BMEG3120: Exercise List 10

Consider the set F of following functional dependencies on relation $R(ABCDE)$:

$$
\begin{aligned}
AB &\to C \\
BC &\to E \\
BD &\to E \\
C &\to B \\
D &\to A
\end{aligned}
$$

Answer the following questions.

Problem 1. Can we simplify F into the following set of FDs?

$$
\begin{aligned}
A &\to C \\
BC &\to E \\
BD &\to E \\
C &\to B \\
D &\to A
\end{aligned}
$$

Answer. No, because $A^+ = \{A\}$ according to F, but $A^+ = \{A, C\}$ in the above set of FDs.

Problem 2. Is R in 3NF?

Answer. The following table shows the closures of all attribute sets (if an attribute set is not shown, its closure is $\{A, B, C, D, E\}$):

attribute set	closure
A	A (short form for $\{A\}$)
B	B
C	BCE
D	AD
E	E
AB	$ABCE$
AC	$ABCE$
AD	AD
AE	AE
BC	BCE
$\underline{BD}$	$ABCDE$
BE	BE
$\underline{CD}$	$ABCDE$
CE	BCE
DE	ADE
ABC	$ABCE$
ABE	$ABCE$
ACE	$ABCE$
ADE	ADE
BCE	BCE
$ABCE$	$ABCE$

The underlined in the above table are candidate keys. R is not in 3NF due to (for example) $D \to A$.

Problem 3. Compute a minimal cover of F.

Answer.

$$
\begin{aligned}
AB &\to C \\
C &\to B \\
C &\to E \\
D &\to A
\end{aligned}
$$

Problem 4. Decompose R into 3NF tables.

Answer. We first decompose R into BCNF tables: $R_1(AC)$, $R_2(AD)$, $R_3(BC)$ and $R_4(BDE)$. Since $AB \to C$ and $C \to E$ have not been preserved in any of the tables, we add: $R_5(ABC)$ and $R_6(CE)$. The final design therefore contains: R_2, R_4, R_5 and R_6. Note that R_1 and R_3 are no longer needed because they are already contained by R_5.