Problem Set #1

(Due 10/13 11:59 pm EST)

Note: In this homework, you do not need to create tables and execute queries using an actual DBMS. A written solution is sufficient.

Problem 1:

Consider the relational database schema below, which models student clubs, club members, and club events in a university.

Each club has a unique name and possibly a description. Students can join clubs on a semester basis, which requires paying a membership fee that might vary from club to club and from one semester to another. For example, the "Debate Club" might have a membership fee of $50 during the "Spring 2022" semester, but the fee could be adjusted to $60 for "Fall 2022". Students are identified by a unique ID, along with attributes such as name, major, and email address.

Clubs organize events. An event has an ID, a name, and a semester and date when it takes place. While some events are exclusively for club members, other events are open to the entire student community. Events usually have an associated cost, where the cost may be different for club members and non-members. Furthermore, certain special events are organized jointly between multiple clubs, in which case the member fee applies for members of any of the organizing clubs. If non-members are not allowed to participate, this is expressed by setting the non-member fee to NULL.

An essential aspect of these events is the registration process. Registration keeps a record of which students registered for an event. For each registration, it's documented whether the student is attending as a club member or a non-member, and if they attended the event. Here is the scheme:

Students (**sid**, name, major, email)
Clubs (**cid**, cname, description)
ClubFee (**cid , semester**, fee)
Membership (**cid , sid, semester**)

Events (**eid**, ename, semester, edate, memberfee, nonmemberfee)
Organizedby (**eid, cid**)
Registration (**sid, eid**, ismember, attended)

a) Write SQL queries for the following problems. Discuss any assumptions you are making in your queries:

   i. List the names of all students who joined more than 3 clubs in Fall 2022.

   ii. Identify the event(s) during Fall 2023 that had the highest number of registered students.

   iii. Output the names and emails of all students who attended an event jointly organized by both the "Debate Club" and "French Student Association" during Spring 2023.

   iv. List the names of all students who did not attend any event during Fall 2021, even though they were members of at least one club during that semester.

   v. Output the student IDs of all students who were members of the "French Student Association" during Spring 2023 and attended all its member-only events.

b) Write statements in Relational Algebra for all queries. Use basic RA whenever possible, and extended RA otherwise.

c) Write statements in (Domain or Tuple) Relational Calculus for all queries or explain why it is not possible to do so.

Problem 2:

"FurniRent" is a furniture rental company located in a major city. The company specializes in offering a wide range of furniture pieces to cater to the dynamic needs of its customers, who often relocate to the city for various reasons. The primary goal of this assignment is to design a relational schema that can model the major aspects of the company's operations.

The database should maintain an extensive catalog of furniture pieces, each uniquely identified by a specific ID. For each piece of furniture, we also store its condition (e.g., "new", "like new", "good", "acceptable"), its model (e.g., "Florence Dining Table for 8 People"), and to which category of furniture it belongs to (e.g.," dining table", "couch", or "bed").   Each model should have a unique identifier, a name, and a description, plus attributes such as size, material, and any other relevant details that distinguish one model from another.

The rental cost a piece of furniture is determined by the model, its condition, and the duration for which it is rented. You should also store suitable details for each customer, such as their name, credit card number, email, and a phone number. You also need to know the address where the customer will use the furniture but note that the address may be different for different rental by the same customer, as they may have moved.

A rental by a customer usually involves multiple furniture items that are delivered to an address by the company and picked up at the end of the rental period — unless the customer decides to extend the rental. For each rental, you need to store the rental period, total price, exact delivery address, whether it is an extension of an existing rental. You also need to store which pieces or furniture are involved in a rental, and the condition of each piece at the beginning and end of the rental.

a) Design a suitable schema for this scenario. Identify all primary and foreign keys.

b) Write SQL queries for the following tasks. If your schema does not allow the queries to be answered, you should revise your schema appropriately.

i) Find the total number of rentals for each customer. Display the customer's first name, last name, and the number of rentals, ordered by the number of rentals in descending order. (Note: this is the number of rentals, not the number of individual pieces of furniture rented)

ii) List all furniture items that are currently available for rent (i.e., not rented out). Include the item's ID, model, type, and condition.

iii) Find the average total price of rentals for each furniture type (e.g., "Dining Table," "Couch"). Display the furniture type and the average price, rounded to two decimal places, ordered by average price in descending order.

iv) Retrieve the details of the most expensive rental, including customer information (first name, last name, email), rental dates, and total price.

v) Identify customers who rented an item that was in condition "new" at the start of the rental and returned it in condition "poor". Output the customer ID, name, furniture piece ID, and return date.