Relational Algebra - Division

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Division – Past Muddiest Points

- Division was a bit confusing and to understand

$$T_1 \div T_2$$

T_1

pid	cid
$p1$	$c1$
$p1$	$c2$
$p1$	$c3$
$p2$	$c2$
$p2$	$c3$
$p3$	$c1$
$p4$	$c1$
$p4$	$c2$
$p4$	$c3$

T_2

cid
$c1$
$c2$
$c3$

Results:
p1
p4

$$\Pi_{S_1-S_2}(T_1) - \Pi_{S_1-S_2}\left(\Pi_{S_1-S_2}(T_1) \times T_2 - T_1\right) = T_1 \div T_2$$

Division

$$\boxed{\Pi_{S_1-S_2}(T_1)} - \boxed{\Pi_{S_1-S_2}\left(\boxed{\boxed{\Pi_{S_1-S_2}(T_1)} \times T_2} - T_1\right)} = T_1 \div T_2$$

Which operations go first?

- Complex expressions can be composed recursively, just as in arithmetic.
- Parentheses and precedence rules define the order of evaluation.
- Precedence, from highest to lowest, is:

  σ, Π, ρ

  $\times, \bowtie$

  $\cap, \div$

  $\cup, -$

- Unless very sure, use brackets!

Division Example

- Get supplier which supply **all** the parts

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

÷

part_id
1
2
3

=

Supp_id
A

Division Example

- Get supplier which supply **all** the parts

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

$\div$

part_id
1
2
3

$=$

Supp_id
A

$$T_1 \div T_2 = \Pi_{S_1-S_2}(T_1) - \Pi_{S_1-S_2}(\Pi_{S_1-S_2}(T_1) \times T_2 - T_1)$$

S_1= {supp_id, part_id} S_2= {part_id} S_1-S_2 = {supp_id}

Note1: S_1 and S_2 are set of attributes that form the ***schema***! They are not the set of tuples.

Note2: $S_2 \subset S_1$

Division Example

- Get supplier which supply **all** the parts

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

$\div$

part_id
1
2
3

$=$

Supp_id
A

$$T_1 \div T_2 = \Pi_{S_1-S_2}(T_1) - \Pi_{S_1-S_2}(\boxed{\Pi_{S_1-S_2}(T_1)} \times T_2 - T_1)$$

All suppliers that supply

supp_id
A
B
C
D

Division Example

- Get supplier which supply **all** the parts

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

÷

part_id
1
2
3

=

Supp_id
A

$$T_1 \div T_2 = \Pi_{S_1 - S_2}(T_1) - \Pi_{S_1 - S_2}(\boxed{\Pi_{S_1 - S_2}(T_1) \times T_2} - T_1)$$

All possible combinations of Parts and Suppliers (which supply).

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
B	3
C	1
C	2
C	3
D	1
D	2
D	3

Division Example

- Get supplier which supply **all** the parts

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

÷

part_id
1
2
3

=

Supp_id
A

$$T_1 \div T_2 = \Pi_{S_1 - S_2}(T_1) - \Pi_{S_1 - S_2}\left(\boxed{\Pi_{S_1 - S_2}(T_1) \times T_2 - T_1}\right)$$

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
B	3
C	1
C	2
C	3
D	1
D	2
D	3

−

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

Supplier and parts that they **really** supply

All possible combinations of Parts and Suppliers (which supply).

Division Example

- Get supplier which supply **all** the parts

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

$\div$

part_id
1
2
3

$=$

Supp_id
A

$$T_1 \div T_2 = \Pi_{S_1 - S_2}(T_1) - \Pi_{S_1 - S_2}(\boxed{\Pi_{S_1 - S_2}(T_1) \times T_2 - T_1})$$

Suppliers, and the parts which the supplier ***do not*** supply

supp_id	part_id
B	3
C	1
C	2
D	1
D	2

<=

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
B	3
C	1
C	2
C	3
D	1
D	2
D	3

All possible combinations of Parts and Suppliers (which supply).

-

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

Supplier and parts that they **really** supply

Division Example

- Get supplier which supply **all** the parts

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

÷

part_id
1
2
3

=

Supp_id
A

$$T_1 \div T_2 = \Pi_{S_1 - S_2}(T_1) - \boxed{\Pi_{S_1 - S_2}(\Pi_{S_1 - S_2}(T_1) \times T_2 - T_1)}$$

supp_id	part_id
B	3
C	1
C	2
D	1
D	2

=>

supp_id
B
C
D

Suppliers which has <u>a/some</u> parts **not** supplied

Division Example

- Get supplier which supply **all** the parts

supp_id	part_id
A	1
A	2
A	3
B	1
B	2
C	3
D	3

$\div$

part_id
1
2
3

$=$

Supp_id
A

$$T_1 \div T_2 = \boxed{\Pi_{S_1-S_2}(T_1) - \Pi_{S_1-S_2}(\Pi_{S_1-S_2}(T_1) \times T_2 - T_1})$$

Supplier which supply ***all*** the parts

Supp_id
A

$=$

supp_id
A
B
C
D

All suppliers that supply

$-$

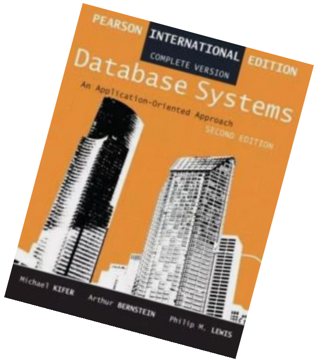
supp_id
B
C
D

Suppliers which has <u>a/some</u> parts **not** supplied

Brain Teasers (2024)

- What is $r \times s$ when s is an empty $\emptyset$ relation?

- What is $r \div s$, if s is empty $\emptyset$?



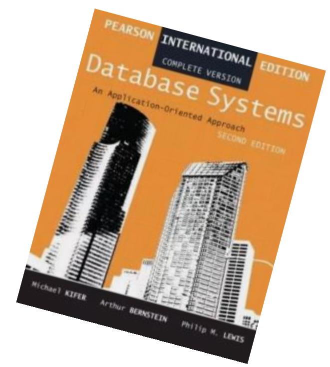
- What is $r \times s$ when s is an empty $\emptyset$ relation?

$$r \times \emptyset = \emptyset, \quad \emptyset \times s = \emptyset$$

- By definition, no tuple to pair.

For every tuple $t_1 \in T_1$ and $t_2 \in T_2$, T contains a tuple t whose values are the same as t_1 (t_2) on the attributes from T_1 (T_2).

- What is $r \div s$, if s is empty $\emptyset$?



for every tuple $t_2 \in T_2$, $t_1 = (t, t_2)$ is a tuple in T_1, where (t, t_2) represents a tuple that concatenates the attributes of t with those of t_2.

Or {<a>} $\in r \div s$ if and only if {<a>} $\times s \subseteq r$

$$\Pi_{S_1 - S_2}(T_1) - \cancel{\Pi_{S_1 - S_2}\left(\Pi_{S_1 - S_2}(T_1) \times T_2 - T_1\right)}$$

$$\emptyset$$

$\Pi_{S_1 - S_2}(T_1)$ *where* $T_1 = r$, i.e., everything in r satisfies.