Exercise 1: Theoretical Problems

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19a. Explain briefly, what is the purpose of the following relational algebra expression, and what does it return. (2p.)

Solution. The given relational algebra expression will return the `restaurantID` and `owner` of restaurants that do not have any contracts with the suppliers listed in the `Suppliers` table. The latter half of the expression returns the `restaurantID` and `owner` of restaurants that have contracts with the suppliers through a natural join of `Restaurants` and `Contracts` (on the shared attribute of `restaurantID`). Hence, when the difference set operator is used with the list of all `restaurantID` and `owner`, we find its complement.

19b. Explain briefly, what is the purpose of the following SQL query, and what does it return. (2p.)

Solution. The given SQL query returns the list of suppliers `ID` and their `name` of suppliers that hold contracts with more than one restaurant in the `Restaurants` table. Considering the `WHERE` condition, the computer is essentially searching through the `Contracts` table to find two tuples where the `supplierID` is the same but the `restaurantID` differs (additional condition is to access the `name` attribute of the supplier).

19c. What is the maximal possible number of rows in the queries (a) and (b)? What is the minimal number of rows? Please justify your answers briefly (2p.)

Solution. Let us consider query (a) first. Given that there are 100 rows in `Restaurants`, 50 rows in `Suppliers` and 100 rows in `Contracts`, the number of restaurants that do not have any contract with the suppliers in the `Suppliers` table will be maximized when two restaurants each have 50 contracts with each of the 50 suppliers and the remaining 98 restaurants do not hold any contracts - this results in 98 rows. Let us now consider query (b). The number of suppliers that hold contracts with more than one restaurant will be maximized when every supplier holds exactly two contracts (with two restaurants), summing to 100 contracts - this results in 50 rows.

20a. Task: List all the courses and their teachers (relational algebra).

Solution. The proposed solution is incorrect as natural join creates a new relation containing the tuples from the two relations that agree in its shared attributes. Unfortunately, the shared attribute between `Course` and `Teacher` is `name` which represent different data in the two relations – the course name and teacher name, respectively. Hence, this relational algebra expression will likely produce an empty relation. [note: Theta join would have been more appropriate]

20b. Task: Find the IDs of all students who have completed both courses Programming 1 and Programming 2.

Solution. The proposed solution is incorrect as it uses an `OR` logical operator in its `WHERE` condition, thereby resulting in the IDs of all students who have completed both courses Programming 1 or Programming 2. Instead, the SQL query should have used the

`INTERSECT` set operator to the IDs of all students who have completed Programming 1 and those who completed Programming 2.