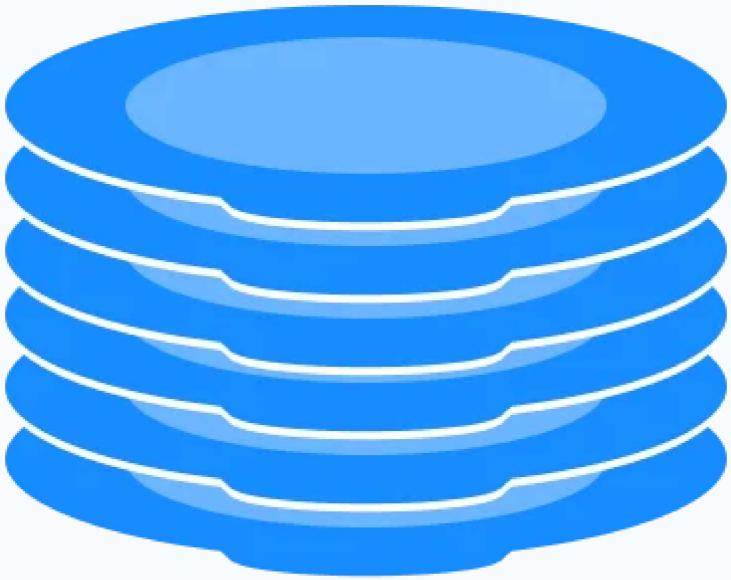
Stack Data Structure

A stack is a linear data structure that follows the principle of **Last In First Out (LIFO).** This means the last element inserted inside the stack is removed first.

You can think of the stack data structure as the pile of plates on top of another.



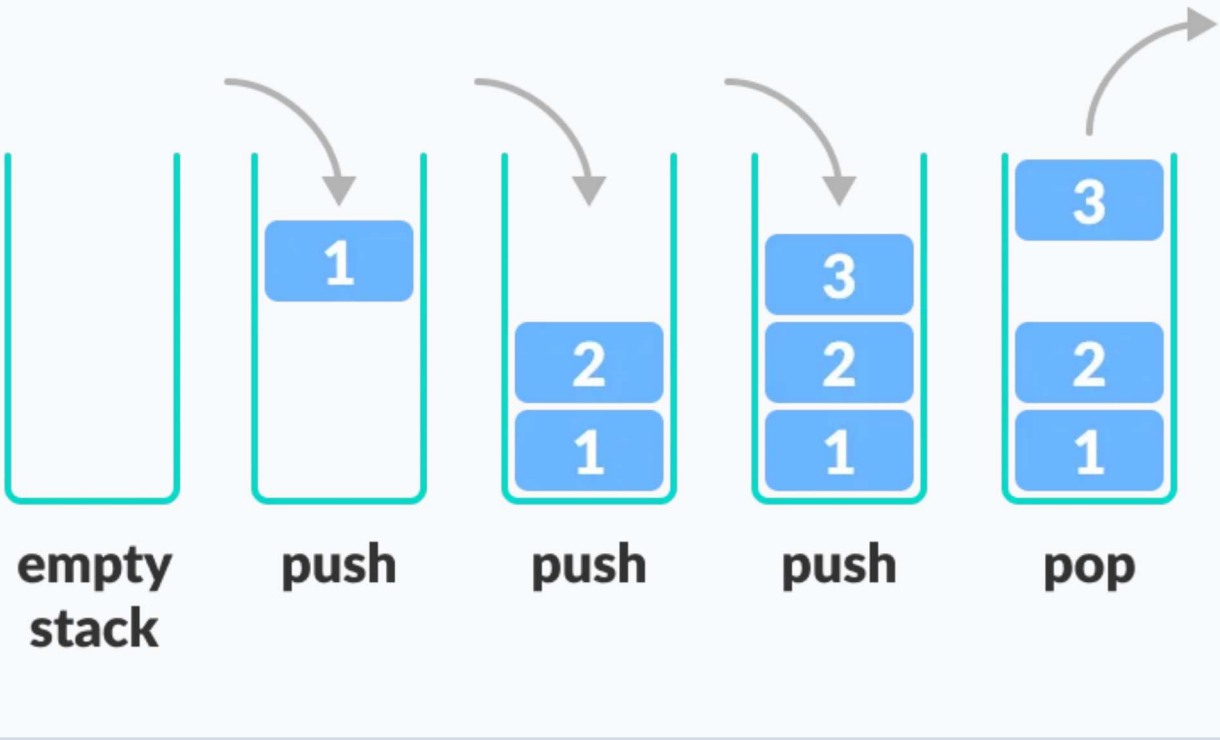
Stack representation similar to a pile of plate

Here, you can:

- Put a new plate on top

LIFO Principle of Stack

In programming terms, putting an item on top of the stack is called **push** and removing an item is called **pop**.



Stack Push and Pop Operations

In the above image, although item **3** was kept last, it was removed first. This is exactly how the **LIFO (Last In First Out) Principle** works.

We can implement a stack in any programming language like C, C++, Java, Python or C#, but the specification is pretty much the same.

Basic Operations of Stack

There are some basic operations that allow us to perform different actions on a stack.

- **Push:** Add an element to the top of a stack
- **Pop:** Remove an element from the top of a stack
- **IsEmpty:** Check if the stack is empty
- **IsFull:** Check if the stack is full
- **Peek:** Get the value of the top element without removing it

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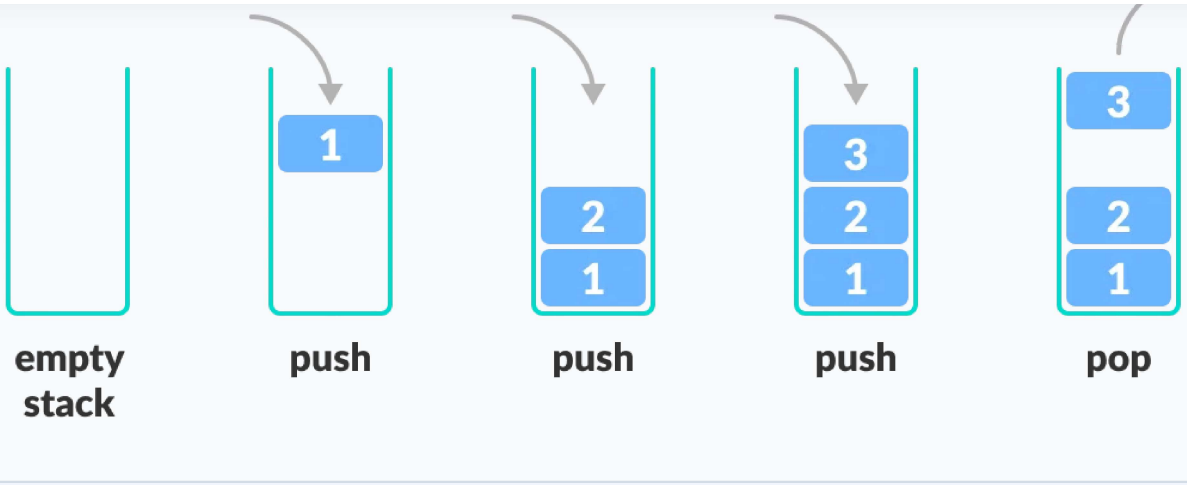
Working of Stack Data Structure

The operations work as follows:

1. A pointer called `TOP` is used to keep track of the top element in the stack.
2. When initializing the stack, we set its value to -1 so that we can check if the stack is empty by comparing `TOP == -1`.
3. On pushing an element, we increase the value of `TOP` and place the new element in the position pointed to by `TOP`.
4. On popping an element, we return the element pointed to by `TOP` and reduce its value.
5. Before pushing, we check if the stack is already full



Working of Stack Data Structure

Stack Implementations in Python, Java, C, and C++

The most common stack implementation is using arrays, but it can also be implemented using lists.

Python | Java | C | C++

```
int size = 0;

// Creating a stack
struct stack {
  int items[MAX];
  int top;
};
typedef struct stack st;

void createEmptyStack(st *s) {
  s->top = -1;
}

// Check if the stack is full
int isfull(st *s) {
  if (s->top == MAX - 1)
    return 1;
  else
    return 0;
}
```

Stack Time Complexity

For the array-based implementation of a stack, the push and pop operations take constant time, i.e. `O(1)`.

Applications of Stack Data Structure

Although stack is a simple data structure to implement, it is very powerful. The most common uses of a stack are:

- **To reverse a word** - Put all the letters in a stack and pop them out. Because of the LIFO order of stack, you will get the letters in reverse order.