DATABASE MANAGEMENT SYSTEM

CS - 631

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Assignment 4 Solutions

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EXERCISE

Consider a relation R(ABCDEFGHIJ) with the following set of functional dependencies
G = { F → AB, CD → E, C → FG, H → IJ, D → H }

1. Is CDE a superkey of R (w.r.t. **G**)?

Solution 1

To check for super key we need to check for CDE^+

Since , CDE^+ = CDEFGHABIJ = R

Therefore CDE^+ is superkey of R

2. Is CDE a key of R (w.r.t. **G**)?

Solution 2

To find whether CD is superkey of R, Since CD is a proper subset of CDE.

CD^+= CDEFGHABIJ = R

Therefore, CD is a superkey of R

And Since CD i.e. the proper set of CDE, is a superkey of R therefore CDE is not a key of R

3. Apply the appropriate algorithm to determine a key for R (w.r.t. **G**).

Solution 3

First, we check for elements not in left side of FD in G. So, only C and D do not appear in the RHS of any FD in F.

Therefore, every key of R must contain C and D.

So According to algorithm,

set K = R. For each attribute A in K compute $(K\text{-}A)^+$ w.r.t F. If $(K – A)^+= R$ then set K=K-{A}.

Thus, for some attribute X in K – {CD} we remove X from K;

Removing E from R: $(CDFGHIJAB)^+ = R$.

K = CDFGHIJAB

Removing F from R: $(CDGHIJAB)^+ = R$.

K = CDGHIJAB

Removing G from R: $(CDHIJAB)^+ = R$.

K = CDHIJAB

Removing H from R: $(CDIJAB)^+ = R$.

K = CDIJAB

Removing I from R: $(CDJAB)^+ = R$.

K = CDJAB

Removing J from R: $(CDAB)^+ = R$.

K = CDAB

Removing A from R: $(CDB)^+ = R$.

K = CDB

Removing B from R: $(CD)^+ = R$.

K = CD

Thus, CD is a key of R.

4. Apply the appropriate algorithm to determine all the keys for R (w.r.t. **G**).

Solution 4

Attributes C and D do not appear in the RHS of any FD.

Every key of R contains CD. Or we can say CD^+=R (ABCDEFGHIJ)

We need to examine if the following sets are keys (ABCDEFGHIJ)

Thus,all the combinations or sets from CD does not need to examine.

So, CD is the unique key of R.

5. Determine the prime attributes of R.

Solution 5

The prime attribute of R are C and D.

6. Is R in BCNF (w.r.t. **G**)?

Solution 6

For the given relation:

F ->AB, F^+=AB ≠ R violates BCNF in R: F is not a superkey of R

C->FG, C^+=CFGAB ≠ R violates BCNF in R: C is not a superkey of R

H->IJ, H^+=HIJ ≠ R violates BCNF in R: H is not a superkey of R

D->H, C^+=DHIJ ≠ R violates BCNF in R: D is not a superkey of R

Thus, R is not in BCNF

7. Is R in 3NF (w.r.t. **G**)?

Solution 7

For the given relation:

F ->AB, F^+=AB ≠ R violates BCNF in R: F is not a superkey of R and neither A nor B is a prime attribute of R.

C->FG, C^+=CFGAB ≠ R violates BCNF in R: C is not a superkey of R and neither F nor G is a prime attribute of R.

H->IJ, H^+=HIJ ≠ R violates BCNF in R: H is not a superkey of R and neither I nor J is a prime attribute of R.

D->H, C^+=DHIJ ≠ R violates BCNF in R: D is not a superkey of R and neither H is a prime attribute of R.

Thus, R is not in BCNF

8. Determine whether the decomposition **D** = { CDE, CFG, DH, HIJ, FAB } has (i) the dependency preservation property and (ii) the lossless join property, with respect to **G**. Also determine which normal form each relation in the decomposition is in.

Solution 8

i)

F ->AB ∈ $\prod_{FAB}$(G).

CD->E ∈ $\prod_{CDE}$(G).

C->FG ∈ $\prod_{CFG}$(G).

H->IJ ∈ $\prod_{HIJ}$(G).

D->H, ∈ $\prod_{DH}$(G).

Since above every FD in G is applicable to at least one schema in D, therefore D has the dependency preservation property.

ii)

Let R1 = CDE, R2 = CFG and R3 = R1 ∪ R2 = CDEFG

Since G|= C → FG, G|= R1 ∩ R2 → R2 – R1. Thus, the decomposition {R1, R2} of R3 is LJ w.r.t. Π_{R3}(G).

Let R4 = DH and R5 = R3 ∪ R4 = CDEFGH

Since G|= D → H, G|= R3 ∩ R4 → R4 – R3. Thus, the decomposition {R3, R4} of R5 is LJ w.r.t. Π_{R5}(G). Therefore, the decomposition {R1, R2, R4} of R5 is LJ w.r.t. Π_{R5}(G).

Let R6 = HIJ and R7 = R5 ∪ R6 = CDEFGHIJ

Since G|= H → IJ, G|= R5 ∩ R6 → R6 – R5. Thus, the decomposition {R5, R6} of R7 is LJ w.r.t. Π_{R7}(G). Therefore, the decomposition {R1, R2, R4, R6} of R7 is LJ w.r.t. Π_{R7}(G).

Let R8 = FAB. Notice that R7 ∪ R8 = R.

Since G|= F→ AB, G|= R7 ∩ R8 → R8 – R7. Thus, the decomposition {R7, R8} of R is LJ w.r.t. G. Therefore, the decomposition {R1, R2, R4, R6, R8} of R is LJ w.r.t. G.

iii)

CDE: Π_{CDE}(F) = { CD → E }. Since CD is a superkey of CDE, CDE is in BCNF.

And also the rest of the schemas in D are in BCNF.