Exercise 4 solution

1. Discuss why the isolation property of ACID properties will apply to both an Online shopping platform as well as an Online banking system despite that they are different applications dealing with different data.

   Solution:

   Both types of systems may need to serve a large number of customers at any given time. For achieving consistency, both systems require that a transaction does not use the values that have been modified by another uncommitted transaction. A naïve approach to achieve this is handling one customer at a time. But the efficiency of the service would be extremely low with this approach. Therefore, the systems should allow different transactions to run concurrently. At the same time, the changes to the data are made as if the transactions run on a serial schedule, i.e., a transaction runs as if it is the only transaction in the system and does not become aware of other concurrent transactions which is the objective of isolation. Isolation helps with achieving a high level of efficiency while maintaining the consistency of the data that is manipulated.

2. In a nested transaction, a transaction PARENT has three sub-transactions A, B, and C. For each of the following scenarios, answer which of these four transactions' commits can be made durable, and which ones have to be forced to rollback.

   - Scenario 1: Commit by A, B, and C; but PARENT rolls back.
   - Scenario 2: Commit by A, B, C, and PARENT.
   - Scenario 3: Commit by A, B, and PARENT; but C rolls back.

   Solution:

   - Scenario 1: Based on the rollback rule, all four transactions roll back, with no durable commit by any transaction.
   - Scenario 2: All four transactions make durable commits, with no roll back.
   - Scenario 3: Durable commits by A, B, and Parent; roll back by C only.

3. Discuss why using a single process for all the transaction processing monitor services is not a good idea.

   Solution:

   One error in the process can impact all the transactions. This could lead to poor performance as well as monitors of different transactions cannot be distributed either.

4. We have seen flat transactions in class. The following flat transaction definition creates a problem for the system and shows why flat transactions alone cannot be used. Please discuss the example and explain the associated issue:

```
GiveEndofYearBonus()
   {  real bonus;
    receive(bonus);
    exec sql BEGIN WORK;
        exec SQL UPDATE customer
        set account = account + :bonus
    exec sql COMMIT WORK;
   }
```

   Solution:

   The customer table here could be a large table with millions of customers. This means this transaction can potentially be doing a lot of work during its execution and take a long time. Any failure in this transaction's execution would mean a lot of work lost. So better not to have this transaction as a flat transaction.

5. What is the difference between a singleton select and a cursor? **Solution**:

   If an SQL statement returns only a single row of data, that's singleton select. If more than one rows are returned, then a 'cursor' is returned, pointing at the first row of the results. The cursor can be used to traverse all the results rows one by one.

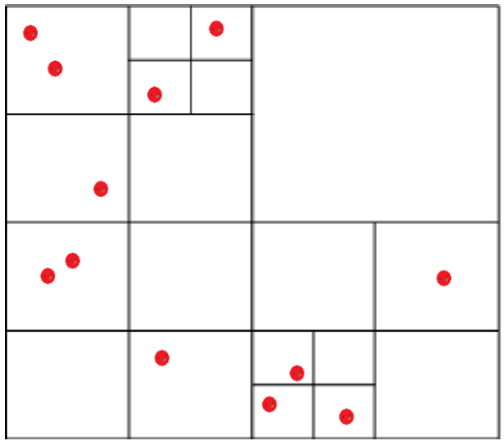
6. What is the value of `AccBalance1` after running the following transaction operations? Discuss why save points are needed.

```
BEGIN WORK
SAVE WORK 1
AccBalance1 = 100;
AccBalance2 = 50;
SAVE WORK 2
AccBalance3 = AccBalance1 + AccBalance2;
AccBalance1 = 0;
AccBalance2 = 0;
SAVE WORK 3
ROLLBACK WORK (2)
AccBalance3 = AccBalance1;
AccBalance1 = 0;
SAVE WORK 4
AccBalance3=AccBalance3 + AccBalance2;
ROLLBACK WORK (2)
AccBalance2 = AccBalance2 + 100;
COMMIT WORK
```

   Solution:

   The value of AccBalance1 is still 100 as the last rollback action takes the state to save point 2, where the value of AccBalance1 had not been changed to 0 but was changed to 100. Without save points, the transaction needs to be started from scratch every time it needs to rollback.

7. In the following quadtree the division of space is based on a rule that each quadrant could only have at most one data point. Based on that we can see that the quadtree is not properly formed. Please finish the space subdivision process for this tree.



   Solution:

   The quadtree can be finished as follows.