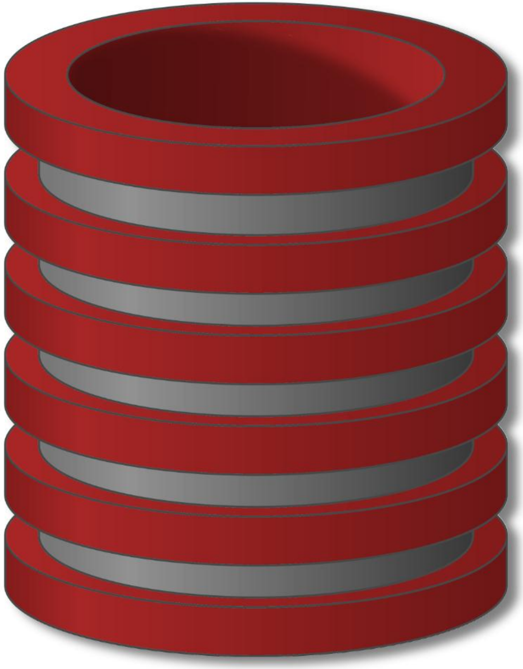


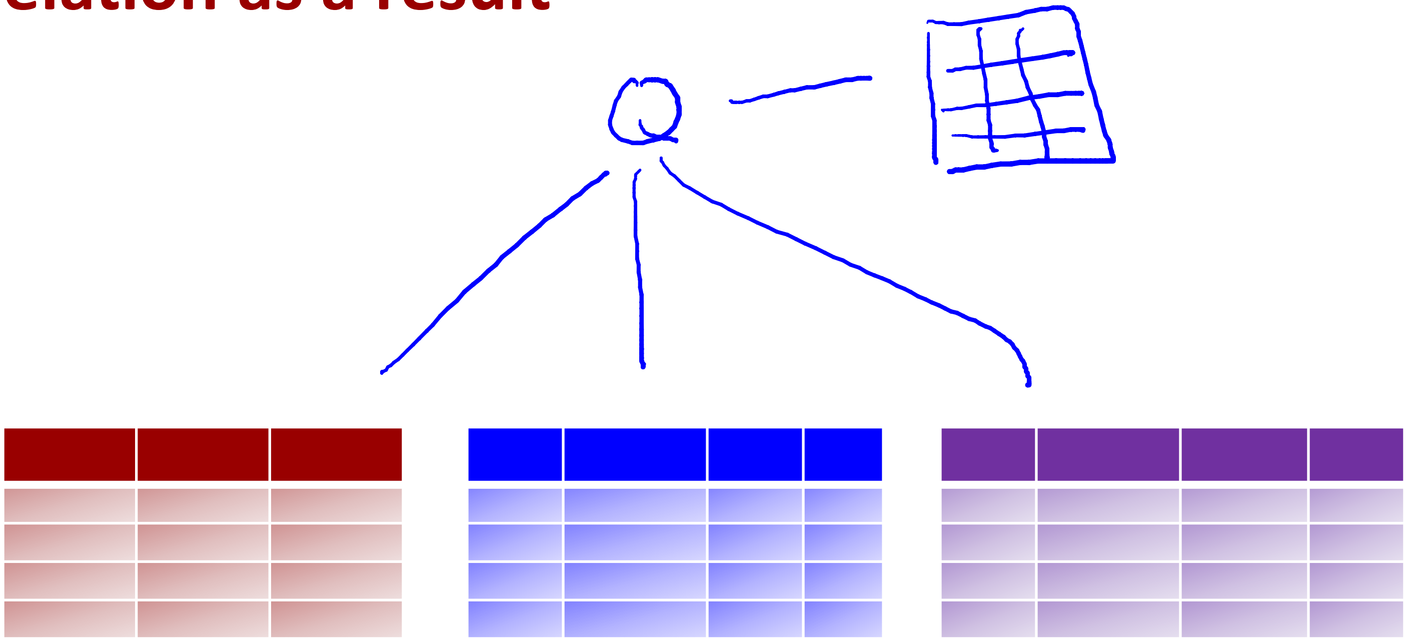
Relational Databases

Relational Algebra (1)
Select, project, join

Jennifer Widom

Relational Algebra (1)

Query (expression) on set of relations produces relation as a result



Relational Algebra (1)

Examples: simple college admissions database

College(cName,state,enrollment)

Student(sID,sName,GPA,sizeHS)

Apply(sID,cName,major,decision)

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

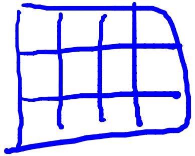
Jennifer Widom

Relational Algebra (1)

Simplest query: relation name

Use operators to filter, slice, combine

Student —



College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

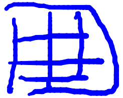
sID	cName	major	dec

Relational Algebra (1)

Select operator: picks certain rows

Students with GPA>3.7

$\sigma_{GPA > 3.7}$ Student



σ_{cond} Rel.

Students with GPA>3.7 and HS<1000

$\sigma_{GPA > 3.7 \wedge HS < 1000}$ Student

Applications to Stanford CS major

$\sigma_{cName = 'Stanford' \wedge major = 'cs'}$ Apply

College

cName	state	enr

Student

sID	sName	GPA	HS

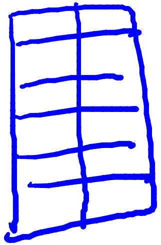
Apply

sID	cName	major	dec

Project operator: picks certain columns

ID and decision of all applications

$\Pi_{sID, dec}$ Apply



$\Pi_{A_1, \ldots, A_n}$ Rel

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

To pick both rows and columns…

ID and name of students with GPA>3.7

$$\pi_{sID, sName}(\sigma_{GPA>3.7} Student)$$

$$\sigma_{cond}(Expr)$$

$$\pi_{A_1,\ldots,A_n}(Expr)$$

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

Duplicates

List of application majors and decisions

$\Pi_{major, dec}$ Apply

SQL: Multisets, bags

R.A.: Sets

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

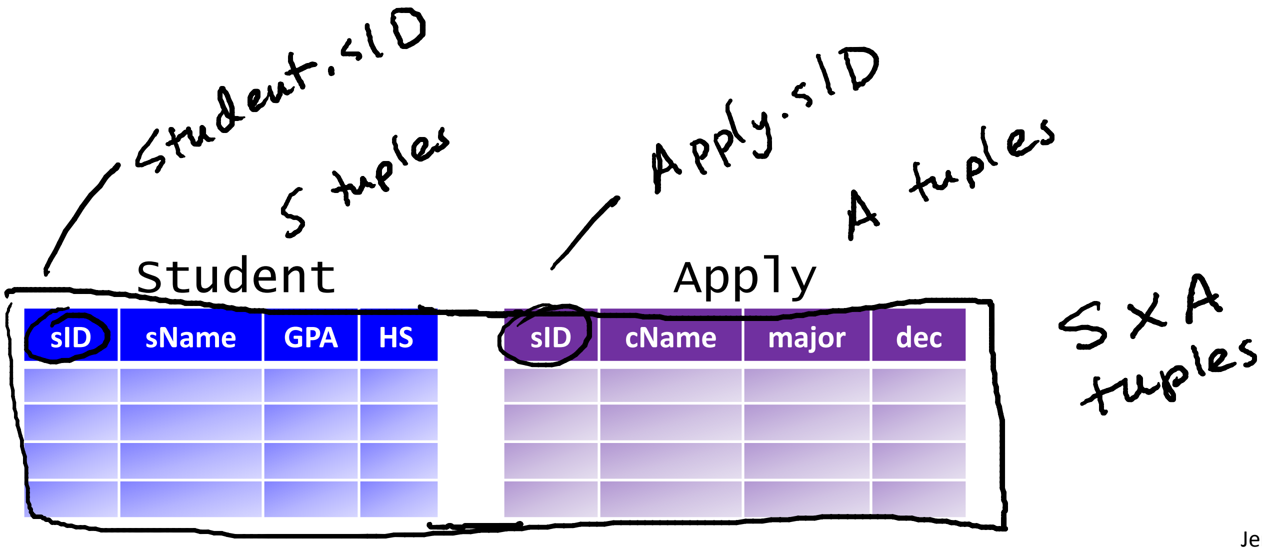
sID	cName	major	dec

Cross-product: combine two relations (a.k.a. Cartesian product)

Student × Apply

College

cName	state	enr



Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

Cross-product: combine two relations (a.k.a. Cartesian product)

Names and GPAs of students with HS>1000 who applied to CS and were rejected

$$\pi_{sName,\ GPA}\left(\sigma_{Student.sID=Apply.sID \wedge HS>1000 \wedge major='cs' \wedge dec='R'}\left(Student \times Apply\right)\right)$$

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

Jennifer Widom

Natural Join $\bowtie$

- Enforce equality on all attributes with same name ←
- Eliminate one copy of duplicate attributes ←

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

Natural Join

Names and GPAs of students with HS>1000 who applied to CS at college with enr>20,000 and were rejected

$$\pi_{sName,\ GPA}$$

$$(\sigma_{HS>1000 \wedge major='cs' \wedge dec='R' \wedge enr>20{,}000} (\underline{Student} \bowtie (\underline{Apply} \bowtie College)))$$

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

Natural Join

$$Exp_1 \bowtie Exp_2 \equiv$$

$$\pi_{schema(E_1) \cup schema(E_2)} \left(\sigma_{E_1.A_1 = E_2.A_1 \wedge E_1.A_2 = E_2.A_2 \wedge \ldots} \left(Exp_1 \times Exp_2 \right) \right)$$

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

Theta Join

condition

$$Exp_1 \bowtie_\theta Exp_2 \equiv \sigma_\theta (Exp_1 \times Exp_2)$$

- Basic operation implemented in DBMS
- Term "join" often means theta join

College

cName	state	enr

Student

sID	sName	GPA	HS

Apply

sID	cName	major	dec

Relational Algebra (1)

Query (expression) on set of relations produces relation as a result

- Simplest query: relation name
- Use operators to filter, slice, combine
- Operators so far: select, project, cross-product, natural join, theta join