CSC 355 Database Systems 502
Assignment 5 (2/20)

Due 11:59:00pm, Wednesday 2/27.

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: $F = \{ a,b \rightarrow c \ ; \ a \rightarrow d \ ; \ c \rightarrow b \ ; \ d \rightarrow b \ \}$.

a. For each 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 all of the superkeys of *R*.

c. List all of the candidate keys of *R*.

2. Consider the following relational schema:

ENCOUNTER(VNumber, VDate PNumber, PAge, PZip, DNumber, DSpec, Diagnosis)

The hospital software designer described the stored data as follows: "Each time a patient visits one of our hospitals, they are assigned a unique visit number. We record the date of the visit, a unique patient number, and the patient's age and zip code. The patient may be seen by several doctors during their visit – there is a row in the table for each doctor that sees the patient (we call this interaction an encounter), which records the unique doctor number, the doctor's specialty, and the diagnosis they have recorded for the patient."

The functional dependencies in ENCOUNTER are

VNumber → VDate, PNumber, PAge, PZip
PNumber → PAge, PZip
DNumber → DSpec
VNumber, DNumber → Diagnosis

a. ENCOUNTER has only one candidate key. What is it?

b. Construct a decomposition of ENCOUNTER into a collection of schemas in BCNF that has the lossless join property. Use the algorithm given in class, and show your work. (Answers that show only the final result without showing the steps taken to obtain it will receive no credit.)

3. For the universal relation *R*(A, B, C, D), consider the decomposition *D* consisting of R_1(A, B) and R_2(B, C, D), and the set *F* of functional dependencies $\{ A \rightarrow D \ ; \ B \rightarrow A,C \ ; \ D \rightarrow A,B \ \}$.

a. Compute the projection of *F* on R_1.

b. Compute the projection of F on R_2.

c. Does the decomposition D preserve the set of dependencies F? Give a detailed explanation why or why not. (That is, don't just repeat back the definition of the dependency preservation property, but rather show why the decomposition D either has or does not have this property.)

4. Perform the chase test for the lossless join property for the universal relation $R(A_1, A_2, A_3, A_4)$, and the decomposition D and set of functional dependencies F given below:

$D = \{ R_1(A_1, A_2) , R_2(A_2, A_3, A_4) , R_3(A_1, A_4) \}$

$F = \{ A_1,A_3 \rightarrow A_2 , A_2 \rightarrow A_1 , A_4 \rightarrow A_3 \}$

a. Show the initial state of the matrix S, and show each step of your work as you modify the matrix using the functional dependencies. (That is, don't just show me the final state of the matrix – each time you change it, show the change, and show which functional dependency you applied to make the change. Answers that show only the final matrix without showing the steps taken to obtain it will receive no credit.)

b. Does the decomposition D have the lossless join property? Explain why or why not in terms of the final state of the matrix S.

5. Find a minimal basis for the following set F of functional dependencies. Show your work. (Answers that show only the final result without showing the steps taken to obtain it will receive no credit.)

U,W → X
W → U,Y
W,Z → Y
Y → X

6. Consider the universal relation

STUDENT(StuID, SSNum, FName, LName, Major, Dept, Group)

with the following set F of functional dependencies:

StuID → SSNum, Major
SSNum → FName, LName, StuID
StuID → Dept
Major → Dept
FName → Group

a. Identify all of the candidate keys of F.

b. Construct a decomposition of EMPLOYEE into relations in 3NF that has both the dependency preservation property and the lossless join property. Use the algorithm discussed in class, and show your work. (Answers that show only the final result without showing the steps taken to obtain it will receive no credit.)

(Hint: I will tell you that if you split StuID → SSNum, Major into two functional dependencies, split SSNum → FName, LName, SID into three functional dependencies, and remove StuID → Dept, then the resulting set is a minimal basis of *F*.)

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. It is always your responsibility to make sure that any files you upload are readable and in the correct locations. I recommend that you download them for yourself after submitting them to be sure that they have been uploaded correctly.

2. Remember that this assignment, like all others, must be completed individually, without copying from any outside sources -- no collaboration or sharing of answers among students is allowed.

Eric J. Schwabe – 02/20/19