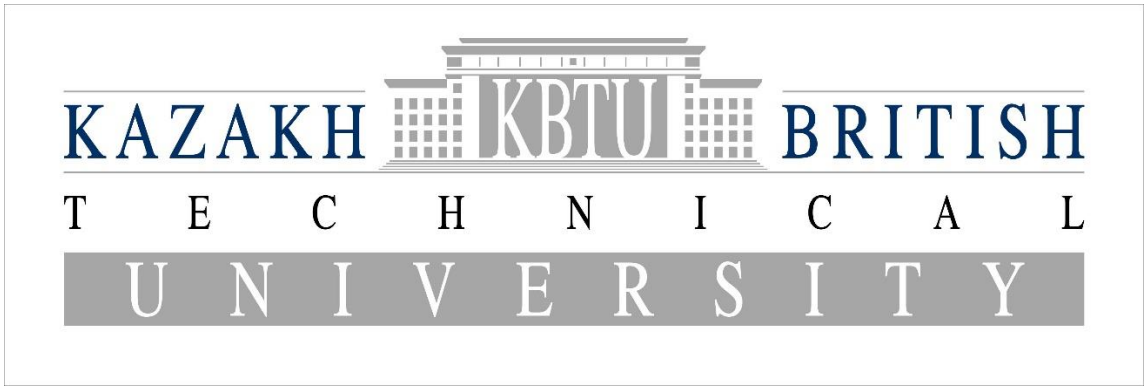

Kazakh-British Technical University
Faculty of Information Technology

Laboratory Work №5

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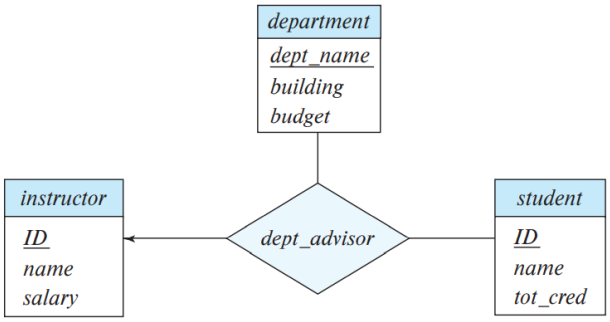
Almaty, 2021

Exercise 1.

Will the conversion to BCNF be dependency preserving in any case? Proof your statement and give reasoning for choosing BCNF design.

Answers:

Decomposition into BCNF can prevent efficient testing of certain functional dependencies. Consider the example where student may have only one advisor (many – to – one), instructor can be associated with only a single department, and a student may have more than one advisor, but no more than one from a given department.:



→ dept_advisor (s_ID, i_ID, dept_name)

Adding extra constraint that "an instructor can act as advisor for only a single department.

i_ID → dept_name

s_ID, dept_name → i_ID

Ater converting to BCNF we obtain: (s_ID, i_ID), (i_ID, dept_name). Because the design doesn't permit the enforcement of this functional dependency without a join, we say that our design is not dependency preserving. It is better to use BCNF in order to distribute data, it means that all redundancy based on functional dependency has been removed, but some other types of redundancy may exist. It is a more restricted form of normalization so that the database does not end in anomalies.

Exercise 2

Given table in 1NF, convert to 3NF if PK is UnitID.

UnitID	StudentID	Date	Tutor ID	Topic	Room	Grade	Book	TutEmail
U1	St1	23.02.03	Tut1	GMT	629	4.7	Deumlich	tut1@fhbb.ch
U2	St1	18.11.02	Tut3	Gln	631	5.1	Zehnder	tut3@fhbb.ch
U1	St4	23.02.03	Tut1	GMT	629	4.3	Deumlich	tut1@fhbb.ch

U5	St2	05.05.03	Tut3	PhF	632	4.9	Dummlers	tut3@fhbb.ch
U4	St2	04.07.03	Tut5	AVQ	621	5.0	SwissTopo	tut5@fhbb.ch

Answer:

Second Normal Form:

Determine the dependencies:

StudentID , UnitID → Grade

UnitID → TutorID

UnitID → Date

UnitID → Topic

UnitID → Room

UnitID → Book

UnitID → TutEmail

TutorID → TutEmail

From the above dependencies we see that the candidate key for the whole table is (StudentId,UnitID) that becomes a primary key since it is the only one candidate key.

The table in 1 NF is divided into 2 tables:

UnitID	**StudentID**	Date	Tutor ID	Topic	Room	Grade	Book	TutEmail

2 expressed tables in **Second Normal Form**:

StudentID	**UnitID**	Grade
St1	U1	4.7
St1	U2	5.1
St4	U1	4.3
St2	U5	4.9
St2	U4	5.0

UnitID	Date	TutorID	Topic	Room	Book	TutEmail
U1	23.02.03	Tut1	GMT	629	Deumlich	tut1@fhbb.ch
U2	18.11.02	Tut3	Gln	631	Zehnder	tut3@fhbb.ch
U5	05.05.03	Tut3	PhF	632	Dummlers	tut3@fhbb.ch
U4	04.07.03	Tut5	AVQ	621	SwissTopo	tut5@fhbb.ch

Third Normal Form:

Eliminate Transitive dependencies from the table above. We have UnitID → TutorID. Furthermore, TutorID → TutorEmail. ← is the transitive dependency.

Tables in **Third Normal Form:**

StudentID	**UnitID**	Grade
St1	U1	4.7
St1	U2	5.1
St4	U1	4.3
St2	U5	4.9
St2	U4	5.0

UnitID	Date	TutorID	Topic	Room	Book
U1	23.02.03	Tut1	GMT	629	Deumlich
U2	18.11.02	Tut3	Gln	631	Zehnder
U5	05.05.03	Tut3	PhF	632	Dummlers
U4	04.07.03	Tut5	AVQ	621	SwissTopo

TutorID	TutEmail
Tut1	tut1@fhbb.ch
Tut3	tut3@fhbb.ch
Tut5	tut5@fhbb.ch

The tables above in **3NF.**

Exercise 3

Given table in 1NF, convert to 2NF if PK is {ProjectName, ProjectManager}, use decomposition:

ProjectName	**ProjectManager**	Position	Budjet	TeamSize
Project1	Manager1	CTO	1 kk $	15
Project2	Manager2	CTO2	1.5 kk $	12

Answer:

The table is already in 1NF. Lets consider for 2NF. Define all the dependencies for 2NF (Partial):

#1 Option of deciding Dependencies:

ProjectName → TeamSize

ProjectManager → Position

ProjectName → Budget

Here the position is assumed as Manager career position.

ProjectManager	Position
Manager1	CTO
Manager2	CTO2

ProjectName	**ProjectManager**
Project1	Manager1
Project2	Manager2

ProjectName	Budget	TeamSize
Project1	1 kk $	15
Project2	1.5 kk $	12

#2 Option of deciding dependencies:

ProjectName, ProjectMan → TeamSize

ProjectName, ProjectMan → Budget

ProjectManager → Position

ProjectManager	Position
Manager1	CTO
Manager2	CTO2

ProjectName	**ProjectManager**	Budjet	TeamSize
Project1	Manager1	1 kk $	15
Project2	Manager2	1.5 kk $	12

Exercise 4

Given table, convert to 3NF if PK is Group, use decomposition:

(Faculties have a number of specialties, each specialty consists of set of particular groups).

Group	Faculty	Speciality
g1	f1	s1
g2	f2	s2

Answer:

2 option of solutions:

OPTION #1 (Normalization):

The provided table is already in 1NF → lets consider it for 2NF.

All the dependencies: group → specialty

group → faculty

specialty → faculty

Considering those dependencies above we can guess that the table is already in 2NF.

Lets consider it for 3NF.

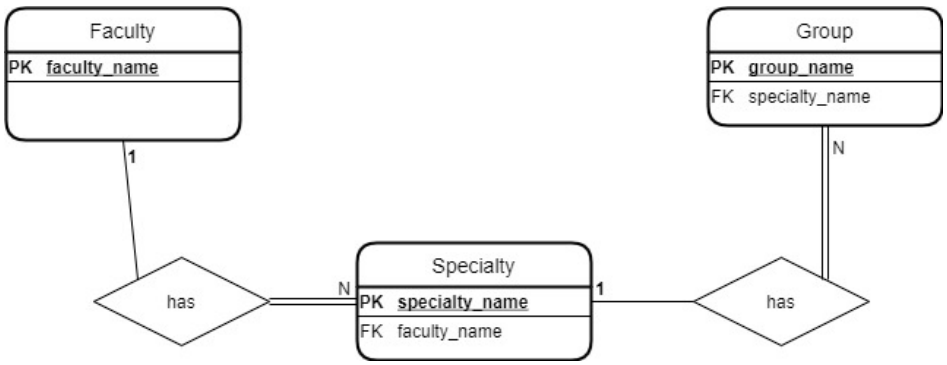
For 3NF we need to consider transitive dependencies. As we see from our list of dependencies the faculty actually depends on specialty directly. The tables in 3NF:

Group	Speciality
g1	s1
g2	s2

Speciality	faculty
s1	f1
s2	f2

OPTION #2 (ERD):

Considering the provided expression: (Faculties have a number of specialties, each specialty consists of set of particular groups). Use it to construct ER diagram.



Exercise 5

Given table, convert to BCNF if PK is {ProjectID, Department}, use decomposition:

(Curator depends on projectID and related departments, teamSize directly relates to project and related departments, ProjectGroupsNumber depends on TeamSize.)

ProjectID	**Department**	Curator	TeamSize	ProjectGroupsNumber
p1	d1	e1	100	5
p2	d2	e2	120	6

Answer:

Define all the dependencies using the provided information:

(ProjectID,Department) → Curator

(ProjectID, Department) → TeamSize

(ProjectId, Department) → ProjectGroupNumber

TeamSize → ProjectGroupNumber

The table is already in 1NF. Let's consider for 2NF. For 2NF everything is already corresponded. Therefore, the table is already in 2NF. For 3NF we need to consider the transitive dependency. That's we need to divide our table into 2 sub tables:

3NF:

ProjectID	**Department**	Curator	TeamSize
p1	d1	e1	100
p2	d2	e2	120

TeamSize	ProjectGroupNumber
100	5
120	6

BCNF:

For the BCNF we can guess that one curator works only in the only one department. That means we can define the name of the department just by the name of the curator.

TeamSize	ProjectGroupNumber
100	5
120	6

Curator	Department
e1	d1
e2	d2

ProjectID	**Curator**
p1	e1
p2	e2

ProjectID	**Department**	TeamSize
p1	d1	100
p2	d2	120

Exercise 6

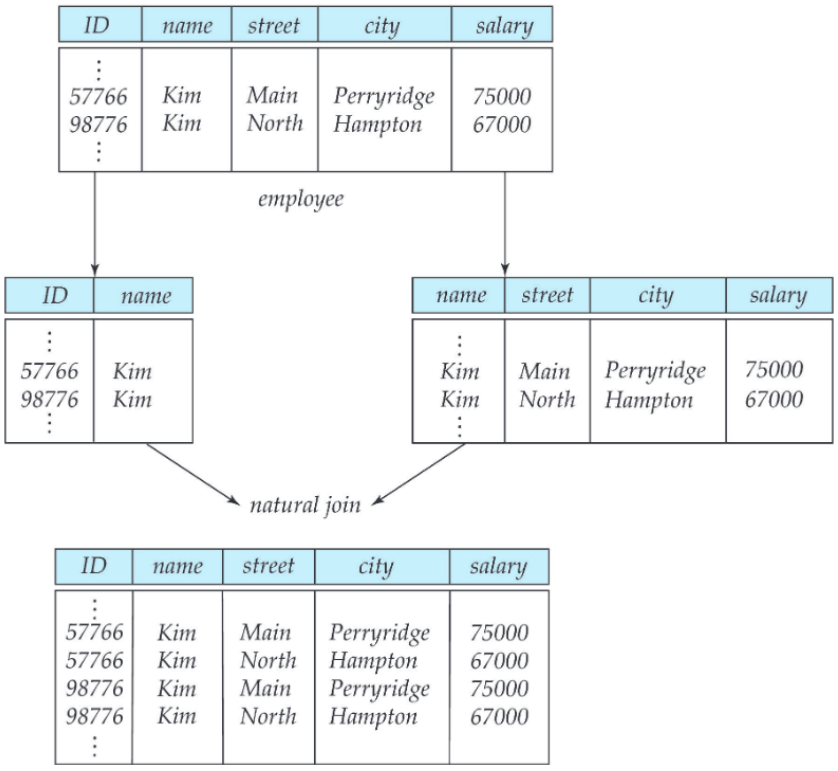
List the three design goals for relational databases, and explain why each is desirable. Give an example of both desirable and undesirable types of decompositions.

Answer:

Three design goals are lossless-join decompositions, dependency preserving decompositions, and minimization of repetition of information. They are desirable so we can maintain an accurate database, check correctness of up-date quickly, and use the smallest amount of space possible.

There are two types of decomposition: Lossy Decomposition, Lossless Join Decomposition.

Example of **Lossy Decomposition**:



As we can see the lossy decomposition can lead to unclear data table with as the join of tables brings the table with redundant information and we can't find person who we are looking for.

Example of **Lossless Decomposition**:

PersonId	PersonName	CityID
101	Temirbolat	Krg09
102	Tamerlan	Alm02

CityID	CityName	Country
Krg09	Karaganda	Kazakhstan
Alm02	Almaty	Kazakhstan

After the inner join or natural join we do not loss the data and we get:

PersonId	PersonName	CityID	CityName	Country
101	Temirbolat	Krg09	Karaganda	Kazakhstan
102	Tamerlan	Alm02	Almaty	Kazakhstan