

COMP 5531/4  
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Assignment 3

**Question #1 (20 Points)**

- a) Consider a relation scheme  $R(A,B,C,D)$  with functional dependencies  $\{A \rightarrow B, B \rightarrow C, C \rightarrow D, D \rightarrow A\}$ .
1. What are the non-trivial dependencies that follow from the given dependencies?
  2. What are the keys of  $R$ ?
  3. What are all super keys of  $R$  that are not keys?
- b) Say whether each of the following statements about the given functional dependencies is TRUE or FALSE. If true, prove it using *Armstrong's axioms*. If false, give a counterexample, i.e. give a relation instance (With at least 2 rows) that satisfies the given dependencies but not the one that allegedly follows:
1. If  $AB \rightarrow C$  and  $A \rightarrow C$  then  $B \rightarrow C$
  2. If  $AB \rightarrow C$ , then  $A \rightarrow C$  or  $B \rightarrow C$
  3. If  $A \rightarrow B$ , and  $BC \rightarrow D$  then  $AC \rightarrow D$
  4. If  $AB \rightarrow C$  and  $B \rightarrow D$  then  $AD \rightarrow C$
  5. If  $A \rightarrow C$  and  $B \rightarrow C$  then  $A \rightarrow B$
  6. If  $A \rightarrow B$  and  $AB \rightarrow C$  then  $A \rightarrow C$

**Question 2 (5 points):**

We say a set of attributes  $X$  is closed (With respect to a given set of FD's) If  $X^+ = X$ . Consider a relation with schema  $R(A,B,C,D)$  and an unknown set of FD's. If we are told which set of attributes are closed, we can discover the FD's. What are the FD's if

- a) All sets of the four attributes are closed
- b) The only closed sets are  $\emptyset$  and  $\{A,B,C,D\}$
- c) The closed sets are  $\emptyset$ ,  $\{A,B\}$ , and  $\{A,B,C,D\}$

**Question 3 (10 points):**

Suppose we have a 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:

- a)  $AB \rightarrow DE$ ,  $C \rightarrow E$ ,  $D \rightarrow C$ , and  $E \rightarrow A$
- b)  $A \rightarrow D$ ,  $BD \rightarrow E$ ,  $AC \rightarrow E$ , and  $DE \rightarrow B$ .
- c)  $AB \rightarrow D$ ,  $AC \rightarrow E$ ,  $BC \rightarrow D$ ,  $D \rightarrow A$  and  $E \rightarrow B$
- d)  $A \rightarrow B$ ,  $B \rightarrow C$ ,  $C \rightarrow D$ ,  $D \rightarrow E$ , and  $E \rightarrow A$

In each case, it is sufficient to give a minimal basis for the full set of FD's of  $S$ .

**Question 4 (15 points):**

Consider the relation scheme  $R \{A, B, C, D, E\}$  in which the following set of functional dependencies hold  $\{ AB \rightarrow C, D \rightarrow E, CE \rightarrow D, B \rightarrow D \}$ .

- 1. Is  $R$  in BCNF ?
- 2. Mention all the functional dependencies that violate BCNF. Using the closure test, show that these dependencies are in violation.
- 3. Decompose  $R$  into sub schemas which are in BCNF.
- 4. List all the dependencies that hold in the sub schemes that you have produced. Does the union of all these dependencies contain the same information as in the original set of functional dependencies? Why or why not?

**Question 5 (10 points):**

Consider  $R (A B C D E G H)$ ,  $F \{AB \rightarrow C, AC \rightarrow B, AD \rightarrow E, B \rightarrow D, BC \rightarrow A, E \rightarrow G\}$

Which of the following decomposition of  $R$  is dependency preserving and/or lossless-join.

- a)  $\{AB, BC, ABDE, EG\}$
- b)  $\{ABC, ACDE, ADG\}$
- c)  $\{BCH, ABC, EG\}$

**DO NOT FORGET TO DO THE PEER EVALUATION/REVIEW  
BEFORE THE DEADLINE**