**CSC343 Assignment 3 Part 2**

**Q1:**

(a):

First, compute

So, NONE of these FDs satisfy BCNF.

Therefore, **,** all violate BCNF.

(b): **Employ BCNF decomposition:**

**Step 1**: Decompose R using FD ,, this yields 2 relations:

and

Project the FDs onto

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| L | P | Q | | R | S | T | Closure | FDs |
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|  |  |  |  | |  |  |  | : violates BCNF |

We must decompose futher.

**Step 2**: Decompose using FD , , this yields 2 relations:

Project the FDs onto

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| --- | --- | --- | --- | --- | --- |
| L | R | S | T | Closure | FDs |
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|  |  |  |  |  | : LR is a superkey |
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|  |  |  |  |  |  |
| Subsets of LR | | | | irrelevant | Can only generate weaker FDs than what we already have |

satisfies BCNF.

Project the FDs onto

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| --- | --- | --- | --- | --- | --- |
| L | P | Q | R | Closure | FDs |
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|  |  |  |  |  | : LPR is a superkey |
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|  |  |  |  |  |  |
| Subsets of LPR | | | | irrelevant | Can only generate weaker FDs than what we already have |

satisfies BCNF.

**Step 3**: Return to and project the FDs onto it.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| L | M | N | O | P | R | Closure | FDs |
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We must decompose futher.

**Step 4**: Decompose using FD , , this yields 2 relations:

Project the FDs onto

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| L | M | O | Closure | FDs |
|  |  |  |  |  |
|  |  |  | O | : M is a superkey |
|  |  |  |  |  |
| Subsets of M | | | irrelevant | Can only generate weaker FDs than what we already have |
|  |  |  |  |  |

satisfies BCNF.

Project the FDs onto

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| M | N | P | R | Closure | FDs |
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We must decompose futher.

**Step 5**: Decompose using FD , , this yields 2 relations:

Project the FDs onto

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| --- | --- | --- | --- | --- |
| M | N | R | Closure | FDs |
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|  |  |  |  | : MR is a superkey |
|  |  |  |  |  |
| Subsets of MR | | | irrelevant | Can only generate weaker FDs than what we already have |

satisfies BCNF.

Project the FDs onto

|  |  |  |  |  |
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| M | P | R | Closure | FDs |
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|  |  |  |  |  |
|  |  |  | ,  We cannot get P since it is not on a RHS |  |
|  |  |  |  |  |

satisfies BCNF.

**Final Decomposition:**

1. with FD ,
2. with FD ,
3. with FD ,
4. with FD ,
5. with no FDs.

Q2:

**(a). Compute minimal basis:**

**Step 1:** Split the RHS to get initial set of FDs, S1:

3. ,

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

1. Since , , we can reduce the LHS (AB) of this FD, yielding the FD: . This will be removed because is already existed.
2. Same as #1 above, reduce to . This will be removed because is already existed.
3. Since , we can reduce to .
4. Since , we can reduce the LHS of this FD, yielding the FD: . This will be removed because is already existed.
5. We cannot reduce since this is a singleton.
6. Same as #5.
7. Same as #5.
8. Since no singleton LHS yields anything. We cannot reduce the LHS of this FD.
9. Same as #8.
10. Since , we can reduce the LHS (CDE) of this FD, yielding the FD: . This will be removed because is already existed.
11. Since no singleton LHS yields anything. Only the RHS of is G among all FDs. So, we cannot reduce .
12. Since , we can reduce the LHS (EB) of this FD, yielding the FD: . This will be removed because is already existed.

Our new set of FDs, S2, is:

1. ,

**Step 3:** Try to eliminate each FD.

|  |  |  |  |
| --- | --- | --- | --- |
| FDs | Exclude these from S2 when computing closure | Closure | Decision |
| #1. | #1 | , B is not existed. | NEED |
| #2. | #2 | , A is the right side of #2. | REMOVE |
| #3. | #2, #3 | , C is not existed. | NEED |
| #4. | #2, #4 | , D is not existed. | NEED |
| #5. | #2, #5 | , A is not existed. | NEED |
| #6. | #2, #6 | , F is not existed. | NEED |
| #7. | #2, #7 | , G is not existed. | NEED |

Therefore, our final minimal basis set of FDs is:

1. ,

After the combination, the minimal basis for T is {, , }.

**(b). Compute all the keys:**

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

Have to consider all combinations of BCD with EH:

. So is a key.

And we do not need to consider , and since is a key.

. This is not a key.

. This is not a key.

. So is a key.

Therefore, for P, and are keys.

**(c).** **Apply 3NF synthesis:**

By (a), we have the minimal basis for T is {, , }.

For each FD in T, we set relations:

with FD .

with FD .

with FD .

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

Since there is no key in P (our relation), we need to add a relation contains a key.

For example: .

Final set of relations is:

(d): **Yes. Our schema allow redundancy.**

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. The only way to find out is to project FDs onto each relation.

We can find a relation that violate BCNF without doing all the full projections:

will project onto the relation R1. And , so B is not a superkey of this relation.

So, this schema allows redundancy.