



## Datenbanksysteme I

WS 2019/20

Torsten Grust, Christian Duta

### Assignment #13

Submission Deadline: February 04, 2020 - 10:00

#### Exercise 1: Queries and Relational Algebra

(6 Points)

Consider the following relations containing airline flight information:

Aircraft(aid, name, manufacturer, range)  
Pilots(pid, name, salary)  
Certified(pid, aid)  
Flights(flno, from, to, distance, departs, arrives)

Recall the schema from assignment #12. Column *cruiserange* describes the maximum distance an aircraft is able to travel airborne before having to land. Column *distance* is the total distance required to complete a flight from start to finish. Column *departs* and *arrives* are timestamps. Timestamps can be compared with the usual operators ( $<$ ,  $=$ ,  $>$ ,  $\leq$ ,  $\dots$ ).

1. The following query returns the *flno* of flights directly from Basel to Amsterdam and all flights from Basel to Berlin for which a connecting flight to Amsterdam exists.

```
SELECT f.flno
FROM Flights AS f
WHERE (f.from = 'Basel' AND f.to = 'Amsterdam') OR
      (f.from = 'Basel' AND f.to = 'Berlin' AND
       EXISTS (SELECT 1
                FROM Flights AS f1
                WHERE f1.from = f.to AND
                      f1.to = 'Amsterdam' AND f1.departs > f.arrives));
```

Translate this SQL query into an equivalent relational algebra expression.

2. The other way round, the following RA query computes pilots that are only certified for aircraft with a cruising range of less than 800 km (or for no aircraft at all). Write an equivalent SQL query.

$$\text{Pilots} \setminus (\pi_{\text{pid}, \text{name}, \text{salary}}(\text{Pilots} \bowtie (\text{Certified} \bowtie \pi_{\text{aid}}(\sigma_{\text{range} \geq 800}(\text{Aircraft}))))))$$

**Exercise 2: Non-monotonic Queries in the Relational Algebra****(9 Points)**

Consider the following relations containing airline flight information again:

Aircraft(aid, name, manufacturer, cruisingrange)  
Pilots(pid, name, salary)  
Certified(pid, aid)  
Flights(flno, from, to, distance, departs, arrives)  
Crew(flno, pid)

Figure 1: Airline database schema

Given the following non-monotonic problems:

- a) Find the *pid* and *name* of all pilots which can be deployed for the flight with *flno* 'LH 970'.  
A pilot is deployable for a flight, if he is certified for an aircraft which can pass the flight distance and he is not yet deployed on another flight during the scheduled flight time. The scheduled flight time is defined by *departs* and *arrives*.

**result(pid, name)**

- b) Find *flno*, *from* and *to* of the flights with the shortest traveling distance.

**result(flno, from, to)**

1. Formulate RA queries to answer the questions. Hand in your queries **in the form of query operator trees (plans)**.

*Hint: A row is minimal with respect to attribute A, if there does not exist any row in the same table whose A value is smaller.*

2. For both queries  $Q$ , give two example database instances  $\mathcal{I}_1 \subset \mathcal{I}_2$ , together with the expected query results  $Q(\mathcal{I}_1)$  and  $Q(\mathcal{I}_2)$ , which show that the question is non-monotonic:  $Q(\mathcal{I}_1) \not\subseteq Q(\mathcal{I}_2)$ .