Warmup

Q.) You will be given a number x and you have to compute the value of f(x)

F[0]=1,F[1]=1

F(x)=F(x-1)+F(x-2) x>=2

Fibonacci Series-> 1 1 2 3 5 8 13 21….

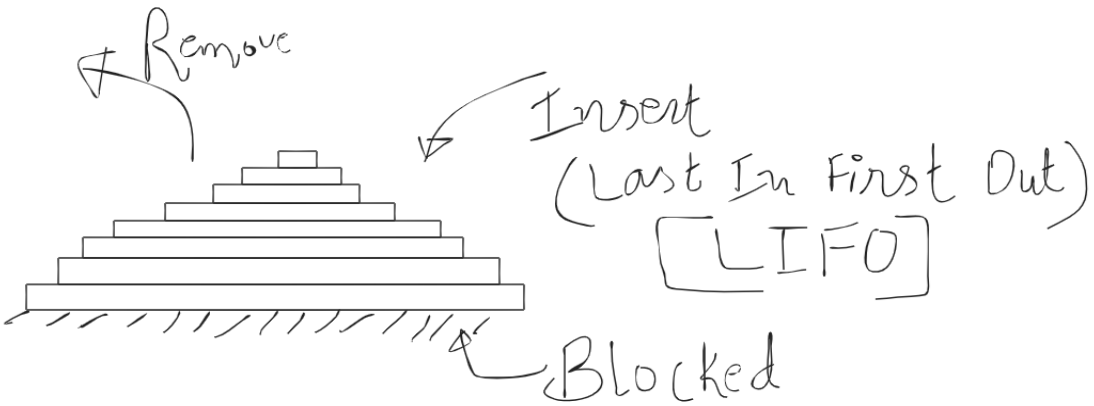
Recursive Solution->

```
int f(int x){
    if(x==0 || x==1) return 1;
    return f(x-1)+f(x-2);
}
```

//f(5)-> f(4),f(3)-> f(3), f(2);

Stack

Stack is a linear data structure. The insertion and deletion happens only at one end. It follows the property of **“Last In First Out”(LIFO)**



Syntax for creating a stack

```
stack<data_type> stack_Name;
```

Example:

```
stack<char> st;
stack<double> st;
```

Functions related to stack: Time Complexity=O(1)

1. push()-> Insert the last element at the back of your stack.

```
st.push(4);
```

2. pop() -> Remove the last element from the back.

```
st.pop();
```

3. empty()-> return true is the stack is empty()

```
st.empty(); //True/False
```

4. size() -> return the number of elements presents in the stack.
5. top() -> show the top element

```
cout<<st.top();
```

Queue

Queue is also a linear data structure in which insertion happens from one end and deletion happens from another end.
It follows the property of **“First In First Out”(FIFO)**

Syntax for creating a queue

```
    queue<data_type> queue_Name;
```

Example:

```
queue<char> q;
queue<double> q;
```

Functions related to queue: Time Complexity=O(1)

1. push() -> insert the element at the back.

```
    q.push(4);
```

2. pop() -> remove the element at the front.

```
    q.pop();
```

3. front() -> show the element present at the front

```
    cout<<q.front();
```

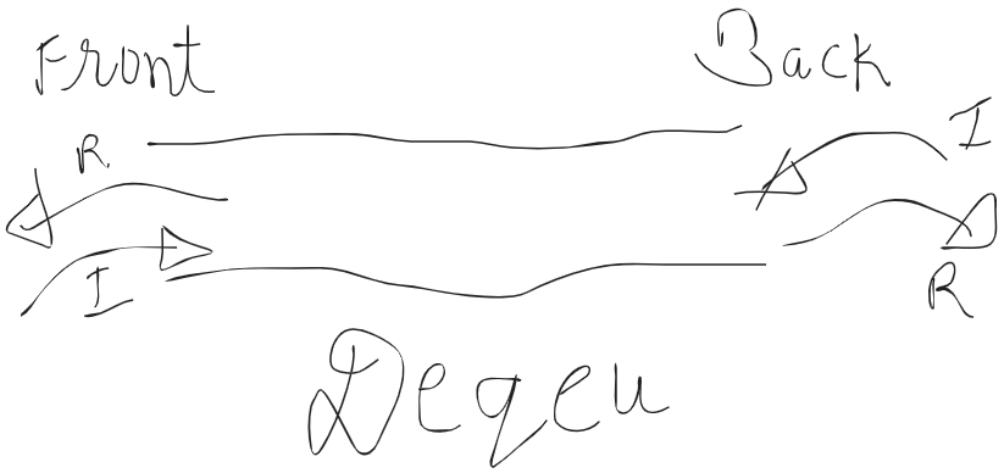
4. empty() -> return true is the queue is empty()

```
    q.empty(); // returns  True or False
```

5. size()->return the number of elements presents in the queue.

Deque (Double ended queue)

It is also a linear data structure but the main difference with queue is that insertion and deletion happens from both ends.



I-> Insertion
R-> Removal

Syntax of creating a deque

```
    deque<data_type> deque_Name;
```

Example

```
deque<char> dq;
deque<double> dq;
```

Functions related to deque: Time Complexity=O(1)

1. push_back() -> Insert an element at the back
2. pop_back() -> Remove the last element present at the back
3. push_front() -> Insert an element at the front
4. pop_front() -> Remove the first element present at the front
5. empty() -> return true is the deque is empty()

```
    dq.empty(); // returns True or False
```

6. size()->return the number of elements presents in the deque.

Note: All these functions for stack, queue and deque have O(1) constant time complexity

Some Problems

Q.) Balanced Parentheses.

A bracket is considered to be any one of the following characters: (,), {, }, [, or].

Two brackets are considered to be a matched pair if the opening bracket (i.e., (, [, or {) occurs to the left of a closing bracket (i.e.,),], or }) of the exact same type. There are three types of matched pairs of brackets: [], {}, and ()

Return whether the given string is a balanced parentheses or not.

Link of the problem:
https://www.hackerrank.com/challenges/balanced-brackets/problem

Examples:
()-> Balanced

[()]-> Balanced
[((]-> not balanced
[(])-> not balanced
{(})-> not balanced

Definition of Balanced Parentheses

Empty string is a balanced parentheses.
{},[],() -> balanced parentheses
Lets say a string s -> s is balanced.
{s},(s),[s] -> balanced parentheses.
S and t -> s and t are balanced.
Then s+t -> balanced.
([)]

Solution Approach:
i^{th} element -> if it is (,[,{ -> push in the stack
-> if it is closing bracket] -> [,)->(, }-> {
(it should match with the top element in stack)
[()[]]
i=0 -> s[i]= [-> push in stack

Sol:

```
    string s; // [[
    cin>>s;
    stack<char> st;
    bool balanced=true;
    for(int i=0;i<s.length();i++){
        if(s[i]=='('||s[i]=='{'||s[i]=='['){
            st.push(s[i]);
            continue;
        }
        // a closing bracket encountered....pop one element
from the stack
        if(!st.empty()){
            char c = st.top();
            st.pop();

if((s[i]==')'&&c=='('||(s[i]=='}'&&c=='{')||(s[i]==']'&&c==
'[')){
                // match of s[i] is found
            }else{
                // c and s[i] are not matching
                balanced=false;
                break;
            }
        }else{
            balanced=false;
            break;
```

```
        }
    }
    if(!st.empty()){
        balanced=false;
    }
    if(balanced){
        cout<<"Balanced";
    }else{
        cout<<"Not balanced";
    }
```

Q: Next Greater Element

https://www.codechef.com/problems/DC206

4,6,5
4,5,6

4,5,7,6

Maintain stack of possible answers

```
int a[n];
stack<int> s;
```

```
for(int i=n-1;i>=0;i--){
    while(!s.empty()&&a[i]>=s.top()){
        s.pop();
    }
    if(!s.empty()){
        ans[i]=s.top();
    else
        ans[i]=-1;
    s.push(a[i]);
}
```

HW:
Try to write code for finding "previous smaller element" for each element.

Practice Problems on Stack, Queue, Deque

1. https://www.hackerrank.com/challenges/deque-stl/problem
2. https://www.spoj.com/problems/STPAR/
3. https://www.hackerrank.com/challenges/largest-rectangle/problem
4. https://www.hackerrank.com/challenges/queries-with-fixed-length/problem
5. https://codeforces.com/contest/1373/problem/B
6. https://www.spoj.com/problems/JNEXT/
7. https://codeforces.com/contest/1374/problem/C

8. https://codeforces.com/contest/1313/problem/C2