

## Exercise 7

Publication: 19.04.2021

Publication of Solutions: 26.04.2021

### 1 Functional Dependencies and Normal Forms

1. Consider the relation schema  $\text{program}(\text{showID}, \text{showName}, \text{date}, \text{time}, \text{genre})$ , where all attributes are atomic, and the functional dependencies are:

$$\mathcal{F}_{\text{program}} = \{ \begin{array}{ll} \text{showID} & \rightarrow \text{showID}, \text{date}, \text{time}, \\ \text{showName} & \rightarrow \text{genre}, \\ \text{date}, \text{time} & \rightarrow \text{showName} \end{array} \}$$

- a) Determine the set of all candidate keys  $S_{\text{program}}$  for relation schema  $\text{program}$ .
- b) For each normal form (1NF, 2NF, 3NF, BCNF) check if the relation schema  $\text{program}$  is in that normal form. Explain your answer.
- c) Decomposition to next normal form:
  - (i) Show the minimal basis for the set of functional dependencies  $\mathcal{F}_{\text{program}}$ .
  - (ii) Decompose the relation schema into new relation schemas.
  - (iii) List the candidate keys of the decomposed relation schemas.
- d) We saw from the slide that output of 3NF synthesis algorithm guarantees recoverability and dependency preservation. Here, please check if the decomposition in (c) has recoverability by applying the condition we saw in slide p.296.

2. Consider  $\mathcal{R}(A,B,C,D)$  and the following functional dependencies:

$$\mathcal{F}_{\mathcal{R}} = \{A \rightarrow BD, B \rightarrow C, C \rightarrow C, AB \rightarrow C, B \rightarrow D\}$$

Determine the minimal basis for the set of functional dependencies  $\mathcal{F}_{\mathcal{R}}$ .

### 2 Multi-valued Dependencies and 4NF

Consider the following relation instance  $R$  with the schema  $\mathcal{R}(A,B,C,D)$ .

<b>R</b>				
	A	B	C	D
$c_1$	Migros	Bern	Pasta	20
$c_2$	Coop	St. Gallen	Bratwurst & mustard	15
$c_3$	Migros	Zürich	Steak	30
$c_4$	Migros	Luzern	Pizza	22
$c_4$	Coop	Aarau	Lasagne	25
$c_6$	Manor	Bahnhofstr.	Rösti	26

The minimal basis for the set of functional dependencies  $\mathcal{F}_{\mathcal{R}}$  of relation  $R$  is **empty** (i.e.  $\mathcal{F}_{\mathcal{R}} = \{\}$ ).

- a) Assume there is in addition to  $\mathcal{F}_{\mathcal{R}}$  the multi-valued dependency (MVD)  $A \twoheadrightarrow B$ .



- (i) Which tuples must be added to the relation  $R$  such that the multi-valued dependency (MVD)  $A \twoheadrightarrow B$  holds?
  - (ii) Is the relation schema  $\mathcal{R}$  in 4NF? Explain your answer.
- b) Assume there is in addition to  $\mathcal{F}_{\mathcal{R}}$  the multi-valued dependency (MVD)  $AB \twoheadrightarrow CD$ .
- (i) Which tuples must be added to the relation  $R$  such that the multi-valued dependency (MVD)  $AB \twoheadrightarrow CD$  holds?
  - (ii) Is the relation schema  $\mathcal{R}$  in 4NF? Explain your answer.