

## CS 353 Spring 2023

### Homework 5

**Due:** May 4, Thursday till midnight

**You will use the Moodle course page for submission of this assignment**

**Q.1 [12 pts, 6 pts each]** Given relation  $R(A, B, C, D, E)$ , determine whether the decomposition of  $R$  into  $ABC$  and  $ADE$  is lossless with the following set of functional dependencies:

(a)  $F = \{A \rightarrow C, A \rightarrow D, E \rightarrow D\}$ .

(b)  $F = \{A \rightarrow B, A \rightarrow D, D \rightarrow E\}$ .

**Q.2 [20 pts]** Given a relation  $R(A, B, C, D, E)$  with FDs  $A \rightarrow BC, B \rightarrow D, C \rightarrow E$ .

(a) [5 pts] Determine if  $A \rightarrow E$  holds on  $R$ .

(b) [5 pts] Determine if  $B \rightarrow E$  holds on  $R$ .

(c) [10 pts] Determine if  $R$  is in BCNF. If not, decompose it into BCNF relations using the BCNF decomposition algorithm discussed in the class. Indicate which FD violates BCNF in each step of decomposition.

**Q.3 [20 pts]** Given a relation  $R(A, B, C, D, E, F, G)$  and its functional dependencies:

$AD \rightarrow F, AE \rightarrow G, DF \rightarrow BC, E \rightarrow C, G \rightarrow E$

(a) [10 pts] Find the candidate key(s) of  $R$ . Show how you derived the key(s).

(b) [5 pts] Check if  $R$  is in BCNF. Why or why not?

(c) [5 pts] Check if  $R$  is in 3NF. Why or why not?

**Q.4 [24 pts]** Given the relation schema  $R(A, B, C, D)$  with the functional dependency set  $F = \{AB \rightarrow C, A \rightarrow E, C \rightarrow DE, D \rightarrow BE\}$

(a) [10 pts] Find a Canonical Cover  $F_c$  of  $F$ .

Show all your work.

(b) [14 pts] Check if  $R$  is in 3NF. If not, decompose it into 3NF relations using the lossless and dependency preserving decomposition algorithm that makes use of the canonical cover you found in part (a).

**Q.5 [24 pts, 12 pts each]** The following relation is used to maintain some information about the employees of a company. In addition to the years each employee worked in each particular section, various emails and addresses used by the employee are also stored in the relation.

Employee(id, name, from, to, section, email, address)

The following functional dependencies and multivalued dependencies are given for the Employee relation:

$id \rightarrow name$

$id, from, to \rightarrow section$

$id \twoheadrightarrow email$

$id \twoheadrightarrow address$

(a) Check if Employee is in BCNF. If not, decompose it into BCNF relations.

(b) Using the multivalued dependencies, check if each relation you found in part (a) is in 4NF. If not, decompose it into 4NF relations.