UNIVERSITY OF SRI JAYEWARDENEPURA - FACULTY OF APPLIED SCIENCES

BSc Degree Second Year First Semester Course Unit Examination – October/November 2022

Department of Computer Science

ICT 204 2.0 Data Structures and Algorithms

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Time: Two (02) hours  No. of questions: 04  No. of pages: 04  Total marks: 100

Answer all questions.

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## Question 01 (Total: 25 Marks)

1. Using your own words explain the following computing concepts.

   (a) Data structures

   (b) Abstract Data Types (ADT)

   [05 Marks]

2. Find the number of steps required when searching an item from an array of size N, in the following cases. Note that duplicates are not allowed.

   (a) Best case

   (b) Average case

   (c) Worst case

   [05 Marks]

3. State whether the following statements are true or false. In each case justify your answer.

   (a) A doubly linked list is a link list where each node refers to both the next and the previous node in the list.

   (b) Inserting an item into an unordered array takes time proportional to the size of the array.

   (c) In an unordered array, it is generally faster to find out an item is not in the array than to find out it is.

   (d) Returning a value from a function runs in constant time.

   [05 Marks]

4. In each of the following examples, choose the best data structure(s) from Array, Linked List, Stack and Queue. In each case justify the answer briefly.



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(a) Maintaining the playlist in media players.

(b) Undo/Redo operations in word processors.

(c) Forward-backward surfing in the browser.

(d) Maintaining a directory of names.

(e) To store a fixed number of keywords which are referenced very frequently.

[10 Marks

## Question 02 (Total: 25 Marks)

1. Show how the selection sort is computationally better than the bubble sort in the average case, regardless of both having the same time complexity.

[05 Marks]

2. Find the time complexity of each of the following code components.

(a)
```
void printAllNumbers (int arr[], int size)
{
    for (int i = 0; i < size; i++)
    {
        printf("%d\n", arr[i]);
    }

    for (int i = 0; i < size; i++)
    {
        for (int j = 0; j < size; j++)
        {
            printf("%d\n", arr[i] + arr[j]);
        }
    }
}
```

(b)
```
void printAll(int arr[], int size)
{
    for (int i = 0; i < size; i++)
    {
        printf("%d\n", arr[i]);
    }
}
```

[10 Marks]

3. Employ the binary search algorithm on the following ordered array to find the integer 33. Clearly write your workings to obtain the answer.

`1, 5, 9, 11, 17, 33, 45, 60, 74, 93`

[05 Marks]

4. Assume an array with 100,000 sorted records. How many comparisons (on average) are needed to find a specific record with binary search and linear search respectively?

[05 Marks]



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## Question 03 (Total: 25 Marks)

1. Consider the `mergeSort()` method given below. You are given the array `arr = {40, 20, 30, 10}` to be sorted using the merge sort algorithm. Write the order of the first five (05) method calls.

```
public ststic void mergeSort(long[] arr, int low, int high)
{
  if(low == high)
    return;
  else
  {  int mid = (low+high) / 2;
     mergeSort(arr, low, mid);
     mergeSort(arr, mid+1, high);
     merge(arr, low, mid, high);
  }
}
```

[10 Marks]

2. State two main advantages of linked list data structure over arrays.

[05 Marks]

3. Write a recursive algorithm to obtain the values in the sequence `1, 1, 2, 6, 24, 120, ...` for a given non-negative input n.

[05 Marks]

4. Write a Java method to search a key value (integer), in a linked list data structure. You may consider the `'Node'` class given in the lectures is provided.

[05 Marks]

## Question 04 (Total: 25 Marks)

1. The data set `[03, 06, 08, 13, 19, 25, 36, 42, 58, 70, 95, 101]` is given to search for the value 42 using binary search algorithm. What are the initial **LB, UB, CURRIn** values and new **LB, UB, CURRIn** values (corresponding array elements) after a single run. [`Note: LB = array elemint in the lower bound, UB = array elemint in the upper bound, CURRIn = array elemint in the current index`].

[05 Marks]

2. Suppose the numbers `[7, 6, 2, 8, 3, 5, 0, 4, 9, 1]` are inserted into an empty binary search tree. By clearly showing your workings, find the post-order traversal sequence of the resultant tree?

[05 Marks]



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3. Demonstrate how the selection sort algorithm works on the given set of integers [9, 7, 1, 2, 10, 8, 3, 5, 6, 4].

[05 Marks]

4. In the following binary tree (see figure 1), find the correct pre-oder, in-order, post-order traversals.

[05 Marks]

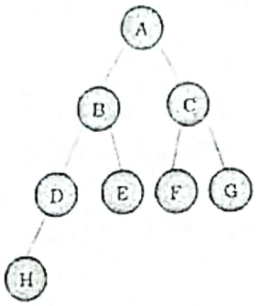


Figure 1: A binary tree

5. State whether the following statements are true or false. In each case justify your answer.

   (a) Doubly linked list is more suitable to implement the stack data structure than a singly linked list.

   (b) A recursive method without a base case will encounter a compile time error.

   (c) Given an array `arr = [55, 65, 23, 27, 89, 12, 87, 72]`, the output of the third pass of the insertion sort algorithm is `[23, 55, 65, 27, 89, 12, 87, 72]`

   (d) Merge sort can be implemented using both recursive and iterative approaches.

   (e) A binary search tree is a tree whose nodes have exactly zero or two children.

[05 Marks]

----------END OF PAPER----------



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