Assignment (III)

Due: April 9, 2023

Problem 1 (30 points). Let R_1, R_2, ..., R_n be a decomposition of a schema R, and let I be a relation instance of R. Prove that

$$I \subseteq \Pi_{R_1}(I) \bowtie \Pi_{R_2}(I) \bowtie \cdots \bowtie \Pi_{R_n}(I).$$

Problem 2 (30 points). Suppose that the following FD's hold on the relation schema $R(A, B, C, D)$

$$AB \to C, \quad AB \to D, \quad C \to A, \quad D \to B.$$

(i) List *all* candidate keys of R.

(ii) Show that R is not in BCNF and give a BCNF decomposition of R.

(iii) Is your BCNF decomposition dependency preserving? Explain your answer.

Problem 3 (30 points). Let F be a set of FD's holds on a schema R and $R_1, \ldots, R_n$ be a decomposition of R. Furthermore, assume the following:

- For every $X \to Y$ in F, there exists some R_i such that R_i contains all the attributes in XY.
- At least one schema in the decomposition contains a candidate key of R.

Prove that the decomposition $R_1, \ldots, R_n$ is join lossless. With this property, we can show that any decomposition produced by the 3NF synthesis algorithm is join lossless.

Problem 4 (10 points, *optional*). Design a linear time algorithm for the attribute closure computation. *Hint*: For each unused $X \to Y$ in F, record the attributes of X not yet in the *closure*.

Problem 5 (10 points). How long does it take you to finish the assignment? Give a score (1,2,3,4,5) to the difficulty of each problem. List all your collaborators if you have any.