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CERTIFICATE

Name: Ms.Keravi Dagha

Roll No: 351   Programme: BSc IT   Semester: III

This is certified to be a bonafide record of practical works done by the above student in the college laboratory for the course **Data Structures (Course Code: 2032UISPR)** for the partial fulfilment of Third Semester of BSc IT during the academic year 2020-21.

The journal work is the original study work that has been duly approved in the year 2020-21 by the undersigned.

_____   _____
External Examiner   Mr. Gangashankar Singh
                                                               (Subject-In-Charge)

Date of Examination: (College Stamp)

Class: S.Y. B.Sc. IT Sem- III   Roll No: 351
                                                     Old Roll No: 3067

Subject: Data Structures

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Sr No	Date	Topic	Sign
1	04/09/2020	Implement the following for Array: a) Write a program to store the elements in 1-D array and provide an option to perform the operations like searching, sorting, merging, reversing the elements. b) Write a program to perform the Matrix addition, Multiplication and Transpose Operation.	
2	11/09/2020	Implement Linked List. Include options for insertion, deletion and search of a number, reverse the list and concatenate two linked lists.	
3	18/09/2020	Implement the following for Stack: a) Perform Stack operations using Array implementation. b. b) Implement Tower of Hanoi. c) WAP to scan a polynomial using linked list and add two polynomials. d) WAP to calculate factorial and to compute the factors of a given no. (i) using recursion, (ii) using iteration	
4	25/09/2020	Perform Queues operations using Circular Array implementation.	
5	01/10/2020	Write a program to search an element from a list. Give user the option to perform Linear or Binary search.	
6	09/10/2020	WAP to sort a list of elements. Give user the option to perform sorting using Insertion sort, Bubble sort or Selection sort.	
7	16/10/2020	Implement the following for Hashing: a) Write a program to implement the collision technique. b) Write a program to implement the concept of linear probing.	
8	23/10/2020	Write a program for inorder, postorder and preorder traversal of tree.	

PRACTICAL - 1(A)

Aim: Implement the following array:- write a program to store the elements in 1-D array and provide an option to perform the operations like searching, sorting, merging, reversing the elements.

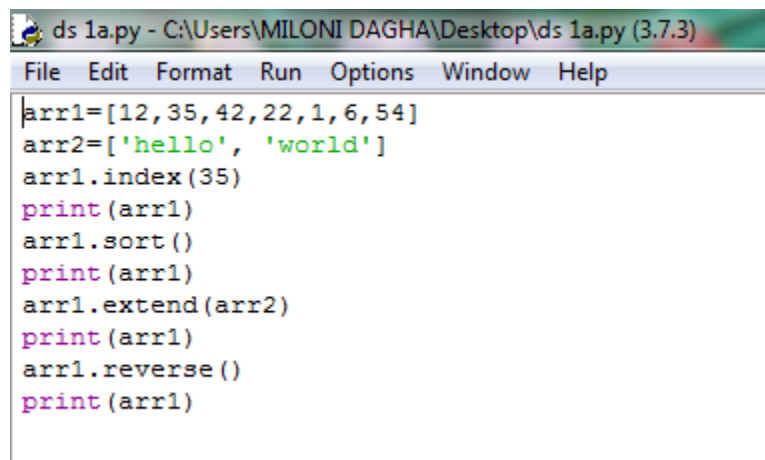**Repository Link:** https://github.com/Keravi/DS

Theory:

Searching: You can search an array for a certain value, and return the indexes that get a match.To search an array, use the where() method.

Sorting: Sorting means putting elements in an ordered sequence.Ordered sequence is any sequence that has an order corresponding to elements, like numeric or alphabetical, ascending or descending.The NumPy ndarray object has a function called sort(), that will sort a specified array.

Merging: There are several ways to join, or concatenate, two or more lists in Python.One of the easiest ways are by using the + operator.Another way to join two lists are by appending all the items from list2 into list1, one by one or you can use the extend() method, which purpose is to add elements from one list to another list.

Reversing: Using the reversed() built-in function. In this method, we neither reverse a list in-place(modify the original list), nor we create any copy of the list. Instead, we get a reverse iterator which we use to cycle through the list. Using the reverse() built-in function. Using the reverse() method we can reverse the contents of the list object in-place i.e., we don't need to create a new list instead we just copy the existing elements to the original list in reverse order. This method directly modifies the original list. Using the slicing technique. In this technique, a copy of the list is made and the list is not sorted in-place. Creating a copy requires more space to hold all of the existing elements. This exhausts more memory.

Code:

```
ds 1a.py - C:\Users\MILONI DAGHA\Desktop\ds 1a.py (3.7.3)
File  Edit  Format  Run  Options  Window  Help
arr1=[12,35,42,22,1,6,54]
arr2=['hello', 'world']
arr1.index(35)
print(arr1)
arr1.sort()
print(arr1)
arr1.extend(arr2)
print(arr1)
arr1.reverse()
print(arr1)
```

Output:

```
============== RESTART: C:\Users\MILONI DAGHA\Desktop\ds 1a.py ===
[12, 35, 42, 22, 1, 6, 54]
[1, 6, 12, 22, 35, 42, 54]
[1, 6, 12, 22, 35, 42, 54, 'hello', 'world']
['world', 'hello', 54, 42, 35, 22, 12, 6, 1]
>>> |
```

PRACTICAL 1B

Aim: Write a program to perform a matrix addition, multiplication and transpose operation.

Repository Link: https://github.com/Keravi/DS

Theory:

Matrix Addition:

In Python, we can implement a matrix as a nested list (list inside a list). We can treat each element as a row of the matrix.

For example X = [[1, 2], [4, 5], [3, 6]] would represent a 3x2 matrix. First row can be selected as X[0] and the element in first row, first column can be selected as X[0][0].

We can perform matrix addition in various ways in Python:

1. Matrix Addition using Nested Loop.

2. Matrix Addition using Nested List Comprehension.

Matrix Multiplication:

In Python, we can implement a matrix as nested list (list inside a list). We can treat each element as a row of the matrix.

For example X = [[1, 2], [4, 5], [3, 6]] would represent a 3x2 matrix.

The first row can be selected as X[0]. And, the element in first row, first column can be selected as X[0][0].

Multiplication of two matrices X and Y is defined only if the number of columns in X is equal to the number of rows Y.

If X is a n x m matrix and Y is a m x l matrix then, XY is defined and has the dimension n x l (but YX is not defined). Here are a couple of ways to implement matrix multiplication in Python.

We can perform matrix multiplication in various ways in Python:

1. Matrix Multiplication using Nested Loop.

2. Matrix Multiplication using Nested List Comprehension.

Matrix Transpose:

In Python, we can implement a matrix as a nested list (list inside a list). We can treat each element as a row of the matrix.

For example X = [[1, 2], [4, 5], [3, 6]] would represent a 3x2 matrix.

The first row can be selected as X[0]. And, the element in the first-row first column can be selected as X[0][0].

Transpose of a matrix is the interchanging of rows and columns. It is denoted as X'. The element at ith row and jth column in X will be placed at jth row and ith column in X'. So if X is a 3x2 matrix, X' will be a 2x3 matrix.

We can perform matrix transpose various ways in Python:

1. Matrix Transpose using Nested Loop.

2. Matrix Transpose using Nested List Comprehension.

Code:

```python
#addition
mat1 = [[1, 2], [3, 4]]
mat2 = [[1, 2], [3, 4]]
mat3 = [[0, 0], [0, 0]]

for i in range(0, 2):
    for j in range(0, 2):
        mat3[i][j] = mat1[i][j] + mat2[i][j]

for i in range(0, 2):
    for j in range(0, 2):
        print(mat3[i][j], end="")
print()

#multiplication
mat1 = [[10, 9], [8, 6]]
mat2 = [[1, 2], [3, 4]]
mat3 = [[0, 0], [0, 0]]

for i in range(0, 2):
    for j in range(0, 2):
        mat3[i][j] = mat1[i][j] * mat2[i][j]


for i in range(len(mat1)):
    for j in range(len(mat2[0])):
        for k in range(len(mat2)):
            mat3[i][j] =mat3[i][j] + ( mat1[i][k] * mat2[k][j])


for r in mat3:
    print(r)

 #transpose
X = [[12,7],
[4 ,5],
[3 ,8]]

result = [[0,0,0],
          [0,0,0]]

for i in range(len(X)):
```

```python
#multiplication
mat1 = [[10, 9], [8, 6]]
mat2 = [[1, 2], [3, 4]]
mat3 = [[0, 0], [0, 0]]

for i in range(0, 2):
    for j in range(0, 2):
        mat3[i][j] = mat1[i][j] * mat2[i][j]


for i in range(len(mat1)):
    for j in range(len(mat2[0])):
        for k in range(len(mat2)):
            mat3[i][j] =mat3[i][j] + ( mat1[i][k] * mat2[k][j])

for r in mat3:
    print(r)

 #transpose
X = [[12,7],
[4 ,5],
[3 ,8]]

result = [[0,0,0],
          [0,0,0]]

for i in range(len(X)):
   for j in range(len(X[0])):
        result[j][i] = X[i][j]

for r in result:
   print(r)
```

Output:

```
=============== RESTART: C:\Users\MILONI DAGHA\Desktop\ds 1b.py ======
2468
[47, 74]
[50, 64]
[12, 4, 3]
[7, 5, 8]
>>>
```

PRACTICAL 2

Aim: Implement Linked List. Include options for insertion, deletion and search of a number,reverse the list and concatenate the two linked list.

Repository Link: https://github.com/Keravi/DS

Theory:

Inserting element in the linked list involves reassigning the pointers from the existing nodes to the newly inserted node. Depending on whether the new data element is getting inserted at the beginning or at the middle or at the end of the linked list, we have the below scenarios.

Inserting at the Beginning of the Linked List .

This involves pointing the next pointer of the new data node to the current head of the linked list. So the current head of the linked list becomes the second data element and the new node becomes the head of the linked list.

We can remove an existing node using the key for that node. In the below program we locate the previous node of the node which is to be deleted. Then point the next pointer of this node to the next node of the node to be deleted.

Singly linked lists can be traversed in only forwrad direction starting form the first data element. We simply print the value of the next data element by assgining the pointer of the next node to the current data element.

Code:

```python
class Node:

    def __init__ (self, element, next = None ):
        self.element = element
        self.next = next
        self.previous = None
    def display(self):
        print(self.element)

class LinkedList:

    def __init__(self):
        self.head = None
        self.size = 0



    def _len_(self):
        return self.size

    def get_head(self):
        return self.head


    def is_empty(self):
        return self.size == 0

    def display(self):
        if self.size == 0:
            print("No element")
            return
        first = self.head
        print(first.element.element)
        first = first.next
        while first:
            if type(first.element) == type(list1.head.element):
                print(first.element.element)
                first = first.next
            print(first.element)
            first = first.next
```

```python
        if type(first.element) == type(list1.head.element):
            print(first.element.element)
            first = first.next
        print(first.element)
        first = first.next

def reverse_display(self):
    if self.size == 0:
        print("No element")
        return None
    last = list1.get_tail()
    print(last.element)
    while last.previous:
        if type(last.previous.element) == type(list1.head):
            print(last.previous.element.element)
            if last.previous == self.head:
                return None
            else:
                last = last.previous
        print(last.previous.element)
        last = last.previous




def add_head(self,e):
    #temp = self.head
    self.head = Node(e)
    #self.head.next = temp
    self.size += 1

def get_tail(self):
    last_object = self.head
    while (last_object.next != None):
        last_object = last_object.next
    return last_object


def remove_head(self):
    if self.is_empty():
        print("Empty Singly linked list")
    else:
        print("Removing")
```

```python
        if self.is_empty():
            print("Empty Singly linked list")
        else:
            print("Removing")
            self.head = self.head.next
            self.head.previous = None
            self.size -= 1

    def add_tail(self,e):
        new_value = Node(e)
        new_value.previous = self.get_tail()
        self.get_tail().next = new_value
        self.size += 1

    def find_second_last_element(self):
        #second_last_element = None


        if self.size >= 2:
            first = self.head
            temp_counter = self.size -2
            while temp_counter > 0:
                first = first.next
                temp_counter -= 1
            return first


        else:
            print("Size not sufficient")

        return None



    def remove_tail(self):
        if self.is_empty():
            print("Empty Singly linked list")
        elif self.size == 1:
            self.head == None
            self.size -= 1
        else:
            Node = self.find_second_last_element()
```

```python
        else:
            Node = self.find_second_last_element()
            if Node:
                Node.next = None
                self.size -= 1

    def get_node_at(self,index):
        element_node = self.head
        counter = 0
        if index == 0:
            return element_node.element
        if index > self.size-1:
            print("Index out of bound")
            return None
        while(counter < index):
            element_node = element_node.next
            counter += 1
        return element_node

    def get_previous_node_at(self,index):
        if index == 0:
            print('No previous value')
            return None
        return list1.get_node_at(index).previous

    def remove_between_list(self,position):
        if position > self.size-1:
            print("Index out of bound")
        elif position == self.size-1:
            self.remove_tail()
        elif position == 0:
            self.remove_head()
        else:
            prev_node = self.get_node_at(position-1)
            next_node = self.get_node_at(position+1)
            prev_node.next = next_node
            next_node.previous = prev_node
            self.size -= 1

    def add_between_list(self,position,element):
        element_node = Node(element)
        if position > self.size:
```

```python
def add_between_list(self,position,element):
    element_node = Node(element)
    if position > self.size:
        print("Index out of bound")
    elif position == self.size:
        self.add_tail(element)
    elif position == 0:
        self.add_head(element)
    else:
        prev_node = self.get_node_at(position-1)
        current_node = self.get_node_at(position)
        prev_node.next = element_node
        element_node.previous = prev_node
        element_node.next = current_node
        current_node.previous = element_node
        self.size += 1

def search (self,search_value):
    index = 0
    while (index < self.size):
        value = self.get_node_at(index)
        if type(value.element) == type(list1.head):
            print("Searching at " + str(index) + " and value is " + str(value.element.element))
        else:
            print("Searching at " + str(index) + " and value is " + str(value.element))
        if value.element == search_value:
            print("Found value at " + str(index) + " location")
            return True
        index += 1
    print("Not Found")
    return False

def merge(self,linkedlist_value):
    if self.size > 0:
        last_node = self.get_node_at(self.size-1)
        last_node.next = linkedlist_value.head
        linkedlist_value.head.previous = last_node
        self.size = self.size + linkedlist_value.size

    else:
        self.head = linkedlist_value.head
```

```
        else:
            | self.head = linkedlist_value.head
              self.size = linkedlist_value.size

l1 = Node('element 1')
list1 = LinkedList()
list1.add_head(l1)
list1.add_tail('element 2')
list1.add_tail('element 3')
list1.add_tail('element 4')
list1.get_head().element.element
list1.add_between_list(2,'element between')
list1.remove_between_list(2)

list2 = LinkedList()
l2 = Node('element 5')
list2.add_head(l2)
list2.add_tail('element 6')
list2.add_tail('element 7')
list2.add_tail('element 8')
list1.merge(list2)
list1.get_previous_node_at(3).element
list1.reverse_display()
list1.search('element 6')
```

Output:

```
================ RESTART: C:\Users\MILONI DAGHA\Deskt
element 8
element 7
element 6
element 5
element 4
element 3
element 2
element 1
Searching at 0 and value is element 1
Searching at 1 and value is element 2
Searching at 2 and value is element 3
Searching at 3 and value is element 4
Searching at 4 and value is element 5
Searching at 5 and value is element 6
Found value at 5 location
>>> |
```

PRACTICAL 3(A)

Aim: Implement the following for stack:- Perform stack operations using Array implementation.

Repository Link: https://github.com/Keravi/DS

Theory:

A stack data structure can be implemented using a one-dimensional array. But stack implemented using array stores only a fixed number of data values. This implementation is very simple.

 Just define a one dimensional array of specific size and insert or delete the values into that array by using LIFO principle with the help of a variable called 'top'. Initially, the top is set to -1. Whenever we want to insert a value into the stack, increment the top value by one and then insert. Whenever we want to delete a value from the stack, then delete the top value and decrement the top value by one

push(value) - Inserting value into the stack

In a stack, push() is a function used to insert an element into the stack. In a stack, the new element is always inserted at top position.

Push function takes one integer value as parameter and inserts that value into the stack.

We can use the following steps to push an element on to the stack...

• Step 1 - Check whether stack is FULL. (top == SIZE-1)

• Step 2 - If it is FULL, then display "Stack is FULL!!! Insertion is not possible!!!" and terminate the function.

 • Step 3 - If it is NOT FULL, then increment top value by one (top++) and set stack[top] to value (stack[top] = value).

 pop() - Delete a value from the Stack.

 In a stack, pop() is a function used to delete an element from the stack. In a stack, the element is always deleted from top position.

Pop function does not take any value as parameter. We can use the following steps to pop an element from the stack...

• Step 1 - Check whether stack is EMPTY. (top == -1)

• Step 2 - If it is EMPTY, then display "Stack is EMPTY!!! Deletion is not possible!!!" and terminate the function.

 • Step 3 - If it is NOT EMPTY, then delete stack[top] and decrement top value by one (top--).

display() - Displays the elements of a Stack

We can use the following steps to display the elements of a stack...

• Step 1 - Check whether stack is EMPTY. (top == -1)

• Step 2 - If it is EMPTY, then display "Stack is EMPTY!!!" and terminate the function.

• Step 3 - If it is NOT EMPTY, then define a variable 'i' and initialize with top. Display stack[i] value and decrement i value by one (i--).

• Step 3 - Repeat above step until i value becomes '0'.

Code:

```
File  Edit  Format  Run  Options  Window  Help
class Stack:

    def __init__(self):
        self.stack_arr = []

    def push(self,value):
        self.stack_arr.append(value)

    def pop(self):
        if len(self.stack_arr) == 0:
            print('Stack is empty!')
            return None
        else:
            self.stack_arr.pop()

    def get_head(self):
        if len(self.stack_arr) == 0:
            print('Stack is empty!')
            return None
        else:
            return self.stack_arr[-1]

    def display(self):
        if len(self.stack_arr) == 0:
            print('Stack is empty!')
            return None
        else:
            print(self.stack_arr)

stack = Stack()
stack.push(4)
stack.push(5)
stack.push(6)
stack.pop()
stack.display()
stack.get_head()
```

Output:

```
================ RESTART: C:\Users\MILONI DAGHA\Desktop\ds
[4, 5]
>>>
```

PRACTICAL 3(B)

Aim: Implement Tower of Hanoi.

Repository Link: https://github.com/Keravi/DS

Theory:

Tower of Hanoi is a mathematical puzzle where we have three rods and n disks.

The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules:

1) Only one disk can be moved at a time.

2) Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack.

3) No disk may be placed on top of a smaller disk.

Note: Transferring the top n-1 disks from source rod to Auxiliary rod can again be thought of as a fresh problem and can be solved in the same manner.

Code:

```python
class Stack:

    def __init__(self):
        self.stack_arr = []

    def push(self,value):
        self.stack_arr.append(value)

    def pop(self):
        if len(self.stack_arr) == 0:
            print('Stack is empty!')
            return None
        else:
            self.stack_arr.pop()

    def get_head(self):
        if len(self.stack_arr) == 0:
            print('Stack is empty!')
            return None
        else:
            return self.stack_arr[-1]

    def display(self):
        if len(self.stack_arr) == 0:
            print('Stack is empty!')
            return None
        else:
            print(self.stack_arr)

A = Stack()
B = Stack()
C = Stack()
def towerOfHanoi(n, fromrod,to,temp):
    if n == 1:
        fromrod.pop()
        to.push('disk 1')
        if to.display() != None:
            print(to.display())
```

Output:

```
=============== RESTART: C:\Users\MILONI DAGHA\Desktop\
Enter the number of the disk in rod A : 2
['disk 1']
['disk 2']
['disk 2', 'disk 1']
>>>
```

PRCTICAL 3(C)

Aim: WAP to scan a polynomial using linked list and add two polynomial.

Repository Link: https://github.com/Keravi/DS

Theory:

A linked list is a sequence of data elements, which are connected together via links. Each data element contains a connection to another data element in form of a pointer. Python does not have linked lists in its standard library. We implement the concept of linked lists using the concept of nodes as discussed in the previous chapter. We have already seen how we create a node class and how to traverse the elements of a node. In this chapter we are going to study the types of linked lists known as singly linked lists. In this type of data structure there is only one link between any two data elements. We create such a list and create additional methods to insert, update and remove elements from the list.

Code:

```python
class Node:

    def __init__ (self, element, next = None ):
        self.element = element
        self.next = next
        self.previous = None
    def display(self):
        print(self.element)

class LinkedList:

    def __init__(self):
        self.head = None
        self.size = 0



    def _len_(self):
        return self.size

    def get_head(self):
        return self.head


    def is_empty(self):
        return self.size == 0

    def display(self):
        if self.size == 0:
            print("No element")
            return
        first = self.head
        print(first.element.element)
        first = first.next
        while first:
            if type(first.element) == type(my_list.head.element):
                print(first.element.element)
                first = first.next
            print(first.element)
            first = first.next
```

```python
                first = first.next
            print(first.element)
            first = first.next

    def reverse_display(self):
        if self.size == 0:
            print("No element")
            return None
        last = my_list.get_tail()
        print(last.element)
        while last.previous:
            if type(last.previous.element) == type(my_list.head):
                print(last.previous.element.element)
                if last.previous == self.head:
                    return None
                else:
                    last = last.previous
            print(last.previous.element)
            last = last.previous




    def add_head(self,e):
        #temp = self.head
        self.head = Node(e)
        #self.head.next = temp
        self.size += 1

    def get_tail(self):
        last_object = self.head
        while (last_object.next != None):
            last_object = last_object.next
        return last_object


    def remove_head(self):
        if self.is_empty():
            print("Empty Singly linked list")
        else:
            print("Removing")
```

```python
        else:
            print("Removing")
            self.head = self.head.next
            self.head.previous = None
            self.size -= 1

    def add_tail(self,e):
        new_value = Node(e)
        new_value.previous = self.get_tail()
        self.get_tail().next = new_value
        self.size += 1

    def find_second_last_element(self):
        #second_last_element = None


        if self.size >= 2:
            first = self.head
            temp_counter = self.size -2
            while temp_counter > 0:
                first = first.next
                temp_counter -= 1
            return first


        else:
            print("Size not sufficient")

        return None



    def remove_tail(self):
        if self.is_empty():
            print("Empty Singly linked list")
        elif self.size == 1:
            self.head == None
            self.size -= 1
        else:
            Node = self.find_second_last_element()
```

```python
                self.size -= 1
        else:
            Node = self.find_second_last_element()
            if Node:
                Node.next = None
                self.size -= 1

    def get_node_at(self,index):
        element_node = self.head
        counter = 0
        if index == 0:
            return element_node.element
        if index > self.size-1:
            print("Index out of bound")
            return None
        while(counter < index):
            element_node = element_node.next
            counter += 1
        return element_node

    def get_previous_node_at(self,index):
        if index == 0:
            print('No previous value')
            return None
        return my_list.get_node_at(index).previous

    def remove_between_list(self,position):
        if position > self.size-1:
            print("Index out of bound")
        elif position == self.size-1:
            self.remove_tail()
        elif position == 0:
            self.remove_head()
        else:
            prev_node = self.get_node_at(position-1)
            next_node = self.get_node_at(position+1)
            prev_node.next = next_node
            next_node.previous = prev_node
            self.size -= 1
```

```python
            prev_node.next = next_node
            next_node.previous = prev_node
            self.size -= 1

    def add_between_list(self,position,element):
        element_node = Node(element)
        if position > self.size:
            print("Index out of bound")
        elif position == self.size:
            self.add_tail(element)
        elif position == 0:
            self.add_head(element)
        else:
            prev_node = self.get_node_at(position-1)
            current_node = self.get_node_at(position)
            prev_node.next = element_node
            element_node.previous = prev_node
            element_node.next = current_node
            current_node.previous = element_node
            self.size += 1

    def search (self,search_value):
        index = 0
        while (index < self.size):
            value = self.get_node_at(index)
            if value.element == search_value:
                return value.element
            index += 1
        print("Not Found")
        return False

    def merge(self,linkedlist_value):
        if self.size > 0:
            last_node = self.get_node_at(self.size-1)
            last_node.next = linkedlist_value.head
            linkedlist_value.head.previous = last_node
            self.size = self.size + linkedlist_value.size

        else:
            self.head = linkedlist_value.head
```

```python
        else:
            self.head = linkedlist_value.head
            self.size = linkedlist_value.size



my_list = LinkedList()
order = int(input('Enter the order for polynomial : '))
my_list.add_head(Node(int(input(f"Enter coefficient for power {order} : "))))
for i in reversed(range(order)):
    my_list.add_tail(int(input(f"Enter coefficient for power {i} : ")))

my_list2 = LinkedList()
my_list2.add_head(Node(int(input(f"Enter coefficient for power {order} : "))))
for i in reversed(range(order)):
    my_list2.add_tail(int(input(f"Enter coefficient for power {i} : ")))

for i in range(order + 1):
    print(my_list.get_node_at(i).element + my_list2.get_node_at(i).element)
```

Output:

```
=============== RESTART: C:\Users\MILONI DAGHA\Deskt
Enter the order for polynomial : 1
Enter coefficient for power 1 : 2
Enter coefficient for power 0 : 3
Enter coefficient for power 1 : 4
Enter coefficient for power 0 : 6
6
9
>>> |
```

PRACTICAL 3(D)

Aim: WAP to calculate factorial and to compute the factors of a given no.(i) using recursion, (ii) using iteration.

Repository Link: **https://github.com/Keravi/DS**

Theory:

The factorial of a number is the product of all the integers from 1 to that number. For example, the factorial of 6 is 1*2*3*4*5*6 = 720. Factorial is not defined for negative numbers and the factorial of zero is one, 0! = 1.

Iterative Solution:

Factorial can also be calculated iteratively as recursion can be costly for large numbers. Here we have shown the iterative approach using both for and while loop. Using For loop

Code:

```python
factorial = 1
n = int(input('Enter Number: '))
for i in range(1,n+1):
    factorial = factorial * i

print(f'Factorial is : {factorial}')

fact = []
for i in range(1,n+1):
    if (n/i).is_integer():
        fact.append(i)

print(f'Factors of the given numbers is : {fact}')

factorial = 1
index = 1
n = int(input("Enter number : "))
def calculate_factorial(n,factorial,index):
    if index == n:
        print(f'Factorial is : {factorial}')
        return True
    else:
        index = index + 1
        calculate_factorial(n,factorial * index,index)
calculate_factorial(n,factorial,index)

fact = []
def calculate_factors(n,factors,index):
    if index == n+1:
        print(f'Factors of the given numbers is : {factors}')
        return True
    elif (n/index).is_integer():
        factors.append(index)
        index += 1
        calculate_factors(n,factors,index)
    else:
        index += 1
        calculate_factors(n,factors,index)

index = 1
factors = []
```

```
index = 1
factors = []
calculate_factors(n,factors,index)
|
```

Output:

```
=============== RESTART: C:\Users\MILONI DAGHA\Desktop\
Enter Number: 4
Factorial is : 24
Factors of the given numbers is : [1, 2, 4]
Enter number : 2
Factorial is : 2
Factors of the given numbers is : [1, 2]
>>> |
```

PRACTICAL 4

Aim: Perform Queues operations using Circular array implementation.

Repository Link: https://github.com/Keravi/DS

Theory:

 A Circular Queue is a queue data structure but circular in shape, therefore after the last position, the next place in the queue is the first position.

We recommend you to first go through the Linear Queue tutorial before Circular queue, as we will be extending the same implementation.

In case of Linear queue, we did not had the head and tail pointers because we used python List for implementing it. But in case of a circular queue, as the size of the queue is fixed, hence we will set a maxSize for our list used for queue implementation.

Code:

```python
class CircularQueue:
    #Constructor
    def __init__(self):
        self.queue = list()
        self.head = 0
        self.tail = 0
        self.maxSize = 8
    #Adding elements to the queue
    def enqueue(self,data):
        if self.size() == self.maxSize-1:
            return ("Queue Full!")
        self.queue.append(data)
        self.tail = (self.tail + 1) % self.maxSize
        return True
    #Removing elements from the queue
    def dequeue(self):
        if self.size()==0:
            return ("Queue Empty!")
        data = self.queue[self.head]
        self.head = (self.head + 1) % self.maxSize
        return data
    #Calculating the size of the queue
    def size(self):
        if self.tail>=self.head:
            return (self.tail-self.head)
        return (self.maxSize - (self.head-self.tail))
```

```python
q = CircularQueue()
print(q.enqueue(1))
print(q.enqueue(2))
print(q.enqueue(3))
print(q.enqueue(4))
print(q.enqueue(5))
print(q.enqueue(6))
print(q.enqueue(7))
print(q.enqueue(8))
print(q.enqueue(9))
print(q.dequeue())
print(q.dequeue())
print(q.dequeue())
print(q.dequeue())
print(q.dequeue())
print(q.dequeue())
print(q.dequeue())
print(q.dequeue())
print(q.dequeue())
```

Output:

```
True
True
True
True
True
True
True
Queue Full!
Queue Full!
1
2
3
4
5
6
7
Queue Empty!
Queue Empty!
>>>
```

PRACTICAL 5

Aim: Write a program to search an element from a list.Give user the option to perform Linear or binary search.

Repository Link: https://github.com/Keravi/DS

Theory:

Searching is a very basic necessity when you store data in different data structures. The simplest approach is to go across every element in the data structure and match it with the value you are searching for. This is known as Linear search. It is inefficient and rarely used, but creating a program for it gives an idea about how we can implement some advanced search algorithms.

Linear Search:

In this type of search, a sequential search is made over all items one by one. Every item is checked and if a match is found then that particular item is returned, otherwise the search continues till the end of the data structure.

Binary Search:

Search a sorted array by repeatedly dividing the search interval in half. Begin with an interval covering the whole array. If the value of the search key is less than the item in the middle of the interval, narrow the interval to the lower half. Otherwise narrow it to the upper half. Repeatedly check until the value is found or the interval is empty.

Code:

```python
list1 = [5,1,78,3,45,12,4,15,44,34,62,54]
print("List = ",list1)
n = len(list1)
def bubbleSort():
    print("Bubble Sorting")
    for i in range(n-1):
        for j in range(0, n-i-1):
            if list1[j] > list1[j+1] :
                list1[j], list1[j+1] = list1[j+1], list1[j]
    print(list1)

def SelectionSort():
        print("Selection Sorting")
        for i in range(n):
                for j in range(i):
                        if list1[i]<list1[j]:
                                list1[i],list1[j] = list1[j],list1[i]
        print(list1)

def InsertionSort():
    print("Insertion Sorting")
    for i in range(1, n):
        c = list1[i]
        j = i-1
        while j >=0 and c < list1[j] :
                list1[j+1] = list1[j]
                j -= 1
        list1[j+1] = c
    print(list1)

inp = input("Enter (B) for Bubble Sort, (S) for elsection Sort and (I) for Insertion Sort \n Enter here:")
if inp=="B" or inp=="b":
        bubbleSort()
elif inp=="S" or inp=="s":
        SelectionSort()
elif inp=="I" or inp=="i":
        InsertionSort()
else:
        print("Invalid input")
```

Output:

```
============ RESTART: C:/Users/MILONI DAGHA/Desktop/DS PRACT 5.py ============
List =  [5, 1, 78, 3, 45, 12, 4, 15, 44, 34, 62, 54]
Enter (B) for Bubble Sort, (S) for elsection Sort and (I) for Insertion Sort
 Enter here:B
Bubble Sorting
[1, 3, 4, 5, 12, 15, 34, 44, 45, 54, 62, 78]
>>>
============ RESTART: C:/Users/MILONI DAGHA/Desktop/DS PRACT 5.py ============
List =  [5, 1, 78, 3, 45, 12, 4, 15, 44, 34, 62, 54]
Enter (B) for Bubble Sort, (S) for elsection Sort and (I) for Insertion Sort
 Enter here:A
Invalid input
>>>
```

PRACTICAL 6

Aim: WAP to sort a list of elements. Give user the option to perform sorting using Insertion sort, Bubble sort or selection sort.

Repository Link: https://github.com/Keravi/DS

Theory:

Sorting refers to arranging data in a particular format. Sorting algorithm specifies the way to arrange data in a particular order.

Most common orders are in numerical or lexicographical order. The importance of sorting lies in the fact that data searching can be optimized to a very high level, if data is stored in a sorted manner. Sorting is also used to represent data in more readable formats. Below we see five such implementations of sorting in python.

Bubble Sort

It is a comparison-based algorithm in which each pair of adjacent elements is compared and the elements are swapped if they are not in order.

Insertion Sort

Insertion sort involves finding the right place for a given element in a sorted list. So in beginning we compare the first two elements and sort them by comparing them. Then we pick the third element and find its proper position among the previous two sorted elements. This way we gradually go on adding more elements to the already sorted list by putting them in their proper position.

Selection Sort

In selection sort we start by finding the minimum value in a given list and move it to a sorted list. Then we repeat the process for each of the remaining elements in the unsorted list. The next element entering the sorted list is compared with the existing elements and placed at its correct position. So at the end all the elements from the unsorted list are sorted.

Code:

```python
list1 = [5,1,78,3,45,12,4,15,44,34,62,54]
print("List = ",list1)
n = len(list1)
def bubbleSort():
    print("Bubble Sorting")
    for i in range(n-1):
        for j in range(0, n-i-1):
            if list1[j] > list1[j+1] :
                list1[j], list1[j+1] = list1[j+1], list1[j]
    print(list1)

def SelectionSort():
    print("Selection Sorting")
    for i in range(n):
        for j in range(i):
            if list1[i]<list1[j]:
                list1[i],list1[j] = list1[j],list1[i]
    print(list1)

def InsertionSort():
    print("Insertion Sorting")
    for i in range(1, n):
        c = list1[i]
        j = i-1
        while j >=0 and c < list1[j] :
            list1[j+1] = list1[j]
            j -= 1
        list1[j+1] = c
    print(list1)

inp = input("Enter (B) for Bubble Sort, (S) for elsection Sort and (I) for Insertion Sort \n Enter here:")
if inp=="B" or inp=="b":
    bubbleSort()
elif inp=="S" or inp=="s":
    SelectionSort()
elif inp=="I" or inp=="i":
    InsertionSort()
else:
    print("Invalid input")
```

Output:

```
============ RESTART: C:/Users/MILONI DAGHA/Desktop/DS PRACT 5.py ============
List =  [5, 1, 78, 3, 45, 12, 4, 15, 44, 34, 62, 54]
Enter (B) for Bubble Sort, (S) for elsection Sort and (I) for Insertion Sort
 Enter here:I
Insertion Sorting
[1, 3, 4, 5, 12, 15, 34, 44, 45, 54, 62, 78]
>>>
```

PRACTICAL 7(A)

Aim: Implement the following for Hashing:- write a program to implement the collision technique.

Repository Link: https://github.com/Keravi/DS

Theory:

Collision Techniques:

When one or more hash values compete with a single hash table slot, collisions occur. To resolve this, the next available empty slot is assigned to the current hash value. The most common methods are open addressing, chaining, probabilistic hashing, perfect hashing and coalesced hashing technique.

Code:

```python
class Hash:
    def __init__(self, keys: int, lower_range: int, higher_range: int) -> None:
        self.value = self.hash_function(keys, lower_range, higher_range)

    def get_key_value(self) -> int:
        return self.value

    @staticmethod
    def hash_function(keys: int, lower_range: int, higher_range: int) -> int:
        if lower_range == 0 and higher_range > 0:
            return keys % higher_range


if __name__ == '__main__':
    linear_probing = True
    list_of_keys = [23, 43, 1, 87]
    list_of_list_index = [None]*4
    print("Before : " + str(list_of_list_index))
    for value in list_of_keys:
        list_index = Hash(value, 0, len(list_of_keys)).get_key_value()
        print("Hash value for " + str(value) + " is :" + str(list_index))
        if list_of_list_index[list_index]:
            print("Collision detected for " + str(value))
            if linear_probing:
                old_list_index = list_index
                if list_index == len(list_of_list_index) - 1:
                    list_index = 0
                else:
                    list_index += 1
                list_full = False
                while list_of_list_index[list_index]:
                    if list_index == old_list_index:
                        list_full = True
                        break
                    if list_index + 1 == len(list_of_list_index):
                        list_index = 0
                    else:
                        list_index += 1
                if list_full:
                    print("List was full . Could not save")
                else:
                    list_of_list_index[list_index] = value
```

```python
                    list_index += 1
                if list_full:
                    print("List was full . Could not save")
                else:
                    list_of_list_index[list_index] = value
        else:
            list_of_list_index[list_index] = value
    print("After: " + str(list_of_list_index))
```

Output:

```
>>>
=============== RESTART: C:\Users\MILONI DAGHA\Desktop\ds 7a.py ============
Before : [None, None, None, None]
Hash value for 23 is :3
Hash value for 43 is :3
Collision detected for 43
Hash value for 1 is :1
Hash value for 87 is :3
Collision detected for 87
After: [43, 1, 87, 23]
>>> |
```

PRACTICAL 7(B)

Aim: write a program to implement the concept of linear probing.

Repository Link: https://github.com/Keravi/DS

Theory:

Linear probing is a component of open addressing schemes for using a hash table to solve the dictionary problem. In the dictionary problem, a data structure should maintain a collection of key– value pairs subject to operations that insert or delete pairs from the collection or that search for the value associated with a given key. In open addressing solutions to this problem, the data structure is an array T (the hash table) whose cells T. (when nonempty) each store a single key–value pair. A hash function is used to map each key into the cell of T where that key should be stored, typically scrambling the keys so that keys with similar values are not placed near each other in the table. A hash collision occurs when the hash function maps a key into a cell that is already occupied by a different key. Linear probing is a strategy for resolving collisions, by placing the new key into the closest following empty cell.

Code:

```python
size_list = 6

def hash_function(val):
    global size_list
    return val%size_list

def map_hash_function(hash_return_values):
    return hash_return_values

def create_hash_table(list_values,main_list):
    for   values in list_values:
        hash_return_values = hash_function(values)
        list_index = map_hash_function(hash_return_values)
        if main_list[list_index]:
            print("collision detected")
            linear_probing(list_index,values,main_list)
        else:
            main_list[list_index]=values

def linear_probing(list_index,value,main_list):
    global size_list
    list_full = False
    old_list_index=list_index
    if list_index == size_list - 1:
        list_index = 0
    else:
        list_index += 1

    while main_list[list_index]:
        if list_index+1 == size_list:
            list_index = 0
        else:
            list_index += 1
        if list_index == old_list_index:
            list_full = True
            break
    if list_full == True:
        print("list was full. could not saved")
def search_list(key,main_list):
    #for i in range(size_list):
    val = hash_function(key)
```

```python
        if main_list[val] == key:
            print("list found",val)
        else:
            print("not found")


list_values = [1,3,8,6,5,14]

main_list = [None for x in range(size_list)]
print(main_list)
create_hash_table(list_values,main_list)
print(main_list)
search_list(5,main_list)
```

Output:

```
=============== RESTART: C:\Users\MILONI
[None, None, None, None, None, None]
collision detected
[6, 1, 8, 3, None, 5]
list found 5
>>>
```

PRACTICAL 8

Aim: Write a program for inorder, preorder and postorder traversal of tree.

Repository Link: https://github.com/Keravi/DS

Theory:

Unlike linear data structures (Array, Linked List, Queues, Stacks, etc) which have only one logical way to traverse them, trees can be traversed in different ways. Following are the generally used ways for traversing trees.

Uses of Inorder

In case of binary search trees (BST), Inorder traversal gives nodes in non-decreasing order. To get nodes of BST in non-increasing order, a variation of Inorder traversal where Inorder traversal s reversed can be used.

Uses of Preorder

Preorder traversal is used to create a copy of the tree. Preorder traversal is also used to get prefix expression on of an expression tree.

Uses of Postorder

Postorder traversal is used to delete the tree. Please see the question for deletion of tree for details. Postorder traversal is also useful to get the postfix expression of an expression tree

Code:

```python
class Node:
    def __init__(self, key):
        self.left = None
        self.right = None
        self.value = key

    def PrintTree(self):
        if self.left:
            self.left.PrintTree()
        print(self.value)
        if self.right:
            self.right.PrintTree()

    def Printpreorder(self):
        if self.value:
            print(self.value)
            if self.left:
                self.left.Printpreorder()
            if self.right:
                self.right.Printpreorder()

    def Printinorder(self):
        if self.value:
            if self.left:
                self.left.Printinorder()
            print(self.value)
            if self.right:
                self.right.Printinorder()

    def Printpostorder(self):
        if self.value:
            if self.left:
                self.left.Printpostorder()
            if self.right:
                self.right.Printpostorder()
            print(self.value)

    def insert(self, data):
        if self.value:
            if data < self.value:
                if self.left is None:
                    self.left = Node(data)
```

Code

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

    def insert(self, data):
        if self.value:
            if data < self.value:
                if self.left is None:
                    self.left = Node(data)
                else:
                    self.left.insert(data)
            elif data > self.value:
                if self.right is None:
                    self.right = Node(data)
                else:
                    self.right.insert(data)
        else:
            self.value = data


if __name__ == '__main__':
    root = Node(10)
    root.left = Node(12)
    root.right = Node(5)
    print("Without any order")
    root.PrintTree()
    root_1 = Node(None)
    root_1.insert(28)
    root_1.insert(4)
    root_1.insert(13)
    root_1.insert(130)
    root_1.insert(123)
    print("Now ordering with insert")
    root_1.PrintTree()
    print("Pre order")
    root_1.Printpreorder()
    print("In Order")
    root_1.Printinorder()
    print("Post Order")
    root_1.Printpostorder()
```

Output:

```
Without any order
12
10
5
Now ordering with insert
4
13
28
123
130
Pre order
28
4
13
130
123
In Order
4
13
28
123
130
Post Order
13
4
123
130
28
>>> |
```