CS 564 Midterm Exam
Fall 2018
Answers

A: Let's write some queries! [30%]

We will use the following database schema:

Student (stid, firstname, lastname, major)
Class (code, title, semester, year, description)
Enrolled (stid, code, numcredits)

Furthermore, Enrolled.stid is a foreign key referring to Student.stid and Enrolled.code is a foreign key referring to Class.code

1. **[10%]** Express the following query in SQL: *output the student IDs of the students that have taken at least 30 credits across all classes.*

```
SELECT     e.stid
FROM       Enrolled e
GROUP BY   e.stid
HAVING     SUM(e.numcredits) > 29;
```

2. **[10%]** Express the following query in SQL: *for each class offered in Spring 2018, output the class code and the number of CS majors that took that class.*

```
SELECT     c.code, COUNT(s.stid)
FROM       Student s, Class c, Enrolled e
WHERE      s.stid = e.stid AND c.code = e.code
AND        s.major = 'CS' AND c.semester = 'Spring' AND c.year = 2018
GROUP BY   c.code ;
```

3. **[10%]** Express the following SQL query in Relational Algebra:

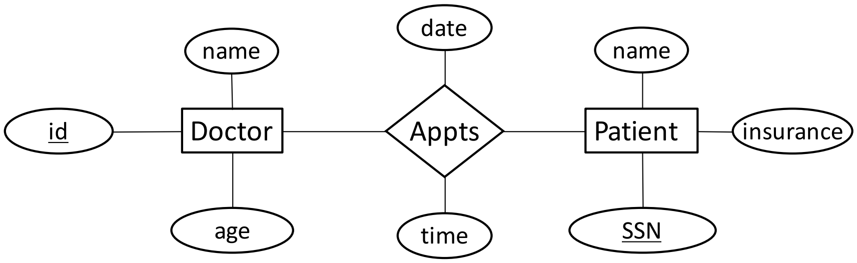
```
SELECT DISTINCT firstname, lastname
FROM Student
WHERE stid NOT IN (
     SELECT s.stid
```

```
            FROM Student s, Enrolled e
            WHERE s.stid  = e.stid AND e.numcredits > 3);
```

B: ER, RELATIONAL MODEL, AND SOME SQL **[13%]**

For the following questions, circle **exactly one** correct option.

1. **[5%]** Consider the following ER diagram:



If we translate the relationship **Appts** to a relation in the relational model, how many attributes will the relation have?

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2. **[4%]** Consider the schema from Part A. The following SQL queries will always give the same result:

```
SELECT * FROM Enrolled
LEFT OUTER JOIN Student on Student.stid = Enrolled.stid;

SELECT * FROM Enrolled
INNER JOIN Student on Student.stid = Enrolled.stid;
```

TRUE

3. **[4%]** Consider the following relational table for `Student`:

studentID	name	age
1234	George	NULL
1144	Anna	19
2214	Maria	NULL

How many tuples will the following SQL query return?

```
SELECT    *
FROM      Student
WHERE     name = 'George' OR age > 20 ;
```

1

C: Normalization and Dependency Theory [42%]

Consider the relation $R(A, B, C, D, E)$ with the following set F of functional dependencies:

$A \rightarrow B, C$ $\quad$ $D \rightarrow C$ $\quad$ $E \rightarrow D$ $\quad$ $B, E \rightarrow C$

[10%] Add a tuple to the instance of R below such that **all** fds in F are violated:

A	B	C	D	E
a	b	c	d	e
a	b	c	d′	e′

ANSWER: a,b,c′,d′,e

For the following questions, circle the right option(s).

#1 There can be more than one correct options for every question!
#2 You can get partial credit by explaining how you came up with your answer.

1. **[12%]** The following attribute sets are **superkeys** but **not keys** in relation R:

   (i) A, E $\quad$ (ii) A, D, E $\quad$ (iii) A, B, C, D $\quad$ (iv) A, B, C, D, E

   ANSWER: (ii) and (iv)

2. **[8%]** The following functional dependencies are **redundant** in F (in other words, if we remove the functional dependency, the fd closure remains the same):

   (i) $A \rightarrow B, C$ $\quad$ (ii) $D \rightarrow C$ $\quad$ (iii) $E \rightarrow D$ $\quad$ (iv) $B, E \rightarrow C$

   ANSWER: (iv)

3. **[12%]** The following hold for the decomposition of R into ABC, AE, DE. It is:

   (i) lossless-join $\quad$ (ii) dependency preserving

   ANSWER: (i)

D: Buffer Management **[15%]**

In this question, we consider a buffer pool with 5 frames, and two files: one with three pages A_1, A_2, A_3, and the other with four pages B_1, B_2, B_3, B_4. We want to read these two files in a nested loop (as we will see later in class, this is one possible implementation of a join between the two files). The sequence of requests is as follows:

Request A_1, Request B_1, Release B_1, Request B_2, Release B_2, ..., Release A_1,
Request A_2, Request B_1, Release B_1, Request B_2, Release B_2, ..., Release A_2,
Request A_3, Request B_1, Release B_1, Request B_2, Release B_2, ..., Release A_3.

Initially, all buffer frames are free, and none of the pages to be accessed are in RAM. For the following questions, circle the right option.

#1 You can get partial credit by explaining how you came up with your answer.

1. **[10%]** If the buffer manager uses the **LRU** replacement policy, how many total I/Os (both reads and writes) occur for the above sequence?

   (i) 5 (ii) 7 (iii) 10 (iv) 15

   ANSWER: 15

2. **[5%]** If the buffer manager knows the sequence a priori, how many total I/Os does the optimal replacement policy achieve?

   (i) 0 (ii) 5 (iii) 7 (iv) 10

   ANSWER: 7

BONUS: write your own SQL joke!