CSC343 Assignment 3, Part 3

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Question 1: S = {I→DGF, H→CEA, BI→J, B→H, CI→K}

a)

• Violates: I+ = DGFI, so I is not a superkey and I+=DGFI violates BCNF.
• Violates: H+ = ACEH so H+ = ACEH also violates BCNF.
• Meets: BI+ = ABCDEFGHIJK so BI is the superkey. The FD does not violate BCNF.
• Violates: B+ = ABCEH also violates BCNF.
• Violates: CI+ = CDFGIK also violates BCNF.

b)

- Decompose R using I -> DGF and this yield two relations: R1 = DGFI, R2 = ABCEHIJK.
- Project the FDs onto R1 = DFGI:

D	G	F	I	Closure	FDs
√				D+ = D	Nothing
	√			G+ = G	Nothing
		√		F+ = F	Nothing
			√	I+ = DGFI	I -> DGF, I is the superkey
Superset of I				Irrelevant	
√	√			DG+ = DG	Nothing
√		√		DF+ = DF	Nothing
	√	√		GF+ = GF	Nothing
√	√	√		DFG+ = DFG	Nothing

This relation satisfies BCNF

- Project the FDs onto R2 = ABCEHIJK

A	B	C	E	H	I	J	K	Closure	FDs
√								A+ = A	Nothing
	√							B+ = ABCEH	Violate BCNF, abort

- Decompose R2 using H -> ACE. This yield two relations: R3 = ACEH, R4 = BHIJK.
- Project FDs onto R3 = ACEH

A	C	E	H	Closure	FDs
√				A+ = A	Nothing
	√			C+ = C	Nothing
		√		E+ = E	Nothing
			√	H+ = ACEH	H -> ACE, H is the superkey
Superset of H				Irrelevant	
√	√			AC+ = AC	Nothing
√		√		AE+ = AE	Nothing
	√	√		CE+ = CE	Nothing
√	√	√		ACE+ = ACE	Nothing

This relation satisfies BCNF

- Project FDs onto R4 = BHIJK

B	H	I	J	K	Closure	FDs
√					B+ = ABCEH	Violate BCNF, abort

- Decompose R4 using B -> H. This yield two relations: R5 = BH, R6 = BIJK
- Project the FDs onto R5 = BH

B	H	Closure	FDs
√		B+ = ABCEH	B->H, B is the superkey
	√	H+ = ACEH	Nothing
Superset of B		irrelevant	

This relation satisfies BCNF

- Project the FDs onto R6 = BIJK

B	I	J	K	Closure	FDs
√				B+ = ABCEH	Nothing
	√			I+ DGFI	Nothing
		√		J+ = J	Nothing
			√	K+ = K	Nothing
√	√			BI+ = ABCDEFGHIJK	Meet the BCNF
√		√		BJ+ = ABCEHJ	Nothing
√			√	BK+ = ABCEHK	Nothing
	√	√		IJ+ = DGFIJ	Nothing
	√		√	IK+ = DGFIL	Nothing
	√	√	√	IJK+ = DGFIJK	Nothing
Superset of BI				Irrelevant	

This relation satisfies BCNF

Final Decomposition:

a) R1 = DFGI, with FD: I -> DFG
b) R3 = ACEH, with FD: H ->ACE
c) R5 = BH, with FD: B -> H
d) R6 = BIJK, with FD: BI -> J,B -> H, H -> ACE and CI -> K

Question 2

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

- (a) ACDE -> B
- (b) BF -> A
- (c) BF -> D
- (d) B -> C
- (e) B -> F
- (f) CD -> A
- (g) CD -> F
- (h) ABF -> C
- (i) ABF -> D
- (j) ABF -> H

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

a. A+ = A, C+ = C, D+ =D, E+= E. In fact, CD could yield A, then A is redundant in this FD, ACDE -> B could become CDE -> B
b. B+ = BCF, F+ = F. Then we can reduce this to B -> A
c. B+ = BCF, F+ = F. Then we can reduce this to B -> D
d. B -> C, we cannot reduce this FD
e. B -> F, we cannot reduce this FD
f. C+ = C, D+=D. We cannot reduce this FD
g. C+ = C, D+=D. We cannot reduce this FD
h. A+ = A, B+ = ABCDF, then this FD is redundant because B -> C already did this job
i. A+ = A, B+ = ABCDF, then this FD is redundant because B -> D already did this job
j. A+ = A, B+ = ABCDF, then we can reduce this FD to B -> H

Then new FDs, let's call it S2 is:

a. CDE -> B
b. B -> A
c. B -> D
d. B -> C
e. B -> F
f. CD -> A
g. CD -> F
h. B -> H

Step 3: Try to eliminate each FD:

a. CDE+(S2-a) = ACDEF. We need this FD
b. B+(S2-b) = ACDFH. We don't need this FD
c. B+(S2- {b, c}) = BCFH. We need this FD
d. B+(S2 - {b, d}) = BDFH. We need this FD

e. B+(S2 - {b, e}) = ABCDHF. We don't need this FD
f. CD+(S2 - {b, e, f}) = CDF. We need this FD
g. CD+(S2 - {b, e, g}) = ACD. We need this FD
h. B+(S2 - {b, e, h}) = ABCDF. We need this FD

Our Final set of FDs is

a. B -> C
b. B -> D
c. B -> H
d. CD -> A
e. CD ->F
f. CDE -> B

(b) E never appear in RHS of FDs, therefore it must be in keys, so does G. Then all keys are BEG and CDEG.

(c) Following the 3NF Synthesis algorithm, we would get a relation for each FD.
FDs are:

a. B -> C
b. B -> D
c. B -> H
d. CD -> A
e. CD ->F
f. CDE -> B

The set of relations that result from these FDs are
R1(B, C) R2(B, D) R3(B, H) R4(CD, A) R5(CD, F) R6(CDE, B)
We can see that R1, R2, R3 have the same LHS and R4, R5 have the same LHS
The final relations are: R1(B, C, D, H), R2(A, C, D, F), R3(B, C, D, E), R4(C, D, E, G)

(d) The only way to find out is to project the FDs onto each relation.

- B -> CDH on R1 and B is a superkey
- CD -> ACDF on R2 and CD is a superkey
- CDE -> B on R3 and CDE is a superkey

Therefore, this schema does NOT allow redundancy.