Curtin College

In association with Curtin University

Mid-Semester Test – Trimester 2, 2020

SUBJECT: DATA STRUCTURES AND ALGORITHMS DSA1002

TIME ALLOWED:

Two (2) hour examination preceded by a 10-MINUTE READING PERIOD. This is a take home test and you are given three days to complete the test.

GENERAL INSTRUCTIONS:

This paper is an open book, open computer test and you are allowed to use google.

This paper consists of Four (4) questions with a total of 70 marks.

ATTEMPT ALL QUESTIONS

Name: _____

Student No: _____

Q1	
Q2	
Q3	
Q4	
Total	

QUESTION ONE (total: 20 marks): Intro and Sorting

a) **(2 marks)** Write the different steps in File IO starting from the beginning to the end?

b) **(2 marks)** What is the purpose of using finally in exception handling? Is it mandatory to use finally in exception handling?

c) **(4 marks)** What are the limitations of using Arrays? Explain the concept of Arrays of Objects with examples from Java and Python. (Do not copy paste from the lecture slides)

d) **(4 marks)**. The following code implements BubbleSort, but it is **wrong**. (submit the running code in a separate Java/Python file)

```
void BubbleSort(int[] A) {
boolean bSorted = false;
int pass = 1;
  int temp = -1;

  while (!bSorted) {
   bSorted = true;
    for (int nn=pass;nn < A.length-1;nn++){
       if (A[nn] > A[nn+1]) {
          A[nn] = A[nn+1];
   A[nn] = temp;        bSorted
   = false;
          }
   }
   pass++;
    }
}
```

```
def BubbleSort(A):
   bSorted = False
   passNum = 1
   temp = -1

   while (not bSorted):    bSorted =
   True    for nn in
   range(passNum,len(A)-1):       if
   (A[nn] > A[nn+1]):
            A[nn] = A[nn+1]
   A[nn] = temp
   bSorted = False
         passNum = passNum + 1
```

What would be the result of trying to sort the following array of numbers with the above flawed code?
Hint: If you show what the array will look like after each iteration, you can gain part marks even if you don't get the final answer correct.

7 16 6 18 13 28 26

e) **(4 marks)**. Given the following array of numbers, show in detailed steps how Insertion Sort would sort them: (coding not required)

31, 30, 54, 86, 76, 63, 28, 17

f) **(4 marks)**. Discuss the Big-O Notation for Bubble sort, Insertion sort and Selection sort. Also discuss the worst case, best case and average case for the three sorts.

QUESTION TWO (total: 15 marks): Stacks, Queues, Recursion

a) The following code implements dequeue() for a Queue class that holds integers and is based on an array with shuffling of elements to ensure FIFO ordering. However, although it compiles, the dequeue implementation contains **flaw(s)** in its logic that causes it to behave incorrectly (the constructor and other methods of the Queue class are not shown – assume they are implemented correctly).

```
public class Queue {
private int[] queue;
private int count;
   ...    public int
dequeue() {
       for (int ii=0; ii< count-1; ii++){
            queue[ii] = queue[ii+1];
         }
         return count-1;
      }
```

```
 class
Queue():
      def __init__(self):
          self.queue = np.zeros(20)
self.count = 0
      ...

     def dequeue():            for ii
in range(0, count-1):
queue[ii] = queue[ii+1]        return
count-1
```

i) **(3 marks)**. Rewrite the dequeue() function so that it is correct (you do not have to re-print the class definition – only dequeue() is needed).

ii) **(2 marks)**. Put 5 values in the queue and then run dequeue() those values to make the queue empty. (Submit the program as a different python/java file)

b) **(5 marks)**. How is recursive algorithm different than iterative algorithm? Write and compare the performance of recursive and iterative of Fibonacci series.

c) **(5 marks)**. Convert the following infix expression to its postfix equivalent using a stack. In your answer, show each step of building the postfix expression, including the contents of the operator stack and the postfix 'output' built up so far at each step.

((A + B) * C) – (D / E)

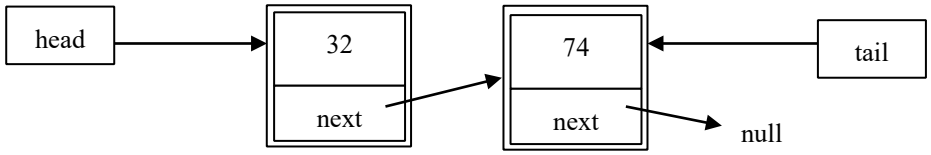
Infix Char	Postfix Written So Far	Operator Stack Contents

QUESTION THREE (total: 15 marks): Linked Lists

a) **(5 marks)**. Under what circumstances a singly linked list is better than doubly linked list. Justify the same with an example. Implement the singly linked list and doubly linked list in Python/Java and draw comparisons on the processing time and Big-O notation.(Submit the code in a separate .py/.java file)

b) **(5 marks)**. The following fragment of code modifies a linked list of ListNodes that contains integers. Given the diagram below that depicts the initial state of the linked list, draw the state of the linked list after each line of code has executed (ie: what the linked list will look like, including reference pointers). Provide three diagrams, one diagram per line of code marked as (i), (ii) or (iii).

```
ListNode newNode = new ListNode(42);   (i)          newNode =
ListNode(42)
head = head.getNext();                 (ii)         head =
head._next
tail.setNext(newNode);                 (iii)        tail._next
= newNode
```



c) **(5 marks)**. Draw and explain a double ended doubly linked list. Explain the scenario when it is best suited to use. Show the steps in creation of this linked list along with 10 elements.

QUESTION FOUR (total: 20 marks): Trees and Advanced Trees

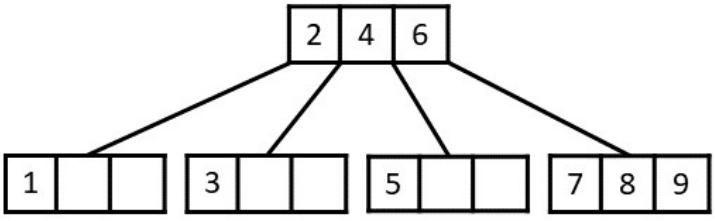
a) **(5 marks)**. Draw the binary search tree that would result from inserting the following numbers in the order that they are shown:

14, 4, 5, 13, 15, 11, 6, 2, 8, 10, 12, 7, 19

b) **(5 marks)**. Redraw the tree from part (a) after deleting 12 and then 8. Show the steps in deletion of both the elements.

c) **(5 marks)** Insert 17 in the tree mentioned in part a. Show the steps and write the complete algorithm to insert this value in the tree.

d) **(2 marks)** Given the 2-3-4 Tree, below, redraw the tree after inserting 10.



e) **(3 marks)** Create a RED BLACK tree by inserting the following sequence of number 10, 20, 7, 17, 20, 27, 50 & 90.