

Relational Algebra (RA)

- It is a procedural query language
- RA is a set of operations on relation(s).
- It is a set of algebraic operations
- Input : One or more relations
- Output: A relation
- It provides a theoretical foundation for relational databases
- Structured Query Language (SQL)
- It allows us to understand database operations in more detail and motivate us to write optimized queries

RA Operations

Fundamental operations are:

- Select (σ)
- Project (Π)
- Union (\cup)
- Set Difference (-)
- Cartesian Product (\times)
- Rename (ρ)

Additional Operations are:

- Set Intersection (\cap)
- Assignment Operation (=)
- Natural join (\bowtie)
- Division Operation (\div)
- Outer join
 - Left outer join (\bowtie_L)
 - Right outer join (\bowtie_R)
 - Full outer join (\bowtie_F)

1. Select (σ)

- Select tuples that satisfy a given predicate
- It is denoted by lowercase Greek letter sigma (σ)
- Syntax: $\sigma_{\text{selection-condition}}(\text{Relation})$
- Example: $\sigma_{\text{Dept-ID} = 2}(\text{Employee})$ this will give all the tuples that are matching the condition or the predicate Dept-ID = 2 from the Employee Relation (or table)
- Comparison operators: =, ≠, <, ≤, > and ≥.
- Connectives: AND (\wedge), OR (\vee) and NOT (\neg).

Example: Consider the instructor's table given below

INSTRUCTOR

ID	Name	Dept-Name	Salary
10101	Tanvi	Software Engineering	1525000
12121	George	Computer Science	900,000
25152	Steven	Cyber Security	450,000
26589	Tracy	Finance	700,000
12547	John	ISN	600,000
87488	Stella	IT	890,000
78711	Daniel	Computer Science	1200000
211000	Yannick	Cyber Security	550,000
12312	Vanessa	Finance	800,000
31231	George	Education	200,000
41410	Yul	Music	750,000

1) Write an RA expression to find all the instructors working in finance dep't

$\bar{O}_{Dept-Name} = "Finance" (INSTRUCTOR)$

Output: ID Name Dept-Name Salary

26589	Tracy	Finance	700,000
12312	Vanessa	Finance	800,000

2) Find all instructors with salary greater than 700,000 rs

$\bar{O}_{Salary > 700,000} (INSTRUCTOR)$

Output : Exercise

3) Find all instructors who are working in "Finance" department and drawing the salary greater than 700,000 rs

$\bar{O}_{Dept-Name = "Finance" \wedge Salary > 700000} (INSTRUCTOR)$

Output : Exercise

4) Find all the instructors drawing salary greater than 600,000 rs

5) Find all the instructors drawing salary between 800000 rs and 1500000 rs

6) Find all the instructors in the INSTRUCTOR relation

2. Project

- It returns its argument relation with ~~certain~~ attributes left out.
- It is a ~~many~~ operator
- It is denoted by the uppercase Greek letter π (Pi)
- Basically a relation is a set
- In the result, the ~~duplicated~~ rows are eliminated.
- Syntax: $\pi_{\text{Attribute}_1, \text{Attribute}_2, \dots} (\text{Relation})$

Example: Consider the INSTRUCTOR table we saw earlier

- 1) List all instructors' ID, name and salary but do not care about the dept-name

$\pi_{\text{ID}, \text{Name}, \text{Salary}} (\text{INSTRUCTOR})$

Output: Exercise

- 2) Find the name of all the instructors in the Computer Science department

$\pi_{\text{Name}} (\sigma_{\text{Dept-Name} = \text{"Computer Science}} (\text{INSTRUCTOR}))$

Output: ID Name Dept-Name Salary

12121	George	Computer Science	900000
78711	Daniel	Computer Science	1200000

Final Output: Name
George
Daniel

- 3) Find the name of the instructors with salary greater than 750,000frs
- 4) Give the ID of the instructors with salary less than 1000 000 frs
- 5) Give the ID and name of all the instructors in the finance department and earn at least 750,000 frs