

## CSE 4701 Spring 2020 (Homework No. 3)

**Due April 7 (Tue), 2020, 11:59 pm in HuskyCT (5% penalty per day late submission).**

### Problem 1

Prove or disprove that the following inference rules for functional dependencies. A proof can be made by using inference rules IR1 through IR3. A disproof should be done by showing a relational instance that refutes the rule. (20 points)

- (a) If  $\{A \rightarrow B, C \rightarrow D\}$ , then  $\{AC \rightarrow BD\}$
- (b) If  $\{AB \rightarrow C, C \rightarrow D\}$ , then  $\{A \rightarrow D\}$

### Problem 2

Show that  $AB \rightarrow D$  is in the closure of  $\{AB \rightarrow C, CE \rightarrow D, A \rightarrow E\}$  (10 points)

### Problem 3

Consider the relation schema  $R = \{A, B, C, D, E, F, G, H, I, J\}$  and the set of functional dependencies  $F = \{AB \rightarrow C, A \rightarrow DE, B \rightarrow F, F \rightarrow GH, D \rightarrow IJ\}$  that hold true for  $R$ . Determine whether each of the decompositions given below has (1) the dependency preservation property, and (2) the lossless join property, with respect to  $F$ . Also determine which normal form each relation in the decomposition is in. (20 points)

- (a)  $D_1 = \{R_1, R_2, R_3\}$  where  $R_1 = \{A, B, C, D, E\}$ ,  $R_2 = \{B, F, G, H\}$ , and  $R_3 = \{D, I, J\}$ ,
- (b)  $D_2 = \{R_1, R_2, R_3, R_4, R_5\}$  where  $R_1 = \{A, B, C, D\}$ ,  $R_2 = \{D, E\}$ ,  $R_3 = \{B, F\}$ ,  $R_4 = \{F, G, H\}$ , and  $R_5 = \{D, I, J\}$ .

### Problem 4

Consider the relation schema  $R = \{A, B, C, D, E, F\}$  and the set of functional dependencies  $F = \{ABC \rightarrow D, D \rightarrow E, BC \rightarrow E, D \rightarrow F\}$  hold in  $R$ . Assume all domains of the attributes in  $R$  is atomic. (20 points)

- (a) Can you decompose  $R$  into  $R_1$  and  $R_2$  in which this decomposition is lossless and  $R_2$  is 1NF at best and  $R_1$  is BCNF?
- (b) Now, can you decompose  $R_2$  into  $R_3$  and  $R_4$  in which this decomposition is lossless and both  $R_3$  and  $R_4$  are BCNF?