BRAC University

CSE221 : Algorithms

Mid Examination

4th November, 2022

Set: A

Total Marks : 10

Jack loves to play with integers. He created a list of n integers where the even indices hold numbers in decreasing order and the odd indices hold numbers in increasing order. For example, this is a list of n=8 integers Jack made.

| Index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number | 23 | 2 | 19 | 3 | 7 | 11 | 5 | 13 |

[Explanation:

The indices 1, 3, 5, and 7 have numbers 2, 3, 11, and 13 in increasing order.

The indices 0, 2, 4, and 6 have numbers 23, 19, 7 and 5 in decreasing order.]

You sorted the the list in quadratic time [O()]. To your utter surprise, Jack replies, “It could be sorted in linear time”.

1. ***[CO2]*** Show the steps how you sorted the list using a suitable algorithm. Mention the name of the algorithm. — 3
2. ***[CO2]*** Describe how Jack sorted the list in linear time. Show the steps too. — 4
3. ***[CO3]*** Jack wants to add the number 15 to your sorted list from (1). He wants you to come up with an efficient idea about how he is going to find the accurate index position for 15 in the list.

Describe how you are going to assist him in this. Show the steps too. — 3

Set: B

Total Marks : 10

Jack loves to play with integers. He created a list of n integers where the even indices hold numbers in decreasing order and the odd indices hold numbers in increasing order. For example this is a list of n=8 integers Jack made.

| Index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number | 33 | 7 | 29 | 11 | 17 | 23 | 13 | 31 |

[Explanation:

The indices 1, 3, 5, and 7 have numbers 7, 11, 23, and 31 in increasing order.

The indices 0, 2, 4, and 6 have numbers 33, 29, 17, and 13 in decreasing order.]

You sorted the the list in quadratic time [O()]. To your utter surprise, Jack replies, “It could be sorted in linear time”.

1. ***[CO2]*** Show the steps how you sorted the list using a suitable algorithm. Mention the name of the algorithm. — 3
2. ***[CO2]*** Describe how Jack sorted the list in linear time. Show the steps too. — 4
3. ***[CO3]*** Jack wants to add the number 12 to your sorted list from (1). He wants you to come up with an efficient idea about how he is going to find the accurate index position for 12 in the list.

Describe how you are going to assist him in this. Show the steps too. — 3

**Solution:**

1) Any sorting algorithm from Insertion, Selection and Bubble Sort. (They are free to choose the order too)

If I use Insertion Sort. The steps will be:

| Sorted | Unsorted | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 23 | 2 | 19 | 3 | 7 | 11 | 5 | 13 |

| Sorted | | Unsorted | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | 23 | 19 | 3 | 7 | 11 | 5 | 13 |

| Sorted | | | Unsorted | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | 19 | 23 | 3 | 7 | 11 | 5 | 13 |

| Sorted | | | | Unsorted | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | 3 | 19 | 23 | 7 | 11 | 5 | 13 |

| Sorted | | | | | Unsorted | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | 3 | 7 | 19 | 23 | 11 | 5 | 13 |

| Sorted | | | | | | Unsorted | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | 3 | 7 | 11 | 19 | 23 | 5 | 13 |

| Sorted | | | | | | | Unsorted |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | 3 | 5 | 7 | 11 | 19 | 23 | 13 |

| Sorted | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | 3 | 5 | 7 | 11 | 13 | 19 | 23 |

2) It can be done using the MERGE step from MergeSort. Taking the odd indices as one branch (for example left) and the even indices in the reverse direction as the other branch, Merge step can easily sort the whole list of integers.

3) It can be done using ideas from (the Binary Search/Partition/Linear Search).

Set A:

| **[CO3]**Consider this graph:     1. **Justify** , where *m* = number of edges in the graph. 2. **Create** an adjacency matrix for this graph. 3. **Apply** Depth First Search to traverse this graph considering S to be the source vertex. **Demonstrate** the results.   Set-A   1. Deg (A) = 3, Deg (B) = 4, Deg (C) = 4, Deg (D)=3, Deg (E)=3, Deg (F)=3, Deg (G)= 4, Deg (H)= 2, Deg (S) = 2   Total number of edges,m = 14  Total Deg = 3+4+4+3+3+3+4+2+2=28=2m  Other solutions are also acceptable.   1. Adjacency Matrix:  |  | S | A | B | C | D | E | F | G | H | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | S | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | A | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | B | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | | C | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | | D | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | | E | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | | F | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | | G | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | | H | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |  1. DFS:   Vertex traveling sequence: S> A> B> D> E> G> C> F> H  There are other acceptable solutions as well. | 2  2  6 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

Set B:

| **[CO3]**Consider this graph:     1. **Justify** , where *m* = number of edges in the graph. 2. **Create** an adjacency list for this graph. 3. **Apply** Breadth First Search to traverse this graph considering S to be the source vertex. **Demonstrate** the results.   Set-B   1. Deg (A) = 3, Deg (B) = 4, Deg (C) = 4, Deg (D)=3, Deg (E)=3, Deg (F)=3, Deg (G)= 4, Deg (H)= 2, Deg (S) = 2   Total number of edges,m = 14  Total Deg = 3+4+4+3+3+3+4+2+2=28=2m  Other solutions are also acceptable.   1. Adjacency List:   S => A > B  A => S > B > C  B => S > A > D > E  C => A > D > F > G  D => B > C > E  E => B > D > G  F => C > G > H  G => C > E > F > H  H => F > G   1. BFS:   Vertex traveling sequence: S> A> B> C> D> E> F> G> H  There are other acceptable solutions as well. | 2  2  6 |
| --- | --- |

SETA

a. Calculate the time complexity of the following function

[CO7]

Finding\_Worst\_Case(n):

int i,j,k,m,multi,a,b,c

for( i = n; i >= 1; i = i / 7 ){

for( j = 1; j <= n; j = j + 3 ) {

for( k=1; k<=40 ; k=k+1){

multi=a\*b

}

for( m=n ; m>=1 ; m=m-5 ){

multi=multi\*c

}

}

}

**Solve** : First for loop -> log7 n

Second for loop -> n/3

Third for loop -> 40

Fourth for loop -> n/5

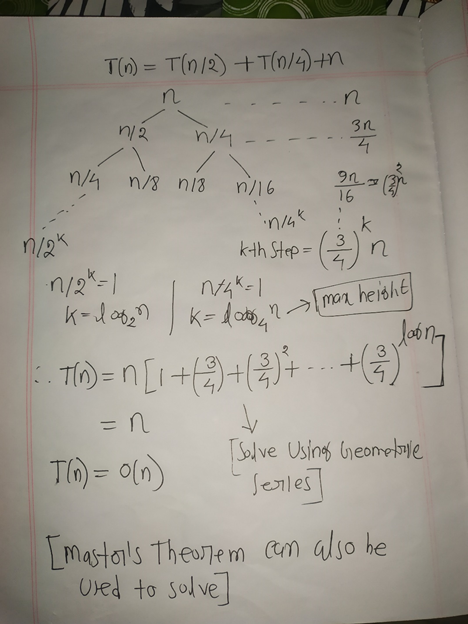
Total = ( log7 n \* n/3 \* (40+n/5))

Final answer = O (n2 logn)

b. Calculate the time complexity of the following recurrence relation.

[CO7] [Any method is acceptable as long as steps are shown]

T(n) = T(n/2) + T(n/4) + n



SETB

a. Calculate the time complexity of the following function

[CO7]

Finding\_Worst\_Case(n):

int i,j,k,m,multi,a,b,c

for( i = n; i >= 1; i = i - 4 ){

for( j = 1; j <= n; j = j \* 3 ) {

for( k=1; k<=20 ; k=k+1){

multi=a\*b

}

for( m=n ; m>=1 ; m=m/5 ){

multi=multi\*c

}

}

}

Solve : First for loop -> n/4

Second for loop -> log3 n

Third for loop -> 20

Fourth for loop -> log5 n

Total = ( n/4 \* log3 n \* (20 + log5 n))

Final answer = O (n (logn)2 )

b. Calculate the time complexity of the following recurrence relation.

[CO7] [Any method is acceptable as long as steps are shown]

T(n) = T(n/3) + T(n/5) + n

