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**DATA STRUCTURES LAB**

**ENCS253**

**LAB PRACTICALS**

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# EXPERIMENT – 1

## INVENTORY MANAGEMENT SYSTEM

### **AIM:**

To implement an inventory management system in Python that allows insertion of new products and display of all products using ArrayList.

### **Question:**

Write a menu-driven program to store product details (SKU, name, quantity) in an inventory. The program should allow the user to insert new products after validating quantity and to display the complete inventory in tabular form.

### **Introduction:**

Inventory management keeps track of items available in stock. Using a list in Python, we can store a dynamic list of products where each product is represented as an object containing SKU, name and quantity.

### **Algorithm:**

- Start.
- Create a `Product` class with fields `sku`, `name` and `quantity`.
- Use a Python list to store all product records.
- Display menu with options:
  1. Insert product
  2. Display inventory
  3. Exit
- For insertion: read `sku`, `name` and `quantity`; validate that `quantity` is positive and `sku` does not already exist; then add new `Product` object to list.

- For display: if list is empty, show message; otherwise print all products in table form.
- Repeat menu until user selects Exit.
- Stop.

### **Python Code:**

```
class Product:
def __init__(self, sku, name, quantity):
self.sku = sku
self.name = name
self.quantity = quantity
inventory = []
def
insert_product():
sku = input("Enter SKU: ").strip()
for p in inventory:
if p.sku.lower() == sku.lower():print("Product
with this SKU already exists!")
return
name = input("Enter Product Name:
").strip() if not name:
print("Product name cannot be empty.")
return
try:
qty = int(input("Enter Quantity: ").strip())
if qty <= 0: print("Quantity must be
positive.") return except
ValueError:
print("Invalid quantity.")
return
inventory.append(Product(sku, name,
qty)) print("Product inserted
successfully.")
def
display_inventory():
```

```

if not inventory:
    print("Inventory is empty.")
    return
print("SKU\t\tName\t\tQuantity") print("-----
-
-----")
for p in
inventory:
    print(f"{p.sku}\t\t{p.name}\t\t{p.quantity}")
def main():
    while True:
        print("\nInventory Management System")
        print("1. Insert Product") print("2.
Display Inventory") print("3. Exit")
        ch = input("Enter your choice: ").strip()
        if ch ==
        "1":
            insert_product()
        elif ch == "2":
            display_inventory()
        elif ch == "3":
            print("Exiting...")
            break
        else:
            print("Invalid choice.")
if __name__ ==
'__main__': main()

```

## EXPERIMENT – 2

### **Inventory Stock Manager – Process Sales & Zero Stock**

#### **AIM:**

To implement an inventory stock manager that processes sales for a given SKU and identifies items with zero stock.

#### **Question:**

Write a program that maintains a list of items (SKU and quantity).

Implement a method to process a sale given SKU and quantity sold, updating stock if available or showing appropriate error messages.

Also implement a method to list all SKUs whose quantity becomes zero.

#### **Algorithm:**

- Use a class `Item` with fields `sku` and `quantity`.
- Store all items in a list.
- For `processSale(sku, qtySold)`: search the list for given sku.
- If sku not found: display message.
- If found and  $\text{quantity} \geq \text{qtySold}$ : reduce quantity and show success message.
- If found and  $\text{quantity} < \text{qtySold}$ : do not update quantity and show insufficient stock message.
- For `identifyZeroStock()`: traverse list and collect all items whose quantity is 0 and display them.

#### **Python Code:**

```
class Item: def __init__(self,
sku, quantity):
self.sku = sku
```

```

self.quantity = quantity
def process_sale(inventory, sku,
qty_sold):
    found = False
    for item in
inventory:
        if item.sku == sku:
            found = True
            if item.quantity
            >= qty_sold:
                item.quantity -= qty_sold
            print(f"Sale processed: {qty_sold} units of SKU
            {sku}")
            print(f"Insufficient stock for SKU {sku}.
            else: Available:
            {item.quantity}")
            break
    if not
    found:
        print(f"SKU {sku} not found in inventory.")
def
identify_zero_stock(inventory):
    zero_list =
    [item.sku for item in
    inventory if item.quantity == 0]
    if not
    zero_list:
        print("No zero stock items found.")
    else:
        print("Zero stock SKUs:", zero_list)
    return zero_list
def
main():
    inventory = [
    Item(101, 50),
    Item(102, 20),
    Item(103, 0)
    ]
    process_sale(inventory, 101, 30) # normal sale
    process_sale(inventory, 102, 25) # insufficient
    stock

```

```
process_sale(inventory, 104, 10) # SKU not found
identify_zero_stock(inventory)
print("Updated Inventory:", [(item.sku,
item.quantity) for item in
inventory])
if __name__ ==
'__main__':
main()
```



## EXPERIMENT – 3

### **Linear Search**

#### **AIM:**

To implement linear search and analyse its best and worst case time complexity.

#### **Question:**

Write a program to perform linear search on an array of integers. Also state the best and worst case time complexities of linear search.

#### **Introduction:**

Linear search scans the array sequentially from left to right and compares each element with the key. It works on both sorted and unsorted arrays but it is inefficient for large datasets.

#### **Algorithm:**

- Input array A of n elements and key K.
- Set  $i = 0$ .
- While  $i < n$ , compare  $A[i]$  with K.
- If  $A[i] == K$ , return index i.
- Else increment i and continue loop.
- If no element matches, return -1 meaning key not found.

#### **Python Code:**

```
def linear_search(arr, key):  
    for i, val in enumerate(arr):  
        if val == key: return i  
    return -1  
  
def main():  
    n = int(input("Enter number of  
elements: "))  
    arr = []  
    print(f"Enter {n}
```

```
elements:") for _ in
range(n):
arr.append(int(input()))
key = int(input("Enter element to search: "))
index = linear_search(arr,
key)
if index == -
1:
print("Element not found.")
else:
print("Element found at index:", index) if
__name__ == "__main__":
main()
```

## EXPERIMENT – 4

### **Insertion in Circular Linked List (Beginning & End)**

#### **AIM:**

To implement insertion at beginning and at end in a circular linked list.

#### **Question:**

Write a program to create a circular linked list and perform insertion of nodes at the beginning and at the end, displaying the list after each operation.

#### **Python Code:**

```
class CNode: def
__init__(self, data):
self.data = data
self.next = None
class
CircularLinkedListInsert:
def __init__(self):
self.head = None
def insert_at_end(self, data):
new_node = CNode(data) if
self.head is None:
self.head = new_node
new_node.next = self.head
return
temp = self.head
while temp.next != self.head:
temp = temp.next
temp.next = new_node
new_node.next = self.head
def insert_at_beginning(self,
data):
```

```

new_node = CNode(data)
if self.head is None:
    self.head = new_node
new_node.next = self.head
return
temp = self.head
while temp.next != self.head:
    temp = temp.next
new_node.next = self.head
temp.next = new_node
self.head = new_node
def
display(self):
    if self.head is None:
        print("List is empty")
        return
    temp = self.head
    print("Circular List:", end=" ")
    while True:
        print(f"{temp.data} ->", end=" ")
        if temp ==
temp = temp.next
        if temp == self.head: break
    print("(back to head)")
def
main():
    cll = CircularLinkedListInsert()
    cll.insert_at_end(10)
    cll.insert_at_end(20)
    cll.insert_at_end(30)
    print("Original
list:")
    cll.display()
    cll.insert_at_beginning(5)
    print("After inserting 5 at beginning:")
    cll.display()
    cll.insert_at_end(40)
    print("After inserting 40 at end:")
    cll.display()

```

```
if __name__ ==  
    "__main__": main()
```

## EXPERIMENT – 5

### **Deletion in Circular Linked List (Beginning & End)**

#### **AIM:**

To delete a node from the beginning and from the end of a circular linked list.

#### **Python Code:**

```
class CNode: def
__init__(self, data):
self.data = data
self.next = None
class
CircularLinkedListDelete:
def __init__(self):
self.head = None
def insert(self, data):
new_node = CNode(data) if
self.head is None:
self.head = new_node
new_node.next = self.head
return
temp = self.head
while temp.next != self.head:
temp = temp.next
temp.next = new_node
new_node.next = self.head
def
delete_from_beginning(self):
if self.head is None:
print("List is empty, nothing to delete.")
```

```

return
if self.head.next ==
self.head:
self.head = None
print("Deleted the only node in the list.")
return
last = self.head
while last.next != self.head:
last = last.next
self.head =
self.head.next last.next =
self.head
print("Node deleted from beginning.")
def
delete_from_end(self):
if self.head is None:
print("List is empty, nothing to delete.")
return
if self.head.next ==
self.head:self.head = None
print("Deleted the only node in the list.")
return
prev = None
temp = self.head
while temp.next !=
self.head:
prev = temp
temp = temp.next
prev.next = self.head
print("Node deleted from end.")
def
display(self):
if self.head is None:
print("List is empty") return
temp = self.head
print("Circular List:", end=" ")

```

```
while True:
    print(f"{temp.data} ->", end=" ")
    if temp ==
temp = temp.next self.head:
break
print("(back to head)")
def
main():
    cll = CircularLinkedListDelete()
    cll.insert(10)
    cll.insert(20)
    cll.insert(30)
    cll.insert(40)
    print("Initial
list:") cll.display()
    cll.delete_from_beginning()
    cll.display()
    cll.delete_from_end()
    cll.display()
    if __name__ ==
    "__main__": main()
```



## EXPERIMENT – 6

### **Deletion from Singly Linked List (Beginning & End)**

#### **AIM:**

To implement deletion of nodes from the beginning and end of a singly linked list.

#### **Python Code:**

```
class SNode: def
__init__(self, data):
self.data = data
self.next = None
class
SinglyLinkedListDelete:
def __init__(self):
self.head = None
def insert(self, data):
new_node = SNode(data)
if self.head is None:
self.head = new_node
return
temp = self.head
while temp.next is not None:
temp = temp.next
temp.next = new_node
def
delete_from_beginning(self):
if self.head is None:
print("List is empty!")
return
self.head = self.head.next
print("Node deleted from beginning.")
def
delete_from_end(self):
```

```

if self.head is None:
    print("List is empty!")
    return
if self.head.next is
None:
    self.head = None
    print("Last node deleted.")
    return
temp = self.head while
temp.next.next is not None:
    temp = temp.next
    temp.next = None
    print("Node deleted from end.")
def display(self):
    if
    self.head is None:
        print("List is empty!")
        return
    temp = self.head while temp
    is not None: print(f"{temp.data}
->", end=" ") temp = temp.next
    print("null")
def
main():
    lst = SinglyLinkedListDelete()
    lst.insert(10)
    lst.insert(20)
    lst.insert(30)
    lst.insert(40)
    print("Original
List:") lst.display()
    lst.delete_from_beginning()
    print("After deleting from beginning:")
    lst.display()
    lst.delete_from_end()
    print("After deleting from end:")
    lst.display()

```

```
if __name__ ==  
"__main__":  
main()
```

## EXPERIMENT – 7

### **Circular Queue using Array**

#### **AIM:**

To implement a circular queue using array with enqueue, dequeue and display operations.

#### **Python Code:**

```
class CircularQueue: def
__init__(self, capacity):
self.arr = [None] * capacity
self.front = -1 self.rear =
-1 self.size = capacity
def
is_empty(self):
return self.front == -1
def
is_full(self):
return (self.front == 0 and self.rear == self.size
- 1) or \
(self.rear + 1 == self.front)
def enqueue(self,
value): if
self.is_full():
print("Queue is full.")
return
if self.front == -
1: self.front =
0
self.rear = (self.rear + 1) % self.size
self.arr[self.rear] = value print("Enqueued:",
value)
def
dequeue(self):
```

```

if self.is_empty():
    print("Queue is empty.")
    return None
element = self.arr[self.front]
if self.front == self.rear:
    # Reset queue self.front =
    self.rear = -1 else:
    self.front = (self.front + 1) % self.size
print("Dequeued:", element)
return element
def display(self):
    if self.is_empty():
        print("Queue is empty.")
        return
    print("Elements in queue:", end=" ")
    i = self.front while True:
        print(self.arr[i], end=" ")
        if i == self.rear:
            break
    i = (i + 1) %
    self.size print()
def main():
    q = CircularQueue(5)
    q.enqueue(10)
    q.enqueue(20)
    q.enqueue(30)
    q.enqueue(40)
    q.display()
    q.dequeue()
    q.dequeue()
    q.display()
    q.enqueue(50)
    q.enqueue(60)
    q.display()
if
__name__ == "__main__":
    main()

```

## EXPERIMENT – 8

### **Stack using Array (Push, Pop, Peek, Display)**

#### **AIM:**

To implement stack operations push, pop, peek and display using array.

#### **Python Code:**

```
class ArrayStack: def
__init__(self, capacity):
self.capacity = capacity
self.stack = [None] * capacity
self.top = -1
def
is_empty(self):
return self.top == -1
def
is_full(self):
return self.top == self.capacity - 1
def push(self, item):
if self.is_full():
print("Stack overflow.")
return self.top += 1
self.stack[self.top] = item
print("Pushed", item)
def pop(self): if
self.is_empty():
print("Stack underflow.")
return None item =
self.stack[self.top] self.top
-= 1 print("Popped", item)
return item
def peek(self): if
self.is_empty():
```

```

print("Stack is empty.")
return None
print("Top element is", self.stack[self.top])
return self.stack[self.top]
def
display(self):
if self.is_empty():
print("Stack is empty.")
return
print("Stack elements:", end=" ")
for i in range(self.top + 1):
print(self.stack[i], end=" ") print()
def
main():
st = ArrayStack(10)
while
True:
print("\n1. Push 2. Pop 3. Peek 4. Display 5.
Exit")
ch = input("Enter your choice: ").strip()if ch ==
"1": int(input("Enter element: "))
st.push(x)
x =
elif ch ==
"2":
st.pop()
elif ch ==
"3":
st.peak()
st.display()
elif ch == "4":
elif ch ==
"5":
print("Exiting.")
break
else:

```

```
print("Invalid choice.")  
if __name__ ==  
    "__main__":  
    main()
```



## EXPERIMENT – 9

### **Evaluate Postfix Expression using Stack**

#### **AIM:**

To evaluate a postfix arithmetic expression using stack.

#### **Python Code:**

```
def apply_operation(op1, op2, operator):
    if operator == '+': return op1 +
    op2 if operator == '-':
    return op1 - op2 if operator == '*':
    return op1 * op2 if operator == '/':
    return int(op1 / op2)
    raise ValueError("Invalid operator")
def
evaluate_postfix(expression):
    stack = []
    tokens = expression.split()
    for token in tokens:
        if token.isdigit():
            stack.append(int(token))
        else:
            op2 = stack.pop()
            op1 = stack.pop()
            stack.append(result)
            result = apply_operation(op1, op2, token[0])
    return stack.pop()
def
main():
    expr = input("Enter postfix expression (space
    separated): ")
    result = evaluate_postfix(expr) print("Result =",
    result)
```

```
if __name__ ==  
"__main__":  
main()
```

## EXPERIMENT – 10

### **Browser Back Button Simulation using Stack**

#### **AIM:**

To simulate a browser back button using stack.

#### **Question:**

Write a program that allows the user to visit pages, go back to the previous page and show history using stack operations.

#### **Python Code:**

```
def main():
    history = []
    while
    True:
        print("\n1. Visit Page")
        print("2. Back") print("3.
        Show History") print("4.
        Exit")
        choice = input("Enter choice: ").strip()
        if choice ==
        "1":
            page = input("Enter page name: ").strip()
            history.append(page) print("Visited:",
            page)
        elif choice ==
        "2": if not
            history:
                print("No pages in history.")
            else:
                last_page = history.pop()
                print("Going back from:", last_page)
        if not
```

```
history:
print("No pages left in history.")
else:
print("Current page:", history[-1])
elif choice ==
"3": if not
history:
else:
print("History is empty.")
print("History:", history)
elif choice ==
"4":
break
print("Exiting browser simulation.")
else:print("Invalid choice.")
if __name__ ==
"__main__":
main()
```

# EXPERIMENT – 11

## Bubble Sort

### AIM:

To implement bubble sort and analyse its time complexity.

### Question:

Write a program to sort an array of integers using bubble sort technique and display the sorted array.

### Python Code:

```
def bubble_sort(arr):
    n = len(arr)
    for i in range(n - 1):
        swapped = False
        for j in range(n - 1 - i):
            if arr[j] > arr[j + 1]:
                # swap
                arr[j], arr[j + 1] = arr[j + 1], arr[j]
        if not swapped:
            break
def main():
    n = int(input("Enter number of elements: "))
    arr = []
    print(f"Enter {n} elements:")
    for _ in range(n):
        arr.append(int(input()))
    bubble_sort(arr)
    print("Sorted array:")
    for x in arr:
        print(x, end=" ")
    print()
if __name__ == "__main__":
    main()
```

# EXPERIMENT – 12

## Binary Search

### AIM:

To implement binary search and analyse its time complexity.

### Question:

Write a program to perform binary search on a sorted array of integers and find the position of a given key element.

### Python Code:

```
def binary_search(arr, key):
    low = 0
    high = len(arr) - 1
    while low <=
    high:
    mid = (low + high) // 2
    if arr[mid] ==
    key:
    return mid
    elif arr[mid] < key:
    low = mid + 1
    else:
    high = mid - 1
    return -1
def main():
    n = int(input("Enter number of
    elements: "))
    arr = []
    print(f"Enter {n} sorted
    elements:")
    for _ in range(n):
    arr.append(int(input()))
    key = int(input("Enter key to search:
    "))
    index = binary_search(arr, key)
    if index == -
```

```
1:
print("Element not found.")
else:
print("Element found at index:", index)
if __name__ ==
"__main__": main()
```