CSCI585 Spring ’18 Midterm Exam & Solutions

March 9th, 2018

CLOSED book and notes. No electronic devices. DO YOUR OWN WORK. Duration: 1 hour. If you are discovered to have cheated in any manner, you will get a 0 and be reported to SJACS. If you continue working on the exam after time is up you will get a 0.

Signature: ___________________________________

Problem Set	**Number of Points**
Q1	5
Q2	5
Q3	5
Q4	5
Q5	5
Q6	5
Q7	5
Total	**35**

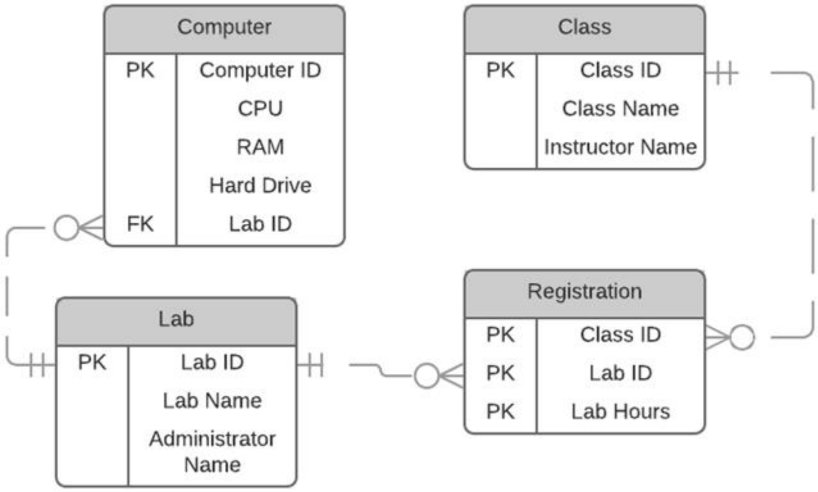
Q1. (5 points total) ER MODELING

Design ERD using Crow's foot notation for the following problem:

Computer Science department needs to design a database to manage computer labs using the following information:

- Each lab has one unique identifier, name, administrator name, and many computers.
- Each computer has a unique identifier, configuration information (CPU, RAM, hard drive) and location (in one of the labs).
- Each class has a unique identifier, class name, and instructor's name.
- Each class can have lab hours in multiple labs and one lab can be registered for multiple classes. A timestamp is stored to indicate a class is registered for a lab session.

Answer:



Q2. (5 points total) SQL

After the Oscars award ceremony last Sunday, you have been contacted by the organizers to write some queries. Their database consists of the following tables:

MEMBERS (MEMBER_ID, NAME).

MOVIES (MOVIE_ID, RELEASE_YEAR, TITLE, DIRECTOR).

REVIEWS (REVIEW_ID, *MEMBER_ID*, *MOVIE_ID*, TEXT, REVIEW_DATE, RATE).

ACTORS (NAME, *MOVIE_ID*).

Primary keys of every table are underlined while foreign keys are italic. The RELEASE_YEAR attribute of a movie is a number, such as 2018.

A (2 points) Display unique member IDs of all the members who reviewed at least one of the movies reviewed by user with member ID “M1”. The list of member IDs must exclude “M1”.

Answer:

```
select distinct r1.MEMBER_ID
from REVIEWS r1
where r1. MEMBER_ID  != 'M1' and r1. MOVIE_ID in (
select r2. MOVIE_ID
from REVIEWS r2
where r2. MEMBER_ID = 'M1');
```

B (1 point) Delete all reviews that have the term “horrible” in their text. If the text contains “XhorribleX” where X refers to any character(s), its review must be deleted as well.

Answer:

```
delete from REVIEWS where TEXT like '%horrible%';
```

C (2 points) Display the actors’ names and average rating for the movies with the highest average rating.

Answer:

```
select NAME, avg(RATE) from ACTORS a, REVIEWS r where r. MOVIE_ID = a.
MOVIE_ID
group by NAME
having avg(RATE) = (select max(avg(RATE)) from REVIEWS group by MOVIE_ID);
```

Q3. (5 points total) NORMALIZATION
Convert the following table into:

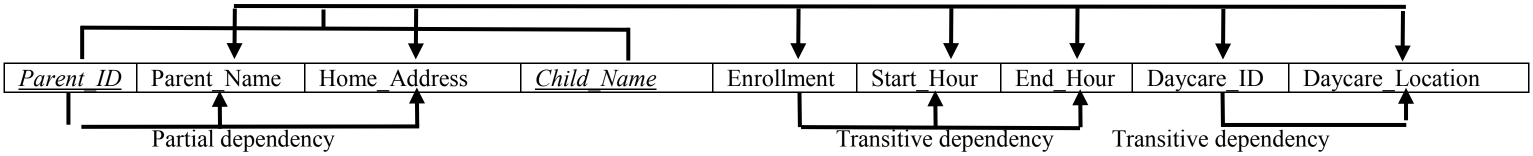
a. The 1NF. (1 point)
b. The 2NF. (2 points)
c. The 3NF. (2 points)

Show the dependency diagram for each form and identify the primary key for each table.

Parent_ID	Parent_Name	Home_Address	Children_Names	Enrollment	Start_Hour	End_Hour	Daycare_ID	Daycare_Location
1	Alice	627 Green St., LA	Mike, Sara	Full	7am	5pm	324	1214 Hover St., LA
2	Brad	93 27th St., LA	Liam	Morning	7am	12pm	324	1214 Hover St., LA
2	Brad	93 27th St., LA	Nina	Full	7am	5pm	324	1214 Hover St., LA
3	Claire	45 Pico Blvd., LA	Luke	Full	7am	5pm	324	1214 Hover St., LA
4	Tom	1308 55th Pl., SD	Sara	Afternoon	1pm	5pm	564	453 5th Ave., SD
5	Alice	433 Maple St., SD	Tony, Yara	Full	7am	5pm	564	453 5th Ave., SD

a. 1NF:

Dependency diagram:



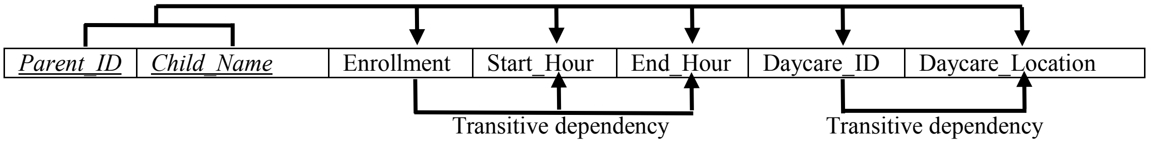
Parent_ID	Parent_Name	Home_Address	*Child_Name*	Enrollment	Start_Hour	End_Hour	Daycare_ID	Daycare_Location

Table in 1NF:

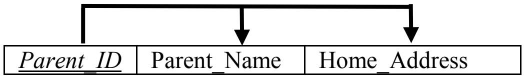
Parent_ID	Parent_Name	Home_Address	*Child_Name*	Enrollment	Start_Hour	End_Hour	Daycare_ID	Daycare_Location
1	Alice	627 Green St., LA	Mike	Full	7am	5pm	324	1214 Hover St., LA
1	Alice	627 Green St., LA	Sara	Full	7am	5pm	324	1214 Hover St., LA
2	Brad	93 27th St., LA	Liam	Morning	7am	12pm	324	1214 Hover St., LA
2	Brad	93 27th St., LA	Nina	Full	7am	5pm	324	1214 Hover St., LA
3	Claire	45 Pico Blvd., LA	Luke	Full	7am	5pm	324	1214 Hover St., LA
4	Tom	1308 55th Pl., SD	Sara	Afternoon	1pm	5pm	564	453 5th Ave., SD
5	Alice	433 Maple St., SD	Tony	Full	7am	5pm	564	453 5th Ave., SD
5	Alice	433 Maple St., SD	Yara	Full	7am	5pm	564	453 5th Ave., SD

b. 2NF:

Dependency diagrams:



Parent_ID	*Child_Name*	Enrollment	Start_Hour	End_Hour	Daycare_ID	Daycare_Location



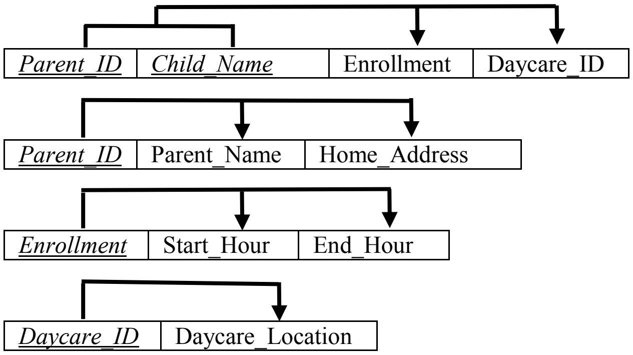
Tables in 2NF:

Parent_ID	*Child_Name*	Enrollment	Start_Hour	End_Hour	Daycare_ID	Daycare_Location
1	Mike	Full	7am	5pm	324	1214 Hover St., LA
1	Sara	Full	7am	5pm	324	1214 Hover St., LA
2	Liam	Morning	7am	12pm	324	1214 Hover St., LA
2	Nina	Full	7am	5pm	324	1214 Hover St., LA
3	Luke	Full	7am	5pm	324	1214 Hover St., LA
4	Sara	Afternoon	1pm	5pm	564	453 5th Ave., SD
5	Tony	Full	7am	5pm	564	453 5th Ave., SD
5	Yara	Full	7am	5pm	564	453 5th Ave., SD

Parent_ID	Parent_Name	Home_Address
1	Alice	627 Green St., LA
2	Brad	93 27th St., LA
3	Claire	45 Pico Blvd., LA
4	Tom	1308 55th Pl., SD
5	Alice	433 Maple St., SD

c. 3NF:

Dependency diagrams:



Tables in 3NF:

Parent_ID	*Child_Name*	Enrollment	Daycare_ID
1	Mike	Full	324
1	Sara	Full	324
2	Liam	Morning	324
2	Nina	Full	324
3	Luke	Full	324
4	Sara	Afternoon	564
5	Tony	Full	564
5	Yara	Full	564

Parent_ID	Parent_Name	Home_Address
1	Alice	627 Green St., LA
2	Brad	93 27th St., LA
3	Claire	45 Pico Blvd., LA
4	Tom	1308 55th Pl., SD
5	Alice	433 Maple St., SD

Enrollment	Start_Hour	End_Hour
Full	7am	5pm
Morning	7am	12pm
Afternoon	1pm	5pm

Daycare_ID	Daycare_Location
324	1214 Hover St., LA
564	453 5th Ave., SD

Q4. (5 points) TRANSACTION MANAGEMENT

A. (3 points) What does ACID in ACID properties stand for? Give an example of a scenario where atomicity is violated.

Answer:

ACID stands for Atomicity, Consistency, Isolation and Durability.
A transaction is atomic if either all or none is executed. Users cannot observe a state that is mid-fly.

An example of violating atomicity: Assume Alice's initial bank account balance is $100, while Bob's is $50. There are two transactions:

T1- Alice transfers $20 to Bob, which is executed in two steps:
 + Subtract $20 from Alice's balance. Alice's new balance becomes $80.
 + Add $20 to Bob's balance. Bob's new balance becomes $70.
T2- Administrator queries for the sum of Alice and Bob's balance.

With atomicity, T2 should always observe value $150. If T2 at some point observes the mid-fly state of executing transaction T1 (i.e., between step 1 and step 2) which results in the sum of Alice and Bob's balance is $130, then atomicity is violated.

B. (2 points) What is two-phase locking (2PL)? Give an example to illustrate how deadlock may happen with two phase locking.

Answer:

Two-phase locking is a locking mechanism used in database systems, which consists of two phases:
1: Growing Phase (Acquire locks)
2: Shrinking Phase (Release locks)
A scenario where dead-lock may happen with two-phase locking:
Consider two transactions:
T1- Update X=X+1, Y=5
T2- Update Y=2*Y, X=7
The execution flow below causes dead-lock. T1 waits for T2 to release lock on Y, while T2 waits for T1 to release lock on X.

T1	T2
Lock(X)	
Lock(Y)	
X = X+1	Y = 2*Y
Lock(Y)	
Lock(X)	

Q5. (5 points) QUERY OPTIMIZATION

Consider the three following tables for an online-sale database and all attributes are neither indexed nor sorted.

1. CUSTOMER (cid, name, age), cid is the primary key.
2. PRODUCT(pid, seller), pid is the primary key.
3. TRANSACTION(tid, cid, pid), tid is the primary key.

And we want to execute the following SQL query:

SELECT T.tid, C.name
FROM TRANSACTION T, CUSTOMER C, PRODUCT P
WHERE C.cid = T.cid
AND P.pid = T.pid
AND seller = ‘Olivera’
AND C.age >= 25
AND C.age <= 34

Assuming:

- There are 100 rows in CUSTOMER, 5,000 rows in PRODUCT and 10,000 rows in TRANSACTION.
- There are 100 different sellers equally distributed in PRODUCT.
- Customers’s ages range from 20 to 44 (both inclusive) equally distributed in CUSTOMER.
- cid and pid are independently equally distributed in TRANSACTION.

Now our task is to optimize the query with a Cost-based optimizer. **Suppose the cost of running a SELECT operation is the number of rows in the source table** and **the cost of running a JOIN operation is the total rows of the two source tables**. If we execute the query with following access plan, the cost will be 5,050,015,100.

STEP	OPERATION	COST	ESTIMATED RESULT ROWS
A1	Join T and C	15,000	50 milliion
A2	Join A1 and P	50,000,100	5 billion
A3	Select rows in A2 with all conditions	5 billion	40 (Explained below)

The possibility of C.cid = T.cid is 1/100 for there are 100 different cid. The possibility of P.pid = T.pid is 1/5000 for there are 5000 different pid. The possiblity of seller = 'Olivera' is 1/100 for there are 100 different sellers. The posibility of C.age >=25 and C.age <= 34 is 10/25. Since all conditions are independent, the number of result rows in A3 is about 5 billion/100/5000/100*(10/25)=40.

T, C and P are abbreviations for TRANSACTION, CUSTOMER and PRODUCT, respectively.

Do you have a better access plan to execute the query with a lower total cost? Please fill the following form (on the next page!) about your access plan with STEP 1 given.

- You don't have to fill all rows depending on how many steps in your access plan.
- Try not to ruin this form. There should be enough room in each cell for you to answer and make corrections.

  Answers on the following page.

Best answer:

STEP	OPERATION	COST	RESULT ROWS
B1	Select rows in C with ages between 25 and 34	100	40
B2	Select rows in P with seller = ‘Olivera’	5,000	50
B3	JOIN B2 and T	10,050	500,000
B4	select rows in B3 with P.pid = T.pid	500,000	100
B5	Join B1 and B4	140	4,000
B6	Select rows in B5 with C.cid = T.cid	4,000	40

Total cost: 519,290 (not required to answer)

STEP	OPERATION	COST	RESULT ROWS
B1	Select rows in C with ages between 25 and 34	100	40
B2	Select rows in P with seller = ‘Olivera’	5,000	50
B3	JOIN B1 and T	10,040	400,000
B4	select rows in B3 with C.cid = T.cid	400,000	4,000
B5	Join B2 and B4	4,050	200,000
B6	Select rows in B5 with P.pid = T.pid	200,000	40

Total cost: 619,190 (not required to answer)

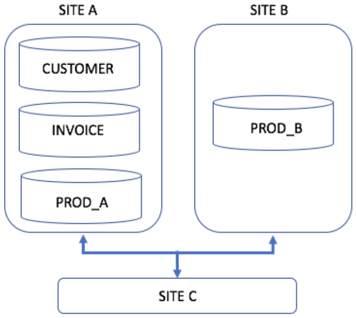
Partial correct answers

STEP	OPERATION	COST	RESULT ROWS
B1	Select rows in C with ages between 25 and 34	100	40
B2	Select rows in P with seller = ‘Olivera’	5,000	50
B3	JOIN B1 and B2	90	2,000
B4	JOIN B3 and T	12,000	20,000,000
B5	select rows in B4 with C.cid=T.cid AND P.pid = T.pid	20,000,000	40

Total cost: 20,017,190 (not required to answer)

Q6. (5 points) DISTRIBUTED DATABASES

TABLES	FRAGMENTS	LOCATION
CUSTOMER	N/A	A
INVOICE	N/A	A
PRODUCT	PROD_A	A
	PROD_B	B



For the DDBMS above, specify the type of operation the database must support (remote request, remote transaction, distributed transaction or distributed request) to perform each of the following operations at SITE C:

a.
```
SELECT   *
FROM     PRODUCT
WHERE    PROD_QOH > 20;
```

Answer: Distributed request

b.
```
SELECT   CUS_NAME, INV_TOTAL
FROM     CUSTOMER, INVOICE
WHERE    CUSTOMER.CUS_NUM = INVOICE.CUS_NUM;
```

Answer: Remote request

c.
```
BEGIN WORK;
UPDATE  PRODUCT
SET      PROD_QOH = PROD_QOH + 5
WHERE    PROD_NUM = '123';
INSERT   INTO CUSTOMER(CUS_NUM, CUS_NAME, CUS_STATE)
         VALUES('111', 'Tommy Trojan', 'CA' );
COMMIT WORK;
```

Answer: Distributed transaction

Q7. (5 points) DB SECURITY, WEB TECHNOLOGIES, BUSINESS INTELLIGENCE

A (1 point) Contrasting between activities of a "database administrator" (DBA) and a "data administrator" (DA), who sets policies and standards?

Answer: Data administrator (DA)

B Which Web technology has a class named DataSet?

Answer: ADO.NET

C (1 point) Name the components of Star schema.

Answer: 1. Facts , 2.Dimensions , 3.Attributes , 4. Attribute hierarchies

D. (1 point) Is snowflake schema normalized or denormalized?

Answer: Normalized

E. (1 point) Name the two extensions SQL offers for OLAP.

Answer: 1. ROLLUP , 2.CUBE