

Common Query

Library microDB:

- Librarian (SSN, Name, SNO)
 - PK: SSN, FK: SNO
- Section (SNO, SName, Head)
 - PK: SNO, FK: SNO

List the names of head librarians.

How?

List the names of head librarians

L: Librarian, S: Section

LS ← Librarian X Section;

- LS schema:
(L.SSN, L.Name, L.SNO, S.SNO, S.Sname, S.Head)

HL ← $\sigma_{L.SSN = S.Head}$ (LS);

RSLT ← $\Pi_{L.name}$ (HL);

Equi-Join

$$r \bowtie_{r.A_i = s.A_j} s$$

=-join is a macro of

$$\sigma_{r.A_i = s.A_j} (r \times s)$$

=-join of r(R) and s(S):

$$r \bowtie_{r.B = s.D} s = ?$$

relation s

C	D
3	4
6	8

relation r

A	B	C	D
1	2	3	4
2	4	6	8
1	2	4	8
2	6	6	8
8	2	3	4
2	4	3	4

Equi-Join

$$r \bowtie_{r.B = s.D} s =$$

relation r

A	B	C	D
1	2	3	4
2	4	6	8
1	2	4	8
2	6	6	8
8	2	3	4
2	4	3	4

relation s

C	D
3	4
6	8

r.A	r.B	r.C	r.D	s.C	s.D
2	4	6	8	3	4
2	4	3	4	3	4

Θ-Join

□ $\Theta = \{=, <, \leq, >, \geq, \neq\}$

□ Θ -join of $r(R)$ and $s(S)$
on attributes $r.A_i$ and $s.A_j$

$$r \bowtie_{r.A_i \theta s.A_j} s$$

$$= \sigma_{r.A_i \theta s.A_j} (r \times s)$$

□ \geq -join of $r(R)$ and $s(S)$:

$$r \bowtie_{r.B \geq s.D} s = ?$$

relation **r**

A	B	C	D
1	2	3	4
2	4	6	8
1	2	4	8
2	6	6	8
8	2	3	4
2	4	3	4

relation **s**

C	D
3	4
6	8

Example of Θ -Join

□ \geq -join of $r(R)$ and $s(S)$:

$$r \bowtie_{r.B \geq s.D} s =$$

r.A	r.B	r.C	r.D	s.C	s.D
2	4	6	8	3	4
2	4	3	4	3	4
2	6	6	8	3	4
8	9	3	4	3	4
8	9	3	4	6	8

relation **r**

A	B	C	D
1	2	3	4
2	4	6	8
1	2	4	8
2	6	6	8
8	2	3	4
2	4	3	4

relation **s**

C	D
3	4
6	8

$$r \bowtie s = r \times s, \Theta = \phi$$

Natural-Join

□ Equi-join without duplicate columns

$$r *_p s$$

□ P =list of attributes: $P = R \cap S$

$$r * s = \pi_{R \cup S} (r \bowtie_{r.P = s.P} s)$$

□ $r * s = ?$

▪ Schema:

A	B	C	D	E
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□ Note other notations & meanings

$$r \bowtie s = r * s, R \cap S \neq \phi$$

$$r * s = r \times s, R \cap S = \phi$$

relation **r**

A	B	C	D
1	2	3	4
2	4	6	8
1	2	4	8
2	6	6	8
8	2	3	4
2	4	3	4

relation **s**

C	D	E
3	4	6
6	8	8

Natural-Join

$$r * s =$$

A	B	C	D	E
1	2	3	4	6
2	4	6	8	8
2	6	6	8	8
8	2	3	4	6
2	4	3	4	6

relation **r**

A	B	C	D
1	2	3	4
2	4	6	8
1	2	4	8
2	6	6	8
8	2	3	4
2	4	3	4

relation **s**

C	D	E
3	4	6
6	8	8

Examples from Library DB

Library DB schema:

- LIBRARIAN(Name, SSN, SNO, BirthPlace)
- SECTION(SName, SNO, Head)
- OUTREACH(Pname, PNO, SNUM, Location)
- WORKSON(LSSN, PNO, Hours)

Q: For every outreach activity located in PGH, list its project number, the responsible section name and the name of its head.

$PP \leftarrow \sigma_{\text{Location} = 'PGH'}(\text{OUTREACH});$
 $SPP \leftarrow PP \bowtie_{SNUM = SNO} \text{SECTION};$
 $HSPP \leftarrow SPP$
 $\bowtie_{SNO = SNO \wedge \text{Head} = SSN} \text{LIBRARIAN};$
 $RSLT \leftarrow \pi_{PNO, Sname, Name}(HSPP);$

Alternative Inefficient Solution

Library DB schema:

- LIBRARIAN(Name, SSN, SNO, BirthPlace)
- SECTION(SName, SNO, Head)
- OUTREACH(Pname, PNO, SNUM, Location)
- WORKSON(LSSN, PNO, Hours)

Why?

Q: For every outreach activity located in PGH, list its project number, the responsible section name and the name of its head.

$LS \leftarrow \text{SECTION} * \text{LIBRARIAN};$
 $OLS \leftarrow \text{OUTREACH} \bowtie_{SNUM = SNO} LS;$
 $POLS \leftarrow \sigma_{\text{Location} = 'PGH'}(OLS);$
 $PHL \leftarrow \sigma_{\text{Head} = SSN}(POLS);$
 $RSLT \leftarrow \pi_{PNO, Sname, Name}(PHL);$

Division



Let $r(R)$ and $s(S)$ be relations such as $S \subset R$

- The division of r by s , denoted by $r \div s$,
- is relation whose schema is $Q = R - S$ and
 - includes all t such as $t_r[Q] = t$ and $t_r[S] = t$

relation r				relation s	
A	B	C	D	C	D
1	2	3	4	3	4
2	4	6	8	6	8
1	2	6	8		
2	4	3	4		

r ÷ s	
A	B
1	2
2	4

Division With Remainder



Let $r(R)$ and $s(S)$ be relations such as $S \subset R$

- $r \div s$
- is relation whose schema is $Q = R - S$
 - includes all t such as $t_r[Q] = t$ and $t_r[S] = t$

relation r				relation s	
A	B	C	D	C	D
1	2	3	4	3	4
2	3	3	5	6	8
2	4	6	8		
1	2	6	8		
8	2	3	4		
2	4	3	4		

r ÷ s	
A	B
1	2
2	4

Division Usage

- ❑ Query: “Retrieve the names of students who took *all* the classes that John took.”

Q=ENROLL÷CLASS

FN	LN
S	A
K	L

ENROLL

FN	LN	DP	No
S	A	CS	4
M	K	CS	5
K	L	EE	8
S	A	EE	8
F	S	CS	4
K	L	CS	4

CLASS

DP	No
CS	4
EE	8

Note:

Division can be expressed

using π , \times and $-$ operations: $r \div s = \pi_Q(r) - \pi_Q((\pi_Q(r) \times s) - r)$

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