

**CS 386/586 ASSIGNMENT 3**  
**FALL 2011**

**Part I: Relational Algebra**

The algebraic expressions below are for the database with schema `officers(club, role, pname)` and `location(club, room)` used in Quiz 2. For each equivalence below, say whether it is true or false in general. Whenever your answer is “false”, give an example instance of the database where the two expressions are not equal (and show the value of the expressions for your database instance).

Question 1 (5 points):  $(\sigma_{\text{officers.club}='sailing'}(\sigma_{\text{officers.role}='VP'}(\text{officers}))) \equiv (\sigma_{\text{officers.role}='VP'}(\sigma_{\text{officers.club}='sailing'}(\text{officers})))$

TRUE

Question 2 (5 points):  $\pi_{\text{officers.pname}}(\text{officers} - \sigma_{\text{officers.role}='VP'}(\text{officers})) \equiv \pi_{\text{officers.pname}}(\text{officers}) - \pi_{\text{officers.pname}}(\sigma_{\text{officers.role}='VP'}(\text{officers}))$

FALSE

Suppose we have an instance of relation `officers` as shown below.

<code>officers</code>	<u><code>club</code></u>	<u><code>role</code></u>	<u><code>pname</code></u>
	outdoor	President	Ross
	sailing	VP	Ross
	outdoor	Treasurer	Mendez

The query answer (here we represent answers as sets) on the left hand side of the equivalence is  $\{Ross, Mendez\}$  and the query answer on the right hand side is  $\{Mendez\}$ . Thus, the two expressions are not equal.

Question 3 (5 points):  $\pi_{\text{location.room}}(\sigma_{\text{officers.club}=\text{location.club}}(\text{officers} \times \text{location})) \equiv \pi_{\text{location.room}}(\text{location})$

FALSE

Suppose we have instances of relations officers and location as shown below.

Officers ( club    role    pname )			location ( club    room)	
outdoor	President	Ross	biking	SH118
sailing	VP	Ross	sailing	NH312
outdoor	Treasurer	Mendez		

The query answer (here we represent answers as sets) on the left hand side of the equivalence is  $\{NH312\}$  and the query answer on the right hand side is  $\{SH118, NH312\}$ . Thus, the two expressions are not equal.

Question 4 (5 points):

$$\pi_{\text{officers.pname,location.room}}(\sigma_{\text{officers.club=location.club AND role='VP'}}(\text{officers} \times \text{location})) \equiv \pi_{\text{officers.pname,location.room}}(\sigma_{\text{officers.club=location.club}}(\sigma_{\text{officers.role='VP'}}(\text{officers}) \times \text{location}))$$

TRUE

## Part II: Group-by and subqueries

Write the SQL for the following queries. Show (at most) the first five rows of the result for each query and the number of rows returned.

Question 5 (10 points): List the highest and lowest salary for agents in each country.

```
SELECT  country, MAX (salary), MIN (salary)
FROM    Agent
GROUP BY country
```

22 rows

country	max	min
China	90748	50175
England	89645	54152
Turkey	77777	51492
Germany	78903	50177
Singapore	56875	56875

Question 6 (10 points): List the highest and lowest salary for agents in each country with at least 10 cities.

```
SELECT  A.country, MAX (A.salary), MIN (A.salary)
FROM    Agent A
GROUP BY A.country
HAVING  COUNT (DISTINCT A.city) >= 10
```

1 row

country	max	min
USA	366962	50171

Question 7 (10 points): List the number of agents who speak each language.

```
SELECT  language, COUNT (agent_id)
FROM    Agent NATURAL JOIN LanguageRel NATURAL JOIN Language
GROUP BY language
```

20 rows

language	count
Hebrew	101
French	101
Portuguese	108
Bengali	89
Arabic	118

Question 8 (15 points): List the agents (id, first, last) who have been on a 'Secret' mission that failed. Write this query two ways, once using EXISTS and once using IN.

```
SELECT DISTINCT A.agent_id, A.first, A.last
FROM    Agent A NATURAL JOIN TeamRel TR
        NATURAL JOIN Mission M
WHERE   mission_status = 'failed'
        AND EXISTS ( SELECT *
                      FROM    SecurityClearance SC
                      WHERE   SC.sc_id = M.access_id
                              AND SC.sc_level = 'Secret')
```

```

SELECT DISTINCT A.agent_id, A.first, A.last
FROM Agent A NATURAL JOIN TeamRel TR
WHERE TR.team_id IN ( SELECT M.team_id
                     FROM Mission M JOIN SecurityClearance SC
                     ON (access_id = sc_id)
                     WHERE M.mission_status = 'failed'
                     AND SC.sc_level = 'Secret')

```

105 rows

agent_id	first	last
554	Peter	Carlos
1091	Chris	Mccraw
769	Craig	Burr
571	George	Byus
59	David	Shapiro

Question 9 (15 points): Return the country for which the agents have the highest average salary, along with that average salary.

```

SELECT A.country, AVG (A.salary)
FROM Agent A
GROUP BY A.country
HAVING AVG (A.salary) >= ALL ( SELECT AVG (A2.salary)
                              FROM Agent A2
                              GROUP BY A2.country )

```

1 row

country	avg
USA	103376.768025078370

## Part III: Views

For this part, you only need to write SQL statements. You don't need to execute them.

Question 10 (10 points). Write an SQL view definition for a table `skill_count(agent_id, num_skills)` that lists the number of skills for each agent.

```
CREATE VIEW skill_count (agent_id, num_skills)
AS SELECT  agent_id, COUNT (DISTINCT skill) AS num_skills
FROM      Agent NATURAL JOIN SkillRel NATURAL JOIN Skill
GROUP BY agent_id
```

Question 11 (10 points). Write an SQL query that find the average number of skills per agents, in each country. Use the skill-count view you defined in the previous question.

```
SELECT  country, AVG (num_skills)
FROM    Agent NATURAL JOIN skill_count
GROUP BY country
```