School of Engineering and Computer Science

SWEN304 **Database System Engineering**

Assignment 3

Due date: 23:59, Monday 17 May

The objective of this assignment is to test your understanding of functional dependencies, normal forms, database normalization. The assignment is worth **10%** of your final grade. It will be marked out of 100.

Submission instructions:

- Submit your assignment in **pdf** via the submission system
- Please make sure to write your **student ID and Name** on your assignment.

Note: Assignments without IDs and names OR not in **pdf** will incur a deduction of 3 marks.

Question 1. Functional Dependencies and Normal Forms [20 marks]

a) **[4 marks]** Consider a relation schema $N\ (R, F)$ where $R = \{A, B, C\}$. Suppose we find the following two tuples in an instance of this relation schema.

A	*B*	*C*
1	*2*	*3*
4	*2*	*3*

Which of the following functional dependencies do definitely **not** hold over the relation schema *N*? Justify your answer.

1) $C \rightarrow A$
2) $A \rightarrow C$
3) $B \rightarrow A$
4) $B \rightarrow C$

b) **[16 marks]** Consider a relation schema $N\ (R, F)$ where $R = \{A, B, C, D\}$. For each of the following sets F of functional dependencies, determine which normal form (1NF, 2NF, 3NF, BCNF) the relation schema N is in. Justify your answer.

Hint: Note that in all four cases AB is the only key for N.

1) $F = \{AB \rightarrow C, C \rightarrow D\}$
2) $F = \{AB \rightarrow D, B \rightarrow C\}$
3) $F = \{AB \rightarrow C, AB \rightarrow D\}$
4) $F = \{AB \rightarrow CD, C \rightarrow B\}$

Question 2. Candidate Key [5 marks]

Consider a relation schema $N(R, F)$ where $R=\{A, B, C, D, E\}$ with the set of functional dependencies

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

Is AB a candidate key of this relation? Explain your answer. Is AE a candidate key of this relation? Explain your answer.

Question 3. Minimal Cover of a set of Functional Dependencies [20 marks]

Consider the set of functional dependencies $F = \{A \rightarrow B, B \rightarrow CD, D \rightarrow A, AC \rightarrow D\}$. Compute a minimal cover of F. Justify your answer.

Question 4. 3NF Normalization [25 marks]

Consider a relation schema $N(R, F)$ where $R = \{A, B, C, D\}$ and $F = \{A \rightarrow B, C \rightarrow D\}$. Perform the following tasks. Justify your answers.

1) [5 marks] Identify all keys for N. Show your process.

2) [5 marks] Identify the highest normal form (1NF, 2NF, 3NF, BCNF) that N satisfies.

3) [10 marks] If N is not in 3NF, compute a lossless transformation into a set of 3NF relation schemas using the Synthesis algorithm.

4) [5 marks] Verify explicitly that your result has the lossless property, satisfies 3NF, and that all functional dependencies are preserved.

Question 5. BCNF Normalization [30 marks]

Consider a relation schema $N(R, F)$, where $R = \{A, B, C, D\}$ and $F = \{A \rightarrow C, D \rightarrow B, BC \rightarrow A, BC \rightarrow D\}$. Perform the following tasks. Justify your answers.

1) [5 marks] Identify all keys for N. Show process.

2) [4 marks] Identify the highest normal form (1NF, 2NF, 3NF, BCNF) that N satisfies.

3) [16 marks] If N is not in BCNF, compute a lossless decomposition into a set of BCNF relation schemas using the BCNF decomposition algorithm.

4) [5 marks] Verify explicitly whether your result satisfies BCNF, and that all functional dependencies are preserved.

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