CS1555 Recitation 5 – Solution

Objective: To practice relational algebra, especially aggregations, joins, and division.

Consider the following relation schemas:

STUDENT (sid, name, class, major)
STUDENT _DIR (id, address, phone)
    FK: (id) → STUDENT (sid)
COURSES_TAKEN (course_no, term, sid, grade)
    FK: (course_no) → COURSE (course_no); (sid) → STUDENT (sid)
COURSE (course_no, course_name, level)
INSTRUCTOR (id, fname, lname)
COURSES _OFFERED(course_no, term, instructor_id)
    FK: (course_no) → COURSE (course_no); (instructor_id) → INSTRUCTOR (id)

Write a relational algebra query using the nested notation for each of the queries below:

1. Find for each instructor, the course names of the courses he/she was teaching in Fall 19. List in addition to the course name, the first name and the last names of the instructor.

$$\pi_{\text{COURSE.name, INSTRUCTOR.fname, INSTRUCTOR.Lname}} (\sigma_{\text{term='Fall 19'}} (\text{INSTRUCTOR} \bowtie_{\text{INSTRUCTOR.id = COURSES\_OFFERED.instructor\_id}} (\text{COURSE} * \text{COURSES\_OFFERED})))$$

2. List the sid, name, and address (if available) of all students.

$$\pi_{\text{sid, name, address}} (\text{STUDENT} \ ] \bowtie_{\text{STUDENT.sid=STUDENT\_DIR. id}} \text{STUDENT\_DIR})$$

(note the left outer join)

Write a relational algebra query using the sequence notation for each of the queries below:

1. Find the total number of students who have enrolled in the course "Operating Systems".

   $OS\_TAKING \leftarrow \pi_{sid}(\sigma_{COURSE.name = 'Operating\ Systems'}(COURSE\_TAKEN * COURSE))$

   $RSLT \leftarrow \mathcal{F}_{COUNT\ sid}(OS\_TAKING)$

   (or you can combine the two steps into one expression (nested operations))

2. Find the sid(s) of the student(s) who has/have the highest GPA

   $STUDENT\_GPA(sid, gpa) \leftarrow {}_{sid}\mathcal{F}_{AVERAGE\ grade}(COURSE\_TAKEN)$

   $HIGHEST\_GPA\ (max\_gpa) \leftarrow \mathcal{F}_{MAX\ gpa}(STUDENT\_GPA)$

   $RSLT \leftarrow \pi_{sid}(STUDENT\_GPA \bowtie_{gpa = max\_gpa} (HIGHEST\_GPA))$

3. Find the sid (s) of the student(s) who has/have taken all courses at the UGrad level

   $COURSE\_DENOMINATOR \leftarrow \pi_{course\_no}(\sigma_{level = 'UGrad'}\ COURSE)$

   $RSLT \leftarrow (\pi_{sid,\ course\_no}(COURSE\_TAKEN)) \div COURSE\_DENOMINATOR$

4. Find for each instructor the number of courses he/she has taught or is teaching. List the first name and the last name of each instructor along with his/her ID and number of courses.

   $COURSES\_TAUGHT(id, n\_courses) \leftarrow {}_{instructor\_id}\mathcal{F}_{COUNT\ course\_no}(COURSES\_OFFERED)$

   $RSLT \leftarrow COURSES\_TAUGHT * INSTRUCTOR$

5. List the SID of the students who did not enroll in any course in Fall 19.

SID_ENROLL_FALL19 ← $\pi_{sid}(\sigma_{term = 'Fall\ 19'}$ (COURSE_TAKEN))

SID_ALL ← π_{sid}(STUDENT)

RSLT ← SID_ALL - SID_ENROLL_FALL19