ADVANCED DATA STRUCTURES AND ALGORITHMS

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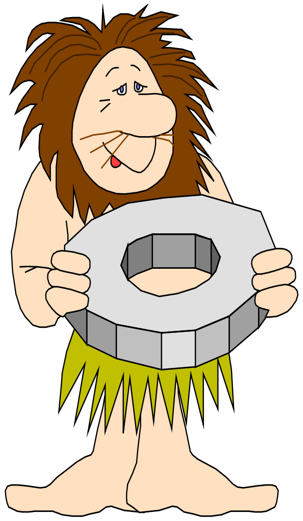
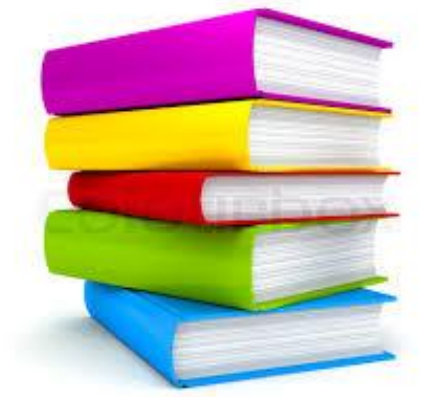
What this Lecture is about:

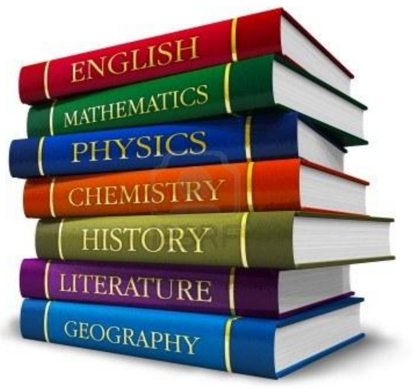
- Stack Structure
- Stack Definition
- Primary operations
- Stack Declaration
- push Algorithm
- pop Algorithm
- Implementation



Stack Structure

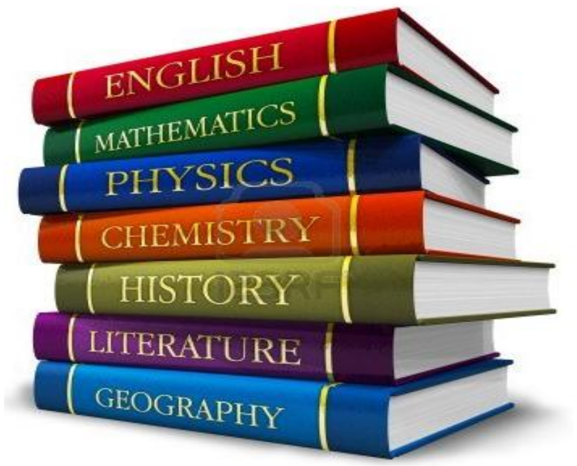
A *stack* is a collection that implements the last-in-first-out (**LIFO**) protocol. This means that the only accessible object in the collection is the last one that was inserted. A stack of books is a good analogy: You can't take a book from the stack without first removing the books that are stacked on top of it.





Stack Definition

A Data structure in which elements are added and removed from one end; “Last in, First out” LIFO Structure.



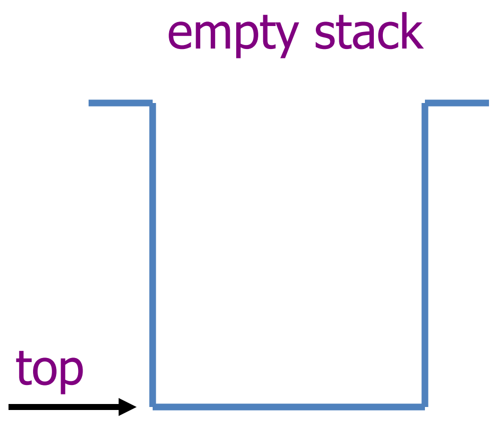
Stack Operations

The fundamental operations of a stack are:

1. **Create** : Create an empty stack.
2. **Push** : Add an element onto the top of the stack.
3. **Pop** : Remove the current element on the top of the stack.
4. **Retrieve or peak** : which reads data without removing it, on the top of the stack .

Primary operations

- Push
  - Add an element to the top of the stack
- Pop
  - Remove the element at the top of the stack



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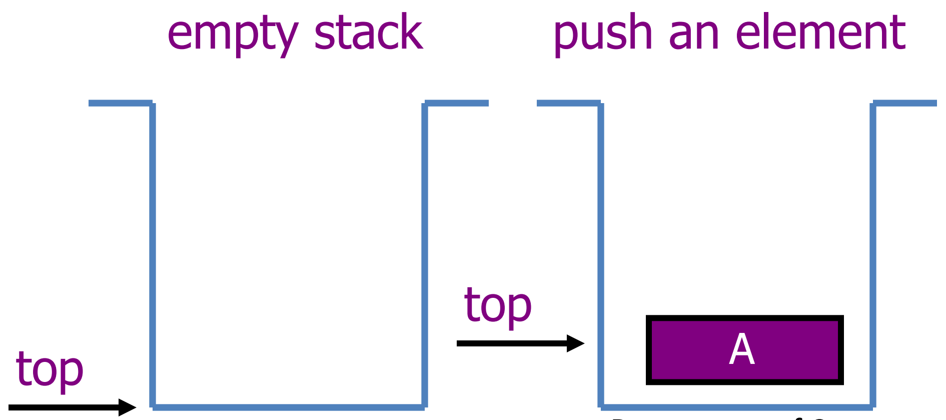

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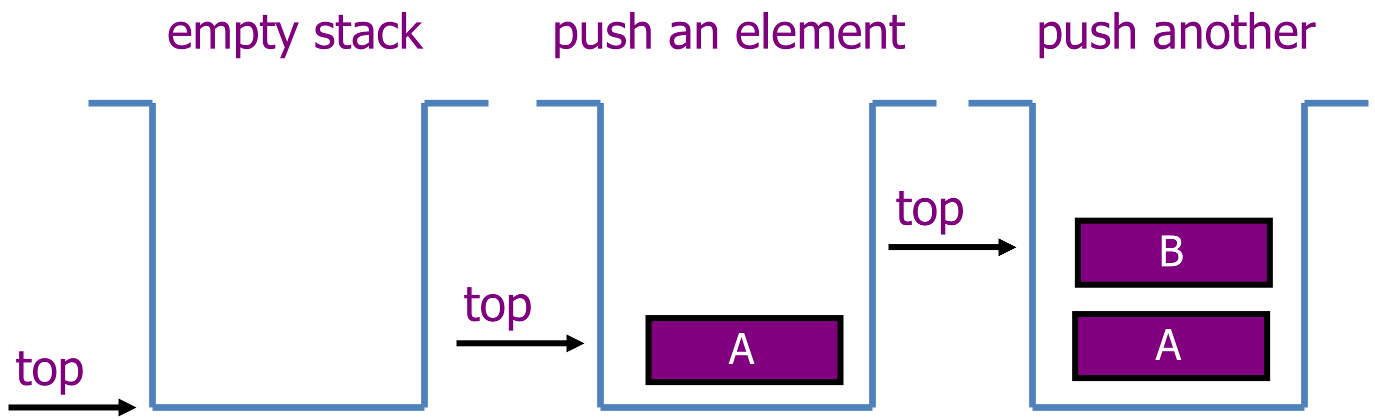

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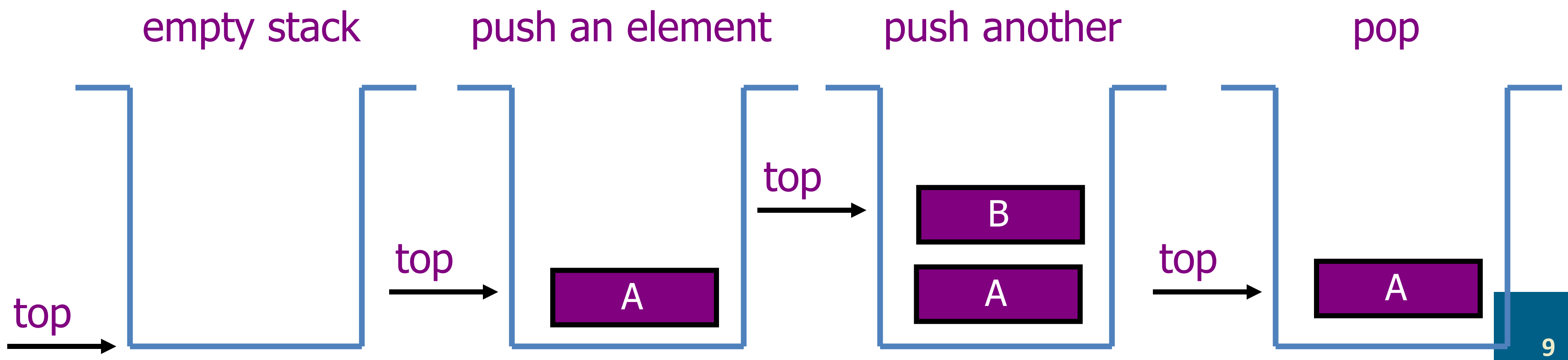
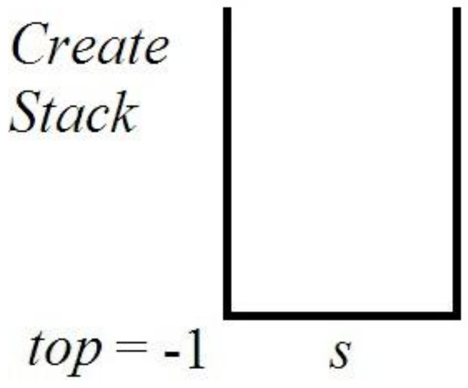
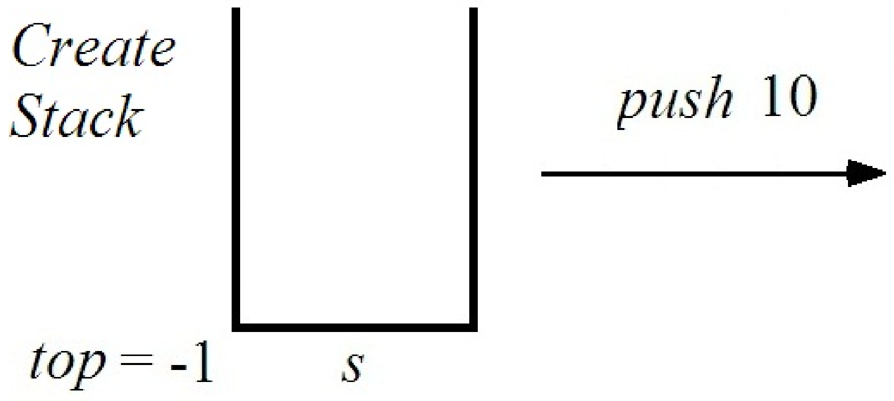


Stack Operations



Stack Operations



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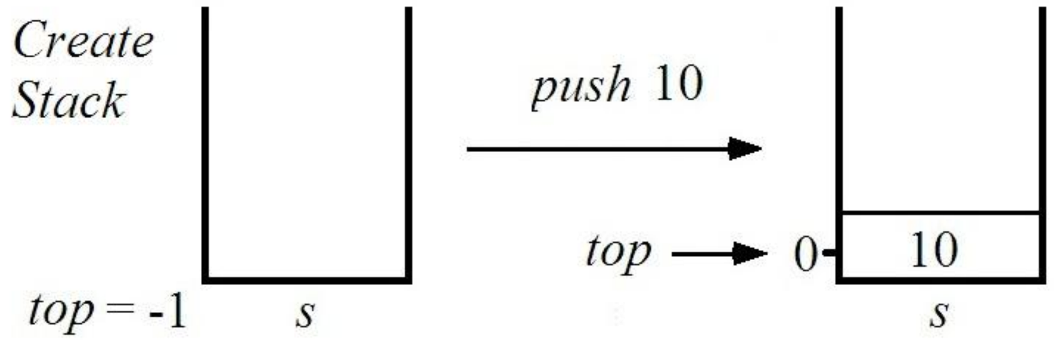

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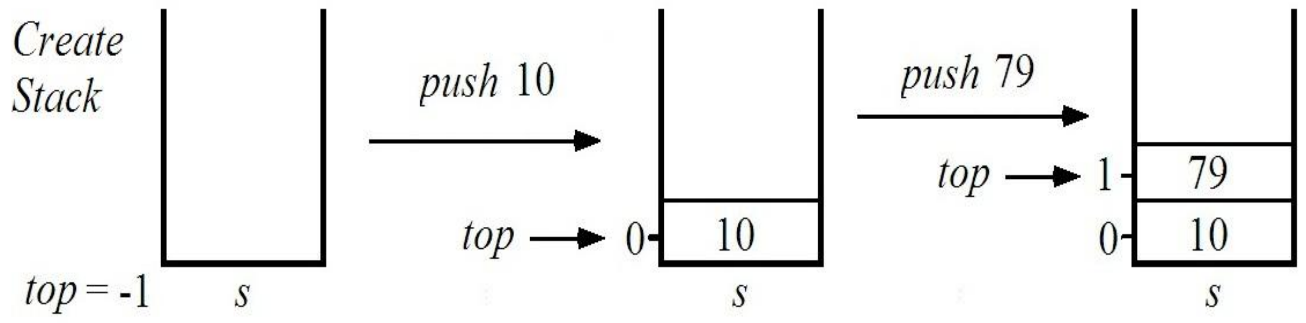

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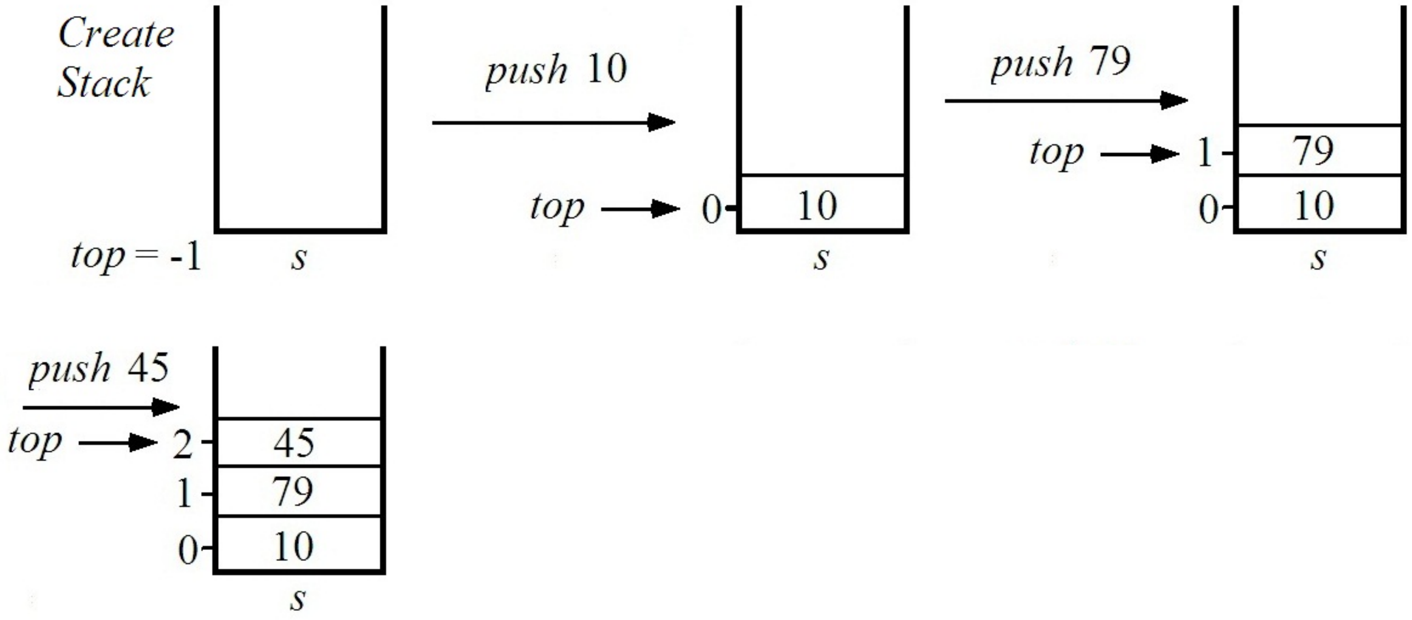

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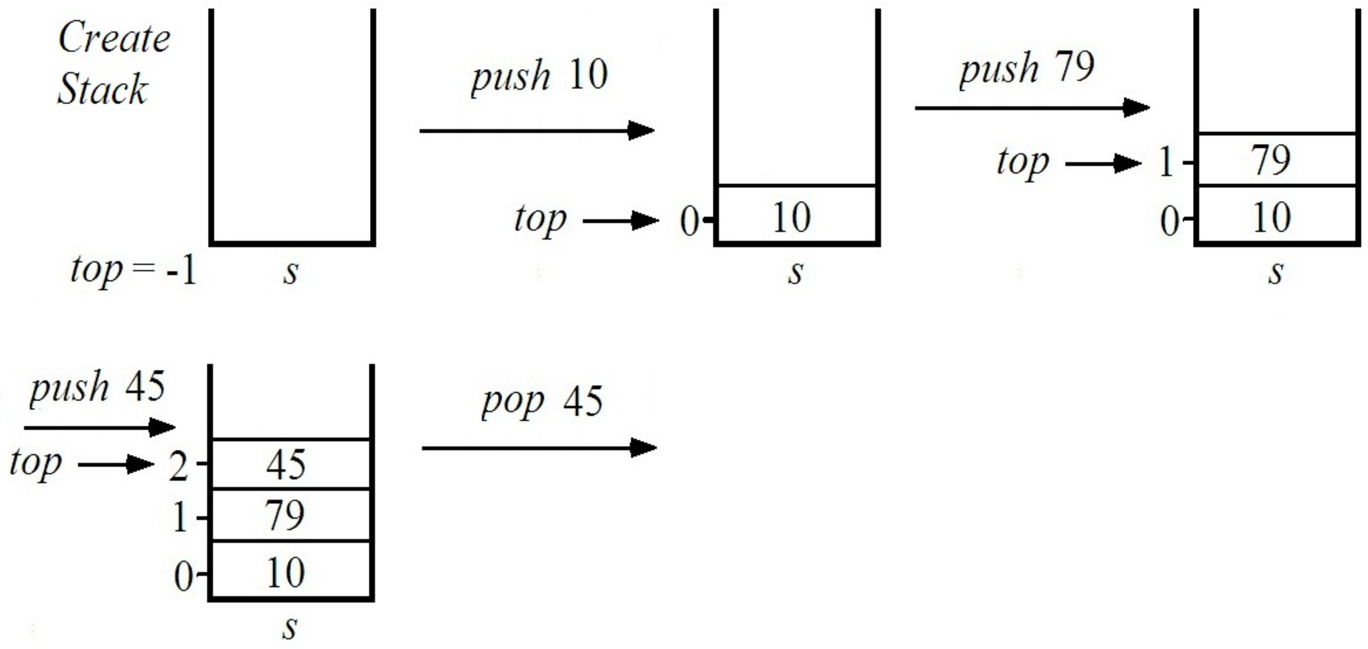

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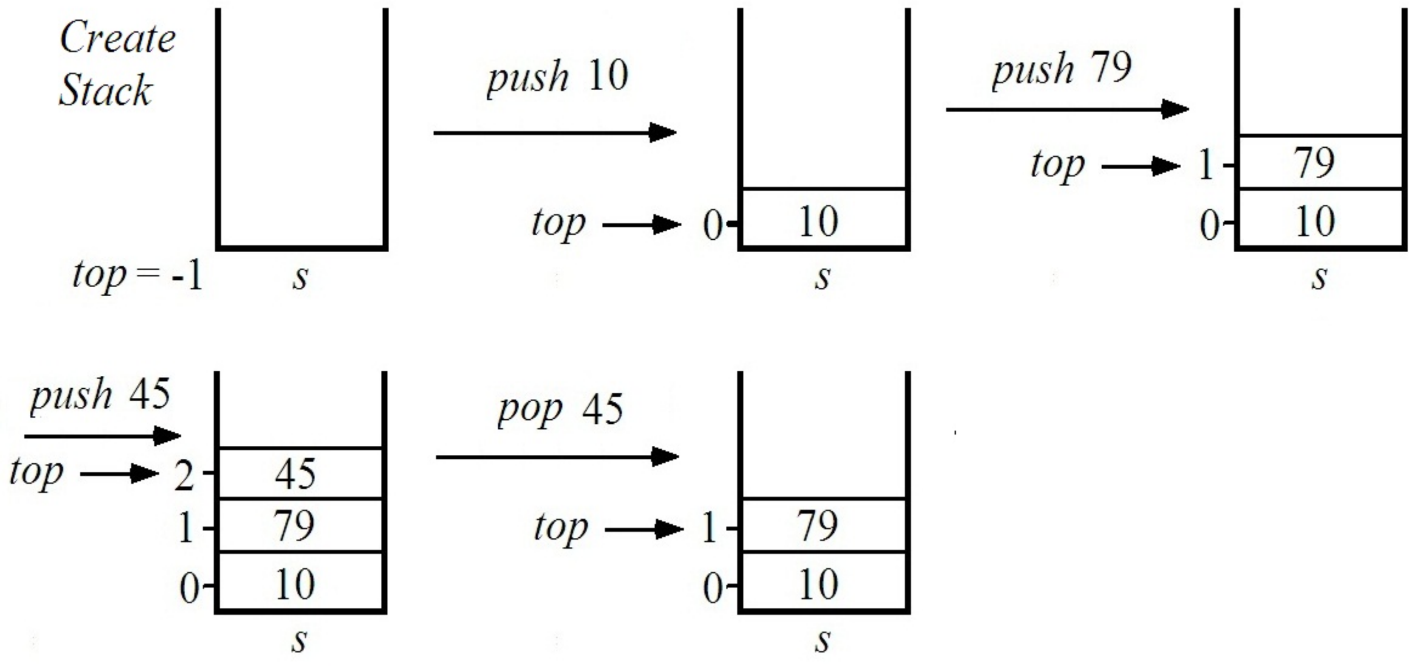
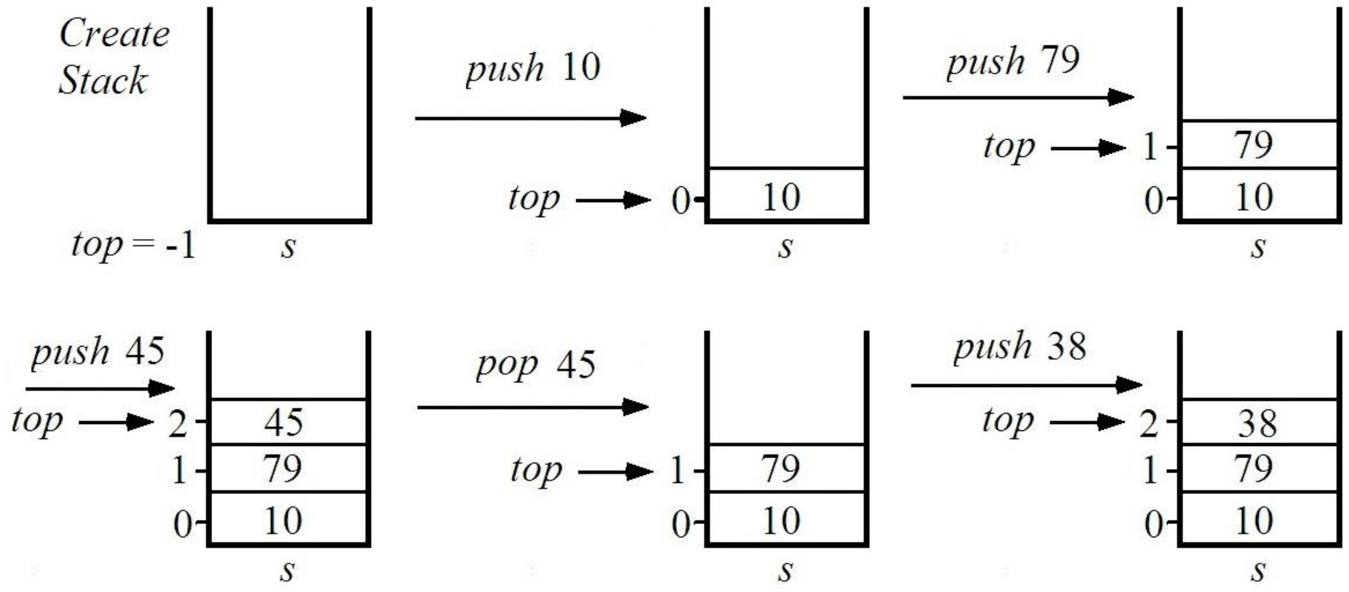
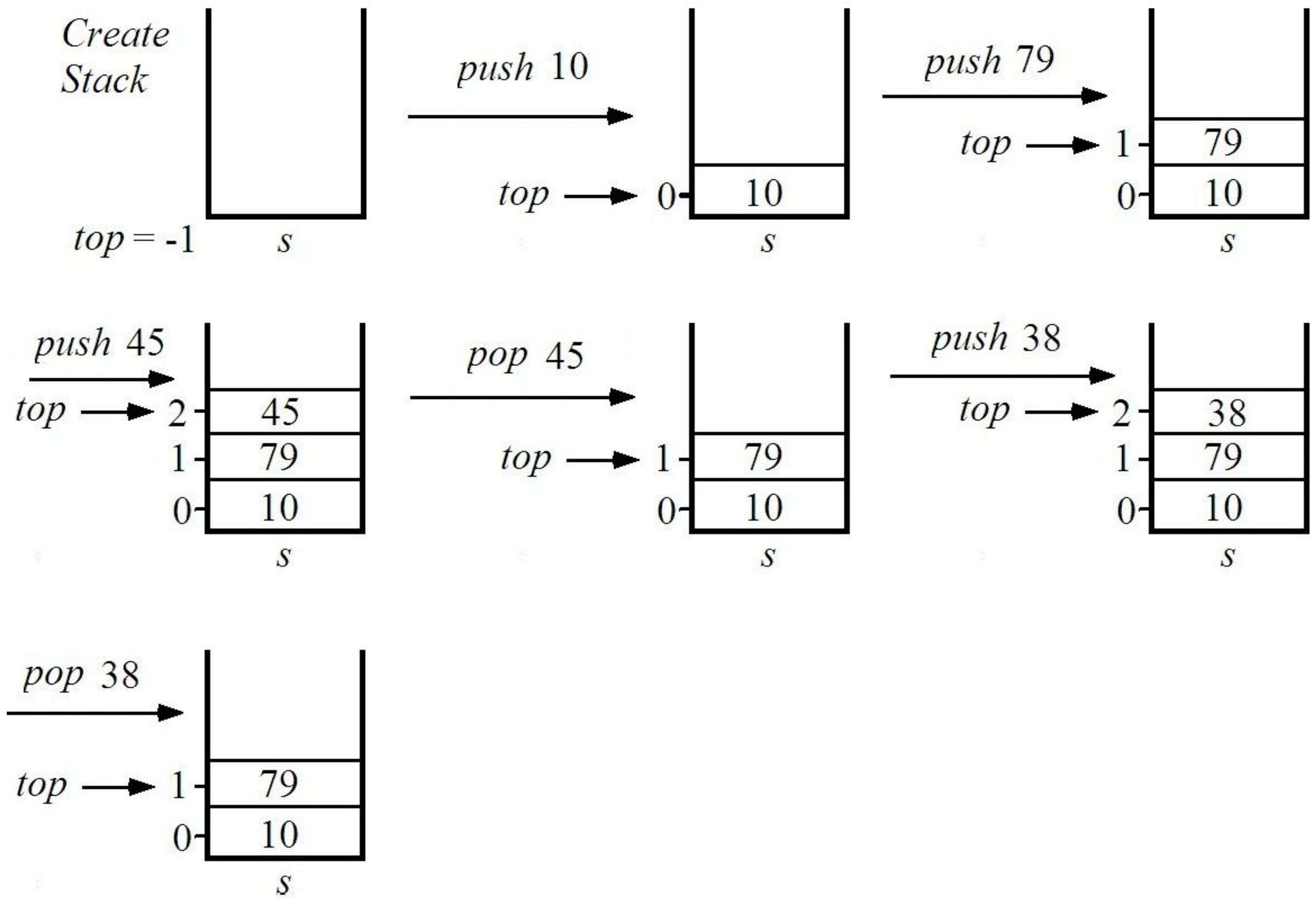


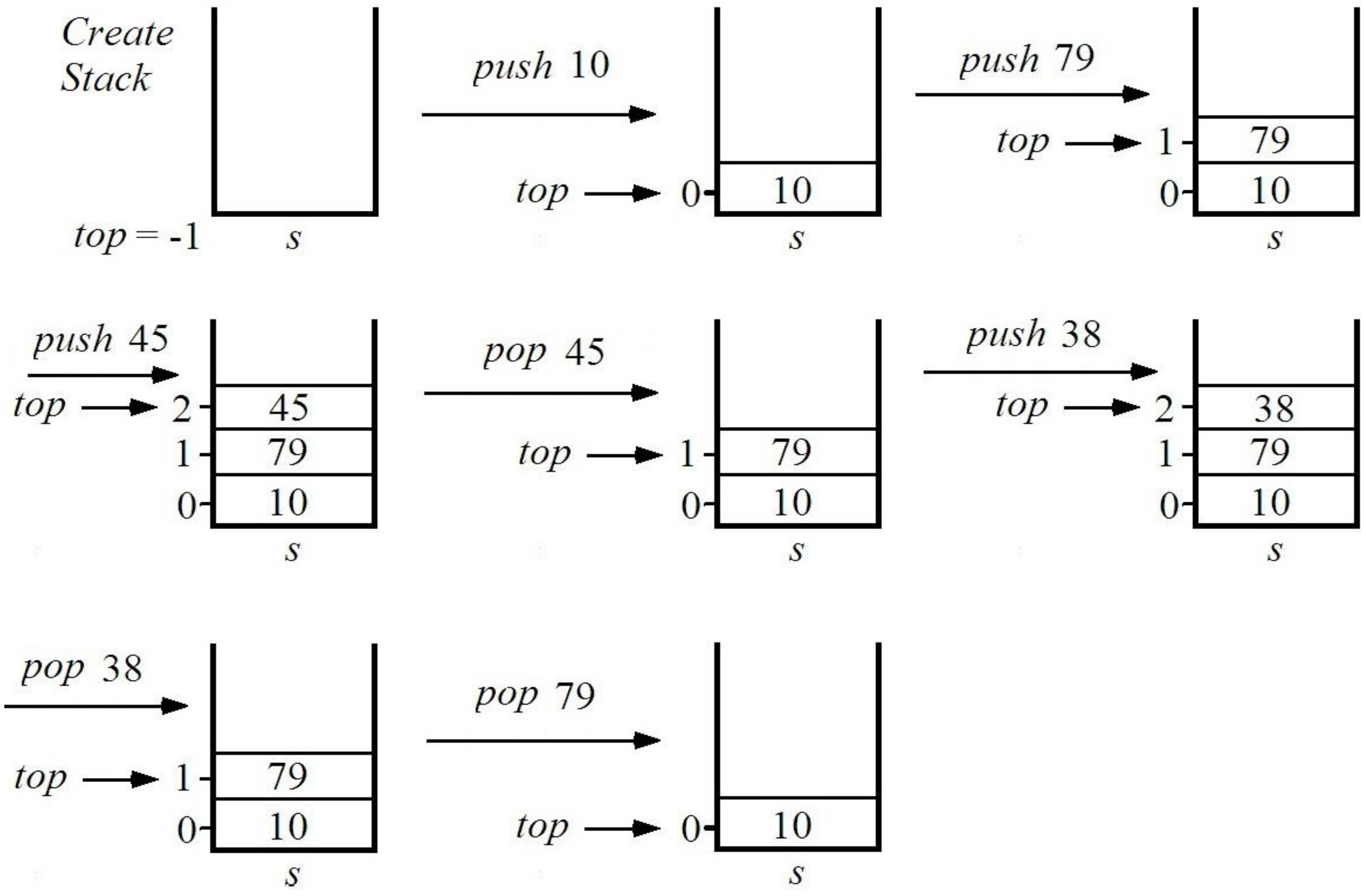
Stack Operations



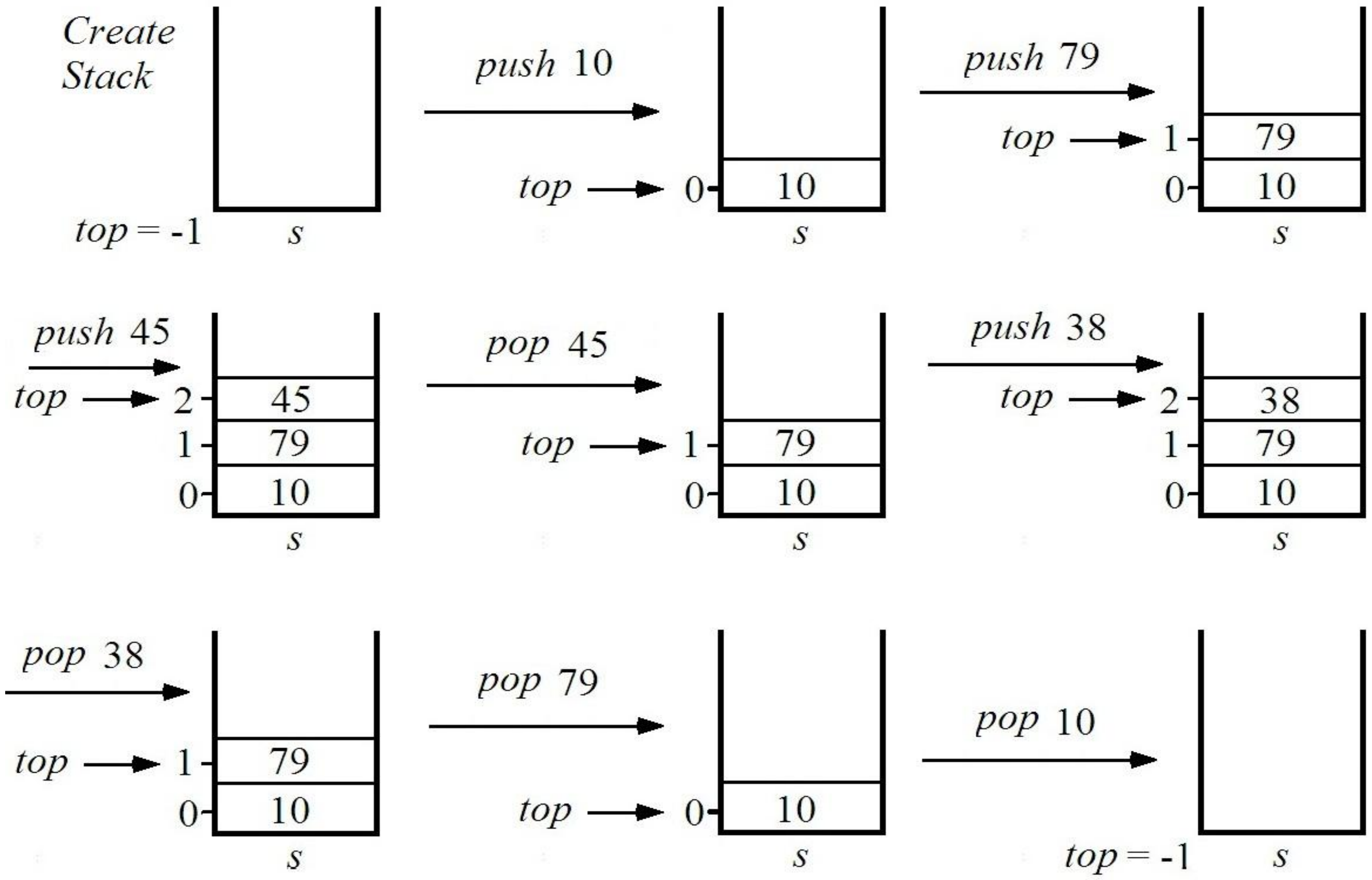
Stack Operations



Stack Operations



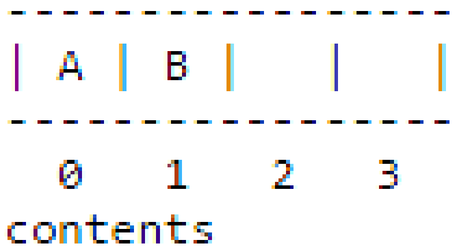
Stack Operations



Implementing a stack with an array:

First, if we want to store letters, we can use type char. **Next**, since a stack usually holds a bunch of items with the same type (**e.g., char**), we can use an array to hold the contents of the stack.
Now, consider how we'll use this array of characters, call it **contents**, to hold the contents of the stack.

Let's choose the array to be of size 4 for now. So, an array getting **A**, then **B**, will look like:



```
-----------------
| A | B |   |   |
-----------------
  0   1   2   3
contents
```

Implementing a stack with an array:

What happens if we apply the following set of operations?

1. Push(stack, 'D')
2. Push(stack, 'E')
3. Push(stack, 'F')
4. Push(stack, 'G')

giving:

```
stack (made up of 'contents' and 'top')
-----------------    -----
| D | E | F | G |    | 3 |
-----------------    -----
  0   1   2   3       top
contents
```

Stack Declaration

When implementing a data structure, the first issue to be addressed is which foundational data structure to use. Often, the choice is between an array-based implementation and a linked-list implementation. The next sections present an **array-based implementation of stacks**.

```
public static class StackX
{
private static int Size;        // size of stack array
private static int[ ] item;
private static int top;         // top of stack
.....
}
```

Stack Functions

For implementing the stack operation we must construct a Java function for each original operations and the other operations:

Create Stack Function

```
public StackX(int s)            // constructor
{
   Size = s;                     // set array size
   item = new int[Size];         // create array
   top = -1;                     // no items yet
}
```

Push Algorithm

```
Input:  x as input New element.
            Stack before pushing x
Output: Stack after pushing x.
1-  [overflow]
      if      top>=N
      Then      Over flow
2-  [increment pointer]
         top ← top+1
3-  [insert element]
          Stack[top] ← New element x
```

Pop Algorithm

Input: stack before popping element

Output: Stack after popping element.

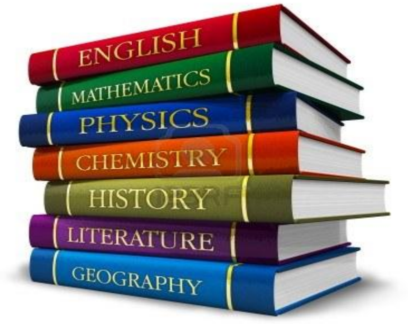
```
1-[underflow]
    if    top<=-1   Then      under flow
2-[unstack element]
    element ← Stack[top]
3-[decrement pointer]
        top ← top-1
```

Implementation

```
public static boolean is Full()
{
 if(top>=size-1)
    return true;
 else
    return false;
}
public static  boolean is Empty()
{
 if(top==-1)
    return true;
 else
    return false;   }
```

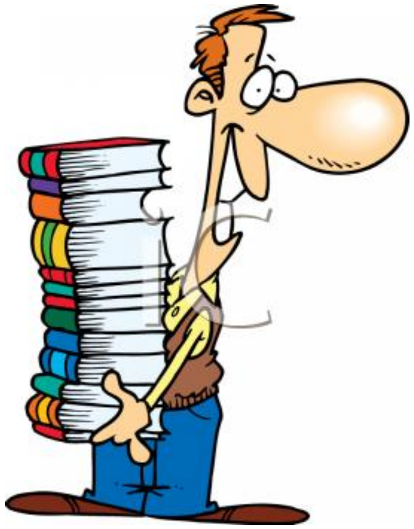
Implementation

```
public static void push(int item)
{
 if(isFull())
        System.out.println("error...the stack is full“);
else
  {
   top=top+1;
   stack[top]=item;
  }
  }
```



Implementation

```
public static int pop()
{
 if(isEmpty())
      System.out.println("error...the stack is empty“);
else
 {
  item=stack[top];
  top=top-1;
  return item;
 }
return 0;
}
```



Implementation

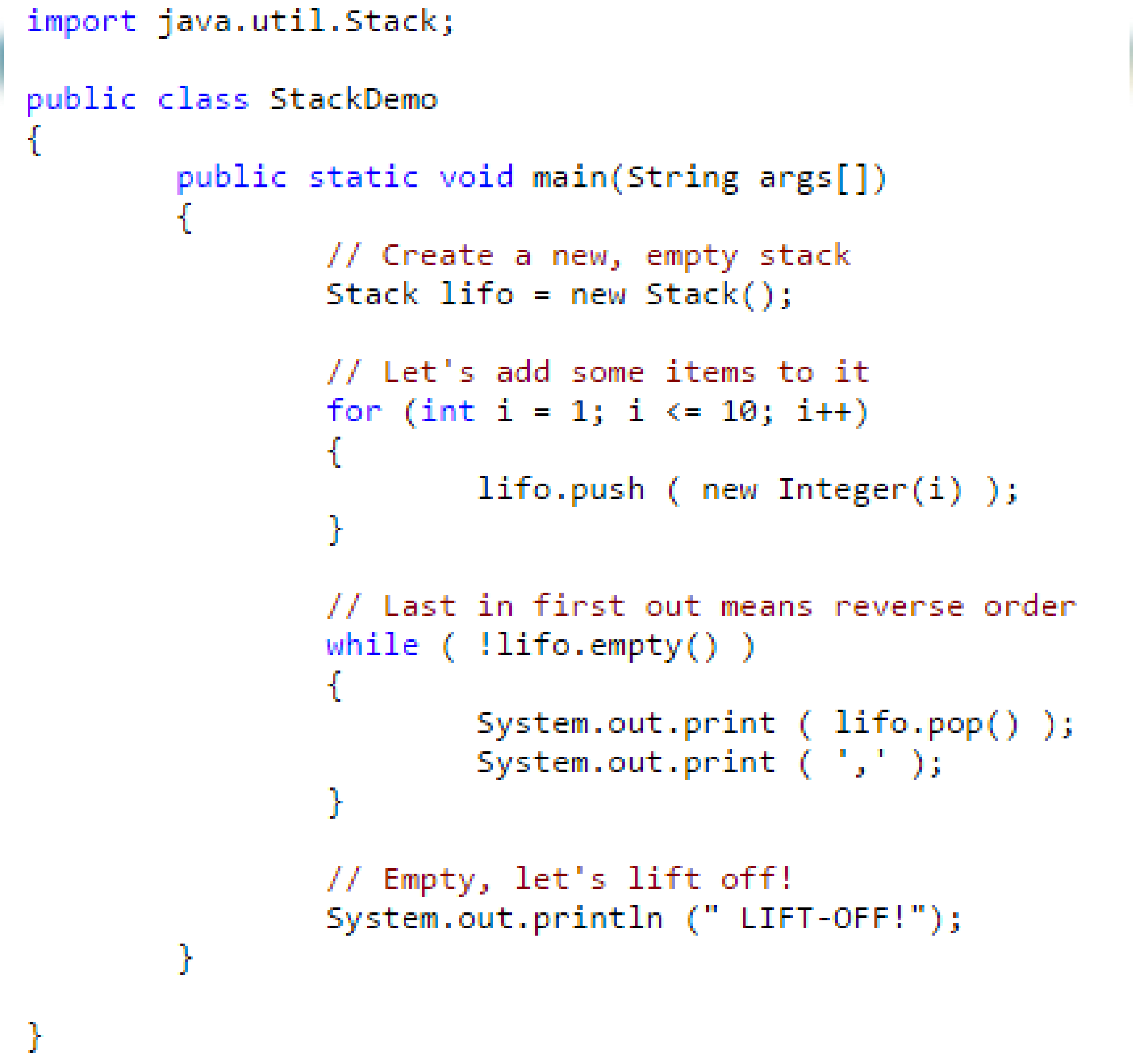
- Retrieve or Peak element from Stack Function

```
public int retrieve()
// take item from top of Stack
{
    return stackArray[top];
    // access item,
}
```

Applications of STACKS

- Stacks can be used **to reverse a sequence**. For example, if a string ”**Computers**” is entered by the user the stack can be used to create and display the reverse string “**sretupmoC**” as follows.
- The program simply *pushes* all of the characters of the string into the stack. Then it *pops* and *display* until the stack is empty.

A Sample Application That Uses A Stack To Reverse A List Of Numbers.



```java
import java.util.Stack;

public class StackDemo
{
        public static void main(String args[])
        {
                // Create a new, empty stack
                Stack lifo = new Stack();

                // Let's add some items to it
                for (int i = 1; i <= 10; i++)
                {
                        lifo.push ( new Integer(i) );
                }

                // Last in first out means reverse order
                while ( !lifo.empty() )
                {
                        System.out.print ( lifo.pop() );
                        System.out.print ( ',' );
                }

                // Empty, let's lift off!
                System.out.println (" LIFT-OFF!");
        }

}
```

Thank you

???