

Division / Quotient operation ( $\div$ )  
 if  $r \div s$ , then  $SCR$

$r(R)$

A	B
p	a
q	a
p	b
p	c
q	t
m	a
q	b

*Annotations: Red checkmarks above header and rows 1, 3, 5, 7. Red 'x' marks on the left of rows 2, 6, 8. Red arrows point to the first column of rows 1, 3, 5. A red line is drawn under the last row.*

$s(S)$

B
a
b

*Annotations: Red checkmarks to the left of each row.*

$r \div s$  has all attributes of  $R - S$ , s.t.  $R$  has combinations of all possible values of  $S$

$r \div s \neq \pi_A (r \bowtie s)$

$r \div s$

A
p
q

*Annotations: Red arrow points to the first row. A red 'x' is under the second row.*

p	a
q	a
q	b

*Annotations: Red circle around the table. Green arrows point from 'a' to 'a' and from 'q' to 'q'.*

If a supplier X supplied all books those are issued to Cardno 'C001'

S_Name
<u>X</u>

$\pi_{Accno, Sname}$  (Supplier)

$\div \pi_{Accno}(\sigma_{Cardno = 'C001'} (borrow))$

Sname	Accno
X	A001
X	A002

Acc No
A001
A002

$$r \div s$$

$$= \pi_{R-S}(r) - \pi_{R-S} \left( (\pi_{R-S}(r) \times s) - r \right)$$

H.W.

Assignment operator

$$t \leftarrow \pi_A(r \bowtie s)$$

$$\begin{array}{c} m \bowtie (\pi_A(r \bowtie s)) \\ \Downarrow \\ m \bowtie t \end{array}$$

# functional dependency (F.D.)

book (AccNo, Year, title)

AccNo  $\longrightarrow$  Year

[Year is functionally dependent on AccNo]

Acc1  $\longrightarrow$  2010

Acc1  $\longrightarrow$  2015

X

Acc1  $\longrightarrow$  2015

Acc2  $\longrightarrow$  2015

✓

JOIN | Natural Join |  $r(R) \bowtie s(S)$

$$r \bowtie s = \{A_1, A_2, \dots, A_n\} = \pi_{R \cup S} \left( \sigma_{\substack{r.A_1 = s.A_1 \\ \vdots \\ r.A_n = s.A_n}} (r \times s) \right)$$

---

Theta ( $\theta$ ) Join |  $r \bowtie_{\theta} s$

$$A \bowtie_{\theta} B = \pi_{R \cup S} \left( \sigma_{\theta} (r \times s) \right)$$



Say	num	square
→	2✓	4
→	3	9
	4	16

Cu	num	cube
→	2✓	8✓
→	3	27
	5	125

Say X Cu	num	square	cube
	2	4	8
	3	9	27

Equi Join → Say. num = Cu. num

θ-Join → Say. num > Cu. num  
Say. num

Say X Cu	num	square	cube	check?
2	4	2	8	
2	4	3	27	
2	4	5	125	
3	9	2	8	
3	9	3	27	
3	9	5	125	
4	16	2	8	
4	16	3	27	
4	16	5	125	

Sqr num	square	Cu num	cube
→ 2 ✓	4	2 ✓	8 ✓
→ 3	9	3	27
4	16	5	125

Sqr ~~No~~ Cu

Sqr. num > Cu. num

Sqr. num	square	cu. num	cube
3	9	2	8
4	16	2	8
4	16	3	27

(\*) Diff. b/w Natural Join & Equi Join

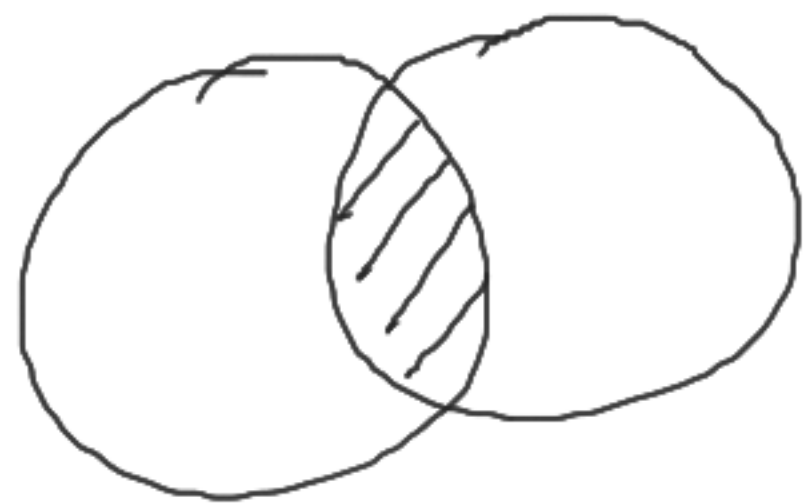
$$r \bowtie s = \pi_{R \cup S} \left( \sigma_{\substack{r.A_1 = s.A_1 \\ \vdots \\ r.A_n = s.A_n}} (r \times s) \right)$$

$$R \cap S = \{A_1, A_2, \dots, A_n\}$$

In Natural Join, by default all common attributes will be taken.

Equi-Join, we can explicitly take the attributes, on which we can perform the equality

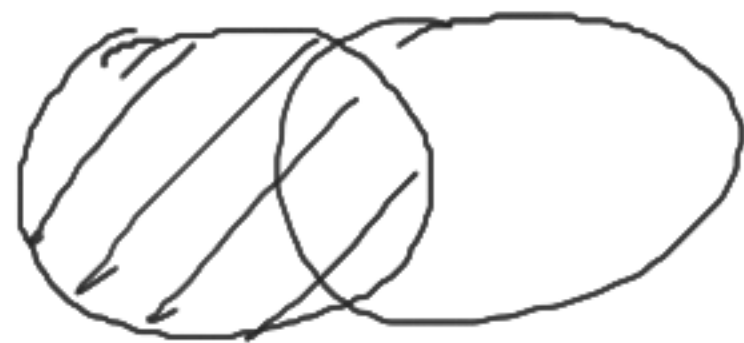




$r \bowtie s$

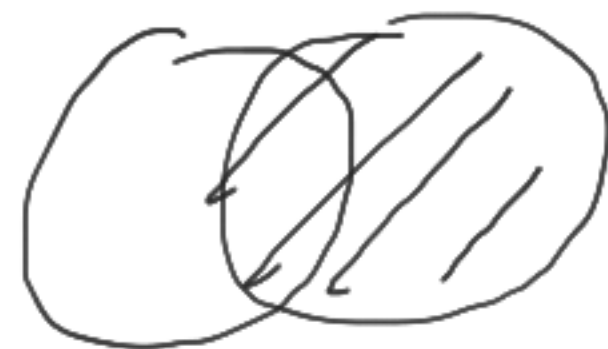
inner join

$\theta$ -Join



$r \Join s$

left (outer)  
join



$r \Join s$

right-  
(outer)  
join



full  
(outer)  
join

$r \Join s$

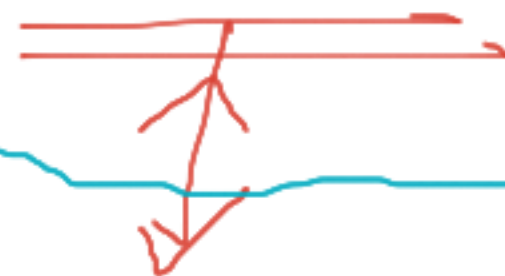
$r \Join s$

↓

$(r \Join s) \cup (r \Join s)$

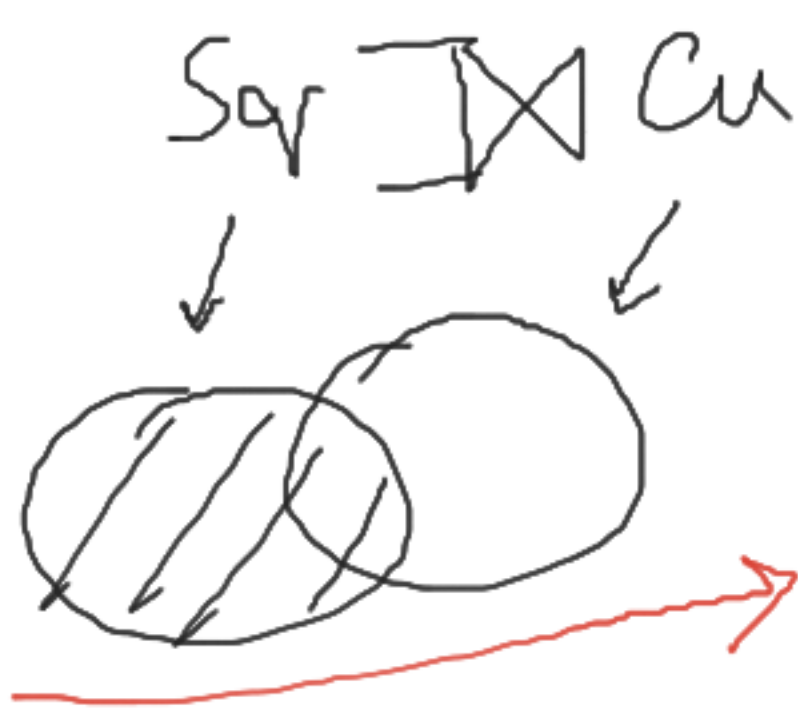
$= (r \Join s) \cup (s \Join r)$

$s \Join r$



Say	num	square
→ 2	4	
→ 3	9	
	16	

cu	num	cube
→ 2	8	
→ 3	27	
	125	



num	square	cube
2	4	8
3	9	27
4	16	NULL

Say ~~IX~~ Cu



num	square	cube
2	4	8
3	9	27
5	NULL	125

Say ~~IX~~ Cu

num	square	cube
2	4	8
3	9	27
4	16	NULL
5	NULL	125

$\swarrow$  S1  
 $\swarrow$  S2

Sav	num	square
→	2	4
→	3	9
	4	16

cu	num	cube
→	2	8
→	3	27
	5	125

$$S1.num = S2.square$$

S1 num	S2 square
4	4

# Self Join

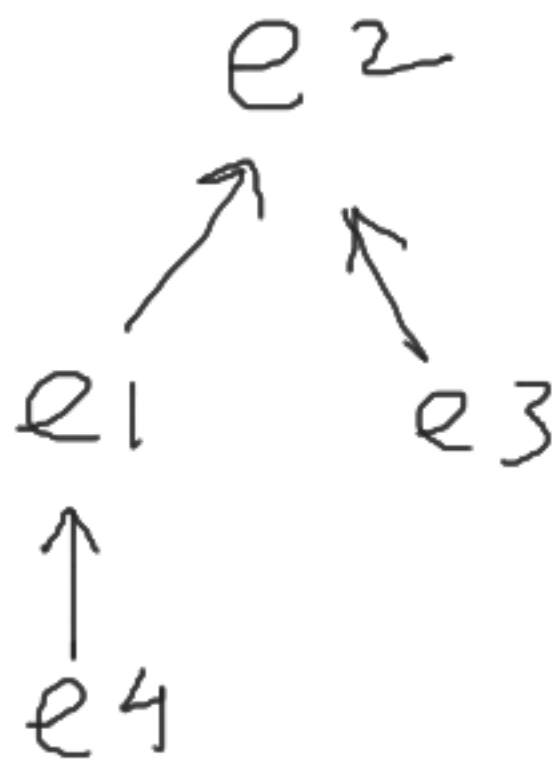
~~Sav~~  $f_{S1}(Sav)$

$f_{S2}(Sav)$

~~Sav~~

emp *input*

eid	ename	mid
e1	A	e2
e2	B	NULL
e3	C	e2
e4	D	e1



(self Join)

*output*

ename	manager
A	B
B	NULL
C	B
D	A

~~def~~

emp id	Salary
e1	1
e2	1.1
e3	1.5
e4	0.9

between

1.1 and 2

1.1, 1.5 / 1.5