CSE 132A **Homework# 3** **Winter 2023**

Due on Friday, March 10, 11:59pm (see instructions below)

This is an **individual** assignment.

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Let R be a relation with attributes ABCDE and

F = {C →D, AC →BDE, AB →CDE, B →CE}

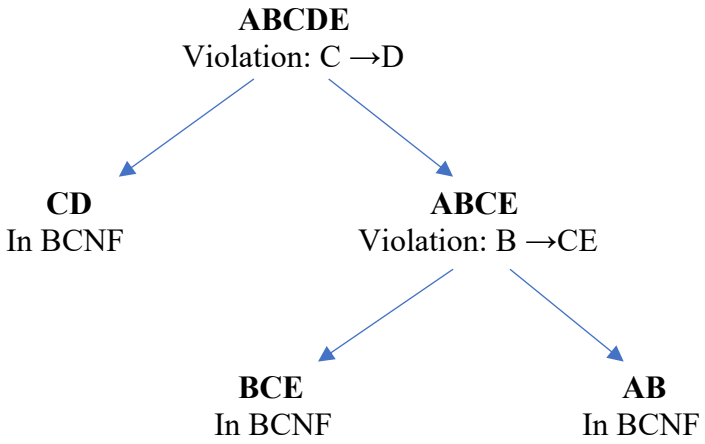
(i) (1 point) Find all the keys of R.

A+ = A	(not key)
B+ = BCE	(not key)
C+ = CD	(not key)
D+ = D	(not key)
E+ = E	(not key)
AB+ = ABCDE	(key)
AC+ = ACBDE	(key)
AD+ = AD	(not key)
AE+ = AE	(not key)

Keys: AB and AC

(ii) (4points) Find a BCNF decomposition of R with lossless join with respect to F. (Show how the decomposition is obtained.)

F = {C →D, AC →BDE, AB →CDE, B →CE}



By decomposing ABCDE using C →D (which violates BCNF within ABCDE), we obtain {CD, ABCE}. Clearly, CD is in BCNF (no violation can occur in a two-attribute relation). By decomposing ABCE using B →CE (which violates BCNF within ABCE), we obtain {BCE, AB}. Clearly, AB is in BCNF (no violation can occur in a two-attribute relation). In BCE, the only violations could come from fds with a single attribute on the lefthand side. Thus, it is sufficient to check B+, C+, and E+ within BCE:
B+ ∩ BCE = BCE, C+ ∩ BCE = C, E+ ∩ BCE = E. So BCE is in BCNF and the final BCNF decomposition is {CD, BCE, AB}.

(iii) (2 points) Is the decomposition obtained in (ii) dependency preserving with respect to F ?

run dependency preservation algorithm
F = {C →D, AC →BDE, AB →CDE, B →CE}
for the previous BCNF decomposition:
CD BCE AB

C →D is preserved because we have CD

For AC →BDE, A+ = A, C+ = CD
the local closure of AC is ACD, so AC →BDE is not preserved

For AB →CDE, A+ = A, B+ = BCE
the local closure of AB is ABCE, so AB →CDE is not preserved

B →CE is preserved because we have BCE

(iv) (5 points) Find a 3NF decomposition of R with lossless join and dependency preserving with respect to F (show the steps). Is the decomposition also in BCNF ?

$$F = \{C \rightarrow D, AC \rightarrow BDE, AB \rightarrow CDE, B \rightarrow CE\}$$

First, we rewrite the FDs as
$C \rightarrow D$
$AC \rightarrow B$
$AC \rightarrow D$ (redundant as $C \rightarrow D$)
$AC \rightarrow E$ (redundant as $AC \rightarrow B$ and $B \rightarrow E$)
$AB \rightarrow C$ (redundant as $B \rightarrow C$)
$AB \rightarrow D$ (redundant as $B \rightarrow C$ and $C \rightarrow D$)
$AB \rightarrow E$ (redundant as $B \rightarrow E$)
$B \rightarrow C$
$B \rightarrow E$

Minimal set of FDs: $\{ C \rightarrow D, AC \rightarrow B, B \rightarrow C, B \rightarrow E \}$

The 3NF decomposition is {CD, ABC, BE}.

For ABC, $A^+ \cap ABC = A$, $B^+ \cap ABC = BC$, $C^+ \cap ABC = C$.
The decomposition is not in BCNF because ABC violate BCNF. A only imply A, and C only imply C. However, B can imply C, and not imply A.