

UNIT 2

Lecture 11

Relational Algebra

Relational Languages

- Relational Algebra
 - It is an procedural language.
- Relational Calculus
 - It is an non procedural language.

Operations of Relational Algebra

1. Select (σ)
2. Project (π)
3. Union ($R \cup S$)
4. Intersection ($R \cap S$)
5. Set Difference ($R - S$)
6. Cross Product ($R \times S$)
7. Theta Join ($R \bowtie_{\theta_c} S$)
8. Natural Join ($R \bowtie S$)
9. Outer Join ($R = \bowtie = S$)
10. Rename Operation (ρ)
11. Division Operation ($R \div S$)

Select Operator (σ)

1. Syntax :

$\sigma_{\text{condition}} (R)$

2. Where condition can be $<$, $>$, \leq , \geq , $=$, \neq .

3. Logical Operators : and (\wedge), or (\vee), not (\neg)

4. Equivalent sql query is

SQL > select * from R where cond;

Select Example : 1

Display all the information of students whose branch is CSE.

RA : $\sigma_{\text{branch} = \text{"CSE"}}$ (STUDENT)

SQL > select * from student where br = 'CSE';

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123

Select Example : 2

Display all the information of students whose sem is 3.

RA : $\sigma_{\text{sem} = 3}$ (STUDENT)

SQL > select * from student where sem = 3;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

Select Example : 3

Display all the information of students whose marks is greater than 50.

RA : $\sigma_{\text{marks} > 50}$ (STUDENT)

SQL > select * from student where marks > 50;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
6	PINKI	3	ETC	90	123

Select Example : 4

Display all the information of students whose marks is greater than or equal to 50.

RA : $\sigma_{\text{marks} \geq 50}(\text{STUDENT})$

SQL > select * from student where marks >= 50;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
6	PINKI	3	ETC	90	123

Select Example : 5

Display all the information of students who are not from CSE branch.

RA : $\sigma_{\text{branch} \neq \text{"CSE"}} (\text{STUDENT})$ or RA : $\sigma_{\neg \text{branch} = \text{"CSE"}} (\text{STUDENT})$

SQL > select * from student where branch <> 'CSE'; or

SQL > select * from student where not branch = 'CSE';

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
6	PINKI	3	ETC	90	123

Select Example : 6

Display all the information of students whose branch is CSE and sem is 3.

RA : $\sigma_{\text{branch} = \text{"CSE"} \vee \text{sem} = 3}(\text{STUDENT})$

SQL > select * from student where branch = 'CSE' or sem = 3;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

Select Example : 7

Display all the information of students whose branch is CSE and sem is 3.

RA : $\sigma_{\text{branch} = \text{"CSE"} \wedge \text{sem} = 3} (\text{STUDENT})$

SQL > select * from student where branch = 'CSE' and sem = 3;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121

Select Example : 7 (Continued)

Display all the information of students whose branch is CSE and sem is 3.

RA : $\sigma_{\text{branch} = \text{"CSE"}} (\sigma_{\text{sem} = 3} (\text{STUDENT}))$ or

RA : $\sigma_{\text{sem} = 3} (\sigma_{\text{branch} = \text{"CSE"}} (\text{STUDENT}))$

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121

Select Rule

$$\sigma_{c1}(\sigma_{c2}(R)) \equiv \sigma_{c2}(\sigma_{c1}(R)) \equiv \sigma_{c1 \wedge c2}(R)$$

Where c1 and c2 are two conditions on R

Project Operator (Π)

1. Syntax :

$\Pi_{\text{col1, col2,}} (R)$

2. Where col1, col2, can be column names of R.

3. Equivalent sql query is

SQL > select distinct col1, col2, from R;

Project Example : 1

Display the names of all the students.

RA : Π_{sname} (STUDENT)

SQL > select distinct sname from student;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Sname
RAM
SHYAM
MOHAN
GOPAL
RINKI
PINKI

Project Example : 2

Display the semester value of all the students.

RA : Π_{sem} (STUDENT)

SQL > select distinct sem from student;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Sem
3
5
7

Project Example : 3

Display the name and semester value of all the students.

RA : $\Pi_{\text{sname, sem}}$ (STUDENT)

SQL > select distinct sname, sem from student;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Sname	Sem
RAM	3
SHYAM	5
MOHAN	7
GOPAL	5
RINKI	3
PINKI	3

Project Example : 4

Display the name of all the students.

RA : $\Pi_{\text{sname}}(\Pi_{\text{sname}, \text{sem}}(\text{STUDENT}))$

SQL > select distinct sname from (select distinct sname, sem from student);

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

Intermediate OUTPUT

Sname	Sem
RAM	3
SHYAM	5
MOHAN	7
GOPAL	5
RINKI	3
PINKI	3

OUTPUT

Sname
RAM
SHYAM
MOHAN
GOPAL
RINKI
PINKI

Project Rule

$$\pi_{\text{sname}}(\pi_{\text{sname, sem}}(\text{STUDENT})) \equiv \pi_{\text{sname}}(\text{STUDENT})$$

$$\pi_{\text{sname}}(\pi_{\text{sem}}(\text{STUDENT})) \not\equiv \pi_{\text{sname}}(\text{STUDENT})$$

$$\pi_{\text{col1}}(\pi_{\text{col2}}(R)) \equiv \pi_{\text{col1}}(R)$$

If and only if $\text{col1} \subseteq \text{col2}$

Select & Project Example : 1

Display the name of all the students of CSE branch.

RA : $\Pi_{\text{sname}}(\sigma_{\text{branch} = \text{"CSE"}}(\text{STUDENT}))$

SQL > select distinct sname from (select * from student where branch = 'CSE');

Or SQL > select distinct sname from student where branch = 'CSE';

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

OUTPUT

Sname
RAM
SHYAM
MOHAN

Select & Project Example : 1

Display the name of all the students of CSE branch.

RA : $\sigma_{\text{branch} = \text{"CSE"}} (\pi_{\text{sname}}(\text{STUDENT}))$

SQL > select * from (select distinct sname from student) where branch = 'CSE';

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

Intermediate OUTPUT

Sname
RAM
SHYAM
MOHAN
GOPAL
RINKI
PINKI

OUTPUT

Wrong Query

Select & Project Example : 2

Display the branch value of all the students of CSE branch.

RA : $\Pi_{\text{branch}} (\sigma_{\text{branch} = \text{"CSE"}} (\text{STUDENT}))$

SQL > select distinct branch from (select * from student where branch = 'CSE');

Or SQL > select distinct branch from student where branch = 'CSE';

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

Intermediate OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123

OUTPUT

Branch
CSE

Select & Project Example : 2

Display the branch value of all the students of CSE branch.

RA : $\sigma_{\text{branch} = \text{"CSE"}} (\pi_{\text{branch}}(\text{STUDENT}))$

SQL > select * from (select distinct branch from student) where branch = 'CSE';

Or SQL > select distinct branch from student where branch = 'CSE';

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

Intermediate OUTPUT

Branch
CSE
IT
MECH
ETC

OUTPUT

Branch
CSE

Select & Project Example : 3

Display the name and marks of those students whose marks is greater than 50.

RA : $\Pi_{\text{sname, marks}} (\sigma_{\text{marks} > 50} (\text{STUDENT}))$

SQL > select distinct sname, marks from (select * from student where marks > 50);

Or SQL > select distinct sname, marks from student where marks > 50;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

Intermediate OUTPUT

Rollno	Sname	Sem	Branch	Marks	Pno
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
6	PINKI	3	ETC	90	123

OUTPUT

Sname	Marks
MOHAN	55
GOPAL	65
PINKI	90

Select & Project Example : 3

Display the name and marks of those students whose marks is greater than 50.

RA : $\sigma_{\text{marks} > 50} (\pi_{\text{sname}, \text{marks}} (\text{STUDENT}))$

SQL > select * from (select distinct sname, marks from student) where marks > 50;

Or SQL > select distinct sname, marks from student where marks > 50;

STUDENT

Rollno	Sname	Sem	Branch	Marks	Pno
1	RAM	3	CSE	40	121
2	SHYAM	5	CSE	50	122
3	MOHAN	7	CSE	55	123
4	GOPAL	5	IT	65	121
5	RINKI	3	MECH	40	122
6	PINKI	3	ETC	90	123

Intermediate OUTPUT

Sname	Marks
RAM	40
SHYAM	50
MOHAN	55
GOPAL	65
RINKI	40
PINKI	90

OUTPUT

Sname	Marks
MOHAN	55
GOPAL	65
PINKI	90

GATE Questions

Select operation in SQL is equivalent to

- A. the selection operation in relational algebra
- B. the selection operation in relational algebra, except that SELECT in SQL retains duplicates
- C. the projection operation in relational algebra
- D. the projection operation in relational algebra, except that SELECT in SQL retains duplicates

[GATE 2015]

GATE Questions

What is the optimized version of the relation algebra expression

$$\Pi_{A1} (\Pi_{A2} (\sigma_{F1} (\sigma_{F2} (r)))) ,$$

where $A1, A2$ are sets of attributes in with $A1 \subset A2$ and $F1, F2$ are Boolean expressions based on the attributes in r ?

- (A) $\Pi_{A1} (\sigma_{(F1 \wedge F2)} (r))$
- (B) $\Pi_{A1} (\sigma_{(F1 \vee F2)} (r))$
- (C) $\Pi_{A2} (\sigma_{(F1 \wedge F2)} (r))$
- (D) $\Pi_{A2} (\sigma_{(F1 \vee F2)} (r))$

[GATE 2014]

University Questions

1. Explain codd's 12 rules for RDBMS.
2. Explain the difference between DBMS and RDBMS.

For Video lecture on this topic please subscribe to my youtube channel.

The link for my youtube channel is

https://www.youtube.com/channel/UCRWGtE76JITp1iim6aOTRuW?sub_confirmation=1