

**Homework Assignment 2**  
(due Thursday, October 10, 2002)

- Exercises 3.5 parts (e), (g), (h), 3.13, 3.14
- Recall the *beer drinkers* database consisting of information about drinkers, beers, and bars telling which drinkers like which beers, which drinkers frequent which bars, and which bars serve which beers. In the previous homework assignment you had to give an appropriate relational database schema for this database.
  - Write a relational algebra expression for the following query: “List all customers who frequent every bar that serves AMSTEL”.
  - Write a relational calculus expression for the same query (you may use either domain or tuple relational calculus, but do not mix the two in your answer).
- Suppose that the relation  $R$  has  $m$  tuples and the relation  $S$  has  $n$  tuples. Give the minimum and maximum number of tuples that the results of the following relational algebra expressions may have:
  - $R \cup S$
  - $R \cap S$
  - $R - S$
  - $R \bowtie S$

Justify briefly each of your answers.

- The *semijoin*  $R \bowtie S$  of two relations  $R$  and  $S$  is the relation consisting of all tuples  $t$  in  $R$  such that there is at least one tuple in  $S$  that agrees with  $t$  in all attributes that  $R$  and  $S$  have in common.

Assume now that the attributes of  $R$  are  $A, B, C$  and the attributes of  $S$  are  $B, C, D$ . Give a relational algebra expression for  $R \bowtie S$ .

For extra credit, give also a (domain or tuple) relational calculus expression for  $R \bowtie S$ .
- Explain why the *difference* operation  $R - S$  cannot be expressed by any relational algebra expression that is a combination of the other four basic relational algebra operations (union, cartesian product, selection, projection).