Query examples with relational algebra

Selection Operation

- select those tuples of the instructor relation where t he instructor is in the "Physics" department.
- Query

$$\sigma_{\text{dept\_name="Physics"}}(\text{instructor})$$

- Result

ID	*name*	*dept_name*	*salary*
22222	Einstein	Physics	95000
33456	Gold	Physics	87000

Selection Operation

- Find the instructors in Physics with a salary greater $90,000

$$\sigma_{\text{dept\_name= ``Physics''} \wedge \text{salary} > 90{,}000}(\text{instructor})$$

- Find all departments whose name is the same as their building name:
  - $\sigma_{\text{dept\_name=building}}$ (department)

Projection Operation

- Eliminate the dept_name attribute of instructor
- Query:

$$\Pi_{ID,\ name,\ salary}\ (instructor)$$

- Result:

ID	*name*	*salary*
10101	Srinivasan	65000
12121	Wu	90000
15151	Mozart	40000
22222	Einstein	95000
32343	El Said	60000
33456	Gold	87000
45565	Katz	75000
58583	Califieri	62000
76543	Singh	80000
76766	Crick	72000
83821	Brandt	92000
98345	Kim	80000

Composition Operation

- Find the names of all instructors in the Physics department.

$$\Pi_{name}(\sigma_{dept\_name = \text{“Physics”}} (instructor))$$

ID	*name*	*dept_name*	*salary*
22222	Einstein	Physics	95000
12121	Wu	Finance	90000
32343	El Said	History	60000
45565	Katz	Comp. Sci.	75000
98345	Kim	Elec. Eng.	80000
76766	Crick	Biology	72000
10101	Srinivasan	Comp. Sci.	65000
58583	Califieri	History	62000
83821	Brandt	Comp. Sci.	92000
15151	Mozart	Music	40000
33456	Gold	Physics	87000
76543	Singh	Finance	80000

Join Operation

- To get only those tuples of "instructor X teaches " that pertain to instructors and the courses that they taught

  $\sigma_{\text{instructor.id} = \text{teaches.id}}$ (instructor x teaches))

- Can equivalently be written as with natural join

  $instructor \bowtie_{Instructor.id = teaches.id} teaches$.

- The result of this expression, shown in the next slide

The *instructor* x *teaches table*

instructor.ID	*name*	*dept_name*	*salary*	*teaches.ID*	*course_id*	*sec_id*	*semester*	*year*
10101	Srinivasan	Comp. Sci.	65000	10101	CS-101	1	Fall	2017
10101	Srinivasan	Comp. Sci.	65000	10101	CS-315	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	10101	CS-347	1	Fall	2017
10101	Srinivasan	Comp. Sci.	65000	12121	FIN-201	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	15151	MU-199	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	22222	PHY-101	1	Fall	2017
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
12121	Wu	Finance	90000	10101	CS-101	1	Fall	2017
12121	Wu	Finance	90000	10101	CS-315	1	Spring	2018
12121	Wu	Finance	90000	10101	CS-347	1	Fall	2017
12121	Wu	Finance	90000	12121	FIN-201	1	Spring	2018
12121	Wu	Finance	90000	15151	MU-199	1	Spring	2018
12121	Wu	Finance	90000	22222	PHY-101	1	Fall	2017
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
15151	Mozart	Music	40000	10101	CS-101	1	Fall	2017
15151	Mozart	Music	40000	10101	CS-315	1	Spring	2018
15151	Mozart	Music	40000	10101	CS-347	1	Fall	2017
15151	Mozart	Music	40000	12121	FIN-201	1	Spring	2018
15151	Mozart	Music	40000	15151	MU-199	1	Spring	2018
15151	Mozart	Music	40000	22222	PHY-101	1	Fall	2017
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
22222	Einstein	Physics	95000	10101	CS-101	1	Fall	2017
22222	Einstein	Physics	95000	10101	CS-315	1	Spring	2018
22222	Einstein	Physics	95000	10101	CS-347	1	Fall	2017
22222	Einstein	Physics	95000	12121	FIN-201	1	Spring	2018
22222	Einstein	Physics	95000	15151	MU-199	1	Spring	2018
22222	Einstein	Physics	95000	22222	PHY-101	1	Fall	2017
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

$\sigma_{instructor.id = teaches.id}(instructor \times teaches))$ table

instructor.ID	name	dept_name	salary	teaches.ID	course_id	sec_id	semester	year
10101	Srinivasan	Comp. Sci.	65000	10101	CS-101	1	Fall	2017
10101	Srinivasan	Comp. Sci.	65000	10101	CS-315	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	10101	CS-347	1	Fall	2017
12121	Wu	Finance	90000	12121	FIN-201	1	Spring	2018
15151	Mozart	Music	40000	15151	MU-199	1	Spring	2018
22222	Einstein	Physics	95000	22222	PHY-101	1	Fall	2017
32343	El Said	History	60000	32343	HIS-351	1	Spring	2018
45565	Katz	Comp. Sci.	75000	45565	CS-101	1	Spring	2018
45565	Katz	Comp. Sci.	75000	45565	CS-319	1	Spring	2018
76766	Crick	Biology	72000	76766	BIO-101	1	Summer	2017
76766	Crick	Biology	72000	76766	BIO-301	1	Summer	2018
83821	Brandt	Comp. Sci.	92000	83821	CS-190	1	Spring	2017
83821	Brandt	Comp. Sci.	92000	83821	CS-190	2	Spring	2017
83821	Brandt	Comp. Sci.	92000	83821	CS-319	2	Spring	2018
98345	Kim	Elec. Eng.	80000	98345	EE-181	1	Spring	2017

Union Operation

- Find all courses taught in the Fall 2017 semester, or in the Spring 2018 semester, or in both

$$\Pi_{\text{course\_id}} (\sigma_{\text{semester="Fall"} \wedge \text{year=2017}} (\text{section})) \cup \Pi_{\text{course\_id}} (\sigma_{\text{semester="Spring"} \wedge \text{year=2018}} (\text{section}))$$

- Result

course_id
CS-101
CS-315
CS-319
CS-347
FIN-201
HIS-351
MU-199
PHY-101

Set-Intersection Operation

- Find the set of all courses taught in both the Fall 2017 and the Spring 2018 semesters.

$$\Pi_{\text{course\_id}} (\sigma_{\text{semester="Fall"} \wedge \text{year=2017}} (\text{section})) \cap \Pi_{\text{course\_id}} (\sigma_{\text{semester="Spring"} \wedge \text{year=2018}} (\text{section}))$$

- Result

course_id
CS-101

ID	name	dept_name	salary
22222	Einstein	Physics	95000
12121	Wu	Finance	90000
32343	El Said	History	60000
45565	Katz	Comp. Sci.	75000
98345	Kim	Elec. Eng.	80000
76766	Crick	Biology	72000
10101	Srinivasan	Comp. Sci.	65000
58583	Califieri	History	62000
83821	Brandt	Comp. Sci.	92000
15151	Mozart	Music	40000
33456	Gold	Physics	87000
76543	Singh	Finance	80000

lent Queries

ne way to write a query in

- Example: Find information about instructors in the Physics department with salary greater than 90,000
- Query 1

$$\sigma_{\text{dept\_name=“Physics”} \wedge \text{salary} > 90{,}000}(\text{instructor})$$

- Query 2

$$\sigma_{\text{dept\_name=“Physics”}}(\sigma_{\text{salary} > 90.000}(\text{instructor}))$$

Equivalent Queries

- There is more than one way to write a que relational algebra.
- Example: Find information about courses instructors in the Physics department
- Query 1

$\sigma_{\text{dept\_name=“Physics”}}$ (instructor) $\bowtie_{\text{instructor.ID = teaches}}$

- Query 2

$\sigma_{\text{dept\_name=“Physics”}}$ (instructor $\bowtie_{\text{instructor.ID = teaches.ID}}$ teaches)

ID	name	dep
22222	Einstein	Phy
12121	Wu	Fin
32343	El Said	His

ID	course_id	sec_id
10101	CS-101	1
10101	CS-315	1
10101	CS-347	1
12121	FIN-201	1
15151	MU-199	1
22222	PHY-101	1
32343	HIS-351	1
45565	CS-101	1
45565	CS-319	1
76766	BIO-101	1
76766	BIO-301	1
83821	CS-190	1
83821	CS-190	2
83821	CS-319	2
98345	EE-181	1

1. $\sigma_{\text{dept\_name=“Physics”}}(\text{instructor}) \bowtie_{\text{instructor.ID = teaches.ID}} \text{teaches}$

2. $\sigma_{\text{dept\_name=“Physics”}}(\text{instructor} \bowtie_{\text{instructor.ID = teaches.ID}} \text{teaches})$

ID	*name*	*dept_name*	*salary*
10101	Srinivasan	Comp. Sci.	65000
12121	Wu	Finance	90000
15151	Mozart	Music	40000
22222	Einstein	Physics	95000
32343	El Said	History	60000
33456	Gold	Physics	87000
45565	Katz	Comp. Sci.	75000
58583	Califieri	History	62000
76543	Singh	Finance	80000
76766	Crick	Biology	72000
83821	Brandt	Comp. Sci.	92000
98345	Kim	Elec. Eng.	80000

Figure 2.1 The *instructor* relation.

ID	*course_id*	*sec_id*	*semester*	*year*
10101	CS-101	1	Fall	2009
10101	CS-315	1	Spring	2010
10101	CS-347	1	Fall	2009
12121	FIN-201	1	Spring	2010
15151	MU-199	1	Spring	2010
22222	PHY-101	1	Fall	2009
32343	HIS-351	1	Spring	2010
45565	CS-101	1	Spring	2010
45565	CS-319	1	Spring	2010
76766	BIO-101	1	Summer	2009
76766	BIO-301	1	Summer	2010
83821	CS-190	1	Spring	2009
83821	CS-190	2	Spring	2009
83821	CS-319	2	Spring	2010
98345	EE-181	1	Spring	2009

Figure 2.7 The *teaches* relation.

ID	Name	Dept_name	Salary
22222	Einstein	Physics	95000
33456	Gold	Physics	87000

ID	Name	Dept_name	Salary	Course_id	Sec_id	semester	Year
22222	Einstein	Physics	95000	PHY-101	1	Fall	2009

1 $\sigma_{\text{dept\_name=“Physics”}}$ (instructor) $\bowtie_{\text{instructor.ID = teaches.ID}}$ teaches

2 $\sigma_{\text{dept\_name=“Physics”}}$ (instructor $\bowtie_{\text{instructor.ID = teaches.ID}}$ teaches)

instructor.ID	*name*	*dept_name*	*salary*	*teaches.ID*	*course_id*	*sec_id*	*semester*	*year*
10101	Srinivasan	Comp. Sci.	65000	10101	CS-101	1	Fall	2017
10101	Srinivasan	Comp. Sci.	65000	10101	CS-315	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	10101	CS-347	1	Fall	2017
12121	Wu	Finance	90000	12121	FIN-201	1	Spring	2018
15151	Mozart	Music	40000	15151	MU-199	1	Spring	2018
22222	Einstein	Physics	95000	22222	PHY-101	1	Fall	2017
32343	El Said	History	60000	32343	HIS-351	1	Spring	2018
45565	Katz	Comp. Sci.	75000	45565	CS-101	1	Spring	2018
45565	Katz	Comp. Sci.	75000	45565	CS-319	1	Spring	2018
76766	Crick	Biology	72000	76766	BIO-101	1	Summer	2017
76766	Crick	Biology	72000	76766	BIO-301	1	Summer	2018
83821	Brandt	Comp. Sci.	92000	83821	CS-190	1	Spring	2017
83821	Brandt	Comp. Sci.	92000	83821	CS-190	2	Spring	2017
83821	Brandt	Comp. Sci.	92000	83821	CS-319	2	Spring	2018
98345	Kim	Elec. Eng.	80000	98345	EE-181	1	Spring	2017