College(cname, state, enrollment)

Student(SID, Sname, GPA, HS)

Apply(SID, CName, Major, Decision)

SELECT OPERATION: Picks certain rows (σ) - Sigma

Students with GPA > 3.7

$$\sigma_{GPA > 3.7} \quad Student$$

Students with GPA>3.7 and HS >1000

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

Applications to Stanford CS Major

$$\sigma_{cname='Stanford' \wedge major='CS'} \quad Apply$$

Generalize the select equation

$$\sigma_{cond} \ (Relation\ Name)$$

OR

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

PROJECT OPERATION: picks certain columns (π) ⇒ dealing with sets

∴ we assume 'no duplicates'

ID and decision of all applications

$$\pi_{sid,dec} \quad Apply$$

Generalize the project operation

$\Pi_{A1 \ldots An}(\text{Relation Name})$ or $\Pi_{A1 \ldots AN}(\text{Expression})$

To pick rows and columns

ID and name of students with GPA >3.7

$\Pi_{\text{sId, name}}(\sigma_{\text{GPA} > 3.7}\ \text{Student})$

Cross Product: Combine two relations (a.k.a Cartesian product) $(\times)$ ⇒ Note: explicit condn required for joining the columns

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

$\Pi_{\text{Sname, GPA}}(\sigma_{\text{Student.sId} = \text{Apply.sid} \wedge \text{HS} > 1000 \wedge \text{major} = \text{'CS'} \wedge \text{dec} = \text{'reject'}}(\text{Student} \times \text{Apply}))$

Natural Join $(\bowtie)$ ⇒ Bow tie symbol [No explicit condn]

Enforce equality on all attributes with same name

Eliminate one copy of duplicates attributes

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

$$\Pi_{sname, GPA}\left(\sigma_{HS>1000 \wedge major='CS' \wedge dec='Reject'}(Student \bowtie Apply)\right)$$

Names and GPAs of student with HS > 1000 who applied to CS at college with enrollment> 20000 and were rejected

$$\Pi_{sname, GPA}\left(\sigma_{HS>1000 \wedge major='CS' \wedge enr>20000 \wedge dec='reject'}(Student \bowtie Apply \bowtie College)\right)$$

$$Exp_1 \bowtie Exp_2 \approx \Pi_{S(E_1) \cup S(E_2)}\left(\sigma_{E_1A_1 = E_2A_1, E_1A_2 = E_2A_2, \ldots E_1A_n E_2A_n}(Exp_1 \times Exp_2)\right)$$

Union Operators $(\cup)$

List of college and student names

$$\Pi_{cname} College \cup \Pi_{sname} Student$$

Note: To make it to same schema, use rename operator (ρ).

Note: Technically when doing union, the schema attribute should be same.

Difference Operator (−)

IDs of student who did not apply anywhere

$$\Pi_{SID}\ Student - \Pi_{SID}\ Apply$$

IDs and Name of students who did not apply anywhere

$$\Pi_{Sname,sid}\left(\left(\Pi_{SID}\ Student - \Pi_{SID}\ Apply\right) \bowtie Student\right)$$

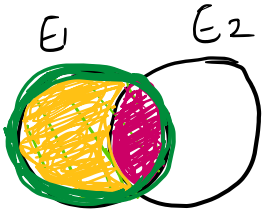
Intersection operator (∩)

Names that are both a college name and a student name

$$\Pi_{cname}\ College \cap \Pi_{Sname}\ Student$$

Note : Use Rename (ρ) to make it a same schema.

$$E1 \cap E2 = E1 - (E1 - E2)$$



E1 – Green area

$E_1 \cap E_2 \approx E_1 \bowtie E_2$

$E_1 - E_2 \Rightarrow$ Yellow

$E_1 \cap E_2$ = Red part

Rename operator ρ (row)

Different forms

$\rho_{R(A1 \cdots AN)}(E) \Rightarrow$ General form

$\rho_R(E)$

$\rho_{A1 \cdots An}(E)$

List of college and student names

$\rho_{C(name)}(\Pi_{cname}\ College) \cup \rho_{C(name)}(\Pi_{sname}\ Student)$

Expression Tree

GPAs of students applying to CS in Montreal