

Database Systems I  
CS3431  
C Term-2013

Solution of Homework 3

## Problem 1

1- Several Nontrivial FDs are (You are required to derive 5 only):

$C \rightarrow D$   
 $D \rightarrow A$   
 $C \rightarrow A$   
 $BD \rightarrow A$   
 $CD \rightarrow A$   
 $BC \rightarrow A$   
 $AB \rightarrow C$   
 $AC \rightarrow D$   
 $AB \rightarrow D$   
 $BD \rightarrow C$   
 $BC \rightarrow D$   
 $ABD \rightarrow C$   
 $ABC \rightarrow D$   
 $BCD \rightarrow A$

2- The attribute closures are:

$\{AD\}^+ = \{AD\}$   
 $\{C\}^+ = \{ACD\}$   
 $\{AB\}^+ = \{ABCD\}$

3- Candidate keys of R are:  $\{AB\}$ ,  $\{BC\}$ ,  $\{BD\}$

Proof:

$\{AB\}^+ = \{ABCD\}$ , and neither  $\{A\}^+$  nor  $\{B\}^+$  contain all the attributes of R  
 $\{BC\}^+ = \{ABCD\}$ , and neither  $\{B\}^+$  nor  $\{C\}^+$  contain all the attributes of R  
 $\{BD\}^+ = \{ABCD\}$ , and neither  $\{B\}^+$  nor  $\{D\}^+$  contain all the attributes of R

## Problem 2

- When decompose a relation R, you need to recheck the new relations against the FDs that you have. In some cases you may need to decompose multiple times as shown below.
- The decomposition is not unique, that is you may find more than one decomposition that satisfy the required normalization level.
- The underlined attributes are the key for its relation.

Relation Number	Candidate Keys	BCNF Violations	BCNF Decomposition	3NF Violations	3NF Decomposition
1	AB, BC, BD	$C \rightarrow D$ $D \rightarrow A$	Using $C \rightarrow D$ <u>(C, D)</u> , ( <u>A, B, C</u> )  Using $D \rightarrow A$ <u>(A, D)</u> , ( <u>B, C, D</u> ) Then (B, C, D) is broken based on $C \rightarrow D$ to have: <u>(A, D)</u> , ( <u>C, D</u> ), ( <u>B, C</u> )	None	
2	AB, BC, CD, AD	None		None	
3	AB, AC, AD	$C \rightarrow D$ $D \rightarrow B$ $D \rightarrow E$	Using $C \rightarrow D$ <u>(C, D)</u> , ( <u>A, B, E, C</u> ) Then (A, B, C, E) is broken based $AB \rightarrow C$ to have: <u>(C, D)</u> , ( <u>A, B, C</u> ), ( <u>A, B, E</u> )  Using $D \rightarrow B$ <u>(D, B)</u> , ( <u>A, C, E, D</u> ) Then (A, C, E, D) is broken based on $C \rightarrow D$ to have: <u>(D, B)</u> , ( <u>C, D</u> ), ( <u>A, C, E</u> )	$D \rightarrow E$	Same decomposition as in the BCNF: <u>(C, D)</u> , ( <u>A, B, C</u> ), ( <u>A, B, E</u> )  Using $D \rightarrow E$ <u>(D, E)</u> , ( <u>A, B, C, D</u> )

## Problem 3

### Part 1

#### **a- (Department, Surname), (Surname, FirstName, Address)**

- Lossy decomposition.
- The reason is that the common attribute (Surname) is not a key in either relations and hence the natural join will generate more tuples than that of the original relation.

#### **b- (Department, FirstName, Surname), (FirstName, Address)**

- Lossless decomposition.
- The reason is that the common attribute (FirstName) can be a key (after removing the duplicates) for the second relation (FirstName, Address) and hence the natural join will generate the same tuples as in the original relation.

### Part 2

#### **Dependencies that hold from the given data are:**

- Department  $\rightarrow$  Surname
- Department  $\rightarrow$  FirstName
- Department  $\rightarrow$  Address
- FirstName  $\rightarrow$  Address
- FirstName  $\rightarrow$  Surname

#### **a- (Department, FirstName, Surname), (Surname, Address)**

- Does not preserve the dependencies because Department  $\rightarrow$  Address cannot be derived.

#### **b- (Department, FirstName, Surname), (Surname, FirstName, Address)**

- Preserve the dependencies because all dependencies can be derived including the Department  $\rightarrow$  Address dependency.