Due 11:59:00pm, Monday 11/4.

Reading: The posted Lecture 10-13 Slides, and Sections 3.1-3.5 of Ullman/Widom. Next week: Sections 7.1-7.5 of Ullman/Widom (some of this will be review).

Problems:

1. Consider the relation R with schema $R(a, b, c, d)$, and the following set of functional dependencies: $F = \{$ a,d $\rightarrow$ b ; b,c $\rightarrow$ d ; c $\rightarrow$ b $\}$.

      a. For <u>each</u> of the fifteen non-empty subsets S of the set of attributes $\{a, b, c, d\}$, find the closure of S using the set of functional dependencies F.

      b. List <u>all</u> of the superkeys of R.

      c. List <u>all</u> of the candidate keys of R.

2. Consider the following relation with five attributes:

      SALE(CarID, OptionPackage, ListPrice, SaleDate, RebateAmount)

The functional dependencies in SALE are:

      CarID $\rightarrow$ SaleDate, RebateAmount
      SaleDate $\rightarrow$ RebateAmount
      CarID, OptionPackge $\rightarrow$ ListPrice

The only candidate key of SALE is {CarID, OptionPackage}. Construct a decomposition of SALE into a collection of relations in BCNF that has the lossless join property. Use the algorithm given in class, and <u>show your work</u>. (That is, at each step, you must state which functional dependency you are removing from which relation, and what the resulting decomposition is after you remove it. Answers that show only the final result without explaining the steps taken to obtain it will receive little or no credit.)

3. Suppose that the relation BILL(StudentID, FirstName, LastName, Major, Tuition) has the set of functional dependencies $F = \{$ StudentID, Major $\rightarrow$ FirstName, LastName, Tuition ; StudentID $\rightarrow$ FirstName, LastName, Major $\}$. Consider the following decomposition of BILL:

      R_1(StudentID, FirstName)
      R_2(StudentID, LastName)
      R_3(StudentID, Major, Tuition)

      a. Give the projections of F on R_1, R_2, and R_3. Does the decomposition have the dependency preservation property? <u>Give a detailed explanation why or why not</u>. (Don't just state the definition of the dependency preservation property, but rather show why the decomposition

either has or does not have this property by showing whether or not each functional dependency in *F* can be derived from the union of the projections.)

b. Does the decomposition have the lossless join property? <u>Give a detailed explanation why or why not</u>. (If you use the matrix test, you should show each step of your work. That is, each time you change the matrix, state which functional dependency you are applying, and show the change to the state of the matrix. Answers that show only the final matrix without showing the steps taken to obtain it will receive little or no credit.)

4. In the relation CHICAGOFOOD(Dish, Price, Restaurant, Owner, Address, Neighborhood), each record gives information on a dish that can be ordered from some restaurant in Chicago. The only candidate key in the relation is {Dish, Restaurant}. The functional dependencies in CHICAGOFOOD are:

Address → Neighborhood
Dish, Restaurant → Price, Owner
Restaurant → Owner, Address, Neighborhood

a. Find a minimal basis for the set of functional dependencies. <u>Show your work</u>. (That is, each time your replace one functional dependency with another or remove a functional dependency, show the change that you are making to the minimal basis. Answers that show only the final result without showing the steps taken to obtain it will receive little or no credit.)

b. Use the minimal basis to find a decomposition of CHICAGOFOOD into relations in 3NF. Use the algorithm discussed in class, and <u>show your work</u>. (Answers that show only the final result without showing the steps taken to obtain it will receive little or no credit.)

Submit a .doc, .docx, .txt or other electronic document with your answers and your name at the top to the "Assignment 5" dropbox.

Remarks:

1. For all assignments, <u>it is your responsibility to make sure that the files you have uploaded are readable and in the correct locations</u>. You should always check that you can successfully download your submitted files back from the course web site to be sure that they have been uploaded correctly.

2. As is the case for every assignment, all work must be completed individually – no collaboration between students or sharing of answers between students is permitted. Do not post this assignment to any website in search of answers, and do not consult posted answers to this assignment on any website while completing the assignment. <u>Your assignment must be your own individual work</u>.

Eric J. Schwabe – 10/28/19