Concordia University
Dept. of Computer Science and Software Engineering
COMP 353 – Databases
Winter 2023
Assignment 3

Submission through Moodle is due by Monday, Mar. 27th at 23:55

Maximum Points: 75.

PLEASE note the correction in Q6. The FD: $B \rightarrow Q$ should be replaced by $B \rightarrow O$.

1. [10 Points] Let $R(A, B, C, D)$ be a relation schema with the following set of FD's:
   $F = \{AB \rightarrow C, \ C \rightarrow D, \ D \rightarrow A\}$.

   (a). Find all the keys of R.

   (b). Find all the superkeys of R that are not keys.

2. [Points 10] In each of the following rules about FD's, prove if the given rule is valid.
   If it is not valid, then give a counter-example

   (a). $AB \rightarrow DE$ and $A \rightarrow C$, then $B \rightarrow C$.

   (b). If $AB \rightarrow C$, then $A \rightarrow C$ or $B \rightarrow C$.

3. [10 Points] Suppose $R(A, B, C, D, E)$ is a relation with some set F of FD's that holds
   on R. For each of the following cases of F, *project* the FD's in F onto relation
   $S(A, B, C)$. Note that the result is the set of FD's that hold on S if F holds on R.

   (a). $AB \rightarrow DE$, $C \rightarrow E$, $D \rightarrow C$, and $E \rightarrow A$.

   (b). $A \rightarrow D$, $BD \rightarrow E$, $AC \rightarrow E$, and $DE \rightarrow B$.

4. [10 Points] Consider the following relations with the FD's that hold on them. In each
   case, (i) determine every FD that violates the BCNF requirements, and (ii) decompose
   the given relation into BCNF relations.

   (a). $R(A, B, C, D)$ with the FD's: $A \rightarrow B$, $B \rightarrow C$, $C \rightarrow D$, and $D \rightarrow A$.

   (b). $R(A, B, C, D, E)$ with the FD's: $AB \rightarrow C$, $C \rightarrow D$, $D \rightarrow B$, and $D \rightarrow E$.

5. [20 Points] For a relation $R(A, B, C, D, E)$, we propose a decomposition R into the
   three relation schemas: $R_1(A, B, C)$, $R_2(B, C, D)$, and $R_3(A, C, E)$. For each of the
   following sets of FD's that hold on R, use the technique discussed in the class to (i)
   prove/disprove the proposed decomposition is lossless, and (ii) determine whether or
   not, the proposed decomposition is dependency-preserving.

   (a). $A \rightarrow D$, $D \rightarrow E$, and $B \rightarrow D$.

   (b). $CD \rightarrow E$, $E \rightarrow D$, and $A \rightarrow D$.

6. [15 Points] Consider the relation $stocks(B, O, I, S, Q, D)$ with the FD's: $S \rightarrow D$, $I \rightarrow B$, $IS \rightarrow Q$, and $B \rightarrow \mathbf{O}$, where you can think of B as broker, O as office (of the broker), I as investor, S as stock, Q as quantity (of the stocks owned by the investor), and D as dividend (of the stock).

(a). Find all the keys of *Stocks*.

(b). Find a minimal basis for the FD's, if not already minimal.

(c). Use the *synthesis* algorithm to find a lossless-join and dependency-preserving decomposition of *Stocks* into 3NF relations. Are any of the resulting relations not in BCNF?