Source Code

1.

```
import random
#Initialise two empty lists.
list1=[]
list2=[]

#Input random numbers using randint into the lists.
for x in range(0,150):
    y=random.randint(0,1024)
    list1.append(y)

for x in range(0,140):
    y=random.randint(0,1024)
    list2.append(y)

#Creation of Shell Short algorithm.
def shellSort(array, n):

    interval = n//2
    while interval > 0:
        for i in range(interval, n):
            temp = array[i]
            j = i
            while j >= interval and array[j - interval] > temp:
                array[j] = array[j - interval]
                j -= interval

            array[j] = temp
        interval //= 2
```

```
#Creation of Quick Sort algorithm.
def partition(arr, low, high):
    i = (low-1)
    pivot = arr[high]

    for j in range(low, high):

        if arr[j] <= pivot:

            i = i+1
            arr[i], arr[j] = arr[j], arr[i]

    arr[i+1], arr[high] = arr[high], arr[i+1]
    return (i+1)

def quickSort(arr, low, high):
    if len(arr) == 1:
        return arr
    if low < high:

        pi = partition(arr, low, high)
        quickSort(arr, low, pi-1)
        quickSort(arr, pi+1, high)

#Inputting the random generated numbers list to the Shell Sort and Quick Sort algorithm.
shellSort(list1,len(list1))
quickSort(list2,0,len(list2)-1)

#Printing the sorted lists.
print("Shell sort: ", list1)
print("Quick sort: ", list2)
```

2.

```
#Length of lists
len1=len(list1)
len2=len(list2)

final=[]
a=0
b=0

#Checks that the current iteration is not larger than the length of list1 and list2.
while (a < len1) and (b <len2):
   #Checks which element is smaller and appends it to the a new list, the smaller elment is incremented.
   if(list1[a]<list2[b]):
      final.append(list1[a])
      a=a+1
   else:
      final.append(list2[b])
      b=b+1

#Prints merged lists.
print("Merged lists: ",final)
```

3.

```
#List of numbers.
list1=[0,5,3,6,8,7,15,9]
#Empty list to put extreme points.
list2=[]

size=len(list1)
```

```
#Loops in list of numbers
for x, item in enumerate(list1):
    #Checks if x is in the last position of the list, if yes it breaks the loop.
    if(x==size-1):
        break
    #Used to skip the first elment of the list.
    elif(x>0):
        #Checks if current item is an extreme point.
        if(list1[x-1] > item < list1[x+1]):
            #Extreme point appended.
            list2.append(item)
        elif(list1[x-1] < item > list1[x+1]):
            #Extreme point appended.
            list2.append(item)
        else:
            continue
    else:
        continue
#Prints extreme point.
print("Extreme points:" ,list2)
```

4.

```
import random
def distinct(list):
    #Loops four times to compare each possibility
    for i in range(len(list)):
        for j in range(len(list)):
            for k in range(len(list)):
                for l in range(len(list)):
                    #Checks  a * b = c * d and a ≠ b ≠ c ≠ d
                    if (list[i] != list[j] and list[i] != list[k] and
```

```
                    list[i] != list[l] and list[j] != list[k] and
                    list[j] != list[l] and list[k] != list[l] and
                    list[i] * list[j] == list[k]  * list[l]):

                print(list[i], " x ", list[j], " =", list[k], " x ", list[l])

A=[]
#Inputting random numbers in a list.
for x in range(50):
   A.append(random.randint(0, 1025))
#Prints the list.
print(A)
#Prints all possibilties.
distinct(A)

5.
#List in RPN
list=[5,4,"-",9,"*"]
#Empty stack
stack=[]

#Temp variables
A=0
B=0
C=0

#For loop to loop through  RPN list
for x in list:
   #Checks if element is *, if it is, it pops the last two elements and the result is appended to the new stack.
   if(x=='*'):
      A=stack.pop()
```

```
        B=stack.pop()
        C=B*A
        stack.append(C)
        continue
    #Checks if element is /, if it is, it pops the last two elements and the result is appended to the new stack.
    elif(x=='/'):
        A=stack.pop()
        B=stack.pop()
        C=B/A
        stack.append(C)
        continue
    #Checks if element is +, if it is, it pops the last two elements and the result is appended to the new stack.
    elif(x=='+'):
        A=stack.pop()
        B=stack.pop()
        C=B+A
        stack.append(C)
        continue
    #Checks if element is -, if it is, it pops the last two elements and the result is appended to the new stack.
    elif(x=='-'):
        A=stack.pop()
        B=stack.pop()
        C=B-A
        stack.append(C)
        continue
    #If the element is not any of the above, it appends to the new stack with out any calculations.
    else:
        stack.append(x)
        continue
```

```
#Prints result
print(“Result: ”, stack)
```

6.

```
num=15

halfNum=num/2

#Function checks if number is prime
if num>1:
    #Loops through half of the number, example if 50 is given it loops through 1-25
    for i in range(2,int(halfNum+1)):
        #If it finds a number that when divided by the input gives a modulus=0 it means the number is not prime.
        if(num%i)==0:
            print("Number given is not prime")
            break
    else:
        #If it loops through and does not find any modulus=0 it means the number is prime
        print("Number is prime")

#Sieve of Eratosthenes.
prime = [True for i in range(num+1)]
p = 2
print(“All prime numbers under the number given: ”)
while (p * p <= num):
    if (prime[p] == True):
        for i in range(p * p, num+1, p):
            prime[i] = False
    p += 1
```

```
for p in range(2, num+1):
    if prime[p]:
        print(p)
```

7.

```
#Class which defines one node in the binary seacrh tree.
class Node:
    def __init__(self,d):
        self.value = d
        self.left = None
        self.right = None

#Function to insert a node, it compares the value of the node inputted to the tree to give it the right position.
    def insert(self, d):
        if self.value:
            if d < self.value:
                if self.left is None:
                    self.left = Node(d)
                else:
                    self.left.insert(d)
            elif d > self.value:
                if self.right is None:
                    self.right = Node(d)
                else:
                    self.right.insert(d)
        else:
            self.value = d

#Function which prints the Inorder traversal.
    def printInorder(self):
        if self.left:
```

```
            self.left.printInorder()
        print(self.value)
        if self.right:
            self.right.printInorder()

#Function which prints the Preorder traversal.
    def printPreorder(self):
        print(self.value)
        if self.left:
            self.left.printPreorder()
        if self.right:
            self.right.printPreorder()

#Function which prints the Postorder traversal.
    def printPostorder(self):
        if self.left:
            self.left.printPostorder()
        if self.right:
            self.right.printPostorder()
        print(self.value)

#Initialises the root node
root = Node(27)
#Initialises other nodes
root.insert(14)
root.insert(35)
root.insert(31)
root.insert(10)
root.insert(19)

#Prints the different traversal.
```

```
print("Inorder: ")
root.printInorder()
print("Preorder: ")
root.printPreorder()
print("Postorder: ")
root.printPostorder()
```

8.

```
#Function which returns an approximation of the sqaure root of a number using the Newton-Raphson Method.
#In the function it loops for 10 times.
def newtonsMethod(num, reps=10):
    cons= float(num)
    for i in range(reps):
        num = (num+(cons/num))/2
    return num


print(newtonsMethod(2))
```

9.

```
#List of numbers.
nums=[1,2,3,4,8,3,1,5,9]
#Temp List.
tempList=[]
#Flag.
bool=False


#Loops in list of numbers.
for i in range(0,len(nums)):
    #Loops in .
    for j in range(0,len(tempList)):
        #Checks if the current value in list of numbers if found in temp list, if found that means its repeated, so it prints the value.
```

```
        if(nums[i]==tempList[j]):
            print(nums[i])
            bool=True
            break
    #If value is not found to be repeated it is appended to temp list to be used in more itterations.
    if(bool==False):
        tempList.append(nums[i])
```

10.

```
#List of numbers.
nums=[1,2,3,4,8,3,1,5,9]
#Temp List.
tempList=[]
#Flag.
bool=False

#Loops in list of numbers.
for i in range(0,len(nums)):
    #Loops in .
    for j in range(0,len(tempList)):
        #Checks if the current value in list of numbers if found in temp list, if found that means its repeated, so it prints the value.
        if(nums[i]==tempList[j]):
            print(nums[i])
            bool=True
            break
    #If value is not found to be repeated it is appended to temp list to be used in more itterations.
    if(bool==False):
        tempList.append(nums[i])
```

11.

```
import math
```

```
#Function which finds the cosin value of a taylor series.
def cos(num, terms):
    cosApprox=0
    #Function loops to have a more accurate approximation.
    for x in range(terms):
        #Cosin function of the taylor series.
        cosApprox += ((-1)**x)*((num**(2*x))/(math.factorial(2*x)))
    return cosApprox

#Function which finds the sin value of a taylor series.
def sin(num, terms):
    sinApprox=0
    #Function loops to have a more accurate approximation.
    for x in range(terms):
        #Sin function of the taylor series.
        sinApprox += ((-1)**x)*((num**((2*x)+1)))/(math.factorial((2*x)+1))

#Value given in radians.
radians1 = math.radians(45)
radians2 = math.radians(20)

#Prints values
print(cos(radians1,5))
print(sin(radians2,5))
```

12.

```
#Function which gives the fibonacci sequence.
def fibonacciSeq(num):
    if num<0:
        print("Input too small")
```

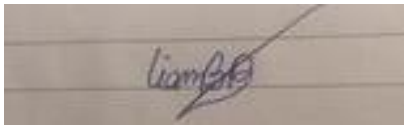
```
    elif num==0:
        return 0
    elif num<2:
        return 1
    else:
        return fibonacciSeq(num-1) + fibonacciSeq(num-2)

    total=0
    for i in range(0,num):
        total=total+fibonacciSeq(i)
    print(total)

print(fibonacciSeq(13))
```

State of Completion

- Question 1: Attempted and works well.
- Question 2: Attempted and works well.
- Question 3: Attempted and works well.
- Question 4: Attempted and works however it prints repeated pairs with different positions
- Question 5: Attempted and works well.
- Question 6: Attempted and works well.
- Question 7: Attempted and works well.
- Question 8: Attempted and works well.
- Question 9: Attempted and works well.
- Question 10: Attempted and works well.
- Question 11: Attempted and works well.
- Question 12: Attempted and works well.



Explanation

- Question 1: The program was tested by inputting list with random numbers into the sorting algorithm, and tested multiple times to check for any errors.
- Question 2: The program was tested by inputting lists with different sizes to check if the function works.
- Question 3: The program was tested by inputting lists with different sizes and also adding negative numbers.
- Question 4: The program was tested by inputting lists with random numbers between 0 and 1025.
- Question 5: The program was tested by using various RPN expressions and it was assumed that each expression given was correct.
- Question 6: The program was tested by inputting prime and non-prime numbers in the function and checked if the output was correct.
- Question 7: The program was tested by inputting various numbers in the tree and checked if the output of the different traversals was correct.
- Question 8: The program was tested by using different numbers and checking with online sources if the output was correct.
- Question 9: The program was tested by giving the function different lists and checking if the output was correct based on the list given.
- Question 10: The program was tested by using different lists and also included negative numbers, the output than was checked with the list given to see if it was correct.
- Question 11: The program was tested by giving different values in radians and checked if the output is correct by calculating the answer.

- Question 12: The program was tested by using different numbers and checked that the output was correct when comparing the input.

Sample Screen Dumps

*Arrays sizes in some questions are reduced in the sample screen dump so the working does not take a lot of pages to show the inputs and outputs.

- Question 1: Input: list1=[375, 169, 1001, 3, 23, 465, 655, 498]

  lists2=[614, 526, 420, 921, 584]

  Output: Shell sort: [3, 23, 169, 375, 465, 498, 655, 1001]

  Quick sort: [420, 526, 584, 614, 921]

- Question 2: Input: list1 = [3, 23, 169, 375, 465, 498, 655, 1001]

  list2 = [420, 526, 584, 614, 921]

  Output: Merged lists: [3, 23, 169, 375, 420, 465, 498, 526, 584, 614, 655, 921]

- Question 3: Input: list1=[0,5,3,6,8,7,15,9]

  Output: Extreme points: [5, 3, 8, 7, 15]

- Question 4: Input: list= [7, 40, 39, 10, 12, 31, 28, 19, 2, 36]

  Output: 7 x 40 = 10 x 28
  7 x 40 = 28 x 10
  40 x 7 = 10 x 28
  40 x 7 = 28 x 10
  10 x 28 = 7 x 40
  10 x 28 = 40 x 7
  28 x 10 = 7 x 40
  28 x 10 = 40 x 7

  *As explained in the state of completion I did not manage to print the possibilities once instead four times with different positions.

- Question 5: Input: list=[5,4,”-”,9,”*”]

  Output: Result: [9]

- Question 6: Input: 17

  Output: Number is prime
  All prime numbers under the number given:
  2
  3
  5
  7
  11
  13
  17

- Question 7: Input: root = Node(27)
  root.insert(14)
  root.insert(35)
  root.insert(31)
  root.insert(10)
  root.insert(19)
  Output: Inorder:
  10
  14
  19
  27
  31
  35
  Preorder:
  27
  14
  10
  19
  35
  31
  Postorder:
  10
  19
  14
  31
  35
  27

- Question 8: Input: print(newtonsMethod(2))

  Output: 1.4142135622373095

- Question 9: Input: nums=[1,2,3,4,8,3,1,5,9]

  Output: 3
  1

- Question 10: Input: nums=[1,6,2,6,7,19,54,21,-12]

  Output: 54

- Question 11: Input: radians1 = math.radians(45)

  radians2 = math.radians(80)

  Output: 0.7071068056832942

  None

- Question 12: Input: print(fibonacciSeq(10))

  Output: 55

Sources

- Question 1: https://www.geeksforgeeks.org/python-program-for-quicksort/

  https://www.programiz.com/dsa/shell-sort

- Question 6: https://www.geeksforgeeks.org/sieve-of-eratosthenes/
- Question 7: https://www.geeksforgeeks.org/binary-search-tree-set-1-search-and-insertion/
- Question 8: https://pythonnumericalmethods.berkeley.edu/notebooks/chapter19.04-Newton-Raphson-Method.html
- Question 11: https://pythonforundergradengineers.com/creating-taylor-series-functions-with-python.html
- Question 12: https://www.geeksforgeeks.org/program-for-nth-fibonacci-number/

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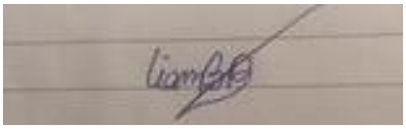

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Course Code

Data Structures and Algorithms 1 CourseWork

Title of work submitted

29/05/2021

Date