# CSC343 Assignment 3 Part 2

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1.

Consider a relation A with attributes LMNOPQRS with functional dependencies D:

D= { L→NQ [a], MNR→O[b], O→M[c], NQ→LS[d], S→OPR[e] }

1.a)

L += NQLSOPRM [a]
MNR += OMNR [b] violation
O += OM [c] violation
NQ += LSNQOPRM [d]
S += OPRM [e] violation

Therefore, MNR→O, O→M, and NQ→LS violate the BCNF.

1.b)

We start BCNF decomposition from [b] MNR→O and the we have:
R1:OMNR
R2: LMNPQRS

In R1 we have: O+= OM(O→M), M+= M, N+=N, R+=R and O→M violate BCNF, then in next decomposition:

> R3: ONR
> And we have O+= OM(O→M), N+=N, R+=R, no FDs violate BCNF and we stop here.
>
> R4 : OM
> And we have O+= OM(O→M) and M+= M, no FDs violate BCNF and we stop here.

In R2 we have L+= LNQSOPRM, M+= M, N+= N, P+= P, Q+= Q, R+= R and S+= SOPRM , we find that S→OPRM violates the BCNF, then in next decomposition:

R5: SOPRM
And we have O+= OM(O→M), S+= SOPRM(O→OPRM), P+= P, R+=R, M+=M and O→M violates the BCNF, then in the decomposition we have:

R7: OM
And we have O+= OM, M+= M, no FDs violate BCNF and we stop here.

R8: OPR
And we have O+= M, P+= P, R+= R, no FDs violate BCNF and we stop here.

R6: LNQS
And we have L+= NQLSOPRM(L ->NQS), N+= N, Q+= Q, S+= OPRM,no FDs violate BCNF and we stop here.

Therefore from the BCNF decomposition:

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                              R:{L,M,N,O,P,Q,R,S}
                            /                       \
                R1: {O,M,N,R}                        R2: {L,M,N,P,Q,R,S}
                /           \                         /                 \
    R3:  {O,N,R }      R4: {O,M}            R5: {S,O,P,R,M }        R6:{ L,N,Q,S }
                                              /            \
                                       R7:{ O,M }      R8: {O,P,R}
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In the final decompositions we have LNQS(L ->NQS), OPR(Ø), ONR(Ø), OM(O->M).

2.a)
Compute a minimal basis for T
Step1: We split the LHS of each FD

AB → C, C→A, C→B, C→D, CFD→E,E→B, BF→E, BF→C, B→D, B→A

Step2: Reduce LHS

A+= A, B+= BDA, then we reduce AB→C to B→C

CF+= CFABD, then we reduce LHS of CFD→E to CF→E

B→ C, C→A , C→B, C→D, CF→E, E→B, BF→E, BF→C, B→D, B→A

Remove excessive FDs:

Remove B→C:

B+= BDA  we cannot remove

Remove C→A:

C+= CBDA we can remove this C→A

Remove C→A & C→B:

C+= CD we cannot remove this

Remove C→A & C→D :

C+=CBDA we can remove this  C→D

Remove C→A & C→D & CF→E:

CF+= CFBDAE we can remove this  CF→E

Remove C→A & C→D & CF→E & E→B:

E+= E we cannot remove this

Remove C→A & C→D & CF→E &  BF→E:

BF→BFDAC we cannot remove this

Remove C→A & C→D & CF→E &  BF→C:

BF→BFDAC we can remove this BF→C

Remove C→A & C→D & CF→E &  BF→C & B→D:

$B \to BAC$ we cannot remove this

Remove $C \to A$ & $C \to D$ & $CF \to E$ & $BF \to C$ & $B \to A$:

$B \to BDC$ we cannot remove this

Step 4 Final Answer:

$B \to A$, $B \to C$, $B \to D$, $BF \to E$, $C \to B$, $E \to B$

2.b)

Compute all keys for P:

Since F,G,H are not in RHS, then they are in every key,

A,D are not in RHS and not in LHS, then they are in no key,

B,C,E are in botH RHS and LHS, so we must check them.

To check BCE:

Case 1(B) :FGHB += FGHBACED contains all attributes

Case 2(C): FGHC += FGHCBAED contains all attributes

Case 3(E): FGHE += FGHEBCDA contains all attributes

Since we find three key with B, C, E, we don't need to check their combinations such as BC, CE, BE……; since they will always be superkeys.

Then FGHB, FGHC, FGHE are keys.

2.c)

3NF synthesis

Combine FDs with same LHS:

$B \to ACD$

$C \to B$

$E \rightarrow B$

$BF \rightarrow E$

For each FD in minimal basis, define a new relation:

R1: {B,A,C,D}

R2: {C,B}

R3: {E,B}

R4: {B,F,E}

Since R3 in R4 and R2 in R1, so we only keep R4 and R1.

Because no relation is super-key (no G, H), add relation whose schema is key:

R1: {B, A, C, D}, R4:{B, F, E}, R5{F, G, H, B}

2.d)

Because we formed each relation from an FD, the LHS of those FDs are indeed superkeys for their relations. However, there may be other FDs that violate BCNF and therefore allow redundancy. Then we need to project the FDs onto each relation.

We can see $E \rightarrow B$ will project onto R4 and $E^+$= EBACD so E is not a superkey of the relation R4. Therefore yes, the schema will allow redundancy.