CSE 462
Database Concepts

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Some Information

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  - Website
    - http://www-student.cse.buffalo.edu/~dlessa/cse462/

Last Week Topics

- Relational Model
  - Relation schema
  - Relation instance
  - Tuples, Attributes, Keys, etc…
- Relational Algebra
  - Selection, Projection, Renaming
  - Cartesian product, Joins
  - Union, Intersection, Difference
  - Quotient

Outline

- Relational Algebra
  - Operators
  - Notations
  - How to write queries using relational algebra

Relational Algebra Operators

Set Difference ($-$)

$S_1 - S_2$ contains the rows in S_1 but not in S_2.

Set Union ($\cup$)

$S_1 \cup S_2$ contains the rows in S_1 or in S_2.

Set Intersection ($\cap$)

$S_1 \cap S_2$ contains the rows in S_1 and S_2.

Relational Algebra Operators

Selection (σ)

$\sigma_E(R)$ contains the subset of rows (horizontal) in R that satisfies E.

Projection (π)

$\pi_{A_1,\ldots,A_k}(R)$ contains the subset of columns (vertical) $A_1, \ldots, A_k$ for all rows in R.

Renaming (ρ)

Assume relation R has attributes $A_1, , \ldots, A_k$.

- $R(B_1, , \ldots, B_k)$ returns the rows of R with attributes renamed as $B_1, , \ldots, B_k$.
- $\rho_S(R)$ returns R renamed as S but attribute names unmodified.
- $\rho_{S(B_1,,\ldots,B_k)}(R)$ returns R renamed as S and attributes renamed as $B_1, , \ldots, B_k$.

Relational Algebra Operators

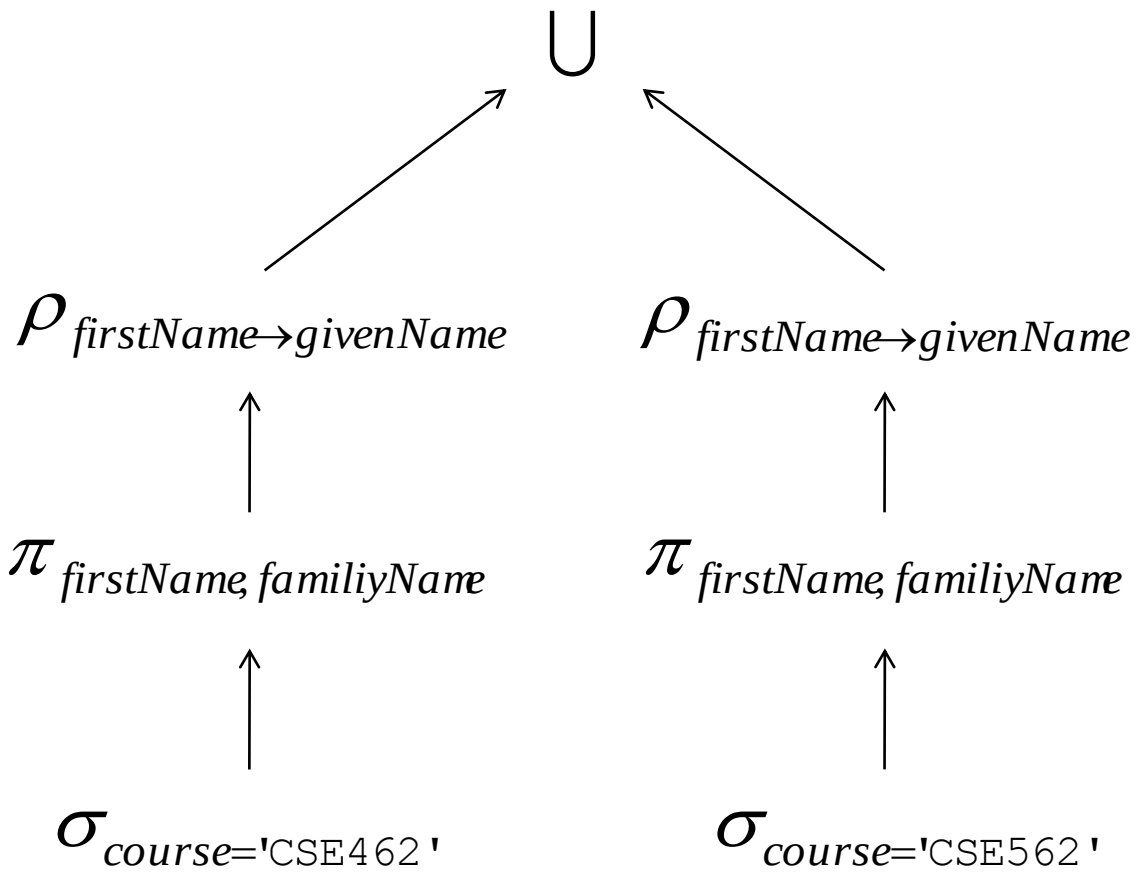
Cartesian Product ($\times$)

$R_1 \times R_2$ contains the rows formed by pairing each row of R_1 with each row of R_2.

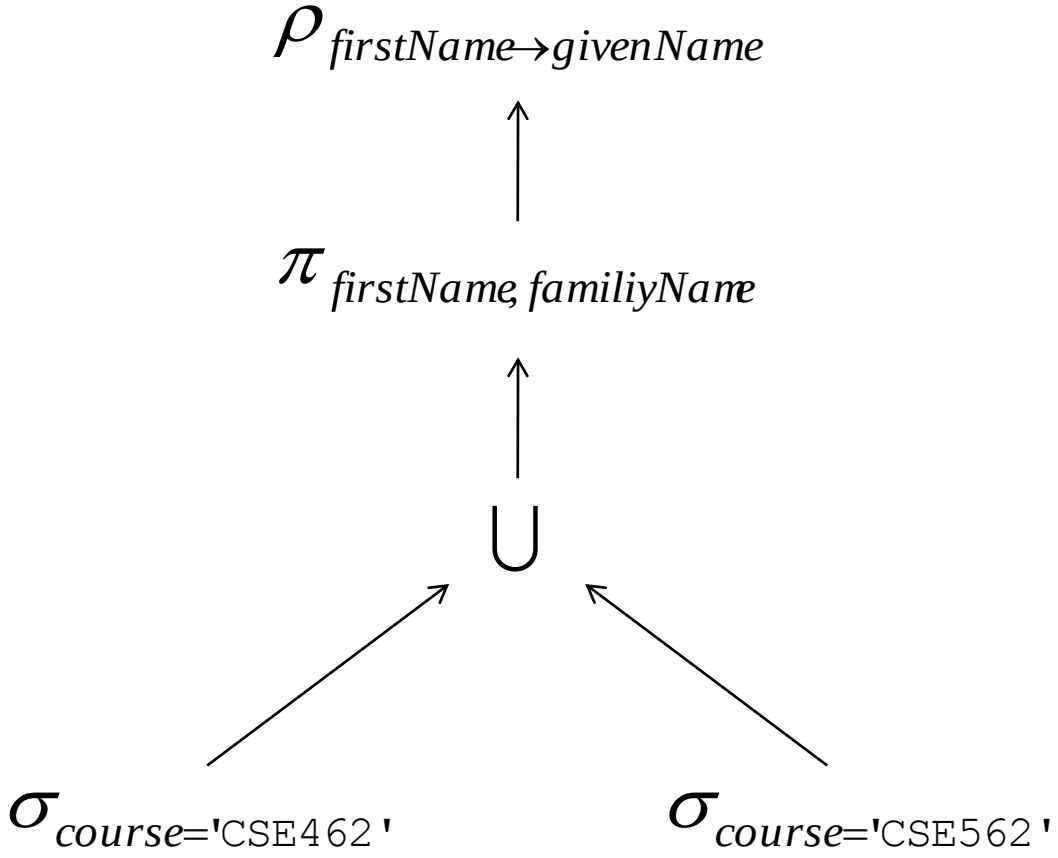
θ-Join ($\bowtie_\theta$)

$R_1 \bowtie_\theta R_2 = \sigma_\theta(R_1 \times R_2)$, that is, the θ-join of R_1 and R_2 is equivalent to first taking the cross product of R_1 and R_2 and then applying the selection σ_θ to the result, where θ is a predicate involving the attributes of R_1 and R_2.

What is this?


$\cup$
$\rho_{firstName \to givenName}$
$\rho_{firstName \to givenName}$
$\pi_{firstName, familiyName}$
$\pi_{firstName, familiyName}$
$\sigma_{course='CSE462'}$
$\sigma_{course='CSE562'}$

What is this?


$\rho_{firstName \to givenName}$
$\pi_{firstName, familiyName}$
$\cup$
$\sigma_{course='CSE462'}$
$\sigma_{course='CSE562'}$

Beer Drinkers Database

Query: **List all drinkers who frequent only bars that serve some beer that they like**

Frequents	
drinker	**bar**
Bob	Cozumel
Bob	Hardware
Joe	Pearl St
Jane	Cozumel
Suzie	Hardware
Suzie	Pearl St

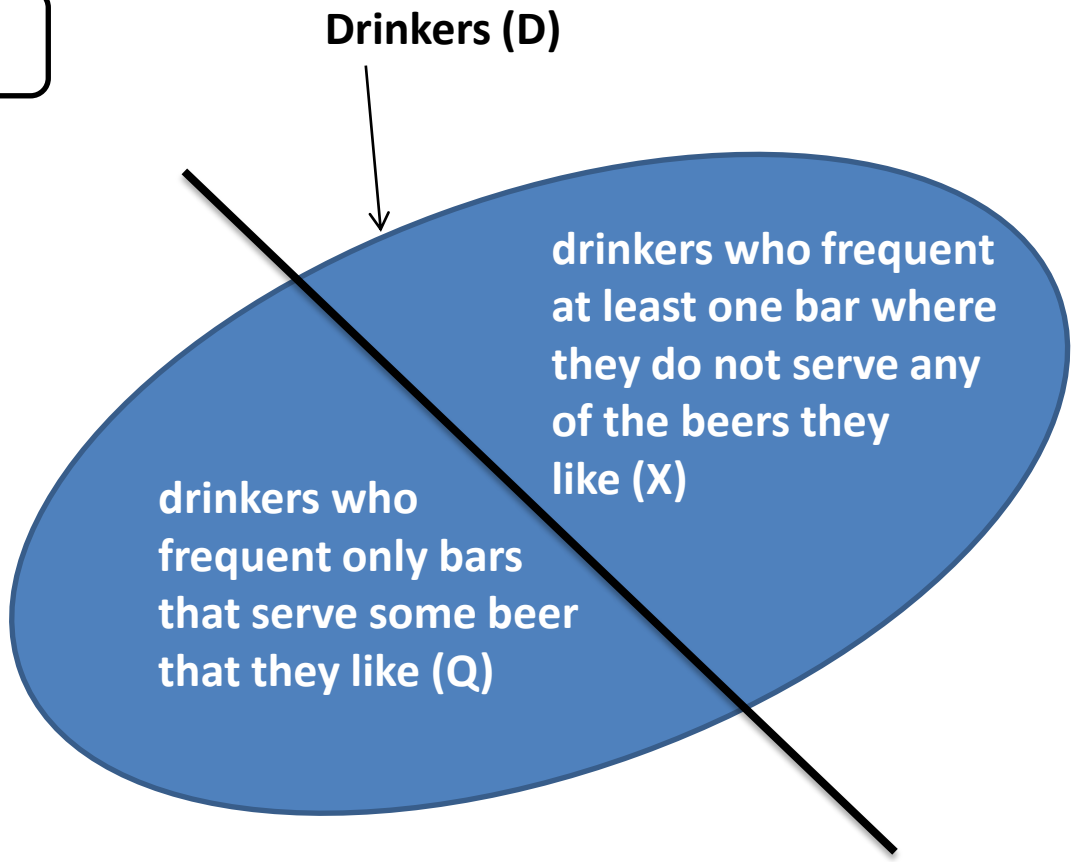
Serves	
bar	**beer**
Cozumel	Budweiser
Cozumel	Heineken
Hardware	Budweiser
Hardware	Miller
Pearl St	Heineken

Likes	
drinker	**beer**
Bob	Budweiser
Joe	Heineken
Jane	Labatt Blue
Jane	Molsen
Suzie	Miller

Beer Drinkers Database

Query: **List all drinkers who frequent only bars that serve some beer that they like**

Q = D - X

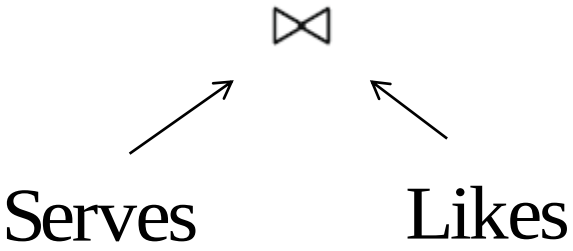


Beer Drinkers Database

Query: **List all drinkers who frequent only bars that serve some beer that they like**

Serves x Likes		
bar	**drinker**	**beer**
Cozumel	Bob	Budweiser
Cozumel	Joe	Heineken
Hardware	Bob	Budweiser
Hardware	Suzie	Miller
Pearl St	Joe	Heineken

Every bar that serves some beer that a drinker D likes

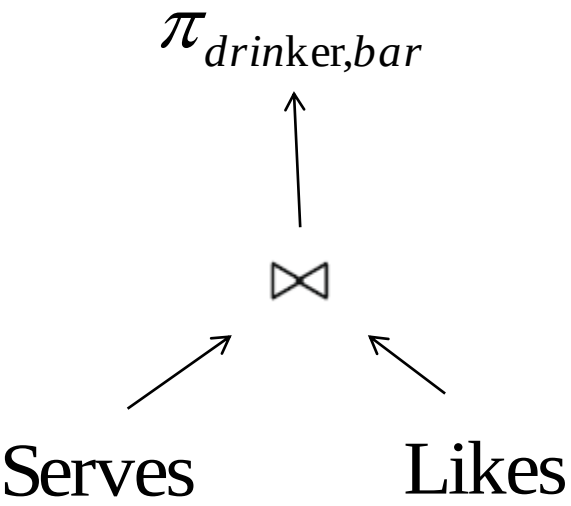


Beer Drinkers Database

Query: **List all drinkers who frequent only bars that serve some beer that they like**

Result	
drinker	**bar**
Bob	Cozumel
Joe	Cozumel
Bob	Hardware
Suzie	Hardware
Joe	Pearl St

Every bar that serves some beer that a drinker D likes

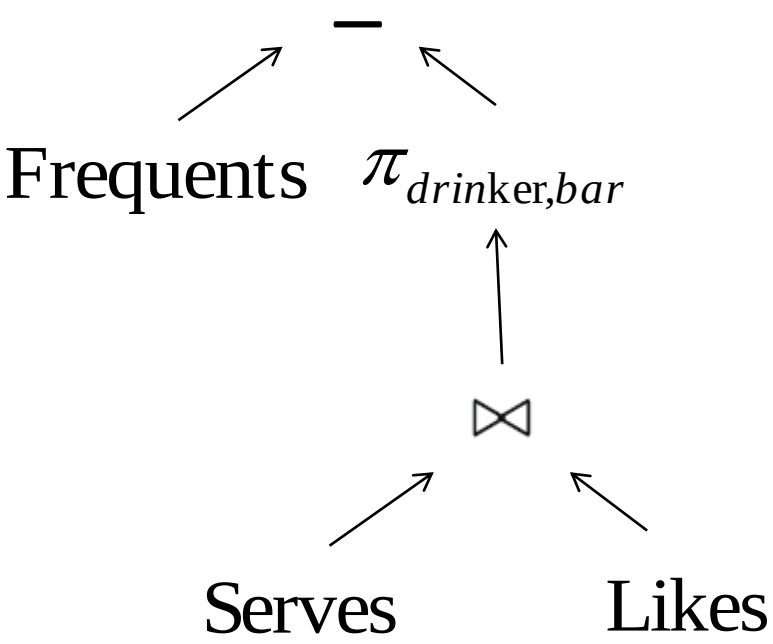


Beer Drinkers Database

Query: **List all drinkers who frequent only bars that serve some beer that they like**

Result	
drinker	**bar**
Jane	Cozumel
Suzie	Pearl St

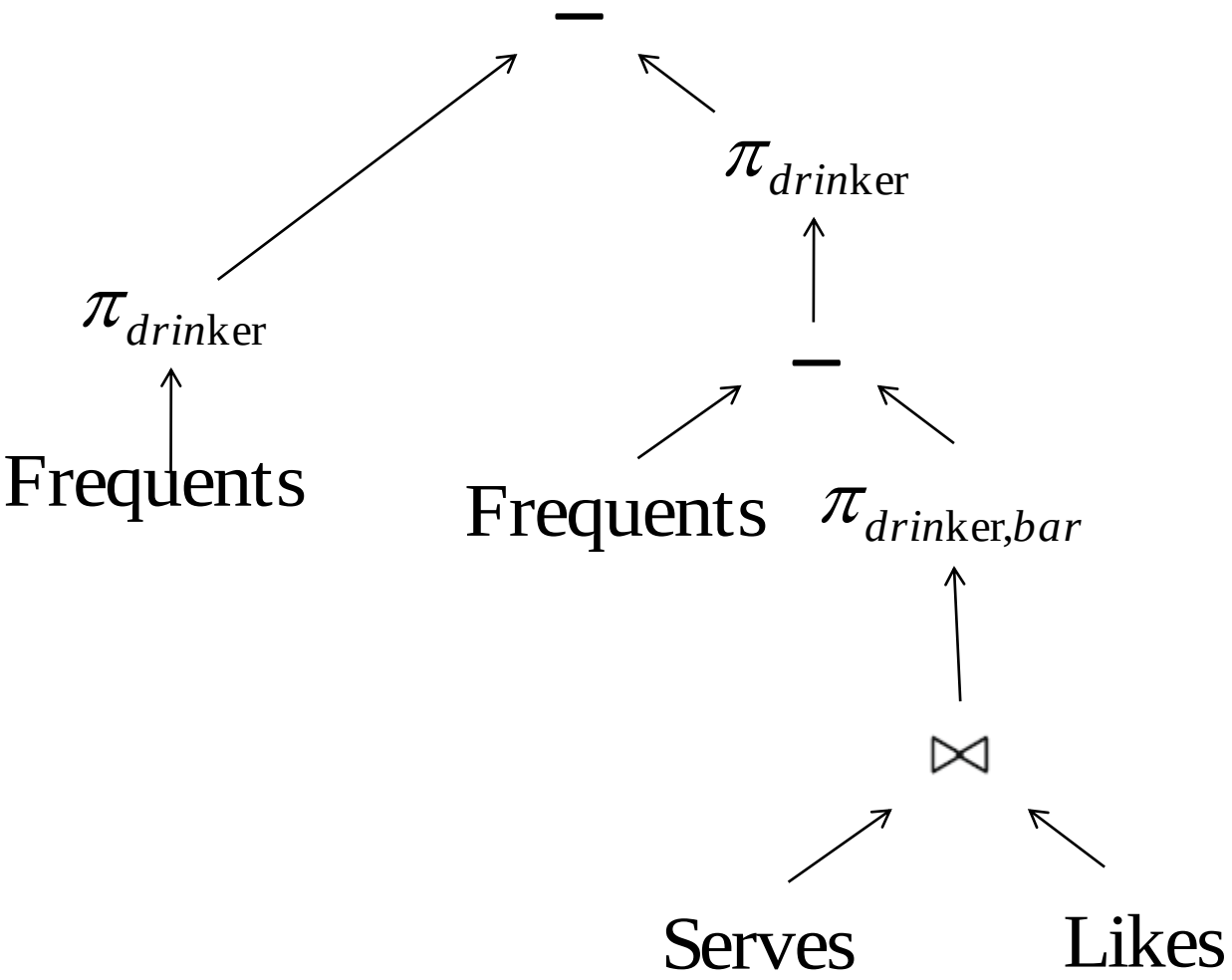
Every drinker who frequents some bars that do not serve any of the beers he/she likes



Beer Drinkers Database

Query: **List all drinkers who frequent only bars that serve some beer that they like**

Result
drinker
Bob
Joe



Films Database

Query: **List all directors such that every actor is cast in one of his films**

Film		
Title	**Director**	**Actor**
Wild	Lynch	Winger
Sky	Berto	Winger
Reds	Beatty	Beatty
Reds	Beatty	Winger
Tango	Berto	Beatty
Tango	Berto	Brando
Tango	Berto	Winger

Films Database

Query: **List all directors such that every actor is cast in (at least) one of his films -> Berto**

Film		
Title	**Director**	**Actor**
Wild	Lynch	Winger
Sky	Berto	Winger
Reds	Beatty	Beatty
Reds	Beatty	Winger
Tango	Berto	Beatty
Tango	Berto	Brando
Tango	Berto	Winger

$$\pi_{\text{director}}(\text{Film}) - \pi_{\text{director}}\left[\pi_{\text{director}}(\text{Film}) \times \pi_{\text{actor}}(\text{Film}) - \pi_{\text{director,actor}}(\text{Film})\right]$$

Films Database

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Tango	Berto	Winger

$$\pi_{\text{director}}(\text{Film}) - \pi_{\text{director}}\left[\pi_{\text{director}}(\text{Film}) \times \pi_{\text{actor}}(\text{Film}) - \pi_{\text{director,actor}}(\text{Film})\right]$$

$$\pi_{director,actor}(Film) \div \pi_{actor}(Film)$$

Quotient

$R \div S$ is the largest T satisfying $S \times T \subseteq R$

Attributes of S are a subset of attributes of R

$\pi_{A_1,\ldots,A_n}(R) \times S$	possible
$\pi_{A_1,\ldots,A_n}(R) \times S - R$	possible - actual
$\pi_{A_1,\ldots,A_n}(\pi_{A_1,\ldots,A_n}(R) \times S - R)$	π(possible - actual)
$\pi_{A_1,\ldots,A_n}(R) - \pi_{A_1,\ldots,A_n}(\pi_{A_1,\ldots,A_n}(R) \times S - R)$	π(actual) - π(possible - actual)

Films Database

Query: **List all actors that play in every movie by Berto**

Film		
Title	**Director**	**Actor**
Wild	Lynch	Winger
Sky	Berto	Winger
Reds	Beatty	Beatty
Reds	Beatty	Winger
Tango	Berto	Beatty
Tango	Berto	Brando
Tango	Berto	Winger

Films Database

Query: **List all actors that play in every movie by Berto -> Winger**

Film		
Title	**Director**	**Actor**
Wild	Lynch	Winger
Sky	Berto	Winger
Reds	Beatty	Beatty
Reds	Beatty	Winger
Tango	Berto	Beatty
Tango	Berto	Brando
Tango	Berto	Winger

$$\pi_{\text{actor}}(\text{Film}) - \pi_{\text{actor}}[\pi_{\text{title}}(\sigma_{\text{director}=\text{Berto}}(\text{Film})) \bowtie \pi_{\text{actor}}(\text{Film}) - \pi_{\text{title,actor}}(\sigma_{\text{director}=\text{Berto}}(\text{Film}))]$$

Relational Model: A Quick Question

- A relation *R* has *n* attributes:
  - A1, A2, … , A*n*
- Given an instance *I* of *R*, can you find a set of attributes that forms a key for *I* ?

Relational Model: A Quick Question

- A relation *R* has *n* attributes:
  - A1, A2, … , A*n*
- Given an instance *I* of *R,* can you find a set of attributes that forms a key for *I* ?
- *Hint: we are using the set semantics*