Data Structures

Stacks

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November 12, 2016

Outline

Introduction

Definition of a stack

It is a linear list where:

- One end is called top
- Other end is called bottom

Additionally, adds and removes are at the top end only.

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What is a stack?

First

Stores a set of elements in a particular order.

Second

Stack principle: LAST IN FIRST OUT = LIFO

Meaning

It means: the last element inserted is the first one to be removed

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Example in Real Life

Stack of Coins

Outline

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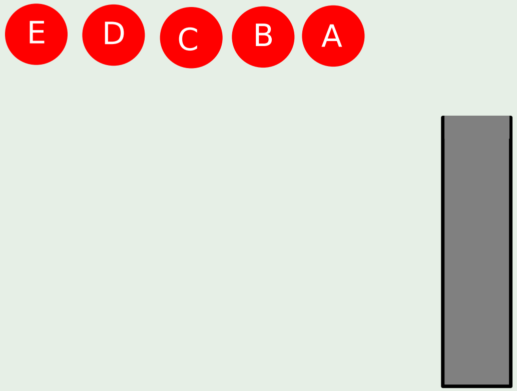
Example

Insert the following items into a stack

List = {A, B, C, D, E}

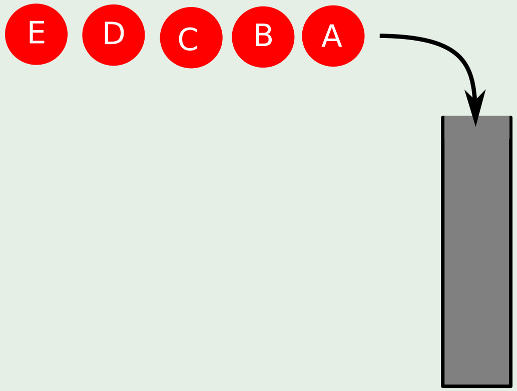
Example

List = {A, B, C, D, E}



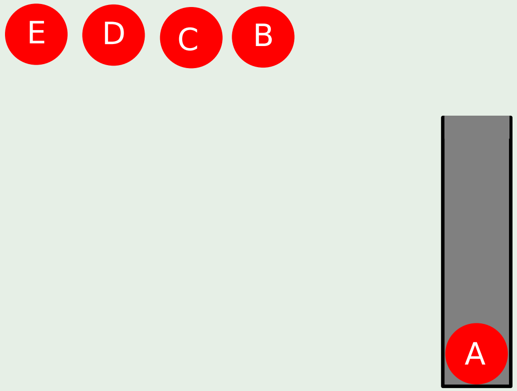
Example

List = {A, B, C, D, E}, Push A



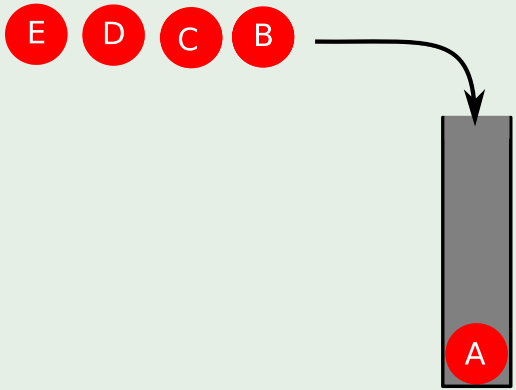
Example

List = {B, C, D, E}



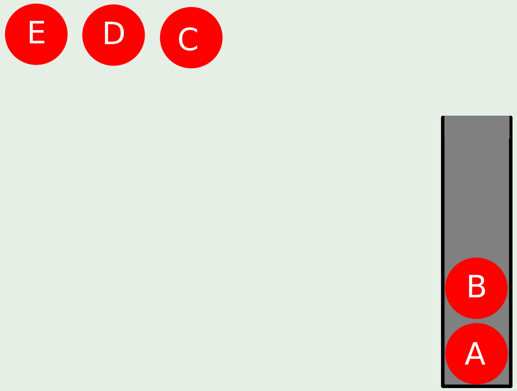
Example

List = {B, C, D, E}, Push B



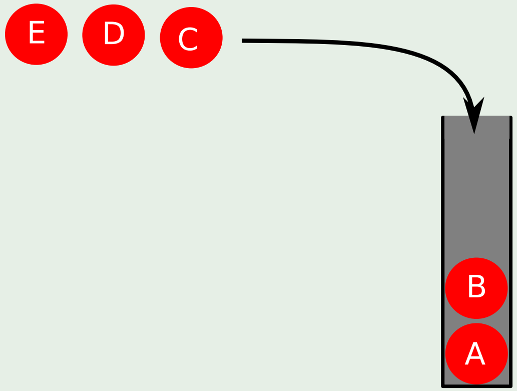
Example

List = {C, D, E}



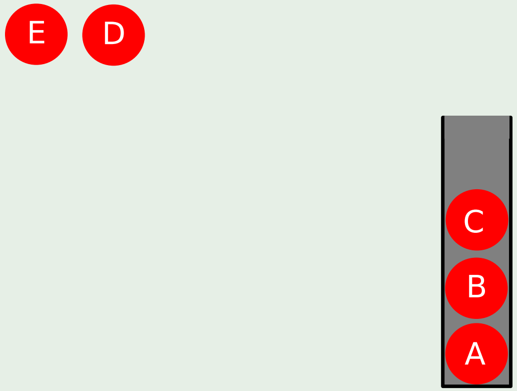
Example

List = {C, D, E}, Push C



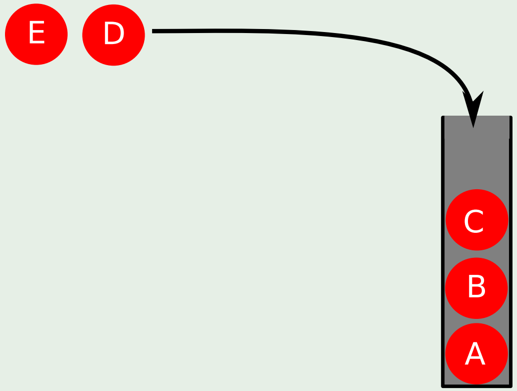
Example

List = {D, E}



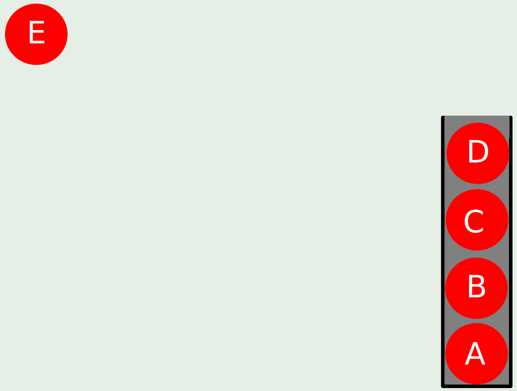
Example

List = {D, E}, Push D



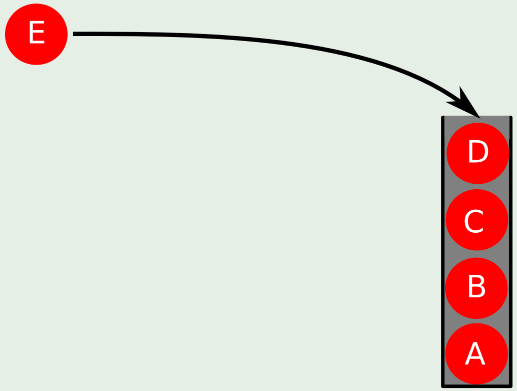
Example

List = {E}



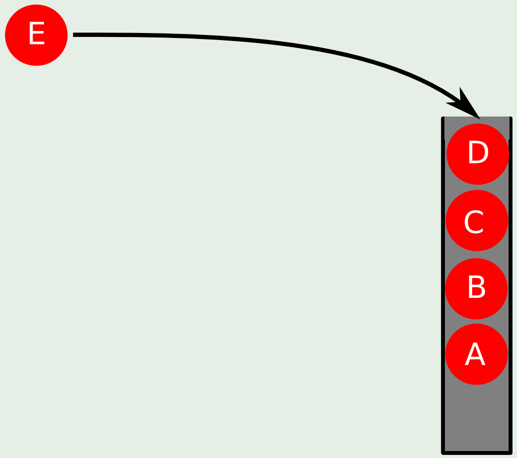
Example

List = {E}, Push E



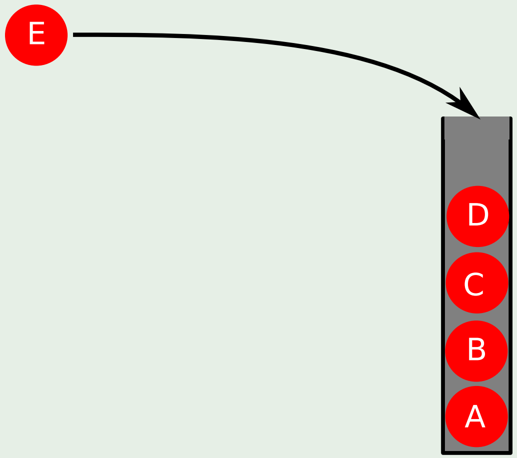
Example

List = {E}, No space!!!Make Space



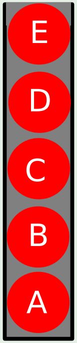
Example

List = {E}, Push E



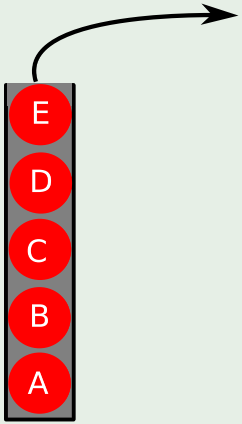
Example

List $= \{\}$



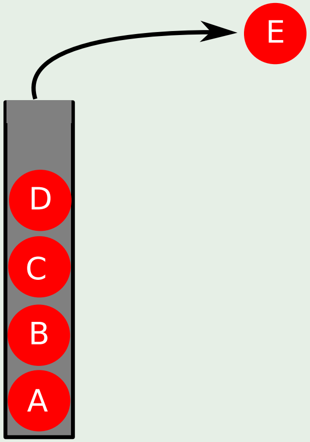
Example

List $= \{\}$, Pop



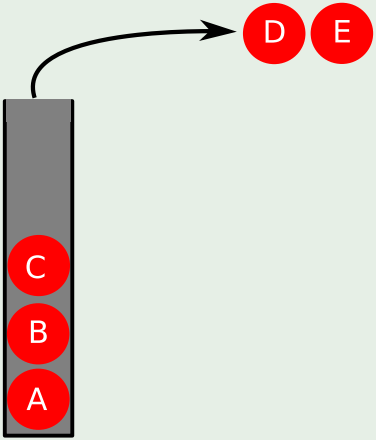
Example

List = {E}, Pop



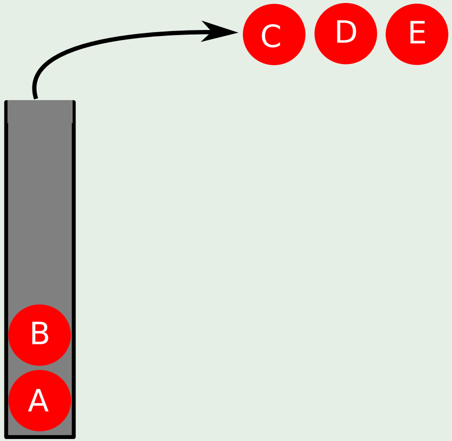
Example

List = {E,D}, Pop



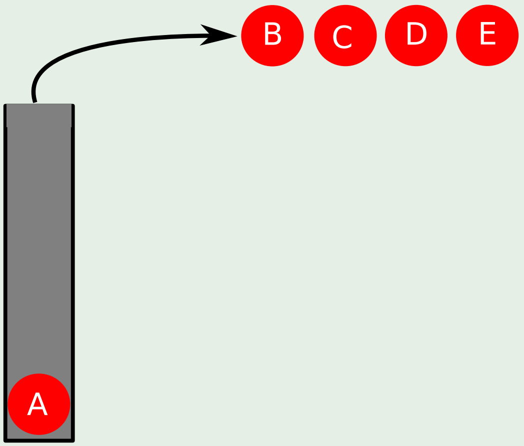
Example

List = {E,D,C}, Pop



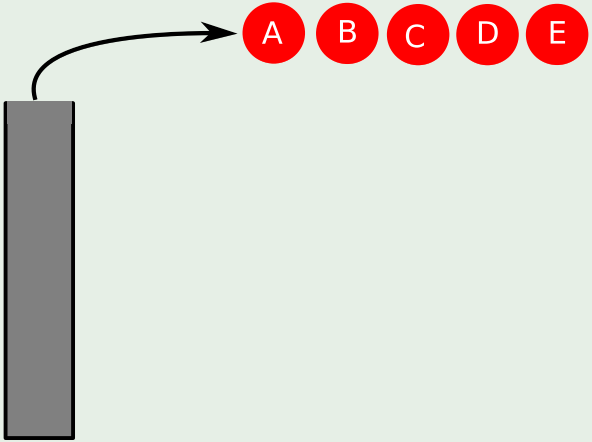
Example

List = {E,D,C,B}, Pop



Example

List = {E,D,C,B,A}



Outline

Stacks ADT

Interface

```
interface Stack
{
    public boolean empty();
    public Item peek();
    public void push(Object);
    public Item pop();
}
```

Explanation of the ADT I

peek()

This method allows to look at the top of the stack without removing it!!!

For Example

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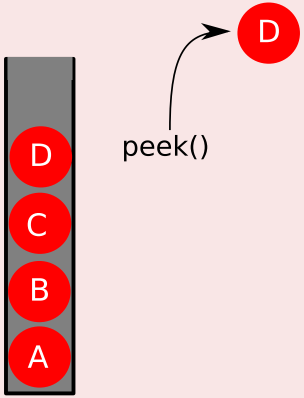

Explanation of the ADT II

pop()

This method allows to pop stuff from the top of the stack!!!

For Example

Explanation of the ADT II

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This method allows to pop stuff from the top of the stack!!!

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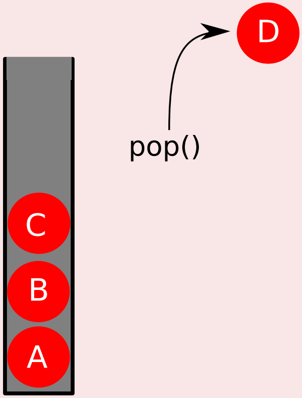

Explanation of the ADT III

push()

This method allows to push stuff to the top of the stack!!!

For Example

Explanation of the ADT III

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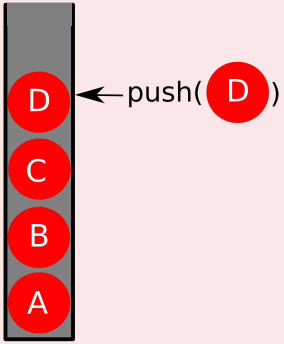

Explanation of the ADT III

empty()

This method allows to know if the stack is empty!!!

Stack Applications

Real life

- Pile of books
- Plate trays

Stack Applications

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More applications related to computer science

- Program execution stack (You will know about this in OS or CA)
- Evaluating expressions

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What do we do now?

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Instead of going toward the implementations!!!

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Why not examples?

1. Parentheses Matching
2. Towers Of Hanoi/Brahma
3. Switch Box Routing
4. Try-Throw-Catch in Java
5. Rat In A Maze

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Parentheses Matching

Example - Input

(((a+b)*c+d-e)/(f+g)-(h+j))

(	(	(	a	$+$	b	)	$*$	c	$+$	d	$-$	e	)	/	...
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...
(	f	$+$	g	)	$-$	(	h	$+$	j	)	)				
15	16	17	18	19	20	21	22	23	24	25	26				

Output

Output pairs (u,v) such that the left parenthesis at position u is matched with the right parenthesis at v.

Or

(2,6) (1,13) (15,19) (21,25) (0,26)

Parentheses Matching

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Input

(a+b))*((c+d)

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(a+b))*((c+d)

Output

1. (0,4)
2. WRONG!!! Right parenthesis at 5 has no matching left parenthesis
3. (8,12)
4. WRONG!!! Left parenthesis at 7 has no matching right parenthesis

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Developing a Recursive Solution I

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What do we do? Ideas

Look at this

What if we have (a+b)?

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boolean Rec-Paren(Chain List)

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     1. List.remove(0)
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Next Case

Cont...

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2. else if (List.get(0)=='[0-9]||[+-]')
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Last Step

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Developing a Recursive Solution II

What if you have?

What if we have (a+b?

What about

What if we have a+b)?

Developing a Recursive Solution II

What if you have?

What if we have (a+b?

What about

What if we have a+b)?

This solution fails!!!

So, we need to send something down the recursion

What do we do? Ideas

What about...?

what if

We send down a flag!!

Thus

We need a flag to send down the recursion!!!

To tell the logic if we saw a left parenthesis

Ok

For simple problems fine!!! However...

Thus

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To tell the logic if we saw a left parenthesis

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For simple problems fine!!! However...

Then

For problems like these ones

((a+b)

Nope

It does not work

Then

For problems like these ones

((a+b)

Nope

It does not work

We need something more complex

A counter!!!

To see how many "(" we have seen down the recursion!!!

Recursive Solution - You assume a list of characters

```
def Balanced(ChainLinearList List, int Counter):

        if (len(List)==0): // Check empty
        if (Counter == 0):// Check Counter
                    return True
        else:
            return False
    if (List[0]=='('):// Case (
          Counter++;
          List.pop(0)
          return Balanced(List,Counter)
    elif (List.get(0)==')'):   // Case )
          if (Counter > 0):
                 Counter--
                 List.pop(0)
                 return Balanced(List, Counter)
          else
                        return False:
        else: // Case Number or -+
        List.pop(0)
        return Balanced(List, Counter)
```

Can we simplify our code?

Yes

Using this memory container the STACK!!!