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Quiz 4

- Suppose you are given a relation *R* with four attributes *ABCD*. For each of the following sets of FDs, assuming those are the only dependencies that hold for *R*, do the following:
- (a) Identify the candidate key(s) for *R*.
- (b) Identify the best normal form that *R* satisfies (1NF, 2NF, 3NF, or BCNF).
- (c) If *R* is not in BCNF, decompose it into a set of BCNF relations that preserve the dependencies.

Quiz 4

- 1. $C \rightarrow D$, $C \rightarrow A$, $B \rightarrow C$
- 2. $B \rightarrow C$, $D \rightarrow A$
- 3. $ABC \rightarrow D$, $D \rightarrow A$
- 4. $A \rightarrow B$, $BC \rightarrow D$, $A \rightarrow C$
- 5. $AB \rightarrow C$, $AB \rightarrow D$, $C \rightarrow A$, $D \rightarrow B$

1. (a) Candidate keys: *B*
(b) *R* is in 2NF but not 3NF.
(c) $C \rightarrow D$ and $C \rightarrow A$ both cause violations of BCNF. One way to obtain a (lossless) join preserving decomposition is to decompose R into *AC*, *BC*, and *CD*.
2. (a) Candidate keys: *BD*
(b) *R* is in 1NF but not 2NF.
(c) Both $B \rightarrow C$ and $D \rightarrow A$ cause BCNF violations. The decomposition: *AD*, *BC*, *BD* (obtained by first decomposing to *AD*, *BCD*) is BCNF and lossless and join-preserving.
3. (a) Candidate keys: *ABC*, *BCD*
(b) *R* is in 3NF but not BCNF.
(c) *ABCD* is not in BCNF since $D \rightarrow A$ and *D* is not a key. However if we split up *R* as *AD*, *BCD* we cannot preserve the dependency $ABC \rightarrow D$. So there is no BCNF decomposition.
4. (a) Candidate keys: *A*
(b) *R* is in 2NF but not 3NF (because of the FD: $BC \rightarrow D$).
(c) $BC \rightarrow D$ violates BCNF since *BC* does not contain a key. So we split up *R* as in: *BCD*, *ABC*.
5. (a) Candidate keys: *AB*, *BC*, *CD*, *AD*
(b) R is in 3NF but not BCNF (because of the FD: $C \rightarrow A$).
(c) $C \rightarrow A$ and $D \rightarrow B$ both cause violations. So decompose into: *AC*, *BCD* but this does not preserve $AB \rightarrow C$ and $AB \rightarrow D$, and *BCD* is still not BCNF because $D \rightarrow B$. So we need to decompose further into: *AC*, *BD*, *CD*. However, when we attempt to revive the lost functioanl dependencies by adding *ABC* and *ABD*, we that these relations are not in BCNF form. Therefore, there is no BCNF decomposition.