



# **DATA STRUCTURES LAB**

## **ENCS253**

### **LAB PRACTICALS**

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## **AIM: EXPERIMENT – 1 : INVENTORY MANAGEMENT SYSTEM**

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 quantity  $\geq$  qtySold: reduce quantity and show success message.
- If found and quantity  $<$  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 == self.head:
            break
        temp = temp.next
    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.peek()
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("Invali
d 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 swapped = True 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()
```