

Relational Database Management System

Prof. Manish Kumar Joshi, Assistant Professor,
Prof. Nishant P Khatri, Assistant Professor
Parul Institute Of Computer Application.



CHAPTER-5

Relational Algebra and calculus

Relational Algebra

Relational database systems are to be equipped with a query language that can assist its users to query the database instances. There are two types of query languages – relational algebra and relational calculus.

Relational algebra is a procedural query language, which takes instances of relations as input and instances of relations as output. It uses operators to perform queries. An operator can be either **unary** or **binary**. They accept relations as their input and relations as their output. It is performed recursively on a relation and intermediate results are also considered relations.

Relational Algebra

The fundamental operations of relational algebra are as shown below –

- Select
- Project
- Union
- Set different
- Cartesian product
- Rename

PU

Select Operation (σ)

It selects rows that satisfy the given predicate from a relation.

Notation – $\sigma_p(r)$

Where σ for selection predicate and r for relation. p is propositional logic formula which may use connect like **and**, **or**, and **not**. terms use relational operators like – $=$, \neq , \geq , $<$, $>$, \leq .

For example –

$\sigma_{\text{subject} = \text{"data"}}(\text{Books})$ **Output** – Selects rows from books where subject is 'data'.

$\sigma_{\text{subject} = \text{"data"} \text{ and } \text{price} = \text{"450"}}(\text{Books})$ **Output** – Selects tuples from books where subject is 'data' and 'price' is 450.

$\sigma_{\text{subject} = \text{"data"} \text{ and } \text{price} = \text{"450"} \text{ or } \text{year} > \text{"2010"}}(\text{Books})$ **Output** – Selects rows from books where subject is 'data' and 'price' is 450 or those books published after 2010.

Project Operation (Π)

- It projects column(s) that satisfied a given predicate.
- Notation – $\Pi_{A_1, A_2, A_n}(r)$
- Where A_1, A_2, A_n are attribute of relation r .
- Duplicate tuples are automatically eliminated, as relation is a set.
- **For example –**
- $\Pi_{\text{subject, author}}(\text{Books})$ Selects and projects columns named as subject and author from the relation Books.



Union Operation (\cup)

- It performs binary union within two given relations and is defined as $r \cup s = \{t \mid t \in r \text{ or } t \in s\}$ **Notation** – $r \cup s$
- Where r and s are database relations or relation result set temporary relation.
- For a union operation can be valid, the following conditions must hold – r , and s must have the same number of attributes.
- domains attributes must be compatible .
- Duplicate rows are automatically eliminated.
- $\Pi_{\text{author}}(\text{Books}) \cup \Pi_{\text{author}}(\text{Articles})$ **Output** – names of the authors who have written a book or an article or both.

Set Difference (–)

- The result of set difference operation is rows, which are present in one relation but are not in the second relation.
- **Notation** – $r - s$
- all the rows are present in r but not in s .
- $\Pi_{\text{author}}(\text{Books}) - \Pi_{\text{author}}(\text{Articles})$
- **Output** – Provides the name of authors who have written books but not written articles.



Cartesian Product (X)

- Combines information of different relations into one.
- **Notation** – $r \times s$
- Where **r** and **s** are relations and their output will be shown as $r \times s = \{ q \mid t \mid q \in r \text{ and } t \in s \}$
- $\sigma_{\text{author} = \text{'tutorialspoint'}}$ (Books X Articles) **Output** – a relation, which shows all the books and articles written by tutorialspoint.



Rename Operation (ρ)

- The results of relational algebra are relations but without any name. The rename operation allowed us to rename the output relation. 'rename' operation is denoted by small Greek **rho** ρ .
- **Notation** – $\rho_x(E)$
- Where the result of expression **E** is showed with name of **x**.
- Additional operations are –
- Set intersection
- Assignment
- Natural join

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