Assignment 1 – Data Structures and Algorithms
Deadline: Wednesday February 7 by 11:59pm
Type: Individual Assignment
Weight: 5%

Theory Questions:

Q1 (10)

Give tilde approximations for the following quantities:

a. N + 1

b. 1 + 1/N

c. (1 + 1/N)(1 + 2/N^2)

d. 2N^3 - 15 N^2 + N

e. lg(2N)/lg N

f. lg(N^2 + 1) / lg N

g. N^{100} / 2^n

h. *(n* $*\log_2(n+1)$ *+ 2) / (n+1)*

Q2 (10)

Give the order of growth (as a function of N using big oh) of the running times of each of the following code fragments:

a.
```
int sum = 0;
for (int n = N; n > 0; n /= 2)
    for(int i = 0; i < n; i++)
        sum++;
```

b.
```
int sum = 0;
for (int i = 1 i < N; i *= 2)
    for (int j = 0; j < i; j++)
        sum++;
```

c.
```
int sum = 0;
for (int i = 1 i < N; i *= 2)
    for (int j = 0; j < N; j++)
```

```
        sum++;
```

d.
```
for (int i = 0; i < n; i = i + C)
        for (int j = 0; j < 10; j++)   O(n)
            Sum[i] += j * Sum[i];
```

Q3 (8)

Describe a method for finding both the minimum and maximum of n numbers using fewer than 3n/2 comparisons. (Hint: First construct a group of candidate minimums and a group of candidate maximum)

Q4 (8)

An array contains n integers taken from the interval [0,4n], with repetitions allowed. Describe an efficient algorithm for determining an integer value k that occurs the most often in A. What is the running time of your algorithm?

Q5 (9)

1.3.3- Suppose that a client performs an intermixed sequence of (stack) push and pop operations. The push operations put the integers 0 through 9 in order onto the stack; the pop operations print out the return values. Which of the following sequence(s) could not occur?

a. 4 3 2 1 0 9 8 7 6 5

b. 4 6 8 7 5 3 2 9 0 1

c. 2 5 6 7 4 8 9 3 1 0

d. 4 3 2 1 0 5 6 7 8 9

e. 1 2 3 4 5 6 9 8 7 0

f. 0 4 6 5 3 8 1 7 2 9

g. 1 4 7 9 8 6 5 3 0 2

h. 2 1 4 3 6 5 8 7 9 0

Programming Questions:

Q1 (15)

1.3.9- Write a program (in java) that takes from standard input an expression without left parentheses and prints the equivalent infix expression with the parentheses inserted. For example, given the input:

1 + 2) * 3 - 4) * 5 - 6)))

your program should print
(1 + 2) * ((3 - 4) * (5 - 6))

Q2 (8)

1.3.20- Write a method delete() that takes an int argument k and deletes the kth element in a linked list, if it exists.

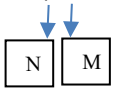
Q3 (7)

1.3.27- Write a method max() that takes a reference to the first node in a linked list as argument and returns the value of the maximum key in the list. Assume that all keys are positive integers, and return 0 if the list is empty.

Q4: (10)

1.3.37- Josephus problem. In the Josephus problem from antiquity, N people are in dire straits and agree to the following strategy to reduce the population. They arrange them-selves in a circle (at positions numbered from 0 to N–1) and proceed around the circle, eliminating every Mth person until only one person is left. Legend has it that Josephus figured out where to sit to avoid being eliminated. Write a Queue client Josephus program (in java) that takes N and M from the command line and prints out the order in which people are eliminated (and thus would show Josephus where to sit in the circle).

% java Josephus 7 2 1 3 5 0 4 2 6



Q5: (15)

1.4.20- Bitonic search: An array is bitonic if it is comprised of an increasing sequence of integers followed immediately by a decreasing sequence of integers. Write a program in java that, given a bitonic array of N distinct int values, determines whether a given integer is in the array. Your program should use ~3lg N compares in the worst case.