CSC343 Assignment 3 Part2

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1.
(a)

LPR^+	$LPRQST$	LPR is not a superkey, so it violates BCNF.
LR^+	$LRST$	LR is not a superkey, so it violates BCNF.
M^+	MLO	M is not a superkey, so it violates BCNF.
MR^+	$MRNLOST$	MR is not a superkey, so it violates BCNF.

Therefore, LPR→Q, LR→ST, M→LO, MR→N. All FDs violate BCNF.
(b)
First, we decompose R using FD LPR→Q.
R1: LPRQST and R2: LMNOPR
Project all FDs on to R1.
Since no single attribute can indicate something other than itself in R1.
Therefore, no need to check a single attribute.
The first FD that violates this relation which includes two attributes is LR→ST
We abort the projection. We must decompose R1 further.

R3: LRST

L	R	S	T	closure	FDs
✓				L+ = L	nothing
	✓			R+ = R	nothing
		✓		S+ = S	nothing
			✓	T+ = T	nothing
✓	✓			LR+ = LRST	LR is a superkey of R3

R3 satisfies BCNF.

R4: LPRQ

L	P	R	Q	closure	FDs
✓				L+ = L	nothing
	✓			P+ = P	nothing
		✓		R+ = R	nothing
			✓	Q+ = Q	nothing
✓	✓	✓		LPR+ = LPRQ	LPR is a superkey of R4

R4 satisfies BCNF.

R2: LMNOPR

L	M	N	O	P	R	closure	FDs
✓						L+ = L	nothing
	✓					M+ = MLO	Violates BCNF

Decompose R2 using M→LO

R5: MLO

M	L	O	closure	FDs
✓			M+ = MLO	M is a superkey in R5
	✓		L+ = L	nothing
		✓	O+ = O	nothing

R5 satisfies BCNF.

R6: MNPR

M	N	P	R	closure	FDs
✓				M+ = M	nothing
	✓			N+ = N	nothing
		✓		P+ = P	nothing
			✓	R+ = R	nothing
✓	✓	✓		MR+ = MRN	Violates BCNF

Decompose R6 using MR→N

R7: MRN

M	R	N	closure	FDs
✓			M+ = M	nothing
	✓		R+ = R	nothing
		✓	N+ = N	nothing
✓	✓		MR+ = MRN	MR is a superkey of R7.

R7 satisfies BCNF.
R8: MPR with no FDs.

Final answer:
R3 = LRST, FDs: LR→ST
R4 = LPQR, FDs: LPR→Q
R5 = LMO, FDs: M→LO
R7 = MNR, FDs: MR→N
R8: MPR with no FDs.

2.

(a)

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

(1) AB → C
(2) AB → D
(3) ACDE → B
(4) ACDE → F
(5) B → A
(6) B → C
(7) B → D
(8) CD → A
(9) CD → F
(10) CDE → F
(11) CDE → G
(12) EB → D

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

(1) B^+ = ACD, so we can reduce the LHS of this FD, yielding the new FD: B → C, which is already existed, then remove
(2) B^+ = ACD, so we can reduce the LHS of this FD, yielding the new FD: B → D, which is already existed, then remove
(3) CD^+ = ACDF, CDE^+ = ABCDEFG, so we can reduce the LHS of this FD, yielding the new FD: CDE → B
(4) CD^+ = ACDF, so we can reduce the LHS of this FD, yielding the new FD: CD → F
(5) Only one attribute on the LHS, we cannot reduce the LHS
(6) Only one attribute
(7) Only one attribute
(8) C^+ = C, D^+ = D, we cannot reduce the LHS
(9) C^+ = C, D^+ = D, we cannot reduce the LHS.
(10) CD^+ = ACDF, so we can reduce the LHS of this FD, yielding the new FD: CD → F which is already existed, then remove
(11) CD^+ = ACDF, C^+ = C, D^+ = D, E^+ = E, so we cannot reduce the LHS of this FD
(12) E^+ = E, B^+ = ACD, so we can reduce the LHS of this FD, yielding the new FD: B → D, which is repeated, remove

Our new set of FDs, S2 is:

(1) CDE → B
(2) B → A
(3) B → C
(4) B → D
(5) CD → A
(6) CD → F

(7) CDE → G

Step 3: Try to eliminate each FD

(1) $CDE^+_{S2\text{-}(1)}$ = ACDEFG. We need

(2) $B^+_{S2\text{-}(2)}$ = ABCDF. We can remove

(3) $B^+_{S2\text{-}(3)}$ = BD. We need

(4) $B^+_{S2\text{-}(4)}$ = BC. We need

(5) $CD^+_{S2\text{-}(5)}$ = ACD. We need

(6) $CD^+_{S2\text{-}(6)}$ = CDF. We need

(7) $CDE^+_{S2\text{-}(7)}$ = ABCDEF. We need

After combination, our minimal basis is:

{ CDE → BG, B → CD, CD → AF }

ABCDEFGH

(b)

Attribute	Appears on		Conclusion
	LHS	RHS	
H	-	-	Must be in every key
E	√	-	Must be in every key
AFG	-	√	Is not in any key
BCD	√	√	Must check

We only need to consider all combinations of B, C, D. For each, we must add in E, H, since they are in every key.

$CDEH^+$ = ABCDEFGH

BEH^+ = ABCDEFGH

All other possibilities include BEH and CDEH, so we've done.

Therefore, BEH is a key.

(c)

Apply 3NF algorithm:

our minimal basis is:

{ CDE → BG, B → CD, CD → AF }

$R1$:(B,C,D,E,G) with FD $CDE \rightarrow BG$.

$R2$:(B,C,D) with FD $B \rightarrow CD$.

$R3$:(A,C,D,F) with FD $CD \rightarrow AF$.

Since the attributes BD occur within R1, we do not need to keep the relation R2.

There is no key in these relations, we need to add a relation contains a key.

R4: (B, E, H)

Then, the final set of relations is: R1(B,C,D,E,G), R3(A,C,D,F) and R4 (B,E,H)

(d)

Our schema allows redundancy.

Because we can find a relation that violate BCNF:

$B \rightarrow CD$ will project onto the relation R1. And B^+ = ABCDF, so B is not a superkey of this relation. Then our schema allows redundancy.