

Module 07

Partha Pratim Das

Objectives Outline

Relational Operators

Aggregation Operators

Module Summary

## Database Management Systems

Module 07: Introduction to Relational Model/2

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# Module Recap

#### Module 07

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### Objectives & Outline

Operators

Aggregation Operators

Module Summar

• Basic notions of modeling introduced

- Attributes and their Types
- Schema and Instance
- Keys and their Categorization
- Languages for Relation Model introduced

# Module Objectives

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### Objectives & Outline

Operator Operator

Aggregation Operators

Module Summary

- To understand relational algebra
- To familiarize with the operators of relational algebra

### Module Outline

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### Objectives & Outline

Relationa Operator

Aggregation Operators

Module Summary

### Operations

- Select
- o Project
- Union
- o Difference
- Intersection
- o Cartesian Product
- Natural Join
- Aggregate Operations



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Module Summar

# **Relational Operators**

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## Basic Properties of Relations

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M- dul- C...

• A relation is set. Hence,

Ordering of rows / tuples is inconsequential

Α	В	
a1	b1	
a1	b2	is
a2	b1	
a2	h2	

is same as:

Α	В
a1	b1
a2	b1
a2	b2
a1	b2

• All rows / tuples must be distinct

A	B
a1	b1
a1	b2
a1	b2
a1	b1

A D

is not valid

Α	В
a1	b1
a1	b2

is

# Select Operation – selection of rows (tuples)

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 $\bullet$  Relation r

A	В	C	D
$\alpha$	α	1	7
$\alpha$	β	5	7
β	β	12	3
β	β	23	10

•  $\sigma_{A=B \wedge D > 5}(r)$ 

$$\begin{array}{c|ccccc}
A & B & C & D \\
\hline
\alpha & \alpha & 1 & 7 \\
\beta & \beta & 23 & 10
\end{array}$$



# Project Operation – selection of columns (Attributes)

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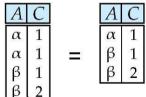
Aggregation Operators

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• Relation *r* 

A	В	C
α	10	1
α	20	1
β	30	1
β	40	2

•  $\pi_{A,C}(r)$ 



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### Union of two relations

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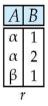
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Module Summar

• Relation r, s



 $\bullet$   $r \cup s$ 

$$\begin{array}{c|c}
A & B \\
\hline
\alpha & 1 \\
\alpha & 2 \\
\beta & 1 \\
\beta & 3 \\
\end{array}$$



### Set difference of two relations

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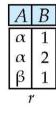
Objectives Outline

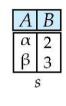
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Module Summar

• Relation r, s





 $\bullet$  r-s



### Set intersection of two relations

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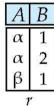
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• Relation r, s



 $\begin{array}{c|c}
A & B \\
\hline
\alpha & 2 \\
\beta & 3
\end{array}$ 

 $\bullet$   $r \cap s$ 

**Note:**  $r \cap s = r - (r - s)$ 



# Joining two relations – Cartesian-product

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• Relation r, s





 $\bullet$   $r \times s$ 

$\boldsymbol{A}$	В	C	D	Ε
α	1	α	10	a
α	1	β	10	a
α	1	β	20	b
α	1	γ	10	b
β	2	α	10	a
β	2	β	10	a
β	2	β	20	b
β	2	γ	10	b



## Cartesian-product – naming issue

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• Relation r, s



	_
10	a
10	a
20	b
10	b
	10 10 20 10

 $\bullet$   $r \times s$ 

A	r.B	s.B	D	Ε
α	1	α	10	a
α	1	β	10	a
α	1	β	20	b
α	1	γ	10	b
β	2	α	10	a
β	2	β	10	a
β	2	β	20	b
β	2	γ	10	b



# Renaming a Table

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• Allows us to refer to a relation, (say *E*) by more than one name.

$$\rho_X(E)$$

returns the expression E under the name X

• Relations r

$$\begin{bmatrix} A & B \\ \alpha & 1 \\ \beta & 2 \end{bmatrix}$$

•  $r \times \rho_s(r)$ 

r.A	r.B	s.A	S.
α	1	α	1
α	1	β	2
β	2	α	1
β	2	β	2



# Composition of Operations

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• Can build expressions using multiple operations

• Example:  $\sigma_{A=C}(r \times s)$ 

$$\bullet$$
  $r \times s$ 

Λ	В		$\Box$	E
=				E
$\alpha$	1		10	
α	1	β	10	a
α	1	β	20	b
α	1	Y	10	Ъ
β	2	$\alpha$	10	а
β	2	β	10	a
β	2	β	20	b
β	2	γ	10	b

•  $\sigma_{A=C}(r \times s)$ 

$\boldsymbol{A}$	В	C	D	Ε
α	1	α	10	a
β	2	β	10	a
β	2	β	10 20	b



## Joining two relations - Natural Join

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- Let r and s be relations on schemas R and S respectively. Then, the "natural join" of relations R and S is a relation on schema  $R \cup S$  obtained as follows:
  - $\circ$  Consider each pair of tuples  $t_r$  from r and  $t_s$  from s.
  - o If  $t_r$  and  $t_s$  have the same value on each of the attributes in  $R \cap S$ , add a tuple t to the result, where
    - $\triangleright$  t has the same value as  $t_r$  on r
    - $\triangleright$  t has the same value as  $t_s$  on s



## Natural Join Example

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Module Summar

• Relations r, s:



В	D	Ε
1	a	α
3	a	β
1	a	Y
2	b	δ
3	b	3
	c	

- Natural Join
  - $\circ r \bowtie s$

$$\pi_{A,r.B,C,r.D,E}(\sigma_{r.B=s.B \land r.D=s.D}(r \times s))$$



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Aggregation
Operators

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# **Aggregation Operators**

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# Aggregate Operators

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- Can we compute:
  - o SUM
  - AVG
  - $\circ$  MAX
  - MIN



## Notes about Relational Languages

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- Each query input is a table (or set of tables)
- Each query output is a table
- All data in the output table appears in one of the input tables
- Relational Algebra is not Turing complete



## Summary of Relational Algebra Operators

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Symbol (Name)	Example of Use	
σ (Selection)	° salary >= 85000 (instructor)	
	Return rows of the input relation that satisfy the predicate.	
П (Projection)	II ID, salary (instructor)	
	Output specified attributes from all rows of the input relation. Remove duplicate tuples from the output.	
X (Cartesian Product)	instructor × department	
	Output all possible combinations of rows in instructor and department.	
U (Union)	$\Pi$ name (instructor) $\cup \Pi$ name (student)	
	Output the union of tuples from the two input relations.	
- (Set Difference)	П name (instructor) — П name (student)	
	Output the set difference of tuples from the two input relations.	
⋈ (Natural Join)	instructor ⋈ department	
	Output pairs of rows from the two input relations that have the same value on all attributes that have the same name.	

# Module Summary

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Objective Outline

Operators

Module Summary

• Introduced relational algebra

Familiarized with the operators of relational algebra

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