CISC637 Spring 2016, Homework 3

Due Thursday, October 13, at 11:55pm on Sakai.

Assignment - each question is worth 10 points for a total of 100. Show your work to ensure the best chance of getting a high grade.

Functional Dependencies

1. Suppose we have a relation schema $R(a, b, c)$ and the relation instance below:

a	b	c
1	1	1
1	2	1
2	1	1
2	2	1

   For each of the following functional dependencies, state whether the instance satisfies the FD.

   (a) $a \rightarrow b$

   (b) $a \rightarrow c$

   (c) $b \rightarrow a$

   (d) $b \rightarrow c$

   (e) $c \rightarrow a$

   (f) $c \rightarrow b$

   (g) $ab \rightarrow c$

   (h) $ac \rightarrow b$

   (i) $bc \rightarrow a$

2. Consider a relation $R(a, b, c, d, e, f)$ with the following functional dependencies:

$$ab \rightarrow abdf$$
$$abf \rightarrow abcef$$
$$af \rightarrow abdf$$

   Find the two candidate keys for R. Make sure you are finding candidate keys, not superkeys!

3. Consider a relation $R(a, b, c, d, e, f)$ with the following functional dependencies:

$$ad \rightarrow adf$$
$$b \rightarrow bcdf$$
$$bd \rightarrow bde$$
$$cf \rightarrow bcf$$
$$e \rightarrow acde$$

   Find *all* candidate keys for R. Make sure you are listing candidate keys, not superkeys!

4. Determine which FD would need to be removed from the set of 5 given in problem #3 in order to make b the only candidate key.

   Determine which FD would need to be removed from the set of 5 given in problem #3 in order to make e the only candidate key.

5. Consider a relation $R(a, b, c, d, e, f)$ with the following functional dependencies:

$$d \rightarrow bcd \qquad\qquad f \rightarrow bdef$$

Find *all* candidate keys for R.

Normal Forms

6. Suppose we have a relation $R(a, b, c)$ and an instance of R with the following four records:

a	b	c
1	2	3
1	2	4
5	2	3
5	2	6

   (a) List all nontrivial functional dependencies that are *satisfied* (not necessarily *hold*) on this instance of R.

   (b) Is this instance of R in Boyce-Codd Normal Form (BCNF) with respect to those FDs you listed for part (a)? If not, state which FDs violate BCNF.

7. Determine the most restrictive normal form (BCNF, 3NF, or 1NF) of relations given in problems #2, 3, and 5 above.

   (a) What normal form is the relation in #2 in? If it is not in BCNF, which FD(s) violate BCNF? If it is not in 3NF, which FD(s) violate 3NF?

   (b) What normal form is the relation in #3 in? If it is not in BCNF, which FD(s) violate BCNF? If it is not in 3NF, which FD(s) violate 3NF?

   (c) What normal form is the relation in #5 in? If it is not in BCNF, which FD(s) violate BCNF? If it is not in 3NF, which FD(s) violate 3NF?

8. Write out a possible table of data for the relation described in problem #5 above. Make sure that all of the given functional dependencies are satisfied in your example data, *and* make sure that no other possible functional dependency could be satisfied.

   Please submit your table as a separate CSV file (comma-separated values) attachment with your assignment on Sakai.

9. Suppose we have a relation $R(a, b, c, d, e)$ with four functional dependencies:

$$b \rightarrow bde \qquad\qquad c \rightarrow cde$$
$$ce \rightarrow ace \qquad\qquad d \rightarrow ade$$
$$e \rightarrow de$$

   (a) Find all candidate keys for R.

   (b) Which of the FDs given above violate BCNF?

   (c) Find two different ways to decompose R into two or more BCNF relations based on the FDs above.

10. For each relation and set of FDs given below, state whether the relation is in BCNF, 3NF, or neither. If not in either, decompose the relation into two or more BCNF relations.

   (a) Relation $R(a, b, c)$; functional dependencies $a \rightarrow b, b \rightarrow c$.

   (b) Relation $R(a, b, c, d)$; functional dependencies $ab \rightarrow c, c \rightarrow d, d \rightarrow a$.

   (c) Relation $R(a, b, c, d)$; functional dependencies $b \rightarrow c, b \rightarrow d$.

   (d) Relation $R(a, b, c, d)$; functional dependencies $ab \rightarrow c, bc \rightarrow d, cd \rightarrow a, ad \rightarrow b$.