



**MALAD KANDIVALI EDUCATION SOCIETY'S**

**NAGINDAS KHANDWALA COLLEGE OF COMMERCE, ARTS &  
MANAGEMENT STUDIES & SHANTABEN NAGINDASKHANDWALA  
COLLEGE OF SCIENCE**

**MALAD [W], MUMBAI – 64**

**AUTONOMOUS INSTITUTION**

(Affiliated To University Of Mumbai)

Reaccredited 'A' Grade by NAAC | ISO 9001:2015 Certified

**CERTIFICATE**

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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.

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External Examiner

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Mr. Gangashankar Singh  
(Subject-In-Charge)

Date of Examination:

(College Stamp)

**Subject: Data Structures****INDEX**

<b>Sr No</b>	<b>Date</b>	<b>Topic</b>	<b>Sign</b>
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.	
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## **Data Structure Practical's**

Link : <https://github.com/razibravo76/DS-Practicals>

Q1 ) 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.

Theory:

Storing Data in Arrays. Assigning values to an element in an array is similar to assigning values to scalar variables. Simply reference an individual element of an array using the array name and the index inside parentheses, then use the assignment operator (=) followed by a value.

Following are the basic operations supported by an array.

Traverse – print all the array elements one by one.

Insertion – Adds an element at the given index.

Deletion – Deletes an element at the given index.

Search – Searches an element using the given index or by the value.

```
C:\Users\198\Desktop\Python> ds > ds prac 1.py > list_fun
1 class list_fun:
2     def __init__(self):
3         self.l = []
4
5     def adding(self, n):
6         self.l.append(n)
7
8     def searching(self, f):
9         if f in self.l:
10            print("found!!")
11        else:
12            print("not found")
13
14    def sorting(self):
15        self.l.sort()
16
17    def reversing(self):
18        self.l = self.l[::-1]
19
20    def display(self):
21        print(self.l)
22
23
24 l1 = list_fun()
25 l1.adding(8)
26 l1.adding(3)
27 l1.adding(9)
28 l1.adding(2)
29
30 l1.searching(3)
31 l1.sorting()
32 l1.display()
33 l1.reversing()
34 l1.display()
```

```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\198\Desktop\Web Dev\college project>C:/
C:\Users\198\Desktop\Web Dev\college project>C:/
/Python/Python37-32/python.exe "c:/Users/198/Des
found!!
[2, 3, 8, 9]
[9, 8, 3, 2]

C:\Users\198\Desktop\Web Dev\college project>
```

B- Write a program to perform the Matrix addition, Multiplication and Transpose Operation.

Theory:

add() – add elements of two matrices.

subtract() – subtract elements of two matrices.

divide() – divide elements of two matrices.

multiply() – multiply elements of two matrices.

dot() – It performs matrix multiplication, does not element wise multiplication.

sqr() – square root of each element of matrix.

sum(x,axis) – add to all the elements in matrix. Second argument is optional, it is used when we want to compute the column sum if axis is 0 and row sum if axis is 1.

“T” – It performs transpose of the specified matrix.

```
C:\Users\198\Desktop\Python> ds > pract1b.py > ...
1 X = [[12, 7, 3],
2   [4, 5, 6],
3   [7, 8, 9]]
4
5
6 Y = [[5, 8, 1, 2],
7   [6, 7, 3, 0],
8   [4, 5, 9, 1]]
9
10 result = [[0, 0, 0, 0],
11   [0, 0, 0, 0],
12   [0, 0, 0, 0]]
13
14 for i in range(len(X)):
15     for j in range(len(Y[0])):
16         for k in range(len(Y)):
17             result[i][j] += X[i][k] * Y[k][j]
18
19 for r in result:
20     print(r)
21
```

```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\198\Desktop\Web Dev\college project>C:/Users/198/AppData/Local/Pr
/Python/Python37-32/python.exe c:/Users/198/Desktop/Python/ds/pract1b.py
[114, 160, 60, 27]
[74, 97, 73, 14]
[119, 157, 112, 23]

C:\Users\198\Desktop\Web Dev\college project>
```

Q2) Implement Linked List. Include options for insertion, deletion and search of a number, reverse the list and concatenate two linked lists

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.

### Insertion in a Linked List

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.

### Deleting an Item form a 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.

### Searching in linked list

Searching is performed in order to find the location of a particular element in the list. Searching any element in the list needs traversing through the list and make the comparison of every element of the list with the specified element. If the element is matched with any of the list element then the location of the element is returned from the function.

#### Reversing a Linked List

To reverse a LinkedList recursively we need to divide the LinkedList into two parts: head and remaining. Head points to the first element initially. Remaining points to the next element from the head. We traverse theLinkedList recursively until the second last element.

#### Concatenating Linked Lists

Concatenate the two lists by traversing the first list until we reach it's a tail node and then point the next of the tail node to the head node of the second list. Store this concatenated list in the first list

```
C: > Users > 198 > Desktop > Python > ds > prac 2.py > ...  
23     def add_head(self, e):  
24         temp = self.head  
25         self.head = Node(e)  
26         self.head.next = temp  
27         self.size += 1  
28  
29     def display(self):  
30         if self.size == 0:  
31             print("No element")  
32             return  
33         first = self.head  
34         print(first.element.element)  
35         first = first.next  
36         while first:  
37             print(first.element)  
38             first = first.next  
39  
40  
41     def get_tail(self):  
42         last_object = self.head  
43         while (last_object.next != None):  
44             last_object = last_object.next  
45         return last_object  
46  
47     def remove_head(self):  
48         if self.is_empty():  
49             print("Empty Singly linked list")  
50         else:  
51             print("Removing")  
52             self.head = self.head.next  
53             self.size -= 1  
54
```

```
C:\Users\198\Desktop\Python> ds > prc 2.py > ...
1 class Node:
2
3     def __init__(self, element, next=None):
4         self.element = element
5         self.next = next
6
7     def display(self):
8         print(self.element)
9
10
11 class LinkedList:
12
13     def __init__(self):
14         self.head = None
15         self.size = 0
16
17     def __len__(self):
18         return self.size
19
20     def is_empty(self):
21         return self.size == 0
22
TERMINAL    SQL CONSOLE: MESSAGES    PROBLEMS    OUTPUT    DEBUG CONSOLE
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\198\Desktop\Web Dev\college project>C:\Users\198\AppData\Local\Programs
/Python/Python37-32/python.exe "c:/Users/198/Desktop/Python/ds/prc 2.py"
AHMAD
PRITAM
SATYAM
JOHANUS
Searching at 0 and value is AHMAD
Found value at 0 location
```

```
pract1b.py  prc 2.py X
C:\Users\198\Desktop\Python> ds > prc 2.py > ...
59
60 def get_node_at(self, index):
61     element_node = self.head
62     counter = 0
63     if index == 0:
64         return element_node.element
65     if index > self.size-1:
66         print("Index out of bound")
67         return None
68     while(counter < index):
69         element_node = element_node.next
70         counter += 1
71     return element_node
72
73 def search(self, search_value):
74     index = 0
75     while (index < self.size):
76         value = self.get_node_at(index)
77         print("Searching at " + str(index) +
78               " and value is " + str(value.element))
79         if value.element == search_value:
80             print("Found value at " + str(index) + " location")
81             return True
82         index += 1
83     print("Not Found")
84     return False
85
86 def merge(self, linkedlist_value):
87     if self.size > 0:
88         last_node = self.get_node_at(self.size-1)
89         last_node.next = linkedlist_value.head
90         self.size = self.size + linkedlist_value.size
91
92     else:
93         self.head = linkedlist_value.head
94         self.size = linkedlist_value.size

Python 3.7.4 32-bit 0 0 0 Connect KxLang Python Ln 111, Col 18 Spaces: 4 UTF-8 CRLF Python Go Live
```



Q3) Implement the following for Stack:

A: Perform Stack operations using Array implementation.

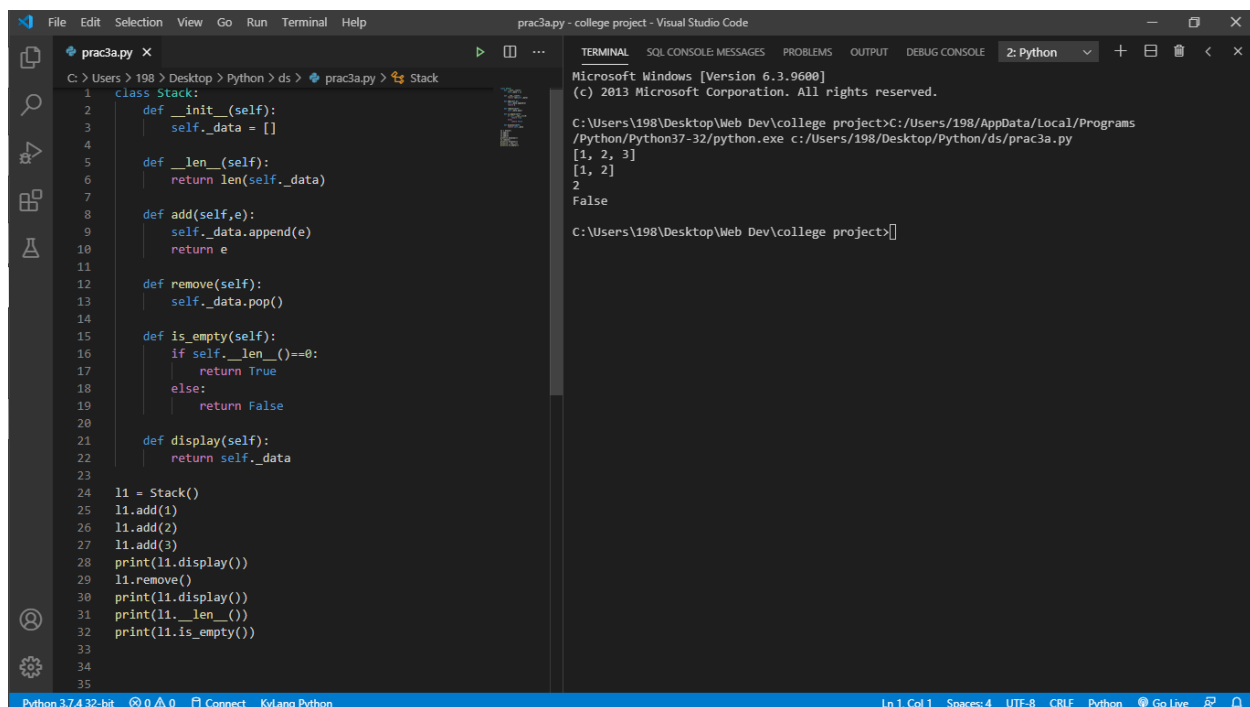
Theory:

Stacks is one of the earliest data structures defined in computer science. In simple words, Stack is a linear collection of items. It is a collection of objects that supports fast last-in, first-out (LIFO) semantics for insertion and deletion. It is an array or list structure of function calls and parameters used in modern computer programming and CPU architecture. Similar to a stack of plates at a restaurant, elements in a stack are added or removed from the top of the stack, in a “last in, first out” order. Unlike lists or arrays, random access is not allowed for the objects contained in the stack.

There are two types of operations in Stack-

Push– To add data into the stack.

Pop– To remove data from the stack



The screenshot shows a Visual Studio Code window with a file named `prac3a.py` open. The code defines a `Stack` class with the following methods:

- `__init__(self)`: Initializes `self._data` as an empty list.
- `__len__(self)`: Returns the length of `self._data`.
- `add(self, e)`: Appends element `e` to `self._data` and returns `e`.
- `remove(self)`: Removes the last element from `self._data` using `pop()`.
- `is_empty(self)`: Returns `True` if `self._data` is empty, otherwise `False`.
- `display(self)`: Returns `self._data`.

The script also includes a test sequence:

```
l1 = Stack()
l1.add(1)
l1.add(2)
l1.add(3)
print(l1.display())
l1.remove()
print(l1.display())
print(l1.__len__())
print(l1.is_empty())
```

The terminal output shows the execution of the script, displaying the stack's state after each operation:

```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\198\Desktop\Web Dev\college project>C:\Users\198\AppData\Local\Programs
/Python/Python37-32/python.exe c:/Users/198/Desktop/Python/ds/prac3a.py
[1, 2, 3]
[1, 2]
2
False
C:\Users\198\Desktop\Web Dev\college projects>
```

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

Theory:

Polynomial is a mathematical expression that consists of variables and coefficients. for example  $x^2 - 4x + 7$

In the Polynomial linked list, the coefficients and exponents of the polynomial are defined as the data node of the list.

For adding two polynomials that are stored as a linked list. We need to add the coefficients of variables with the same power. In a linked list node contains 3 members, coefficient value link to the next node.

a linked list that is used to store Polynomial looks like –

Polynomial :  $4x^7 + 12x^2 + 45$

```
File Edit Selection View Go Run Terminal Help
prac3cpy - college project - Visual Studio Code

C:\Users\198\Desktop\Python> ds > prac3cpy > ...
1 class Node:
2
3     def __init__(self, element, next=None):
4         self.element = element
5         self.next = next
6         self.previous = None
7
8     def display(self):
9         print(self.element)
10
11
12 class LinkedList:
13
14     def __init__(self):
15         self.head = None
16         self.size = 0
17
18     def add_head(self, e):
19         self.head = Node(e)
20         self.size += 1
21
22     def get_tail(self):
23         last_object = self.head
24         while (last_object.next != None):
25             last_object = last_object.next
26         return last_object
27
28     def add_tail(self, e):
29         new_value = Node(e)
30         new_value.previous = self.get_tail()
31         self.get_tail().next = new_value
32         self.size += 1
33
34     def get_node_at(self, index):
35         element_node = self.head
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```

The image shows a Visual Studio Code editor window with a file named `prac3cpy.py`. The code defines a `LinkedList` class with methods `get_node_at`, `add_head`, `add_tail`, and a method to calculate the sum of two linked lists. The terminal output shows the program running, prompting for the order of the polynomial and coefficients, and displaying the resulting list `[1, 2, 3]`.

```
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

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)
```

```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\198\Desktop\Web Dev\college project>C:\Users\198\AppData\Local\Programs\Python\Python37-32\python.exe c:/Users/198/Desktop/Python/ds/p
[1, 2, 3]
[1, 2]
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C:\Users\198\Desktop\Web Dev\college project>C:\Users\198\AppData\Local\Programs\Python\Python37-32\python.exe c:/Users/198/Desktop/Pyth
on/ds/prac3c.py
Enter the order for polynomial : 3
Enter coefficient for power 3 : 2
Enter coefficient for power 2 : 0
Enter coefficient for power 1 : 1
Enter coefficient for power 0 : 1
Enter coefficient for power 3 : 4
Enter coefficient for power 2 : 2
Enter coefficient for power 1 : 1
Enter coefficient for power 0 : 0
6
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C:\Users\198\Desktop\Web Dev\college project>
```

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

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,  $0! = 1$ .

Recursion

In Python, we know that a function can call other functions. It is even possible for the function to call itself. These types of construct are termed as recursive functions.

Iteration

Repeating identical or similar tasks without making errors is something that computers do well and people do poorly. Repeated execution of a set of statements is called iteration. Because iteration is so common, Python provides several language features to make it easier.

```
1 def factorial(number):
2     if number < 0:
3         print('Invalid entry! Cannot find factorial of a negative number')
4         return -1
5     if number == 1 or number == 0:
6         return 1
7     else:
8         return number * factorial(number - 1)
9
10
11 def factorial_iteration(number):
12     if number < 0:
13         print('Invalid entry! Cannot find factorial of a negative number')
14         return -1
15     fact = 1
16     while(number > 0):
17         fact = fact * number
18         number = number - 1
19     return fact
20
21
22 if __name__ == '__main__':
23     userInput = 8
24     print('Factorial using Recursion of',
25           userInput, 'is:', factorial(userInput))
26     print('Factorial using Iteration of', userInput,
27           'is:', factorial_iteration(userInput))
28
```

```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\198\Desktop\Web Dev\college project>C:/Users/198/AppData/Local/Programs/Python/Python37-32/python.exe c:/Users/198/Desktop/Python/ds/prac3d
Factorial using Recursion of 8 is: 40320
Factorial using Iteration of 8 is: 40320

C:\Users\198\Desktop\Web Dev\college project>
```

#### Q4) Perform Queues operations using Circular Array implementation.

Theory:

Circular queue avoids the wastage of space in a regular queue implementation using arrays. Circular Queue works by the process of circular increment i.e. when we try to increment the pointer and we reach the end of the queue, we start from the beginning of the queue.

Here, the circular increment is performed by modulo division with the queue size. That is,

if  $REAR + 1 == 5$  (overflow!),  $REAR = (REAR + 1) \% 5 = 0$  (start of queue)

The circular queue work as follows:

two pointers FRONT and REAR

FRONT track the first element of the queue

REAR track the last elements of the queue

initially, set value of FRONT and REAR to -1

## 1.Enqueue Operation

check if the queue is full

for the first element, set value of FRONT to 0

circularly increase the REAR index by 1 (i.e. if the rear reaches the end, next it would be at the start of the queue)

add the new element in the position pointed to by REAR

## 2. Dequeue Operation

check if the queue is empty

return the value pointed by FRONT

circularly increase the FRONT

index by 1 for the last element, reset the values of FRONT and REAR to -1

```

pract4.py - college project - Visual Studio Code
c:\Users\198\Desktop\Python> ds > pract4.py > LinkedList
1 class Node:
2     def __init__(self, element, next=None):
3         self.element = element
4         self.next = next
5         self.previous = None
6
7     def display(self):
8         print(self.element)
9
10
11 class LinkedList:
12     def __init__(self):
13         self.head = None
14         self.size = 0
15
16     def len(self):
17         return self.size
18
19     def get_head(self):
20         return self.head
21
22     def is_empty(self):
23         return self.size == 0
24
25     def display(self):
26         if self.size == 0:
27             print("No element")
28             return
29         first = self.head
30         print(first.element.element)
31         first = first.next
32         while first:
33             if type(first.element) == type(my_list.head.element):
34                 print(first.element.element)
35                 first = first.next
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```

```
c:\Users\198\Desktop\Python> ds > pract4.py > LinkedList
38
39     def reverse_display(self):
40         if self.size == 0:
41             print("No element")
42             return None
43         last = my_list.get_tail()
44         print(last.element)
45         while last.previous:
46             if type(last.previous.element) == type(my_list.head):
47                 print(last.previous.element.element)
48                 if last.previous == self.head:
49                     return None
50             else:
51                 last = last.previous
52             print(last.previous.element)
53             last = last.previous
54
55     def add_head(self, e):
56         self.head = Node(e)
57         self.size += 1
58
59     def get_tail(self):
60         last_object = self.head
61         while (last_object.next != None):
62             last_object = last_object.next
63         return last_object
64
65     def remove_head(self):
66         if self.is_empty():
67             print("Empty Singly linked list")
68         else:
69             print("Removing")
70             self.head = self.head.next
71             self.head.previous = None
72             self.size -= 1
```

Q5) Write a program to search an element from a list. Give user the option to perform Linear or Binary search.

Theory:

### Linear Search:

This linear search is a basic search algorithm which searches all the elements in the list and finds the required value. ... This is also known as sequential search.

## Binary Search:

In computer science, a binary search or half-interval search algorithm finds the position of a target value within a sorted array. The binary search algorithm can be classified as a dichotomies divide-and-conquer search algorithm and executes in logarithmic time.

```
File Edit Selection View Go Run Terminal Help
prac5.py - college project - Visual Studio Code

prac4.py Untitled-1 prac5.py x

c:\Users> 198 > Desktop > Python > ds > prac5.py > binary_search

1 def linearSearch(arr, x):
2     for i in range(len(arr)):
3         if arr[i] == x:
4             return i
5
6
7 def binary_search(arr, x):
8     low = 0
9     high = len(arr) - 1
10    mid = 0
11    while low <= high:
12        mid = (high + low) // 2
13        if arr[mid] < x:
14            low = mid + 1
15
16        elif arr[mid] > x:
17            high = mid - 1
18
19        else:
20            return mid
21
22
23 arr = [2, 3, 4, 10, 40]
24 x = 10
25 opt = input("enter l or b for searching")
26 if opt == "b":
27     result = binary_search(arr, x)
28     print("binary search")
29     print(result)
30
31 elif opt == "l":
32     result = linearSearch(arr, x)
33     print("linear search")
34     print(result)
35
```

TERMINAL ... 2: Python

Microsoft Windows [Version 6.3.9600]  
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C:\Users\198\Desktop\Web Dev\college project>C:/Users/198/AppData/Local/Programs  
C:\Users\198\Desktop\Web Dev\college project>C:/Users/198/AppData/Local/Python/Python37-32/python.exe c:/Users/198/Desktop/Python/ds/prac5.  
enter l or b for searchingl  
linear search  
3

C:\Users\198\Desktop\Web Dev\college project>]

Python 3.7.4 32-bit 0 0 0 Connect KVLang Python

Ln 10, Col 12 Spaces: 4 UTF-8 CRLF Python Go Live

Q6) WAP to sort a list of elements. Give user the option to perform sorting using Insertion sort, Bubble sort or Selection sort.

Theory:



Bubble Sort:

Bubble Sort is the simplest sorting algorithm that works by repeatedly swapping the adjacent elements if they are in wrong order.

Selection Sort:

The selection sort algorithm sorts an array by repeatedly finding the minimum element (considering ascending order) from unsorted part and putting it at the beginning. The algorithm maintains two subarrays in a given array

Insertion Sort:

Insertion sort iterates, consuming one input element each repetition, and growing a sorted output list. At each iteration, insertion sort removes one element from the input data, finds the location it belongs within the sorted list, and inserts it there. It repeats until no input elements remain.

```
c:\Users\198\Desktop\Python> ds > prac6.py > ...
1 def selectionSort(A):
2     for i in range(len(A)):
3         small = i
4         for j in range(i+1, len(A)):
5             if A[small] > A[j]:
6                 small = j
7         A[i], A[small] = A[small], A[i]
8
9
10 # insertion sort
11 def insertionSort(arr):
12
13     for i in range(1, len(arr)):
14         key = arr[i]
15         j = i-1
16         while j >= 0 and key < arr[j]:
17             arr[j+1] = arr[j]
18             j -= 1
19         arr[j+1] = key
20
21
22 # bubble sort
23 def bubbleSort(arr):
24     n = len(arr)
25     for i in range(n-1):
26         for j in range(0, n-i-1):
27             if arr[j] > arr[j+1]:
28                 arr[j], arr[j+1] = arr[j+1], arr[j]
29
30
31 A = [64, 25, 12, 22, 11]
32 opt = input("enter 1,b or s for sorting")
33 if opt == '1':
34     bubbleSort(A)
35     print("bubble sort")
36 elif opt == 'b':
37     bubbleSort(A)
38     print("bubble sort")
39 elif opt == 's':
40     selectionSort(A)
41     print("selection sort")
42 else:
43     print("Invalid option")
44
45 if __name__ == '__main__':
46     main()
```

Microsoft Windows [Version 6.3.9600]  
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C:\Users\198\Desktop\Web Dev\college project>C:/Users/198/AppData/Local/Python/Python37-32/python.exe c:/Users/198/Desktop/Python/ds/prac6.py  
enter 1,b or s for sorting  
s  
[11, 12, 22, 25, 64]

C:\Users\198\Desktop\Web Dev\college project>

Q7) Implement the following for Hashing:

A: Write a program to implement the collision technique.

Theory:

Hashing:

Hashing is an important Data Structure which is designed to use a special function called the Hash function which is used to map a given value with a particular key for faster access of elements. The efficiency of mapping depends of the efficiency of the hash function used.

Collisions:

A Hash Collision Attack is an attempt to find two input strings of a hash function that produce the same hash result. If two separate inputs produce the same hash output, it is called a collision.

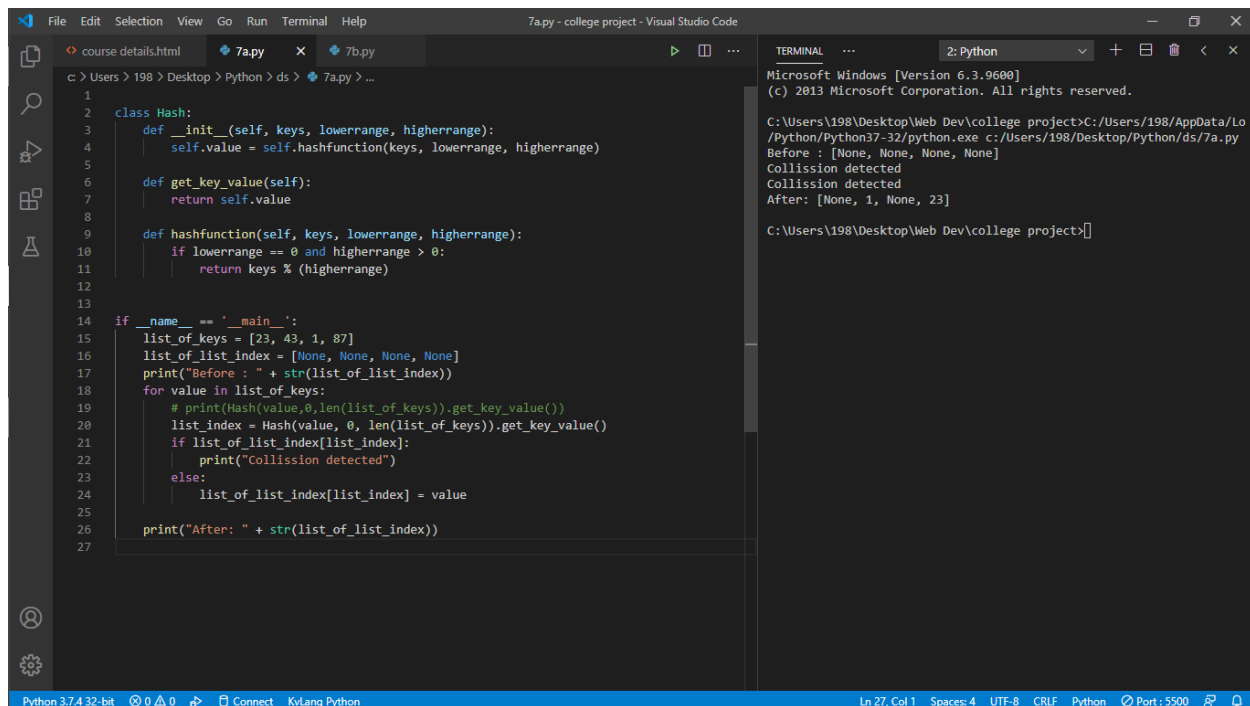
Collision Techniques:

Separate Chaining:

The idea is to make each cell of hash table point to a linked list of records that have same hash function value.

Open Addressing:

Like separate chaining, open addressing is a method for handling collisions. In Open Addressing, all elements are stored in the hash table itself. So at any point, the size of the table must be greater than or equal to the total number of keys (Note that we can increase table size by copying old data if needed).



```
File Edit Selection View Go Run Terminal Help
7a.py - college project - Visual Studio Code

course details.html 7a.py x 7b.py

c:\Users\198\Desktop\Python> ds > 7a.py > ...
1
2 class Hash:
3     def __init__(self, keys, lowerrange, higherrange):
4         self.value = self.hashfunction(keys, lowerrange, higherrange)
5
6     def get_key_value(self):
7         return self.value
8
9     def hashfunction(self, keys, lowerrange, higherrange):
10        if lowerrange == 0 and higherrange > 0:
11            return keys % (higherrange)
12
13
14 if __name__ == '__main__':
15     list_of_keys = [23, 43, 1, 87]
16     list_of_list_index = [None, None, None, None]
17     print("Before : " + str(list_of_list_index))
18     for value in list_of keys:
19         # print(Hash(value,0,len(list_of keys)).get_key_value())
20         list_index = Hash(value, 0, len(list_of keys)).get_key_value()
21         if list_of_list_index[list_index]:
22             print("Collision detected")
23         else:
24             list_of_list_index[list_index] = value
25
26     print("After: " + str(list_of_list_index))
27

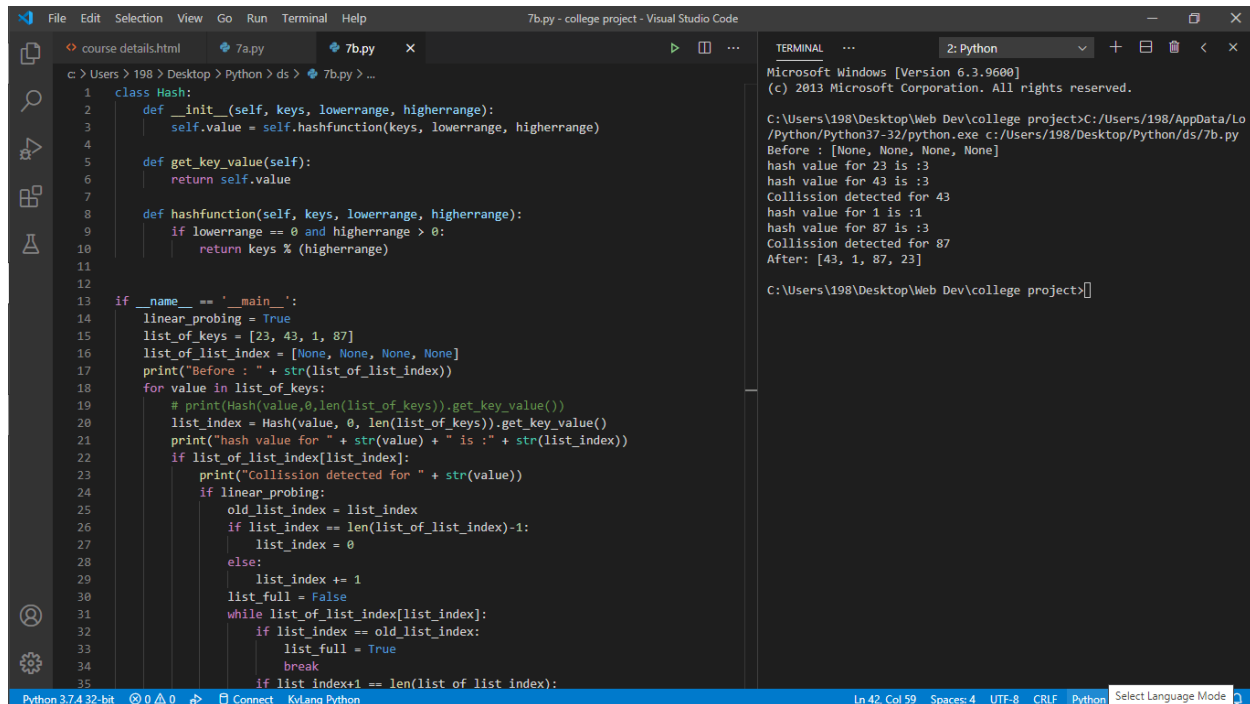
TERMINAL ... 2: Python
Microsoft Windows [Version 6.3.9600]
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C:\Users\198\Desktop\Web Dev\college project>C:\Users\198\AppData\Lo
/Python/Python37-32/python.exe c:\Users\198\Desktop/Python/ds/7a.py
Before : [None, None, None, None]
Collision detected
Collision detected
After: [None, 1, None, 23]

C:\Users\198\Desktop\Web Dev\college project>[]

Python 3.7.4 32-bit 0 0 0 Connect KiLang Python Ln 27, Col 1 Spaces: 4 UTF-8 CRLF Python Port: 5500
```

B): Write a program to implement the concept of linear probing.



```
1 class Hash:
2     def __init__(self, keys, lowerrange, higherrange):
3         self.value = self.hashfunction(keys, lowerrange, higherrange)
4
5     def get_key_value(self):
6         return self.value
7
8     def hashfunction(self, keys, lowerrange, higherrange):
9         if lowerrange == 0 and higherrange > 0:
10            return keys % (higherrange)
11
12
13 if __name__ == '__main__':
14     linear_probing = True
15     list_of_keys = [23, 43, 1, 87]
16     list_of_list_index = [None, None, None, None]
17     print("Before : " + str(list_of_list_index))
18     for value in list_of_keys:
19         # print(Hash(value,0,len(list_of_keys)).get_key_value())
20         list_index = Hash(value, 0, len(list_of_keys)).get_key_value()
21         print("hash value for " + str(value) + " is : " + str(list_index))
22         if list_of_list_index[list_index]:
23             print("Collision detected for " + str(value))
24             if linear_probing:
25                 old_list_index = list_index
26                 if list_index == len(list_of_list_index)-1:
27                     list_index = 0
28                 else:
29                     list_index += 1
30             list_full = False
31             while list_of_list_index[list_index]:
32                 if list_index == old_list_index:
33                     list_full = True
34                     break
35                 if list_index+1 == len(list_of_list_index):
```

```
Microsoft Windows [Version 6.3.9600]
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C:\Users\198\Desktop\Web Dev\college project>C:/Users/198/AppData/Local/Python/Python37-32/python.exe c:/Users/198/Desktop/Python/ds/7b.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]

C:\Users\198\Desktop\Web Dev\college project>
```

Q8) Write a program for inorder, postorders and preorder traversal of tree.

Theory:

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 is reversed can be used.

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.

Postorder:

Postorder traversal is also useful to get the postfix expression of an expression tree.

```
course details.html 7a.py 7b.py 8.py x
c:\Users\198\Desktop>Python>ds> 8.py> printInorder

1 class Node:
2     def __init__(self, key):
3         self.left = None
4         self.right = None
5         self.val = key
6
7
8 def printInorder(root):
9     if root:
10        printInorder(root.left)
11        print(root.val),
12        printInorder(root.right)
13
14
15 def printPostorder(root):
16     if root:
17        printPostorder(root.left)
18        printPostorder(root.right)
19        print(root.val),
20
21
22 def printPreorder(root):
23     if root:
24        print(root.val),
25        printPreorder(root.left)
26        printPreorder(root.right)
27
28
29 root = Node(1)
30 root.left = Node(2)
31 root.right = Node(3)
32 root.left.left = Node(4)
33 root.left.right = Node(5)
34 print("Preorder traversal of binary tree is", printPreorder(root))
35 print("Inorder traversal of binary tree is", printInorder(root))
36 print("Postorder traversal of binary tree is", printPostorder(root))

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C:\Users\198\Desktop\Web Dev\college project>C:/Users/198/AppData/Lo
/Python/Python37-32/python.exe c:/Users/198/Desktop/Python/ds/8.py
1
2
3
4
5
Preorder traversal of binary tree is None
1
2
3
Inorder traversal of binary tree is None
4
5
2
3
1
Postorder traversal of binary tree is None
C:\Users\198\Desktop\Web Dev\college project>
```