

# Data Structure and Algorithms

## Midterm Practice Questions

1. What is the main advantage that arrays have over linked lists, give an example to support your answer?
2. What is Abstract Data Types?
3. Give a brief description of (a) inserting and (b) deleting an element from an array?
4. Discuss whether a stack or a queue is the appropriate structure for determining the order in which elements are processed in each of the following situations?
  - a. Batch computer programs are submitted to the computer center.
  - b. Program A calls subprogram B which calls subprogram C, and so on.
5. What is an Algorithm and what are the properties of a good algorithm?
6. What is algorithm analysis?
7. What is the goal of algorithm analysis?
8. What is the difference between linear data structures and nonlinear data structures
9. What is the advantage of doubly linked list over singly linked list?
10. Find the worst-case runtime complexity of the following function

```
int Foo(int n, j){
    int sum = 0;
    For (int i = 0; i<n; i++){
        if(i>j)
            sum = sum +1;
        else {
            for(int k = 0; k<n; k++)
                sum = sum -1;
        }
    }
}
```

11. Convert the following expressions from infix to postfix
$$A + B * (C - D) / (E + F)$$
$$(A + B) * C - D$$
12. How to design a stack such that GetMinimum(Stack \*myStack) takes  $O(1)$ ?
13. How to implement a stack which will support following operations in  $O(1)$  time complexity?
  - a. Push: which add an element to the top of the stack
  - b. Pop: which remove an element from the top of the stack
  - c. Find Middle: which will return middle element of the stack
  - d. Delete Middle: which will remove the middle element from the stack
14. Write an algorithm to insert an element into a queue. Use sketches or diagrams to illustrate your answer.

15. Write an algorithm to delete an element from the middle of a linked list. Use sketches or diagrams to illustrate your answer.

16. Find the upper bound for:

a.  $f(n) = 3n + 2n + 100$

b.  $f(n) = n^4 + 100n^2 + 50$

c.  $f(n) = n \log n + 10n + 5$

17. Find the worst-case runtime complexity of the following function

```
int f3(int n) {
    int sum = 73;
    for(int i=0; i < n; i++) {
        for(int j=i; j >= 5; j--) {
            Sum--;
        }
    }
    return sum;
}
```

18. Write an algorithm to reverse a singly linked list. What is the big-oh of your algorithm?

19. Give a big-O estimate for the number of operations (where an operation is an addition or a multiplication) used in this segment of an algorithm.

```
t := 0
for i := 1 to 3
    for j := 1 to 4
        t := t + ij
```

20. How much time does an algorithm take to solve a problem of size  $n$  if this algorithm uses  $2n^2 + 2n$  operations, each requiring  $10^{-9}$  seconds, with these values of  $n$ ?

a) 10   b) 20   c) 50   d) 100

21. Write an algorithm based on the binary search for determining the correct position in which to insert a new element in an already sorted list. What is the runtime to insert an element using this algorithm in a sorted array.