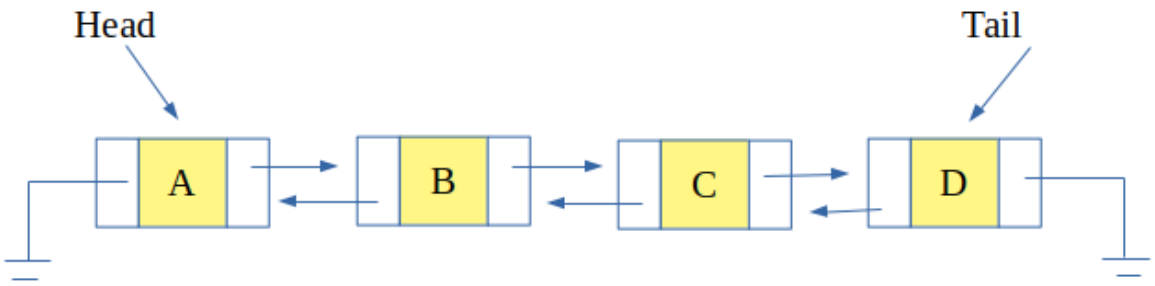
Implement Stack and Queue using Deque

Deque also known as **double ended queue**, as name suggests is a special kind of queue in which insertions and deletions can be done at the last as well as at the beginning.

A link-list representation of deque is such that each node points to the next node as well as the previous node. So that insertion and deletions take constant time at both the beginning and the last.



Now, deque can be used to implement a stack and queue. One simply needs to understand how deque can made to work as a stack or a queue.

The functions of deque to tweak them to work as stack and queue are list below.

DEQUE	STACK	QUEUE
size()	size()	size()
isEmpty()	isEmpty()	isEmpty()
Insert_First()	-	-
Insert_Last()	Push()	Enqueue()
Remove_First()	-	Dequeue()
Remove_Last()	Pop()	-

Examples: Stack

Input : Stack : 1 2 3
Push(4)
Output : Stack : 1 2 3 4

Input : Stack : 1 2 3
Pop()
Output : Stack : 1 2

Examples: Queue

Input: Queue : 1 2 3
Enqueue(4)
Output: Queue : 1 2 3 4

Input: Queue : 1 2 3
Dequeue()
Output: Queue : 2 3

```
#include <bits/stdc++.h>
using namespace std;

// structure for a node of deque
struct DQueNode {
    int value;
    DQueNode* next;
    DQueNode* prev;
};

// Implementation of deque class
class Deque {
private:

    // pointers to head and tail of deque
    DQueNode* head;
    DQueNode* tail;

public:
    // constructor
    Deque()
    {
        head = tail = NULL;
    }

    // if list is empty
    bool isEmpty()
```

```
    {
        if (head == NULL)
            return true;
        return false;
    }

    // count the number of nodes in list
    int size()
    {
        // if list is not empty
        if (!isEmpty()) {
            DQueNode* temp = head;
            int len = 0;
            while (temp != NULL) {
                len++;
                temp = temp->next;
            }
            return len;
        }
        return 0;
    }

    // insert at the first position
    void insert_first(int element)
    {
        // allocating node of DQueNode type
        DQueNode* temp = new DQueNode[sizeof(DQueNode)];
        temp->value = element;

        // if the element is first element
        if (head == NULL) {
            head = tail = temp;
            temp->next = temp->prev = NULL;
        }
        else {
            head->prev = temp;
            temp->next = head;
            temp->prev = NULL;
            head = temp;
        }
    }

    // insert at last position of deque
    void insert_last(int element)
    {
        // allocating node of DQueNode type
        DQueNode* temp = new DQueNode[sizeof(DQueNode)];
        temp->value = element;
```

```
        // if element is the first element
        if (head == NULL) {
            head = tail = temp;
            temp->next = temp->prev = NULL;
        }
        else {
            tail->next = temp;
            temp->next = NULL;
            temp->prev = tail;
            tail = temp;
        }
    }

    // remove element at the first position
    void remove_first()
    {
        // if list is not empty
        if (!isEmpty()) {
            DQueNode* temp = head;
            head = head->next;
            if(head) head->prev = NULL;
            delete temp;
            if(head == NULL) tail = NULL;
            return;
        }
        cout << "List is Empty" << endl;
    }

    // remove element at the last position
    void remove_last()
    {
        // if list is not empty
        if (!isEmpty()) {
            DQueNode* temp = tail;
            tail = tail->prev;
            if(tail) tail->next = NULL;
            delete temp;
            if(tail == NULL) head = NULL;
            return;
        }
        cout << "List is Empty" << endl;
    }

    // displays the elements in deque
    void display()
    {
        // if list is not empty
        if (!isEmpty()) {
            DQueNode* temp = head;
```

```
            while (temp != NULL) {
                cout << temp->value << " ";
                temp = temp->next;
            }
            cout << endl;
            return;
        }
        cout << "List is Empty" << endl;
    }
};

// Class to implement stack using Deque
class Stack : public Deque {
public:
    // push to push element at top of stack
    // using insert at last function of deque
    void push(int element)
    {
        insert_last(element);
    }

    // pop to remove element at top of stack
    // using remove at last function of deque
    void pop()
    {
        remove_last();
    }
};

// class to implement queue using deque
class Queue : public Deque {
public:
    // enqueue to insert element at last
    // using insert at last function of deque
    void enqueue(int element)
    {
        insert_last(element);
    }

    // dequeue to remove element from first
    // using remove at first function of deque
    void dequeue()
    {
        remove_first();
    }
};

// Driver Code
int main()
```

```
{
    // object of Stack
    Stack stk;

    // push 7 and 8 at top of stack
    stk.push(7);
    stk.push(8);
    cout << "Stack: ";
    stk.display();

    // pop an element
    stk.pop();
    cout << "Stack: ";
    stk.display();

    // object of Queue
    Queue que;

    // insert 12 and 13 in queue
    que.enqueue(12);
    que.enqueue(13);
    cout << "Queue: ";
    que.display();

    // delete an element from queue
    que.dequeue();
    cout << "Queue: ";
    que.display();

    cout << "Size of Stack is " << stk.size() << endl;
    cout << "Size of Queue is " << que.size() << endl;
    return 0;
}
```