Relational Algebra and Relational Calculus

Part I: Unary Operations

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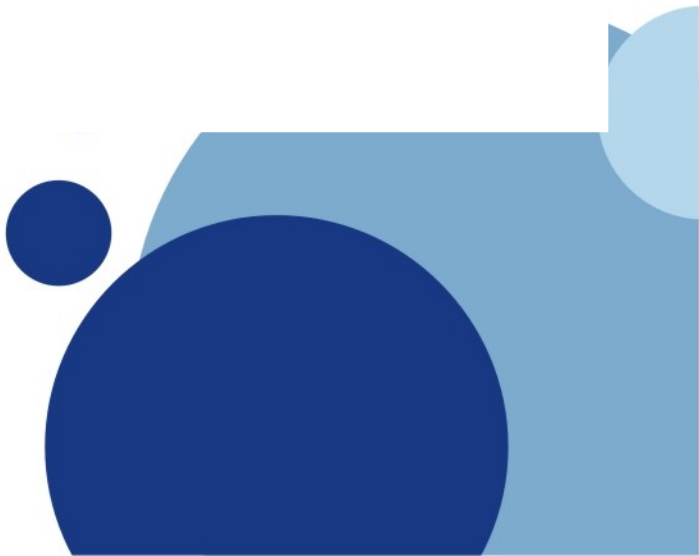

Outline

- **Unary operations**
  - **SELECT**
  - **PROJECT**
- Binary Operations
  - CROSS PRODUCT (aka CARTESIAN PRODUCT, CROSS JOIN)
  - JOIN
    - INNER JOIN (aka EQUIJOIN)
    - LEFT | RIGHT OUTER JOIN
    - THETA JOIN
  - UNION
  - INTERSECTION
  - DIFFERENCE (aka MINUS, EXCEPT)
  - DIVISION
- Existential and Universal Quantifiers

SELECT Operation

- The select operation selects tuples that satisfy a given *predicate*. We use the lowercase Greek letter sigma (σ) to denote *selection*.
- Query: ***All instructors of Physics departement***

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

predicate

relation

SQL statement:

```
SELECT *
FROM  instructor
WHERE dept_name = 'Physics';
```

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

Query resultset

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

Instructor relation

SELECT Operation –more examples

- Query: *All instructors with salary greater than $90,000*

  RA Expression: $\sigma_{\text{salary >= 90000}}$ **(instructor)**

  SQL statement:

```
SELECT *
FROM  instructor
WHERE salary >= 90000;
```

- Query: *All instructors in Physics with a salary greater than $90,000*

  RA Expression: $\sigma_{\text{(salary >= 90000)} \wedge \text{(dept\_name = “Physics”)}}$ **(instructor)**

  SQL statement:

```
SELECT *
FROM  instructor
WHERE (salary >= 90000) AND (dept_name = 'Physics');
```

SELECT Operation –more examples

- Query: *All instructors in Physics or Music*

  RA Expression: $\sigma_{(dept\_name = \text{“Music”}) \vee (dept\_name = \text{“Physics”})}$ **(instructor)**

  SQL statement:

```
SELECT *
FROM  instructor
WHERE (dept_name = 'Music') OR  (dept_name = 'Physics');
```

  –

```
SELECT *
FROM  instructor
WHERE dept_name IN ('Music', 'Physics');
```

list-of-values

SELECT Operation –more examples

- Query: *All instructors not in Physics*

  RA Expression: $\sigma_{\text{NOT(dept\_name = “Physics”)}}$ **(instructor)**

  SQL statement:

```
SELECT *
FROM  instructor
WHERE dept_name <> 'Physics';
–
SELECT *
FROM  instructor
WHERE dept_name NOT IN ('Physics');
```

list-of-values

SELECT Operation properties

- SELECT operation is **commutative**; that is,

  $\sigma_{<cond1>}(\sigma_{<cond2>}(R)) = \sigma_{<cond2>}(\sigma_{<cond1>}(R))$

- Combine a cascade (or sequence) of SELECT operations into a single SELECT operation with a conjunctive (AND) condition;

  $\sigma_{<cond1>}(\sigma_{<cond2>}(\ldots(\sigma_{<condn>}(R))\ldots))$

  $= \sigma_{<cond1> \text{ AND } <cond2> \text{ AND} \ldots \text{AND } <condn>}(R)$

PROJECT Operation

- The project operation is a unary operation that returns its argument relation, with certain attributes left out.
- Since a relation is a set, any duplicate rows are eliminated.
- Projection is denoted by the uppercase Greek letter pi (Π).

  Π **<list of columns>** **(R)**

- Query: ***Show ID, name and salary of all instructors***

  RA Expression: **Π** **ID, name, salary** **(instructor)**

  SQL statement:

```
SELECT DISTINCT id, name, salary
FROM  instructor;
```

PROJECT Operation

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

Instructor relation

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

Query resultset

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

Composition of SELECT and PROJECT Operations

- Query: *Find the names of all instructors in the Physics department*

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

SQL statement:

```
SELECT DISTINCT name
FROM  instructor
WHERE dept_name = 'Physics';
```