COMP3278C Introduction to Database Management Systems

Assignment 3 Functional Dependencies and BCNF Decomposition

Due Date: May 1, 2025, 11:59 PM HKT

1. **[15%]** Given relation $R(A, B, C, D, E)$ and functional dependencies, $F = \{A \rightarrow B, B \rightarrow C, CA \rightarrow D, C \rightarrow A, D \rightarrow E\}$. Let $\alpha = \{A, C\}$. Compute the closure α^+ under F.
   - You are only required to provide the result, i.e., no need to show the steps.
2. **[25%]** Given a relation $R(A, B, C)$ and the following functional dependencies:

   $$F = \{ A \rightarrow B, \quad C \rightarrow B\},$$

   compute F^+, the closure of all functional dependencies in F. Your final answer should present a comprehensive list of all functional dependencies that can be derived from F.
   - You may apply the basic and additional axioms (i.e., reflexivity, transitivity, augmentation, union, decomposition, pseudo-transitivity) as needed.
   - No need to label the specific axioms used.
   - You need to follow the table format provided on slide p.72 of Chapter 5 – Database Design Slides v3 (update) to present the results.
3. **[60%]** Consider the relation schema:

   $$R = (A, B, C, D, E)$$

   with the following functional dependencies:

   $$F = \{ A \rightarrow B, C \rightarrow D, AB \rightarrow E, C \rightarrow E, AB \rightarrow C\}.$$

   1. Identify all candidate keys for R.
      - You should follow the steps outlined on pages 100-141 of the Chapter 5 tutorial slides and write down the steps of your solutions.
   2. Determine whether R is in Boyce–Codd Normal Form (BCNF).
      - Clearly explain all functional dependencies (if any) that violate BCNF.
   3. If R does not satisfy BCNF, perform a BCNF decomposition of R. You need to write down the decomposition process. The decomposition must meet the following requirements:
      - The resulting relations form a lossless-join decomposition.
      - The original functional dependencies are all preserved (dependency preservation).
      - Every decomposed relation is in BCNF.

Notes for the question 3. You may apply the basic and additional axioms (i.e., reflexivity, transitivity, augmentation, union, decomposition, pseudo-transitivity) as needed. There's no need to label the specific axioms used in each step, but you need to demonstrate that decomposition satisfies the required conditions.