db hw7

3200105872 庄毅非

7.1

7.1 Suppose that we decompose the schema $R = (A, B, C, D, E)$ into

$$(A, B, C)$$
$$(A, D, E).$$

Show that this decomposition is a lossless decomposition if the following set F of functional dependencies holds:

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

Answer: From the functional dependencies set we can get that A^+ = R,so that A is a candidate key for relation R. Denote R1 = (A,B,C) and R2 = (A,D,E), since $R1 \bigcap R2$ = A, which is a candidate key. So this decomposition is a lossless decomposition.

7.13 Show that the decomposition in Exercise 7.1 is not a dependency-preserving decomposition.

Answer: It's clearly that function dependency $CD \to E$, $B \to D$ and $E \to A$ are all not preserved in result set.

7.21 Give a lossless decomposition into BCNF of schema *R* of Exercise 7.1.

Answer: From the FD set we can see that A is not candidate key for the attribute set. Then FD $A \to BC$ violate BCNF's definition, we can split R into R1 = (A,B,C,E) and R2 = (B, D), which is a BCNF schema.

7.22 Give a lossless, dependency-preserving decomposition into 3NF of schema *R* of Exercise 7.1.

Answer: We can split the original set R into R1 = (A,B,C), R2 = (C,D,E), R3 = (B,D) and R4 = (A,E) and we know that R1 contians a candidate key (A), so (R1,R2,R3,R4) is a 3nf decomposition.

7.30 Consider the following set *F* of functional dependencies on the relation schema (*A* , *B* , *C* , *D* , *E* , *G*):

$$\begin{aligned} &A \ \to BCD \\ &BC \ \to DE \\ &B \ \to D \\ &D \ \to A \end{aligned}$$

a. compute B^+

Answer: B^+ = ABCDE

b. Prove (using Armstrong's axioms) that *AG* is a superkey.

Answer:

$$\begin{aligned} &\because A \ \to BCD \\ &\therefore A^+ = ABCD \quad (by\, definition\, of\, attribute's\, closure) \\ &\because BC \to DE \\ &\therefore A^+ = ABCDE \quad (transitivity\, rule) \\ &\therefore (ABCDEG) \subset (AG)^+ \\ &\because (AG)^+ \subset (ABCDEG) \\ &\therefore (AG)^+ = (ABCDEG) \end{aligned}$$

c. Compute a canonical cover for this set of functional dependencies *F* ; give each step of your derivation with an explanation.

Answer:

step 1: remove column `D` in the right side of $BC \to DE$. Since it is an extraneous attribute, since before and after we remove it, the closure for BC is always ABCDE.

step 2: remove column `D` in the right side of A → BCD, since B → D

step 3: remove column `C` in the left side of BC → E, since B^+ contains C.
step 4: conbine B → E and B → D.
step 3: we can deduce that current funciton dependency and the original FD are equivalent to each other, and there is no extraneous attributes any more. So FD

$$\begin{aligned} A &\rightarrow BC \\ B &\rightarrow DE \\ D &\rightarrow A \end{aligned}$$

is the canonical cover we want.

d. Give a 3NF decomposition of the given schema based on a canonical cover.
Answer: From question we can get R1 = (A,B,C), R2 = (B,D,E), R3 = (D,A). After removing redundant set, result we get is (R1 = (A,B,C), R2 = (B,D,E),R3 = (D,A)). Since there is no candidate key, we add a set R4 = (A,G). So final result is R1 = (A,B,C) and R2 = (B,D,E),R3 = (D,A),R4 = (A,G)

e. Give a BCNF decomposition of the given schema using the original set *F* of functional dependencies.
Answer:
step 1: FD $B \rightarrow CDE$ violates BCNF's defininititon, so we split R into $R1 = (\underline{B}, C, D, E), R1' = (A, B, G)$,we can see R1 is a BCNF.
step 2: FD $A \rightarrow B$ voilates BCNF's definition, so we can split $R1'$ into $R2 = (\underline{A}, B)$, $R2' = (\underline{A}, \underline{G})$, then we can see R2 and $R2'$ both satisfy BCNF's defintiion.
step 3: Final result is $R1 = (\underline{B}, C, D, E), R2 = (\underline{A}, B), R3 = (\underline{A}, \underline{G})$