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:

1. R1 = DFGI, with FD: I -> DFG
2. R3 = ACEH, with FD: H ->ACE
3. R5 = BH, with FD: B -> H
4. R6 = BIJK, with FD: BI -> J,B -> H, H -> ACE and CI -> K

Question 2

1. Step 1: Split the RHSs to get our initial set of FDs, S1:
2. ACDE -> B
3. BF -> A
4. BF -> D
5. B -> C
6. B -> F
7. CD -> A
8. CD -> F
9. ABF -> C
10. ABF -> D
11. ABF -> H

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

* 1. 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
  2. B+ = BCF, F+ = F. Then we can reduce this to B -> A
  3. B+ = BCF, F+ = F. Then we can reduce this to B -> D
  4. B -> C, we cannot reduce this FD
  5. B -> F, we cannot reduce this FD
  6. C+ = C, D+=D. We cannot reduce this FD
  7. C+ = C, D+=D. We cannot reduce this FD
  8. A+ = A, B+ = ABCDF, then this FD is redundant because B -> C already did this job
  9. A+ = A, B+ = ABCDF, then this FD is redundant because B -> D already did this job
  10. A+ = A, B+ = ABCDF, then we can reduce this FD to B -> H

Then new FDs, let’s call it S2 is:

1. CDE -> B
2. *B -> A*
3. B -> D
4. B -> C
5. *B -> F*
6. CD -> A
7. CD -> F
8. B -> H

Step 3: Try to eliminate each FD:

1. CDE+(S2-a) = ACDEF. We need this FD
2. B+(S2-b) = ACDFH. We don’t need this FD
3. B+(S2- {b, c}) = BCFH. We need this FD
4. B+(S2 - {b, d}) = BDFH. We need this FD
5. B+(S2 - {b, e}) = ABCDHF. We don’t need this FD
6. CD+(S2 - {b, e, f}) = CDF. We need this FD
7. CD+(S2 - {b, e, g}) = ACD. We need this FD
8. B+(S2 - {b, e, h}) = ABCDF. We need this FD

Our Final set of FDs is

1. B -> C
2. B -> D
3. B -> H
4. CD -> A
5. CD ->F
6. CDE -> B
7. E never appear in RHS of FDs, therefore it must be in keys, so does G. Then all keys are BEG and CDEG.
8. Following the 3NF Synthesis algorithm, we would get a relation for each FD.

FDs are:

1. B -> C
2. B -> D
3. B -> H
4. CD -> A
5. CD ->F
6. 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)

1. 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.