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Homework Assignment 1

Due Date: Tuesday, Sept 26, 2017

CS425 - Database Organization

Please leave this empty!

1.1	1.2	1.3	1.4	1.5	1.6

1.7	1.8	1.9	1.10	1.11	1.12	Sum

Instructions

- Try to answer all the questions using what you have learned in class
- **When writing a query, write the query in a way that it would work over all possible database instances and not just for the given example instance!**

Consider the following database schema and example instance:

Student

sid	name	dept
001	Alice	CS
002	Bob	EE
003	Carol	CS
004	David	PHYS

Course

cid	title	dept	credits
CS425	Databases	CS	3
CS595	Database Security	CS	3
EE591	Microcomputers	EE	4
EE401	VLSI Design	EE	3
PHYS571	Radiation Physics	PHYS	3

Enroll

cid	sid	grade	gradepoint
CS425	001	A	4.0
CS595	001	B	3.0
CS595	002	A	4.0
EE401	001	A	4.0
EE401	002	B	3.0
EE401	004	A	4.0
PHYS571	002	C	2.0
PHYS571	004	A	4.0

Prereq

cid	pid
CS595	CS425
EE591	EE401
...	...

Hints:

- Attributes shown with grey background form the primary key of a relation.
- The attribute *cid* and *sid* of relation *Enroll* is a foreign key to relations *Course* and *Student*, respectively. All the attributes *cid* and *pid* (except for the one in *Course*) are a foreign key to relation *Course*.
- Attribute *gradepoint* is converted from the letter *grade* (4.0 scale).

Part 1.1 Relational Algebra (Total: 100 + 10 bonus Points)

Question 1.1.1 (6 Points)

Find the names of all the students enrolled in course 'EE401'.

$\Pi_{name}(\sigma_{cid='EE401'}(Student \bowtie Enroll))$

Question 1.1.2 (6 Points)

Write an relational algebra expression that for each student the title of the courses he/she has received an 'A' grade in. Return this information as tuples (*name*, *title*) where title and name represent the course title and student name, respectively.

$\Pi_{name,title}(Course \bowtie (\Pi_{name,cid,gradepoint}(\sigma_{grade='A'}(Student \bowtie Enroll))))$

Question 1.1.3 (8 Points)

Find the students (sid and name) that have taken at least one of the prerequisite(s) of course 'CS595' and got an 'A' grade in this prerequisite course.

$$\Pi_{sid,name}(\sigma_{pid='cs595'}(Prereq \times (\sigma_{grade='A'}(Student \bowtie Enroll))))$$

Question 1.1.4 (8 Points)

Find all the 'EE' students (sid and name) that have taken all the courses offered by the 'CS' department.

$$\Pi_{sid,name}(((\Pi_{name,Enroll.cid}(\sigma_{Enroll.cid=Course.cid \wedge Course.dept='cs'}((\sigma_{Student.dept='EE'}(Student \bowtie Enroll)) \times Course))) \div (\Pi_{cid}(\sigma_{dept='cs'}(Course)))))$$

Question 1.1.5 (8 Points)

Find the IDs of all the students (sid), whose grade in 'EE401' is lower than their grade in 'CS595'.

$$\Pi_{sid}\left(\sigma_{X.sid = Enroll.sid \wedge X.gradepoint > Enroll.gradepoint}\left(\left(\sigma_{X.cid = 'EE401'}\left(\rho_{X}\left(Enroll\right)\right)\right) \times \left(\sigma_{Enroll.cid = 'CS595'}\left(Enroll\right)\right)\right)\right)$$

Question 1.1.6 (8 Points)

List all the students (sid and name) who never got a grade lower than 'B' (grade point below 3.0).

$$\Pi_{sid, name}\left(Student \bowtie \left(\Pi_{sid}\left(Student\right) - \left(\Pi_{sid}\left(\sigma_{gradepoint < 3.0}\left(Enroll\right)\right)\right)\right)\right)$$

Question 1.1.7 (8 Points)

List the titles of all the courses that student 'Alice' has not taken.

$$A\_cid \leftarrow \Pi_{cid}\left(\left(\Pi_{sid}\left(\sigma_{name='Alice'}(Student)\right)\right) \bowtie Enroll\right)$$

$$\Pi_{title}\left(Course - \left(A\_cid \bowtie Course\right)\right)$$

Question 1.1.8 (10 Points)

List all the students and their GPA (result schema: sid and GPA). The GPA is calculated by summing up the grade of each course multiplied the number of credits for the course and then dividing the result by the total number of credits the student has taken.

$$\Pi_{sid, GPA}\left(sid\ \mathcal{G}\left(sum(gradepoint * credits)/sum(credits)\right) \text{ as } GPA\ (Course \bowtie Enroll)\right)$$

Question 1.1.9 (8 Points)

List all the courses (their id) and for each course return the number of courses it has as a prerequisite.

$\Pi_{cid, pcount}(_{cid}\mathcal{G}_{count(pid)\ as\ pcount}(Course \bowtie Prereq))$

Question 1.1.10 (8 Points)

Return the number of courses for which the average grade of all students enrolled in the course is lower than 'B' (grade point below 3.0).

$\Pi_{cid}(\sigma_{avg\_gp < 3.0}(_{cid}\mathcal{G}_{avg(gradepoint)\ as\ avg\_gp}))$

Question 1.1.11 (10 Points)

For every course, return the names of the highest-scoring students (result schema: course title and student name).

$$h \leftarrow \left({}_{cid}\mathcal{G}_{\max(Enroll.gradepoint)\ as\ gradepoint}(Enroll)\right) \bowtie (\Pi_{cid,title}(Course)$$

$$\Pi_{name,title}(Enroll \bowtie Student \bowtie h))$$

Question 1.1.12 (12 Points)

List all the students (sid and name) that are enrolled in courses for which they have taken the prerequisites.

$$\Pi^{1}_{sid,name}\left(\sigma^{2}_{Enroll.cid=Prereq.cid \wedge X.cid=Prereq.pid}\left(\left(\sigma^{3}_{Enroll.sid=X.sid}(Enroll^{4} \times \rho_X(Enroll^{5})^{5,4,3}\right) \times Prereq^{2}\right)^{1}\right)$$

Question 1.1.13 (BONUS QUESTION) (10 Points)

Write a query that returns the names of all students that are ready to graduate. A student is ready to graduate if the student fulfills **all** the following requirements:

1. The student has a GPA of 3.0 or higher
2. The student has taken at least 30 credits of coursework
3. The student is not missing any prerequisite of the courses he/she has taken. That is, for every course the student has taken that has a prerequisite, the student has taken one or more of these prerequisites

$A \leftarrow {}_{sid}\mathcal{G}(sum(gradepoind * credits) / sum(credits)) \text{ as } GPA\ (Course \bowtie Enroll)$

// sid & GPA

$B \leftarrow \Pi_{sid}(\sigma_{A.GPA \geq 3.0}(A))$

// sid whose GPA is 3.0 or higher

$C \leftarrow \Pi_{name}(B \bowtie Student)$

// students' name whose GPA is 3.0 or higher

$D \leftarrow \Pi_{sid}(\sigma_{total\_cre \geq 30}({}_{sid}\mathcal{G}_{sum(credits) \text{ as } total\_cre}(Enroll \bowtie Course)))$

// sid whose credits are at lease 30

$E \leftarrow \Pi_{name}(D \bowtie Student)$

// name of students who has taken at least 30 credits.

$F \leftarrow \Pi_{sid}((Enroll \bowtie Prereq) - (Enroll \bowtie \rho_{piol/cid}(\Pi_{sid,cid}(Enroll))))$

$\Pi_{name}(C \cap E \cap F)$