CS 455: Principles of Database Systems

Review Guide 3: Database Theory

1. Given: $\alpha, \beta, \gamma, \delta$ refer to distinct sets of attributes in $R$. For each of the following inference rules, show it is either sound through derivation using only Armstrong's Axioms, or unsound by providing a counterexample.

   (a) $\alpha \rightarrow \beta \overset{?}{\Rightarrow} \alpha \cup \gamma \rightarrow \beta$
   (b) $\alpha \rightarrow \beta \overset{?}{\Rightarrow} \beta \subseteq \alpha$
   (c) $\alpha \rightarrow \beta, \beta \rightarrow \gamma \overset{?}{\Rightarrow} \alpha \cup \delta \rightarrow \gamma \cup \delta$
   (d) ** $\alpha \rightarrow \beta, \beta \cup \gamma \rightarrow \delta \overset{?}{\Rightarrow} \alpha \cup \gamma \rightarrow \beta \cup \delta$

2. ** Consider the relation $U(W, X, Y, Z)$ with a set of functional dependencies

   \[
   FD(U) = \{ \\
   XZ \rightarrow YZ, \\
   Y \rightarrow Z \}
   \]

   (a) List all of $U$'s superkeys with respect to $FD(U)$.
   (b) Is $U$ in BCNF with respect to $FD(U)$? If so, show that every functional dependency $\alpha \rightarrow \beta$ is either trivial or that $\alpha$ is a superkey in $U$. Otherwise, decompose $U$ into a set of BCNF relations with respect to $FD(U)$. Show your work.
   (c) Find $FD_c(U)$, a canonical cover of $FD(U)$.
   (d) List all of $U$'s superkeys with respect to $FD_c(U)$.
   (e) Is $U$ in BCNF with respect to $FD_c(U)$? If so, show that every functional dependency $\alpha \rightarrow \beta$ is either trivial or that $\alpha$ is a superkey in $U$. Otherwise, decompose $U$ into a set of BCNF relations with respect to $FD_c(U)$. Show your work.