## COP 4710 – Database Systems – Fall 2013

Homework #2 - 100 points -

KEY

Due: Thursday September 12, 2013 by 11:55 pm NO LATE ASSIGNMENTS ACCEPTED

Answer each of the following questions completely. Make sure that your answers are **neatly written and very readable**. Points will be deducted if your assignment is not presented in a neat format. Submit your assignment via WebCourses.

1. (50 points total – 10 points each)

Given the relational schemas and instances shown below, construct relational algebra queries, using only the five fundamental operators, that will correctly produce the results for each of the queries (a)-(e).

S = STUDENTS(<u>s#</u>, name, age, major, gpa, hours\_completed)

C = COURSES(c#, term, name, dept, enrollment)

P = PROFESSORS(<u>p#,</u> name, dept, yrs\_teaching, area)

TA = TAKES(<u>s#, c#, term</u>, grade)

TE = TEACH(p#, c#, term)

(a) List the s# and name of those students who took COP4710 in Fall 2013 term.

 $\begin{aligned} r1 &= S \times TA \\ r2 &= \sigma_{(S.s\# = TA.s\# AND TA.c\# = "COP4710" AND TA.term="Fall2013")}(r1) \\ r3 &= \pi_{(s\#, name)}(r2) \end{aligned}$ 

or

 $\begin{aligned} r1 &= \sigma_{(TA.c\# = "COP4710" AND TA.term="Fall2013")}(TA) \\ r2 &= \pi_{(TA.s\#)}(r1) \\ r3 &= S \times r2 \\ r4 &= \sigma_{(S.s\# = TA.s\#)}(r3) \\ r5 &= \pi_{(s\#, name)}(r4) \end{aligned}$ 

(b) List the s# and name for those students who have not taken COP4710.

$$\begin{split} r1 &= \sigma_{(TA.c\# \neq \text{``COP4710'')}}(TA) \\ r2 &= \pi_{(TA.s\#)}(r1) \quad //\text{students in some course which is not cop 4710} \\ r3 &= \sigma_{(TA.c\# = \text{``COP4710'')}}(TA) \\ r4 &= \pi_{(TA.s\#)}(r3) \quad //\text{students in cop 4710 in some term} \end{split}$$

r5 = r2 - r4 //s# never in cop 4710  $r6 = r5 \times S$   $r7 = \sigma_{(r5.s\# = S.s\#)}(r6)$  $r8 = \pi_{(s\#, \text{ name})}(r7)$ 

(c) List the p# and name of every professor who has taught the student with s# = 12.

 $\begin{aligned} r1 &= \sigma_{(s\# = "12")}(TA) \\ r2 &= TE \times r1 \\ r3 &= \sigma_{(TE.c\# = TA.c\# AND TE.term = TA. term)}(r2) \\ r4 &= P \times r3 \\ r5 &= \sigma_{(P.p\# = TE.p\#)}(r4) \\ r6 &= \pi_{(p\#, name)}(r5) \end{aligned}$ 

(d) List the p# and names of professors who have only taught students who are CS majors.

$$r1 = \sigma_{(major = "CS")}(S)$$
  

$$r2 = \pi_{(s\#)}(r1)$$
  

$$r3 = TA \times r2$$
  

$$r4 = \sigma_{(TA.s\# = S.s\#)}(r3)$$
  

$$r5 = TE \times r4$$
  

$$r6 = \sigma_{(TE.c\# = TA.c\# AND TE.term = TA.term)}(r5)$$
  

$$r7 = P \times r6$$
  

$$r8 = \sigma_{(P.p\# = TE.p\#)}(r7)$$
  

$$r9 = \pi_{(P.p\#)}(r8)$$
  

$$r10 = \sigma_{(major \neq "CS")}(S)$$
  

$$r11 = \pi_{(s\#)}(r10)$$
  

$$r12 = TA \times r11$$
  

$$r13 = \sigma_{(TA.s\# = S.s\#)}(r12)$$
  

$$r14 = TE \times r13$$
  

$$r15 = \sigma_{(TE.c\# = TA.c\# AND TE.term = TA.term)}(r14)$$
  

$$r16 = P \times r15$$
  

$$r17 = \sigma_{(P.p\# = TE.p\#)}(r16)$$

 $r18 = \pi_{(P.p\#)}(r17)$ r19 = r9 - r18 r20 = P × r19 r21 =  $\sigma_{(P.p\# = r20.p\#)}(r20)$ r22 =  $\pi_{(p\#, name)}(r21)$ 

(e) List the s# for those students who have taken every course.

 $r1 = \pi_{(s\#, c\#)}(TA) //all s\#, c\# pairs for students who have taken a course$   $r2 = \pi_{(c\#)}(C) //all c\#s$   $r3 = \pi_{(s\#)}(r1) //all s\# for students who have taken a course$   $r4 = r2 \times r3 //all possible s\#, c\# pairs for students who have taken a course$  r5 = r4 - r1 //leaves only pairs that didn't actually exist in TA  $r6 = \pi_{(s\#)}(r5) //get just s\# from pairs that didn't really exist in TA$  r7 = r3 - r6 //leaves only s# who have taken every course

2. (50 points total – 10 points each)

or

Produce relational algebra query expressions for each of the queries (a)-(e) in Question 1 above, but this time use the redundant relational algebra operators whenever possible.

(a) List the s# and name of those students who took COP4710 in Fall 2013 term.

r1 = S \* TA //join on s#  $r2 = \sigma_{(TA.c# = "COP4710" AND TA.term="Fall2013")}(r1)$   $r3 = \pi_{(s#, name)}(r2)$   $r1 = \sigma_{(TA.c# = "COP4710" AND TA.term="Fall2013")}(r1)$  r2 = S \* r1  $r3 = \pi_{(s#, name)}(r2)$ 

(b) List the s# and name for those students who have not taken COP4710.

 $\begin{aligned} r1 &= \sigma_{(TA.c\# \neq "COP4710")}(TA) \\ r2 &= \pi_{(TA.s\#)}(r1) \quad //students in some course which is not cop 4710 \\ r3 &= \sigma_{(TA.c\# = "COP4710")}(TA) \end{aligned}$ 

 $\begin{array}{ll} r4 = \pi_{(TA.s\#)}(r3) & //students in cop 4710 in some term \\ r5 = r2 - r4 & //s\# never in cop 4710 \\ r6 = r5 * S & //join on s\# \\ r7 = \pi_{(s\#, name)}(r6) \end{array}$ 

(c) List the p# and name of every professor who has taught the student with s# = 12.

 $\begin{aligned} r1 &= \sigma_{(s\# = ``12")}(TA) \\ r2 &= TE * r1 //join on c# and term \\ r3 &= P * TE //join on p# \\ r4 &= \pi_{(p\#, name)}(r3) \end{aligned}$ 

(d) List the p# and names of professors who have only taught students who are CS majors.

 $r1 = \sigma_{(major = "CS")}(S)$   $r2 = \pi_{(s\#)}(r1)$  r3 = TA \* r2 //join on s# r4 = TE \* r3 //join on c# and term r5 = P \* r4 //join on p#  $r6 = \pi_{(P.p#)}(r5)$   $r7 = \sigma_{(major \neq "CS")}(S)$   $r8 = \pi_{(s\#)}(r7)$  r9 = TA \* r8 //join on s# r10 = TE \* r9 //join on c# and term r11 = P \* r10 //join on p#  $r12 = \pi_{(P.p#)}(r11)$  r13 = r6 - r12 r14 = P \* r13 //join on p# $r15 = \pi_{(p.p.m)}(r14)$  (e) List the s# for those students who have taken every course.

 $r1 = \pi_{(s\#, c\#)}(TA)$ r2 =  $\pi_{(c\#)}(C)$ r3 = r1 ÷ r2

- (50 points total 10 points each) Produce tuple relational calculus expressions for each of the queries (a)-(e) in Question 1 above.
  - (a) List the s# and name of those students who took COP4710 in Fall 2013 term.

{x.s#, x.name | x∈S and ∃y∈TA (y.term = "Fall 2013" and y.c# = "COP4710" and y.s# = x.s# ) }

(b) List the s# and name for those students who have not taken COP4710.

(c) List the p# and name of every professor who has taught the student with s# = 12.

{x.p#, x.name | x∈P and ∃y∈TE (y.p# = x.p# and ∃z∈TA ( z.c# = y.c# and z.term = y.term and z.s# = "12" ) ) }

(d) List the p# and names of professors who have only taught students who are CS majors.

{x.p#, x.name | x∈P and not ∃y∈TE (y.p# = x.p# and ∃z∈TA (z.c# = y.c# and z.term = y.term and ∃w∈S ( w.s# = z.s# And w.major ≠ "CS") ) ) }

(e) List the s# for those students who have taken every course.

{x.s# |  $x \in S$  and not  $\exists y \in C$  (not  $\exists z \in TA$  (z.c# = y.c# and x.s# = z.s# ) ) }

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or –  \{x.s\# \mid x \in S \text{ and } \forall y \in C \ (\exists z \in TA \ (y.c\# = z.c\# \text{ and } z.s\# = x.s\#) ) \}
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