

## Assignments 4

Due Friday, October 6, 2017

In this assignment, you will be required to use PostgreSQL. Your solutions should include the PostgreSQL statements for solving the problems. Submit a file Assignment4.sql with your solutions and a file OutputAssignment4.txt with your outputs to the queries.

**Remark:** Consider a relation  $R(A, B)$  and a relation  $S(C)$  and consider the following RA (Relational Algebra) expression  $F$ :

$$\pi_A(R) - \pi_A(\sigma_{B=1}(R \bowtie_{B=C} S))$$

Then we can write this query in SQL in a way that closely mimics its RA formulation. This can be done using the WITH statement of SQL as follows.<sup>1</sup>

First, we break the RA expression  $F$  up into sub-expressions as follows. (Notice that each sub-expression corresponds to the application of a single RA operation.)

Expression Name	RA expression
$E_1$	$\pi_A(R)$
$E_2$	$R \bowtie_{B=C} S$
$E_3$	$\sigma_{B=1}(E_2)$
$E_4$	$\pi_A(E_3)$
$F$	$E_1 - E_4$

Then we write the following SQL query. Notice how the expressions  $E_1$ ,  $E_2$ ,  $E_3$ , and  $E_4$  occur as separate queries in the WITH statements and that the final query gives the result for the expression  $F$ .<sup>2</sup>

If you use overloading of the relational name, the query becomes

```
WITH
E1 AS (SELECT DISTINCT A FROM R),
E2 AS (SELECT A, B, C FROM R INNER JOIN S ON (B = C)),
E3 AS (SELECT A, B, C FROM E2 WHERE B = 1),
E4 AS (SELECT DISTINCT A FROM E3)
(SELECT A FROM E1) EXCEPT (SELECT A FROM E4);
```

In your answer to a problem, you should write the resulting RA expression as such an SQL query. (Your SQL query should of course execute correctly in PostgreSQL). In a separate file you should also submit the text for the RA expressions in their standard notation, just as show for the expression  $F$  above.

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<sup>1</sup>For more information about the WITH statement see <https://www.postgresql.org/docs/9.1/static/queries-with.html>.

<sup>2</sup>For better readability, I have used relational-name overloading. Sometimes, you may need to introduce new attribute names in SELECT clauses using the AS clause. Also, use DISTINCT where needed.

In the following questions, use the data provided for the student, majors, book, cites, buys relations.

Write the following queries as RA expressions. For each such RA expression, write a SQL query (using the WITH statement) that mimics this expression.

Each problem is worth 10 points.

1. Find the bookno of each book that is cited by at least one book that cost less than \$50.
2. Find the bookno and title of each book that was bought by a student who majors in CS and in Math.
3. Find the sid-bookno pairs  $(s, b)$  pairs such student  $s$  bought book  $b$  and such that book  $b$  is cited by at least two books that cost less than \$50.
4. Find the bookno of each book with the next to highest price.
5. Find the sid of each student who bought all books that cost more than \$50.
6. Find the Bookno of each book that was not bought by any student who majors in CS.
7. Find the Bookno of each book that was not bought by all students who majors in CS.
8. Find sid-bookno pairs  $(s, b)$  such that not all books bought by student  $s$  are books that cite book  $b$ .
9. Find sid-bookno pairs  $(s, b)$  such student  $s$  only bought books that cite book  $b$ .
10. Find the bookno of each book that cites all but two books. (In other words, for such a book, there exists only two books that it does not cite.)