Past Muddiest Points

- RA => SQL Natural Join

- SQL: Natural Join

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- SQL: Division

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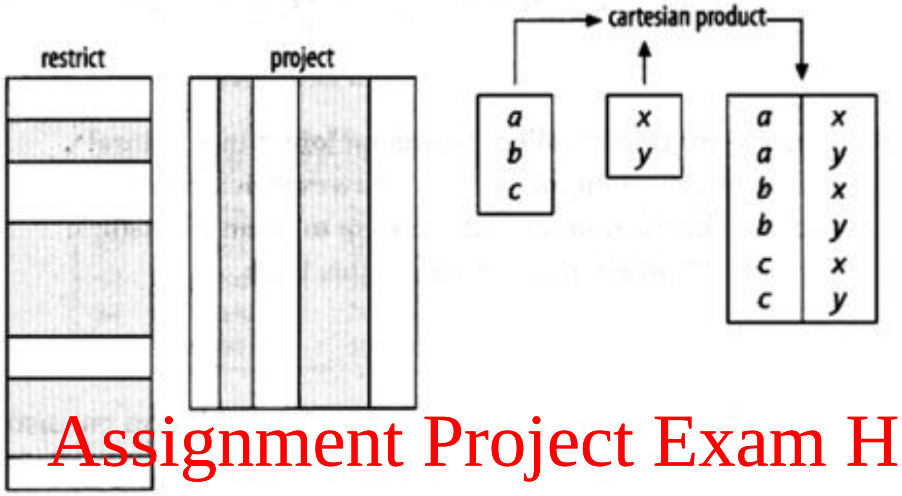
Summary for Relational Algebra



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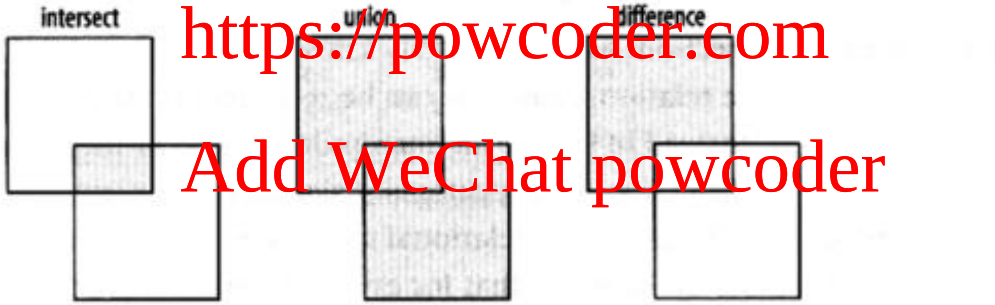
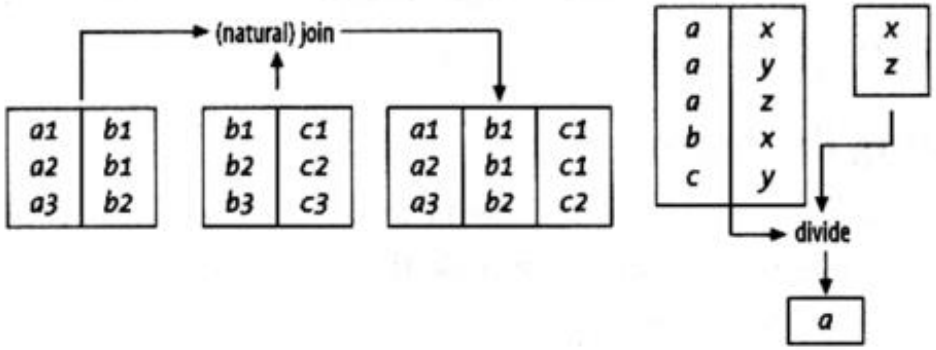
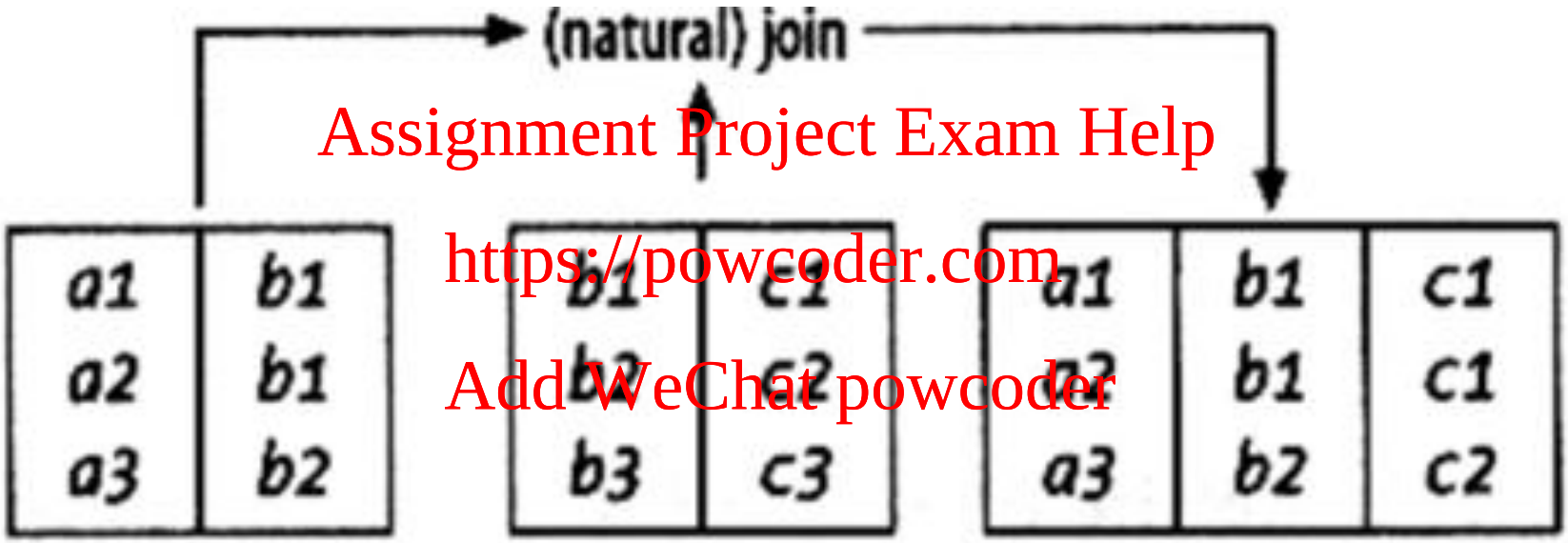




Natural Join



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PROF

pid	name	dept	rank	sal
$p1$	Adam	CS	asst	6000
$p2$	Bob	EE	asso	8000
$p3$	Calvin	CS	full	10000
$p4$	Dorothy	EE	asst	5000
$p5$	Emily	EE	asso	8000

TEACH

pid	cid	year
$p1$	$c1$	2011
$p2$	$c2$	2012
$p1$	$c2$	2012

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PROF $\bowtie$ TEACH returns:

pid	name	dept	rank	sal	cid	year
$p1$	Adam	CS	asst	6000	c_1	2011
$p2$	Bob	EE	asso	8000	c_2	2012
$p1$	Adam	CS	asst	6000	c_2	2012

How many attributes / columns are there?

Natural Join

In general:

$$T_1 \bowtie T_2 \quad = \quad \Pi_S\Big(\sigma_{T_1.A_1 = T_2.A_2 \wedge \ldots \wedge T_1.A_d = T_2.A_d}(T_1 \times T_2)\Big)$$

where

$$S = (S_1 - S_2) \cup \{T_1.A_1, \ldots, T_1.A_d\} \cup (S_2 - S_1)$$

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where S_1 and S_2 are the schemas of T_1 and T_2 respectively, and $A_1, \ldots, A_d$ are the common attributes of T_1 and T_2.

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PROF

pid	name	dept	rank	sal

TEACH

pid	cid	year

PROF $\bowtie$ TEACH

A: pid S1-S2: name, dept, rank, sal S2-S1: cid, year

pid	name	dept	rank	sal	cid	year
$p1$	Adam	CS	asst	6000	c_1	2011
$p2$	Bob	EE	asso	8000	c_2	2012
$p1$	Adam	CS	asst	6000	c_2	2012

PROF

pid	name	dept	rank	sal
$p1$	Adam	CS	asst	6000
$p2$	Bob	EE	asso	8000
$p3$	Calvin	CS	full	10000
$p4$	Dorothy	EE	asst	5000
$p5$	Emily	EE	asso	8500

TEACH

pid	cid	year
$p1$	$c1$	2011
$p2$	$c2$	2012
$p1$	$c2$	2012

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```
select distinct PROF.pid, name, dept, rank, sal, cid, year
from PROF, TEACH
where PROF.pid = TEACH.pid
```

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$\Pi_{\text{PROF.pid, name, dept, rank, sal, cid, year}}(\sigma_{\text{PROF.pid=TEACH.pid}}(\text{PROF} \times \text{TEACH}))$

$\text{PROF} \bowtie \text{TEACH}$

pid	name	dept	rank	sal	cid	year
$p1$	Adam	CS	asst	6000	c_1	2011
$p2$	Bob	EE	asso	8000	c_2	2012
$p1$	Adam	CS	asst	6000	c_2	2012

Past Muddiest Points

- RA => SQL Natural Join

- SQL: Join Condition, Inner Join, Natural Join

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- SQL: Division

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Past Muddiest Points

- Phone codes

areaCode	cityCode	cityName
40	01792	Swansea
86	10	Beijing
1	416	Toronto
1	212	NewYork

City

areaCode	areaName
40	United Kingdom
852	Hong Kong
1	North America
86	China

Area

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```
select *
from City, Area
Where City.areaCode = Area.areaCode
```

Explicit Join Condition

areaCode	cityCode	cityName	areaCode	areaName
40	01792	Swansea	40	United Kingdom
86	10	Beijing	86	China
1	416	Toronto	1	North America
1	212	NewYork	1	North America

Past Muddiest Points

- Phone codes

areaCode	cityCode	cityName
40	01792	Swansea
86	10	Beijing
1	416	Toronto
1	212	NewYork

City

areaCode	areaName
40	United Kingdom
852	Hong Kong
1	North America
86	China

Area

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```
select *
from City inner join Area
on City.areaCode = Area.areaCode
```

areaCode	cityCode	cityName	areaCode	areaName
40	01792	Swansea	40	United Kingdom
86	10	Beijing	86	China
1	416	Toronto	1	North America
1	212	NewYork	1	North America

Past Muddiest Points

- Phone codes

areaCode	cityCode	cityName
40	01792	Swansea
86	10	Beijing
1	416	Toronto
1	212	NewYork

City

areaCode	areaName
40	United Kingdom
852	Hong Kong
1	North America
86	China

Area

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```
select *
from City natural join Area
```

areaCode	cityCode	cityName	areaName
40	01792	Swansea	United Kingdom
86	10	Beijing	China
1	416	Toronto	North America
1	212	NewYork	North America

Past Muddiest Points

- One day, a guy added a column

areaCode	cityCode	cityName	lastupdate
40	01792	Swansea	1990
86	10	Beijing	1988
1	416	Toronto	1975
1	212	NewYork	1971

City

areaCode	areaName	lastupdate
40	United Kingdom	1980
852	Hong Kong	1978
1	North America	1979
86	China	1987

Area

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```
select *
from City, Area
Where City.areaCode = Area.areaCode
```

```
select *
from City inner join Area
on City.areaCode = Area.areaCode
```

areaCode	cityCode	cityName	lastupdate	areaCode	areaName	lastupdate
40	01792	Swansea	1990	40	United Kingdom	1980
86	10	Beijing	1988	86	China	1987
1	416	Toronto	1975	1	North America	1979
1	212	NewYork	1971	1	North America	1979

Past Muddiest Points

- One day, a guy added a column

areaCode	cityCode	cityName	lastupdate
40	01792	Swansea	1990
86	10	Beijing	1988
1	416	Toronto	1975
1	212	NewYork	1971

City

areaCode	areaName	lastupdate
40	United Kingdom	1980
852	Hong Kong	1978
1	North America	1979
86	China	1987

Area

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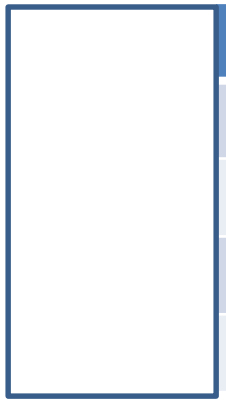
```
select *
from City natural join Area
```

areaCode	cityCode	cityName	areaName	lastupdate
empty				

Natural Join breaks the whole system!

Past Muddiest Points

- One day, the guy change the schema (by mistake)



cityCode	cityName
01792	Swansea
10	Beijing
416	Toronto
212	NewYork

City

areaCode	areaName
40	United Kingdom
852	Hong Kong
1	North America
86	China

Area

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```
select *
from City, Area
where City.areaCode = Area.areaCode
```

SQL Warning:
No areaCode

```
select *
from City inner join Area
on City.areaCode = Area.areaCode
```

```
select *
from City natural join Area
```

Cartesian Product!

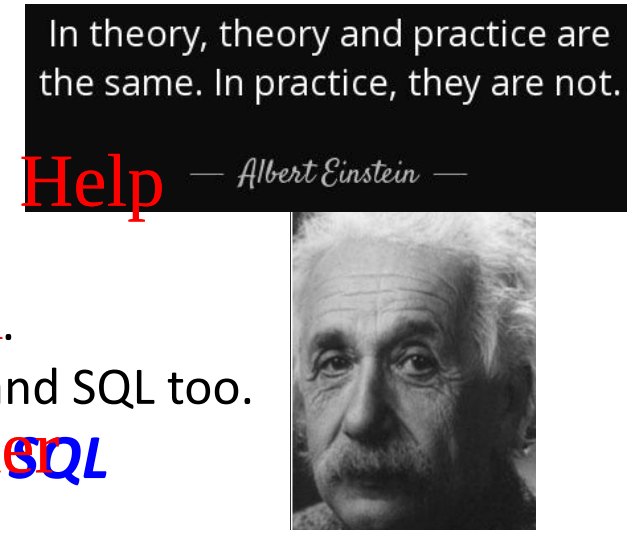
It breaks the system!
But no warning.

Past Muddiest Points

- Lesson learnt
  - Database related codes may not update for years.
  - If something wrong, you need some warnings reminders.

aka, compile-time warning in Java / C / C++. Spot mistakes early.

- Old School Wisdom
  - Use join with ***explicit join condition in SQL***
  - Never use ***Natural Join Keyword in SQL***



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- Natural join in Relational Algebra is fine.
  - Part of the theory, designed for easy manipulation.
  - You should use the ***concept*** in Relational Algebra and SQL too.
- But practically, treat ***Natural Join keyword in SQL***
  - as if it never exists, avoids it likes a plague.

- In CW2 & Exam, if you use ***natural join keyword in SQL, no marks.***
  - Learn the **correct** way of translating concept of natural join from RA to SQL.

http://www.dba-oracle.com/oracle_news/2004_2_19_rittman.htm
http://blog.mclaughlinsoftware.com/2008/05/24/unnatural-outcome-of-natural-joins
http://www.postgresqltutorial.com/postgresql-natural-join
https://stackoverflow.com/questions/1599050/ansi-vs-non-ansi-sql-join-syntax

Past Muddiest Points

- RA => SQL Natural Join
- SQL: Natural Join
- SQL: Division

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Division

- RA: Division was a bit confusing and to understand

T_1

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

T_2

cid
$c1$
$c2$
$c3$

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$T_1 \div T_2$

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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

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

Which operations go first?

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- Complex expressions can be composed recursively, just as in arithmetic.

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- Parentheses and precedence rules define the order of evaluation.

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- Precedence, from highest to lowest, is:
  σ, Π, ρ
  $\times$, $\bowtie$
  $\cap$, $\div$
  $\cup$, $-$
- Unless very sure, use brackets!

SQL and Division

(select pid from T_1)
minus
select pid from (
(select * from (select pid from T_1), T_2)
minus
(select * from T_1))

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

SQL and Division

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(select pid from T_1)

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$\Pi_{S_1-S_2}(T_1)$

SQL and Division

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(select * from (select pid from T_1), T_2)

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

SQL and Division

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(select * from (select pid from T_1), T_2)
minus
(select * from T_1)

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

SQL and Natural Join

```
select pid from (
(select * from (select pid from T1), T2)
minus
(select * from T1))
```

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

SQL and Natural Join

(select pid from T_1)

select pid from (
(select * from (select pid from T_1), T_2)
minus
(select * from T_1))

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

SQL and Division

(select pid from T_1)
minus
select pid from (
(select * from (select pid from T_1), T_2)
minus
(select * from T_1))

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