Vavuniya Campus of the University of Jaffna

First Examination in Information and Communication Technology - 2018

Second Semester - April/May - 2020

ICT 1213 - Data Structures (Old Syllabus)

Answer Five Questions Only

Time : Three hours

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1. (a) Discuss the differences between *linear* and *non-linear* data structures with suitable examples. [20%]

   (b) Describe three characteristics of *an algorithm*. [15%]

   (c) Write *an algorithm* and draw *a flowchart* to find the sum of the first ten positive integers. [25%]

   (d) Describe the properties used to measure the performance of an algorithm. [10%]

   (e) *An exception* (or exceptional event) is a problem that arises during the execution of a program. When an exception occurs the normal flow of the program is disrupted and the application program terminates abnormally.

      i. State three scenarios where an exception can occur. [15%]

      ii. Write a Java code segment for throwing one of the exceptions stated in part (e) i. [15%]

2. (a) Describe a method in Java to implement the *merge sort algorithm.* [30%]

(b) Execute the steps for sorting the following integers using the method written in part (a):

(54, 26, 93, 17, 77, 31, 44, 55, 20) [20%]

(c) Trace the *selection sort algorithm* to sort an array of integers:

(5, 1, 3, 4, 6, 2) [30%]

(d) Compare the time efficiency of the *merge sort algorithm* the and *selection sort algorithm.* [20%]

3. (a) Write a *linear search algorithm* to search an element in a given one-dimensional array. [20%]

(b) Write a method in Java to perform *a binary search* using *an iterative approach.* [30%]

(c) Consider an array with ten numbers as shown in Figure 1 below:

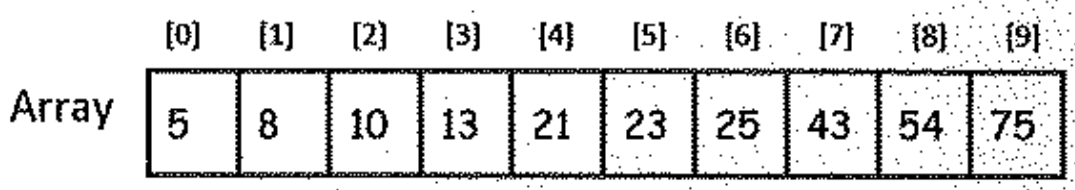

Figure 1: An Array with ten numbers

Trace the *binary search algorithm* to determine whether 21 is in the array. [20%]

(d) Compare the performance of the *linear search technique* and the *binary search technique* in terms of time complexity. [15%]

(e) Write Java statements to *swap two numbers* without using a third variable. [15%]

4. (a) Describe briefly the stack data structure and *its operations.* [20%]

(b) Write a Java program to implement a stack *using arrays.* [20%]

(c) Discuss the drawbacks of the array-based stack implementation. [20%]

(d) A function f is defined on stack of integers satisfies the following properties:

$f(\phi) = 0$, where ϕ denotes an `empty stack`

and

$f(Snew) = max(f(S), 0) + i$, where *Snew* is a `new state of stack S` after pushing the integer i to the current state of `stack S`.

Assume that `K` be a `stack` of size n≥1.

The operations on `stack K` are started with an empty stack, and pushed five integers to the `stack K` in sequence. The resultant `stack K` contains the integers (2, -3, 2, -2, 2) in order from bottom to top.

Determine the value of the function $f(K)$. [40%]

5. (a) Describe briefly the queue data structure and *its operations.* [25%]

(b) A queue can easily be represented by using *linear arrays.*

i. Demonstrate the array representation of *a queue* which contains five elements when forming the English word "HELLO". [20%]

ii. Write an algorithm for each of the following operations in a queue:

A. Insert an element in a queue [20%]

B. Delete an element from the queue [20%]

(c) Discuss the drawbacks of a queue implemented using an array in programming. [15%]

6. (a) Describe a **linked list data structure** in your own words. [20%]

(b) Discuss the differences between *a linked list* and *an array*. [20%]

(c) A linked list is shown in Figure 2, where *head* references the firstNode and the *tail* references the lastNode.

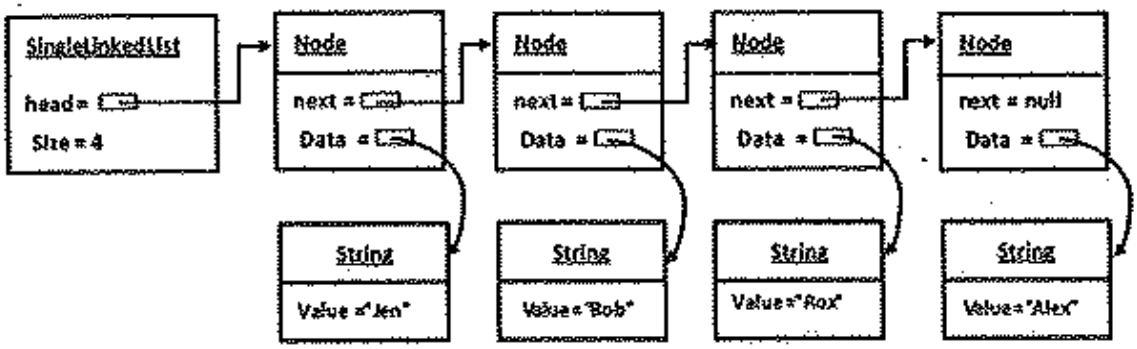

Figure 2: A linked List

i. Define a Java class to represent the above linked list. [30%]

ii. Write Java code segments to perform each of the following operations on the above linked list in the given order and draw the resultant linked list after the execution of each operation:

A. `insert` "Micky" before "Bob". [10%]

B. `remove` "Micky". [10%]

C. `insert` "Nicky" before "Jen". [10%]