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**Data and Database Management System**

**Module 9 - Relational Algebra and Relational Calculus**

**What is Relational Algebra?**

- Relational Algebra is a set of operations (like math formulas) that you can use to get data from a database. It uses tables (called relations) as input and gives a new table as output.
- Think of it like using a calculator for databases – instead of numbers, you're working with tables and data.
- It tells the steps to get the required data.
- It uses mathematical operations based on set theory and logic.
- The result of a query is also a table (relation).

**Key Characteristics:**

- Procedural: You must describe how to get the result.
- Works with tables (relations).
- Uses a small set of operations to filter and combine data.

**Basic Operations in Relational Algebra:**

Operation	Symbol	Description	Example
Select	$\sigma$	Picks rows that satisfy a condition	$\sigma(\text{age} > 18)(\text{Students}) \rightarrow$ Students older than 18
Project	$\pi$	Picks specific columns	$\pi(\text{name, age})(\text{Students})$
Union	$\cup$	Combines rows from two tables (no duplicates)	$A \cup B$
Set Difference	$-$	Rows in one table but not in the other	$A - B$
Cartesian Product	$\times$	Combines every row of one table with another	$A \times B$
Rename	$\rho$	Renames the result table	$\rho(S)(\text{Students})$

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Join	⋈	Combines rows from two tables using a condition	Students ⋈ Marks ON Students.id = Marks.id
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**Solved Example:**

Suppose you have a table named Students:

ID	Name	Age
1	Alice	18
2	Bob	17

Query: Get the names of students who are older than 17.

**Relational Algebra expression:**

$\pi(\text{Name})(\sigma(\text{Age} > 17)(\text{Students}))$

Explanation:

- First, select rows where Age > 17
- Then, project only the Name column from those rows

**What is Relational Calculus?**

Relational Calculus is a **non-procedural query language** used in relational databases. It focuses on **what** data is required, rather than how to retrieve it.

- It is based on **predicate logic**.
- It describes **conditions** that the result must satisfy.
- The system decides the best way to retrieve the data.

**Key Characteristics:**

- Non-Procedural: You describe **what** you want, not how to get it.
- Based on mathematical logic.
- Uses variables and logical expressions.

**Types of Relational Calculus:**

**1. Tuple Relational Calculus (TRC)**

- Uses tuple variables (entire rows).

○ Syntax:

$\{ t \mid \text{condition}(t) \}$

○ Example:

$\{ t \mid t \in \text{Students AND } t.\text{Age} > 18 \}$

→ This means: Get all tuples (rows) from the Students table where Age > 18.

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**2. Domain Relational Calculus (DRC)**

○ Uses domain variables (individual column values).

○ Syntax:

$\{ \langle x, y \rangle \mid \text{condition}(x, y) \}$

○ Example:

$\{ \langle \text{name}, \text{age} \rangle \mid \exists \text{id} (\text{Students}(\text{id}, \text{name}, \text{age}) \text{ AND } \text{age} > 18) \}$

→ This means: Get name and age of students whose age is greater than 18.

**Comparison Table: Relational Algebra vs Relational Calculus**

Feature	Relational Algebra	Relational Calculus
Language Type	Procedural	Non-Procedural
Focus	How to get the data	What data is needed
Based on	Set theory	Predicate logic
Result	A new table (relation)	A set of satisfying tuples
Common Use	Step-by-step query processing	Logical expression for desired output

**Assignment**

**Q1. Identify the Operation**

You have a table Students(ID, Name, Age).

Which relational algebra operation would you use to get only the names and ages of all students?

- A) Select
- B) Project
- C) Join
- D) Rename

**Q2. Write the Relational Algebra Expression**

Given:

Table: Students

ID	Name	Age
1	Riya	17
2	Kunal	19

**Question:** Get the names of students older than 18.

**Q3. What will the expression  $A \cup B$  do in relational algebra?**

- A) Select certain rows
- B) Combine all columns

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- C) Combine rows from tables A and B, removing duplicates
- D) Multiply rows from A and B

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