



## Exercise Sheet 10: Normalization (until Thursday 11.01.2018) – 38 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 **Matrike-Inummer** and your **tutorial group number** on your solutions. **If you forget** to write your Matrike-Inummer 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 (9 points)

Prove the correctness of the following three derived axioms. Use the Armstrong Axioms for the derivation process.

#### Armstrong Axioms:

Reflexivity:  $\beta \subseteq \alpha \Rightarrow \alpha \rightarrow \beta$

Augmentation:  $\alpha \rightarrow \beta \Rightarrow \alpha\gamma \rightarrow \beta\gamma$

Transitivity:  $\alpha \rightarrow \beta \wedge \beta \rightarrow \delta \Rightarrow \alpha \rightarrow \delta$

#### Derived Axiom:

- Union:  $\alpha \rightarrow \beta \wedge \alpha \rightarrow \delta \Rightarrow \alpha \rightarrow \beta\delta$
- Decomposition:  $\alpha \rightarrow \beta\delta \Rightarrow \alpha \rightarrow \beta \wedge \alpha \rightarrow \delta$
- Pseudotransitivity:  $\alpha \rightarrow \beta \wedge \gamma\beta \rightarrow \delta \Rightarrow \alpha\gamma \rightarrow \delta$

### Exercise 10.2 (15 points)

Given the following relation R with four attributes ABCD: For each of the following sets of FDs (assuming those are the only dependencies that hold for R) do the following:

- Identify the candidate key(s) for R.
- Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). Why is it in this normal form?
- If R is not in BCNF, decompose it into a set of BCNF relations that preserve the dependencies. Explain all of your decomposition steps (Which FDs did you use for the decomposition?).

- $C \rightarrow D, C \rightarrow A, B \rightarrow C$
- $B \rightarrow C, D \rightarrow A$
- $ABC \rightarrow D, D \rightarrow A$
- $A \rightarrow B, BC \rightarrow D, A \rightarrow C$
- $AB \rightarrow C, AB \rightarrow D, C \rightarrow A, D \rightarrow B$

### Exercise 10.3 (6 points)

Find a minimal set of functional dependencies. Which of the derived schemas are in BCNF?

- ABCDE(A,B,C,D,E) with  $A \rightarrow BC$ ,  $BC \rightarrow A$ ,  $BCD \rightarrow E$ ,  $E \rightarrow C$
- ABCDEF(A,B,C,D,E,F) with  $A \rightarrow BC$ ,  $C \rightarrow DA$ ,  $E \rightarrow ABC$ ,  $F \rightarrow CD$ ,  $CD \rightarrow BEF$

### Exercise 10.4 (8 points)

The city of Braunschweig holds its voters registers in an excel table. They want you to put it into a normalized relational schema.

The schema consists of voters IDs for each eligible voter. These IDs are unique per election district. An eligible voter has a name, an address, a birthdate and a birthplace. The election districts have a unique name. Furthermore, polling stations have numbers, which are unique within an election district. The election administration consists of at least one person.

Voters ID	Name	Address	Born	District No	District Name	Election Station	Administration
1	Müller, Peter	Schleinitzstraße 1, 38106 Braunschweig	01.01.1960, Bonn	171	BS-Univiertel	1	Frederik Niemann, Frieda Paul
2	Schneider, Ella	Pockelsstraße 8, 38106 Braunschweig	05.08.1951, Gifhorn	171	BS-Univiertel	2	Frederik Niemann, Frieda Paul
3	Schneider, Hans	Pockelsstraße 8, 38106 Braunschweig	27.03.1950, Gifhorn	171	BS-Univiertel	2	Frederik Niemann, Frieda Paul
7	Winter, Felix	Wendentorwall 3, 38106 Braunschweig	29.02.1973	171	BS-Univiertel	3	Frederik Niemann, Frieda Paul
1	Peters, Rainer	Jasperallee 37, 38106 Braunschweig	31.12.1948, Bonn	172	BS-Ost	1	Elisabeth Nickel, Heinz Schmidt, Friedrich Dietrich
2	Rothe, Jan	Allerstraße 1, 38106 Braunschweig	26.10.1980, Hannover	172	BS-Ost	1	Elisabeth Nickel, Heinz Schmidt, Friedrich Dietrich
1	Meyer, Hendrik	Cyriaksring 34, 38118 Braunschweig	02.07.1990, Uelzen	173	BS-West	4	Torben, Blume

- (5 Points)** Find all non-trivial functional dependencies in the schema. Then find all key candidates.
- (3 points)** Put the schema into the Third Normal Form using the functional dependencies from a). Explain all of your decomposition steps.