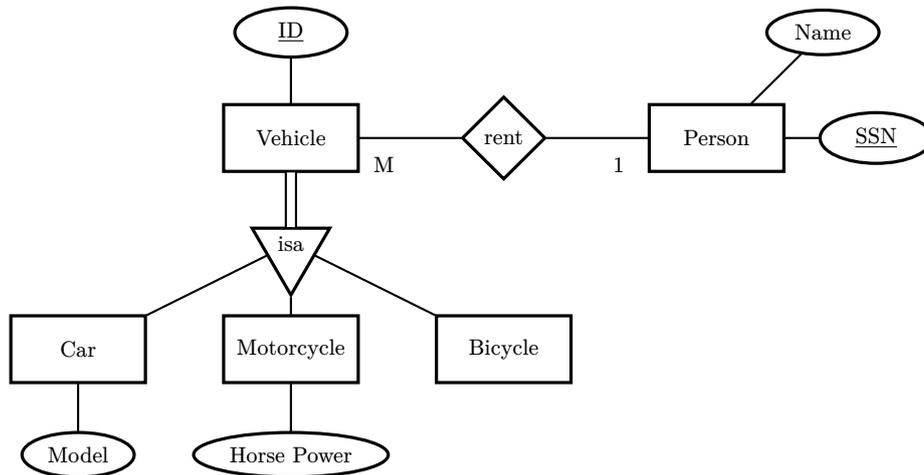


Exercise 1

1 Point

Mark the following statements as true (**T**) or false (**F**) with respect to the given ER-diagram.



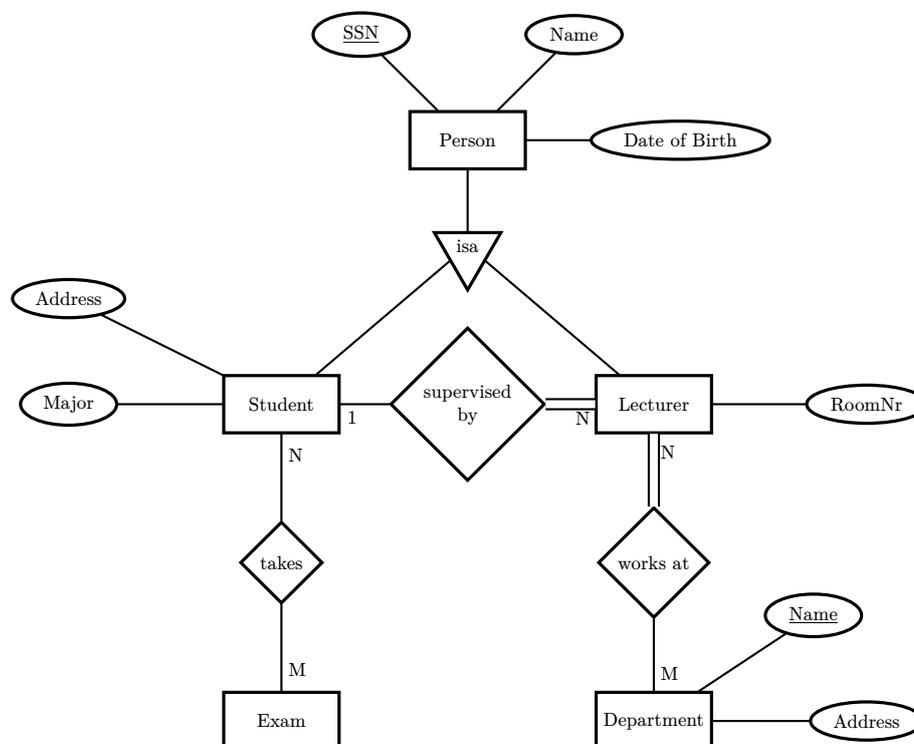
- (1) Each vehicle has to be neither a car, nor a motorcycle, nor a bicycle.
- (2) A vehicle can be rented by more than one person.
- (3) Each vehicle is of a certain model and has a certain horse power.
- (4) A vehicle can be both car and bicycle.
- (5) Each bicycle has an ID.

Exercise 2

1 Point

Correct the ER diagram to satisfy the following requirements:

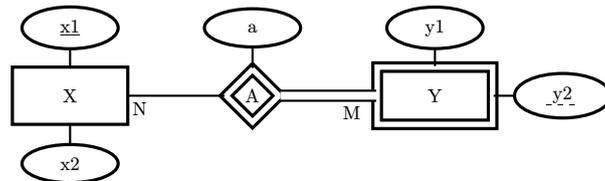
- (1) A person must be either a student or a lecturer.
- (2) A lecturer has an e-mail.
- (3) A lecturer can supervise multiple students.
- (4) A lecturer must work at exactly one department.
- (5) A lecturer can hold exams, and each exam must be held by exactly one lecturer.



Exercise 3

1 Point

Translate the following ER-diagram into a **relational schema** and state all **foreign key constraints** using projection and subset operations.



Relational Schema (0.6 Punkte)

Foreign Key Constraints (0.4 Punkte)

This schema is used for the following exercises

Relational schema

Band(band_name, founded)

Released(album_name, band_name, label_name, sales)

Label(label_name, country, num_employees)

Instrument(instr_id, band_name, description, value)

Foreign keys

$\pi_{band_name}(\text{Released}) \subseteq \pi_{band_name}(\text{Band})$

$\pi_{label_name}(\text{Released}) \subseteq \pi_{label_name}(\text{Label})$

$\pi_{band_name}(\text{Instrument}) \subseteq \pi_{band_name}(\text{Band})$

Database instance for the following exercises

Band		Label		
band_name	founded	label_name	country	num_employees
AC/DC	1973	Albert	Australia	15
Boston	1975	Asylum	USA	75
Eagles	1971	Atlantic	USA	130
Fleetwood Mac	1967	Apple	England	60
Guns N Roses	1985	Columbia	USA	270
Led Zeppelin	1968	Geffen	USA	100
Pink Floyd	1965	Harvest	England	40
The Beatles	1960	Warner Bros.	USA	650

Released

album_name	band_name	label_name	sales
Their Greatest Hits	Eagles	Asylum	29.000.000
Led Zeppelin IV	Led Zeppelin	Atlantic	23.000.000
The Wall	Pink Floyd	Harvest	23.000.000
Back in Black	AC/DC	Atlantic	22.000.000
Rumours	Fleetwood Mac	Warner Bros.	20.000.000
White Album	The Beatles	Apple	19.000.000
Appetite for Destruction	Guns N Roses	Geffen	18.000.000
Boston	Boston	Columbia	17.000.000
1967 - 1970	The Beatles	Apple	17.000.000

Instrument

instr_id	band_name	description	value
4	The Beatles	Rickenbacker 325	600000
17	The Beatles	Höfner 500/1	350000
34	Guns N Roses	Gibson LP	490000
51	Led Zeppelin	Fender Telecaster	125000
74	Eagles	Takamine EF381	90000

The space above and below the message intentionally is left blank.

Exercise 41 Point

Formulate the following query using **relational algebra**. Pay attention to syntactic correctness.

(1) List the founding date (**founded**) of all bands (**band_name**) for which an instrument is registered. **(0.4P)**

(2) List the names of all labels (**label_name**) that have not yet released an album. **(0.6P)**

Exercise 5

1 Point

Formulate the following queries using **SQL**. Pay attention to syntactic correctness.

(1) List all names of albums of those bands that have been founded after 1965 and that sold at least $2 \cdot 10^7$ copies.

(2) List the name (`band_name`) and the number of albums sold of all bands that were founded before 1970.

Exercise 6

1 Point

Consider the relations $R[A, B]$ and $S[C, D]$. Rewrite the following queries to use **exists** or **not exists** instead of **in**, **some**, **any**, and **all**. Your queries should be equivalent to the given queries.

(1) `select R.A
from R
where R.B > some (select S.C from S where S.D < 42)`

(2) `select R.A
from R
where R.B < all (select S.C from S where S.D <> 42)`

Exercise 7

1 Point

Consider relation $R[A, B, C, D, E, F, G]$ with the following functional dependencies:

$$F = \{AB \rightarrow D, \\ CD \rightarrow F, \\ EF \rightarrow G, \\ G \rightarrow D, \\ F \rightarrow C, \\ E \rightarrow B\} .$$

Find and list all candidate keys of R . **Explain your answer.**

Name:

Student ID:

11/12

Exercise 8

1 Point

Use the Armstrong axioms to show the soundness of the pseudo-transitivity rule:

$$X \rightarrow Y, WY \rightarrow Z \models WX \rightarrow Z$$

Exercise 9

1 Point

Consider relation $R[A, B, C, D, E]$ (already in first normal form – 1NF) with the following functional dependencies:

$$F = \{BE \rightarrow C, \\ D \rightarrow B, \\ AD \rightarrow BCE\}$$

Use the synthesis algorithm to decompose R into 3NF. **Show your work after every step of the algorithm.**