Relational Algebra Operations
Set Operators

Set Operators

- Set operators **combine the results of two or more queries** into a single result.

Three types of Set Operators

Sr.	Set Operators	Symbol
1.	Union	U
2.	Intersect / Intersection	∩
3.	Minus / Set difference	−

Conditions Set operators will take two or more queries as input, which must be union-compatible.

- Both queries should have **same (equal) number of columns**
- Corresponding **attributes should have the same data type** or **domain**

Conditions to perform Set Operators

Conditions-1 Both queries should have same (equal) number of columns.

Student

RNo	Name	Dept	SPI
101	Raj	CE	8
102	Meet	ME	9
103	Jay	CE	9

Faculty

FId	Name	Dept
101	Patel	CE
102	Shah	ME
103	Dave	ME

Student

RNo	Name	Dept
101	Raj	CE
102	Meet	ME
103	Jay	CE

Faculty

FId	Name	Dept
101	Patel	CE
102	Shah	ME
103	Dave	ME

Conditions-2 Corresponding attributes should have the same data type.

Student

RNo	Name	Dept	SPI
101	Raj	CE	8
102	Meet	ME	9
103	Jay	CE	9

Faculty

FId	Name	Dept	Sub
101	Patel	CE	DS
102	Shah	ME	DBMS
103	Dave	ME	DF

Student

RNo	Name	Dept	SPI
101	Raj	CE	8
102	Meet	ME	9
103	Jay	CE	9

Faculty

FId	Name	Dept	Exp
101	Patel	CE	5
102	Shah	ME	3
103	Dave	ME	4

Set Operators [Exercise]

Exercise Check whether following tables are compatible or not:

- A: (First_name(char), Last_name(char), Date_of_Birth(date))
- B: (FName(char), LName(char), PhoneNumber(number))

X (Not compatible) Both tables have 3 attributes but **third attributes datatype is different**.

- A: (First_name(char), Last_name(char), Date_of_Birth(date))
- B: (FName(char), LName(char), DOB(date))

✓ (Compatible) Both tables have 3 attributes and of same data type.

- Person (PersonID, Name, Address, Hobby)
- Professor (ProfessorID, Name, OfficeAddress, Salary)
- (Not compatible) Both tables have 4 attributes but **forth attributes datatype is different**.

$\prod_{Name,\ Address}$ (Person) & $\prod_{Name,\ OfficeAddress}$ (Professor)

- (Compatible) Both tables have 2 attributes and of same data type.

Union Operator

- Symbol: U
- Notation: *Relation-1 (R1)* U *Relation-2 (R2)* **OR** *Algebra-1* U *Algebra-2*
- Operation:
  - It displays all the tuples/records belonging to the first relation (left relation) or the second relation (right relation) or both.
  - It also eliminates duplicate tuples (tuples present in both relations appear once).

Example Perform Union between Customer and Employee.

Answer (Customer) **U** (Employee)

Customer

Name
Raju
Suresh
Meet

Employee

Name
Meet
Suresh
Manoj

Output

Name
Manoj
Meet
Raju
Suresh

Exercise Is there any difference in the output if we swap the tables in Union operator. (Employee) **U** (Customer)

Intersect/ Intersection Operator

- Symbol: ∩
- Notation: *Relation-1 (R1)* ∩ *Relation-2 (R2)* **OR** *Algebra-1* ∩ *Algebra-2*
- Operation:
  - It displays all the tuples/records belonging to both relations. OR
  - It displays all the tuples/records which are common from both relations.

Example Perform Intersection between Customer and Employee. **Answer** (Customer) ∩ (Employee)

Customer

Name
Raju
Suresh
Meet

Employee

Name
Meet
Suresh
Manoj

Output

Name
Meet
Suresh

Exercise Is there any difference in the output if we swap the tables in Intersection. (Employee) ∩ (Customer)

Minus/ Set difference Operator

- Symbol: −
- Notation: *Relation-1 (R1)* − *Relation-2 (R2)* **OR** *Algebra-1* − *Algebra-2*
- Operation:
  - It displays all the tuples/records belonging to the first relation (left relation) but not in the second relation (right relation).

Example Perform Set difference between Customer and Employee. **Answer** (Customer) − (Employee)

Customer

Name
Raju
Suresh
Meet

Employee

Name
Meet
Suresh
Manoj

Output

Name
Raju

Exercise Is there any difference in the output if we swap the tables in Set difference. (Employee) − (Customer).

Union Operators Example

Example Display Name of person who are either employee or customer.

Customer

ID	Name	Balance
1	Raju	10000
2	Suresh	20000

Employee

ID	Name	Dept	Salary
2	Suresh	CE	8000
3	Manoj	ME	9000

Answer $\prod_{Name}$ (Customer) **U** $\prod_{Name}$ (Employee)

Output

Name
Manoj
Raju
Suresh

Intersect/ Intersection Operators Example

Example Display Name of person who are employee as well as customer.

Customer

ID	Name	Balance
1	Raju	10000
2	Suresh	20000

Employee

ID	Name	Dept	Salary
2	Suresh	CE	8000
3	Manoj	ME	9000

Answer $\prod_{Name}(\text{Customer}) \cap \prod_{Name}(\text{Employee})$

Output

Name
Suresh

Minus/ Set difference Operators Example

Example Display Name of person who are employee but not customer.

Customer

ID	Name	Balance
1	Raju	10000
2	Suresh	20000

Employee

ID	Name	Dept	Salary
2	Suresh	CE	8000
3	Manoj	ME	9000

Answer $\prod_{Name}(\text{Employee}) - \prod_{Name}(\text{Customer})$

Output

Name
Manoj

Minus/ Set difference Operators Example

Example Display Name of person who are customer but not employee.

Customer

ID	Name	Balance
1	Raju	10000
2	Suresh	20000

Employee

ID	Name	Dept	Salary
2	Suresh	CE	8000
3	Manoj	ME	9000

Answer $\prod_{Name}$ (Customer) − $\prod_{Name}$ (Employee)

Output

Name
Raju

Set Operators [Exercise]

Exercise What is the output of following relational algebra for the below mentioned tables:

Customer

ID	Name	Balance
1	Raju	10000
2	Suresh	20000

Employee

ID	Name	Dept	Salary
2	Suresh	CE	8000
3	Manoj	ME	9000

Algebra-1 $\prod_{ID, Name}$ (Customer) **U** $\prod_{ID, Name}$ (Employee)

Algebra-2 $\prod_{ID, Name, Balance}$ (Customer) **U** $\prod_{ID, Name, Salary}$ (Employee)

Algebra-3 $\prod_{ID, Name}$ (Customer) ∩ $\prod_{ID, Name}$ (Employee)

Algebra-4 $\prod_{ID, Name, Balance}$ (Customer) ∩ $\prod_{ID, Name, Salary}$ (Employee)

Set Operators [Exercise]

Exercise What is the output of following relational algebra for the below mentioned tables:

Customer

ID	Name	Balance
1	Raju	10000
2	Suresh	20000

Employee

ID	Name	Dept	Salary
2	Suresh	CE	8000
3	Manoj	ME	9000

Algebra-1 $\prod_{ID,\ Name}(\text{Customer}) - \prod_{ID,\ Name}(\text{Employee})$

Algebra-2 $\prod_{ID,\ Name,\ Balance}(\text{Customer}) - \prod_{ID,\ Name,\ Salary}(\text{Employee})$

Algebra-3 $\prod_{ID,\ Name}(\text{Employee}) - \prod_{ID,\ Name}(\text{Customer})$

Algebra-4 $\prod_{ID,\ Name,\ Balance}(\text{Employee}) - \prod_{ID,\ Name,\ Salary}(\text{Customer})$

Relational Algebra Operations

Division Operator

Division Operator

- Symbol: ÷ (Division)
- Notation: *Relation1 (R1)* ÷ *Relation2 (R2)* **OR** *Algebra1* ÷ *Algebra2*
- Condition:
  - Attributes of relation2/algebra2 must be a proper subset of attributes of relation1/algebra1.
- Operation:
  - The output of the division operator will have attributes =

    All attributes of relation1 – All attributes of relation2
  - The output of the division operator will have tuples =

    Tuples in relation1, which are associated with the all tuples of relation2.

Division Operator Example

Example Perform Division operation between Student and Subject.

Student

Name	Subject
Raj	DBMS
Raj	DS
Meet	DS
Meet	DF
Rohit	DBMS
Rohit	DS
Rohit	DF
Suresh	DBMS
Suresh	DF
Suresh	DS

Subject

Subject
DBMS
DS
DF

Answer (Student) ÷ (Subject)

Output

Name
Rohit
Suresh

Division Operator Example

A

Sno	PNo
S1	P1
S1	P2
S1	P3
S1	P4
S2	P1
S2	P2
S3	P2
S4	P2
S4	P4
S5	P4

B1

PNo
P2

Algebra (A) ÷ (B1)

Output

SNo
S1
S2
S3
S4

B2

PNo
P2
P4

Algebra (A) ÷ (B2)

Output

SNo
S1
S4

B3

PNo
P1
P2
P4

Algebra (A) ÷ (B3)

Output

SNo
S1

B4

PNo
P2
P5

Algebra (A) ÷ (B4)

Output

SNo

Division Operator Example

Example List the name of students doing a project in all technologies.

Student

RNo	Name	Technology
101	Raj	.NET
101	Raj	PHP
102	Meet	.NET
102	Meet	PHP
102	Meet	iPhone
102	Meet	Android
103	Rohit	Android
104	Suresh	.NET
104	Suresh	iPhone
104	Suresh	Android

Project

TID	Technology
1	.NET
2	PHP
3	Android
4	iPhone

Answer $\prod_{Name,\ Technology}(Student) \div \prod_{Technology}(Project)$

Output

Name
Meet

Relational Algebra Operations

Rename Operator

Rename Operator

- Symbol: ρ (Rho)
- Notation: $\rho_{A\,(X1,X2....Xn)}$ (Relation)
- Operation:
  - The rename operation is used to **rename the output relation**.
  - The result of rename operator are also relations with new name.
  - The **original relation name can not be changed** when we perform rename operation on any relation.
- How to use:
  - $\rho_{x}(E)$
    Returns a relation E under a new name X.
  - $\rho_{A1, A2. \ldots, An}(E)$
    Returns a relation E with the attributes renamed to A1, A2, …., An.
  - $\rho_{x(A1, A2. \ldots, An)}(E)$
    Returns a relation E under a new name X with the attributes renamed to A1, A2, …., An.
- Reasons to rename a relation can be many, like –
- We may want to save the result of a relational algebra expression as a relation so that we can use it later.
- We may want to join a relation with itself, in that case, it becomes too confusing to specify which one of the tables we are talking about, in that case, we rename one of the tables and perform join operations on them.

Rename Operator Example

Example Rename table

Student

RNo	Name	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Algebra ρ_{Person} (Student)

Person

RNo	Name	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Example Rename attributes

Student

Rno	Name	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Algebra $\rho_{(RollNo,\ StudentName,\ SPI)}$ (Student)

Student

RollNo	StudentName	SPI
101	Raj	8
102	Meet	9
103	Jay	7

Rename Operator Example

Example Rename table and attributes both

Student

Rno	Name	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Algebra $\rho_{Person\ (RollNo,\ StudentName)}\ (\prod_{RNo,\ Name}\ (Student))$

Person

RollNo	StudentName
101	Raj
102	Meet
103	Jay

Example Rename particular attributes

Student

Rno	Name	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Algebra $\rho_{StudentName\ /\ Name}\ (Student)$

Student

Rno	StudentName	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Rename Operator Example

Example Find out maximum CPI from student table.

Student

Rno	Name	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Step-1 ρ_A (Student) X ρ_B (Student)

Output-1

A.Rno	A.Name	A.CPI	B.Rno	B.Name	B.CPI
101	Raj	8	101	Raj	8
101	Raj	8	102	Meet	9
101	Raj	8	103	Jay	7
102	Meet	9	101	Raj	8
102	Meet	9	102	Meet	9
102	Meet	9	103	Jay	7
103	Jay	7	101	Raj	8
103	Jay	7	102	Meet	9
103	Jay	7	103	Jay	7

Step-2 $\sigma_{A.CPI<B.CPI}$ (ρ_A (Student) X ρ_B (Student))

Output-2

A.Rno	A.Name	A.CPI	B.Rno	B.Name	B.CPI
101	Raj	8	102	Meet	9
103	Jay	7	101	Raj	8
103	Jay	7	102	Meet	9

Rename Operator Example

Example Find out maximum CPI from student table.

Student

Rno	Name	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Step-3 $\prod_{A.CPI} (\sigma_{A.CPI<B.CPI} (\rho_A (Student) \ X \ \rho_B (Student)))$

Output-

A.CPI
8
7

Step-2 $\sigma_{A.CPI<B.CPI} (\rho_A (Student) \ X \ \rho_B (Student))$

Output-

A.Rno	A.Name	A.CPI	B.Rno	B.Name	B.CPI
101	Raj	8	102	Meet	9
103	Jay	7	101	Raj	8
103	Jay	7	102	Meet	9

Rename Operator Example

Example Find out maximum CPI from student table.

Student

Rno	Name	CPI
101	Raj	8
102	Meet	9
103	Jay	7

Step-3 $\prod_{A.CPI} (\sigma_{A.CPI<B.CPI} (\rho_A (Student) \ X \ \rho_B (Student)))$

Output-

A.CPI
8
7

Step-4 $\prod_{CPI} (Student) - \prod_{A.CPI} (\sigma_{A.CPI<B.CPI} (\rho_A (Student) \ X \ \rho_B (Student)))$

Stude

CPI
8
9
7

−

Output-

A.CPI
8
7

=

Output

CPI
9

Relational Algebra Operations

Aggregate Functions

Aggregate Functions

- Symbol: *g* or G
- Notation: $g_{\textit{function-name(column), function-name(column), …, function-name(column)}}$ (Relation)
- Operation:
  - It **takes a more than one value** as input and **returns a single value** as output (result).
- Aggregate functions are:
  - Sum (It **returns the sum (addition)** of the values of a column.)
  - Max (It **returns the maximum** value for a column.)
  - Min (It **returns the minimum** value for a column.)
  - Avg (It **returns the average** of the values for a column.)
  - Count (It **returns total number** of values in a given column.)

Aggregate Functions Example

Student

Rno	Name	Branch	Semester	CPI
101	Ramesh	CE	3	9
102	Mahesh	EC	3	8
103	Suresh	ME	4	7
104	Amit	EE	4	8
105	Anita	CE	4	8
106	Reeta	ME	3	7
107	Rohit	EE	4	9
108	Chetan	CE	3	8
109	Rakesh	CE	4	9

Example Find out sum of CPI of all students.

Answer $g_{sum(CPI)}$ (Student)

Output

sum
73

Example Find out maximum & minimum CPI.

Answer $g_{max(CPI),\ min(CPI)}$ (Student)

Output

max	min
9	7

Example Count the number of students.

Answer $g_{count(Rno)}$ (Student)

Output

count
9

Example Find out average of CPI of all students.

Answer $g_{avg(CPI)}$ (Student)

Output

avg
8.11

Relational Algebra [Exercise]

- Write down relational algebras for the following table:
  - Employee (person-name, street, city)
  - Works (person-name, company-name, salary)
  - Company (company-name, city)
  - Managers (person-name, manager-name)
- Find the names of all employees who work for “TCS”.
- Find the names and cities of residence of all employees who work for “Infosys”.
- Find the names, street and city of residence of all employees who work for “ITC” and earn more than $10,000 per annum.
- Find the names of all employees in this database who live in the same city as the company for which they work.
- Find the names of all employees working in “TCS” who earn more than 25000 and less than 40000.
- Find the name of employee whose manager is “Ajay Patel” and salary is more than 50000.
- Display the name of employee with street, city, company name, salary and manager name staying in “Rajkot” and working in “Ahmedabad”.
- Find maximum, minimum and average salary of all employee.
- Find out the total number of employee.