EECS 495—Intro to Database Systems
Fall - 2015

HW No. 2 –Solutions

Q1:

a) $Y \to Z \Rightarrow Y \to YZ$ (augmentation)
$X \to Y, Y \to YZ \Rightarrow X \to YZ$ (transitivity)

b) $X \to Y \Rightarrow XZ \to YZ$ (augmentation)
$Z \to W \Rightarrow YZ \to YW$ (augmentation)
$XZ \to YZ, YZ \to YW \Rightarrow XZ \to YW$ (transitivity)

c) To disprove the rule, we show a relation which violates it.

X	Y	Z
x1	y1	z1
x1	y2	z1

In this relation, $XY \to Z$ and $Z \to X$ holds but $Z \to Y$ does not hold.

Q2:

1. The first FD causes no violation since the closure of ABH contains all attributes.
2. The second FD A->DE violates BCNF since A is not a superkey.
   We split into R1= (ADE; { A->DE}) and
   R2= (ABCFGH; { ABH→C, BGH→F, F →AH, BH → G})
   Note that F→ADH has been replaced by the derived FD F→AH.
   Similarly BH→GE is been replaced by B→G.

3. In the second iteration we test R1 and see tit is in BCNF.
   In R2 observe that ABH-→C and BGH –> do not violate BCNG since ABH and BGH are superkeys in the original relation R and they still remain superkeys in R2.
   The FD causing problems is F→AH since F is not superkey in R2 and we split R2 into :
   R21 =(FAH; {F→AH}) and
   R22 =(FBCG ;{FB→CG})
   Note that FB→CG is not in the original set of FDs F in R, but is derivable from F.
   Now we are finished since both R21 and R22 are in BCNF.

Observe, however that the decomposition is lossy.

Q3:

We claim that any two-attribute relation is in BCNF. We need to examine the possible nontrivial FD's with a single attribute on the right. There are not too many cases to consider, so let us consider them in turn. In what follows, suppose that the attributes are A and B.

1. There are no nontrivial FD's. Then surely the BCNF condition must hold, because only a nontrivial FD can violate this condition. Incidentally, note that {A,B} is the only key in this case.

2. $A \rightarrow B$ holds, but $B \rightarrow A$ does not hold. In this case, A is the only key, and each nontrivial FD contains A on the left (in fact the left can only be A). Thus there is no violation of the BCNF condition.

3. $B \rightarrow A$ holds, but $A \rightarrow B$ does not hold. This case is symmetric to case (2).

4. Both $A \rightarrow B$ and $B \rightarrow A$ hold. Then both A and B are keys. Surely any FD has at least one of these on the left, so there can be no BCNF violation.

Q4:

If we apply the extraneity test to $A \rightarrow BC$, we find that both B and C are extraneous under F. However, it is incorrect to delete both! The algorithm for finding the canonical cover picks one of the two, and deletes, it. Then,

?

1. If C is deleted, we get the set $F' = \{A \rightarrow B, B \rightarrow AC, \text{ and } C \rightarrow AB\}$. Now, B is not extraneous in the right-hand side of $A \rightarrow B$ under F'. Continuing the algorithm, we find A and B are extraneous in the right-hand side of $C \rightarrow AB$, leading to two canonical covers

   $F_C = \{A \rightarrow B, B \rightarrow C, \text{ and } C \rightarrow A\}$, and
   $F_C = \{A \rightarrow B, B \rightarrow AC, \text{ and } C \rightarrow B\}$.

2. If B is deleted, we get the set $\{A \rightarrow C, B \rightarrow AC, \text{ and } C \rightarrow AB\}$. This case is symmetrical to the previous case, leading to the canonical covers

   $F_C = \{A \rightarrow C, C \rightarrow B, \text{ and } B \rightarrow A\}$, and
   $F_C = \{A \rightarrow C, B \rightarrow C, \text{ and } C \rightarrow AB\}$.

Q5:

a. select *b*
from *r*
group by *b*
having count(distinct *c*) >1

b. create assertion *b-to-c* check
(not exists
(select b
from r
group by b
having count(distinct *c*)>1
)

Q6:

a. Starting with $A \to BC$. We can conclude: $A \to B$ and $A \to C$.

Since $A \to B$ and $B \to D$, $A \to D$	(decomposition, transitive)
Since $A \to CD$ and $CD \to E$, $A \to E$	(union, decomposition, transitive)
Since $A \to A$, we have	(reflexive)
$A \to ABCDE$ from the above steps	(union)
Since $E \to A$, $E \to ABCDE$	(transitive)
Since $CD \to E$, and $CD \to ABCDE$	(transitive)
Since $B \to D$ and $BC \to CD$, $BC \to ABCDE$	(augmentative, transitive)

The candidate keys are *A*, *BC*, *CD*, and *E*.

b. Answer: A decomposition $\{R_1, R_2\}$ is a lossless-join decomposition if $R_1 \cap R_2 \to R_1$ or $R_1 \cap R_2 \to R_2$. Let $R_1 = (A, B, C), R_2 = (A, D, E)$, and $R_1 \cap R_2 = A$. A is a candidate key. Therefore $R_1 \cap R_2 \to R_1$.