Tutorial #2

Normal Forms

G. Raschia

Last update: January 16, 2024

Problem 1

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

1. Show 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.
2. Is R 3NF?
3. Decompose the relation R, as necessary, into collections of relations that are in BCNF.

Problem 2

Let $R(A, B, C, D, E)$ be decomposed into relations with the following three sets of attributes: $\{A, B, C\}$, $\{B, C, D\}$, and $\{A, C, E\}$.

1. For each of the following sets of FD's, use the Chase Test to tell whether the decomposition of R is lossless. For those that are not lossless, give an example of an instance of R that returns more than R when projected onto the decomposed relations and rejoined.
   (a) $AC \rightarrow E$ and $BC \rightarrow D$
   (b) $A \rightarrow D$, $CD \rightarrow E$, and $E \rightarrow D$
2. For each of the previous sets of FD's, are dependencies preserved by the decomposition?

1 Problem 3

1. Compute the minimal cover of the following set of FD's:

   $\{AB \rightarrow CF, BG \rightarrow C, AEF \rightarrow C, ABG \rightarrow ED, CF \rightarrow AE, A \rightarrow CG, AD \rightarrow FEG, AC \rightarrow B\}$

Problem 4

Consider the relation `Courses`(C, T, H, R, S, G), whose attributes may be thought of informally as course, teacher, hour, room, student, and grade.

1. Translate into FD's, when applicable, the following constraints:
   (a) a course has a unique teacher;
   (b) only one course can meet in a given room at a given hour;
   (c) a teacher can be in only one room at a given hour;
   (d) a student can be in only one room at a given hour;
   (e) students get only one grade in a course.
2. What are all the keys for `Courses`?
3. Verify that the given FD's are their own minimal basis.
4. Use the 3NF synthesis algorithm to find a lossless-join, dependency-preserving decomposition of `Courses` into 3NF relations. Is there any of the relations not in BCNF?