Equivalent Notations in Relational Algebra, Tuple Relational Calculus, and Domain Relational Calculus

Select Operation

R = (A, B)

Relational Algebra: $\sigma_{B=17}(r)$

Tuple Calculus: $\{t \mid t \in r \wedge B = 17\}$

Domain Calculus: $\{<a, b> \mid <a, b> \in r \wedge b = 17\}$

Project Operation

R = (A, B)

Relational Algebra: $\Pi_A(r)$

Tuple Calculus: $\{t \mid \exists\ p \in r\ (t[A] = p[A])\}$

Domain Calculus: $\{<a> \mid \exists\ b\ (<a, b> \in r)\}$

Combining Operations

R = (A, B)

Relational Algebra: $\Pi_A(\sigma_{B=17}(r))$

Tuple Calculus: $\{t \mid \exists\ p \in r\ (t[A] = p[A] \wedge p[B] = 17)\}$

Domain Calculus: $\{<a> \mid \exists\ b\ (<a, b> \in r \wedge b = 17)\}$

Natural Join

R = (A, B, C, D) S = (B, D, E)

Relational Algebra: $r \bowtie s$

$$\Pi_{r.A,r.B,r.C,r.D,s.E}(\sigma_{r.B=s.B \wedge r.D=s.D}(r \times s))$$

Tuple Calculus: $\{t \mid \exists p \in r \; \exists q \in s \; (t[A] = p[A] \wedge t[B] = p[B] \wedge t[C] = p[C] \wedge t[D] = p[D] \wedge t[E] = q[E] \wedge p[B] = q[B] \wedge p[D] = q[D])\}$

Domain Calculus: $\{<a, b, c, d, e> \mid <a, b, c, d> \in r \wedge <b, d, e> \in s\}$

Union

R = (A, B, C) S = (A, B, C)

Relational Algebra: $r \cup s$

Tuple Calculus: $\{t \mid t \in r \vee t \in s\}$

Domain Calculus: $\{<a, b, c> \mid <a, b, c> \in r \vee <a, b, c> \in s\}$

Intersection

R = (A, B, C) S = (A, B, C)

Relational Algebra: $r \cap s$

Tuple Calculus: $\{t \mid t \in r \wedge t \in s\}$

Domain Calculus: $\{<a, b, c> \mid <a, b, c> \in r \wedge <a, b, c> \in s\}$

Set Difference

R = (A, B, C) S = (A, B, C)

Relational Algebra: $r - s$

Tuple Calculus: $\{t \mid t \in r \wedge t \notin s\}$

Domain Calculus: $\{<a, b, c> \mid <a, b, c> \in r \wedge <a, b, c> \notin s\}$

Cartesian/Cross Product

R = (A, B) S = (C, D)

Relational Algebra: $r \times s$

Tuple Calculus: $\{t \mid \exists\, p \in r\ \exists\, q \in s\ (t[A] = p[A] \wedge t[B] = p[B] \wedge t[C] = q[C] \wedge t[D] = q[D])\}$

Domain Calculus: $\{<a, b, c, d> \mid <a, b> \in r \wedge <c, d> \in s\}$

Division

R = (A, B) S = (B)

Relational Algebra: $r \div s$

Tuple Calculus: $\{t \mid \exists\, p \in r\ \forall q \in s\ (p[B] = q[B] \Rightarrow t[A] = p[A])\}$

Domain Calculus: $\{\langle a \rangle \mid \langle a \rangle \in r \wedge \forall \langle b \rangle\ (\langle b \rangle \in s \Rightarrow \langle a, b \rangle \in r)\}$

Use of the Universal Quantifier

salary = (employee, salary-amount)

To find the maximum salary-amount:

(Extended) Relational Algebra:

$\max_{\text{salary-amount}}(\text{salary})$

Tuple Calculus:

$\{t \mid \forall p \in \text{salary} \Rightarrow p[\text{salary-amount}] \leq t[\text{salary-amount}]\}$

Domain Calculus:

$\{\langle s \rangle \mid \exists e(\langle e, s \rangle \in \text{salary} \wedge \forall e1, s1(\langle e1, s1 \rangle \in \text{salary} \Rightarrow s1 \leq s))\}$
