



## Exercise Sheet 10: Normalization (until Thursday, 19.01.2017) (30 points)

**Please note:** you need **50%** of all exercise points to receive the *Studienleistung* for this lecture. In order to pass the RDB I Module, you need both the *Studienleistung* **and** you need to pass the exam. Exercises have to be turned in until **Thursday before the lecture** either in the lecture hall or into our mailbox at the IFIS floor (Mühlenpfordtstraße 23, 2<sup>nd</sup> floor). Please do not forget your **Matrikelnummer** and your **tutorial group number** on your solutions. **If you forget** to write your Matrikelnummer and/or your tutorial group number, you get **automatically 0 points**. Your solutions may be in German or English. Unless otherwise specified: **Always use your own words!**

### Exercise 10.1 (7 points)

Answer the following questions

1. What is a lossless decomposition? (1 point)
2. Given a relation schema with only one relation R (A, B, C, D) and a functional dependency  $B \rightarrow CD$ . Apply Heath's theorem to decompose R into two relations  $R_1$  and  $R_2$  using the given functional dependency. (2 points)
3. What kind of modification anomalies can occur in non-normalized relation schemas? (3 points)
4. Can a violation of the first normal form be detected using functional dependencies? Explain your answer. (1 point)

### Exercise 10.2 (16 points)

1. Given the following relation schema with one relation R(A,B,C,D,E,F) and the following functional dependencies:  $F = \{ A, B \rightarrow C; A, D \rightarrow E; B \rightarrow D; A, F \rightarrow B; \}$  answer the following
  - a. What is the closure of {A, B} under F? (3 points)
  - b. What is the closure of {A, F} under F? (3 points)
  - c. What combination of attributes is a superkey? (3 points)

2. Consider the following sets of functional dependencies over a relation R(A,B,C)

$F1 = \{A \rightarrow B, B \rightarrow C\}$   $F2 = \{A \rightarrow B, A \rightarrow C\}$   $F3 = \{A \rightarrow B, AB \rightarrow C\}$

Which of these are equivalent? Provide an explanation of the steps you followed to answer the question. (4 points)

3. Given a relation R(A, B, C) as well as some data:

A	B	C
7	8	3
7	8	4
5	8	3
5	8	6

Find all non-trivial functional dependencies that do not conflict with the given data (3 points)

### Exercise 10.3 (7 points)

Consider the relation R (A, B, C, D, E) with the following functional dependencies {A, B  $\rightarrow$  C; B, C  $\rightarrow$  D; D, E  $\rightarrow$  A; C, D  $\rightarrow$  E}

- a) Which of the functional dependencies are BCNF violations? (2 points)
- b) Give a decomposition of R into BCNF. (2 points)

Consider the relation and functional dependencies that follow:

- R (A, B, C, D, E, F, G, H, I, J, K)
- Functional dependencies:
  1. A  $\rightarrow$  B, C, D
  2. H, I  $\rightarrow$  J
  3. A, E, F, G  $\rightarrow$  H, I, K

Decompose into BCNF (3 points)

**HINT:** use Heath's Theorem for both exercises, as it was shown in the lecture.