

Database Systems: Written Assignment 4

Due Date: Friday, March 30, 11:30AM in Canvas.

Problem 1. [30 pts] Prove the followings (if it is one of the 3 basic rules, you need to prove it by definition).

- 1) Given $A \rightarrow B$, and $B \rightarrow C$, we have $A \rightarrow C$.
- 2) Given $A \rightarrow B$, and $C \rightarrow D$, we have $AC \rightarrow BD$.
- 3) Given $AB \rightarrow C$, we do NOT have $A \rightarrow C$ NOR $B \rightarrow C$.

Part 2. [40 pts] Given the WORK schema as $W=EJHRD$ where E is eid (employee id), J is pid (project id), H is hours (number of hours worked on any date), R is rating (rating employee received), and D is the date. Suppose $F=\{EJ \rightarrow H, EJD \rightarrow R, E \rightarrow J\}$ holds over W.

- 1) An employee may choose how many hours he/she'd like to work on a project on any given date. True or False. Why?
- 2) An employee may work on multiple different projects. True or False. Why?
- 3) An employee receives only one rating for a project. True or False. Why?
- 4) Multiple employees may work on the same project. True or False. Why?
- 5) What's the key of W? (or what are the keys if there is more than one) Show your steps.
- 6) Is W in BCNF? Why or why not?
- 7) Decompose W into BCNF. Makes sure your decomposition is lossless, and show your steps. Is your decomposition dependency preserving?
- 8) Write the FD for the following constraint with respect to $W=EJHRD$: All employees work on the same project on one day must work the same number of hours on that date. Briefly justify your answer.

Problem 3. [10 pts] We learn that if $W \cap Z = \emptyset$ and $W \rightarrow Z$, then decomposing R into WZ and R-Z is a lossless join decomposition.

- 1) Prove that this is indeed a lossless join decomposition.
- 2) What happens if $W \cap Z = A$ and $W \rightarrow Z$? What can you do in this case? Prove your claim.

Problem 4. [10 pts] Consider the hourly employee example from our lecture, Hourly_Emps (ssn, name, lot, rating, wage_per_hr, hrs_per_wk), which is represented as $T=SNLRWH$. Its functional dependency set $F = \{S \rightarrow SNLRWH, R \rightarrow W\}$. Show the followings.

- 1) T is not in BCNF, and T is not in 3NF.
- 2) Decomposing T into $R_1 = SNLRH$ and $R_2 = RW$ is lossless, and both R_1 and R_2 are in BCNF.
- 3) Prove that this decomposition is dependency preserving.

Problem 6. [10 pts] Consider a relational schema $R=ABC$, and its set of functional dependency is $F=\{A \rightarrow B, B \rightarrow C, C \rightarrow A\}$.

- 1) Suppose we decompose R into $X=AC$ and $Y=BC$, is this decomposition dependency preserving? is this decomposition lossless? Prove your claim.
- 2) Now suppose $F=\{A \rightarrow B, C \rightarrow B\}$ instead, and we decompose R into $X=AC$, and $Y=BC$. Is this decomposition dependency preserving? Is this decomposition lossless? Prove your claim.