K.R. MANGALAM UNIVERSITY
DESTINATION SUCCESS

Data Structures
&
Algorithms
(ENCS205)

Lab File

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Q1: Application of Stack

1. Reversing a String using Stack

Code:

```
def
    reverse_string(input_string
    ): stack = []
    for char in input_string:
        stack.append(char)
    reversed_string = ''
    while stack:
```

2. Balancing the brackets

Code:

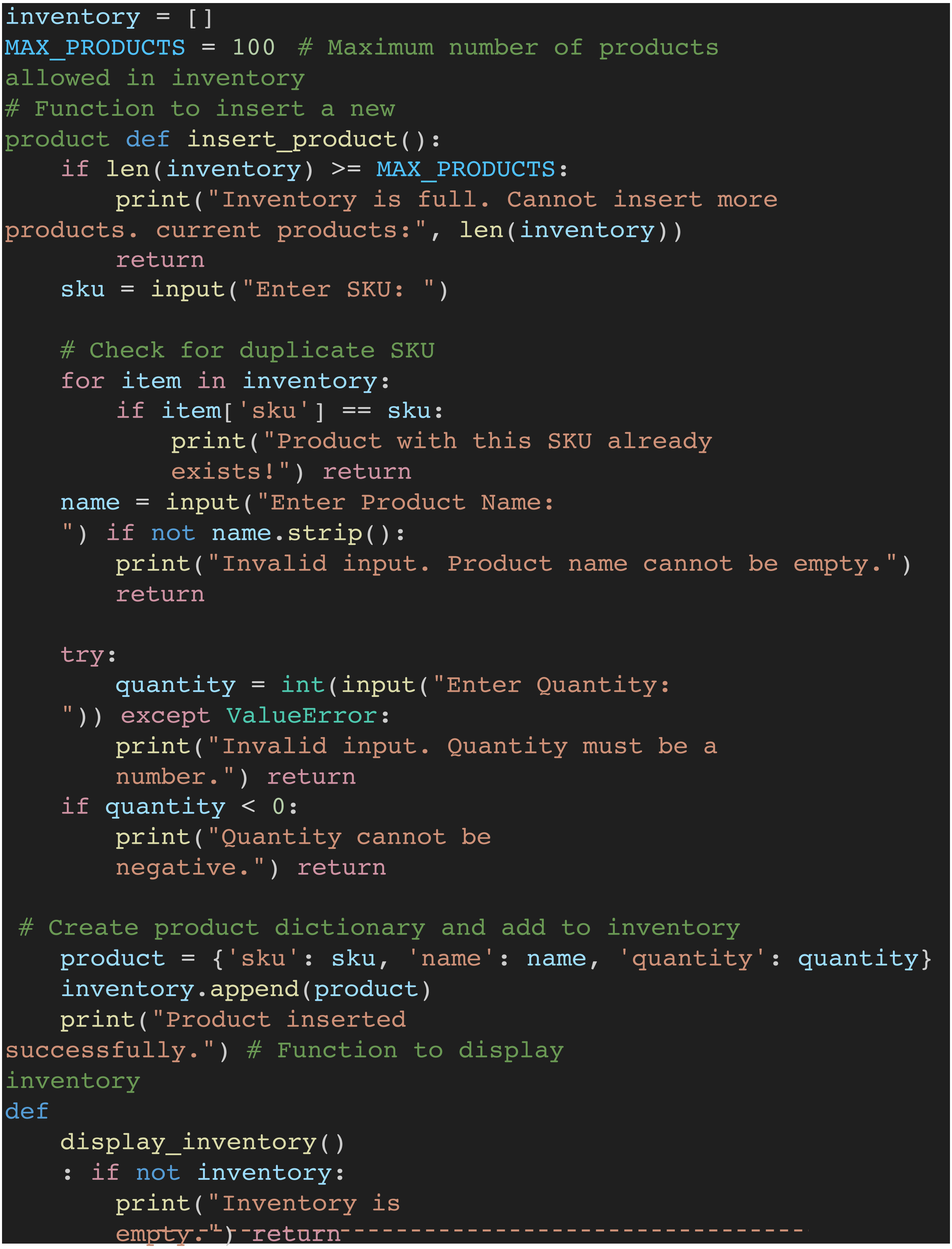
```
def
    is_balanced(expression
    ): stack = []
    opening = "({["
    closing = ")}]"
    match = {')': '(', '}': '{', ']': '['}

    for char in
        expression: if
        char in opening:
            stack.append(char)
        elif char in closing:
            if not stack or stack[-1] !=
```

3. Undo Operation

```
def undo_operations(stack):
    stack.append(1)
    stack.append(2)
    stack.append(3)
    stack.append(4)
    print("initial stack:",
    stack)
```

Q2 Inventory (Inserting products, Searching, Display, Update, Delete)

Code:



```
inventory = []
MAX_PRODUCTS = 100  # Maximum number of products
allowed in inventory
# Function to insert a new
product def insert_product():
    if len(inventory) >= MAX_PRODUCTS:
        print("Inventory is full. Cannot insert more
products. current products:", len(inventory))
        return
    sku = input("Enter SKU: ")

    # Check for duplicate SKU
    for item in inventory:
        if item['sku'] == sku:
            print("Product with this SKU already
            exists!") return
    name = input("Enter Product Name:
    ") if not name.strip():
        print("Invalid input. Product name cannot be empty.")
        return

    try:
        quantity = int(input("Enter Quantity:
    ")) except ValueError:
        print("Invalid input. Quantity must be a
        number.") return
    if quantity < 0:
        print("Quantity cannot be
        negative.") return

 # Create product dictionary and add to inventory
    product = {'sku': sku, 'name': name, 'quantity': quantity}
    inventory.append(product)
    print("Product inserted
successfully.") # Function to display
inventory
def
    display_inventory()
    : if not inventory:
        print("Inventory is
        empty.") return-----------------------------------
    print("\nCurrent Inventory:")
print("SKU\t\tProduct Name\t\tQuantity")
print("                                           ")
```

```
    for item in inventory: print(f"{item['sku']}
        \t\t{item['name']}\t\t{item['quantity'
]}")
        print()
def insert_Nproducts():
    try:
        count = int(input("How many products do you want to add?
    ")) except ValueError:
        print("Invalid input. Please enter a
        number.") return

    for i in range(count):
        print(f"\n--- Product {i+1}
        ---") insert_product()
def Search_Product_SKU():
    sku = input("Enter SKU to search:
    ") for item in inventory:
        if item['sku'] == sku:
            print(f"Product found: {item['name']} with quantity
{item['quantity']}")
            return
    print("Product not
    found.")
def Search_Product_Name():
    name = input("Enter Product Name to search:
    ") for item in inventory:
        if item['name'].lower() == name.lower():
            print(f"Product found: SKU {item['sku']} with
            quantity
{item['quantity']}")
            return
def
Delete_Product():
    sku = input("Enter SKU of the product to delete:
    ") for item in inventory:
        if item['sku'] == sku:
            inventory.remove(item)
            print("Product deleted
            successfully.") return
    print("Product not
found.") def
update_quantity():
    sku = input("Enter SKU of the product to update quantity
    for: ") for item in inventory:
        if item['sku'] ==
            sku: try:
                new_quantity = int(input("Enter new quantity:
```

```
")) if new_quantity < 0:
    print("Quantity cannot be
    negative.") return
```

```
                item['quantity'] = new_quantity
                print("Quantity updated
                successfully.") return
            except ValueError:
                print("Invalid input. Quantity must be a
                number.") return
# Main program loop
def main():
    while True:
        print("\nInventory Stock
        Manager") print("1. Insert New
        Product") print("2. Display
        Inventory") print("3. Insert N
        Products") print("4. Search
        Product by SKU") print("5.
        Search Product by Name")
        print("6. Delete Product")
        print("7. Update Product
        Quantity")

        print("8. Exit")
         # Get user
         choice
        choice = input("Enter your choice (1-8):
        ") if choice == '1':
            insert_product()
        elif choice == '2':
            display_inventory(
        ) elif choice =='3':
            insert_Nproducts()
        elif choice == '4':
            Search_Product_SKU()
        elif choice == '5':
            Search_Product_Name()
        elif choice == '6':
            Delete_Product()
        elif choice == '7':
            update_quantity()
        elif choice == '8':
            print("Exiting Inventory
            Manager.") break
        else:
            print("Invalid choice. Please select from 1 to
8.") # Start the program
main()
```

Q3 Library

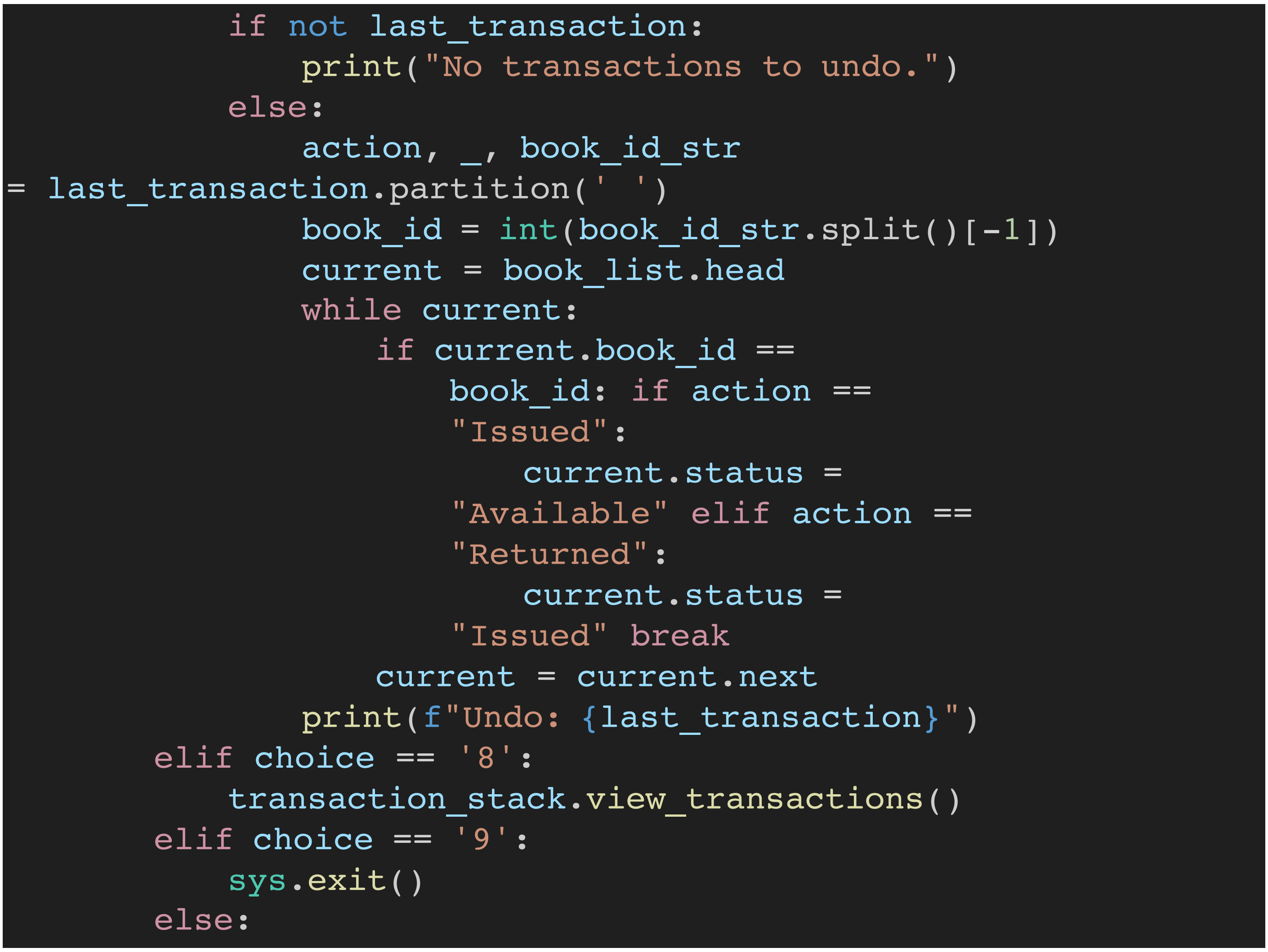
Code:

```
import sys
class
BookNode:
    def __init__(self, book_id, title, author,
        status="Available"): self.book_id = book_id
        self.title = title
        self.author = author
        self.status = status
        self.next = None
class BookList:
    def __init__(self):
        self.head = None
    def insert_book(self, book_id, title,
        author): new_book = BookNode(book_id,
        title, author) if not self.head:
            self.head = new_book
        else:
            current =
            self.head while
            current.next:
                current =
            current.next current.next
            = new_book
        print(f"Book '{title}'
    inserted.") def delete_book(self,
    book_id):
        current = self.head
        prev = None
        while current and current.book_id !=
            book_id: prev = current
            current =
        current.next if not
        current:
            print("Book not
            found.") return
        if prev:
            prev.next =
        current.next else:
            self.head = current.next
        print(f"Book ID {book_id} deleted.")
    def search_book(self,
        book_id): current =
        self.head
```

```python
        while current:
            if current.book_id == book_id:
                print(f"Book Found: ID: {current.book_id}, Title: {current.title}, Author: {current.author}, Status: {current.status}")
                return
            current = current.next
        print("Book not found.")
    def
        display_books(self)
        : if not self.head:
            print("No books
            available.") return
        current = self.head
        print("Books in Library:")
        while current:
            print(f"ID: {current.book_id}, Title:
{current.title}, Author: {current.author}, Status:
{current.status}")
            current = current.next
class TransactionStack:
    def __init__(self):
        self.stack = []
    def push(self, transaction):
        self.stack.append(transaction)
    def pop(self):
        if not self.stack:
            return None
        return self.stack.pop()
    def
    view_transactions(self):
        if not self.stack:
            print("No transactions
            available.") return
        print("Recent Transactions:")
        for transaction in reversed(self.stack):
            print(transaction)
    def is_empty(self):
        return len(self.stack) == 0
book_list = BookList()
transaction_stack =
TransactionStack() def main():
    while True:
        print("\nLibrary Management System Menu:")
        print("1. Insert Book")
        print("2. Delete Book")
        print("3. Search Book")
        print("4. Display Books")
        print("5. Issue Book")
        print("6. Return Book")
        print("7. Undo Last
        Transaction") print("8. View
Transactions") print("9.
Exit")
choice = input("Enter your choice:
") if choice == '1':
```

```
            book_id = int(input("Enter Book ID:
            ")) title = input("Enter Book Title:
            ") author = input("Enter Author Name:
            ")
            book_list.insert_book(book_id, title,
        author) elif choice == '2':
            book_id = int(input("Enter Book ID to delete: "))
            book_list.delete_book(book_id)
        elif choice == '3':
            book_id = int(input("Enter Book ID to search: "))
            book_list.search_book(book_id)
        elif choice == '4':
            book_list.display_books()
        elif choice == '5':
            book_id = int(input("Enter Book ID to issue: "))
            current = book_list.head
            while current:
                if current.book_id == book_id:
                    if current.status == "Available":
                        current.status = "Issued"
                        transaction_stack.push(f"Issued Book ID

{book_id}"              print(f"Book ID {book_id} issued.")
)                   else:
                        print("Book is already
                    issued.") break
                current = current.next
            else:
                print("Book not found.")

        elif choice == '6':
            book_id = int(input("Enter Book ID to return: "))
            current = book_list.head
            while current:
                if current.book_id == book_id:
                    if current.status == "Issued":
                        current.status = "Available"
                        transaction_stack.push(f"Returned
                        Book ID

{book_id}"              print(f"Book ID {book_id}
)                   returned.") else:
                        print("Book is not issued.")
                    break
                current = current.next
            else:
```

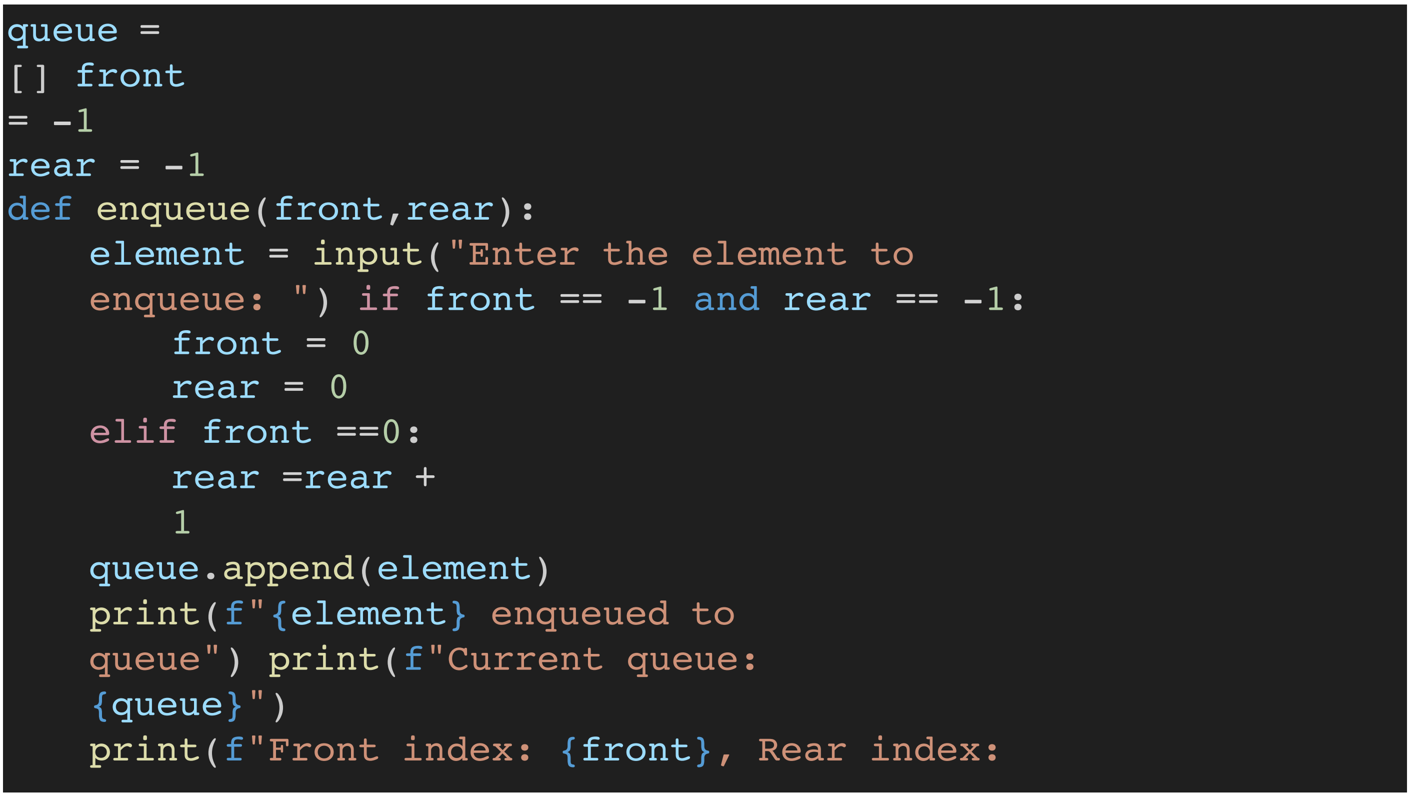
```
    print(      not found.")
    "Book
        elif choice == '7':
            last_transaction = transaction_stack.pop()
```



```
            if not last_transaction:
                print("No transactions to undo.")
            else:
                action, _, book_id_str
= last_transaction.partition(' ')
                book_id = int(book_id_str.split()[-1])
                current = book_list.head
                while current:
                    if current.book_id ==
                        book_id: if action ==
                        "Issued":
                            current.status =
                        "Available" elif action ==
                        "Returned":
                            current.status =
                        "Issued" break
                    current = current.next
                print(f"Undo: {last_transaction}")
        elif choice == '8':
            transaction_stack.view_transactions()
        elif choice == '9':
            sys.exit()
        else:
```

Q4 Insertion in QUEUE

Code:

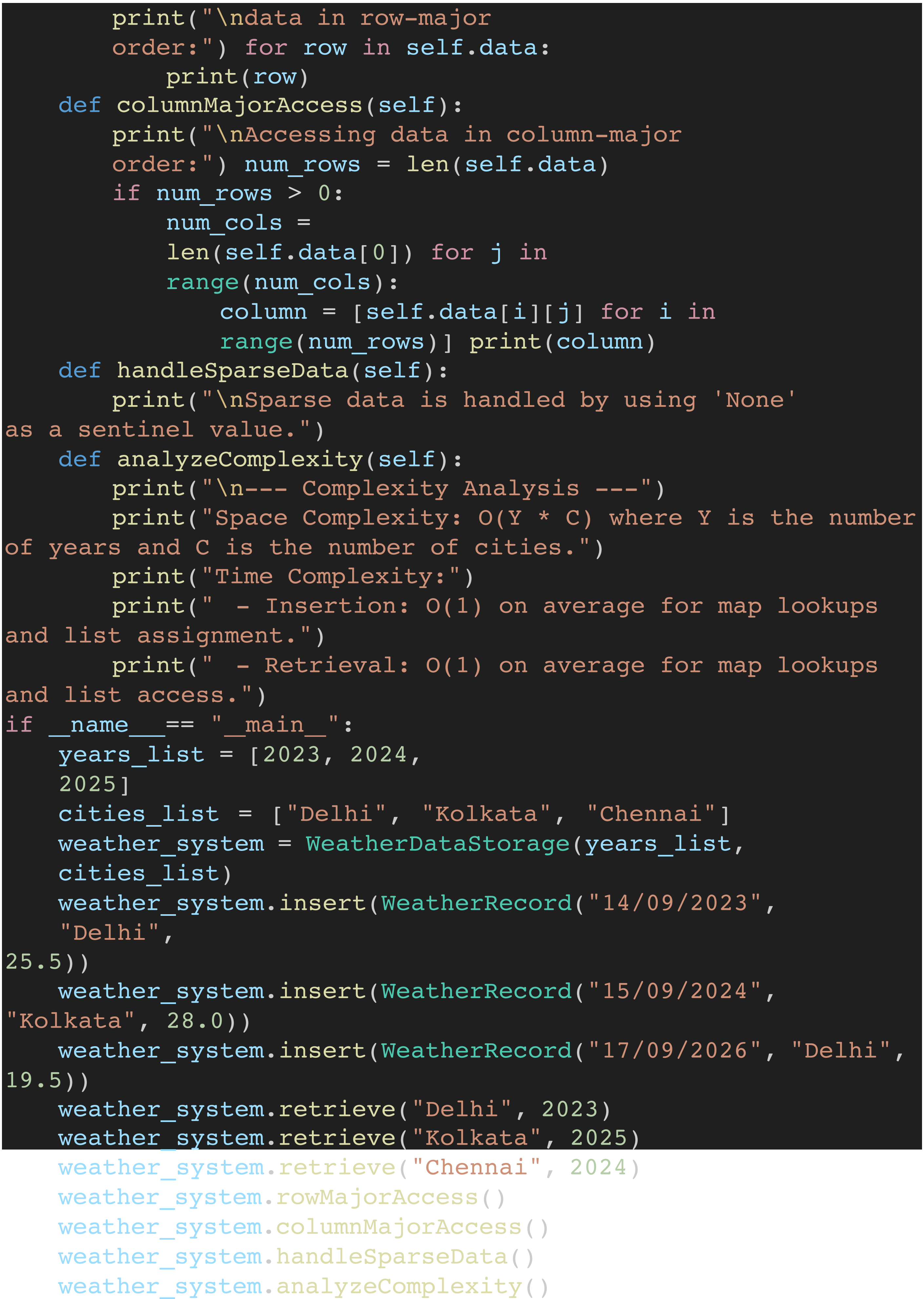


```
queue =
[] front
= -1
rear = -1
def enqueue(front,rear):
    element = input("Enter the element to
    enqueue: ") if front == -1 and rear == -1:
        front = 0
        rear = 0
    elif front ==0:
        rear =rear +
        1
    queue.append(element)
    print(f"{element} enqueued to
    queue") print(f"Current queue:
    {queue}")
    print(f"Front index: {front}, Rear index:
```

Q5 Whether Record Storage using Abstract Data Type

Code:

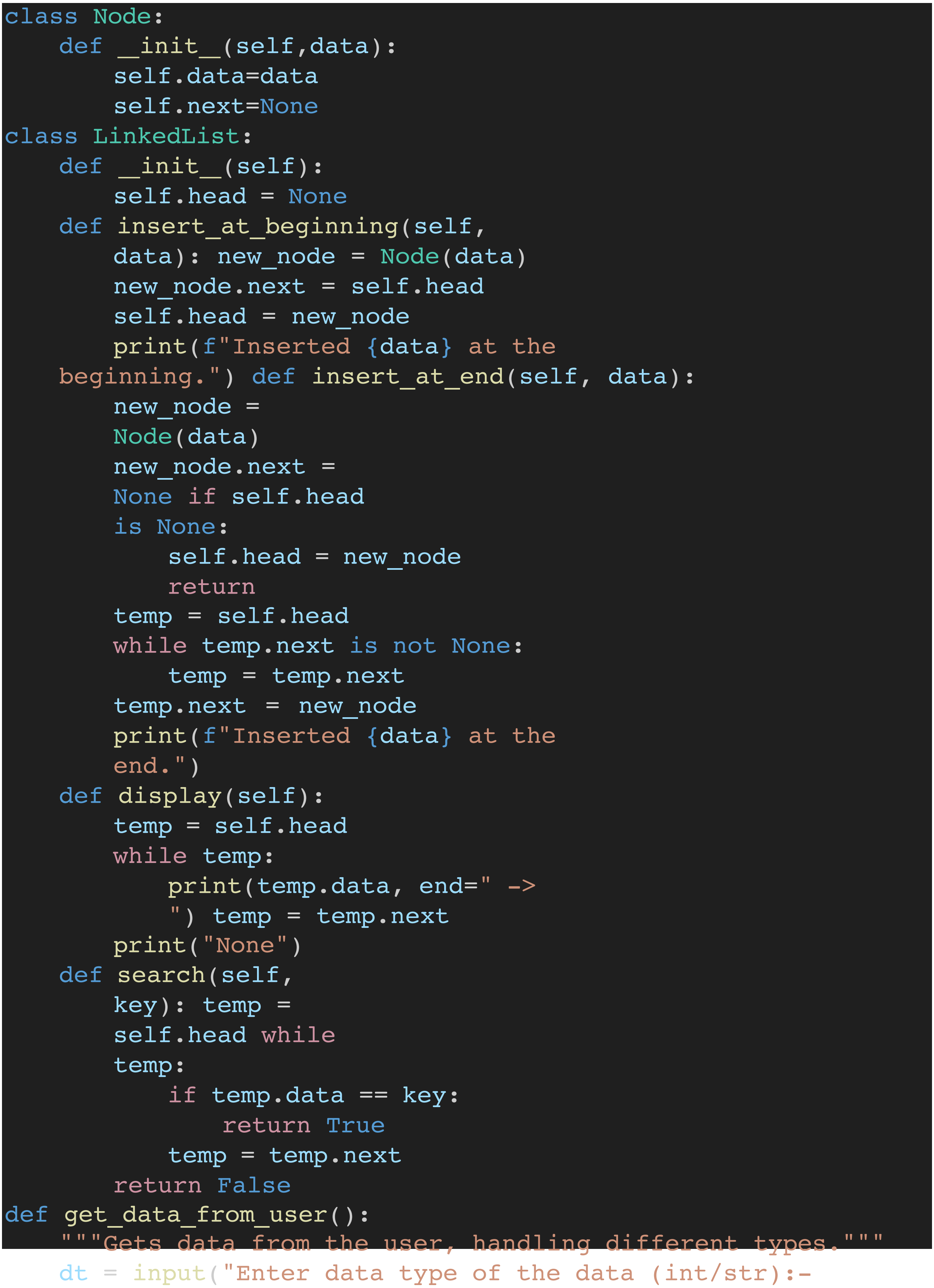
```
class WeatherRecord:
    def _init_(self, date, city,
        temperature): self.date = date
        self.city = city
        self.temperature =
        temperature
class WeatherDataStorage:
    def _init_(self, years, cities):
        self.data = [[None for _ in cities] for _ in years]
        self.years = {year: i for i, year in
        enumerate(years)} self.cities = {city: i for i, city
        in enumerate(cities)}
    def insert(self, record):
        try:
            year = int(record.date.split('/')[-1])
            year_index = self.years.get(year)
            city_index =
            self.cities.get(record.city)
            if year_index is not None and city_index is not None:
                self.data[year_index][city_index] =
record.temperature
                print(f"Record for {record.city} on {record.date}
inserted successfully.")
            else:
                print("Error: Year or City not found in the
                storage
system.")
        except (ValueError, IndexError):
            print("Error: Invalid date format. Please
use day/month/year.")
    def retrieve(self, city, year):
        year_index =
        self.years.get(year) city_index
        = self.cities.get(city)
        if year_index is not None and city_index is not
            None: temperature = self.data[year_index]
            [city_index] if temperature is not None:
                print(f"Temperature for {city} in {year}:
{temperature}°C")
                return temperature
            else:
                print(f"No data available for {city} in {year}.")
                return None
        else:
            print("Error: Year or City not found in the storage system.")
            return None
    def rowMajorAccess(self):
```



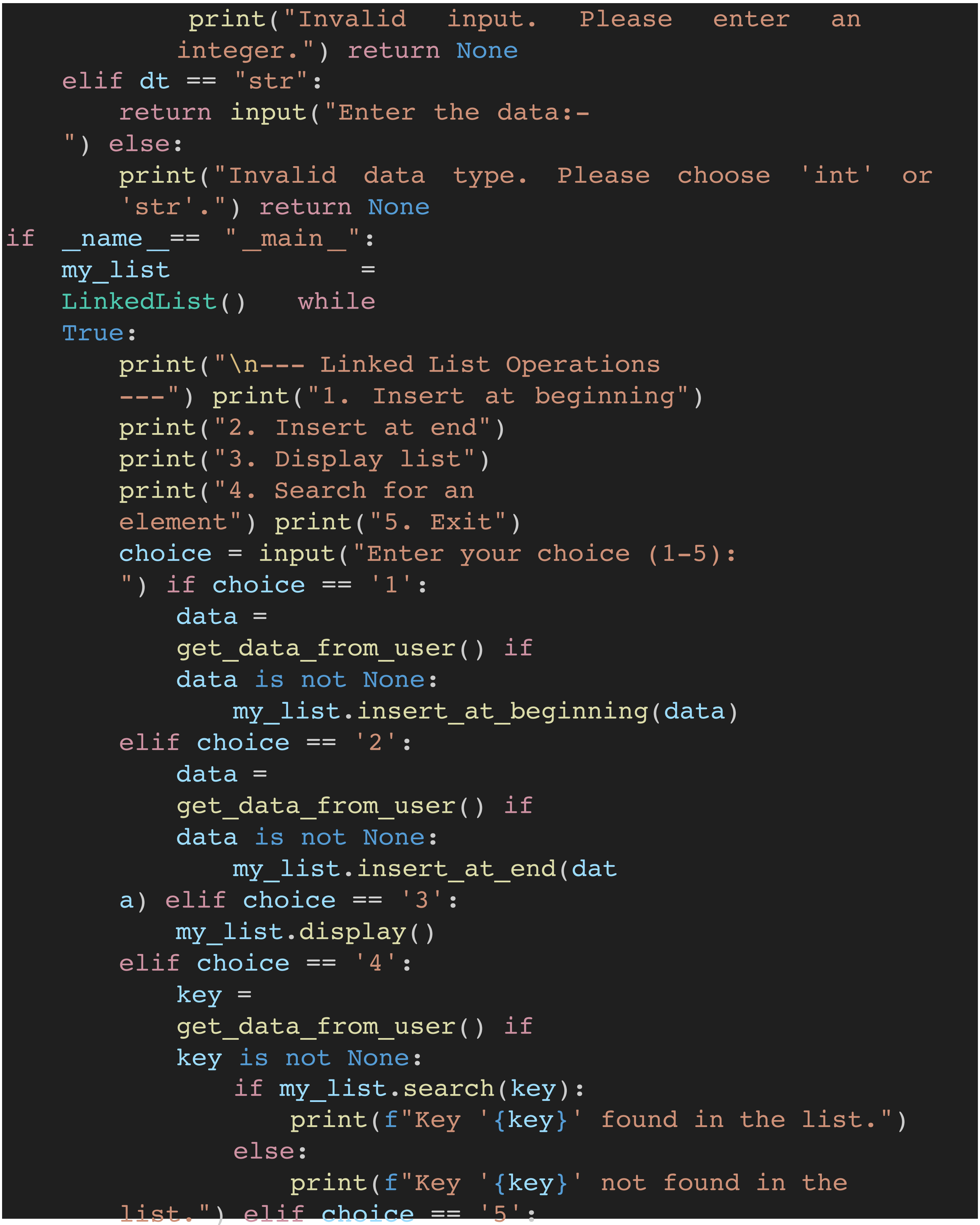
```
        print("\ndata in row-major
        order:") for row in self.data:
            print(row)
    def columnMajorAccess(self):
        print("\nAccessing data in column-major
        order:") num_rows = len(self.data)
        if num_rows > 0:
            num_cols =
            len(self.data[0]) for j in
            range(num_cols):
                column = [self.data[i][j] for i in
                range(num_rows)] print(column)
    def handleSparseData(self):
        print("\nSparse data is handled by using 'None'
as a sentinel value.")
    def analyzeComplexity(self):
        print("\n--- Complexity Analysis ---")
        print("Space Complexity: O(Y * C) where Y is the number
of years and C is the number of cities.")
        print("Time Complexity:")
        print("  - Insertion: O(1) on average for map lookups
and list assignment.")
        print("  - Retrieval: O(1) on average for map lookups
and list access.")
if __name__== "__main__":
    years_list = [2023, 2024,
    2025]
    cities_list = ["Delhi", "Kolkata", "Chennai"]
    weather_system = WeatherDataStorage(years_list,
    cities_list)
    weather_system.insert(WeatherRecord("14/09/2023",
    "Delhi",
25.5))
    weather_system.insert(WeatherRecord("15/09/2024",
"Kolkata", 28.0))
    weather_system.insert(WeatherRecord("17/09/2026", "Delhi",
19.5))
    weather_system.retrieve("Delhi", 2023)
    weather_system.retrieve("Kolkata", 2025)
    weather_system.retrieve("Chennai", 2024)
    weather_system.rowMajorAccess()
    weather_system.columnMajorAccess()
    weather_system.handleSparseData()
    weather_system.analyzeComplexity()
```

Q6. Node operations

Code:

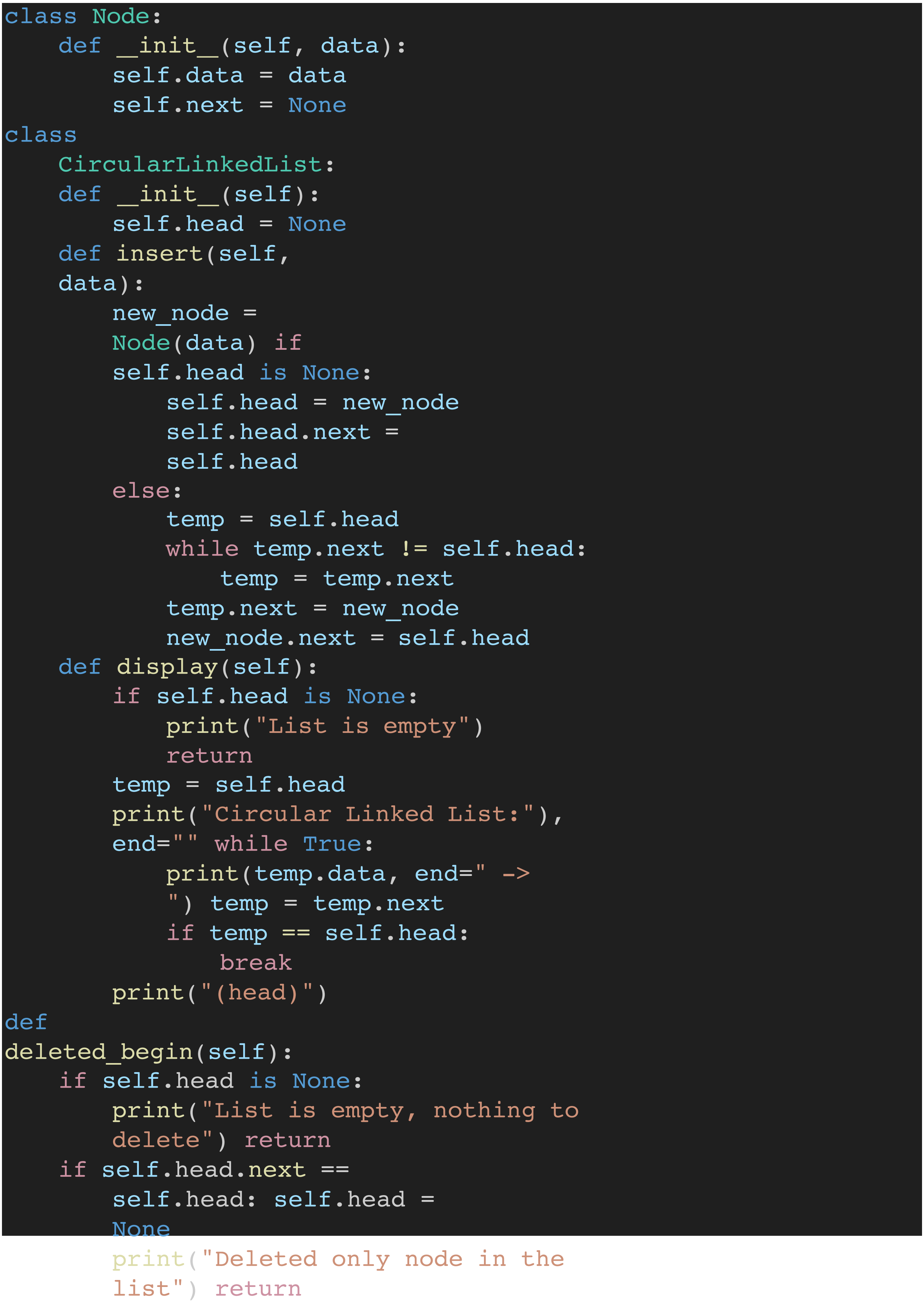


```
class Node:
    def __init__(self,data):
        self.data=data
        self.next=None
class LinkedList:
    def __init__(self):
        self.head = None
    def insert_at_beginning(self,
        data): new_node = Node(data)
        new_node.next = self.head
        self.head = new_node
        print(f"Inserted {data} at the
    beginning.") def insert_at_end(self, data):
        new_node =
        Node(data)
        new_node.next =
        None 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
        print(f"Inserted {data} at the
        end.")
    def display(self):
        temp = self.head
        while temp:
            print(temp.data, end=" ->
            ") temp = temp.next
        print("None")
    def search(self,
        key): temp =
        self.head while
        temp:
            if temp.data == key:
                return True
            temp = temp.next
        return False
def get_data_from_user():
    """Gets data from the user, handling different types."""
    dt = input("Enter data type of the data (int/str):-
    ").lower() if dt == "int":
        try:
            return int(input("Enter the data:-
        ")) except ValueError:
```



```
             print("Invalid   input.   Please   enter   an
            integer.") return None
    elif dt == "str":
        return input("Enter the data:-
    ") else:
        print("Invalid  data  type.  Please  choose  'int'  or
        'str'.") return None
if  _name_== "_main_":
    my_list               =
    LinkedList()   while
    True:
        print("\n--- Linked List Operations
        ---") print("1. Insert at beginning")
        print("2. Insert at end")
        print("3. Display list")
        print("4. Search for an
        element") print("5. Exit")
        choice = input("Enter your choice (1-5):
        ") if choice == '1':
            data =
            get_data_from_user() if
            data is not None:
                my_list.insert_at_beginning(data)
        elif choice == '2':
            data =
            get_data_from_user() if
            data is not None:
                my_list.insert_at_end(dat
        a) elif choice == '3':
            my_list.display()
        elif choice == '4':
            key =
            get_data_from_user() if
            key is not None:
                if my_list.search(key):
                    print(f"Key '{key}' found in the list.")
                else:
                    print(f"Key '{key}' not found in the
        list.") elif choice == '5':
            print("Exiting program.")
            break
        else:
            print("Invalid choice. Please enter a number between
            1
and 5.")
```

Q7 Insertion in Circular Linked List
Code:



```
class Node:
    def __init__(self, data):
        self.data = data
        self.next = None
class
    CircularLinkedList:
    def __init__(self):
        self.head = None
    def insert(self,
    data):
        new_node =
        Node(data) if
        self.head is None:
            self.head = new_node
            self.head.next =
            self.head
        else:
            temp = self.head
            while temp.next != self.head:
                temp = temp.next
            temp.next = new_node
            new_node.next = self.head
    def display(self):
        if self.head is None:
            print("List is empty")
            return
        temp = self.head
        print("Circular Linked List:"),
        end="" while True:
            print(temp.data, end=" ->
            ") temp = temp.next
            if temp == self.head:
                break
        print("(head)")
def
deleted_begin(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 only node in the
        list") return
```

```
last = self.head
while last.next != self.head:
    last = last.next
last.next = self.head.next
self.head = self.head.next
```

```
    print("Deleted node from the
beginning") def deleted_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 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("Deleted node from the
end") cll = CircularLinkedList()
cll.insert(10)
cll.insert(20)
cll.insert(30)
cll.insert(40)
print("initial
list:")
cll.display()
cll.deleted_begin()
print("after deleting from
beginning:") cll.display()
cll.deleted_end()
```

Q8 Binary Search

Code:

```
#include <iostream>
using namespace std;
int binarySearch(int array[], int x, int low, int
    high) { if (high<= low) {
        int mid = low + (high - low) /
        2; if (array[mid] == x)
            return mid;
       if (array[mid] > x)
            return binarySearch(array, x, low, mid -
        1); return binarySearch(array, x, mid + 1,
        high);
    }
```

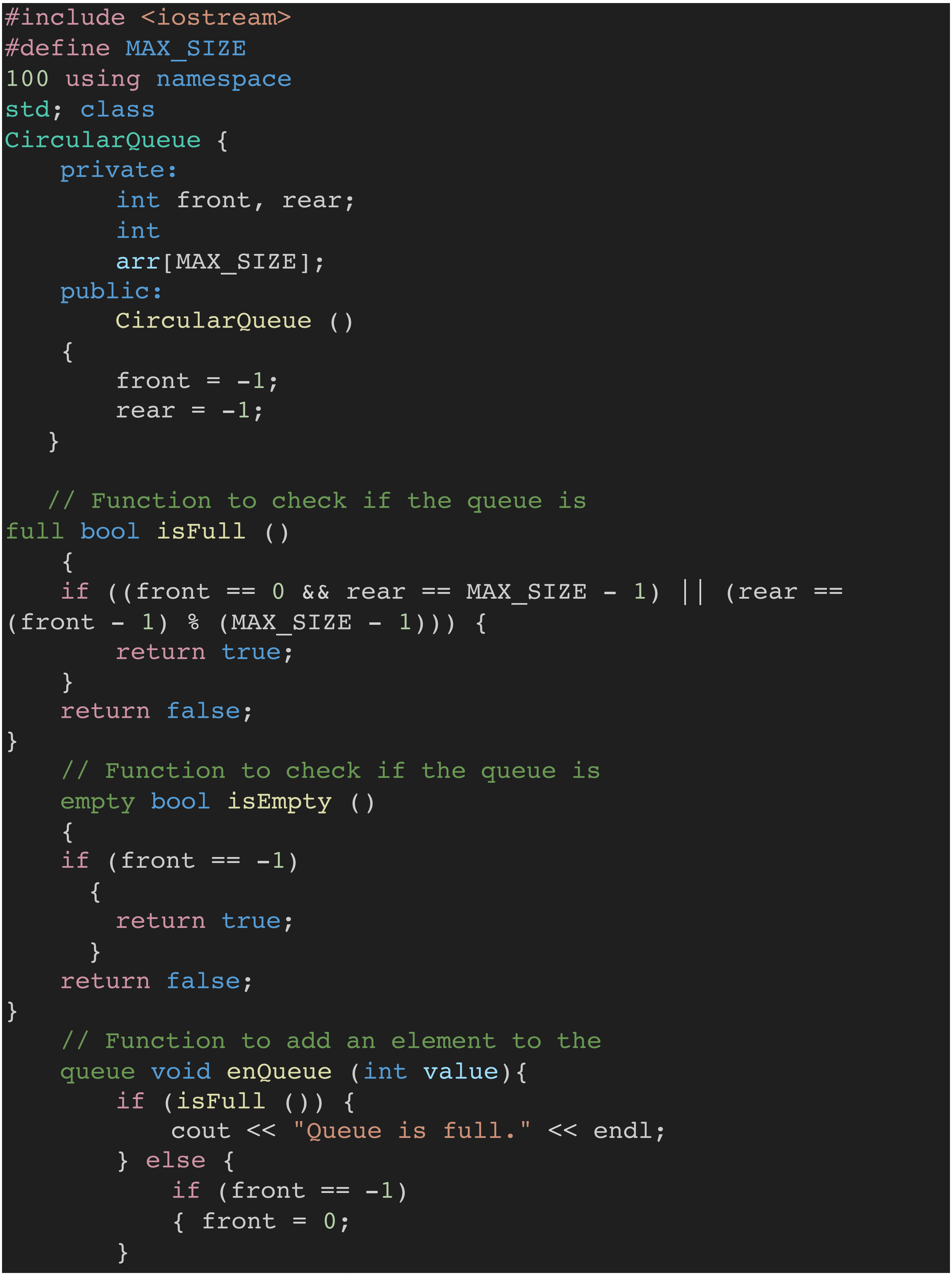
```
int main() {
    int array[] = {3,4,5,6,7,8,9};
    int n = sizeof(array) /
    sizeof(array[0]); int x = 4;
    int result = binarySearch(array, x, 0, n -
    1); if (result == -1)
        cout << "not
    found"; else
        cout << "Element is present at index " <<
    result; return 0;
```

Q9 Bubble Sort

Code:

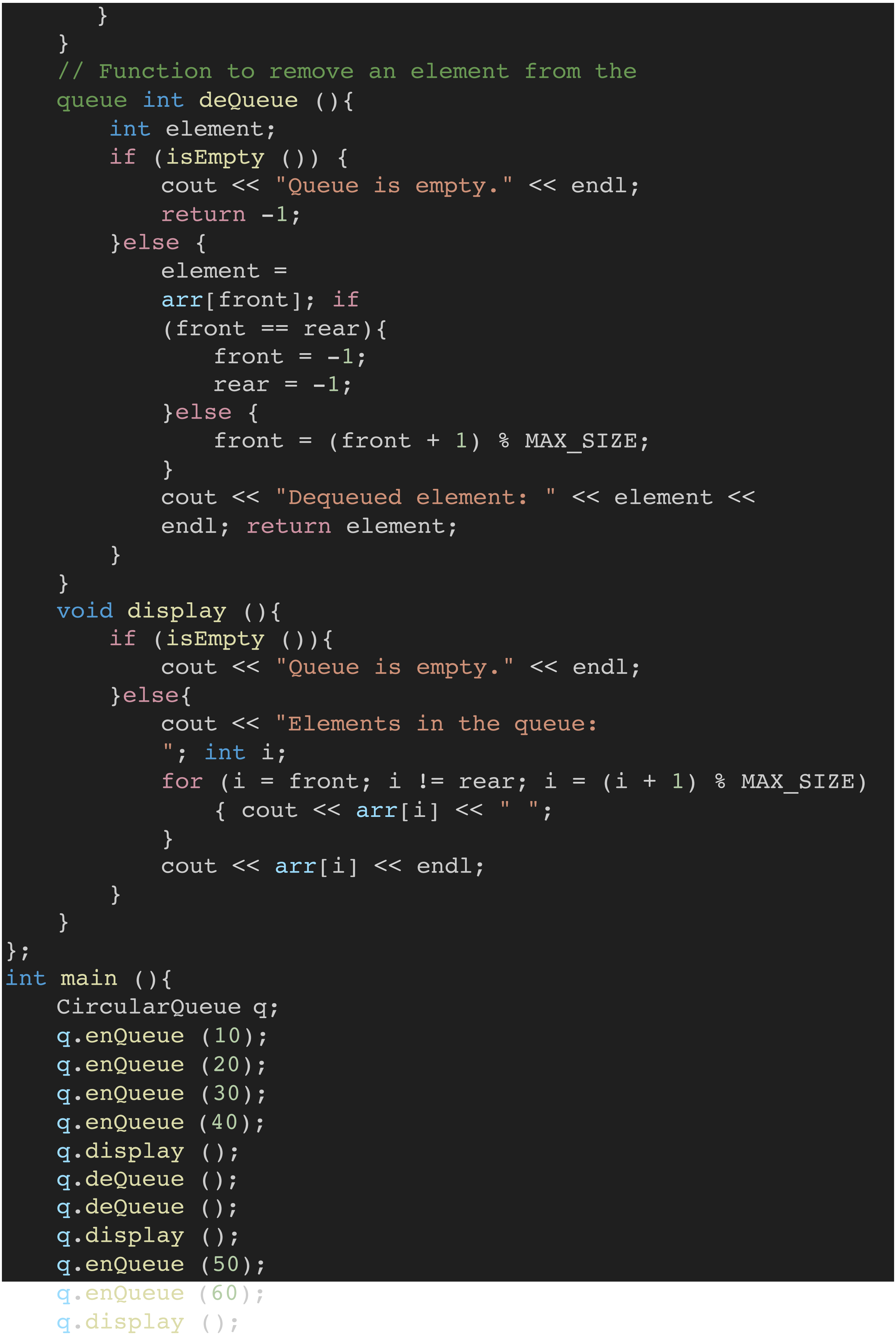
```
include <bits/stdc++.h>
using namespace std;
void bubbleSort(int arr[], int n)
    { for (int i = 0; i < n - 1; i+
    +) {
        for (int j = 0; j < n - i - 1; j++)
            { if (arr[j] > arr[j + 1]) {
                swap(arr[j], arr[j + 1]);
            }
        }
    }
}
void printArray(int arr[], int size)
    { for (int i = 0; i < size; i++)
        cout << arr[i] << " ";
    cout << endl;
}
int main() {
    int arr[] = {5,1,4,2,8};
    int n = sizeof(arr) /
    sizeof(arr[0]); bubbleSort(arr,
    n);
    cout << "Sorted array: \n";
```

Q10 Circular Queue : Insertion and Deletion of elements
Code:



```
#include <iostream>
#define MAX_SIZE
100 using namespace
std; class
CircularQueue {
    private:
        int front, rear;
        int
        arr[MAX_SIZE];
    public:
        CircularQueue ()
    {
        front = -1;
        rear = -1;
   }

   // Function to check if the queue is
full bool isFull ()
    {
    if ((front == 0 && rear == MAX_SIZE - 1) || (rear ==
(front - 1) % (MAX_SIZE - 1))) {
        return true;
    }
    return false;
}
    // Function to check if the queue is
    empty bool isEmpty ()
    {
    if (front == -1)
      {
        return true;
      }
    return false;
}
    // Function to add an element to the
    queue void enQueue (int value){
        if (isFull ()) {
            cout << "Queue is full." << endl;
        } else {
            if (front == -1)
            { front = 0;
        }
        rear = (rear + 1) % MAX_SIZE;
        arr[rear] = value;
```

```
cout << "Enqueued element: " << value << endl;
```



```
       }
    }
    // Function to remove an element from the
    queue int deQueue (){
        int element;
        if (isEmpty ()) {
            cout << "Queue is empty." << endl;
            return -1;
        }else {
            element =
            arr[front]; if
            (front == rear){
                front = -1;
                rear = -1;
            }else {
                front = (front + 1) % MAX_SIZE;
            }
            cout << "Dequeued element: " << element <<
            endl; return element;
        }
    }
    void display (){
        if (isEmpty ()){
            cout << "Queue is empty." << endl;
        }else{
            cout << "Elements in the queue:
            "; int i;
            for (i = front; i != rear; i = (i + 1) % MAX_SIZE)
                { cout << arr[i] << " ";
            }
            cout << arr[i] << endl;
        }
    }
};
int main (){
    CircularQueue q;
    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 ();
```

```
    return 0;
}
```

Q11 Linear Search

Code:

```
#include <iostream>
using namespace std;
int main() {
    int   arr[10],   i,   num,
    index;   cout<<"enter   10
    numbers:                 ";
    for(i=0;i<10;i++) {
        cin>>arr[i];
    }
    cout<<"enter number to be searched: ";
    cin>>num;
    for(i=0;i<10;i++)
        { if(arr[i]==num) {
            index=i
            ;
            break;
        }
    }
    if(i<10)
        cout<<"number found at index: "<<index;
```