Databases
Laboratory work 5

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Task 1. Will the conversion to BCNF be dependency preserving in any case? Proof your statement and give a reasoning for choosing BCNF design.

Answer: Every conversion into BCNF may not be dependency preserving.
Proof: We only need to give a counter example: Consider the following schema;

- a b c and c → b
- Clearly the above schema is in 3NF, because ab → c is a super key dependency and, from c → b we can see that b-c=b, which is a subset of the primary key (such dependency is also allowed in 3NF).

But, the above schema is not in BCNF because c → b is neither super-key nor trivial dependency. So, we decompose above schema, keeping it lossless. Only possible lossless decomposition is: ac and cb. (because, their intersection c is primary key for the 2nd table).
But clearly the dependency ab → c is lost.
Hence, proved.

Task 2. Given table in 1NF, convert to 3NF if PK is UnitID and StudentID:

UnitID	StudentID	Date	TutorID	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	GIn	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	Dümmlers	tut3@fhbb.ch
U4	St2	04.07.03	Tut5	AVQ	621	5.0	SwissTopo	tut5@fhbb.ch

Solution:

To convert this table to 3NF, first of all, we should convert it to the 2nd normal form. That is:

1. The table should be in the First Normal Form.
2. There should be no Partial Dependency.

2nd NF of the tables:

UnitID	StudentID	Date	Topic	Room	Grade	Book	TutorID
U1	St1	23.02.03	GMT	629	4.7	Deumlich	Tut1
U2	St1	18.11.02	GIn	631	5.1	Zehnder	Tut3

U1	St4	23.02.03	GMT	629	4.3	Deumlich	Tut1
U5	St2	05.05.03	PhF	632	4.9	Dümmlers	Tut3
U4	St2	04.07.03	AVQ	621	5.0	SwissTopo	Tut5

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

Then, for a table to be in the third normal form:

1. It should be in the Second Normal form.
2. And it should not have Transitive Dependency.

3nd NF of the tables:

UnitID	**StudentID**	**Date**	**Room**	**Grade**	**TopicID**	**TutorID**
U1	St1	23.02.03	629	4.7	Top1	Tut1
U2	St1	18.11.02	631	5.1	Top2	Tut3
U1	St4	23.02.03	629	4.3	Top1	Tut1
U5	St2	05.05.03	632	4.9	Top3	Tut3
U4	St2	04.07.03	621	5.0	Top4	Tut5

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

TopicID	**Topic**	**Book**
Top1	GMT	Deumlich
Top2	GIn	Zehnder
Top3	PhF	Dümmlers
Top4	AVQ	SwissTopo

Task 3. Given table in 1NF, convert to 2NF if PK is {<u>ProjectName</u>, <u>ProjectManager</u>}, use decomposition:

<u>ProjectName</u>	<u>ProjectManager</u>	Position	Budget	TeamSize
Project1	Manager1	CTO	1 kk $	15
Project2	Manager2	CTO2	1.5 kk $	12

Solution:

Here, **Position** depends on **ProjectManager** but not **ProjectName**. So, that is a partial dependency. To reduce it we use a decomposition method like shown below.

<u>ProjectName</u>	ProjectManager	Budget	TeamSize
Project1	Manager1	1 kk $	15
Project2	Manager2	1.5 kk $	12

<u>ProjectManager</u>	Position
Manager1	CTO
Manager2	CTO2

Task 4. Given table, convert to 3NF if PK is Group, use decomposition:

Faculties have a number of specialties; each specialty consists of a set of particular groups.

<u>Group</u>	Faculty	Specialty
g1	f1	s1
g2	f2	s2

Solution:

<u>Group</u>	S_F_ID
g1	1
g2	2

<u>S_F_ID</u>	Faculty	Specialty
1	f1	s1
2	f2	s2

Task 5. Given table, convert to BCNF if PK is {<u>ProjectID</u>, <u>Department</u>}, use decomposition:

*Curator depends on **ProjectID** and related departments, **TeamSize** directly relates to project and related departments, **ProjectGroupsNumber** depends on **TeamSize**.*

<u>ProjectID</u>	<u>Department</u>	Curator	TeamSize	ProjectGroupsNumber
p1	d1	e1	100	5
p2	d2	e2	120	6

Solution:

In this task, first of all, we see a transitive dependency, i.e. **ProjectGroupsNumber** depends on **TeamSize**, that depends on {**<u>ProjectID</u>**, **<u>Department</u>**}. From the definition of Boyce-Codd Normal Form (BCNF), we have:

1. It should be in the Third Normal Form.
2. And, for any dependency A → B, A should be a super key.

Hence, before BCNF, we should convert actual table to 3rd NF, because of transitive dependency. The reduced form looks like:

<u>ProjectID</u>	<u>Department</u>	Curator	TeamID
p1	d1	e1	t1
p2	d2	e2	t2

<u>TeamID</u>	TeamSize	ProjectGroupsNumber
t1	100	5
t2	120	6

Then, if we look at the first table, we can see that,

{**<u>ProjectID</u>**, **<u>Department</u>**} → **Curator**
Curator → ProjectID

So, here we have that **Curator** is not a super key, therefore the first table is not in BCNF. To convert it to BCNF we should decompose it:

<u>Department</u>	Curator
d1	e1
d2	e2

Curator	ProjectID	TeamID
e1	p1	t1
e2	p2	t2

TeamID	TeamSize	ProjectGroupsNumber
t1	100	5
t2	120	6

Task 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: The 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 updates quickly, and use the smallest amount of space possible. In Figure 1, there is an example for undesirable decomposition, i.e. **lossy decompositions.** We shall refer to such decompositions as being **lossy decompositions**, and, conversely, to those that are not as **lossless decompositions**.

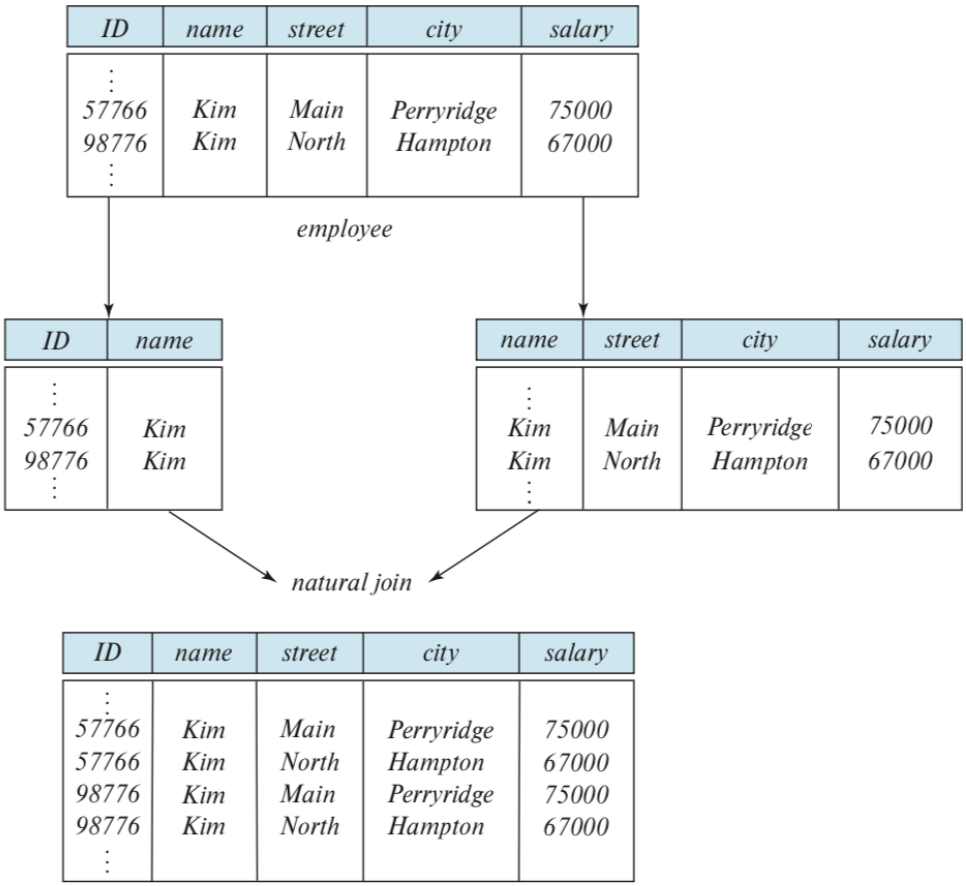

Figure 1 - Loss of information via a bad decomposition.

We say that the decomposition is a **lossless decomposition** if there is no loss of information by replacing R with two relation schemas R1 and R2. In Figure 2, we can notice the lossless decomposition.

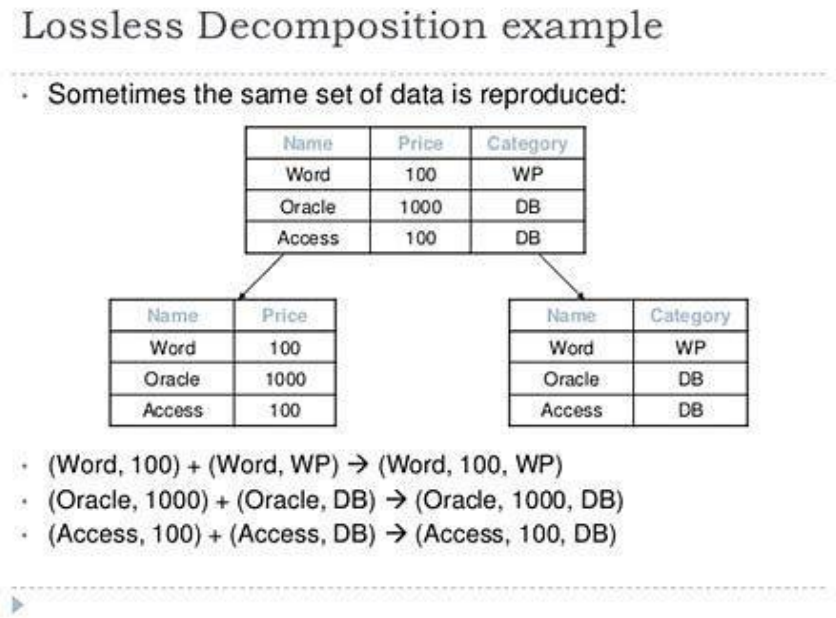

Figure 2 – Example of lossless decomposition

That's all of laboratory work 5.