

CS 353 Fall 2023

Homework 5

Due: November 23, Thursday till midnight

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

Q.1 [12 points, 2 pts each] Consider the following instance of relation R(A, B, C, D):

A	B	C	D	
a1	b1	c1	d1	Tuple 1
a1	b2	c2	d1	Tuple 2
a2	b4	c1	d3	Tuple 3
a3	b3	c4	d4	Tuple 4
a4	b1	c1	d5	Tuple 5
a5	b3	c4	d6	Tuple 6

Which of the following dependencies may hold in relation R? If a dependency cannot hold, indicate which tuples cause the violation.

- (a) $A \rightarrow B$
- (b) $B \rightarrow C$
- (c) $D \rightarrow A$
- (d) $AD \rightarrow C$
- (e) $AC \rightarrow B$
- (f) $BC \rightarrow A$

Q.2 [12 pts, 6 pts each] Given the relational schema R(A, B, C, D, E), and the functional dependency set:

$\{AB \rightarrow C, AD \rightarrow E, C \rightarrow A, C \rightarrow D\}$.

Determine if the following decompositions are lossless or not. Show all your work.

- (a) R is decomposed into R1(A, B, C) and R2(C, D, E).
- (b) R is decomposed into R1(A, C, D) and R2(B, D, E).

Q.3 [12 pts, 6 pts each] Given the relational schema R(A, B, C, D, E), and the functional dependency set:

$F = \{A \rightarrow B, A \rightarrow D, E \rightarrow D, BD \rightarrow C\}$

Determine whether each of the following functional dependencies can be derived from F.

- (a) $A \rightarrow C$
- (b) $CE \rightarrow B$

Q.4 [24 pts] Given the following functional dependency sets F1 and F2:

$F1 = \{A \rightarrow BD, CD \rightarrow B, C \rightarrow D, B \rightarrow D\}$

$F2 = \{A \rightarrow B, C \rightarrow BD, B \rightarrow D\}$

- (a) [8 pts] Does F1 cover F2 (i.e., can all the functional dependencies in F2 be inferred from F1)?
- (b) [8 pts] Does F2 cover F1?
- (c) [4 pts] Are F1 and F2 equivalent?
- (d) [4 pts] Is there any extraneous attribute/functional dependency in F2?

Q.5 [14 pts] Given two relations $R(\underline{A}, B, C)$ and $S(\underline{D}, E, F)$. Determine the minimal set of functional dependencies held on the relation returned by the following query:

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SELECT *  
FROM R, S  
WHERE R.C = S.D AND R.B = S.E
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Q.6 [26 pts] Given the relation schema $R(A, B, C, D, E, G, H)$ with the functional dependency set $F = \{AB \rightarrow C, CD \rightarrow EH, CH \rightarrow AG\}$.

- (a) [6 pts] Find the candidate key(s) of R. Show how you derived the key(s).
- (b) [10 pts] Show that R is not in 3NF. Then, decompose it into 3NF relations using the decomposition algorithm discussed in the class.
- (c) [10 pts] For each relation resulting from **part (b)**, check if it is also in BCNF.