

Database Systems
Homework Assignment 2
Answers

Beer Drinkers

List all drinkers who frequent every bar that serves AMSTEL

relational algebra

$frequents \div \pi_{bar}(\sigma_{beer='AMSTEL'}(serves))$

TRC

$\{t | (\forall u \in serves)(u[beer] = 'AMSTEL' \rightarrow (\exists w \in frequents)(w[drinker] = t[drinker] \wedge w[bar] = u[bar]))\}$

DRC

$\{x | (\forall y)(\forall z)((y, z) \in serves \rightarrow (x, y) \in frequents)\}$

Semijoin

$\pi_{R.A, R.B, R.C}(\sigma_{R.B=S.B \wedge R.C=S.C}(R \times S))$

Explain why $R - S$ cannot be expressed using the other four basic relational algebra operations.

Quick Answer: The other four operations are monotone, while $R - S$ is not monotone.

Definition: an operation F on relations with arguments R_1, R_2, \dots, R_k is monotone if whenever $R_1 \subseteq R'_1, R_2 \subseteq R'_2, \dots, R_k \subseteq R'_k$, then $F(R_1, R_2, \dots, R_k) \subseteq F(R'_1, R'_2, \dots, R'_k)$.

Fact 1: Each of the operations $\cup, \times, \sigma, \pi$ is monotone (follows easily from the definitions).

Fact 2: $-$ is not monotone. For instance, $R - \emptyset = R$, but $R - R = \emptyset$ (i.e. we increased the second argument and got a smaller result).

Fact 3: Compositions of monotone operations are monotone (proved using induction).

Hence, every relational algebra expression built using $\cup, \times, \sigma, \pi$ is monotone so it cannot express $-$.