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) $\alpha \to \beta \stackrel{?}{\Longrightarrow} \alpha \cup \gamma \to \beta$

   (b) $\alpha \to \beta \stackrel{?}{\Longrightarrow} \beta \subseteq \alpha$

   (c) $\alpha \to \beta, \beta \to \gamma \stackrel{?}{\Longrightarrow} \alpha \cup \delta \to \gamma \cup \delta$

   (d) ** $\alpha \to \beta, \beta \cup \gamma \to \delta \stackrel{?}{\Longrightarrow} \alpha \cup \gamma \to \beta \cup \delta$

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

$$\begin{aligned} FD(U) = \{ & \\ & XZ \to YZ, \\ & Y \to Z\} \end{aligned}$$

   (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 $\alpha \to \beta$ is either trivial or that α 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 $\alpha \to \beta$ is either trivial or that α is a superkey in U. Otherwise, decompose U into a set of BCNF relations with respect to $FD_c(U)$. Show your work.