



United International University

Department of Computer Science and Engineering

Mid Exam, Spring2024

CSE 2215: DATA STRUCTURE AND ALGORITHMS I

Total Marks: 30 Duration: 1 Hour 30 Minutes

Any examinee found adopting unfair means will be expelled from the trimester/program as per UIU disciplinary rules.

Answer all the questions.

1. (a) Consider the following two algorithms to find the factorial of a number and determine which [4] one will take shorter time. Make your decision using asymptotic notation.

```
FactorialIterative(n) {
    y = 1
    for( i = 1 to n) {
        y = y*i
    }
    return y
}
```

Solution a

```
FactorialRec(n) {
    if (n==0) return 1
    else return n*FactorialRec(n-1)
}
```

Solution b

- (b) Consider the following arrays. In order to search for a particular number in these arrays [3] correctly and efficiently, mention which algorithm can be chosen from Binary Search and Linear Search. Justify your choice of algorithm in each of the cases. Note that no modifications can be made to the arrays before applying the selected algorithms.

- i. 5 9 1 2 0 18 4 7
- ii. 1 6 6 8 8 9 21 24
- iii. 15 12 8 6 3 1

2. (a) Apply Merge Sort on the given array to sort it in Descending order. You must show each step [3] of the simulation in detail.

Array: 50 32 12 50 45 99 12 10 4 93

- (b) Picking pivot in Quicksort plays a significant role in deciding the time complexity of the [2] algorithm – whether it will achieve the best case, worst case, or the average case. We have a choice regarding which element to pick as the pivot – we can pick the first element, middle element, median element, last element, etc. as pivot. Discuss which pivot selection strategy is optimal for achieving the best-case scenario, and on the other hand, which strategy is more likely to lead to the worst-case scenario?

- (c) Consider the following array of 5 elements where Insertion Sort Algorithm is to be applied. [3]

Array: 30,10,40,20,15

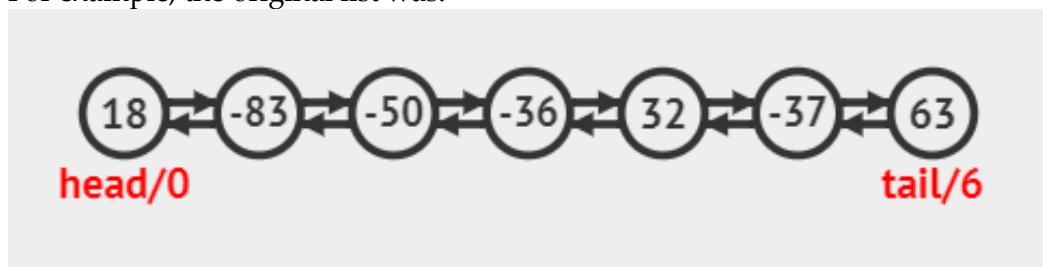
```
InsertionSort(A){  
    for( j = 2 to A.length){  
        key = A[j]  
        i = j - 1  
        while( i > 0 and A[i] > key){  
            A[i+1] = A[i]  
            i = i - 1  
        }  
        A[i+1] = key  
    }  
}
```

- i. How many times will the condition of the while loop be executed? Justify your answer.
 - ii. How many times will the while loop be executed if the above array was already sorted in Ascending order? Justify your answer.
 - iii. How many times will the while loop be executed if the above array was already sorted in Descending order? Justify your answer.
3. (a) Suppose there is a doubly linked node declared as below: [3]

```
struct node{  
    int value;  
    struct node *next;  
    struct node *prev;  
}*head;
```

Given a pointer to the **head** node of a doubly linked list only, write a code to delete the middle node and the node previous to the middle node of the linked list. For this problem, you can assume that the number of nodes in the linked list is odd and more than 5.

For example, the original list was:



After deletion:



- (b) Given a singly/linear linked list defined with a **head** pointer, show the effect of each of the statements by drawing nodes and linking them: [3]

```
a = (node*)malloc(sizeof(node)); OR a = new node();
b = (node*)malloc(sizeof(node)); OR b = new node();
c = (node*)malloc(sizeof(node)); OR c = new node();
d = (node*)malloc(sizeof(node)); OR d = new node();
a->value=2;
b->value=3;
c->value=4;
d->value=5;
d->next = a;
a->next = b;
b->next = c;
c->next = d;
e=a;
d->next = a->next;
```

- (c) Suppose you are given the task to delete all the nodes of a single linked list. You came up [2] with an ingenious idea and wrote a single line of code:

head = NULL; // head is a pointer to the first node of the list

Will this work? Why/Why not?

4. (a) Write algorithms to create a new data structure named “Stalk” using an array based on **FILO** [3] (**First In Last Out**) that works with integers. You need to write two methods: *push(int a)* and *pop()*. The “push” method should push an element to the Stalk and the “pop” method should delete an element according to FILO.

- (b) i. How can you move the first element of a queue to the last? Assume that you have the [4] *enqueue()* and *dequeue()* functions implemented.
ii. Show the following operations on the given array of size 5 (You cannot use another array).

front	rear		
5	6	4	

dequeue()
enqueue(7)
enqueue(dequeue())
enqueue(10)