EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Database Systems 1
Summerterm 2023
Prof. Torsten Grust, Louisa Lambrecht, Tim Fischer
WSI — Database Systems Research Group

Assignment 11

Hand in this assignment until **Thursday, 20 July 2023, 12:00** at the latest.

Ⓔxam-style Exercises

Exercises marked with Ⓔ are similar in style to those you will find in the exam. You can use these to hone your expectations and gauge your skills.

Running out of ideas?

Are you hitting a roadblock? Are some of the exercises unclear? Do you just need that one hint to get the ball rolling? Refer to the `#forum` channel on our Discord server and check the tag for this assignment —maybe you'll find just the help you need.

Copy-Paste Symbols

This assignment focuses heavly on relational algebra. As such we have prepared a small relational-algebra-themed collection of our finest copy-pasteable Unicode symbols for you. 😉

$$\pi \quad \sigma \quad \cup \quad \cap \quad \bowtie \quad \times \quad \div \quad \setminus \quad \vee \quad \wedge \quad \neg \quad \leftarrow \quad \leq \quad \geq$$

Task 1: Relational Algebra Trivia

Please answer the following questions about relation algebra **briefly**.

(a) Which are the **core** operators? Explain the term "relationally complete".

(b) Briefly explain the difference between **monotonic** and **non-monotonic** operators.

(c) Consider the relations $R(A,B,C)$ and $S(B,D)$. Rewrite the following expressions into equivalent expressions that use only core operators:

i. $R \bowtie S$

ii. $\pi_B(R) \cap \pi_B(S)$

Task 2: Relational Flights Ⓔ

Consider the following relations containing airline flight information:

Aircraft

aid	name	manufacturer	maximum_range
1234	A350-900ULR	Airbus	18000 km
...	...	...	...

Pilots

pid	name	salary
5678	Launchpad McQuack	$330,000
...	...	...

Certified

aid	pid
1234	5678
...	...

Flights

flno	origin	destination	distance	departure	arrival
SQ 23	Singapore	New York	15349 km	2023-07-03 12:10	2023-07-03 18:50
...	...	...	...	...	...

> ✈️ Trivia
>
> The example is currently the longest commercial flight with a duration of about 19 hours! 😱 The departure and arrival times may look odd, but all is well because the timestamps are given in their respective local time zones, which are 12 hours apart. 😉

Use relational algebra to formulate the following queries:

(a) Find the flno and the origin of all flights to **Berlin**.

flno	origin
...	...

(b) Find the aid of all aircraft which can be used on non-stop flights from **Bonn** to **Madras**.

aid
...

(c) Find the pid and name of all pilots certified for some **Boeing** aircraft.

pid	name
...	...

(d) Find the names of all cities that lie on a round trip with exactly three flights.

city
...

> **Note**
>
> departure and arrival times do not have to be considered here.

Task 3: Relational Tavern

> ⚠️ Caution
>
> Though this task may be similar to task 2, some subtasks are non-monotonic in nature!

Consider the following relations containing information about taverns and their patrons:

Patrons

person	tavern
Torsten	Schänzle
...	...

Likes

person	beer
Torsten	Hefe Weizen
...	...

Offers

tavern	beer
Schänzle	Hefe Weizen
...	...

Use relational algebra to formulate the following queries:

(a) Ⓔ Which beers are mentioned in the database?

beer
...

(b) Ⓔ Which beers are not liked by any person?

beer
...

(c) Which patrons have not been to all taverns?

person
...

(d) Ⓔ List all patrons which like none of the beers on offer.

person
...

(e) Ⓔ Which patrons have been to any taverns that offer any of their favorite beers?

person
...

(f) Which patrons have been visiting **only** taverns that offer **any** of their favorite beers?

person
...

(g) Which patrons have been visiting **any** taverns that offer **only** their favorite beers?

person
...

(h) Which patrons have been visiting **only** taverns that offer **only** their favorite beers?

person
...