Relational Algebra Concept

- Relational Algebra is the basic set of operators for the relational model.
- Relational algebra is a procedural query language, which takes instances of relations as **input** and produces instances of relations as **output**.
- It uses operators to perform queries.
- These operators enable a user to specify Quires.

Cont.....

- The result of an operation is a new relation, which may have been formed from one or more input relations.
- Relational algebra mainly provides a theoretical foundation for relational databases and SQL.
- As it is pure mathematics, there is no use of English Keywords in Relational Algebra and operators are represented using symbols.

Fundamental Operators of RA

- The fundamental operators of RA are as follows:
- Select, Project, Rename (Unary Relational Algebra Operators)
- 2. Union, Intersection, Set Deference, (Relational Algebra Operators From Set Theory)
- 3. Cartesian product
- 4. **Joins** (Binary Relational Operators)

The operators have their own symbols.

Operation	Symbol
Projection	π
Selection	σ
Renaming	ρ
Union	
Intersection	
Assignment	

Operation	Symbol
Cartesian product	\times
Join	M
Left outer join	M
Right outer join	X
Full outer join	M
Semijoin	X

Select Operator

Select Operator (σ): Select Operator is used to select a subset of the tuples from a relation based on a selection condition.

- > The selection condition acts as a filter
- > Keeps only those tuples that satisfy the qualifying condition.
- Notation $\sigma(\mathbf{r})$: Where σ stands for selection predicate and \mathbf{r} stands for relation.

Select Operations: Examples

1- $\sigma_{subject = "database"}(Books)$

Output: - Selects tuples from books where subject is 'database'.

2- $\sigma_{\text{subject} = \text{"database" and price} = \text{"}450\text{"}}(Books)$

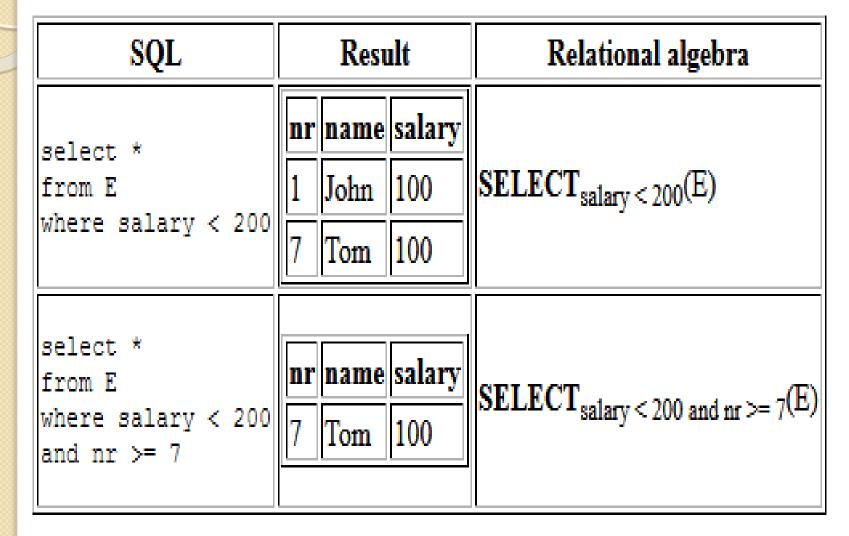
Output: - Selects tuples from books where subject is 'database' and 'price' is 450.

3- $\sigma_{subject = "database"}$ and price = "450" or year > "2016" (Books)

Output: - Selects tuples from books where subject is 'database' and 'price' is 450 or those books which published after 2016.

Relational Algebra and SQL-----Selection

Same table E (for EMPLOYEE)



Select Operator Properties

• A cascade of select operator may be replaced by a single selection with a conjunction of all the condition.

$$\sigma_{\text{cond1}}(\sigma_{\text{cond2}}(\sigma_{\text{cond3}}(R)) = \sigma_{\text{cond1}} \cap (R)$$

• The number of tuples in the Output of select is less than or (equal) to the number of tuples in the input relation R.

Project Operator

Project Operator (\square): - It projects column(s) that satisfy a given predicate.

- PROJECT Operator is denoted by π pi)
- PROJECT creates a vertical partitioning
- Notation: $\prod_{A1, A2, An}$ (r)
- Where A_1 , A_2 , A_n are attribute names of relation \mathbf{r} .
- Duplicate rows are automatically eliminated.
- $ightharpoonup Notation \prod_{\text{cattribute list}} (R)$ Where π stands for Projection predicate and **R** stands for relation.

Project Operator's Examples

1- $\prod_{\text{subject, author}}$ (Books)

Selects and projects columns named as subject and author from the relation Books.

2- $\prod_{\text{name, fname, salary}}$ (Employee)

Select and project columns named as name, fname, and salary from the relation Employee.

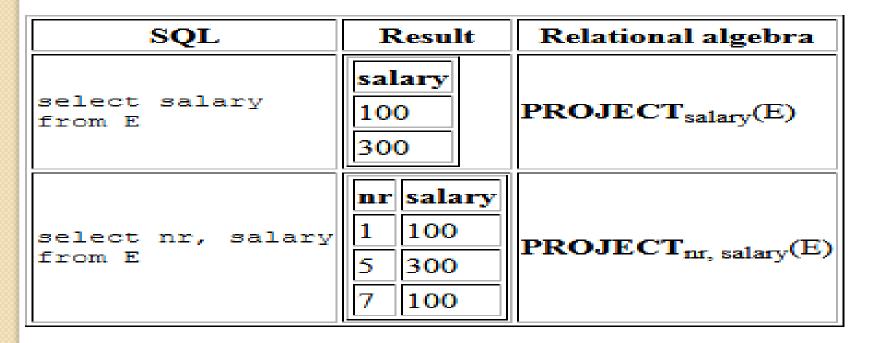
3- $\prod_{gender, address}$ (Student)

Select and project columns named as gender and address from the relation Student

Relational Algebra and SQL-----Projection

mr	name	salary
1	John	100
5	Sarah	300
7	Tom	100

The table E (for EMPLOYEE)



Note: - there are no duplicate rows in the result.

Project Operator Properties

- The number of tuples in the result of projection is always less or equal to the number of tuples in R.
- If the list of attributes include a key of R, then the number of tuples in the result of Project is equal to the number of tuples in R.
- The project operator removes any duplicate tuples.

Differences B/W Select and Project Operators

- With the selection operator you specify which rows you want but with the projection operator you specify which columns you want.
- If the user is interested in selecting the values of a few attributes, then one should go for **Project** Operator.
- If the user is interested in selecting the values of all attributes rather than selection all attributes, , then one should go for **Select** Operator.

Combination of Selection and Projection

SQL	Result	Relational algebra		
select name, salary from E where salary < 200	name salary John 100 Tom 100	T name, salary (T salary < 200(E))		

Rename Operator

Rename Operation (ρ): -The rename operator allows us to rename the output relation.

- In some cases, we may want to **Rename** the attributes of a relation or the relation name or both.
- 'rename' operator is denoted with small Greek letter ${\bf rho}\, {\bf \rho}$.
- Notation: ρ x (E) Where the result of expression E is saved with name of x.

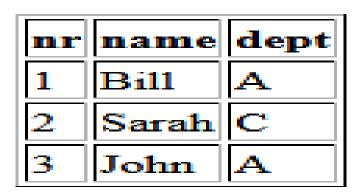
Example of Rename Operator

1-
$$\rho_{s(B1,B2,...,Bn)}(R)$$

- The relation name to S, and
- The column (attribute) names to B1,B2,.....Bn
- 2- $\rho_s(\mathbf{R})$ changes:
- The relation name only to S
- 3- $\rho_{(B1,B2,...,Bn)}$ (**R**) changes
- The column (attribute) names to B1, B2,,Bn

The table **E** (for **EMPLOYEE**)

The table **D** (for **DEPARTMENT**)





We want to join and Rename these tables

	SQL	Result			ult		Relational algebra
	<pre>select * from E as E(enr, ename, dept), D as D(dnr, dname) where dept = dnr</pre>	enr	enam	dep	dnr	dname	
		1	Bill	A	A	Marketing	(RENAME: (CE)) IOIN (RENAME: (D))
wh		2	Sarah	С	C	Legal	(RENAME _(enr, ename, dept) (E)) JOIN _{dept = dnr} (RENAME _(dnr, dname) (D))
		3	John	A	A	Marketing	
		nr	name	lept r	ır	name	
	elect *	1	Bill /	A A	Ma	arketing	E IOIN D
from E, D where dept = D.nr	'	2	Sarah	C (Le	gal	$E JOIN_{dept = D.nr} D$
		3	John	A A	Ma	arketing	

