CS143: Database Systems
Homework #1

1. Suppose relation $R(A, B, C)$ has the tuples:

A	B	C
3	2	1
4	2	3
4	5	6
2	5	3
1	2	6

A	B	C
4	5	6
1	2	6
2	5	4

and relation $S(A, B, C)$ has the tuples:

A	B	C
2	5	3
2	5	4
4	2	3
3	2	1

Compute $(R - S) \cup (S - R)$, often called the "symmetric difference" of R and S. List all the tuples in the result relation.

2. Suppose relation $R(A, B)$ has the tuples:

A	B	C	D
1	2	4	6

A	B
1	2
3	4
5	6

and relation $S(B, C, D)$ has the tuples:

B	C	D
2	4	6
8	6	8
7	5	9

Compute $R \bowtie_{R.A<S.C \wedge R.B<S.D} S$ and list all the result tuples.

3. Assume the following database for this problem. The relations represent information on bank branches:

   Customer(<u>customer-name</u>, street, city)
   Branch(<u>branch-name</u>, city)
   Account(<u>customer-name</u>, <u>branch-name</u>, <u>account-number</u>)

   The **Customer** relation has customer names and their addresses. The **Branch** Relation has branch names and the city that a branch is located in. The **Account** relation represents at which branch a customer has his/her accounts. We assume that customer names and branch names are unique. We also assume that a customer may have multiple accounts in one branch and the customer may have accounts in multiple branches.

   Write an relational-algebra expression for each of the following queries. We can use only the operators learned in the class.
   (Hint: When a query is difficult to write, think of its complement.)

   (a) Find the names of all customers who have an account in the 'Region12' branch.

   $\pi_{customer\text{-}name}(\sigma_{branch\text{-}name = 'Region12'}(Branch \bowtie Account))$

   (b) Find the names of all customers who have an account in a branch NOT located in the same city that they live in.

   $\pi_{customer\text{-}name}(Branch \bowtie_{Branch.city \neq S.city} \rho_S(Account \bowtie Customer))$

   (c) Find the branches that do not have any accounts.

   $\pi_{branch\text{-}name}(Branch) - \pi_{branch\text{-}name}(Account)$

   (d) Find the customer names who do not have any account in the 'Region12' branch.

   $\pi_{customer\text{-}name}(Customer) - \pi_{customer\text{-}name}(\sigma_{branch = 'Region12'}(Account))$

   (e) Find the customer names who have accounts in all the branches located in 'Los Angeles'. You are not allowed to use the division operator directly for this question.

   $\pi_{customer\text{-}name}(Customer) - \pi_{customer\text{-}name}(\pi_{customer\text{-}name}(Customer) \times \pi_{branch\text{-}name}(\sigma_{city = 'Los\ Angeles'}(Branch)) - \pi_{customer\text{-}name, branch\text{-}name}(Account))$

   (f) Find the customer names who have only one account.

   $\pi_{c\text{-}name}(Account) - \pi_{A.c\text{-}name}(\sigma_{Account.c\text{-}name = A.c\text{-}name \wedge Account.num = A.num}(Account \times \rho_A(Account)))$

4. The relation **Student(sid, GPA)** captures the student-GPA information, where **sid** is the id of a student and **GPA** is the student's GPA. Write a relational algebra that finds the ids of the students with the lowest GPA.
   (Hint: When a query is difficult to write, think of its complement.)

   $\pi_{sid}(Student) - \pi_{Student.sid}(\sigma_{Student.GPA > S.GPA}(Student \times \rho_S(Student)))$