UMass Lowell
Department of Computer Science
Fall 2019

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COMP.3090
Midterm Exam
Closed Book, 75 Minutes
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Problem	Score	
1	(50%)	33
2	(50%)	36
Total	(100%)	69

NOTE: Write clearly — if your handwriting can not be read easily, your exam will not be graded.

Use the following relations for both Problems 1 and 2.

```
students (id, name, grade-level)
class (title, year, instructor, dept)
taken (id, title, year, score)
```

(NOTE: name and title may not be unique.)

Problem 1

(10 points each question)

Express the following queries in Relational Algebra. (Do not use extended Relational-Algebra operations such as aggregation.)

1. Find the titles of classes taught by Prof. Turing.

$R1 := \sigma_{instructor = 'Prof.\ Turing'}(class)$

$R2 := \Pi_{title}(R1)$ ✓

2. Find the names of students who have taken a CS class and a Math class.

Students who have taken CS

$CS1 := \sigma_{dept='cs'}(class)$

$CS2 := CS1 \bowtie taken$

$CS3 := CS2 \bowtie students$

Students who have taken Math

$M1 := \sigma_{dept='Math'}(class)$

$M2 := M1 \bowtie taken$

$M3 := M2 \bowtie students$

$Result := \Pi_{name}(CS3 \cap M3)$ -1

Students (id, name, grade)
class (title, year, dept, instr)
taken (id, title, year, score)

3. Find the names of students who have repeated a class.

$T1 := \rho_{T1}\ taken$

$R1 := Students \bowtie_{Students.id = T1.id} T1$

$T2 := \rho_{T2}\ taken$

$R2 := Students \bowtie_{Students.id = T2.id} T2$

$Result := \pi_{name}\ (R1 \bowtie_{R1.id = R2.id\ AND\ (R1.year <> R2.year\ AND\ R1.title = R2.title)} R2)$

X

−1

4. Find the names of students who have taken only one class.

$T1 := \rho_{T1}\ (taken)$

$T2 := \rho_{T2}\ (taken)$

−8

$more\_than\_one \leftarrow \pi_{t1.id}\ (\sigma_{(t1.title \neq t2.title\ \vee\ t1.year \neq t2.year)\ \wedge\ t1.id = t2.id}\ (\rho_{t1}(taken) \times \rho_{t2}(taken)))$

$exactlyone \leftarrow \pi_{id}(taken) - more\_than\_one$

$result \leftarrow \pi_{name}(student \bowtie exactlyone)$

will be in Final Exam

5. Find the names of students who have taken every class taught by Prof. Turing. Use double negation.

$R1 := \sigma_{instructor = 'Prof. Turing'}(class)$

$R2 := \Pi_{title,}(R1)$

$r \leftarrow \Pi_{id, title, year}(taken)$

$S \leftarrow \Pi_{title, year}(\sigma_{instructor = 'Turing'}(class))$

$temp1 \leftarrow \Pi_{id}(r)$

$temp2 \leftarrow \Pi_{id}((temp1 \times S) - r)$

$result \leftarrow \Pi_{name}((temp1 - temp2) \bowtie students)$

Problem 2

(10 points each question)

Express the following queries in SQL. (Only standard SQL syntax shown in the textbook and the slides is allowed. Each query should be answered by a single SQL statement that is ended by one semicolon. "WITH" should not be used.)

1. Find the titles of classes taught by Prof. Turing.

```
SELECT    title
FROM      class
WHERE     instructor = 'Prof. Turing' ;
```

2. Find the names of students who have taken classes from CS department and Math department.

```
SELECT name
FROM students
WHERE id IN (SELECT id
             FROM taken
             WHERE title IN (
                 SELECT title
                 FROM class
                 WHERE dept = 'CS'
             )
INTERSECT
SELECT name
FROM students
WHERE id IN (SELECT id
             FROM taken
             WHERE title IN (
                 SELECT title
                 FROM class
                 WHERE dept = 'Math'
             );)
```

3. Find the names of students who have repeated a class.

```
SELECT    name
FROM      Students
WHERE     id IN (SELECT id
                 FROM taken T1, taken T2
                 WHERE T1.title = T2.title AND
                       T1.year <> T2.year
                 );
```

t1.id

t1.id = T2.id

-1

```
SELECT id, name
FROM students
WHERE id IN (SELECT t1.id
             FROM taken t1, taken t2
             WHERE t1.title=t2.title AND
                   t1.year <> t2.year AND
                   t1.id=t2.id
            );
```

```
+-----+------+
| id  | name |
+-----+------+
| 444 | Bob  |
+-----+------+
```

4. Find the names of students who have taken only one class.

```
SELECT    name
FROM      Student
WHERE     id IN (SELECT id
                 FROM taken T1, taken T2
                 WHERE NOT EXISTS
```

-7

```
SELECT name
FROM students
WHERE id IN ((SELECT id FROM taken)
             minus
             (SELECT t1.id
             FROM taken t1, taken t2
             WHERE t1.id=t2.id AND t1.title<>t2.title));
```

5. Find the names of students who have taken every class ~~taught~~ by Prof. Turing.

```
SELECT   name

FROM     Students

WHERE    id  IN (SELECT id
                 FROM taken
                 WHERE title IN (SELECT title
                                 FROM class
                                 WHERE instructor=
                                       'Prof. Turing'
                                 )
                 );
```

-6

```
SELECT name
FROM students s
WHERE NOT EXISTS (SELECT title, year
                  FROM class
                  WHERE instructor='Turing' AND
                        (title, year) NOT IN (SELECT title, year
                                              FROM taken t
                                              WHERE t.id=s.id));
```