Dependencies, Decompositions, Normal forms

Submitted by: Saminul Islam (1004511833), Sadman Hasan(1003918246)

Question 1 Part A:

Step 1: Split the RHSs to get our initial set of FDs, S1:

1) M → I
2) M → J
3) M → L
4) J → L
5) J → I
6) JN → K
7) JN → M
8) KLN → M
9) K → I
10) K → J
11) K → L
12) IJ → K

Step 2: For each FD, try to reduce the LHS:

(1)-(5) and (9-11) cannot be reduced.

6) J^+ = JILK thus can be reduced to J → K

7) J^+ = JILK and N^+ = N so cannot be reduced

8.) K^+ = KIJL so can be reduced to KN → M

12.) J^+ = JILK so can be reduced to J → K (redundant, same as 6)

So, our new set of FDs, S2, is:

1) M → I
2) M → J
3) M → L
4) J → L
5) J → I
6) J→ K
7) J → M
8) KN → M
9) K → I
10) K → J
11) K → L

Step 3: Try to eliminate each FD.

1	M → I	$M^{+}_{S2 - (1)} = MJL\underline{I}K$, RHS included	*Need to remove*
2	M → J	$M^{+}_{S2 - \{(1),(2)\}} = ML$	***Keep***
3	M → L	$M^{+}_{S2 - \{(1),(3)\}} = MJ\underline{L}IK$, RHS included	*Need to remove*
4	J → L	$J^{+}_{S2 - \{(1),(3),(4)\}} = JIKM\underline{L}$, RHS included	*Need to remove*
5	J → I	$J^{+}_{S2 - \{(1),(3),(4),(5)\}} = JKM\underline{I}L$, RHS included	*Need to remove*
6	J → K	$J^{+}_{S2 - \{(1),(3),(4),(5),(6)\}} = J$	***Keep***
7	JN → M	$JN^{+}_{S2 - \{(1),(3),(4),(5),(7)\}} = JNKIL\underline{M}$, RHS included	*Need to remove*
8	KN → M	$KN^{+}_{S2 - \{(1),(3),(4),(5),(7),(8)\}} = KNIJL$	***Keep***
9	K → I	$K^{+}_{S2 - \{(1),(3),(4),(5),(7),(9)\}} = KJL$	***Keep***
10	K → J	$K^{+}_{S2 - \{(1),(3),(4),(5),(7),(10)\}} = KIL$	***Keep***
11	K → L	$K^{+}_{S2 - \{(1),(3),(4),(5),(7),(11)\}} = KIJ$	***Keep***

So, our minimal basis is:

- J → K
- K → I
- K → J
- K → L
- KN → M
- M → J

<u>Question 1 Part B:</u>

Attribute	**Appears on**		**Conclusion**
	LHS	**RHS**	
J,K,M	X	X	***must check***
I,L	-	X	***is not in any key***
N	X	-	***must be in every key***
O,P	-	-	***must be in every key***

- *JNOP*$^{+}$ = JNOPIKLM. So **JNOP** is a key
- *KNOP*$^{+}$ = KNOPIJLM. So **KNOP** is a key
- *MNOP*$^{+}$ = MNOPIJKL. So **MNOP** is a key

Question 1 Part C:

Combining FDs with the same LHS (from minimal basis):

- J → K
- K → IJL
- KN → M
- M → J

We get the following set of relations:

R1(J, K), R2(K, I, J, L), R3(K, N, M), R4(M, J)

R1 is included in R2 so we can remove it to get:

R1(K, I, J, L), R2(K, N, M), R3(M, J)

Need to add a relation that includes key:

R1(K, I, J, L), R2(K, N, M), R3(M, J), R4(J, N, O, P)

Question 1 Part D:

J → K will project onto the relationship R1 and J^+ = JK so J is not a superkey of this relation, so the schema does allow redundancy as there are some FDs that violate BCNF.

Question 2 Part A:

BCNF requires that the LHS of an FD be a superkey.

C → EH	C^+ = CDEFGHIJ	***Key***
DEI → F	DEI^+ = DEIF	*Not key, violates BCNF*
F → D	F^+ = FD	*Not key, violates BCNF*
EH → CJ	EH^+ = CDEFGHIJ	***Key***
J → FGI	J^+ = JFGID	*Not key, violates BCNF*

Keys in S_T that violate BCNF:

DEI → F F → D J → FGI

Question 2 Part B:

- $F \rightarrow D$ violates BCNF, $F^+ = FD$ so we split R into:

  R1(D, F) R2(C, E, F, G, H, I, J)

  R1 satisfies BCNF with FD $F \rightarrow D$.

  R2 violates BCNF so we must decompose further.

- Decompose R2 using FD $J \rightarrow FGI$ ($J^+ = JFGID$) to get:

  R3(F, G, I, J) R4(C, E, H, J)

  R3 satisfies BCNF with FD $J \rightarrow FGI$.

  R4 satisfies BCNF with FD $C \rightarrow EH$ (which is a key).

Final Decomposition:

- R1(D, F) with FD $F \rightarrow D$
- R3(F, G, I, J) with FD $J \rightarrow FGI$
- R4(C, E, H, J) with FD $C \rightarrow EH$