CPSC 304: Introduction to Relational Databases
Tutorial #4: Relational Algebra

General Notes

1. Be sure to complete these tutorials. Tutorials are not for marks, and will not be handed in, but a substantial part of the quizzes and course content are based on them.

2. Tutorials answers are generally released at the start of when the next tutorial is released.

Task 1

Consider the **Sailors-Boats-Reserves DB** described in the textbook, with primary keys underlined:

Sailors (sid, sname, rating, age)

Boats (bid, bname, color)

Reserves (sid, bid, day)

Give a Relational Algebra expression for each of the following queries. It is OK to decompose your relation into parts (using the appropriate renaming/assignment conventions). Single quotes or double quotes are fine when specifying names in a condition.

1. Find the colors of boats reserved by sailors named Albert or Andrea. Be sure to specify which of the colors apply to Albert and which of the colors apply to Andrea.

2. Find the IDs of sailors who have a rating of 7 or who have reserved boat ID 103.

3. Find the names of sailors who have *not* reserved a red boat. Note that a sailor who has never reserved a boat also qualifies.

4. Find the names of sailors who have reserved neither a red boat nor a green boat.

5. Find the IDs of sailors under the age of 19 who have reserved a red boat.

6. Find the names of sailors who have reserved at least 2 boats.

7. Find the names of sailors who have reserved *all* boats.

8. Find the names of sailors who have reserved all boats named Titanic. Note that multiple boats could be named Titanic.

9. Find the IDs of those sailors who have the highest rating. Hint: Don't include any sailor that has a lower rating than someone else.

10. Find the sailor IDs of sailors whose rating is better than that of any sailor named Ron.

11. Find the sailor IDs of sailors whose rating is better than that of every sailor named Ron.

Task 2

Consider this relational schema:

1. Customer(customerID, firstName, lastName, email, streetAddress)
2. Reservation(confirmationNumber, **customerID**)
    a. customerID refers to customerID in Customer table
3. Branch(branchName, streetAddress, city)
4. VehicleType (typeName, rentalRate, numberOfSeats)
5. Reserves(**branchName, confirmationNumber, typeName**, startDate, endDate)
    a. branchName refers to branchName in Branch table
    b. confirmationNumber refers to confirmationNumber in Reservation table
    c. typeName refers to typeName in VehicleType table
6. Equipment(equipmentID, brand, equipmentName, purchasedDate, price)
7. 4-wheeler (**typeName**, airbagManufacturer)
    a. Refers to typeName of VehicleType table
    b. Child ISA of the VehicleType table (disjoint and covering)
8. 2-wheeler(**typeName,** hasBackseat)
    a. Refers to typeName of VehicleType table
    b. Child ISA of the VehicleType table (disjoint and covering)
9. EquipRental(**customerID, equipmentID**, **branchName,** startDate, endDate)
    a. customerID refers to customerID in Customer table
    b. equipmentID refers to equipmentID in Equipment table
    c. branchName refers to branchName in Branch table
10. PaymentReserve(paymentCode, **customerID**, date, paymentAmount, **confirmationNumber**)
    a. customerID refers to customerID of Customer table
    b. confirmationNumber refers to confirmationNumber in Reservation table

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Write Relational Algebra expressions for the following queries:

1) Find the email addresses of customers whose first name is “Mark” or whose last name is “Solar”.

2) Find the equipment IDs for equipment purchases made earlier than 2019-01-01, but only report the cases where the equipment has never been rented (reserved) by anyone.

3) Find the last names of customers who have made 2 or more vehicle reservations.

Provide a plain English explanation for the following Relational Algebra expressions.

Aim for one sentence, keeping your explanation concise, accurate, and easy to understand. Avoid using Relational Algebra terminology like “project”, “join”, “intersect”, etc. For example, depending on the RA expression, you might write something like, “Find the last names of all customers in Vancouver who reserved a vehicle on August 18, 2020.”

4) $\text{Ans} \leftarrow \pi_{\text{startDate}}(\sigma_{\text{endDate = "2018-02-02"}} (\text{Reserves} \bowtie (\sigma_{\text{city = “Winnipeg”}}(\text{Branch}))))$

5) $\text{Ans} \leftarrow \pi_{\text{streetAddress}}(\sigma_{\text{paymentAmount > 100}}(\text{PaymentReserve} \bowtie \text{Customer}))$

   $\cup \pi_{\text{streetAddress}}(\sigma_{\text{firstName = “Jeremy”}}(\text{Customer}))$

6) $\text{Ans} \leftarrow \pi_{\text{e1.startDate, e1.endDate}}(\rho(\text{e1, EquipRental}) \bowtie_{\text{e1.startDate < e2.startDate}}$

   $(\rho(\text{e2, EquipRental}) \bowtie \sigma_{\text{confirmationNumber = 12345}}(\text{Reservation})))$