Study Questions for Midterm 1, Data Structures & Algorithms

You are welcome to discuss questions and solutions with your classmates or others. I have no solutions to provide but can answer questions you may have.

1. Arrange the following expressions by growth rate from slowest to fastest.

   $4n^2$
   $\log_3 n$
   $n!$
   3^n
   $20n$
   2
   $\log_2 n$
   $n^{2/3}$

2. Using the definition of Big-O and Ω, find the upper and lower bounds for the following expressions.
   a. $37n$
   b. $23n^3 + 88$
   c. $2n\lg n + 10000n$
   d. $0.5*2^n + 10000n^6$

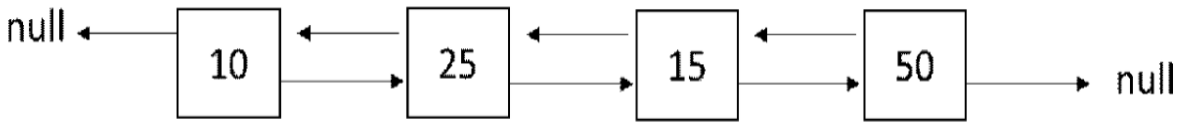
3. Determine the Big-O runtime for this code fragment

```
for (cnt4 = 0, i = 1; i <= n; i*=2)
    for (j = 1; j <= i; j++)
          cnt4++;
```

4. Determine the Big-O runtime for this recursive function (note it does not do anything useful)

```
int foo(int[] a, int n)
{
   if (n > 1)
   {
         if (a[n/2]==1)
               return 1;
         return foo(a, n/2);
   }
   return 0;
}
```

5. Given the doubly linked list below, where `head` points to the node with 10 and `tail` points to the node with 50:



   a. If p is a pointer to the node with the value of 15, give the code that deletes that node from the doubly-linked list.

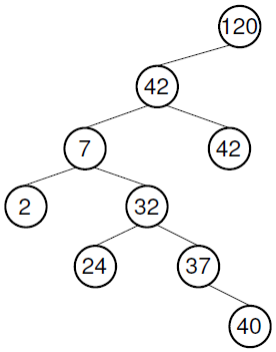
   b. If p is a pointer to the node with the value of 10 and q is a pointer to the node with 25, give the code that swaps those two nodes in the linked list by swapping next/previous pointers (not just copying the value from one node to the other).

6. Let Q be a non-empty queue, and let S be an empty stack. Using only the stack and queue ADT functions and a single element variable X, give an algorithm to reverse the order of the elements in Q.

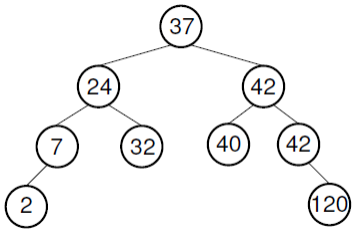
7. Write a recursive function that takes as input a pointer to the root node of a binary tree (pseudocode is fine). The function should return the height of the tree (the height of an empty tree is 0, the height of a tree with one node is 1, etc.)

8. Write a recursive function that takes as input a pointer to the root node of a binary tree (pseudocode is fine). The function should return the number of total leaves in the tree.

9. Given the binary search tree below:



   a. List the order the nodes are visited if we use the pre-order traversal algorithm
   b. Show the resulting tree if we insert the values 45, 41, and 35
   c. Show (using the original tree) how the tree would be reorganized if we delete the node with value 7
   d. Given this tree, show how the tree would be reorganized if we delete the root node.



10. Describe a set of characters and frequencies for which the worst case scenario of the Huffman compression scheme that results in the worst/least amount of compression.

11. You must keep track of some data. Your options are:
    a. A linked list in sorted order
    b. A linked list in unsorted order
    c. A binary search tree
    d. An array maintained in sorted order
    e. An array in unsorted order

    For each of the following scenarios, which of these choices would be best?

    1. The records are guaranteed to arrive already sorted from lowest to highest (i.e., whenever a record is inserted, its key value will always be greater than that of the last record inserted). A total of 1000 inserts will be interspersed with 1000 searches
    2. The records arrive with values having a uniform random distribution. 1,000,000 insertions are performed, followed by 10 searches.
    3. The records arrive with values having a uniform random distribution. 1000 insertions are interspersed with 1000 searches.
    4. The records arrive with values having a uniform random distribution. 1000 insertions are performed, followed by 1,000,000 searches.