

# CSC343 Worksheet 13

July 4, 2020

- a) **Exercise 3.4.1:** Let  $R(A, B, C, D, E)$  be decomposed into relations with the following three sets of attributes:  $\{A, B, C\}$ ,  $\{B, C, D\}$ , and  $\{A, C, E\}$ . For each of the following sets of FD's, use the chase test to tell whether the decomposition of  $R$  is lossless. For those that are not lossless, give an example of an instance of  $R$  that returns more than  $R$  when projected onto the decomposed relations and rejoined.
- a)  $B \rightarrow E$  and  $C \rightarrow A$ .
  - b)  $AC \rightarrow E$  and  $BC \rightarrow D$ .
  - c)  $A \rightarrow D$ ,  $D \rightarrow E$ , and  $B \rightarrow D$ .
  - d)  $A \rightarrow D$ ,  $CD \rightarrow E$ , and  $E \rightarrow D$ .
- b) **Exercise 3.4.2:** For each of the sets of FD's in Exercise 3.4.1, are dependencies preserved by the decomposition?
- c) **Exercise 3.6.1:** Suppose we have a relation  $R(A, B, C)$  with an MVD  $A \twoheadrightarrow B$ . If we know that the tuples  $(a_1, b_1, c_1)$ ,  $(a_2, b_2, c_2)$ , and  $(a_3, b_3, c_3)$  are in the current instance of  $R$ , what other tuples do we know must also be in  $R$ ?
- d) **Exercise 3.5.1:** For each of the relation schemas and sets of FD's of Exercise 3.3.1:
- i) Indicate all the 3NF violations.
  - ii) Decompose the relations, as necessary, into collections of relations that are in 3NF.
- e) **Exercise 3.5.2:** Consider the relation  $Courses(C, T, H, R, S, G)$ , whose attributes may be thought of informally as course, teacher, hour, room, student, and grade. Let the set of FD's for  $Courses$  be  $C \rightarrow T$ ,  $HR \rightarrow C$ ,  $HT \rightarrow R$ ,  $HS \rightarrow R$ , and  $CS \rightarrow G$ . Intuitively, the first says that a course has a unique teacher, and the second says that only one course can meet in a given room at a given hour. The third says that a teacher can be in only one room at a given hour, and the fourth says the same about students. The last says that students get only one grade in a course.
- a) What are all the keys for  $Courses$ ?
  - b) Verify that the given FD's are their own minimal basis.

- c) Use the 3NF synthesis algorithm to find a lossless-join, dependency-preserving decomposition of  $R$  into 3NF relations. Are any of the relations not in BCNF?
- f) **Exercise 3.5.3:** Consider a relation  $Stocks(B, O, I, S, Q, D)$ , 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 FD's for Stocks be  $S \rightarrow D$ ,  $I \rightarrow B$ ,  $IS \rightarrow Q$ , and  $B \rightarrow O$ . Repeat Exercise 3.5.2 for the relation Stocks.
- g) **Exercise 3.5.4:** Verify, using the chase, that the decomposition of Example 3.27 has a lossless join.