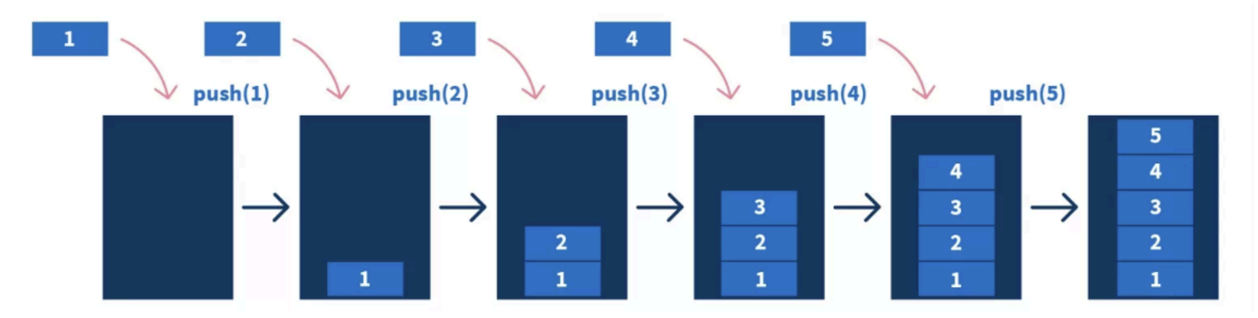
Stacks

A stack is a linear data structure that follows the Last-In-First-Out (LIFO) principle. In simpler terms, the last element that was added to the stack will be the first one to be removed. A stack has two main operations, namely push and pop. Push is used to add an element to the top of the stack, while pop is used to remove the topmost element.

Basic functions of Stack

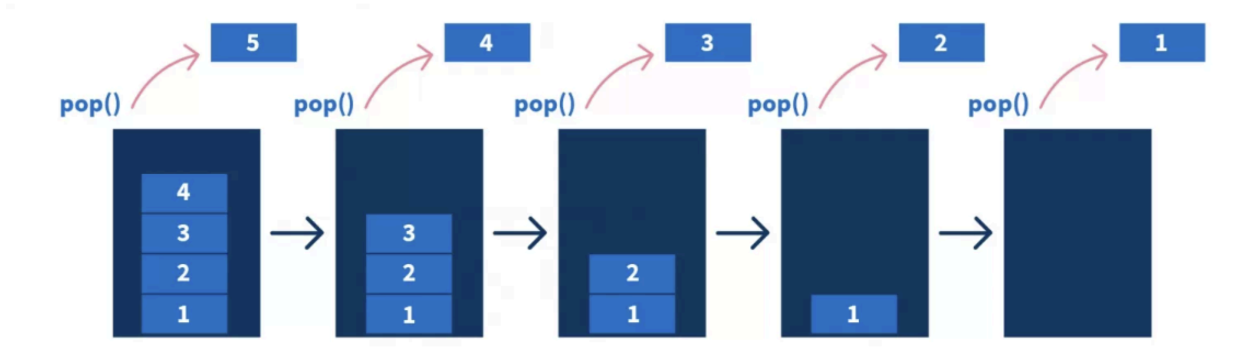
Push

This function is used to add an element to the top of the stack. It takes one argument, which is the element to be added. The time complexity of push operation is O(1).



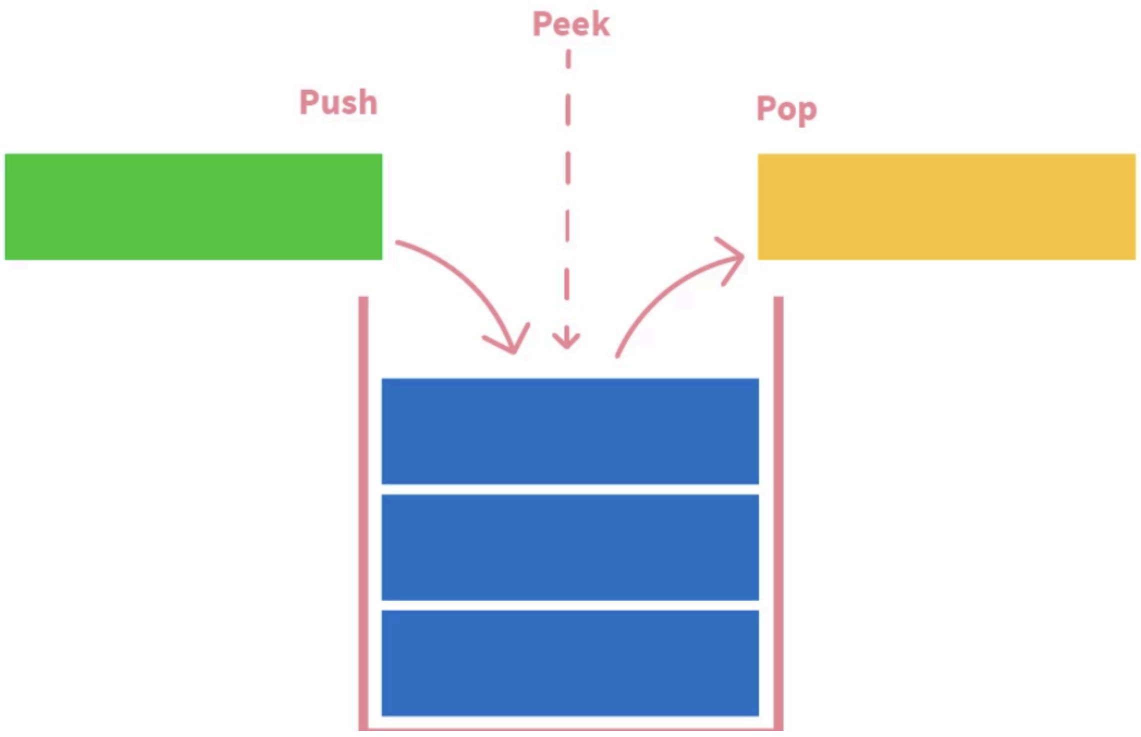
Pop

This function is used to remove the topmost element from the stack. It does not take any argument. The time complexity of pop operation is also O(1).



Peek

This function is used to get the value of the topmost element without removing it from the stack. It does not take any argument. The time complexity of peek operation is O(1).



Implementation

```
int stack[MAX_SIZE];
int top;

void push(int element) {
    if (top < MAX_SIZE - 1) {
        top++;
        stack[top] = element;
    } else {
        cout << "Stack Overflow" << endl;
    }
}
```

```
int pop() {
    if (top >= 0) {
        int element = stack[top];
        top--;
        return element;
    } else {
        cout << "Stack Underflow" << endl;
    }
}

bool isEmpty() {
    return top < 0;
}

int peek() {
    if (!isEmpty()) {
        return stack[top];
    } else {
        cout << "Stack is empty" << endl;
    }
}
```

Applications of Stack

1. **In code editors** – Stacks are used in various code editors like VS Code, Atom, etc. to match the opening and closing tags in the languages like HTML, XML, etc.
2. **In matching bracket pairs** – This is one of the most famous applications of stacks. Stacks help us in identifying if the bracket pairs in a sentence or string are complete or missing.
3. **In browsers** – You are reading this article in your web browser, what will happen if you press the back button present at the left-hand corner of your screen? It would take you back to your last visited website or link. It is done using stacks. Every time you visit a new link, it is stored in the stack. And, every time you press the back button, the current link is popped out from the stack, and the previous link is made available.

Famous Questions on Stack-

Parentheses Check

Check if the given string of parentheses is balanced or not. A string of parentheses is considered balanced if every opening parenthesis has a corresponding closing parenthesis and they appear in the correct order. For example, “((()))” and “()()()” are balanced strings of parentheses, while “(()” and “)(” are not.

Solution :-

- Create an empty stack.
- Traverse the string of parentheses from left to right.
- If the current character is an opening parenthesis, push it to the stack.
- If the current character is a closing parenthesis, pop the topmost element from the stack and check if it is the corresponding opening parenthesis. If not, the string of parentheses is not balanced.
- If the stack is empty at the end of the traversal, the string of parentheses is balanced.

Code:-
```
is_balanced(string):
    stack = empty stack
    for each character c in string:
        if c is an opening parenthesis:
            push(stack, c)
        else if c is a closing parenthesis:
              if stack is empty or peek(stack) is not the corresponding opening
parenthesis for c:
                  return false
              else:
                  pop(stack)
   return true if stack is empty else false
```

Nearest Smaller element on Left

Find the nearest smaller element on the left of each element in a given array. For example, consider the array [3, 1, 4, 2, 5, 1, 3]. The nearest smaller element on the left of the first element (3) is none, the nearest smaller element on the left of the second element (1) is none, the nearest smaller element on the left of the third element (4) is 1, and so on.

Code :-

```
nearest_smaller_element_on_left(array):
   stack = empty stack
   result = empty array
    for each element e in array:
       while stack is not empty and peek(stack) >= e:
            pop(stack)
       if stack is empty:
            result.append(None)
       else:
            result.append(peek(stack))
       push(stack, e)
  return result
```

Revision Video -

https://drive.google.com/file/d/1DEujBlO2QPMEMKGvgldNHrnB0997n_1s/view?usp=share_link