

Shubham Mittal
Prin Info

Professor Garcia

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19.2:

Homework #4

1. The keys for R are BCD, ECD, and ACD.
2. R is in 3NF because all three dependencies in this scenario have no non-prime attributes. From this we can deduce that cannot violate the requirements of being in 3NF.
3. R is not in BCNF because the superkey of the three dependencies doesn't determine all the other attributes in the relationship.

19.3:

1. The functional dependencies are:
 1. a) $Z \twoheadrightarrow Y$
 2. b) $X \twoheadrightarrow Y$
 3. c) $XZ \twoheadrightarrow Y$
2. This scenario will keep the functional dependencies unchanged:
 1. a) $Z \twoheadrightarrow Y$
 2. b) $X \twoheadrightarrow Y$
 3. c) $XZ \twoheadrightarrow Y$

19.5:

- 1) This relation is in 1NF.
 - a) The BCNF decomposition is: AB, CD, ACE.
- 2) This relation is in 1NF.
 - a) The BCNF decomposition is: AB, BF
- 3) This relation is in BCNF.
- 4) This relation is in BCNF.
- 5) This relation is in BCNF.

19.6:

1) Part A:

- a) $A \twoheadrightarrow B$ does hold over the Schema S because the tuples under A are unique and the elements in B are dependent on A.
- b) $BC \twoheadrightarrow A$ does not hold over Schema S because combining B and C still does not allow for us to derive A since (2,3) derives 1, and (2,3) also derives 4.
- c) $B \twoheadrightarrow C$ does hold over Schema S because the elements in C are dependent on C. 2) It is not possible to identify any dependencies that hold over S because only some of the

dependencies hold over S. We cannot say they hold over the entire Schema S because we do not have enough information and would need another relation in order to assume this.

19.7:

1. The first part is:

- a) The candidate key is B
- b) The best normal form that R satisfies is 2NF.
- c) $C \twoheadrightarrow D$ and $C \twoheadrightarrow A$ violate BCNF. We can decompose this to AC, BC, and CD.

2. The second part is:

- a) The candidate key is BD
- b) The best normal form for this case is 1NF.
- c) $B \twoheadrightarrow C$ and $D \twoheadrightarrow A$ violate BCNF. We can decompose these relations to AD, BD, and BC.

3. The third part is:

- a) The candidate key are ABC and BCD
- b) The best normal form is 3NF.
- c) $D \twoheadrightarrow A$ violate BCNF since D is not a key in this case. There is no decomposition for this case since we cannot preserve the dependency of ABC.

4. The fourth part is:

- a) The candidate key is A
- b) The best normal form is 2NF.
- c) $BC \twoheadrightarrow D$ violates BCNF. We can decompose this to BCD and ABC.

5. The fifth part is:

- a) The candidate keys are AB, AD, BC, and CD.
- b) The best normal form is 3NF.
- c) $C \rightarrow A$ and $D \rightarrow B$ violate BCNF. We can decompose this to AC and BCD, but, this does not preserve $AB \twoheadrightarrow C$ and $AB \twoheadrightarrow D$, so we decompose again into AC, BD, and CD. This also does not work as the lost functional dependencies, when added, are not in BCNF form, thus there is no decomposition for this case.

19.10:

1. The first part is:

- a) The candidate key is BD
- b) This is not a good decomposition because the dependency is not preserved for $D \rightarrow A$.

2. The second part is:

- a) The candidate keys are AB and CB.
- b) This is a good composition because the dependencies are preserved.

3. The third part is:

- a) The candidate keys are A and C.
- b) This is not a good decomposition because this decomposition makes it so that C is not a candidate key.

4. The fourth part is:

- a) The candidate key is A.
- b) This is not a good decomposition because the dependencies are not full preserved.

5. The fifth part is:

a) The candidate key is A.

b) This is a good decomposition because all dependencies are preserved in this case.