Name

CWID

Homework Assignment 1

Due Date: Tuesday, Sept 19, 2017

CS425 - Database Organization Results

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:

- Underlined attribute 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*) is a foreign key to relation *Course*.
- Attribute *gradepoint* is converted from the letter *grade* (4.0 scale).

Part 1.1 Relational Algebra (Total: 100 Points)

Question 1.1.1 (6 Points)

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

Solution

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

Question 1.1.2 (6 Points)

Return the result as "title, name, and grade" where the grade is 'A' (title and name represent the course title and student name, respectively).

Solution

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

Question 1.1.3 (8 Points)

Find the students (sid and name) who has taken the prerequisite(s) for 'CS595' and got an 'A'.

Solution

$$\pi_{sid,name}(\sigma_{Enroll.cid=`CS595' \wedge grade=`A'}(Enroll \bowtie_{Enroll.cid=Prereq.pid} Prereq \bowtie Student))$$

Question 1.1.4 (10 Points)

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

Solution

$$
\begin{aligned}
E1 &\leftarrow \pi_{sid,name,cid}(\sigma_{dept='EE'} Enroll \bowtie Student) \\
E2 &\leftarrow \pi_{cid}(\sigma_{dept='CS'}(Course)) \\
E &\leftarrow E1 \div E2
\end{aligned}
$$

Question 1.1.5 (10 Points)

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

Solution

$$
\begin{aligned}
E1 &\leftarrow \sigma_{cid='EE401'}(Enroll) \\
E2 &\leftarrow \sigma_{cid='CS595'}(Enroll) \\
E &\leftarrow \pi_{E1.sid}(\sigma_{(E1.sid=E2.sid)\wedge(E1.gradepoint<E2.gradepoint)}(E1 \times E2))
\end{aligned}
$$

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).

Solution

$$S' \leftarrow \pi_{sid}(Student) - \pi_{sid}(\sigma_{gradepoint<3.0}(Enroll))$$
$$S \leftarrow \pi_{sid,name}(S' \bowtie Student)$$

Question 1.1.7 (8 Points)

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

Solution

$$\pi_{title}(Course) - \pi_{title}(\sigma_{name='Alice'}(Student \bowtie Enroll \bowtie \pi_{cid,title}(Course))$$

Question 1.1.8 (6 Points)

List all the students and their GPA (result: sid and GPA).

Solution

$$gp \leftarrow \pi_{Enroll.cid,sid,(gradepoint*credits)\ as\ gp}(Enroll \bowtie Course)$$
$$totalgp \leftarrow_{sid} \mathcal{G}_{sum(gp)\ as\ tgp}(gp)$$
$$totalcre \leftarrow_{sid} \mathcal{G}_{sum(credits)\ as\ tcr}(Enroll \bowtie Course)$$
$$result \leftarrow \pi_{totalgp.sid,(tgp/tcr)\ as\ GPA}(totalgp \bowtie totalcre)$$

Question 1.1.9 (8 Points)

List all the courses and each course's number of prequisites.

Solution

$$
\begin{aligned}
courseprereq &\leftarrow Enroll \bowtie_{Enroll.cid=Prereq.cid} Prereq \\
noprereq &\leftarrow \pi_{cid}(Course) - \pi_{cid}(Prereq) \\
numpre &\leftarrow_{Enroll.cid} \mathcal{G}_{count(*)}(courseprereq) \cup \pi_{cid,0}(noprereq)
\end{aligned}
$$

Question 1.1.10 (8 Points)

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

Solution

$$
\begin{aligned}
avgG &\leftarrow_{cid} \mathcal{G}_{avg(gradepoint)}(Enroll) \\
num &\leftarrow \mathcal{G}_{count(*)}(\sigma_{avg(gradepoint)<3.0}(avgG))
\end{aligned}
$$

Question 1.1.11 (10 Points)

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

Solution

$$
\begin{aligned}
nonhigh &\leftarrow \pi_{Enroll.cid,Enroll.sid}(\sigma_{(Enroll.gradepoint<x.gradepoint) \wedge Enroll.course=x.course}(Enroll \times \rho_x(Enroll))) \\
cidsid &\leftarrow \pi_{Enroll.cid,Enroll.sid}(\pi_{cid,sid}(Enroll) - nonhigh) \\
result &\leftarrow \pi_{title,name}(Course \bowtie cidsid \bowtie Student)
\end{aligned}
$$

Question 1.1.12 (12 Points)

List all the students (sid and name) enrolled in the courses where the prerequisites are taken.

Solution

$$
\begin{aligned}
cidpre &\leftarrow \pi_{Enroll.cid, Enroll.sid, Prereq.pid}(Enroll \bowtie_{Enroll.cid=Prereq.cid} Prereq) \\
pretaken &\leftarrow \pi_{cidpre.sid}(\sigma_{(cidpre.pid=x.cid)\wedge(cidpre.sid=x.sid)}(cidpre \times \rho_x(Enroll))) \\
result &\leftarrow \pi_{sid,name}(pretaken \bowtie Student)
\end{aligned}
$$