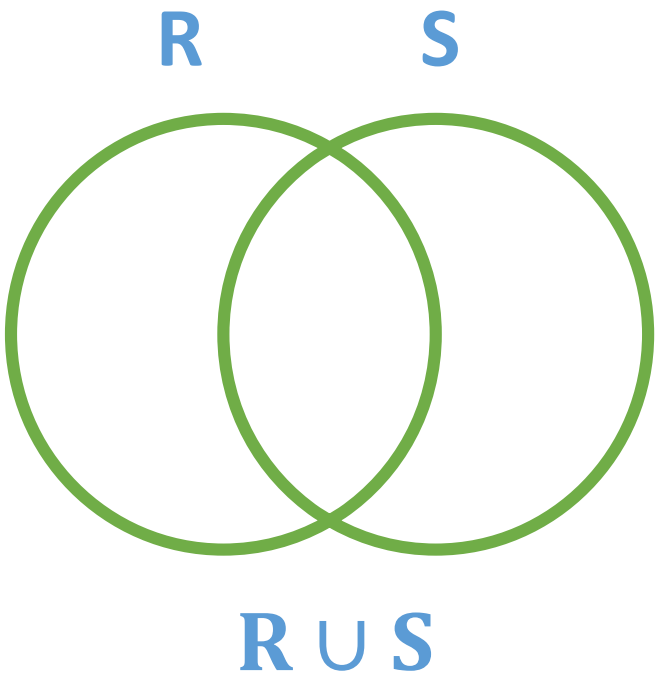
UNIT 2

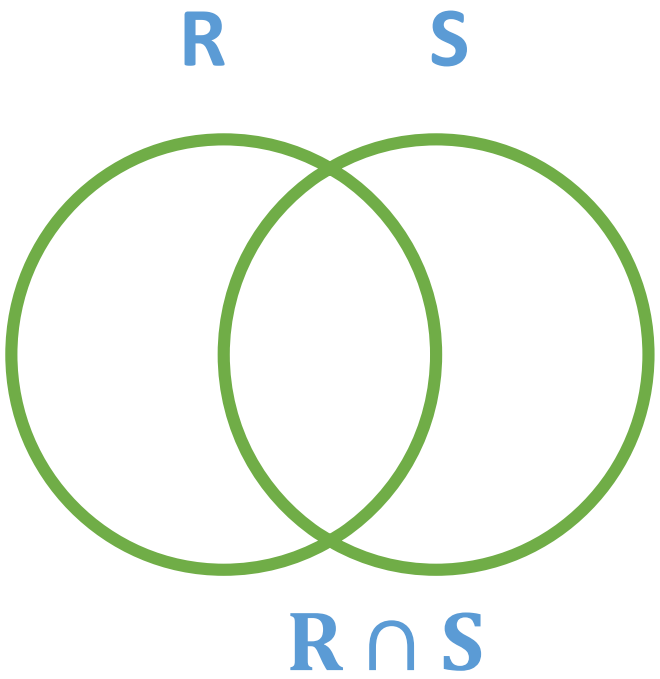
Lecture 16

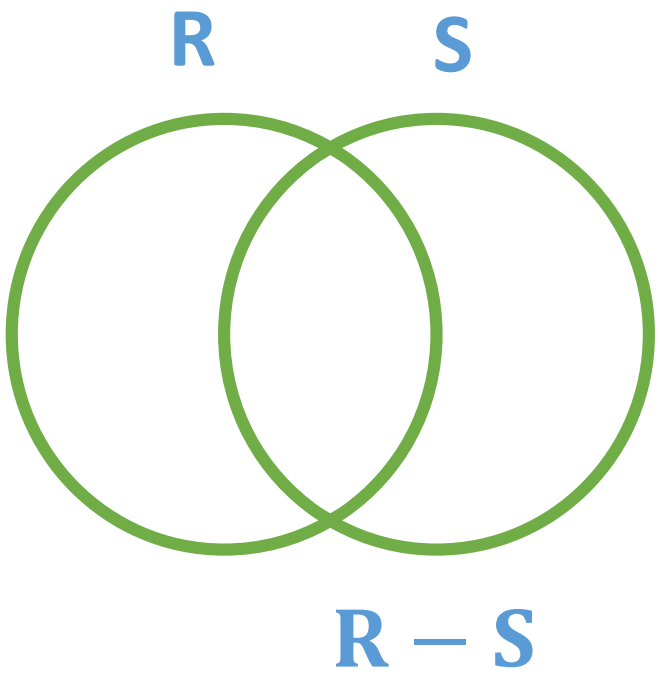
Relational Algebra

Set Operations

- Union ($\mathbf{R \cup S}$)
- Intersection ($\mathbf{R \cap S}$)
- Set difference ($\mathbf{R - S}$)







Set Operations

R

A	B
1	2
3	4

S

A	B
1	2
5	6

$R \cup S$

A	B
1	2
3	4
5	6

$R \cap S$

A	B
1	2

$R - S$

A	B
3	4

$S - R$

A	B
5	6

Relations must have union compatible

1. They have same number of columns.
2. Their domains should be same.

$$R \cup S \equiv S \cup R$$

$$R \cap S \equiv S \cap R$$

$$R - S \not\equiv S - R$$

Union

R

A	B
1	2
3	4

S

A	B
1	2
5	6

$R \cup S$

A	B
1	2
3	4
5	6

$R \cap S$

A	B
1	2

$R - S$

A	B
3	4

$S - R$

A	B
5	6

Equivalent SQL Queries

Select * from R

union

Select * from S;

$OUTPUT$

A	B
1	2
3	4
5	6

Union all in SQL

R

A	B
1	2
3	4

S

A	B
1	2
5	6

$R \cup S$

A	B
1	2
3	4
5	6

$R \cap S$

A	B
1	2

$R - S$

A	B
3	4

$S - R$

A	B
5	6

Equivalent SQL Queries

Select * from R

union all

Select * from S;

$OUTPUT$

A	B
1	2
3	4
1	2
5	6

Intersect

R

A	B
1	2
3	4

S

A	B
1	2
5	6

$R \cup S$

A	B
1	2
3	4
5	6

$R \cap S$

A	B
1	2

$R - S$

A	B
3	4

$S - R$

A	B
5	6

Equivalent SQL Queries

Select * from R

intersect

Select * from S;

$OUTPUT$

A	B
1	2

Set Difference (minus in oracle SQL)

R

A	B
1	2
3	4

S

A	B
1	2
5	6

$R \cup S$

A	B
1	2
3	4
5	6

$R \cap S$

A	B
1	2

$R - S$

A	B
3	4

$S - R$

A	B
5	6

Equivalent SQL Queries

Select * from R

minus / except

Select * from S;

$OUTPUT$

A	B
3	4

Set Difference (minus in oracle SQL)

R

A	B
1	2
3	4

S

A	B
1	2
5	6

$R \cup S$

A	B
1	2
3	4
5	6

$R \cap S$

A	B
1	2

$R - S$

A	B
3	4

$S - R$

A	B
5	6

Equivalent SQL Queries

Select * from S

minus / except

Select * from R;

$OUTPUT$

A	B
5	6

Example : 1

Display the name of branches in which project 121 or 122 or both are running.

RA : $\Pi_{branch}(\sigma_{pno = 121}(STUDENT)) \cup \Pi_{branch}(\sigma_{pno = 122}(STUDENT))$

```
SQL > select distinct branch from student where pno = 121
      Union
      select distinct branch from student where pno = 122;
```

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

Branch
CSE
IT

Branch
CSE
MECH

OUTPUT

Branch
CSE
IT
MECH

Example : 1

Display the name of branches in which project 121 or 122 or both are running.

RA : $\Pi_{branch}(\sigma_{pno = 121 \vee pno=122}(STUDENT))$

SQL > select distinct branch from student where pno = 121 or pno = 122;

or

SQL > select distinct branch from student where pno in (121, 122);

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

Branch
CSE
IT
MECH

Example : 2

Display the name of branches in which project 121 and 122 are running.

RA : $\Pi_{branch}(\sigma_{pno = 121}(STUDENT)) \cap \Pi_{branch}(\sigma_{pno = 122}(STUDENT))$

```
SQL > select distinct branch from student where pno = 121
      intersect
      select distinct branch from student where pno = 122;
```

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

Branch
CSE
IT

Branch
CSE
MECH

OUTPUT

Branch
CSE

Example : 2 (Wrong query)

Display the name of branches in which project 121 and 122 are running.

RA : $\Pi_{branch}(\sigma_{pno = 121 \wedge pno=122}(STUDENT))$

SQL > select distinct branch from student where pno = 121 and pno = 122;

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

Invalid Query

Example : 3

Display the name of branches in which student got 50 and project 122 is running.

RA : $\Pi_{branch}(\sigma_{marks = 50}(STUDENT)) \cap \Pi_{branch}(\sigma_{pno = 122}(STUDENT))$

```
SQL > select distinct branch from student where marks = 50
      intersect
      select distinct branch from student where pno = 122;
```

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

Branch
CSE

Branch
CSE
MECH

OUTPUT

Branch
CSE

Example : 3

Display the name of branches in which student got 50 and project 122 is running.

RA : $\Pi_{branch}(\sigma_{marks = 50 \wedge pno=122}(STUDENT))$

SQL > select distinct branch from student where marks = 50 and pno = 122;

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

Branch
CSE

Example : 4

Display the name of branches in which project 121 is running but 122 is not.

RA : $\Pi_{branch}(\sigma_{pno = 121}(STUDENT)) - \Pi_{branch}(\sigma_{pno = 122}(STUDENT))$

SQL > select distinct branch from student where pno = 121

minus / except

select distinct branch from student where pno = 122;

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

Branch
CSE
IT

Branch
CSE
MECH

OUTPUT

Branch
IT

Example : 5

Display the name of branches in which project 122 is running but 121 is not.

RA : $\Pi_{branch}(\sigma_{pno = 122}(STUDENT)) - \Pi_{branch}(\sigma_{pno = 121}(STUDENT))$

SQL > select distinct branch from student where pno = 122

minus / except

select distinct branch from student where pno = 121;

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

Branch
CSE
MECH

Branch
CSE
IT

OUTPUT

Branch
MECH

Example : 6

RA : $\Pi_{branch}(\sigma_{pno = 121}(STUDENT))$

$-$

$(\Pi_{branch}(\sigma_{pno = 121}(STUDENT))$

$-$

$\Pi_{branch}(\sigma_{pno = 122}(STUDENT)$

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

Branch
CSE
IT

Branch
CSE
IT

OUTPUT

Branch
CSE
MECH

Branch
IT

Branch
CSE

Intersection is derived from set difference

$$R - (R - S) \equiv S \cap R$$

That is why, intersection is not a basic (fundamental) operation of Relational Algebra

Example : 7

$$\Pi_{pno}(STUDENT) \cup \Pi_{pno}(PROJECT)$$

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

PROJECT

Pno	Pname	Duration
121	P1	10
122	P2	20
123	P3	30
124	P4	40

OUTPUT

Pno
121
122
123
124

Example : 8

$$\Pi_{pno}(STUDENT) \cap \Pi_{pno}(PROJECT)$$

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

PROJECT

Pno	Pname	Duration
121	P1	10
122	P2	20
123	P3	30
124	P4	40

OUTPUT

Pno
121
122
123

Example : 9

$$\Pi_{pno}(STUDENT) - \Pi_{pno}(PROJECT)$$

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

PROJECT

Pno	Pname	Duration
121	P1	10
122	P2	20
123	P3	30
124	P4	40

OUTPUT

Pno

No rows selected

Example : 9

$$\Pi_{pno}(PROJECT) - \Pi_{pno}(STUDENT)$$

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

PROJECT

Pno	Pname	Duration
121	P1	10
122	P2	20
123	P3	30
124	P4	40

OUTPUT

Pno
124

GATE question

Suppose R1 (A, B) and R2 (C, D) are two relation schemas. Let r1 and r2 be the corresponding relation instances. B is a foreign key that refers to C in R2. If data in r1 and r2 satisfy referential integrity constrains, which of the following is ALWAYS TRUE?

(A) $\Pi_B (r1) - \Pi_C (r2) = \phi$

(B) $\Pi_C (r2) - \Pi_B (r1) = \phi$

(C) $\Pi_B (r1) = \Pi_C (r2)$

(D) $\Pi_B (r1) - \Pi_C (r2) \neq \phi$

[GATE 2012]

GATE question

Which of the following query transformations (i.e. replacing the l.h.s. expression by the r.h.s. expression) is incorrect? R1 and R2 are relations, C1, C2 are selection conditions and A1, A2 are attributes of R1?

(A) $\sigma_{c1}(\sigma_{c2}(R1)) \rightarrow \sigma_{c1}(\sigma_{c2}(R1))$

(B) $\sigma_{c1}(\Pi_{A1}(R1)) \rightarrow \Pi_{A1}(\sigma_{c1}(R1))$

(C) $\sigma_{c1}(R1 \cup R2) \rightarrow \sigma_{c1}(R1) \cup \sigma_{c2}(R2)$

(D) $\Pi_{A2}(\sigma_{c1}(R1)) \rightarrow \sigma_{c1}(\Pi_{A2}(R1))$

[GATE 1998]

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

The link for my youtube channel is

https://www.youtube.com/channel/UCRWGtE76JlTp1iim6aOTRuw?sub_confirmation=1