

## Relational Algebra operators

### 1. The select operator, $\sigma$

- Pick rows satisfying a given condition,  $\sigma_{\text{condition}}$  (Relational expression)
- Example:  $\sigma_{\text{gpa} > 3.5}$  Students
- Output a subset of the Students relation containing only rows/students with gpa bigger than 3.5

### 2. The project operator, $\pi$

- Pick the specified columns,  $\pi_{A_1, A_2, \dots, A_n}$  (Relational expression)
- Example:  $\pi_{\text{sId}, \text{sName}}$  Students
- Output the entire Students table but lists only the sId and sName columns

### 3. Cross-product or Cartesian product, $T_1 \times T_2$

- Combine two tables or table expressions
- Output is a new relation whose schema is the union of the schemas of operand tables or expressions and contents consist of every possible row combinations
- A binary operator but can compose

### 4. Natural Join

- Like the cross product but ensures that the result consists of only row combinations in which similarly-named column values are equal and only one of those columns is retained
- Does not add expressive power to RA, as every natural join expression has an equivalent cross product expression. But it's notationally convenient

### 5. Theta Join

- Like cross product but output consists of only tuples satisfying the theta predicate
- Does not add more expressive power to RA, but it's the basic operation implemented by most RDBMS
- Think of "join" as theta join

### 6. Union, $R_1 \cup R_2$

- combines R1 and R2 "vertically", rather than "horizontally" as in a cross product
- R1 and R2 must have same schemas

### 7. Difference, $R_1 - R_2$

- result table consists of tuples in R1 that are not in R2

### 8. Intersection, $R_1 \cap R_2$

- result consists of tuples in both R1 and R2
- no additional expressiveness as it's equivalent to  $R_1 \text{ natural join } R_2$  or  $R_1 - (R_1 - R_2)$

### 9. Rename, $\rho$

- $\rho_{R(A_1, A_2, \dots, A_n)}(\text{Expr})$ : rename Expr name to R and attributes to A1, A2, ..., An
- $\rho_R(\text{Expr})$ : rename Expr name to R and retain attribute names of Expr in R
- $\rho_{(A_1, A_2, \dots, A_n)}(\text{Expr})$ : retain Expr name, and rename attributes