

Lecture 5



Introduction to Relational Algebra - 2



Some more about Traditional Set Operators

□ Commutative

- **Union, Intersect and Times** are Commutative:
 - **A UNION B** is equal to **B UNION A**
 - **A INTERSECT B** is equal to **B INTERSECT A**
 - **A TIMES B** is equal to **B TIMES A**
- **MINUS** is not Commutative i.e.,
 - **A MINUS B** is not equal to **B MINUS A**

□ Associative

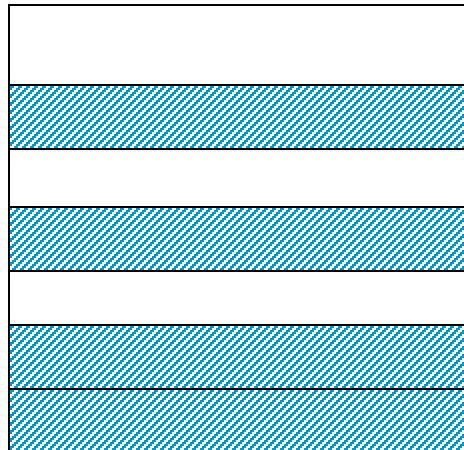
- **Union, Intersect and Times** are Associative:
 - **(A UNION B) UNION C** is equal to **A UNION (B UNION C)**
 - **(A INTERSECT B) INTERSECT C** is equal to **A INTERSECT (B INTERSECT C)**
 - **(A TIMES B) TIMES C** is equal to **A TIMES (B TIMES C)**
- **MINUS** is not Associative i.e.,
 - **(A MINUS B) MINUS C** is not equal to **A MINUS (B MINUS C)**

- is actually abbreviation for **θ -restriction**, where “ **θ** ” stands for any simple scalar comparison operator(=,<,>=)
- **θ -restriction** of relation **A** on attributes **X** and **Y**(in that order)

A where $X \theta Y$

is a relation with the same heading as **A** and with a body consisting of the set of all tuples of **A** such that the condition “**X** θ **Y**” evaluates true for those tuples.

- **X** and **Y** must be defined on the same domain
- operator must make sense for that domain



Special Relational Operators

□ RESTRICTION

- Returns a relation consisting of all tuples from a specified relation that satisfy a specified condition.

A

| ID | Name | Age | Department | NIC |
|----|--------|-----|------------|---------------|
| S1 | Ahmad | 23 | Sales | 245-77-245367 |
| S2 | Salman | 34 | Marketing | 234-66-245368 |
| S3 | Karim | 21 | Sales | 255-79-256369 |
| S4 | Tariq | 29 | Admin | 245-71-325370 |
| S5 | Sadiq | 32 | Sales | 245-68-345371 |

A WHERE Department="Sales"

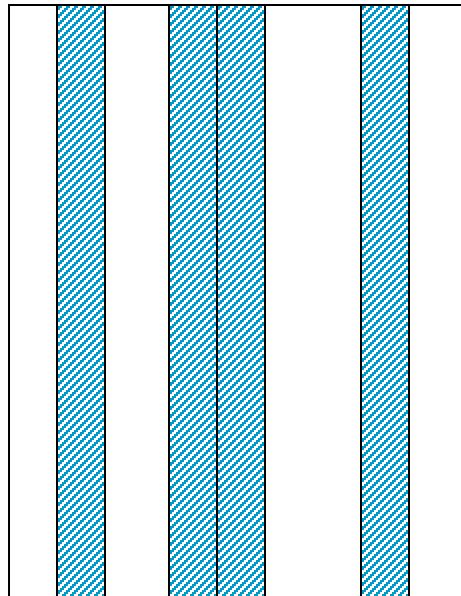
| ID | Name | Age | Department | NIC |
|----|-------|-----|------------|---------------|
| S1 | Ahmad | 23 | Sales | 245-77-245367 |
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Special Relational Operators

□ PROJECTION

- the projection of relation A on X, Y, \dots, Z (where each of X, Y, \dots, Z is an attribute of A) is a relation with heading $\{X, Y, \dots, Z\}$ and body consisting of the set of all tuples $\{X:x, Y:y, \dots, Z:z\}$ such that a tuple appears in A with X -value x , Y -value y, \dots, Z -value z .
- projection yields a vertical subset of relation

A



Special Relational Operators

□ PROJECTION

- Returns a relation consisting of all tuples that remain as (sub) tuples in a specified relation after specified attributes have been eliminated

A

| ID | Name | Age | Department | NIC |
|----|--------|-----|------------|---------------|
| S1 | Ahmad | 23 | Sales | 245-77-245367 |
| S2 | Salman | 34 | Marketing | 234-66-245368 |
| S3 | Karim | 21 | Sales | 255-79-256369 |
| S4 | Tariq | 29 | Admin | 245-71-325370 |
| S5 | Sadiq | 32 | Sales | 245-68-345371 |

A [Name]

| Name |
|--------|
| Ahmad |
| Salman |
| Karim |
| Tariq |
| Sadiq |

A where Department="Sales"

| [Name, Department] | | |
|--------------------|-----|------------|
| Name | Age | Department |
| Ahmad | 23 | Sales |
| Karim | 21 | Sales |
| Sadiq | 32 | Sales |

Special Relational Operators

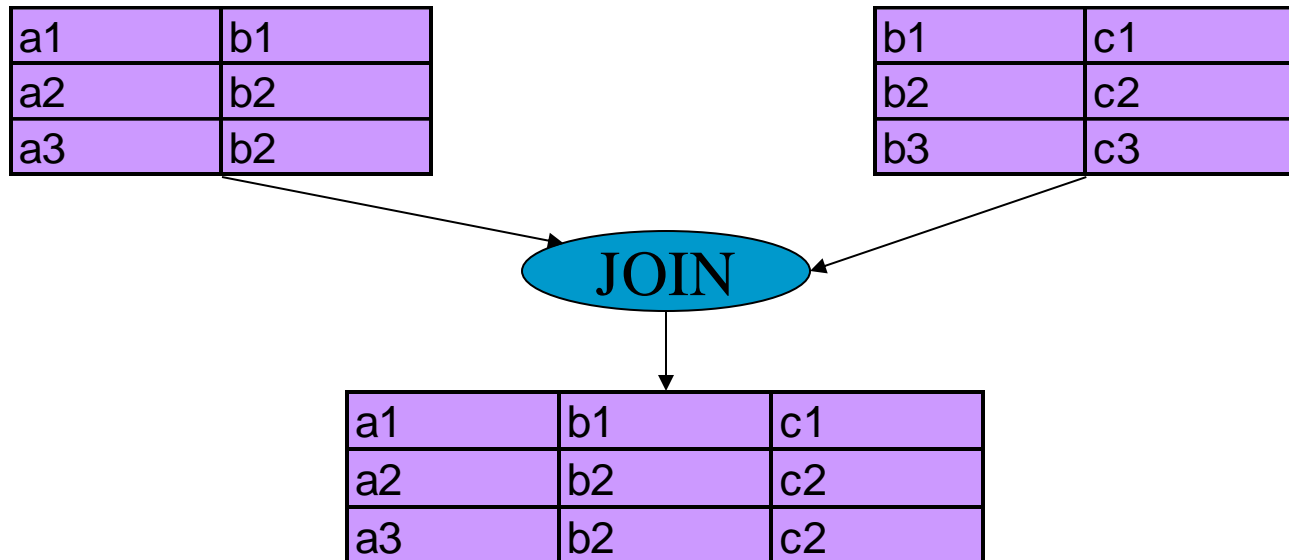
□ JOIN(NATURAL JOIN)

- Let relations A and B have headings $[X, \dots, Y]$ and $[X, \dots, Z]$ respectively, then

A JOIN B

is a relation with heading $[X, \dots, Y, \dots, Z]$ and with a body consisting of the set of all tuples $[X:x, Y:y, Z:z]$ such that a tuple appears in A with X-value x and Y-value y and in B with X-value x and Z-value z.

- there should be some common attribute(s)



Special Relational Operators

□ JOIN(NATURAL JOIN)

- Returns a relation consisting of all possible tuples that are combination of two tuples, one from each of the two specified relations, such that two tuples contributing to any given combination have a common value for the common attributes (and that value appears just once)

A

| ID | Name |
|----|--------|
| S1 | Ahmad |
| S2 | Salman |
| S3 | Karim |

B

| ID | Subject |
|----|---------|
| S1 | Math |
| S2 | Urdu |
| S1 | English |

A JOIN B

| ID | Name | Subject |
|----|--------|---------|
| S1 | Ahmad | Math |
| S1 | Ahmad | English |
| S2 | Salman | Urdu |

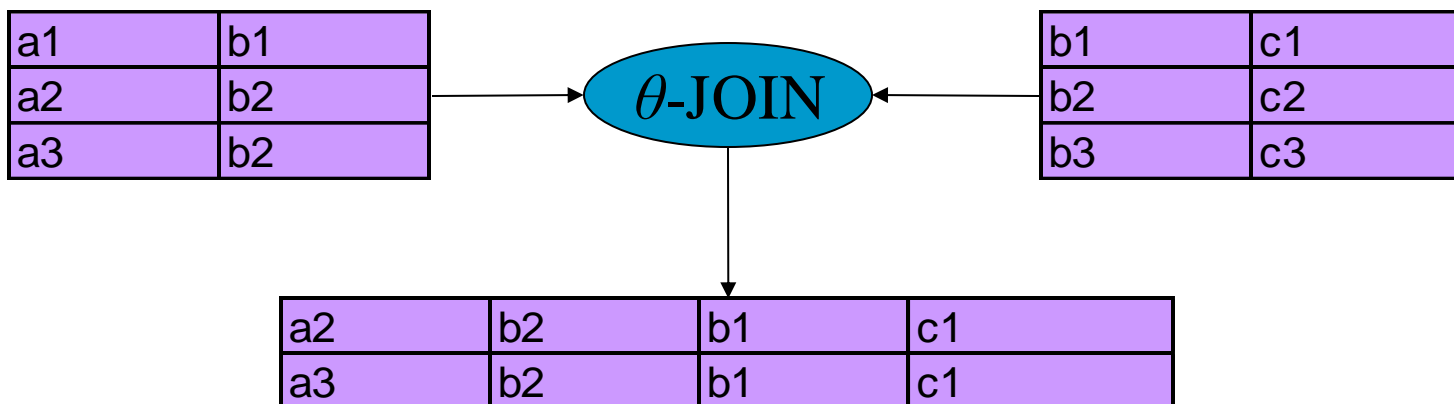
Special Relational Operators

□ θ -JOIN

- Let relations A and B have no attribute names in common (as in Cartesian Product), and let θ be as defined in restriction. Then the θ -JOIN of relation A on attribute X with relation B on attribute Y is defined by the result of the expression

(A TIMES B) where $X \theta Y$

- it is a relation with same heading as Cartesian Product of A and B and with a body consisting of the set of all those tuples belonging to that Cartesian Product of that evaluate true for $X \theta Y$.
- if θ is “equals”, the θ -JOIN is called an EQUIJOIN.



Special Relational Operators

□ θ - JOIN

A

| ID | Name |
|----|--------|
| S1 | Ahmad |
| S2 | Salman |
| S3 | Karim |

B

| ID | Subject |
|----|---------|
| S1 | Math |
| S2 | Urdu |
| S1 | English |

(A TIMES B) where $IDA > IDB$

| IDA | Name | IDB | Subject |
|-----|--------|-----|---------|
| S2 | Salman | S1 | Math |
| S2 | Salman | S1 | English |
| S3 | Karim | S1 | Math |
| S3 | Karim | S1 | English |
| S3 | Karim | S2 | Urdu |

(A TIMES B) where $IDA = IDB$

| IDA | Name | IDB | Subject |
|-----|--------|-----|---------|
| S1 | Ahmad | S1 | Math |
| S1 | Ahmad | S1 | English |
| S2 | Salman | S2 | Urdu |

Special Relational Operators

□ DIVISION

- Let relations A and B have headings

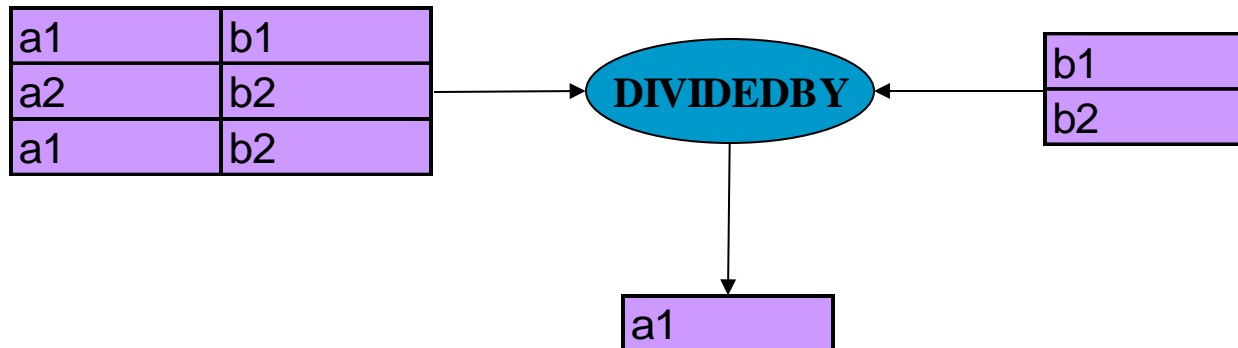
$\{x_1, x_2, \dots, x_m, y_1, y_2, \dots, y_n\}$ and
 $\{y_1, y_2, \dots, y_n\}$

respectively; i.e., attributes y_1, y_2, \dots, y_n are common, A additionally has attributes x_1, x_2, \dots, x_m , B has no other attributes. Then division of A by B

A DIVIDEDBY B

is a relation with heading x_1, x_2, \dots, x_m and body consisting of the set of all tuples $\{X_1:x_1, X_2:x_2, \dots, X_m:x_m\}$ such that a tuple $\{X_1:x_1, X_2:x_2, \dots, X_m:x_m, Y_1:y_1, Y_2:y_2, \dots, Y_n:y_n\}$ appears in A for all tuples $\{Y_1:y_1, Y_2:y_2, \dots, Y_n:y_n\}$ appearing in B.

- A is called dividend(DEND) and B is called divisor(DOR)



Special Relational Operators

□ DIVISION

- Take two relations, one binary and one unary, and returns a relation consisting of all values of one attribute of binary relation that match(in the other attribute) all the values in the unary relation.

A

| ID | Subject |
|----|---------|
| S1 | Math |
| S2 | Urdu |
| S1 | English |
| S1 | Urdu |

B

| ID |
|----|
| S1 |
| S2 |

A DIVIDE BY B

| Subject |
|---------|
| Urdu |

Special Relational Operators

□ Some Facts

- If A and B have no common attribute names in common, $A \text{ JOIN } B$ is equal to $A \text{ TIMES } B$
- In EQUIJOIN , if one of the two attributes having common values is eliminated (may be through projection), then the result is equal to the natural join.
- JOIN is both commutative and associative i.e.,
$$A \text{ JOIN } B = B \text{ JOIN } A$$
$$A \text{ JOIN } (B \text{ JOIN } C) = (A \text{ JOIN } B) \text{ JOIN } C$$

Quiz # 2

□ Consider relations A and B such that

- Cardinality of A = 12, Degree of A = 4
- Cardinality of B = 10, Degree of B = 4
- Cardinality of A UNION B = 20

what would be the value of following:

- Cardinality and Degree of A INTERSECT B
- Cardinality and Degree of A TIMES B
- Degree of A UNION B
- Cardinality and Degree of A MINUS B
- Cardinality and Degree of B MINUS A