CSCI 6315 Applied Database Systems
ASSIGNMENT 3: Functional Dependencies and Normalization

02/27/2020 00:30

Ulvi Bajarani
Student ID 20539914
E-mail: ulvi.bajarani01@utrgv.edu

Initial Relationship R:

$$R \ = \ (A, B, C, D, E)$$

Initial set F of Functional Dependencies holds on R:

$$A \rightarrow BC$$
$$CD \rightarrow E$$
$$B \rightarrow D$$
$$E \rightarrow A$$

Answers:

1) *Suppose that we decompose the schema R into $R_1 = (A, B, C)$ and $R_2 = (A, D, E)$. Show that this decomposition is a lossless-join decomposition with respect to F.*

To understand if the decomposition is a lossless-join, we should understand if A has a functional dependency with either B or C. It helps do define if A is a superkey or not.

Knowing $A \rightarrow BC$, we might also define $A \rightarrow B$ and $A \rightarrow C$ by the decomposition rule. Then, by transitivity we define that $A \rightarrow D$, and as a result, $AC \rightarrow E$, which might be reduced to $A \rightarrow E$.

Knowing $R_1 \cap R_2 = (A, B, C) \cap (A, D, E) = (A)$, $A \rightarrow A, B, C, D, E$ it is defined that $A \rightarrow R_1$. It proves that the decomposition is a lossless-join decomposition with respect to F.

2) *Suppose that we decompose the schema R into $R_1 = (A, B, C)$ and $R_2 = (C, D, E)$. Show that this decomposition is not a lossless-join decomposition.*

We use the same approach and the functional dependencies as in the Problem 1:

To understand if the decomposition is a lossless-join, we should understand if C has a functional dependency with either D or E. After using calculations in Problem 1, it might be seen that C is not enough to imply E alone: only with a combination in D, $AD \rightarrow E$.

Knowing $R_1 \cap R_2 = (A, B, C) \cap (C, D, E) = (C)$, $C \rightarrow D$ it is defined that $C \not\rightarrow R_1$ and $C \not\rightarrow R_2$. It proves that the decomposition is **not** a lossless-join decomposition with respect to F.

3) *Compute* $(BC)^+$.

The steps:

1) $(BC)^+ \Rightarrow\ (BC)$
2) $(BC)^+ \Rightarrow\ (BCD)$ due to $B \to D$
3) $(BC)^+ \Rightarrow\ (BCDE)$ due to $B \to D$ and $CD \to E$
4) $(BC)^+ \Rightarrow\ (ABCDE)$ due to $E \to A$

The answer is: $(BC)^+ \Rightarrow\ (ABCDE)$

4) *Compute the canonical cover F_c .*

$F_c = (A \to B, A \to C, CD \to E, B \to D, E \to A)$ which are
$F_c \to F$ and $F \to F_c$

5) *Show that the decomposition of* R *into* $R_1 = (A, B, C)$ *and* $R_2 = (A, D, E)$ *is not a dependency-preserving decomposition.*

Because of the fact that B and D are in different tables, the decomposition could not be a dependency-preserving.

For Problem 6 and Problem 7, we have to define candidate keys for the relationships. They are A, E, CD, BC.

6) *Give a lossless-join decomposition into BCNF of R.*

In the functional dependency $B \to D$, B is not a superkey, so we have to decompose $R = (A, B, C, D, E)$ into $R_0 = (B, D)$ and $R_1 = R - D = (A, B, C, E)$. While R_1 is in BCNF form, R_2 is not due to $A \to BC$, where A is not a superkey. So, we have to decompose $R_1 = (A, B, C, E)$ into $R_2 = (A, B, C)$ and $R_3 = R_1 - (B, C) = (A, E)$. Finally, all tables are in BCNF form.

The answer is:

$R_0 = (A, B, C)$ that has $F_0^+ = (A \to B, A \to C)$.
$R_1 = (B, D)$ that has $F_1^+ = (B \to D)$.
$R_2 = (A, E)$ that has $F_2^+ = (E \to A)$.

7) *Give a lossless-join, dependency preserving decomposition into 3NF of R.*

Knowing $F_c = (A \to B, A \to C, CD \to E, B \to D, E \to A)$
We might create tables:

$$\begin{aligned}
R_0 &= (A, B) \text{ that has } F_0^+ = (A \to B). \\
R_1 &= (A, C) \text{ that has } F_1^+ = (A \to C). \\
R_2 &= (C, D, E) \text{ that has } F_2^+ = (CD \to E). \\
R_3 &= (B, D) \text{ that has } F_3^+ = (B \to D). \\
R_4 &= (E, A) \text{ that has } F_4^+ = (E \to A).
\end{aligned}$$

Due to the fact that the key BC doesn't occur in the relations, we have to create

$R_5 = (B, C, D)$ that has $F_5^+ = (BC \to D)$, because $(A \to B)$, $(B \to D)$, and $(A \to C)$.
Also, we might composite it with R_2

We might simplify R_0 and R_1 as (A, B, C)

The answer is:

$$\begin{aligned}
R_0 &= (A, B, C) \text{ that has } F_0^+ = (A \to B, A \to C). \\
R_1 &= (C, D, E) \text{ that has } F_1^+ = (CD \to E). \\
R_2 &= (B, C, D) \text{ that has } F_2^+ = (BC \to D). \\
R_3 &= (E, A) \text{ that has } F_3^+ = (E \to A).
\end{aligned}$$