Information and Database Management Systems I

(CIS 4301)

Spring 2022

Instructor: Dr. Markus Schneider

TA: Kyuseo Park

Homework 2

Name:	
UFID:	
Email Address:	

Pledge (Must be signed[1] according to UF Honor Code)

On my honor, I have neither given nor received unauthorized aid in doing this assignment.

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Student signature

Question 1 (Relational Algebra) [30 points]

Consider the relation schemas below. The primary keys are underlined. All attributes are of type *string* if not indicated otherwise. [Hint: Use multi-step and multi-line queries to ease the formulation of queries. Use the rename operator ρ to give intermediate query results a name (some textbooks use the equivalent '←' notation). Aggregate functions as you can find them defined in some textbooks are *not* allowed, neither in homework assignments nor in exams.]

- Theaters(tID, name, location)
- Auditoriums(tID, aID, number of seats: integer)
- Movies(mID, title, running time: integer, genre, director, release date:integer)
- Book(tID, aID, cID, mID, bID, seat number, date:integer, year:integer, time:integer)
- Customers(cID, name, street, city)

Comments:
- "date:integer" has a format as follows: 0101, ..., 1231
- "time:integer" has a format as follows: 0000, ..., 2359

(a) [5 points] Find the names of customers who have booked the movie "ABC" more than once on the same day. ("ABC" is a title and unique.)

(b) [5 points] Find the names of customers who have watched the movie directed by "Bong" and the movie's running time is the shortest among his movies.

(c) [5 points] Find the names of customers who always watch movies in the morning.

(d) [5 points] Find the titles of the movies along with their directors that have been on every theater in Gainesville. Assume all movies in all theaters have been booked at least once.

(e) [5 points] Find the names of customers in Gainesville who watched the movie "ABC" on Christmas Eve and New Years eve in 2021.

(f) [5 points] Find the names of customers who never booked in 2022.

Question 2 (Relational Algebra) [25 points]

Consider the relation schemas below. The primary keys are underlined. All attributes are of type *string* if not indicated otherwise. [Hint: Use multi-step and multi-line queries to ease the formulation of queries. Use the rename operator ρ to give intermediate query results a name (some textbooks use the equivalent '$\leftarrow$' notation). Aggregate functions as you can find them defined in some textbooks are *not* allowed, neither in homework assignments nor in exams.]

- Department(<u>dID</u>, name, office)
- Project(<u>prID</u>, name, sponsor, start date, end date, budget:integer)
- Professor(<u>pSSN</u>, name, age:integer, specialty, rank, dID)
- Graduate(<u>gSSN</u>, name, age:integer, advisorSSN, dID)
- WorkIn(<u>pSSN</u>, <u>prID</u>)
- WorkOn(<u>gSSN</u>, <u>prID</u>)

(a) [5 points] Find the names of professors who work on projects sponsored by "CompanyA".

(b) [5 points] Find the names of graduates who work on the same project that their advisors work on.

(c) [5 points] Find the names of projects that Mathematics and CISE departments professors work on together.

(d) [5 points] Find the names of graduates (along with their age, advisor, and advisor's age) who are older than their advisors.

(e) [5 points] Find the names of the people who work on the project that has the largest budget.

Question 3 (Relational Algebra) [20 points]

Consider the following relations. The primary keys are underlined. All attributes are of type string if not indicated otherwise. [Hint: Use multi-step and multi-line queries to ease the formulation of queries. Use the rename operator ρ to give intermediate query results a name (some textbooks use the equivalent '$\leftarrow$' notation). Aggregate functions as you can find them defined in some textbooks are not allowed, neither in homework assignments nor in exams.]

- Student(studentID, name, major, gpa)
- Class(classID, name)
- ClassOffering(coID, classID, lecturer, semester, classroom, day)
- Enroll(coID, studentID, grade)

Comment:
- Day means "day of the week".

(a) [5 points] Find the names of CISE students who got an A grade in every enrolled class.

(b) [5 points] Find the names and major of students who have enrolled in every class offered by "Lee".

(c) [5 points] Find the names of CISE students who have not enrolled in the DB class.

(d) [5 points] Find the names of lecturers who have ever taught only one class.

Question 4 (Relational Algebra)   [25 points]

The following questions let you think deeper about the concepts of the Relational Algebra.

(a) [5 points] Let $\mathscr{R}$ be the schema of a relation R, and let $A_1,\ldots,A_n \subseteq \mathscr{R}$. Is the Relational Algebra expression $\pi_{A_1}(\pi_{A_2}(\ldots(\pi_{A_n}(R))\ldots))$ correct, in general? If yes, argue why. If not, argue why not. If your answer is no, are there any restrictions that could make the statement true? If so, what are these restrictions in mathematical notation?

(b) [5 points] Let $\mathscr{R}$ be the schema of a relation R, and let $A \subseteq \mathscr{R}$. What is the condition in mathematical notation such that $\pi_A(\sigma_F(R)) = \sigma_F(\pi_A(R))$ holds where F is assumed to be a correct predicate on R?

(c) [15 points] Let $R(A,B,C)$, $S(B,D)$, and $T(A,C)$ be relations such that R has r tuples, S has s tuples, and T has t tuples with $r > 0$, $s > 0$, and $t > 0$. The attributes A,B,C, and D are supposed to have the same numerical data type. Consider the given Relational Algebra expressions below and determine the *minimum* number and the *maximum* number of possible tuples of each result relation. Explain your answers.

   (1) [5 points] $\pi_{A,\,C}(R) \cap T$

   (2) [5 points] $R \bowtie_{R.B=S.B} S$

   (3) [5 points] $\pi_B(\pi_B(R) \cup \pi_B(S))$ (For this question, also consider two other *possible* numbers of tuples beside the *minimum* and *maximum* number of tuples.)