Practice Problems

Quiz 4 Transactions

1. Define a transaction.
   *Transaction: An action, or series of actions, carried out by a single user or application program, which reads or updates the contents of the database. A logical unit of work that transforms the database from one consistent state to another. Also the unit of concurrency and recovery control.*
2. Describe the types of problems that occur in a multi-user environment when concurrent access to the database is allowed. List example of these problems.
   1) *Lost update problem: two active transactions update the same data item. The first write is lost because of the 2nd write.*
   2) *Uncommitted dependency problem: one active transaction updates a data item, another active transaction reads the data item BEFORE the first active transaction commits.*
   3) *The inconsistent analysis problem: an active transaction reads a subset of records from the database, it then performs the same action and generates a different result than the prior read because another transaction has updated some of the read values or added new records.*
   4) *Nonrepeatable read problem occurs when a transaction reads the same data object from the database and is returned 2 different values due to the fact that another active transaction modified the data*
   5) *Phantom read occurs when a transaction receives different values from the database for the same query due to the fact that another transaction either inserted or deleted a tuple that would change the result for the query.*
3. Explain the concepts of serial, nonserial and serializable schedules.

***Schedule*** *A sequence of the operations by a set of concurrent transactions that preserves the order of the operations in each of the individual transactions.*

***Serial schedule*** *A schedule where the operations of each transaction are executed consecutively without any interleaved operations from other transactions*

***Nonserial schedule*** *A schedule where the operations from a set of concurrent transactions are interleaved.*

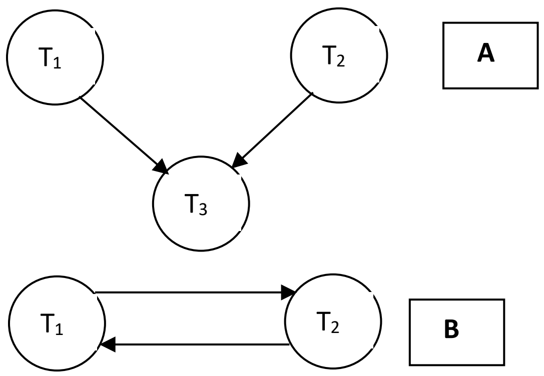
***Serializable schedule*** *A nonserial schedule where the result to the database is equivalent to a serial schedule.*

4. Define deadlock, give an example of a schedule with a deadlock.

*Deadlock: when two (or more) transactions are each waiting for locks held by the other to be released.*

| Time | $T_{17}$ | $T_{18}$ |
|---|---|---|
| $t_1$ | begin_transaction | |
| $t_2$ | write_lock(**bal**$_x$) | begin_transaction |
| $t_3$ | read(**bal**$_x$) | write_lock(**bal**$_y$) |
| $t_4$ | **bal**$_x$ = **bal**$_x$ − 10 | read(**bal**$_y$) |
| $t_5$ | write(**bal**$_x$) | **bal**$_y$ = **bal**$_y$ + 100 |
| $t_6$ | write_lock(**bal**$_y$) | write(**bal**$_y$) |
| $t_7$ | WAIT | write_lock(**bal**$_x$) |
| $t_8$ | WAIT | WAIT |
| $t_9$ | WAIT | WAIT |
| $t_{10}$ | ⋮ | WAIT |
| $t_{11}$ | ⋮ | ⋮ |

5. Review the following precedence graphs



A. **True** or False: Schedule A is a serializable schedule.

B. True or **False**: Schedule B is a conflict serializable schedule.

6. Describe the circumstances when the recovery manager has to 'redo' a transaction during the recovery process. Describe the circumstances when the recovery manager has to 'undo' a transaction during the recovery period.
*Recovery manager has to redo all operations associated with transactions that were active since the last checkpoint in order to guarantee their effects are stored in the database. This is especially true when a no-force policy is used for buffer management. No-force policy means that committed updates are not guaranteed to be written to the database at commit time.*

*Recovery manager has to undo all operations associated with active transactions at the time of the crash. It undoes the operations in reverse order of the log, starting with the most recent update for the uncommitted transactions. If a steal policy is used for the buffer manager the database management system may have updated the database or given concurrent transactions access to uncommitted results. These updates must be undone, this means restoring the original value for the updated value found in the log record as the value for the object in the database.*

7. Describe an algorithm associated with deadlock detection, describe an algorithm associated with deadlock prevention.
   *Deadlock prevention: wait-die. The algorithm assigns each transaction a unique timestamp, that is ordered by time. If an older transaction requests a resource locked by a younger transaction then it is allowed to wait for the resource. If a younger transaction requests a resource locked by an older transaction it must abort and restart with its original timestamp. Deadlock prevention: wound-wait. Wound-wait algorithm actually allows older transactions to abort younger transactions that have a resource they want. If a younger transaction requests a resource that is allocated to an older transaction it is allowed to wait.*
   *Deadlock detection and recovery: waits for graph. Create a waits for graph G(N,E) where N are the nodes of the graph and represent each active transaction and E are the edges of the graph. An edge is drawn from Ni -→ Nj if Ni is waiting to lock a resource locked by Nj.*
8. **True**/False An exclusive lock gives a transaction exclusive access to that data object.
9. True/**False** All relational database systems must implement a locking mechanism.
10. State why the *Wait-Die* deadlock prevention algorithm does not reassign the timestamp associated with the restarted transaction.
    *In the wait-die algorithm older transactions can wait for completion of conflicting transactions. By keeping its original timestamp, the restarted transaction will have the highest precedence once all older transactions have finished. This allows the original timestamp to determine the order of the completed transactions.*
11. Describe the data models associated with the NoSQL databases.

- **Key-value :** associate a data value with a specific key
- **Document-oriented :** associate a structured data value with a specific key. The structure is embedded in the object
- **Graph database :** consists of nodes and edges. Typically the nodes represent entities and the edges represent relationships.
- **Columnar database:** stores data by columns as oppose to rows. Columns are grouped into families, typically a family corresponds to a real world object

12. Using Compass, write a filter for the sample_restaurants database that returns all restaurants that are in the borough Brooklyn and serves American cuisine.
    { borough : "Brooklyn", cuisine : "American"}

13. Describe the CAP theorem.

CAP theorem states that there are three basic requirements for a distributed database
Consistency - the data in the database remains consistent after the execution of an operation. For example, after an update operation all clients see the same data.

Availability - This means that the system is always on (service guarantee availability), no downtime.

Partition Tolerance - This means that the system continues to function even when the communication among the servers is unreliable, i.e. the servers may be partitioned into multiple groups that cannot communicate with one another.

Theoretically it is impossible to guarantee the fulfillment of all 3 requirements. CAP provides the basic requirements for a distributed system to follow 2 of the 3 requirements. Therefore all the current NoSQL database follow different combinations of the C, A, P from the CAP theorem.

14. State whether the following schedule is a serial schedule. State whether the following schedule is a conflict serializable schedule. State whether the following schedule is a recoverable schedule. Draw the precedence graph.
    *Interleaves operations so not a serial schedule, Cycle : so not a conflict serializable. Recoverable.*

| | |
|---|---|
| TIME1 | READ(T1, X) |
| TIME2 | READ(T2,X) |
| TIME3 | WRITE(T1,X) |
| TIME4 | WRITE(T2,X) |
| TIME5 | COMMIT(T1) |
| TIME6 | COMMIT(T2) |