

COSC 4820, Spring 2023  
Databases  
Homework 6, Multi-Value Dependencies

**Question 1: [15 points]**

Suppose we have a relation in which we want to record for each person their name, Social Security number, and birthdate. Also, for each child of the person, the name, Social Security number, and birthdate of the child, and for each automobile the person owns, its serial number and make. To be more precise, this relation has all tuples

$$(n, s, b, cn, cs, cb, as, am)$$

such that

- $n$  is the name of the person with Social Security number  $s$ .
- $b$  is  $n$ 's birthdate.
- $cn$  is the name of one of  $n$ 's children.
- $cs$  is  $cn$ 's Social Security number.
- $cb$  is  $cn$ 's birthdate.
- $as$  is the serial number of one of  $n$ 's automobiles.
- $am$  is the make of the automobile with serial number  $as$ .

For this relation:

- (a) [10 points] Tell the functional and multivalued dependencies that you would **expect** to hold.
- (b) [5 points] Suggest a decomposition of the relation into 4NF.

**Question 2: [40 points]**

For each of the following relation schemas and dependencies

1.  $R(A, B, C, D)$  with MVD's  $A \twoheadrightarrow B$  and  $A \twoheadrightarrow C$ .
2.  $R(A, B, C, D)$  with MVD's  $A \twoheadrightarrow B$  and  $B \twoheadrightarrow CD$ .
3.  $R(A, B, C, D)$  with MVD  $AB \twoheadrightarrow C$  and FD  $B \rightarrow D$ .
4.  $R(A, B, C, D, E)$  with MVD's  $A \twoheadrightarrow B$  and  $AB \twoheadrightarrow C$  and FD's  $A \rightarrow D$  and  $AB \rightarrow E$ .

do the following:

- (a) [16 points] Find all the 4NF violations. (4 points each)
- (b) [24 points] Decompose the relations into a collection of relation schemas in 4NF. This means apply Algorithm 3.33 to all the relations. (6 points each)

**Question 3: [20 points]**

Use the chase test to tell whether each of the following dependencies hold in a relation  $R(A, B, C, D, E)$  with the dependencies  $A \twoheadrightarrow BC$ ,  $B \rightarrow D$ , and  $C \twoheadrightarrow E$ .

- (a) [5 points]  $A \rightarrow D$
- (b) [5 points]  $A \twoheadrightarrow D$
- (c) [5 points]  $A \rightarrow E$
- (d) [5 points]  $A \twoheadrightarrow E$

**Question 4: [5 points]**

If we project the relation  $R$  of the previous problem onto  $S(A, C, E)$ , what nontrivial FD's and MVD's hold in  $S$ ?

**Bonus Question 5: [10 points (bonus)]**

Show the following rule for MVD's. You can set up a proof as a chase test but you must think a little more generally than in the examples since the set of attributes are (a) arbitrary sets  $X$ ,  $Y$ ,  $Z$ , and (b) the other unnamed attributes of the relation in which these dependencies hold.

**The Union Rule:** If  $X$ ,  $Y$ , and  $Z$  are sets of attributes,  $X \twoheadrightarrow Y$  and  $X \twoheadrightarrow Z$ , then  $X \twoheadrightarrow (Y \cup Z)$ .