Stack

A stack is an Abstract Data Type (ADT), commonly used in most programming languages. It is named stack as it behaves like a real-world stack, for example – a deck of cards or a pile of plates, etc


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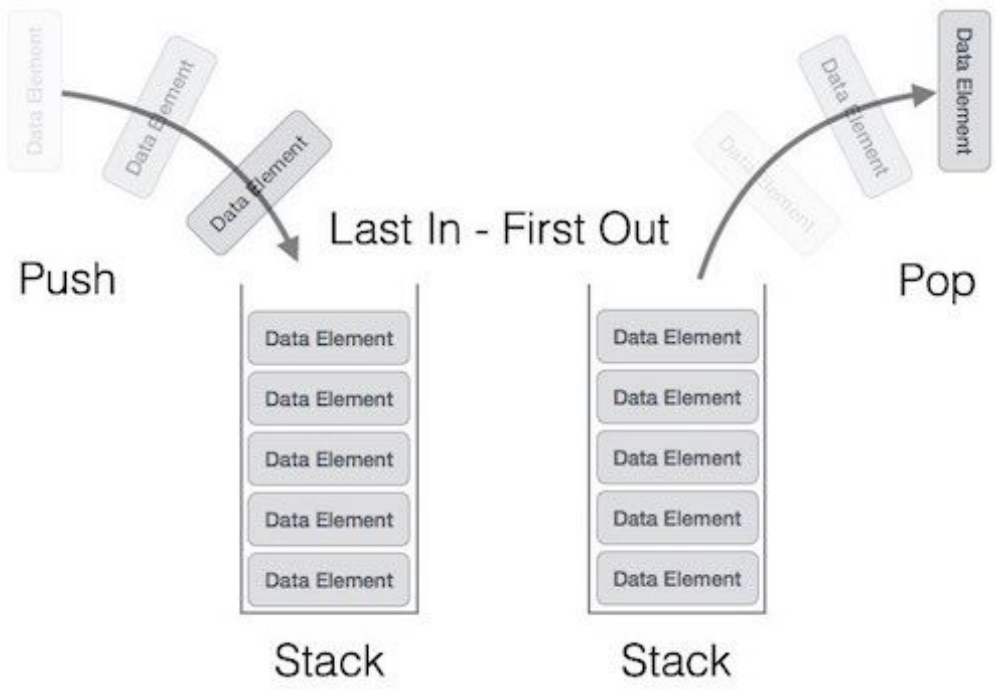
A real-world stack allows operations at one end only. For example, we can place or remove a card or plate from the top of the stack only. Likewise, Stack ADT allows all data operations at one end only. At any given time, we can only access the top element of a stack.

This feature makes it LIFO data structure. LIFO stands for Last-in-first-out. Here, the element which is placed (inserted or added) last, is accessed first. In stack terminology, insertion operation is called PUSH operation and removal operation is called POP operation.

Stack Representation

The following diagram depicts a stack and its operations −



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A stack can be implemented by means of Array, Structure, Pointer, and Linked List. Stack can either be a fixed size one or it may have a sense of dynamic resizing. Here, we are going to implement stack using arrays, which makes it a fixed size stack implementation.

Basic Operations

Stack operations may involve initializing the stack, using it and then de-initializing it. Apart from these basic stuffs, a stack is used for the following two primary operations –

- push() – Pushing (storing) an element on the stack.
- pop() – Removing (accessing) an element from the stack.

When data is PUSHed onto stack.

To use a stack efficiently, we need to check the status of stack as well. For the same purpose, the following functionality is added to stacks –

- peek() – get the top data element of the stack, without removing it.
- isFull() – check if stack is full.
- isEmpty() – check if stack is empty.

At all times, we maintain a pointer to the last PUSHed data on the stack. As this pointer always represents the top of the stack, hence named top. The top pointer provides top value of the stack without actually removing it.

First we should learn about procedures to support stack functions –

peek()

Algorithm of peek() function –

```
begin procedure peek
   return stack[top]
end procedure
```

isfull()

Algorithm of isfull() function –

```
begin procedure isfull

   if top equals to MAXSIZE
      return true
   else
      return false
   endif

end procedure
```

isempty()

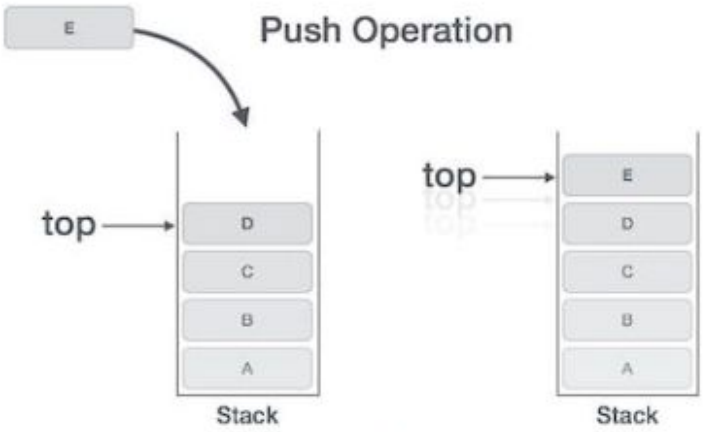
Algorithm of isempty() function –

```
begin procedure isempty

   if top less than 1
      return true
   else
      return false
   endif

end procedure
```

Push Operation

The process of putting a new data element onto stack is known as a Push Operation. Push operation involves a series of steps –

- **Step 1** – Checks if the stack is full.
- **Step 2** – If the stack is full, produces an error and exit.
- **Step 3** – If the stack is not full, increments **top** to point next empty space.
- **Step 4** – Adds data element to the stack location, where top is pointing.
- **Step 5** – Returns success.



If the linked list is used to implement the stack, then in step 3, we need to allocate space dynamically.

Algorithm for PUSH Operation

A simple algorithm for Push operation can be derived as follows –

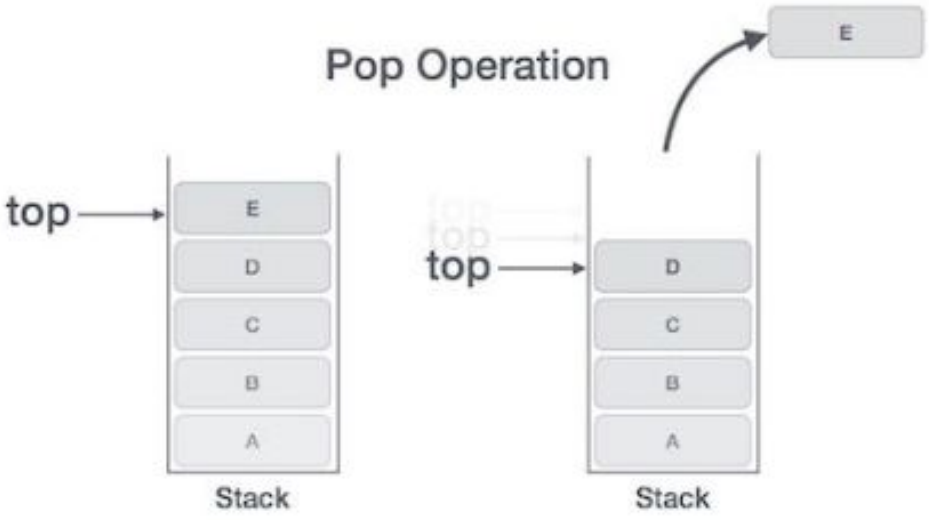
```
begin procedure push: stack, data

   if stack is full
      return null
   endif

   top ← top + 1
   stack[top] ← data

end procedure
```

Pop Operation

Accessing the content while removing it from the stack, is known as a Pop Operation. In an array implementation of pop() operation, the data element is not actually removed, instead **top** is decremented to a lower position in the stack to point to the next value. But in linked-list implementation, pop() actually removes data element and deallocates memory space.

A Pop operation may involve the following steps –

- **Step 1** – Checks if the stack is empty.
- **Step 2** – If the stack is empty, produces an error and exit.
- **Step 3** – If the stack is not empty, accesses the data element at which **top** is pointing.
- **Step 4** – Decreases the value of top by 1.
- **Step 5** – Returns success.



Algorithm for Pop Operation

A simple algorithm for Pop operation can be derived as follows –

```
begin procedure pop: stack

   if stack is empty
      return null
   endif

   data ← stack[top]
   top ← top - 1
   return data

end procedure
```

PROGRAMMING EXERCISES

Question - 01:

Write a program that **uses a stack** to print the prime factors of a positive integer in descending order.

Question - 02:

Write a program that takes as input an arithmetic expression. The program outputs whether the **expression contains matching grouping symbols**. For example, the arithmetic expressions **{25 + (3 – 6) * 8}** and **7 + 8 * 2** contains **matching grouping symbols**. However, the expression **5 + {(13 + 7) / 8 - 2 * 9** does not contain matching grouping symbols. Implement your solution using Stacks.

Question - 03

Two stacks of the same type are the same if they have the same number of elements and their elements at the corresponding positions are the same. Overload the **relational operator ==** for the class stackType that returns true if two stacks of the same type are the same, false otherwise. Also, write the definition of the function template to overload this operator.

Question - 04

a- Add the following operation to the class Stack:

void reverseStack(stack &otherStack);

This operation copies the elements of a stack in reverse order onto another stack. Consider the following statements:

Stack stack1;
Stack stack2;

The statement

stack1.reverseStack(stack2);

copies the elements of stack1 onto stack2 in reverse order. That is, the top element of stack1 is the bottom element of stack2, and so on. The old contents of stack2 are destroyed and stack1 is unchanged.

b- Write the definition of the function to implement the operation **reverseStack.**

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