

CS143: Database Systems

Homework #6

- Suppose that we decompose the schema $R(A, B, C, D, E, F)$ into (A, B, C, F) and (A, D, E) . When the following set of functional dependencies hold, is the decomposition lossless?
 $A \rightarrow BC, CD \rightarrow E, B \rightarrow D, E \rightarrow A$
(A,B,C,F) INTERSECT (A,D,E) = A, and A is a key for (A,D,E), so the decomposition is losless.
 Explain your answer.
- List non-trivial functional dependencies satisfied by the following relation. You do not need to find all functional dependencies. It is enough to identify a set of functional dependencies that imply all functional dependencies that is satisfied by the relation.

A	B	C
a_1	b_1	c_2
a_1	b_1	c_2
a_2	b_1	c_1
a_2	b_1	c_3

$A \twoheadrightarrow B$
 $C \twoheadrightarrow A$

- Assume *Student* and *Class* entity sets that we have used in the class. The *Student* and *Class* sets are connected by Take relationship set. We now convert the Take relationship set into a table **Take(sid, dept, cnum)** using our standard translation algorithm, where sid is the key for a student and (dept, cnum) is the key for a class.

Explain how functional dependencies can be used to indicate the following:

- A one-to-one relationship exists between entity sets *Student* and *Class*. $sid \twoheadrightarrow dept, cnum$
 $dept, cnum \twoheadrightarrow sid$
- A many-to-one relationship exists between entity sets *Student* and *Class*. $sid \twoheadrightarrow dept, cnum$

- Assume the following set of functional dependencies hold for the relation $R(A, B, C, D, E)$:
 $A \rightarrow BC, CD \rightarrow E, B \rightarrow D, E \rightarrow A$

- Is E a key for R ? Explain your answer. **Yes, E is a key. $E^+ = ABCDE$**
- Is BC a key for R ? Explain your answer. **Yes, BC is a key. $BC^+ = ABCDE$**

- Assume the following set of functional dependencies hold for the relation $R(A, B, C, D, E, F)$:
 $A \rightarrow BC, C \rightarrow E, B \rightarrow D$

Is it in **BCNF**? Explain your answer. If it is not, normalize it into a set of relations in **BCNF**.

- Suppose we have a relation $R(A, B, C, D)$ with a MVD $A \twoheadrightarrow BC$. If we know that the tuples $(a, b_1, c_1, d_1), (a, b_2, c_2, d_2)$ and (a, b_3, c_3, d_3) are in the current instance of R , what other tuples do we know must also be in R ?

- For relation $R(A, B, C, D, E, F)$, suppose a FD $AB \rightarrow E$ and two MVDs $AB \twoheadrightarrow C$ and $A \twoheadrightarrow B$ hold. Is it in 4NF? Explain your answer. If not, normalize it into 4NF.

5. It is not in BCNF.

The key is AF, so $A \twoheadrightarrow BC, C \twoheadrightarrow E$ and $B \twoheadrightarrow D$ all violate BCNF.

$R(A, B, C, D, E, F) \implies R_1(A, B, C, D, F)$ and $R_2(C, E)$ using $C \twoheadrightarrow E$

$R_1(A, B, C, D, F) \implies R_3(A, B, C, D, F)$ and $R_4(B, D)$ using $B \twoheadrightarrow D$

$R_3(A, B, C, F) \implies R_5(A, F)$ and $R_6(A, B, C)$ using $A \twoheadrightarrow BC$

The final BCNF tables are:

$R_2(C, E)$

$R_4(B, D)$

$R_5(A, F)$

$R_6(A, B, C)$

6. The following must also exist: 7. It is not 4NF. We need to normalize it.

(a, b_1, c_1, d_3)

(a, b_2, c_2, d_1)

(a, b_2, c_2, d_3)

(a, b_3, c_3, d_1)

(a, b_3, c_3, d_2)

Using $AB \twoheadrightarrow E$, decompose $R \implies R_1(A, B, E)$ and $R_2(A, B, C, D, F)$.

Using $A \twoheadrightarrow B$, decompose $R_1 \implies R_3(A, B)$ and $R_4(A, E)$.

Using $AB \twoheadrightarrow C$, decompose $R_2 \implies R_5(A, B, C)$ and $R_6(A, B, D, F)$.

Using $A \twoheadrightarrow B$, decompose $R_5 \implies R_3(A, B)$ and $R_7(A, C)$.

Using $A \twoheadrightarrow B$, decompose $R_6 \implies R_3(A, B)$ and $R_8(A, D, F)$.

In the end, we have $R_3(A, B)$, $R_4(A, E)$, $R_7(A, C)$, and $R_8(A, D, F)$.