

Lab 2

Functional dependencies and Normal forms

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EXERCISES

1. Consider the relation scheme with attributes S (store), D (department), I (item), and M (manager), with functional dependencies $SI \rightarrow D$ and $SD \rightarrow M$.

$R \{ S, D, I, M \}$

$F \{ SI \rightarrow D, SD \rightarrow M \}$

- a) Find all keys for SDIM.

$L : S, I$

$M : D$

$key : \{ S, I, D \}$

- b) Show that SDIM is in second normal form but not third normal form.

R is in 2NF because D and M is fully dependent on PK

But R is not 3NF because M is not a prime attribute of R

2. Consider the relation scheme with attributes CITY, ST, and ZIP, which we here abbreviate C, S, and Z. We observed the dependencies $CS \rightarrow Z$ and $Z \rightarrow C$. The decomposition of the relation scheme CSZ into SZ and CZ has a lossless join. Does this decomposition reserve dependencies?

$R \{ C, S, Z \}$

$F \{ CS \rightarrow Z, Z \rightarrow C \}$

$L : S$

$M : C, Z$

$key : \{ S, C \} \text{ or } \{ S, Z \}$

$R1 \{ SZ \} \quad PK : \{ SZ \}$

$R2 \{ CZ \} \quad PK : \{ Z \}$

R1 are PK \Rightarrow the decomposition preserve dependencies

3. Let $F = \{AB \rightarrow C, A \rightarrow D, BD \rightarrow C\}$.

a) Find a minimal cover for F .

$$A \rightarrow D, BD \rightarrow C \Rightarrow AB \rightarrow C \text{ (pseudo transitivity)}$$

$$G \{ A \rightarrow D, BD \rightarrow C \}$$

b) Give a 3NF, dependency-preserving decomposition of ABCD into only two schemes (with respect to the set of functional dependencies F).

$$R1 \{ A, D \} \quad F1 \{ A \rightarrow D \}$$

$$R2 \{ B, C, D \} \quad F2 \{ BD \rightarrow C \}$$

c) What are the projected dependencies for each of your schemes?

$$F1 \{ A \rightarrow D \} \quad F2 \{ BD \rightarrow C \}$$

d) Does your answer to (a) have a lossless join? If not, how could you modify the database scheme to have a lossless join and still preserve dependencies?

$$L : AB$$

$$M : D$$

$$\text{key} : \{ A, B, D \}$$

(a) doesn't have lossless join because it have no key $\{ A, B, D \}$

$$R1 \{ A, D \} \quad F1 \{ A \rightarrow D \}$$

$$R2 \{ B, C, D \} \quad F2 \{ BD \rightarrow C \}$$

$$R3 \{ A, B, D \}$$

4. Let $F = \{AB \rightarrow C, A \rightarrow B\}$.

a) Find a minimal cover for F .

$$F \{ AB \rightarrow C, A \rightarrow B \}$$

$$A \rightarrow B, AB \rightarrow C \Rightarrow A \rightarrow C \text{ (pseudo transitivity)}$$

$$G \{ A \rightarrow B, A \rightarrow C \}$$

b) When (a) was given on an exam at a large western university, more than half the class answered $G = \{A \rightarrow B, B \rightarrow C\}$. Show that answer is wrong by giving a relation

that satisfies F but violates G .

$$G \{ A \rightarrow B, A \rightarrow C \}$$

$$A \rightarrow C \Rightarrow AB \rightarrow C$$

G keep all dependencies of F but F have nothing to find $B \rightarrow C$

5. Suppose we are given relation scheme ABCD with functional dependencies ($A \rightarrow B, B \rightarrow C, A \rightarrow D, D \rightarrow C$). Let p be the decomposition (AB, AC, BD).

a) Find the projected dependencies for each of the relation schemes of p.

$$p \{ AB, AC, BD \}$$

$$R1 \{ A, B \} \quad F1 \{ A \rightarrow B \}$$

$$R2 \{ A, C \} \quad F2 \{ A \rightarrow C \}$$

$$R3 \{ B, D \} \quad F3 \{ \}$$

b) Does p preserve the given dependencies?

p does not preserve the given dependencies because $F1 \cup F2 \cup F3 \neq F$

6. Consider the relation scheme ABCD with dependencies

$$F = \{ A \rightarrow B, B \rightarrow C, D \rightarrow B \}$$

We wish to find a lossless-join decomposition into BCNF.

a) Suppose we choose, as our first step, to decompose ABCD into ACD and BD. What are the projected dependencies in these two schemes?

$$R1 \{ B, D \} \quad F1 \{ D \rightarrow B \}$$

$$R2 \{ A, C, D \} \quad F2 \{ AD \rightarrow C \}$$

b) Are these schemes in BCNF? If not, what further decomposition is necessary?

These schemes in BCNF because $\{ D \}$ is the super - key of R1 and $\{ AD \}$ are the super - key of R2