

# Relational Algebra

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- Relational algebra is a collection of operations used to manipulate relations (tables).
- Each Operator of relational algebra takes either one or two relations as its input and produces a new relation as its output.
- In Relational algebra, user has to specify what information is required from the database and what are the steps or procedures performed on the database to obtain the required information.

## Types of Relational Operators



(i) Traditional Set Operators

(ii) Special Operators

→ Union

→ Intersection

→ Difference

→ Cartesian Product

→ Selection

→ Projection

→ Join

→ Division

(i) Traditional Set Operators :-

These include Union, Intersection, Difference, Cartesian Product. All of these operations are binary operations which means that operation applies to pair of Relations.

(ii) Union :- The Union operations contains all the tuples that are either R1 or R2 or both.

→ It is denoted by  $\cup$ .

Example :-

| R1   |     |     | R2   |     |     |
|------|-----|-----|------|-----|-----|
| Name | Age | Sex | Name | Age | Sex |
| A    | 20  | M   | D    | 20  | F   |
| C    | 21  | M   | A    | 20  | M   |
| B    | 21  | F   | E    | 21  | F   |

$R3 = R1 \cup R2$

| NAME | AGE | SEX |
|------|-----|-----|
| A    | 20  | M   |
| C    | 21  | M   |
| B    | 21  | F   |
| D    | 20  | F   |
| E    | 21  | F   |

(2) Intersection:- The intersection operations contains all tuples that are both in R1 and R2.

→ It is denoted by intersection  $\cap$ .

→ Notation:  $R1 \cap R2$ .

Example

| R1   |     |     | R2   |     |     |
|------|-----|-----|------|-----|-----|
| Name | Age | Sex | Name | Age | Sex |
| A    | 20  | M   | D    | 20  | F   |
| C    | 21  | M   | A    | 20  | M   |
| B    | 21  | F   | E    | 21  | F   |

$R3 = R1 \cap R2$

| Name | Age | Sex |
|------|-----|-----|
| A    | 20  | M   |

(3) Difference:- The difference between two relations between R1 and R2 ( $R1$  MINUS  $R2$ ), is the set of all records or tuples belongs to R1 and not to R2.

→ It is denoted by minus (-).

→ Notation:  $R1 - R2$

Example -

R1

R2

| Name | AGE | Sex |
|------|-----|-----|
| A    | 20  | M   |
| C    | 21  | M   |
| B    | 21  | F   |

| Name | AGE | SEX |
|------|-----|-----|
| D    | 20  | F   |
| A    | 20  | M   |
| E    | 21  | F   |

$R3 = R1 - R2$

| Name | AGE | Sex |
|------|-----|-----|
| C    | 21  | M   |
| B    | 21  | F   |

(IV) Cartesian Product :- The Cartesian Product is used to combine each row in one table with each row in the other table.

→ It is also known as cross product.

→ It is denoted by X.

Example:

R1 =

| Name | Age | Sex |
|------|-----|-----|
| A    | 20  | M   |
| C    | 21  | M   |

R2 =

| Name | Age | Sex |
|------|-----|-----|
| D    | 20  | F   |
| E    | 21  | F   |

$R3 = R1 \times R2$

| Name | Age | Sex | Name | Age | Sex |
|------|-----|-----|------|-----|-----|
| A    | 20  | M   | D    | 20  | F   |
| C    | 21  | M   | D    | 20  | F   |
| A    | 20  | M   | E    | 21  | F   |
| C    | 21  | M   | E    | 21  | F   |

## (2) Special Operators :-

The special relational operators are :-

- (i) Selection (Unary Operation)
- (ii) Projection (Unary Operation)
- (iii) Join
- (iv) Division

(i) Selection :- The select operation selects a subset of tuples or records from a relation.

→ It is Unary operator.

→ It is denoted by sigma ( $\sigma$ ).

→ Notation :-  $\sigma \langle \text{select condition} \rangle \langle \text{relation} \rangle$

Example R

| Name | Age | Sex |
|------|-----|-----|
| A    | 20  | M   |
| M    | 21  | F   |
| B    | 20  | F   |
| F    | 19  | M   |
| A    | 20  | F   |
| R    | 21  | F   |
| C    | 21  | M   |

$R_1 = \sigma (\text{Age} = 20) (R)$

| Name | Age | Sex |
|------|-----|-----|
| A    | 20  | M   |
| B    | 20  | F   |
| A    | 20  | F   |

(iii) Projection :- It contains a subset of columns of a table and eliminates any duplicate rows that may result.

→ It is a Unary operation.

→ Notation :-  $\langle \text{attribute list} \rangle (\text{relation})$

Example:

$R_1 = \pi (\text{Name, Sex}) (R)$

| Name | Age | Sex |
|------|-----|-----|
| A    | 20  | M   |
| M    | 21  | F   |
| B    | 20  | F   |
| F    | 19  | M   |
| A    | 20  | F   |

| Name | Sex |
|------|-----|
| A    | M   |
| M    | F   |
| B    | F   |
| F    | M   |
| A    | F   |

(iii) Join :- The Join operation concatenates two relations based on a joining condition.

→ It is denoted by a join symbol ( $\bowtie$ )

→ Notation :-

$R \bowtie \langle \text{join condition} \rangle S$

R1

R2

| FirstName | LastName |
|-----------|----------|
| A         | Mary     |
| B         | John     |
| C         | Ann      |

| LastName | Sex |
|----------|-----|
| Ann      | F   |
| John     | M   |
| Mary     | F   |
| Bill     | M   |

$R3 = R1 (LastName = LastName) R2$

| FirstName | LastName | LastName | Sex |
|-----------|----------|----------|-----|
| A         | Mary     | Mary     | F   |
| B         | John     | John     | M   |
| C         | Ann      | Ann      | F   |

(IV) Division: The division operator divides a relation  $R1$  of degree  $(n+m)$  by a relation  $R2$  of degree  $m$  and produces a relation of degree  $n$ .

→ The formal notation for a division operation is  $\div$ .

| Name | Sex |
|------|-----|
| A    | M   |
| B    | F   |
| A    | F   |
| C    | F   |
| D    | M   |
| C    | M   |

| Sex |
|-----|
| M   |
| F   |

$R3 = R1 \div R2$

| Name |
|------|
| A    |
| C    |