2020 S midexam - midterm exam

Database Systems (University of Southern California)

CS585 Midterm

Spring term, 2/28/2020
Duration: 1 hour and 15min

Instructions/notes

- the exam is closed books/notes/devices/neighbors, and open mind :)
- there are 6 questions, and a non-data-related bonus, for a total of **35** points
- there are no 'trick' questions, or ones with long calculations or formulae
- you can write on the two blank sheets (that are at the end) if you like
- **please DO NOT CHEAT; you will get a 0 if you are found to have cheated**
- **when time is up, please STOP WRITING**; **you will get a 0 if you continue**

Q	Your score	Max possible score
1		6
2		5
3		6
4		6
5		6
6		6
Bonus		1
Total		**35 (NOT 36)**

Q1 (3+3 = 6 points)

Consider a table, with several (2 or more) columns that contain repeating data values (within each column).

a. when is this acceptable? Explain, with an example.

A. It is acceptable when it is a bridge table, where redundancies cannot be avoided (eg. an 'Enrollment' bridge entity with a (StudentID,CourseID) PK where values can repeat in each column.

b. when is this not acceptable? Explain, with an example.

A. Not acceptable when it is in the form of a 1NF table - here we have NEEDLESS repetition, which calls for the table to be segmented using normalization principles (eg. the 'Project' example from the lecture).

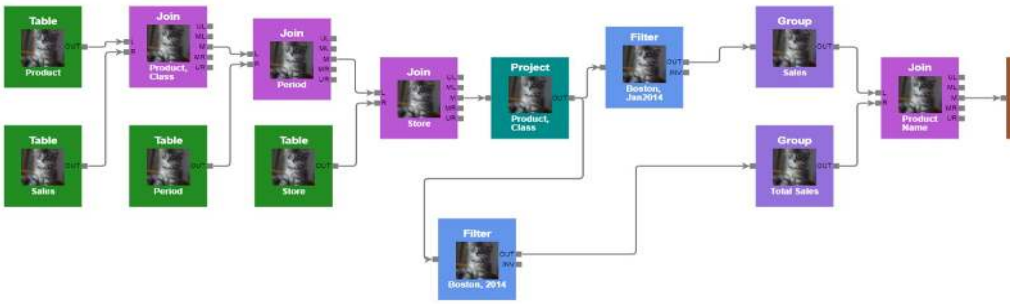
Q2 (5 points)

A ‘shared lock’ is granted to a set of transactions that all want to read data (unlike an ‘exclusive lock’ that is granted to a single transaction that wants to write data). Why is this even a thing, ie. why does reading (which causes no change to contents being read) require locking at all?

A. Because while the readings are occurring other transactions might write to the cells that being read, causing non-repeatable reads.

Q3 (3+3 = 6 points)

The diagram below, shows a SQL dataflow graph. Users can construct non-trivial queries by dragging and dropping 'ops' (operators/nodes) on to a palette (graph area), and wiring them up by connecting inputs and outputs as shown - in other words, queries can be built up by chaining nodes, as shown (eg. in the graph shown, we are reading four tables using a 'Table' op, and performing joins using 'Join', projecting using 'Project', etc.).



a. what is the advantage of such visual construction, over coding queries by hand using SQL commands (like you did for HW2)?

A. The advantage is that non-programmers (casual users, business analysts...) can create SQL queries without having to write code.

b. conversely, what are the advantages of being able to hand-code queries?

A. Hand-coding offers flexibility, control and power - queries that can't be visually constructed (eg ones with two or three levels of subquery nesting, correlated subqueries etc) can always be explicitly coded.

Q4 (3+3 = 6 points)

As you know, in 2PL, a transaction acquires locks during the locking phase, carries out the transaction, then releases locks during the unlocking phase (there is no interleaving of locking and unlocking).

a. what issue can arise, during the locking phase, how is it resolved?

A. Deadlocks can arise, on account of two or more transactions in the process of lock acquisition being unable to complete the step on account of mutual dependencies. Deadlock detection and mitigation strategies will help resolve the issue (the dependency cycles need to be broken).

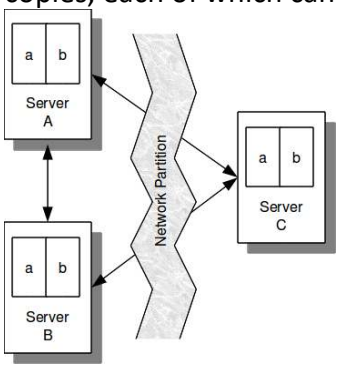
b. what issue can arise during the unlocking phase, how is that resolved?

A. During sequential unlocking, the transaction doing the unlocking might need to abort, in which case other transactions that acquired the released locks and started their own transaction operations will also need to be aborted ('cascading aborts'). To resolve (prevent) this, we hold on to the locks until our transaction is commited (or aborted), and release the locks after (using a protocol called 'Strict 2PL').

Q5 (3+2+1 = 6 points)

During a network partition (failure), a portion of a distributed DB (with replicated data stored in multiple nodes, and the cluster operating as a single unit) gets separated from the rest (eg. on account of a network switch failure).

In the figure below, a partition separates nodes A and B (which remain connected to each other), from node C - this will lead to AB, and C, operating as two independent DB copies, each of which can receive read/write requests.



Consider a write request arrives at node C.

a. what are the two options that C would choose from?

A. C can accept (perform) the write operation, or it can refuse the request.

b. what are the implications of choosing either option?

A. If C carries out the write, we will have an inconsistency (between C, and AB) - we are prioritizing availability; if we refuse, the transaction requesting the write would need to be aborted and possibly retried - we are prioritizing consistency.

c. what distributed DB principle/idea/'law'/theorem are we referring to?

A. The CAP Theorem.

Q6 (6 points)

Consider the following table (PrinterControl), which is used to assign specific printers to named users as well as guests, in a workgroup (the first three entries are named users):

```
PrinterControl
user_id_start    user_id_finish   printer_name
printer_description
=========================================================
'chacha'   'chacha'        'LPT1'   'First floor's printer'
'lee'      'lee'           'LPT2'   'Second floor's printer'
'thomas'   'thomas'        'LPT3'   'Third floor's printer'
'aaaaaaaa' 'mzzzzzzzz'     'LPT4'   'Common printer #1 '
'naaaaaaa' 'zzzzzzzz'      'LPT5'   'Common printer #2'
```

Explain what the following query does, when the :my_id variable can contain a variety of userIDs, of named users and guests (eg. it could contain 'lee' or 'archit' or 'yiming') - the BETWEEN keyword returns a boolean if a given string lexicographically (alphabetically) lies between two others. Be very specific in your explanation (eg. be sure to explain why we use MIN()).

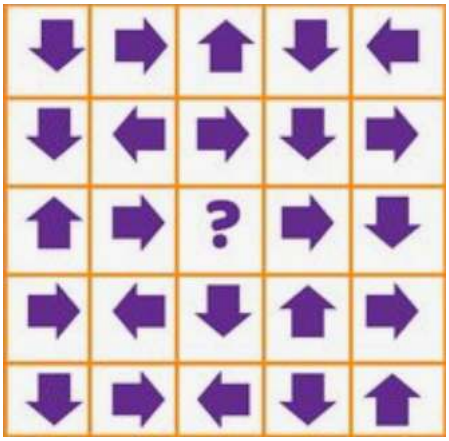
```
SELECT MIN(printer_name)
  FROM PrinterControl
 WHERE :my_id BETWEEN user_id_start AND user_id_finish;
```

A. The query assigns (selects) a printer, based on incoming username - if the user is chacha or lee or thomas, the assigned printer is LPT1, LPT2 or LPT3, respectively; for all other users, LPT4 is assigned if their username lies in a..m, or LPT5 otherwise (n..z). The MIN operation selects LPT1 instead of LPT4 for chacha (and likewise for the other two named users).

Bonus (1 point)

Note - this bonus is optional - if you do get it right, you get 1 point, which is counted only when you don't have 35/35 already :) In other words, the max you can get for the whole test is 35, not 36.

In which direction should the missing arrow point (there is only ONE right answer :))?



A. Down - starting from top-left, follow this spiralling path where 'Down-Right-Up-Down-Left-Right' repeats: