

University authorities decided to build the information system to keep track of all theses (Master and Engineering) prepared by students of PUT. For each student we would like to keep track of the following information: student index number (unique), last name, first name and the field of study. For each PUT teacher we would like to keep track of the following information: id of the teacher (unique), last name, first name and the academic title.

The student declares the willingness to prepare a diploma thesis under the supervision of a selected university teacher. A teacher who supervises the thesis is called supervisor. Each diploma thesis, depending on the field of study, may be either Master thesis or Engineering thesis. Each diploma thesis has unique identifier, title, brief description, and the end date (planned date of completion of the thesis). A teacher may supervise many theses. A diploma thesis may be prepared by a single student or may be prepared by a group of students (usually it concerns an Engineering thesis). If the thesis is prepared by a group of students, for each student in the group, the scope of work (a set of tasks) assigned to him is defined. To each diploma thesis an additional academic teacher is assigned acting as a reviewer of the thesis. Each student during her/his study may prepare more than one thesis (e.g. first she/he prepares the Engineering thesis, and, later on, a Master thesis).

After finishing the preparation of a diploma thesis the student (or a group of students) gives it back to the supervisor on a specific day (the submission day may be different from the planned one). For each thesis, we would like also to keep track of the submission date of the thesis. Then, the supervisor sets the date and place of the diploma examination and appoints the chairperson of the examination committee (the chairperson is elected from other academic teachers of the university). Neither the supervisor nor the reviewer may be the chairperson of the examination committee.

During the diploma exam, the student receives a diploma thesis grade and the thesis presentation grade. Additionally, during the exam, each member of the examination committee asks the student one question. We would like to save in the database the name of a person asking the question, the text of the question and the grade of the student's answer. Finally, the examination committee determines the final grade for the student's studies, and also decides whether the thesis deserves an additional award.

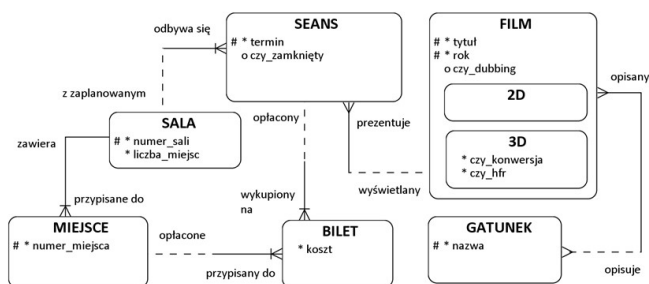
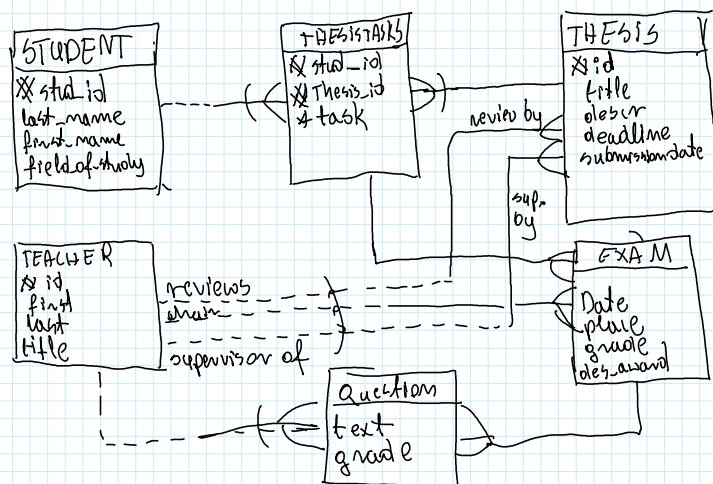


Fig. 1. EER diagram

SEANS
termin NOT NULL
film references film(tytuł) NOT NULL,
sala references sala(nr_sali) NOT NULL,
 czy_zamkniety NULL,
 seans_id UNIQUE)

SALA
numer_sali PRIMARY KEY,
 liczba_miejsc NOT NULL)

MIEJSCE
numer_miejsc PK,
numer_sali NOT NULL)

FILM_2D
tytuł NOT NULL
rok NOT NULL

dubbing NULL
 gatunek NOT NULL
 references gatunek(nazwa)

GATUNEK
nazwa PK)

FILM_3D
tytuł
rok
 dubbing NULL
 czy_konw NOT NULL
 czy_hfr NOT NULL
 gatunek NOT NULL

BILET
seans_id NOT NULL ref seans(seans_id),
MIEJSCE NN ref miejsce(numer_miejsc)
 koszt NOT NULL)

Ex. 3. Consider the relation R(A, B, C, D) given below:

A	B	C	D
3	3	3	4
3	4	3	5
4	4	3	6
4	3	3	7

1. Suppose that the user tried to execute the following instruction (5 pkt.):

Insert into R values (4, 4, 4, 4)

DBMS rejected the instruction due to the „integrity constraint” violation. Which of the following integrity constraints might have caused the instruction to be rejected?

superkey - a set of attributes that uniquely identifies tuples
 min superkey (candidate key) - if we take any attr from it, it is no longer a superkey. there may be more than one such key. One of them is chosen to be PK, other are secondary keys,

1. Suppose that the user tried to execute the following instruction (5 pkt):

Insert into R values (4, 4, 4, 4)

DBMS rejected the instruction due to the "integrity constraint" violation. Which of the following integrity constraints might have caused the instruction to be rejected?

- (a) (A, B, C) is the secondary key of the schema R.
- (b) (A, B) is the primary key of the schema R. ✓
- (c) $C \rightarrow A$ (functional dependency) no subdependency
- (d) The attribute C is the foreign key of the schema R referencing to a primary key of the schema of another relation S ✓
- (e) $B \rightarrow C$ (functional dependency) ✓

• A legal instance of a relation must satisfy all specified ICs, including all specified FDs

2. Given the following set of functional dependencies for the relation R(A, B, C, D, E) (5 pkt):

$AB \rightarrow E$ $D \rightarrow C$

- (a) Does the functional dependency $AB \rightarrow E$ violate the definition of 3NF? Justify your answer (1 sentence).
- (b) Does the functional dependency $D \rightarrow C$ violate the definition of 3NF? Justify your answer (1 sentence).
- (c) If the given schema R is not in BCNF, then decompose the schema R into a set of relation schemas in BCNF.

3NF: if $X \rightarrow Y$ then:

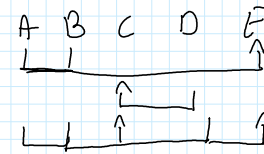
1. X is a superkey
2. X is a prime attr

Boyce-Codd Normal Form (BCNF)

A relation schema R is in BCNF if whenever a functional dependency $X \rightarrow A$ holds in R, then X is a superkey of R

More restricted

a) and b) This relation is not even in 2NF so it can't be in 3NF



PK dependencies

I'll take $D \rightarrow C$ and make it R1 and now R - {C} is R2

R1(D, C)
↑
3NF

R2(A, B, D, E) → this is still not in 3NF nor not yet in 2NF

R1(D, C) R2(ABE) R3(ABD)

Ex. 4. Given relation R(A, B, C, D, E, G, H) and the following set of functional dependencies for the relation R:

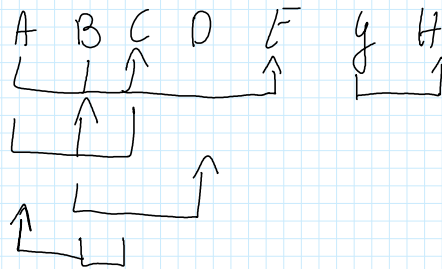
Part I

$AB \rightarrow C$ $AC \rightarrow B$ $AB \rightarrow E$ $B \rightarrow D$ $BC \rightarrow A$ $G \rightarrow H$

(a) List all keys for the schema R. [1,5 pkt]

1. (G, A, B) → minimal superkey

(b) What is the strongest form that the schema R is in (1NF, 2NF, 3NF, or BCNF)? Justify your answer. [1,5 pkt]



1NF, dependencies

$ABG \rightarrow H$ and $ABG \rightarrow D$ and $ABG \rightarrow C, E$ are not fully functional

first $G \rightarrow H$

R1(A, B, C, D, E, G), R2(G, H) → 3NF

(c) If R is not in 3NF, decompose it into a set of relation schemas in 3NF. [4 pkt]

(d) Relation schemas obtained in step (c) are also in BCNF? If not, present the decomposition of the relation schema R into a set of relation schemas in BCNF. [3 pkt]

R1(A, B, G) R3(AB, C, D, E)

3NF
BC

3NF BC

Part II

Given the relation schema $R(A, B, C, D, E, X)$ and the following set of functional dependencies for the relation R :

$AB \rightarrow CDE$ $BE \rightarrow X$ $C \rightarrow A$

Let the schema R be decomposed into 2 relation schemas $R_1(B, E, X)$ and $R_2(A, B, C, D, E)$. For each of the following questions answer whether it is TRUE or FALSE: (6 pkt):

- | | | | |
|-----|---|------|-------|
| (a) | the decomposition of R into R_1 and R_2 is lossless-join? | TRUE | FALSE |
| (b) | both schemas R_1 and R_2 are in BCNF | TRUE | FALSE |
| (c) | both schemas R_1 and R_2 are in 3NF | TRUE | FALSE |

we have lossless join iff

- $R_1 \cap R_2 \rightarrow R_1$ or
- $R_1 \cap R_2 \rightarrow R_2$

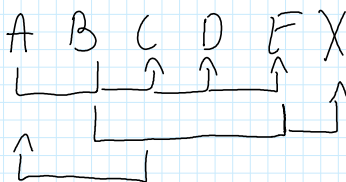
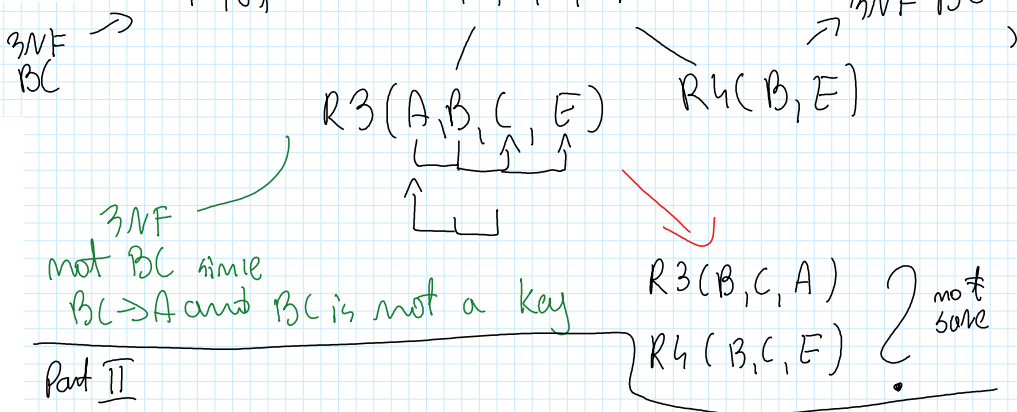
$$R_1(B, E, X) \cap R_2(A, B, C, D, E) = (B, E)$$

$$(B, E) \rightarrow R_1$$

so yes this is lossless join

are $R_1(B, E, X)$, $R_2(A, B, C, D, E)$ in 3NF
this, yes
this also since
 $C \rightarrow A$, A is prime attr.

But R_2 is not in BCNF, as
 $C \rightarrow A$ and C is not
a superkey.



Transitive functional dependency

A functional dependency $X \rightarrow Y$ in a relation schema R is a **transitive dependency**, if there is a set of attributes Z that is not a subset of any key of R , and both $X \rightarrow Z$ and $Z \rightarrow Y$ hold and both $Z \rightarrow X$ or $Y \rightarrow Z$ do not hold

from

$AB \rightarrow E$ and $BE \rightarrow X$

can we deduce $AB \rightarrow X$?

if yes then PK = AB