CS 631: DATA MANAGEMENT SYSTEMS DESIGN

ASSIGNMENT 4

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

Yes,
Because CDE+ = ABCDEFGHIJ = R

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

CD is a proper subset of CDE (CD ⊂ CDE).
CD is a superkey of R: CD+ = R.
Since a proper superset of CDE is a superkey of R, CDE is 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 F. 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:
remove E from R: (CDFGHIJAB)+ = R. then K := CDFGHIJAB
remove F from R: (CDGHIJAB)+ = R. then K := CDGHIJAB
remove G from R: (CDHIJAB)+ = R. then K := CDHIJAB
remove H from R: (CDIJAB)+ = R. then K := CDIJAB
remove I from R: (CDJAB)+ = R. then K := CDJAB
remove J from R: (CDAB)+ = R. then K = CDAB
remove A from R: (CDB)+ = R. then K := CDB
remove B from R: (CD)+ = R. then 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 F. Therefore, every key of R must contain C and D.
From question 2, 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.

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

Consider H $\rightarrow$ IJ in F.H $\rightarrow$ IJ violates BCNF in R: H is not a superkey of R (F+ = IJ $\neq$ R).R is not in BCNF.

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

Consider H $\rightarrow$ IJ in F. H $\rightarrow$ IJ violates 3NF in R: H is not a superkey of R (H+ = IJ $\neq$ 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 F is applicable to at least one schema in D. For instance, CD $\rightarrow$ E $\in$ Π CDE(F).

(ii)We use the property of binary LJ decomposition and the property of repeated LJ decompositions. Let R1 = CDE, R2 = CFG and R3 = R1 $\cup$ R2 = CDEFG. Since F $\models$ C $\rightarrow$ FG, F $\models$ R1 $\cap$ R2 $\rightarrow$ R2 – R1. Thus, the decomposition {R1, R2} of R3 is LJ w.r.t. ΠR3(F). Let R4 = DH and R5 = R3 $\cup$ R4 = CDEFGH. Since F $\models$ D $\rightarrow$ H, F $\models$ R3 $\cap$ R4 $\rightarrow$ 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 $\cup$ R6 = CDEFGHIJ Since F $\models$ H $\rightarrow$ IJ, F $\models$ R5 $\cap$ R6 $\rightarrow$ R6 – R5. Thus, the decomposition {R5, R6} of R7 is LJ w.r.t. ΠR7(F). Therefore, the decomposition {R1, R2, R4, R6} of R7 is LJ w.r.t. ΠR7(F). Let R8 = FAB. Notice that R7 $\cup$ R8 = R. Since F $\models$ F $\rightarrow$ AB, F $\models$ R7 $\cap$ R8 $\rightarrow$ R8 – R7. Thus, the decomposition {R7, R8} of R is LJ w.r.t. F. Therefore, the decomposition {R1, R2, R4, R6, R8} of R is LJ w.r.t. F.

(iii) CDE: ΠCDE(F) = { CD $\rightarrow$ 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.