

## Homework Assignment 2

Due in class on February 4<sup>th</sup> 2004

1. Write the queries of Question 3 from Homework 1 in Tuple Relational Calculus.
2. Let  $R(x)$  be a relation schema and  $r_1, r_2$  two instances of  $R$ . Write expressions in relational tuple calculus that compute the following expressions:  $r_1 \cup r_2$ ,  $r_1 \cap r_2$ ,  $r_1 - r_2$ .
3. Consider the following relational schema:  $R(A, B, C), S(B, C, D)$ . Write an SQL expression for each one of the following relational algebra queries:

1.  $\pi_A(R \bowtie \sigma_{D>10}(S))$
2.  $\pi_D(\pi_{B,D}(\sigma_{C=1}(R) \bowtie S) \cap \pi_{B,D}(\sigma_{C=2}(R) \bowtie S))$
3.  $R/\pi_{B,C}(S)$

4. Consider the following SQL query over a relational schema  $R(A, B), S(B, C), T(C, D)$ :

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SELECT DISTINCT r.A
FROM R r, S s, T t
WHERE r.B = s.B AND r.A > 10 AND s.C = t.C AND t.D = 20

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Do the following relational algebra expressions compute the same result? Provide a brief explanation for each case.

1.  $\pi_A(\sigma_{A>10 \wedge D=20}(R \bowtie S \bowtie T))$
2.  $\pi_A(\pi_{A,C}(\sigma_{A>10}(R) \bowtie S) \bowtie \sigma_{D=20}(T))$
3.  $\pi_A(\pi_{A,B,C}(\sigma_{A>10}(R) \times \sigma_{D=20}(T)) \bowtie S)$

5. Consider a relational schema  $E(\underline{u}, \underline{v})$  which represents a directed graph. Assume that  $u, v$  are integer fields that represent the ids of graph nodes. A tuple  $(x_i, x_j) \in E$  denotes the existence of an edge from node with id  $x_i$  to node with id  $x_j$ . A cycle of length  $n$  is a path  $x_1 \rightarrow x_2 \rightarrow \dots \rightarrow x_n \rightarrow x_1$ , i.e., it starts and ends to the same node and passes through  $n - 1$  intermediate nodes. Write an SQL query that computes all cycles of length 3.

6. Exercise 5.4 from the textbook.

7. Consider the following relational schema which stores information on employees, the companies they work for, their salaries, and their managers.

*employee*(employee-name, street, city)  
*works*(employee-name, company-name, salary)  
*manages*(employee-name, manager-name)

Give an expression in SQL for each of the following queries:

1. Find all employees who earn more than their manager.
2. Find all employees who earn more than the average salary of all employees in their company.
3. Find the company that has the most employees.
4. Find the company that has the smallest payroll.
5. Find those companies whose employees earn a higher salary, on average, than the average salary at First Bank Corporation.