COS 126 General Computer Science Spring 2005

Midterm 2 Solutions

1. **Encapsulation, ADT (8 points)**

```
public class Account {
   private int balance;

   //constructor, initializing account balance to init
   public Account(int init) {
      this.balance = init;
   }

   // deposit amt into account
   public void deposit(int amt) {
      this.balance = this.balance + amt;
   }

   // withdraw amt from account if there is enough balance
   // otherwise, print an error message and withdraw nothing
   public void withdraw(int amt) {
      if (amt <= this.balance)
         this.balance = this.balance - amt;
      else
         System.out.println("Insufficient funds");
   }

   // transfer amt to the account b if there is enough balance
   // otherwise, print an error message and transfer nothing
   public void transfer(int amt, Account b) {
      if (amt <= this.balance) {
         this.balance = this.balance - amt;
         b.balance = b.balance + amt;
      }
      else
         System.out.println("Insufficient funds");
   }

   // get current balance
   public int getBalance() {
      return this.balance;
   }
}
```

2. **Regular Expressions, Deterministic Finite State Automata (6 points)**

   a) The answer, iii) generates all desired strings and only desired strings.

      i) can generate a string that starts with b.

      ii) cannot generate a single a.

      iv) can generate a string that starts with b.

      v) cannot generate a single a.

   b) The answer, i) accepts all desired strings and only desired strings.

      ii) accepts the empty string.

      iii) accepts strings that start with b.

3. **Linked Lists (6 points)**

   (a)
   - i) returns true
   - ii) returns true
   - iii) returns false
   - iv) returns false

   (b) `linky_dink` returns true for a null-terminated linked list. It returns false for a circular linked list, even if the circular part is preceded by a straight path.

   (c) N

   For a null terminated linked list, b will traverse each node once before the method returns true. For a circular linked list, b which is traveling twice as quickly as a, will catch up to a in a constant number of circuits of the length N list.

4. **Analysis of Algorithms (3 points)**

   (a) N^2

   The nested loop performs N times N additions.

   (b) N

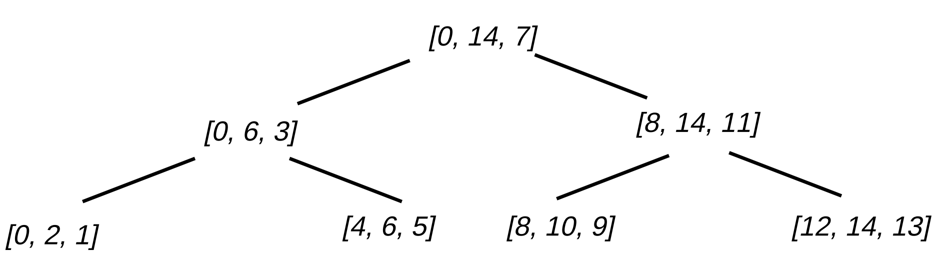
   The loop performs N multiplications.

   (c) $\log N$

   The recursive method uses repeated squaring. It calls itself approximately $\log N$ times, performing either one or two multiplications each call.

5. **QuickSort (5 points)**

   (a)

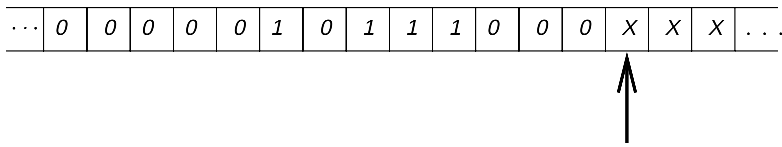


   (b) $N \log N$ Just like QuickSort.

6. **Queue (8 points)**

```
   // Add an element to the rear of this queue if there is room.
   // If there is no room left on the queue, just return.
   public void enqueue(double item) {
      // Check for room on the queue
      if (isFull) return;

      // Place the item on the queue, move the rear marker.
      queue[rear] = item;
      rear++;

      // At end of array, wrap around to the beginning
      if (rear == capacity) rear = 0;

      // increase the item count.
      numItems++;
   }

   // Remove and return the element from the front of this queue
   // If there are no elements on the queue, return 0.
   public double dequeue() {
      // Check for empty queue
      if (isEmpty) return 0.0;
      // Remove item from front of the queue, move the front marker
      double item = queue[front];
      front++;
      // At end of array, wrap around to the beginning
      if (front == capacity) front  = 0;

      // Decrease the item count.
      numItems--;

      // Lastly, return the item.
      return item;
   }

   // Check if this queue is empty
   public boolean isEmpty() {
      return (numItems == 0);
   }

   // Check if this queue is full
   public boolean isFull() {
      return (numItems == capacity);
   }
}
```

7. **Turing Machine (4 points)**



a)

b) The Turing Machine adds 1 to the binary number on the tape.

8. **Data Structures (3 points)**

   (a) Symbol Table
   (b) Binary Search Tree
   (c) Graph

9. **True or False (6 points)** Circle your answer.

T (a) P is the set of decision problems solvable in Polynomial time by a deterministic Turing Machine.

F (b) NP is the set of decision problems not solvable in Polynomial time by a deterministic Turing Machine.

F (c) For proper encapsulation, instance variables should always be declared public.

F (d) Because the Halting Problem is unsolvable, it is impossible to tell if *your* TSP program for Assignment 6 has an infinite loop.

T (e) A Universal Turing Machine can compute anything that any other Turing Machine could possibly compute.

F (f) If Bob wants to send a message to Alice using RSA encryption, he would first encrypt his message with his own public key, and then encrypt the result with Alice's public key.

T (g) If P equals NP, then the Traveling Salesperson Problem can be solved in polynomial time by a deterministic Turing Machine.

F (h) If P does not equal NP, then there is no case of the Traveling Salesperson Problem for which you can find the optimal tour in polynomial time.

T (i) In a symbol table implementation using a hash table, a good hash function would distribute the keys more or less evenly over the symbol table positions.

F (j) Factoring is known to be in NP but has not been proven to be NP-complete, so the discovery of a polynomial-time algorithm for factoring would mean that P equals NP.

F (k) Factoring is known to be in NP but has not been proven to be NP-complete, so no polynomial-time algorithm for factoring is possible.

F (l) The Turing Test is a test of whether a problem can be solved by a Turing Machine.