Information and Database Management Systems I

(CIS 4301 UF Online)

Fall 2019

Instructor: Dr. Markus Schneider

Homework 2

Name:	Joshua Main-Smith
UFID:	7160-7655
Email Address:	joshuamainsmith@ufl.edu

Pledge (Must be signed according to UF Honor Code)

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

Josh Smith

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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 relations. The primary keys are underlined. All attributes are of type string if not indicated otherwise.

- Student (<u>s_ID</u>, s_name, s_degree: integer, advisorID, d_ID)
- Lecture (<u>l_ID</u>, l_name, l_degree: integer, p_ID, d_ID)
- Register (<u>s_ID</u>, <u>l_ID</u>, score: integer, Semester)
- Professor (<u>p_ID</u>, p_name, d_ID)
- Department (<u>d_ID</u>, d_name, address)

1. [5 points] Find the names of professors who have taught in every semester.
2. [5 points] List the names of lectures that the CISE department offers but that are taught by a professor whose department is not CISE.
3. [5 points] Find the names of students who got the highest score in the lecture 'Databases'.
4. [5 points] Find the names of students who have registered every lecture of the CISE department.
5. [5 points] Find the names of students who got more than 90 in the 'DB' lecture and less than 70 in the 'Algorithm' lecture.

Exercise 1

1. $\sigma_{l\text{-}ID}(\text{Register}) \bowtie (\sigma_{p\text{-}ID}(\text{Professor} \bowtie \text{Lecture})) \div \pi_{p\_name}(\text{Professor})$

2. $\pi_{l\_name}(\text{Lecture}) \bowtie (\sigma_{d\_ID \land d\text{-}name \neq \text{'CISE'}}(\text{Professor} \bowtie \text{Department}))$
$\bowtie (\sigma_{d\text{-}ID \land \text{Department}.d\text{-}name = \text{'CISE'}}(\text{Department} \bowtie \text{Lecture}))$

3. $\rho_{R1}(\sigma_{l\text{-}name = \text{'Databases'}}(\text{Lecture}) \bowtie \sigma_{l\_ID}(\text{Register}))$
$\rho_{R2}(R1)$
$\pi_{s\_name}(\text{Student}) \bowtie (\sigma_{s\text{-}ID}(\text{Student}) \bowtie (\sigma_{R1.score < R2.score}(R1 \times R2)))$

4. $\pi_{s\_name}(\text{Student}) \bowtie (\sigma_{s\text{-}ID}(\text{Student}) \bowtie (\sigma_{l\_ID}(\text{Register})$
$\bowtie (\sigma_{d\_name = \text{'CISE'}} \land \sigma_{d\_ID}(\text{Department}) \bowtie (\sigma_{d\_ID}(\text{Lecture})))))$

5. $\pi_{s\text{-}name}(\cancel{\text{Student}}\ \sigma_{s\_ID}(\text{Student}) \bowtie (\sigma_{l\text{-}ID \land score > 90}(\text{Register})) \bowtie (\sigma_{l\text{-}ID}$
$\land l\text{-}name = \text{'DB'}(\text{Lecture}))$
$\cap$
$(\sigma_{s\_ID}(\text{Student}) \bowtie (\sigma_{l\text{-}ID \land score < 70}(\text{Register})) \bowtie$
$(\sigma_{l\_ID \land l\_name = \text{'Algorithm'}}(\text{Lecture})))$

Exercise 2 (Relational Algebra) [25 points]

Consider the following relations for an online bookstore. The primary keys are underlined. All attributes are of type string if not indicated otherwise.

- Book(bID, title, author, publisher, year, price)
- Customer(cID, name, ssn, gender, age: integer, email, street, city, state, zipcode)
- Credit_Card(ccID, cID, cardNumber, exprDate)
  - cID is a foreign key to Customer relation.
- Book_Order(bID, ccID, quantity: integer, time)
  - bID is a foreign key to Book relation.
  - ccID is a foreign key to Credit_Card relation.

1. [4 points] Find the titles of books that were purchased by the customers Ahn or Berr.
2. [6 points] Find the names of customers who ordered the book "DB" the most.
3. [4 points] Find the names of publishers whose books are not sold yet.
4. [3 points] Find the genders of customers who ordered the "Machine Learning" book authored by Chris Bishop.
5. [4 points] List the titles of books that were purchased by customers whose credit cards are expiring in 2018.
6. [4 points] List the emails of customers who have not purchased any book.

Exercise 2

1. $\pi_{title}(Book \bowtie (\sigma_{name='Ahn' \lor name='Berr'}(Customer \bowtie Credit\_Card \bowtie Book\_order)$

2. $\rho R1(\sigma_{title='DB'}(Book \bowtie Book\_order \bowtie (Credit\_Card \bowtie Customer))$

   $\pi_{name}(R1)$

3. $\pi_{publisher}(Book - (\sigma_{bID}(Book \bowtie Book\_order)))$

4. $\pi_{gender}((\sigma_{title='Machine\ Learning' \land author='Chris\ Bishop'}(Book))$
   $\bowtie (Book\_order \bowtie ((Credit\_Card \bowtie Customer)))$

5. $\rho R1(Book \bowtie Book\_order \bowtie Credit\_Card \bowtie Customer)$

   $\pi_{title}(\sigma_{exprDate='2018'}(R1))$

6. $\rho R1(Customer)$

   $\rho R2(Customer \bowtie Credit\_Card \bowtie Book\_order)$

   $\pi_{email}(R1 - R2)$

Exercise 3 (Relational Algebra) [22 points]

Consider the following relations. The primary key is underlined. All attributes are of type string if not indicated otherwise.

- branch (branch_name, branch_city, assets: integer)
- customer (customer_id, customer_name, customer_street, customer_city)
- account (account_number, branch_name, balance)
- depositor (customer_id, account_number)

1. [6 points] Find the names of customers who have an account in the branch with highest assets.

2. [4 points] Find the names of customers who live in the same city where the branches are located that the customers use.

3. [4 points] Find the names of customers whose account balance is less than $1,000 and the branch that has the account is located in Gainesville.

4. [4 points] Find the names of customers that have accounts in every branch in Gainesville.

5. [4 points] Find the names of customers who do not have an account. (assume the bank keeps the customer information even if the account is closed.).

Exercise 3

1. $\Pi_{customer\_name}(customer) - \Pi_{R1.customer\_name}((customer \bowtie (depositer \bowtie$
$(account \bowtie (R1 \bowtie_{R1.asset < R2.asset} R2))))$

2. $\Pi_{customer\_name}(account \bowtie depositer \bowtie (customer \bowtie_{customer\_city = branch.city} branch)$

3. $\Pi_{customer\_name}(\sigma_{balance < '1000' \wedge branch\_city = 'Gainesville'}(account \bowtie depositer$
$\bowtie (customer \bowtie branch))$

4. $\sigma_{customer\_name}((customer \bowtie depositer \bowtie account \bowtie branch) \div \Pi_{branch\_city =}$
$'Gainesville'(branch)$

5. $\Pi_{customer\_name}((customer - ((customer \bowtie depositer \bowtie account))$

Exercise 4 (Relational Algebra) [28 points]

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

1. [6 points] Let R be the schema of a relation R, and let $A_1, A_2, \ldots, A_n \subseteq \mathrm{R}$. Is the term $\pi_{A_1}(\pi_{A_2}(\ldots(\pi_{A_n}(R))\ldots)) = \pi_{A_1}(R)$ 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 R be the schema of a relation R, and let $A \subseteq \mathrm{R}$. 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] $\sigma_{A=C}(R \bowtie S)$

1. The equivalency is not true. The left-hand side of the equation projects all the columns of relation R, where the right-hand side only projects column A_1 from relation R. To make the equivalency true, we could write $\pi_{A_1}(\pi_{A_2}(\ldots(\pi_{A_n}(R))\ldots)) = \pi_{A_1,\ldots,A_n}(R)$.
2. This equation would hold under the condition that $F \subseteq R$ and if F and A are under the same schema.
3.
   a. Under the condition that $R \subseteq S \vee S \subseteq R$ the minimum would r if $r \geq s$, or s if $s \geq r$ (the union between two sets would have a minimum value of the largest set).
   b. This expression is equivalent to R, so the minimum number of tuples is r and the maximum number of tuples would also be r.
   c. It’s possible that R and S don’t share any common values in B, so the minimum would be 0. It’s also possible that R and S have every B value in common, so the maximum would be r x s.
   d. If R and S have no values in common for B, then the minimum would be s if $s \leq r$, or r if $r \leq s$. If R and S have every value in common for B, then max = r = s.