federal Aviation Administration(FAA) test number, a name and a maximum possible score.
- The FAA requires the airport to keep track of each time a given airplane is tested by a given technician using a given test. For each testing event, the information needed is the date, the number of hours the technician spent doing the test, the score the airplane received on the test.

1. Draw an ER diagram for the airport database. Be sure to indicate the various attributes of each entity and relationship set. Also specify the key and participation constraints for each relationship set. Specify any necessary overlap and covering constraints as well.
2. The FAA passes a regulation the tests on a plane must be conducted by technicians who are expert on that model. How will you express this constraint in the ER model? If you cannot express it, explain briefly.

**Problem 2:** Consider a relation  $R$  with five attributes  $ABCDE$ . You are given the following dependencies:  $A \rightarrow B, BC \rightarrow E, ED \rightarrow A$ .

1. List all keys for  $R$ .
2. Is  $R$  in 3NF?
3. Is  $R$  in BCNF?

**Problem 3:** Consider the attribute set  $R = ABCDEGH$  and the FD set  $F = \{AB \rightarrow C, AC \rightarrow B, AD \rightarrow E, B \rightarrow D, BC \rightarrow A, E \rightarrow G\}$ .

1. For each of the following attribute sets, do the following: (i) Compute the set of dependencies that hold over the set and write down a minimal cover. (ii) Name the strongest normal form that is not violated by the relation containing these attributes. (iii) Decompose it into a collection of BCNF relations if it is not already in BCNF.
  - (a)  $ABC$
  - (b)  $ABCD$
  - (c)  $ABCEG$
  - (d)  $DCEGH$
  - (e)  $ACEH$
2. Which of the following decompositions of  $R = ABCDEG$ , with the same set of dependencies  $F$ , is (a) dependency preserving? (b) lossless join?
  - (a)  $\{AB, BC, ABDE, EG\}$
  - (b)  $\{ABC, ACDE, ADG\}$

**Problem 4:** Suppose you are given a relation  $R(A, B, C, D)$ . For each of the following sets of FDs, assuming they are the only dependencies that hold for  $R$ , do the following: (a) Identify the candidate key(s) for  $R$ . (b) State whether or not the proposed decomposition of  $R$  into smaller relations is a good decomposition and briefly explain why or why not.

1.  $B \rightarrow C, D \rightarrow A$ ; decompose into  $BC$  and  $AD$ .
2.  $A \rightarrow BC, C \rightarrow AD$ ; decompose into  $ABC$  and  $AD$ .
3.  $A \rightarrow B, B \rightarrow C, C \rightarrow D$ ; decompose into  $AB, AD$  and  $CD$