**Assignment 4**

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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)?**

Yes. Since CDE+ = {ABCDEFGHIJ}= R

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

Here CD is a proper subset of CDE (CD ⊂ CDE) and a superkey of R because CD+ = R.

Since a proper superset of CDE is a superkey of R but not a key of R.

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

C and D do not appear in the RHS of any FD in **G**. Therefore, every key of R must contain C and D. We will not try to remove them from K. Initially K = R. If (K – X)+ = R for some attribute X in

K – {CD} then we remove X from K otherwise, we leave X in K and continue with another attribute in K – {CD}, until all attributes in K – {CD} are considered.

Check for- remove E from R: (CDFGHIJAB)+ = R. K= {CDFGHIJAB }

Check for- remove F from R: (CDGHIJAB)+ = R . K= {CDGHIJAB }

Check for- remove G from R: (CDHIJAB)+ = R. K= {CDHIJAB }

Check for- remove H from R: (CDIJAB)+ = R. K= {CDIJAB}

Check for- remove I from R: (CDJAB)+ = R. K= {CDJAB}

Check for- remove J from R: (CDAB)+ = R. K = {CDAB}

Check for- remove A from R: (CDB)+ = R. K = {CDB}

Check for- remove 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).**

C and D do not appear in the RHS of any FD in **G**. Therefore, every key of R must contain C and D. From answer of question 2 & 3, CD is a superkey of R. Thus, CD is the unique key of R.

**5. Determine the prime attributes of R.**

The prime attribute of R are C and D as CD is key of R.

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

No. Consider H → IJ. H → IJ violates BCNF in R:H is not a superkey of R (**G**+ = IJ ≠ R).

R is not in BCNF.

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

No. Consider H → IJ in **G**. H → IJ violates 3NF in R: H is not a superkey of R (H+ = IJ ≠ R) and neither I nor J is a prime attribute of R.

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.

(i) Yes, since every FD in **G** is applicable to at least one schema in **D**.

For instance, CD → E ∈ ΠCDE(**G**).

(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. ΠR3(**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. ΠR5(**G**).

Therefore, the decomposition {R1, R2, R4} of R5 is LJ w.r.t. ΠR5(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. ΠR7(**G**).

Therefore, the decomposition {R1, R2, R4, R6} of R7 is LJ w.r.t. ΠR7(**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: ΠCDE(**G**) = { CD → E }.

Since CD is a superkey of CDE, CDE is in BCNF.

Similarly we show that the rest of the schemas in **D** are in BCNF.