

COSC 4820, Spring 2023
Databases
Chase test, 3NF

Question 1: [15 points]

Let $R(A, B, C, D, E)$ be decomposed into relations with following sets of attributes: $\{A, B, C\}$, $\{B, C, D\}$, and $\{A, C, E\}$. For each of the following sets of FD's, use the chase test to tell whether the decomposition of R is lossless. For those that are not lossless, give an example of an instance of R that returns more than R when projected on the decomposed relations and rejoined. (Please note that an instance of a relation is one in which there is actual data.)

- (a) [5 points] $AC \rightarrow E$ and $BC \rightarrow D$.
- (b) [5 points] $A \rightarrow D$, $D \rightarrow E$, and $B \rightarrow D$.
- (c) [5 points] $A \rightarrow D$, $CD \rightarrow E$, and $E \rightarrow D$.

Question 2: [15 points]

For each of the sets of FD's in Question 1, are the dependencies preserved by the decomposition? A yes or no answer is sufficient. Please refer to the discussion in Section 3.4.4. (5 points each)

Question 3: [40 points]

For the following we will look at 3NF violations and subsequent decomposition of the relations.

- (a) Indicate all of the 3NF violations, if none, so state.
 - i. [2 points] $R(A, B, C, D)$ with FD's $B \rightarrow C$ and $B \rightarrow D$.
 - ii. [2 points] $R(A, B, C, D)$ with FD's $AB \rightarrow C$, $BC \rightarrow D$, $CD \rightarrow A$, and $AD \rightarrow B$.
 - iii. [2 points] $R(A, B, C, D, E)$ with FD's $AB \rightarrow C$ and $DE \rightarrow C$, and $B \rightarrow D$.
 - iv. [2 points] $R(A, B, C, D, E)$ with FD's $AB \rightarrow C$ and $C \rightarrow D$, $D \rightarrow B$, and $D \rightarrow E$.
- (b) Decompose the above relations, as necessary, into collections of relations that are in 3NF and project the FD's onto the new relations.

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Question 4: [20 points]

Consider the relation **Courses**(C, T, H, R, S, G), whose attributes may be thought of informally as course, teacher, hour, room, student, and grade. Let the set of FD's for **Courses** be $C \rightarrow T$, $HR \rightarrow C$, $HT \rightarrow R$, $HS \rightarrow R$, and $CS \rightarrow G$. Intuitively, the first says that a course has a unique teacher, and the second says that only one course can meet in a given room at a given hour. The third says that a teacher can be in only one room at a given hour, and the fourth says the same about students. The last says that students get only one grade in a course.

- (a) [5 points] What are all the keys for **Courses**?
- (b) [5 points] Verify that the given FD's are their own minimal basis. (You must demonstrate this not just make a flat statement.)
- (c) [5 points] Use the 3NF synthesis algorithm to find a lossless-join, dependency-preserving decomposition of R into 3NF relations.
- (d) [5 points] Are any of the relations from (c) not in BCNF? Explain why or why not.