Exercise 1.

We have R(A,B,C) and S(C,D) relations. Rewrite the following extended relational algebra expressions into SQL.

$\gamma_{A,AVG(D)}(\sigma_{B>=2}(R \times S)$

$\Pi_A (\sigma_{AV>10}(\gamma_{A,AVG(D)->AV}(R \bowtie S)))$

$\delta (\Pi_A (\sigma_{R.C=S.C} (R \times S)))$

$\tau_A(\Pi_{A,C}(\sigma_{B=2}(R)$

$\delta (\Pi_{A,B} (\sigma_{R.C=S.C \text{ AND } D=1} (R \times S)))$

$\Pi_A R - \Pi_A (\sigma_{R.C=S.C} (R \times S))$

Solution

You can find the equivalent SQL queries in Exercise 2. The last relational algebra expression is equivalent to the last two SQL queries.

Exercise 2.

Rewrite the following SQL queries into extended relational algebra.

```
SELECT A, AVG(D) FROM R, S WHERE R.B >=2 GROUP BY A;
SELECT A FROM R NATURAL JOIN S GROUP BY A HAVING AVG(S.D)>10;
SELECT DISTINCT A FROM R, S WHERE R.C = S.C;
SELECT A, C FROM R WHERE B = 2 ORDER BY A;
SELECT DISTINCT A, B FROM R WHERE C IN (SELECT C FROM S WHERE D=1);
SELECT A FROM R WHERE C NOT IN (SELECT C FROM S);
SELECT A FROM R WHERE NOT EXISTS (SELECT * FROM S WHERE R.C = S.C);
```

Exercise 3.

We have the following relation: R(A,B,C).

R (A, B, C)

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

Compute the results of the following expressions, without rewriting them into SQL. You can check yourself with SQL, but SQL statements are not required.

a) $\gamma_{A,AVG(C)}(\sigma_{B>=2}R)$ {(X,3), (Y,4)}

b) $\gamma_{A,B,SUM(C)}(R)$ {(X,1,7), (Y,2,3), (Y,3,9), (X,4,6)}

c) $\gamma_{A,SUM(B),SUM(C)}(R)$ {(X,10,13), (Y,8,12)}

d) $\tau_{B,A}\ \Pi_{A,B}(\sigma_{C>=4}\ R)$ {(X,1), (Y,3), (Y,3), (X,4)}

e) $\delta(\Pi_{A,B}(\sigma_{B>=2}\ R))$ {(Y,2), (Y,3), (X,4)}

f) $\gamma_{A,SUM(E)}(\Pi_{A,B*C->E}\ R)$ {(X,31), (Y,33)}

Exercise 4.

We have the following two relations:

R(A,B)

A	B
0	1
2	3
0	1
2	4
3	4

S(B,C)

B	C
0	1
2	4
2	5
3	4
0	2
3	4

Compute the results of the following expressions, without rewriting them into SQL. You can check yourself with SQL, but SQL statements are not required.

a) $\pi_{A+B,A*A,B*B}(R)$ {(1,0,1), (5,4,9), (1,0,1), (6,4,16), (7,9,16)}
b) $\pi_{B+1,C-1}(S)$ {(1,0), (3,3), (3,4), (4,3), (1,1), (4,3)}
c) $\tau_{B,A}(R)$ {(0,1), (0,1), (2,3), (2,4), (3,4)}
d) $\tau_{B,C}(S)$ {(0,1), (0,2), (2,4), (2,5), (3,4), (3,4)}
e) $\delta(R)$ {(0,1), (2,3), (2,4), (3,4)}
f) $\gamma_{sum(B)}(R)$ {(13)}
g) $\gamma_{A,sum(B)}(R)$ {(0,2), (2,7), (3,4)}
h) $\gamma_{B,avg(C)}(S)$ {(0,1.5), (2,4.5), (3,4)}
!i) $\gamma_{A}(R)$ {(0), (2), (3)}
!j) $\gamma_{A,max(C)}(R \bowtie S)$ {(2,4)}
!k) $\gamma_{sum(E)}(\pi_{A+B\text{->}E,A*A\text{->}F,B*B\text{->}G}(R))$ {(20)}
!l) $\gamma_{G,sum(E)}(\pi_{A+B\text{->}E,A*A\text{->}F,B*B\text{->}G}(R))$ {(1,2), (9,5), (16,13)}

Exercise 5.

Give the following result for which you can use views, or you can use the `WITH` statement. Compute the average salary by departments (**deptno, dept_avg**), then compute the general average salary (**gen_avg**), finally give the department name, average salary on that department, the general average and the difference between the department average and the general average. **(dname, dept_avg, gen_avg, diff)**

```
WITH
tmp1 AS (
   SELECT deptno, AVG(sal) dept_avg FROM emp GROUP BY deptno),
tmp2 AS (
   SELECT AVG(sal) gen_avg FROM emp)
SELECT dname, round(dept_avg), round(gen_avg),
       round(dept_avg-gen_avg) diff
FROM tmp1, tmp2, dept
WHERE tmp1.deptno = dept.deptno;
```

Tmp1 = γ deptno;avg(sal)→dept_avg (Emp)
Tmp2 = γ avg(sal)→gen_avg (Emp)
π dname, round(dept_avg)→av, round(gen_avg)→gen, round(dept_avg - gen_avg)→diff
((Tmp1 $\bowtie$ Dept) × Tmp2)