Exercise 05

Relational algebra and functional dependencies

Task 1: Relational algebra

Given the following relations:

Studenten:

SName	SMatrikel	SGeburtstag
Heintje	2143	1900-01-01
Eva	3333	1900-01-01
Luise	3334	1990-03-01
Daniel	3335	1990-04-02
Daniel	3336	1990-10-10
Heintje	3337	1990-10-10

Dozenten:

DName	DBuero	DTel
Klaus	C201	123
Maria	D22	NULL
Marlene	C204	443
Matze	E4	NULL

Veranstaltungen:

VName	VSemester	VRaum	VDozent
Beachvolleyball	ss17	Strand	Maria
Beachvolleyball	ss18	Strand	Maria
Drachenfliegen	ss17	Strand	Maria
Drachenfliegen	ss18	Strand	Maria
Sackhüpfen	ws17	NULL	Klaus
Sackhüpfen	ws18	NULL	Klaus
Tanzgymnastik	ss18	D111	Klaus
Tanzgymnastik	ws17	D111	Klaus

a) Specify the formal relational schemas and the mapping $dom : U \rightarrow D$ for the relations Students and Lecturers. To do so, you can define your own value ranges or reference suitable ones from TSQL.
b) Specify the formal database schema *S*.
c) What is *r(Lecturers)*?
d) What is t_2*(ESemester)* of *Events*?
e) Specify a deletion anomaly, insertion anomaly and update anomaly for the relation Lecturers.

Task 2: Keys and superkeys

Justify the following statements and show them formally by applying the definitions:

a) `SName` in `Students` cannot be a key.
b) `LName` from `Lecturers` does not meet the foreign key constraint for `ELecturer` in `Events`.
c) `ELecturer` in `Events` fulfils the foreign key constraint for `LName` from `Lecturers`.
d) `ESemester`, `ERoom`, `ELecturer` in `Events` is not an identifier attribute set of `Events`.
e) `LName`, `LOffice` is not a minimal identifier attribute set of `Lecturers`.
f) `LOffice` in `Lecturers` fulfils the key constraint.
g) The relational schema `R` is a superkey of `R`.
h) `EName`, `ESemester` is a superkey of `Events`.

Task 3: Functional dependencies

Starting from our example using Lecturers, Students, Events and Grades which students can get in the events, we now assume that there are only the following attributes: `SName, SMatriculation, SDate_of_birth, LName, LOffice, LTel, EName, ESemester, ERoom` and `Grade`. We can already store the required data with these attributes, for example in a single relation `RData`:

SName	SMatrikel	SGeburtstag	DName	DBuero	DTel	VName	VSemester	VRaum	Note
Eva	3333	1900-01-01	Maria	D22	NULL	Beachvolleyball	ss18	Strand	4.0
Eva	3333	1900-01-01	Maria	D22	NULL	Drachenfliegen	ss17	Strand	NULL
Luise	3334	1990-03-01	Maria	D22	NULL	Beachvolleyball	ss17	Strand	4.0
Luise	3334	1990-03-01	Maria	D22	NULL	Beachvolleyball	ss18	Strand	2.0
Luise	3334	1990-03-01	Maria	D22	NULL	Drachenfliegen	ss18	Strand	NULL

a) What functional dependencies between these attributes do you know from the domain knowledge of the previous exercises?
b) Simplify this set F using the SPLITTING algorithm.
On the right, everything that is single-element and trivial will disappear:
c) Determine $\{F\}^+$ for the functional dependencies *F* identified in part (a) of the task.
d) What is $\{SMatriculation\}^+_F$?
e) What is $\{SMatriculation,LName\}^+_F$?
f) What is $\{SName, LOffice, ERoom\}^+_F$?
g) Simplify the set from part (b) of the task further using the COVER algorithm.
h) Determine the keys using heuristics.