



Relational Algebra

ERIN KEITH

Goals

1. Introduce Relational Algebra
2. Practice!

Relational Algebra

Selection	σ
Projection	π
Renaming	ρ
Union	\cup
Intersection	\cap
Difference	$-$
Cartesian product	\times
Join	\bowtie

Relational Algebra

Union – set of all elements in each relation (duplicates are removed)

Intersection – set of elements that are only in both relations

Difference – set of elements in one relation but not the other (order matters)

- The relations must have schemas with identical sets of attributes.
- The types (domains) and order for each attribute must be the same
- This may require renaming of attributes in one or both relations

Relational Algebra

Projection – eliminates some columns

Selection – eliminates some rows (tuples)

Cartesian Product – pairs tuples of two relations in all possible ways

Join – selectively pairs tuples from two relations

<i>title</i>	<i>year</i>	<i>length</i>	<i>genre</i>	<i>studioName</i>	<i>producerC#</i>
Star Wars	1977	124	sciFi	Fox	12345
Galaxy Quest	1999	104	comedy	DreamWorks	67890
Wayne's World	1992	95	comedy	Paramount	99999

Figure 2.13: The relation *Movies*

Projection

- Performed on one relation
- Produces a subset of columns

$\pi_{title, year, length}(\text{Movies})$

<i>title</i>	<i>year</i>	<i>length</i>	<i>genre</i>	<i>studioName</i>	<i>producerC#</i>
Star Wars	1977	124	sciFi	Fox	12345
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<i>title</i>	<i>year</i>	<i>length</i>
Star Wars	1977	124
Galaxy Quest	1999	104
Wayne's World	1992	95

Selection

- Performed on one relation
- Produces a subset of tuples

$\sigma_{length \geq 100}(\text{Movies})$

<i>title</i>	<i>year</i>	<i>length</i>	<i>genre</i>	<i>studioName</i>	<i>producerC#</i>
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Cartesian Product

- Performed on two relations
- Produces all possible combinations of tuples

<i>A</i>	<i>B</i>
1	2
3	4

(a) Relation *R*

<i>B</i>	<i>C</i>	<i>D</i>
2	5	6
4	7	8
9	10	11

(b) Relation *S*

<i>A</i>	<i>R.B</i>	<i>S.B</i>	<i>C</i>	<i>D</i>
1	2	2	5	6
1	2	4	7	8
1	2	9	10	11
3	4	2	5	6
3	4	4	7	8
3	4	9	10	11

(c) Result $R \times S$

(natural) Joins

- Performed on two relations
- Produces combinations of tuples where values in a column match

<i>A</i>	<i>B</i>
1	2
3	4

(a) Relation *R*

<i>B</i>	<i>C</i>	<i>D</i>
2	5	6
4	7	8
9	10	11

(b) Relation *S*

<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
1	2	5	6
3	4	7	8

(c) Result $R \bowtie S$

(natural) Joins

- Performed on two relations
- Produces combinations of tuples where values in a column match

<i>A</i>	<i>B</i>	<i>C</i>
1	2	3
6	7	8
9	7	8

(a) Relation *U*

<i>B</i>	<i>C</i>	<i>D</i>
2	3	4
2	3	5
7	8	10

(b) Relation *V*

<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
1	2	3	4
1	2	3	5
6	7	8	10
9	7	8	10

(c) Result $U \bowtie V$

Figure 2.16: Natural join of relations

Practice

Provide the results for the following query on the relation below.

$\pi_{title, year}(\sigma_{length \geq 100 \text{ AND } studioName = 'Fox'}(Movies))$

Selection	σ
Projection	π
Renaming	ρ
Union	\cup
Intersection	\cap
Difference	$-$
Cartesian product	\times
Join	\bowtie
Logical AND	\wedge
Logical OR	\vee
Logical NOT	\sim

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Figure 2.13: The relation Movies

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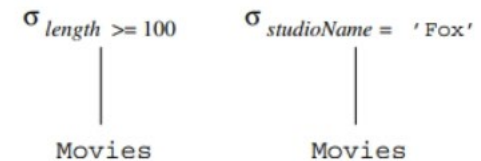


Figure 2.18: Expression tree for a relational algebra expression

<i>title</i>	<i>year</i>	<i>length</i>	<i>genre</i>	<i>studioName</i>	<i>producerC#</i>
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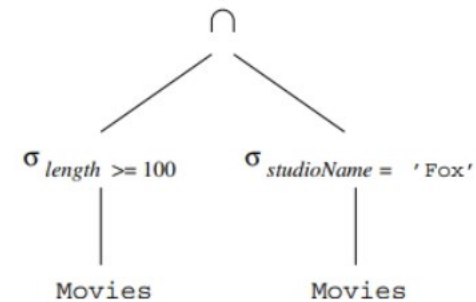


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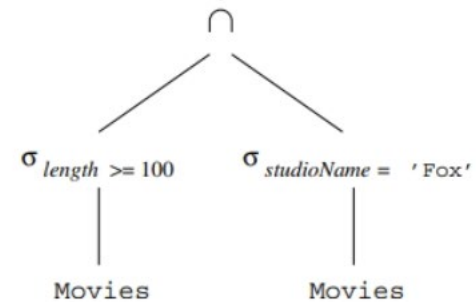


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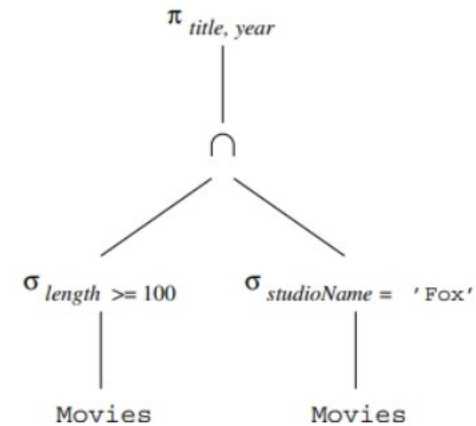


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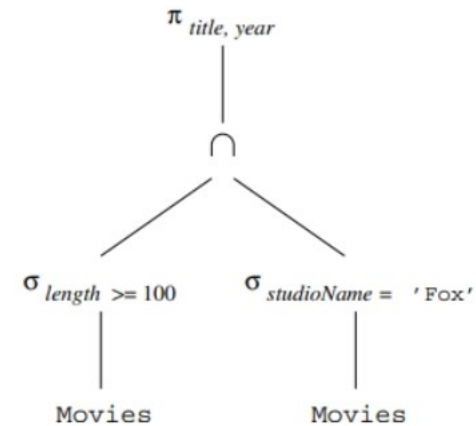


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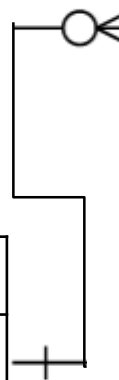
title	year
Star Wars	1977

Practice

College Rankings

- How much was in-state tuition at UNR?

Tuition		
PK, FK	inst	int
PK	year	int
	instate	float
	outstate	float
	room_board	float



Institution		
PK	UNITID	int
	name	varchar(255)
	address	varchar(255)
	city	varchar(128)
	state	char(2)

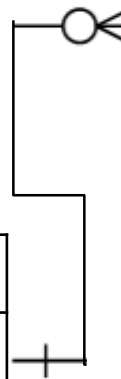
$\pi_{\text{instate}}(\sigma_{\text{name}='UNR'}(\text{Tuition} \bowtie \text{Institution}))$

Practice

College Rankings

- How much was in-state tuition at UNR in 2023?

Tuition		
PK, FK	inst	int
PK	year	int
	instate	float
	outstate	float
	room_board	float



Institution		
PK	UNITID	int
	name	varchar(255)
	address	varchar(255)
	city	varchar(128)
	state	char(2)

$\pi_{\text{instate}}(\sigma_{\text{year}=2023 \text{ AND name}='UNR'}(\text{Tuition} \bowtie \text{Institution}))$

Activity

In pairs, come up with 3 more questions you would have about this data.

Write out the corresponding relational algebra expressions.

Next Class

Module:

Week 6: Ch 5.1

Topic:

Relational Operations on Bags

