

# Tutorial on Relational Algebra

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# Reminder

1. *SELECT*

$$\sigma_{\{selection\_condition\}}R$$

2. *PROJECT*

$$\pi_{\{attribute\_list\}}R$$

3. *UNION*

$$R \cup S$$

4. *INTERSECTION*

$$R \cap S$$

5. *SET\_DIFFERENCE*

$$R - S$$

*Aka. MINUS*

6. *JOIN*

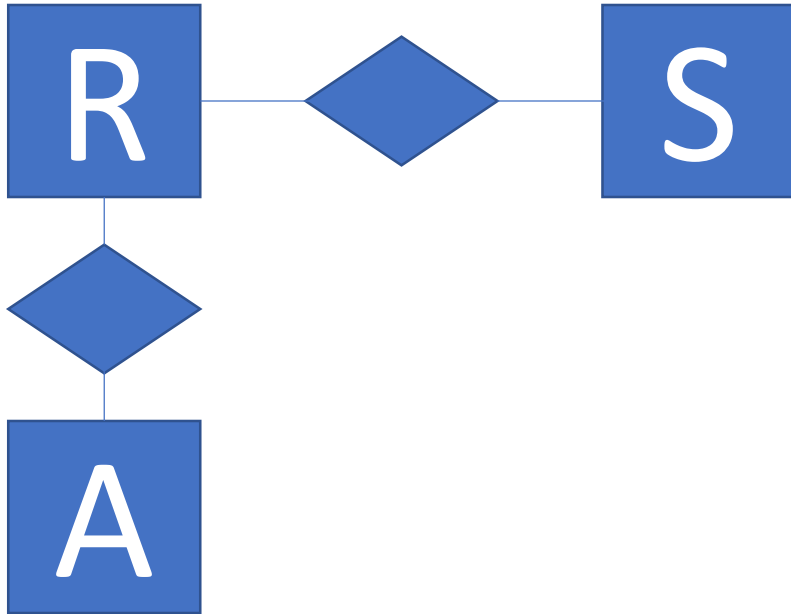
$$R \bowtie_{join\_condition} S$$

7. *NATURAL\_JOIN*

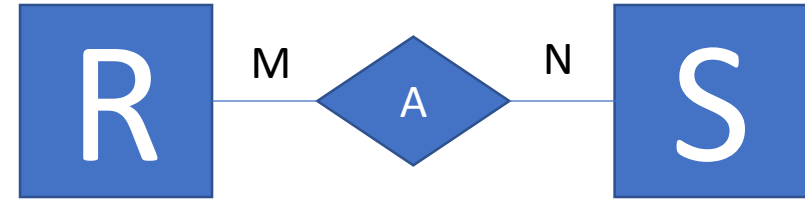
$$R \bowtie S$$

*R & S have at least 1 attribute  
with the same name*

# Most common mistakes



- Joining two relations that are not connected through a relationship (S & A)



- To join two relations that participate in an M-N relationship (i.e. R & S), you also need to join them with their *relationship relation* (i.e. A).
- $R \bowtie S$  is wrong
- $R \bowtie S \bowtie A$  is correct

# Most common mistakes

- Referring to individual relations within an RA operation
- Every expression creates a new relation with an unknown name. You can't refer to individual relations within an expression
- Wrong:  $\pi_{R_a}(R \bowtie S)$
- Correct:  $\pi_a(R \bowtie S)$

# Most common mistakes

- Use one-liners with caution, if not at all!

$$(\pi_{Pno}((\rho_{Essn})(\pi_{Ssn}(\sigma_{Lname='Smith'}(EMPLOYEE)))) \bowtie WORKS\_ON)) \cup \\ (\rho_{Pno}(\pi_{Pnumber}((\rho_{Dnum}(\pi_{Dnumber}(\sigma_{Lname='Smith'}(\pi_{Lname,Dnumber}(EMPLOYEE \bowtie_{Ssn=Mgr\_ssn} \\ DEPARTMENT)))))) \bowtie PROJECT)))$$

Retrieve the name and address of all employees who work for the 'Research' department.

# Exercise 1

## EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
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## DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
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## DEPT\_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
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## PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
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## WORKS\_ON

<u>Essn</u>	<u>Pno</u>	Hours
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## DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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# Solution

RESEARCH\_DEPT  $\leftarrow \sigma_{\text{Dname}=\text{'Research'}}(\text{DEPARTMENT})$

RESEARCH\_EMPS  $\leftarrow (\text{RESEARCH_DEPT} \bowtie_{\text{Dnumber}=\text{Dno}} \text{EMPLOYEE})$

RESULT  $\leftarrow \pi_{\text{Fname, Lname, Address}}(\text{RESEARCH_EMPS})$

# Exercise 2

For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birth date.

## EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
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## DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
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## DEPT\_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
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## PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
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## WORKS\_ON

<u>Essn</u>	<u>Pno</u>	Hours
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## DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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# Solution

STAFFORD\_PROJS  $\leftarrow \sigma_{Plocation='Stafford'}(PROJECT)$   
CONTR\_DEPTS  $\leftarrow (STAFFORD\_PROJS \bowtie_{Dnum=Dnumber} DEPARTMENT)$   
PROJ\_DEPT\_MGRS  $\leftarrow (CONTR\_DEPTS \bowtie_{Mgr\_ssn=Ssn} EMPLOYEE)$   
RESULT  $\leftarrow \pi_{Pnumber, Dnum, Lname, Address, Bdate}(PROJ\_DEPT\_MGRS)$

# Exercise 3

Retrieve the names of employees who have no dependents.

## EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
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## DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
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## DEPT\_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
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## PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
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## WORKS\_ON

<u>Essn</u>	<u>Pno</u>	Hours
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## DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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# Solution

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ALL_EMPS  $\leftarrow \pi_{Ssn}(\text{EMPLOYEE})$   
EMPS_WITH_DEPS(Ssn)  $\leftarrow \pi_{Essn}(\text{DEPENDENT})$   
EMPS_WITHOUT_DEPS  $\leftarrow (\text{ALL\_EMPS} - \text{EMPS\_WITH\_DEPS})$   
RESULT  $\leftarrow \pi_{Lname, Fname}(\text{EMPS\_WITHOUT\_DEPS} \bowtie \text{EMPLOYEE})$ 
```

# Exercise 4

List the names of managers (i.e. department managers) who have at least one dependent.

## EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
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## DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
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## DEPT\_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
----------------	------------------

## PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------

## WORKS\_ON

<u>Essn</u>	<u>Pno</u>	Hours
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## DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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# Solution

$\text{MGRS}(\text{Ssn}) \leftarrow \pi_{\text{Mgr\_ssn}}(\text{DEPARTMENT})$

$\text{EMPS\_WITH\_DEPS}(\text{Ssn}) \leftarrow \pi_{\text{Essn}}(\text{DEPENDENT})$

$\text{MGRS\_WITH\_DEPS} \leftarrow (\text{MGRS} \cap \text{EMPS\_WITH\_DEPS})$

$\text{RESULT} \leftarrow \pi_{\text{Lname, Fname}}(\text{MGRS\_WITH\_DEPS} \bowtie \text{EMPLOYEE})$

# Exercise 5

Make a list of project numbers for projects that involve an employee whose last name is 'Smith', either as a worker or as a manager of the department that controls the project.

## EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

## DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
-------	----------------	---------	----------------

## DEPT\_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
----------------	------------------

## PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------

## WORKS\_ON

<u>Essn</u>	<u>Pno</u>	Hours
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## DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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# Solution

$\text{SMITHS}(\text{Essn}) \leftarrow \pi_{\text{Ssn}} (\sigma_{\text{Lname}='Smith'}(\text{EMPLOYEE}))$   
 $\text{SMITH\_WORKER\_PROJS} \leftarrow \pi_{\text{Pno}}(\text{WORKS\_ON} \bowtie \text{SMITHS})$   
 $\text{MGRS} \leftarrow \pi_{\text{Lname}, \text{Dnumber}}(\text{EMPLOYEE} \bowtie_{\text{Ssn}=\text{Mgr\_ssn}} \text{DEPARTMENT})$   
 $\text{SMITH\_MANAGED\_DEPTS}(\text{Dnum}) \leftarrow \pi_{\text{Dnumber}} (\sigma_{\text{Lname}='Smith'}(\text{MGRS}))$   
 $\text{SMITH\_MGR\_PROJS}(\text{Pno}) \leftarrow \pi_{\text{Pnumber}}(\text{SMITH\_MANAGED\_DEPTS} \bowtie \text{PROJECT})$   
 $\text{RESULT} \leftarrow (\text{SMITH\_WORKER\_PROJS} \cup \text{SMITH\_MGR\_PROJS})$

# References

- Ramez Elmasri and Shamkant Navathe. 2010. *Fundamentals of Database Systems* (6th ed.). Addison-Wesley Publishing Company, , USA.

