University of California, Los Angeles
**Department of Computer Science**

**Computer Science 143** **Prof. Ryan Rosario**

# Homework 5

*Due Tuesday, June 1, 2021 at 11:59pm on CCLE*

## Part 1: A Purely Transactional Relationship

1. We will use the following transaction schedule $S$ for this problem.

| $T_1$ | $T_2$ |
|---|---|
| `read(A)` | |
| `write(A)` | |
| | `read(A)` |
| | `read(B)` |
| `read(B)` | |
| `write(B)` | |

   (a) Is $S$ serial?

   (b) Is $S$ conflict serializable? If so, what are the equivalent serial schedules and what is the proper ordering? Show your work using the swap method or the graph method.

2. Look carefully at these three transactions $T_1$, $T_2$ and $T_3$.

| $T_1$ | $T_2$ | $T_3$ |
|---|---|---|
| `write(A)` | | |
| | | `write(B)` |
| | | `write(B)` |
| | `write(A)` | |
| | | `read(B)` |
| | `read(B)` | |
| | `read(A)` | |
| `read(B)` | | |

   (a) Construct the precedence graph for this schedule $S$.

   (b) Is $S$ conflict serializable? Justify your answer. If yes, compute the a serial ordering of the transactions.

## Part 2: There's Nothing Wrong with Being Abnormal Unless you are a Relation

1. Suppose that we decompose the schema $R(A, B, C, D, E, F)$ into $R_1 = (A, B, C, F)$ and $R_2 = (A, D, E)$. Given the following functional dependencies hold, is the decomposition lossless? Explain your answer.

$$F = \{A \to B, A \to C, CD \to E, B \to D, E \to A\}$$

2. List non-trivial functional dependencies satisfied by the following relation. You do not need to find *all* dependencies. In other words, please find $F$, but there is no need to find $F^+$. It is enough to identify a set $F$ of functional dependencies that imply all functional dependencies satisfied by this relation (i.e. irreducible).

| $A$ | $B$ | $C$ |
|---|---|---|
| $a_1$ | $b_1$ | $c_2$ |
| $a_1$ | $b_1$ | $c_2$ |
| $a_2$ | $b_1$ | $c_1$ |
| $a_2$ | $b_1$ | $c_3$ |

3. Assume the following set of functional dependencies hold for the relation $R(A, B, C, D, E, G) : F = \{A \rightarrow B, A \rightarrow C, C \rightarrow E, B \rightarrow D\}$

   Is $R$ in Boyce-Codd Normal Form (BCNF)? Explain your answer. If it is not, normalize it into a set of relations in BCNF such that the decomposition is lossless and determine whether or not it is dependency preserving. If it is not, which dependencies are not preserved?

4. Consider the following relational schema describing musical events in California in some prior decade. Assume each event has at least one band. Bands stick to one genre of music and they do not visit the same venue twice in the same year. This implies that you should consider the full context of the problem and not just this instance of the data.

| $A$ | $B$ | $C$ | $D$ |
|---|---|---|---|
| Venue | Year | Band | Genre |
| Hollywood Bowl | 1999 | Mighty Mighty Bosstones | ska |
| Royce Hall | 1999 | Mighty Mighty Bosstones | ska |
| Shoreline Amphitheater | 2001 | Mighty Mighty Bosstones | ska |
| Shoreline Amphitheater | 2001 | Dinosaur Jr. | rock |

   Is this relation in 2NF? 3NF? Determine the functional dependencies and keys and justify your answer.

5. We now modify the schema to include the number of attendees. The same constraints from the previous part apply:

| $A$ | $B$ | $C$ | $D$ |
|---|---|---|---|
| Venue | Year | Band | Attendees |
| Hollywood Bowl | 1999 | Mighty Mighty Bosstones | 10000 |
| Royce Hall | 1999 | Mighty Mighty Bosstones | 8000 |
| Shoreline Amphitheater | 2001 | Mighty Mighty Bosstones | 90000 |
| Shoreline Amphitheater | 2001 | Dinosaur Jr. | 10000 |

   Is the new schema in 2NF? 3NF? BCNF? Explain your answer.