

CSCC43 Tutorial #2

More Relational Algebra

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Administration

A1 is out on Quercus

Due on MarkUs June 8

Group size is up to 2 people

Piazza is your friend!

Schema

Student (sID, surName, firstName, campus, email, cgpa)

Course (dept, cNum, name, breadth)

Offering (oID, dept, cNum, term, instructor)

Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]

Took [sID] \subseteq Student [sID]

Took [oID] \subseteq Offering [oID]

Note: “breadth” is a Boolean indicating whether or not a course satisfies the breadth requirement for degrees in the Faculty of Arts and Science.

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

1. Student number of all students who have taken csc343.

$\pi_{sID} \sigma_{dept='csc' \wedge cNum=343} (Took \bowtie Offering)$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

2. Student number of all students who have taken csc343 and earned an A+ in it. (Assume grade A for ≥ 90)

$R1 := \pi_{sID} \sigma_{dept='CSC' \wedge cNum=343 \wedge grade \geq 90} (Took \bowtie Offering)$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

3. The names of all such students.

$\pi_{\text{surName, firstName}}(R \bowtie \text{Student})$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

4. The names of all students who have passed a breadth course with Professor Percy.

PercyBreadth := $\pi_{oID} \sigma_{breadth=true \wedge instructor='Percy'} (Course \bowtie Offering)$

Passers := $\pi_{sID} \sigma_{grade \geq 50} (PercyBreadth \bowtie Took)$

Names := $\pi_{surName, firstName} (Passers \bowtie Student)$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

5. sID of all students who have earned some grade over 80 and some grade below 50.

$$\left(\pi_{sID} \sigma_{\text{grade} > 80} \text{ Took} \right) \cap \left(\pi_{sID} \sigma_{\text{grade} < 50} \text{ Took} \right)$$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

6. Terms when Horton and Heap were both teaching something.

$$\left(\pi_{\text{term}} \sigma_{\text{instructor} = \text{'Horton'}} \text{Offering} \right) \cap \left(\pi_{\text{term}} \sigma_{\text{instructor} = \text{'Heap'}} \text{Offering} \right)$$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

7. Terms when either of them was teaching CSC343.

π_{term} $\sigma_{\text{dept}='csc' \wedge \text{cNum}='343' \wedge (\text{instructor}='Horton' \vee \text{instructor}='Heap')}$ *Offering*

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

8. sID of students who have earned a grade of 85 or more, or who have passed a course taught by Atwood (Assume passing at 50).

HighGrade := $\pi_{sID} \sigma_{grade \geq 85} Took$

Passed By Atwood := $\pi_{sID} \sigma_{grade \geq 50 \wedge instructor = 'Atwood'} (Took \bowtie Offering)$

Students := HighGrade \cup Passed By Atwood

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

9. Terms when CSC369 was not offered.

$$\pi_{\text{term}} \text{Offering} - \left(\pi_{\text{term}} \sigma_{\text{dept} = \text{'CSC'} \wedge \text{cNum} = 369} \text{Offering} \right)$$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

10. Department and course number of courses that have never been offered.

$\pi_{dept, cNum} \text{ Course} - \pi_{dept, cNum} \text{ Offering}$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

11. SIDs and surnames of all pairs of students who have taken a course together.

$$\text{Pairs}(sID1, sID2) := \pi_{T1.sID, T2.sID} \left(\sigma_{T1.oID = T2.oID \wedge T1.sID < T2.sID} (pt1 \text{ Took} \times pt2 \text{ Took}) \right)$$

$$\text{OneName}(sID1, sID2, name) := \pi_{sID1, sID2, surName} \left(\sigma_{sID1 = sID} \text{ Pairs} \times \text{Student} \right)$$

$$\text{Answer}(sID1, sID2, name1, name2) := \pi_{sID1, sID2, name1, surName} \left(\sigma_{sID2 = sID} (\text{OneName} \times \text{Student}) \right)$$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

12. sID of student(s) with the highest grade in CSC343, in term 20089.

Takers := $\pi_{sID, oID, grade} \left(\left(\sigma_{dept='csc' \wedge cNum=343 \wedge term=20089}^{Offering} \right) \bowtie Took \right)$

NotTop := $\pi_{T1.sID, T1.oID, T1.grade} \left(\sigma_{T1.grade < T2.grade} (\rho_{T1} Takers \times \rho_{T2} Takers) \right)$

Answer := $\pi_{sID} (Takers - NotTop)$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

13. sID of students who have a grade of 100 at least twice.

AtLeastTwice := $\Pi_{T1.sID} \left(\sigma_{T1.grade = T2.grade = 100} \left(\rho_{T1} \text{Took} \times \rho_{T2} \text{Took} \right) \right)$
 $T1.sID = T2.sID \wedge$
 $T1.oID < T2.oID$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

14. sID of students who have a grade of 100 exactly twice.

AtLeastThrice := $\Pi_{T1.sID} \left(\sigma_{T1.oID < T2.oID < T3.oID} \left(\rho_{T1} \text{Took} \times \rho_{T2} \text{Took} \times \rho_{T3} \text{Took} \right) \right)$
 $\wedge T1.grade = T2.grade = T3.grade = 100$
 $\wedge T1.sID = T2.sID = T3.sID$

ExactlyTwice := AtLeastTwice - AtLeastThrice

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

15. sID of students who have a grade of 100 at most twice.

$\pi_{sID} \text{ Student} - \text{AtLeastThrice}$

Queries

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

16. Department and cNum of all courses that have been taught in every term when CSC320 was taught.

$320Terms := \pi_{term} \sigma_{dept='CSC' \wedge cNum=320} Offering$

$CourseTerms := \pi_{dept, cNum, term} Offering$

$Answer := CourseTerms \div 320Terms$

Exercise: Find equivalent query without using \div .

Integrity Constraints

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

Use the notation.

<relational algebra expression> = \emptyset

to write an integrity constraint for each of the following.

Integrity Constraints

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

1. Courses at the 400-level cannot count for breadth.

$$\sigma_{400 \leq cNum < 500 \wedge breadth = true} \text{ Course} = \emptyset$$

Integrity Constraints

Student (sID, surName, firstName, campus, email, cgpa)
Course (dept, cNum, name, breadth)
Offering (oID, dept, cNum, term, instructor)
Took (sID, oID, grade)

Offering [dept, cNum] \subseteq Course [dept, cNum]
Took [sID] \subseteq Student [sID]
Took [oID] \subseteq Offering [oID]

2. CSC490 can only be offered at the same time as CSC454.

$490_{\text{terms}} := \Pi_{\text{term}} \sigma_{\text{dept}='CSC' \wedge \text{cNum}=490} \text{Offering}$

$454_{\text{terms}} := \Pi_{\text{term}} \sigma_{\text{dept}='CSC' \wedge \text{cNum}=454} \text{Offering}$

$490_{\text{terms}} - 454_{\text{terms}} = \emptyset$