

## Homework 4

Due date: 6/15 before class

1. Consider a relation schema  $R$  with attributes  $ABCDEF\ GH$  with functional dependencies  $F$ :

$$F = \{B \rightarrow CD, BF \rightarrow H, C \rightarrow AG, CEH \rightarrow F, CH \rightarrow B\}$$

- 1) Which of these functional dependencies violate BCNF?
- 2) Employ the BCNF decomposition algorithm to obtain a lossless decomposition of  $R$  into a collection of relations that are in BCNF. Make sure it is clear which relations are in the final decomposition and project the dependencies onto each relation in that final decomposition.
- 3) Is your decomposition dependency-preserving?

2. Consider a relation  $R$  with attributes  $ABCDEF\ GH$  and functional dependencies  $F$ :

$$F = \{A \rightarrow CD, ACF \rightarrow G, AD \rightarrow BEF, BCG \rightarrow D, CF \rightarrow AH, CH \rightarrow G, D \rightarrow B, H \rightarrow DEG\}$$

- 1) Compute all keys for  $R$ .
- 2) Compute a minimal basis (canonical cover) for  $F$ . In your final answer, put the FDs into alphabetical order.
- 3) Using the minimal basis from part (b), employ the 3NF synthesis algorithm to obtain a lossless and dependency-preserving decomposition of relation  $R$  into a collection of relations that are in 3NF.
- 4) Does your schema allow redundancy?

3. Questions about functional dependency:

1) Consider relation  $R(A,B,C,D,E)$  with functional dependencies:

$AB \rightarrow C, BC \rightarrow D, CD \rightarrow E, DE \rightarrow A, AE \rightarrow B$

Which of the following FDs is guaranteed to be satisfied by  $R$ ?

- a)  $D \rightarrow C$    b)  $CE \rightarrow B$    c)  $AC \rightarrow D$    d)  $ACD \rightarrow B$

2) Let relation  $R(A,B,C,D)$  satisfy the following functional dependencies:

$A \rightarrow B, B \rightarrow C, C \rightarrow A$

Call this set  $S1$ . A different set  $S2$  of functional dependencies is equivalent to  $S1$  if exactly the same FDs follow from  $S1$  and  $S2$ . Which of the following sets of FDs is equivalent to the set above?

- a)  $B \rightarrow A, B \rightarrow C, C \rightarrow B$   
b)  $C \rightarrow B, B \rightarrow A, A \rightarrow C$   
c)  $A \rightarrow B, B \rightarrow A, B \rightarrow C$   
d)  $A \rightarrow BC, C \rightarrow AB$

3) Suppose relation  $R(A,B,C)$  currently has only the tuple  $(0,0,0)$ , and it must always satisfy the functional dependencies  $A \rightarrow B$  and  $B \rightarrow C$ . Which of the following tuples may be inserted into  $R$  legally?

- a)  $(1,0,2)$    b)  $(0,1,2)$    c)  $(2,0,1)$    d)  $(1,2,3)$

4. Questions about multi-valued dependency:

1) Here is an instance of a relation  $R(A,B,C)$ :

A	B	C	D
1	2	3	4
1	3	3	3
1	3	3	4
1	2	3	3
2	2	4	4
2	4	2	4
2	4	4	4
2	2	2	4

Which of the following multivalued dependencies does this instance of R satisfy?

- a)  $A \twoheadrightarrow B$
- b)  $BD \twoheadrightarrow C$
- c)  $D \twoheadrightarrow BC$
- d)  $B \twoheadrightarrow C$

2) Here is an instance of a relation  $R(A,B,C)$ :

A	B	C
1	2	3
1	3	2
1	2	2
3	2	1
3	2	3

Which of the following multivalued dependencies does this instance of R not satisfy?

- a)  $AB \twoheadrightarrow A$
- b)  $C \twoheadrightarrow B$
- c)  $AB \twoheadrightarrow C$
- d)  $B \twoheadrightarrow C$

3) Consider relation  $R(A,B,C,D,E)$  with multivalued dependencies:

$A \twoheadrightarrow B, B \twoheadrightarrow D$

Suppose R contains the tuples (0,1,2,3,4) and (0,5,6,7,8). Which of the following tuples must also be in R?

- a) (0,1,2,7,8)
- b) (0,1,2,3,8)
- c) (0,5,6,3,8)
- d) (0,5,6,7,4)