Database Management Systems

(COP 5725)

Fall 2021

Instructor: Dr. Markus Schneider

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Homework 2

Name:	
UFID:	
Email Address:	

Pledge (Must be signed according to UF Honor Code)

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

_____

Signature

For scoring use only:

	Maximum	Received
Exercise 1	25	
Exercise 2	25	
Exercise 3	22	
Exercise 4	28	
Total	100	

Exercise 1 (Relational Algebra) [25 points]

Consider the following relation schemas for a company. 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.]

- `Employee (SSN, name, age: integer, gender, address, salary: integer, Supervisor_ssn, Dno)`
  [*Comment*: Dno means "department number"]
- `Department (Dnumber, name, Manager_ssn, Manager_start_date)`
- `Dept_location (Dnumber, Dlocation)`
- `Project (Pnumber, name, location, Dno)`
  [*Comment*: Dno means "department number"]
- `Works_on (Essn, Pno, hours)`
  [*Comment*: Pno means "project number"]

1. [5 points] Find the names of IT department employees who do not work on any project that the IT department runs.

2. [5 points] Find the names of departments that are located at the same location as the IT department.

3. [5 points] Find the names of employees who work the most hours on projects that the IT department runs.

4. [5 points] Find the names of employees who work on both Project 'A' and Project 'B'.

5. [5 points] Find the name of employees who work on every project run by the IT department.

Exercise 2 (Relational Algebra) [25 points]

Consider the following relations for an online flight booking system. 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.]

- `Company (company_ID, company_name, location)`
- `Flight (company_ID, flight_number, destination, price: integer, number_of_seats: integer)`
  [*Comment*: A company usually has several flight airlines.]
- `Book (company_ID, flight_number, customer_ID, date)`
- `Customer (customer_ID, name, address)`

1. [4 points] Find the names of customers who have booked flights at every company in the US.

2. [3 points] Find the names of customers who have never booked a flight.

3. [6 points] Find the names of customers who booked the flight to New York more than once.

4. [4 points] Find the names of the companies that have the biggest (in terms of the number of seats) airplane.

5. [4 points] Find the names of customers who booked flights to Boston and Seattle.

6. [4 points] Find all destinations (unequal to Gainesville) of cheap flights (<=$500) provided by companies that also provide flights to Gainesville.

Exercise 3 (Relational Algebra) [22 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 '←' notation). Aggregate functions as you can find them defined in some textbooks are *not* allowed, neither in homework assignments nor in exams.]

- `Student (student_ID, name, major, gpa)`
- `Enroll (class_ID, student_ID, semester)`
- `Class (class_ID, name, classroom, lecturer, day)`
  [*Comment*: Day means "day of the week".]

1. [6 points] Find the names and GPA of CISE students who have enrolled in the DB class.

2. [4 points] Find the names and major of students who have enrolled in the DB class on Wednesdays and the Algorithm class on Thursdays but have not enrolled in the OS class on Fridays.

3. [4 points] Find the names and major of students who have enrolled in every class taught by 'James'.

4. [4 points] Find the names of students who have enrolled in the DB class more than twice.

5. [4 points] Find the names of students who have not enrolled in the DB class.

Exercise 4 (Relational Algebra) [28 points]

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

1. [6 points] Let $\mathbb{R}$ be the schema of a relation R, and let A_1, A_2, …, $A_n \subseteq \mathbb{R}$. Is the term $\pi_{A_1}(\pi_{A_2}(...(\pi_{A_n}(R))...)) = \pi_{A_1}(R)$ 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?

2. [6 points] Let $\mathbb{R}$ be the schema of a relation R, and let $A \subseteq \mathbb{R}$. 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?

3. [16 points] Let $R(A, B)$ be a relation with $r > 0$ tuples, and let $S(B, C)$ be a relation with $s > 0$ tuples. We assume that A, B, and C have the *same data type*. For each of the following Relational Algebra expressions, in terms of r and s, determine the *minimum* and *maximum number of tuples* that the result relation can have. In other words, we are interested in the number of tuples the following Relational Algebra expressions can have *at least* and *at most*. The numbers have to be given by using the two variables r and s. Please note that you have to give precise explanations for your answers.

    a. [4 points] $R \cup \rho_{T(A,B)}(S)$

    b. [3 points] $(R \bowtie R) \bowtie R$

    c. [4 points] $\pi_{A, C}(R \bowtie S)$

    d. [5 points] $\sigma_{A=C}(R \bowtie S)$