

Quiz 3: Database Systems I

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1. [10] Show that each of the following are **not** valid rules about FD's by giving a small example relations that satisfy the given FD's (following the "if") but not the FD that allegedly follows (after the "then").
 - a. (3) If $A \rightarrow B$ then $B \rightarrow A$
 - b. (3) If $AB \rightarrow C$ and $A \rightarrow C$, then $B \rightarrow C$
 - c. (4) If $AB \rightarrow C$, then $A \rightarrow C$ or $B \rightarrow C$

2. [10] Suppose we have relation $R(A,B,C,D,E)$, with some set of FD's, and we wish to project those FD's onto relation $S(A,B,C)$. Give the FD's that hold in S if the FD's for R are:
- $AB \rightarrow D$, $AC \rightarrow E$, $BC \rightarrow D$, $D \rightarrow A$, and $E \rightarrow B$.

3. [10] Let $R(A,B,C,D,E)$ be decomposed into relations with the following three sets of attributes: $\{A,B,C\}$, $\{B,C,D\}$, and $\{A,C,E\}$. For the following sets of FD's, use the chase test to tell whether the decomposition of R is lossless. If it is not lossless, give an example of an instance of R that returns more than R when projected onto the decomposed relations and rejoined.

$A \rightarrow D$, $D \rightarrow E$, and $B \rightarrow D$

4. [10] Consider a relation $\text{Stocks}(B, O, I, S, Q, D)$, whose attributes may be thought of informally as broker, office (of the broker), investor, stock, quantity (of the stock owned by the investor), and dividend (of the stock). Let the set of FD's for Stocks be $S \rightarrow D$, $I \rightarrow B$, $IS \rightarrow Q$, and $B \rightarrow O$.

(2) What are all the keys for Stocks

(3) Verify that the given FD's are their own minimal basis.

(5) Use the 3NF synthesis algorithm to find a lossless-join, dependency-preserving decomposition of R into 3NF relations. Are any of the relations not in BCNF?

5. [10] For each of the following relations schemas and dependencies.

a. $R(A,B,C,D,E)$ with MVD's $A \twoheadrightarrow B$ and $AB \twoheadrightarrow C$ and FD's $A \rightarrow D$ and $AB \rightarrow E$

Do the following:

i. (4) Find all the 4NF violations.

ii. (6) Decompose the relations into a collection of relation schemas in 4NF.

6. [10] Use the chase test to tell whether the following dependencies hold in a relations $R(A, B, C, D, E)$ with the dependencies $A \twoheadrightarrow BC$, $B \rightarrow D$, and $C \twoheadrightarrow E$.

a. (4) $A \twoheadrightarrow D$

(6) $A \rightarrow E$