Experiment No. 7
Program for data structure using built in function for link list, stack and queues
Date of Performance:
Date of Submission:

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Title: Program for data structure using built in function for link list, stack and queues

Aim: To study and implement data structure using built in function for link list, stack and queues

Objective: To introduce data structures in python

Theory:

Stacks -the simplest of all data structures, but also the most important. A stack is a collection of objects that are inserted and removed using the LIFO principle. LIFO stands for "Last In First Out". Because of the way stacks are structured, the last item added is the first to be removed, and vice-versa: the first item added is the last to be removed.

Queues – essentially a modified stack. It is a collection of objects that are inserted and removed according to the FIFO (First In First Out) principle. Queues are analogous to a line at the grocery store: people are added to the line from the back, and the first in line is the first that gets checked out – BOOM, FIFO!

Linked Lists

The Stack and Queue representations I just shared with you employ the python-based list to store their elements. A python list is nothing more than a dynamic array, which has some disadvantages.

The length of the dynamic array may be longer than the number of elements it stores, taking up precious free space.

Insertion and deletion from arrays are expensive since you must move the items next to them over

Using Linked Lists to implement a stack and a queue (instead of a dynamic array) solve both of these issues; addition and removal from both of these data structures (when implemented with a linked list) can be accomplished in constant O(1) time. This is a HUGE advantage when dealing with lists of millions of items.

Linked Lists – comprised of 'Nodes'. Each node stores a piece of data and a reference to its next and/or previous node. This builds a linear sequence of nodes. All Linked Lists store a head, which is a reference to the first node. Some Linked Lists also store a tail, a reference to the last node in the list.

Code:

1) Linked List:

```
class Node:
    def __init__(self, data=None):
        self.data = data
        self.next = None


class LinkedList:
    def __init__(self):
        self.head = None


    # Traversing the linked list and printing elements with their indices
    def traverse_with_index(self):
        current = self.head
        index = 0
        while current:
            print("Index:", index, "Data:", current.data)
```

```
        current = current.next
        index += 1

# Appending an element at the end of the linked list
def append(self, data):
    new_node = Node(data)
    if self.head is None:
        self.head = new_node
        return
    last_node = self.head
    while last_node.next:
        last_node = last_node.next
    last_node.next = new_node

# Inserting an element at a specific index
def insert_at_index(self, index, data):
    new_node = Node(data)
    if index == 0:
        new_node.next = self.head
        self.head = new_node
        return
    current = self.head
    position = 0
```

```
    while current and position < index - 1:
        current = current.next
        position += 1
    if current is None:
        print("Index out of range.")
        return
    new_node.next = current.next
    current.next = new_node

# Removing an element at a specific index
def remove_at_index(self, index):
    if index == 0:
        if self.head is None:
            print("List is empty.")
            return
        self.head = self.head.next
        return
    current = self.head
    position = 0
    while current and position < index - 1:
        current = current.next
        position += 1
    if current is None or current.next is None:
```

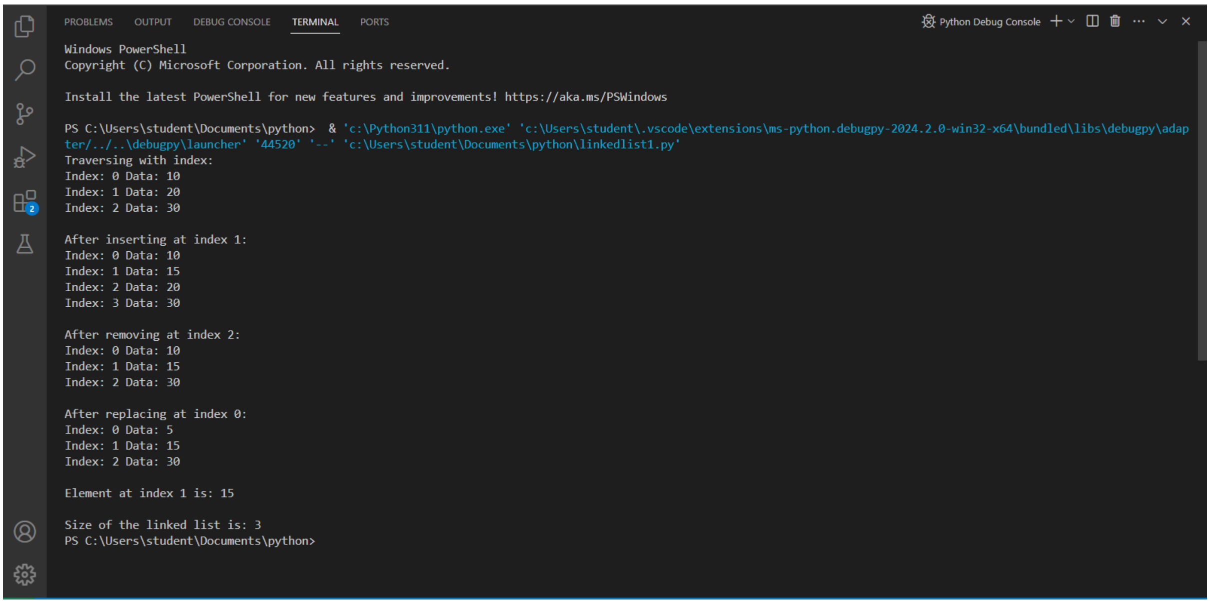
```
            print("Index out of range.")
            return
        current.next = current.next.next

    # Replacing an element at a specific index
    def replace_at_index(self, index, data):
        current = self.head
        position = 0
        while current and position < index:
            current = current.next
            position += 1
        if current is None:
            print("Index out of range.")
            return
        current.data = data

    # Searching for the location of an element by its index
    def search_by_index(self, index):
        current = self.head
        position = 0
        while current and position < index:
            current = current.next
            position += 1
```

```
        if current is None:
            print("Index out of range.")
            return
        return current.data, position

    # Size of the linked list
    def size(self):
        count = 0
        current = self.head
        while current:
            count += 1
            current = current.next
        return count

# Example usage
if __name__ == "__main__":
    linked_list = LinkedList()

    # Appending elements
    linked_list.append(10)
    linked_list.append(20)
    linked_list.append(30)
```

```
print("Traversing with index:")
linked_list.traverse_with_index()

# Inserting an element at index 1
linked_list.insert_at_index(1, 15)
print("\nAfter inserting at index 1:")
linked_list.traverse_with_index()

# Removing an element at index 2
linked_list.remove_at_index(2)
print("\nAfter removing at index 2:")
linked_list.traverse_with_index()

# Replacing an element at index 0
linked_list.replace_at_index(0, 5)
print("\nAfter replacing at index 0:")
linked_list.traverse_with_index()

# Searching for the location of an element at index 1
data, position = linked_list.search_by_index(1)
print("\nElement at index 1 is:", data)

# Size of the linked list
```

```
    print("\nSize of the linked list is:", linked_list.size())
```

Output:



2)Stack and Queue Implementations Using a Linked List:

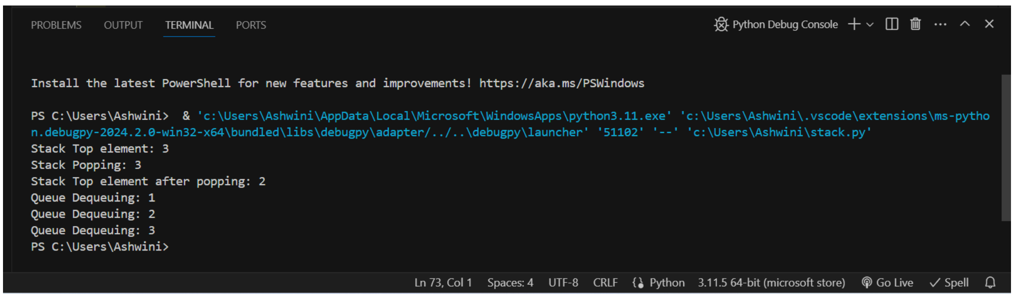
```
class Node:

    def __init__(self, value):

        self.value = value

        self.next = None



class Stack:

    def __init__(self):

        self.top = None



    def push(self, value):
```

```
        new_node = Node(value)
        new_node.next = self.top
        self.top = new_node

    def pop(self):
        if self.is_empty():
            return None
        value = self.top.value
        self.top = self.top.next
        return value

    def peek(self):
        if self.is_empty():
            return None
        return self.top.value

    def is_empty(self):
        return self.top is None

class Queue:
    def __init__(self):
        self.front = None
        self.rear = None
```

```
    def enqueue(self, value):
        new_node = Node(value)
        if not self.rear:
            self.front = self.rear = new_node
            return
        self.rear.next = new_node
        self.rear = new_node

    def dequeue(self):
        if self.is_empty():
            return None
        value = self.front.value
        self.front = self.front.next
        if not self.front:
            self.rear = None
        return value

    def is_empty(self):
        return self.front is None

# Example usage:
stack = Stack()
```

```
stack.push(1)
stack.push(2)
stack.push(3)


print("Stack Top element:", stack.peek())
print("Stack Popping:", stack.pop())
print("Stack Top element after popping:", stack.peek())


queue = Queue()
queue.enqueue(1)
queue.enqueue(2)
queue.enqueue(3)


print("Queue Dequeuing:", queue.dequeue())
print("Queue Dequeuing:", queue.dequeue())
print("Queue Dequeuing:", queue.dequeue())
```

Output:



Conclusion: Data structures python has been studied and implemented.