Compulsory exercise for practice 5.
Use Relax environment, upload the data from Relax_R_S.txt and run the first query in exercise 1 below. Then create a table whose name is PRACTICE5 and the content of the table is the same as the result of the previous query.

You can use the following SQL statements to create the sample tables for the exercises below.

```
CREATE TABLE R(A VARCHAR(10), B INTEGER, C INTEGER);
INSERT INTO R VALUES('X',1, 2);
INSERT INTO R VALUES('Y',2, 3);
INSERT INTO R VALUES('Y',3, 4);
INSERT INTO R VALUES('X',1, 5);
INSERT INTO R VALUES('Y',3, 5);
INSERT INTO R VALUES('X',4, 2);
INSERT INTO R VALUES('X',4, 4);

CREATE TABLE S(C INTEGER, D INTEGER);
INSERT INTO S VALUES(2, 8);
INSERT INTO S VALUES(2, 15);
INSERT INTO S VALUES(3, 9);
INSERT INTO S VALUES(3, 14);
INSERT INTO S VALUES(4, 11);
INSERT INTO S VALUES(4, 17);
INSERT INTO S VALUES(2, 1);
INSERT INTO S VALUES(6, 20);
```

Exercise 1.

We have the following two relations: R(A,B,C) and S(C,D). Rewrite the following relational algebra expressions into SQL. Run the SQL queries on the sample tables (see above) and give the results too.

γ A; AVG(D) $\rightarrow$ av (σ B >= 2 (R x S)) ← Compulsory exercise !!!

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

δ (Π_A ($\sigma_{R.C = S.C}$ (R x S)))

τ_A($\Pi_{A,C}$($\sigma_{B = 2}$(R)

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

Π_A (R $\bowtie$ (Π_C R - Π_C S))

Exercise 2.

We have the following two relations: R(A,B,C) and S(C,D). 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 result of the following expressions, without rewriting them into SQL. You can check yourself with SQL, but SQL statements are not required.

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

b) $\gamma_{A,B,SUM(C)}(R)$

c) $\gamma_{A,SUM(B),SUM(C)}(R)$

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

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

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

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

a) $\pi_{A+B,A*A,B*B}(R)$

b) $\pi_{B+1,C-1}(S)$

c) $\tau_{B,A}(R)$

d) $\tau_{B,C}(S)$

e) $\delta(R)$

f) $\gamma_{sum(B)}(R)$

g) $\gamma_{A,sum(B)}(R)$

h) $\gamma_{B,avg(C)}(S)$

!i) $\gamma_{A}(R)$

!j) $\gamma_{A,max(C)}(R \bowtie S)$

!k) $\gamma_{sum(E)}(\pi_{A+B->E,A*A->F,B*B->G}(R))$

!l) $\gamma_{G,sum(E)}(\pi_{A+B->E,A*A->F,B*B->G}(R))$

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)