

## Chapter 4 - Relational Algebra

### 1. Q & A

- i. What are the PIDs of the students whose name is "Bob"?
- ii. Which pairs of students live at the same address?
- iii. Which departments have courses that have pre-requisites in other departments?
- iv. Compute the set of all courses that are their own pre-requisites.
- v. What are the names and addresses for students taking CS 513?
- vi. What are the courses (specified by course number and department name) that the head of the CS department is teaching?
- vii. Return the PID and names of any department head who teaches a course in another department?

## Q & A

Consider the following scenario modelling courses, students, professors, departments, and the like at a single university in a single semester.

- Each student has a name, a unique PID, and an address. A professor has a name, a unique PID, and belongs to a department. We also want to record the age and office of the professor. Each course has a name, a number, an offering department, a classroom, and an enrollment. (This university has not yet invented the concept of university wide course numbers.) Each department offers only one course with each number.
- Each department has a unique name. Each department has at most one chairperson who is its head (there are times when a department may not have a chairperson). Each chairperson can be the head of at most one department.
- Each student enrolls in a certain number of courses in the semester. At most one professor teaches each course. Each student receives a grade in each course he/she is enrolled in. In turn, each student evaluates the professor teaching the course.
- A course can have multiple pre-requisites. A course can be a prerequisite for multiple courses. A course cannot be a pre-requisite for itself! A student enrolled in a course must have enrolled in all its pre-requisites.

In class, we came up with the following relations (or a very similar set of relations) to model this scenario:

- Students(StudentPID: string, Name: string, Address: string)
- Professors(PID: string, Name: string, Office: string, Age: integer, DepartmentName: string)
- Courses(Number: integer, DeptName: string, CourseName: string, Classroom: string, Enrollment: integer)
- Departments(Name: string, ChairPID: string)
- Take(StudentPID: string, Number: integer, DeptName: string, Grade: string, ProfessorEvaluation: integer)
- Teach(ProfessorPID: string, Number: integer, DeptName: string)
- PreReq(Number: integer, DeptName: string, PreReqNumber: integer, PreReqDeptName: string)

Write down solutions to the following questions in relational algebra:

**What are the PIDs of the students whose name is "Bob"?**

$$\Pi_{\text{studentpid}}(\sigma_{\text{name}="Bob"}(\text{Students}))$$

**Which pairs of students live at the same address?**

$$\begin{aligned} R1 &:= \text{Students} \bowtie_{\text{Students.address} = S1.\text{address}} (\rho_{(\text{pid}, \text{name}, \text{address})}(\text{Students})) \\ &\Pi_{(\text{Students.studentpid}, \text{Students.address})}(\sigma_{\text{address}="some address"}(R1)) \end{aligned}$$

**Which departments have courses that have pre-requisites in other departments?**

$$\Pi_{\text{deptname}}(\sigma_{\text{deptname} \neq \text{prereqdeptname}}(\text{PreReq}))$$

### Compute the set of all courses that are their own pre-requisites.

The purpose of this query is to ensure that the constraint "A course cannot be a pre-requisite for itself" holds in the database. Your query needs to return only the course number and department name.

```
 $\Pi_{\text{number,deptname}}(\sigma_{\text{deptname}=\text{prereqdeptname} \text{ AND } \text{number}=\text{prereqnumber}}(\text{PreReq}))$ 
```

### What are the names and addresses for students taking CS 513?

```
R1:=Students  $\bowtie_{\text{Students.studentpid}=\text{Take.studentpid}}$  Take  
 $\Pi_{\text{name,address}}(\sigma_{R1.\text{number}=513 \text{ AND } R1.\text{deptname}=\text{"CS"}}(R1))$ 
```

### What are the courses (specified by course number and department name) that the head of the CS department is teaching?

```
R0:=Teach  $\bowtie_{\text{Teach.number}=\text{Take.number} \text{ AND } \text{Teach.deptname}=\text{Take.deptname}}$  Take  
R1:= $\Pi_{(R0.\text{studentpid}, R0.\text{professorpid}, R0.\text{number}, R0.\text{deptname})}(R0)$   
R2:=R1  $\bowtie_{R1.\text{professorpid}=\text{Departments.chairpid}}$  Departments  
 $\Pi_{(\text{number,deptname})}(\sigma_{R2.\text{deptname}=\text{"CS"}}(R2))$ 
```

### Return the PID and names of any department head who teaches a course in another department?

```
R1:=Departments  $\bowtie_{(\text{chairpid}=\text{professorpid})}$  Teach  
 $P_{(\text{pid,name})}(\Pi_{(\text{chairpid,name})}(\sigma_{\text{name} \neq \text{deptname}}(R1)))$ 
```