CS143: Homework #1 (Relational Algebra)

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

A	B	C
7	5	3
2	1	2
1	4	3
5	8	7
6	7	9

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

A	B	C
2	1	2
1	4	4
8	3	2
5	8	7

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 $R(L, M)$ has the tuples:

L	M
4	3
6	5
8	7

and relation $S(M, N, P)$ has the tuples:

M	N	P
6	1	8
1	6	4
2	5	1
3	4	7

Compute $\sigma_{R.L > S.M \wedge R.M < S.P}(R \times S)$. List all the tuples in the result relation.

3. Assume the following database for this problem. The relations represent information on course enrollment in a university:

Student(Student-name, Department)
Course(Course-name, Department)
Enrollment(Student-name, Course-name)

The **Student** relation has student names and the departments they belong to.
The **Course** relation has course names and the departments they are offered by.
The **Enrollment** relation represents which courses the students are enrolled in.

Assumptions:

- Student names and course names are unique.
- A student can enroll in multiple courses.
- A student can enroll in a course offered by any department.

Write a relational-algebra expression for each of the following queries. Use only the operators we learnt in class.
(Hint: When a query is difficult, think of its complement.)

(a) Find the names of all students who are not enrolled in the 'Database Management Systems' course.

(b) Find the names of all students who are enrolled in at least one course not offered by their home department.

(c) Find the names of all courses which have no students enrolled.

(d) Find the department names that students belong to if the students takes at least one class offered by the CS department.

(e) Find the department names of all students who are enrolled in at most one course.

4. The relation **Company(company-name, valuation)** captures Company-valuation information, where **company-name** is the name of a company and **valuation** is its valuation. Write a relational algebra expression to find the name of the lowest valued companies. (Hint: When a query is difficult, think of its complement.)

CS143: Homework #1 Solution (Relational Algebra)

1. Solution:

   Relation $(R - S)$:

A	B	C
7	5	3
1	4	3
6	7	9

   Relation $(S - R)$:

A	B	C
1	4	4
8	3	2

   Relation $(R - S) \cup (S - R)$:

A	B	C
7	5	3
1	4	3
6	7	9
1	4	4
8	3	2

2. Solution: Relation $X = \sigma_{R.L > S.M \wedge R.M < S.P}(R \times S)$ is:

R.L	R.M	S.M	S.N	S.P
4	3	1	6	4
4	3	3	4	7
6	5	3	4	7
8	7	6	1	8

3. Solution:

   (a)

   $$\Pi_{\text{Student-name}} - \Pi_{\text{Student-name}}(\sigma_C(\text{Enrollment}))$$

   where $C = (\text{Course-name} = \text{``Database Management Systems''})$

(b)

$$\Pi_{\text{Student-name}}(\sigma_C(\text{Student} \bowtie \text{Enrollment}) \times \text{Course})$$

where $C = (\text{Student.Department} \neq \text{Course.Department} \wedge \text{Enrollment.Course-name} = \text{Course.Course-name})$

(c)

$$\Pi_{\text{Course-name}}(\text{Course}) - \Pi_{\text{Course-name}}(\text{Enrollment})$$

(d)

$$\Pi_{\text{Department}}(\text{Student} \bowtie \Pi_{\text{Student-name}}(\sigma_{\text{Department=CS}}(\text{Enrollment} \bowtie \text{Course})))$$

(e)

$$\Pi_{\text{Department}}(\text{Student} \bowtie (\Pi_{\text{Student-name}}(\text{Student}) - \Pi_{\text{E1.Student-name}}(\sigma_C(D))))$$

where $D = (\rho_{\text{E1}}(\text{Enrollment}) \times \rho_{\text{E2}}(\text{Enrollment}))$
and
$C = (\text{E1.Student-name} = \text{E2.Student-name} \wedge \text{E1.Course-name} \neq \text{E2.Course-name})$

4.

$$\Pi_{\text{Company-name}}(\text{Company}) - \Pi_{\text{C1.Company-name}}(\sigma_{\text{C1.valuation>C2.valuation}}(\rho_{C1}(\text{Company}) \times \rho_{C2}(\text{Company})))$$