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

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

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

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

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
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

R.A	R.B	S.B	S.C	S.D
1	2	2	4	6
1	2	8	6	8
1	2	7	5	9
3	4	2	4	6
3	4	8	6	8
3	4	7	5	9
5	6	8	6	8

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

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

   Customer(customer-name, street, city)
   Branch(branch-name, city)
   Account(customer-name, branch-name, account-number)

   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.

   Πcustomer-name(σbranch-name='Region12'(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.

   Πcustomer-name(σA.city<>B.city∧A.branch-name=B.branch-name(ρB(Branch) × ρA(Customer ⋈ Account)))

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

   Πcustomer-name(Branch)—Πcustomer-name(Account)

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

   (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.

   Πcustomer-name(Customer)—(Πcustomer-name(Πcustomer-name(Customer) × Πbranch-name(σcity='Los Angeles'(Branch))— Πcustomer-name, branch-name(Account))

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

   Πcustomer-name(Account)—A1.customer-name(σ(A1.customer-name=A2.customer-name)∧(A1.branch-name<>A2.branch-name)∨(A1.account-number<>A2.account-number)(ρA1(Account) × ρA2(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.)

Πsid(Student—(ΠS2.sid,S2.GPA(σS1.GPA<S2.GPA(ρS1(Student) × ρS2(Student)))))

3.(d) Πcustomer-name(Account)—(Πcustomer-name(σbranch-name='Region12'(Account)))