

## Databases Homework 4

1. Below are two relations. Each relation has a corresponding set of FDs that hold in the relation. For each relation and corresponding FDs, answer these three questions:
  - (i) What are all the nontrivial FDs that follow from the given FDs? List each FD with a single attribute on the right side.
  - (ii) What are the keys of the relation?
  - (iii) What are the superkeys for the relation that are not keys?

Schemas and FDs:

- (a)  $R(A, B, C, D)$  with FDs  $C \rightarrow B$ ,  $C \rightarrow A$ , and  $AB \rightarrow D$ .
  - (b)  $R(A, B, C, D)$  with FDs  $AB \rightarrow C$ ,  $C \rightarrow D$ , and  $D \rightarrow B$ .
2. For all the parts of this question, only write FDs which are completely nontrivial and which have single attributes on the right side. Also, in each question, you only need to provide a minimal basis of FDs (though if you give extras, that's OK).
    - (a) Suppose we have a relation  $\text{PizzaOrders}(\text{customerId}, \text{customerName}, \text{pizzaId}, \text{pizzaName}, \text{orderTime}, \text{quantity}, \text{slices})$  which has the following FDs:  
customerId  $\rightarrow$  customerName  
pizzaId  $\rightarrow$  pizzaName  
customerId orderTime pizzaId  $\rightarrow$  quantity slices  
Project these FDs onto the relation  $X(\text{customerId}, \text{customerName}, \text{quantity}, \text{orderTime})$ .  
*In other words, suppose relation  $X = \pi_{\text{customerId}, \text{customerName}, \text{quantity}, \text{orderTime}}(\text{PizzaOrders})$ . Determine a minimal basis of FDs that hold in  $X$ .*
    - (b) Suppose we have a relation  $\text{TakeCourses}(\text{studentId}, \text{studentName}, \text{profId}, \text{profName}, \text{courseNumber}, \text{department}, \text{capacity})$  which has the following FDs:  
studentId  $\rightarrow$  studentName  
profId  $\rightarrow$  profName  
courseNumber department  $\rightarrow$  profId capacity  
Project these FDs onto the relation  $Y(\text{profName}, \text{studentName}, \text{courseNumber}, \text{department})$ .
    - (c) Suppose we have a relation  $R(A, B, C, D, E, F)$  which has the following FDs:  
 $B \rightarrow A$ ,  $E \rightarrow C$ ,  $F \rightarrow D$ ,  $CD \rightarrow B$ ,  $CF \rightarrow A$ .  
Project these FDs onto the relation  $Z(A, E, F)$ .
  3. Consider the relation  $R(A, B, C, D, E)$  with FDs  $C \rightarrow AD$ ,  $DE \rightarrow B$ ,  $A \rightarrow E$ , and  $B \rightarrow C$ .
    - (a) List all the keys of  $R$ .
    - (b) Indicate which FDs are BCNF violations.

- (c) Decompose  $R$ , if necessary, into relations that are in BCNF. You can choose any BCNF violations you want to do the decomposition. Show your work.
  - (d) Is the result of your decomposition dependency-preserving? In other words, is the set of FDs that hold in the individual relations in your decomposition equivalent to the original set of FDs in  $R$ ? Explain your answer. If your decomposition is not dependency-preserving, re-decompose  $R$  into 3NF. Show your work.
4. 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 FDs for  $\text{Stocks}$  be  $S \rightarrow D$ ,  $I \rightarrow B$ ,  $IS \rightarrow Q$ , and  $B \rightarrow O$ .
- (a) List all the keys for  $\text{Stocks}$ .
  - (b) Use the 3NF synthesis algorithm to find a lossless-join, dependency-preserving decomposition of  $\text{Stocks}$  into a set of 3NF relations. Show your work.
  - (c) Are any of the relations in your final decomposition not in BCNF? If yes, decompose them into BCNF.