CS315: Introduction to Database Systems

Assignment #3

Due: 8 Apr. 2013, 18:00 HRS 1 Apr. 2013
Max Marks: 95

This assignment is on normalization. Please submit pdf files (you can use Latex (preferred) or handwrite and scan).

1. Given the schema $R = (A_1, A_2, A_3, A_4)$ and FDs $A_1A_2 \rightarrow A_3$, $A_3 \rightarrow A_4$ and $A_4 \rightarrow A_1$ answer the following:

   (a) What non-trivial FDs follow from the given FDs?

   (b) Find all candidate keys for R.

   (c) Find all super keys for R that are not candidate keys.

   (d) Find all minimal bases for R.

   [5x4=20]

2. Let X be a set of attributes. We say X is *closed* with respect to a set of FDs F if $X^+ = X$. Given $R = (A_1, A_2, A_3, A_4)$ and information about which subsets of R are closed we can find F. Find F in the following cases:

   (a) All subsets of R including R are closed.

   (b) Only R and ϕ are closed.

   (c) R, ϕ and $\{A_1, A_2\}$ are closed.

   [5x3=15]

3. In the past we have shown that certain rules about FDs are sound using Armstrong's axioms. For the following rules show that the rules **do not hold** by giving counter examples:

   (a) If $A_1 \rightarrow A_2$ then $A_2 \rightarrow A_1$.

   (b) If $A_1A_2 \rightarrow A_3$ and $A_1 \rightarrow A_3$ then $A_2 \rightarrow A_3$.

   (c) If $A_1A_2 \rightarrow A_3$ then $A_1 \rightarrow A_3$ or $A_2 \rightarrow A_3$.

   [5x3=15]

4. A functional dependency $\alpha \rightarrow \beta$ is called a partial dependency if there is a proper subset γ of α such that $\gamma \rightarrow \beta$. We say that β is *partially dependent* on α. A relation schema R is in second normal form (2NF) if each attribute A in R meets one of the following criteria:

   (a) It appears in a candidate key.

   (b) It is not partially dependent on a candidate key.

   Argue that every 3NF schema is in 2NF.

   [10]

5. Define a *prime* attribute as one that appears in at least one candidate key. Let α, β be attribute sets such that the FD $\alpha \rightarrow \beta$ holds but $\beta \rightarrow \alpha$ does not hold. Let attribute A be such that $A \notin \alpha$, $A \notin \beta$ and $\beta \rightarrow A$. Then A is said to be *transitively dependent* on α. A relation schema R is in 3NF with respect to a set of FDs F if there is no non-prime attribute $A \in R$ that is transitively dependent on a key of R.

   Argue that the above defintion of 3NF is equivalent to the definition discussed in class.

   [10]

6. Let schema R be decomposed into $R_1, \ldots, R_n$, let $r(R)$ be a relation and $r_i = \Pi_{R_i}(r)$ $i \in 1..n$. Show:

$$r \subseteq r_1 \bowtie r_2 \ldots \bowtie r_n$$

   [10]

7. Give an example of a schema R and set of FDs F such that there are at least three distinct lossless join decompositions of R into BCNF.

   [5x3=15]