DEPARTMENT OF COMPUTER SCIENCE

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PARIS LODRON UNIVERSITÄT SALZBURG

Databases I — Exam
Summer Semester 2023 — 30.06.2023

Name: ______________________ **Student ID:** ______________________

Hints

- Check whether you received all pages of the exam (11 pages).
- Write your name or your student ID on each sheet of the exam and hand in all pages.
- All answers are expected to be written on the exam sheets.
- Clearly highlight and enumerate additional pages that are used for longer answers. Match your text with the according exercise.
- Only use pencils that are permanent and non-red colored.
- Use the notation and techniques discussed in the lecture.
- Exercises with more than one solution are not graded.
- You are allowed to use one A4 sheet with your personal notes (both sides, hand written or printed).
- Exam duration: 90 minutes

Signature ______________________

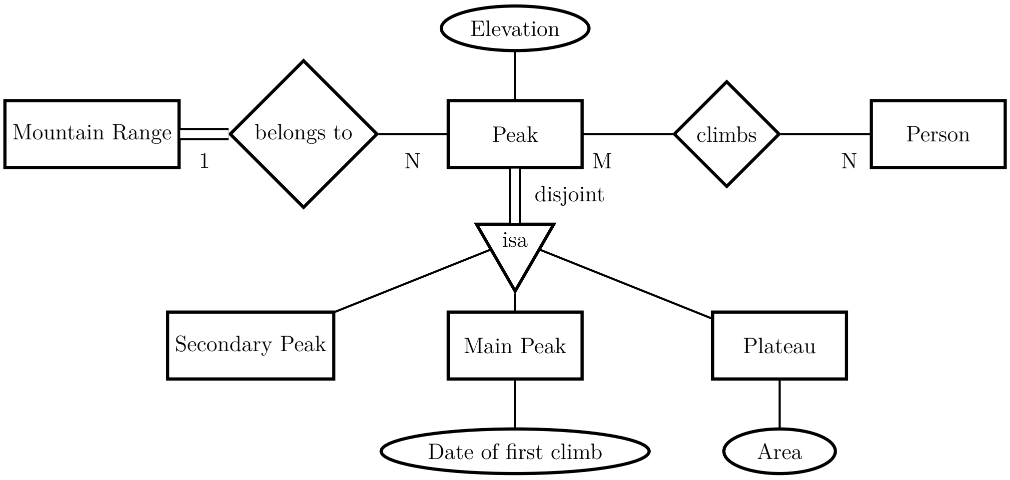
Grading

Filled by the examiner

Exercise	1	2	3	4	5	6	7	8	9	Sum
Total points	1	1	1	1	1	1	1	1	1	9
Points reached										

Exercise 1 — 1 Point

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



1. There are mountain ranges without peaks. ☐
2. Every person has to climb a peak. ☐
3. Each peak is either a main peak, a secondary peak, or a plateau. ☐
4. Every peak has a date of first climb. ☐
5. Each secondary peak has an elevation. ☐

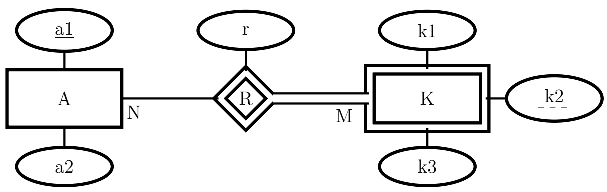
Exercise 2 — 1 Point

Draw an **ER-diagram** which satisfies the following requirements:

1. Every person has a unique social security number (SSN) and a name.
2. An orchestra has a unique name and a hometown.
3. A concert venue has a unique name, an associated town, and a capacity.
4. An instrument has a unique name and a type (wind instrument, percussion instrument,...).
5. A person is either a conductor or a musician.
6. A conductor has a year of their debut.
7. An orchestra can consist of several people, but at least one.
8. A person can be part of several orchestras.
9. A musician plays exactly one instrument.
10. An instrument can be played by several musicians.
11. One orchestra can perform at one venue at a certain time.
12. There can only be a performance by one orchestra at a venue at a certain time.

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)

Schema for the following exercises

Relational schema

Character(name, species, hometown)

Game(title, release_year, developer, platform)

AppearsIn(character_name, game_title, role)

Genre(game_title, type)

Foreign key constraints

$\pi_{\text{character\_name}}(\text{AppearsIn}) \subseteq \pi_{\text{name}}(\text{Character})$

$\pi_{\text{game\_title}}(\text{AppearsIn}) \subseteq \pi_{\text{title}}(\text{Game})$

$\pi_{\text{game\_title}}(\text{Genre}) \subseteq \pi_{\text{title}}(\text{Game})$

Instance for the following exercises

(C)haracter

name	species	hometown
Bowser	koopa	Koopa Kingdom
Donkey Kong	ape	Kongo Bongo Island
Link	human	Hyrule
Funky Kong	ape	Kongo Bongo Island
Mario	human	Mushroom Kingdom
Princess Zelda	human	Hyrule
Samus	hybrid	Earth Colony K-2L
Wario	human	Mushroom Kingdom

(Ge)nre

game_title	type
Donkey Kong	platform
Metroid Dread	action
Metroid Dread	platform
Super Mario Odyssey	adventure
Super Mario Odyssey	platform
Super Smash Bros	fighting
TLoZ: Ocarina of Time	adventure
TLoZ: Ocarina of Time	action

(Ga)me

title	release_year	developer	platform	sales
Donkey Kong	1981	Nintendo	Arcade	152,000
Metroid Dread	2021	Mercury Steam	Switch	2,900,000
Super Mario Odyssey	2017	Nintendo	Switch	25,760,000
Super Smash Bros	1999	HAL	N64	5,550,000
TLoZ: Ocarina of Time	1998	Nintendo	N64	7,400,000

(A)ppearsIn

character_name	game_title	role
Bowser	Super Smash Bros	other
Bowser	Super Mario Odyssey	antagonist
Donkey Kong	Donkey Kong	antagonist
Donkey Kong	Super Smash Bros	other
Link	Super Smash Bros	other
Link	TLoZ: Ocarina of Time	protagonist
Mario	Super Smash Bros	other
Mario	Super Mario Odyssey	protagonist
Princess Zelda	TLoZ: Ocarina of Time	other
Samus	Super Smash Bros	other
Samus	Metroid Dread	protagonist

Exercise 4 — 1 Point

Given the following query in **relational algebra**:

$$\pi_{type}(\sigma_{\text{character\_name='Link'}}(\text{AppearsIn}) \bowtie \text{Genre})$$

1. *Describe the result of the query in natural language (in 1-2 sentences).* (**0.2P**)

2. *Provide the output of the result with respect to the example instance.* (**0.4P**)

3. *Provide a query in extended relational algebra that computes:*
all characters that do not appear in any of the games. (**0.4P**)

Exercise 5 1 Point

Formulate the following queries using **SQL** for the schema on page 5.

1. *All antagonists (without duplicates) that are not of the species koopa.* (**0.4P**)

2. *The year of each character, in which the character appears the first time in a game. Characters not occurring in any game can be ignored.* (**0.6P**)

Exercise 6 — 1 Point

Formulate the following query using **SQL**.

For each character, the number of games in which the character occurs. Characters not appearing in any game should be considered as well. Also, sort the result by the number of games in decreasing order. (**1P**)

Exercise 7 1 Point

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

$$
\begin{aligned}
F = \{E &\rightarrow BCF,\\
ABDE &\rightarrow F,\\
F &\rightarrow ACE,\\
BDE &\rightarrow F\}
\end{aligned}
$$

Find and list all candidate keys of R.

Exercise 8 — 1 Point

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

$$
\begin{aligned}
F = \{D &\rightarrow AC, \\
B &\rightarrow ABCDF, \\
F &\rightarrow B, \\
BDE &\rightarrow ACF\}
\end{aligned}
$$

Compute the canonical cover F_C of F and ahow the results after each of the following four steps.

1. Left reduction.

2. Right reduction.

3. Remove empty sets.

4. Union.

Exercise 9 1 Point

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

$$\begin{aligned} F = \{A &\to C, \\ AB &\to D, \\ B &\to CE, \\ E &\to AB\} \end{aligned}$$

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