

The following materials have been collected from the numerous sources such as Stanford CS106 and Harvard CS50 including my own and my students over the years of teaching and experiences of programming. Please help me to keep this tutorial up-to-date by reporting any issues or questions. Please send any comments or criticisms to [idebtor@gmail.com](mailto:idebtor@gmail.com). Your assistances and comments will be appreciated.

## stack – using a singly-linked list

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## Getting Started

This problem set consists of implementing a simple stack by using singly-linked list of nodes. Your job is to complete the given program, **stack.cpp**, that implements a singly linked list that don't have a header structure nor sentinel nodes. It simply links node to node and the first node always becomes a head node which we consider as the top of the stack.

- stack.cpp – a skeleton code, most of **your implementation goes here**.
- stack.h – an interface file, you are **not** supposed to modify this file.
- stackDriver.cpp – a driver code to test your implementation.
- stackx.exe – a sample solution for Windows PC

**Mac Users:** Use [Wine or WineBottler](#) to run Windows executable on your Mac.

### Sample run.

```

C:\WINDOWS\system32\cmd.exe

Stack(nodes:0, show:ALL, show_n:10) MENU
p - push  0(1)      P - push N  0(n)
o - pop   0(1)      O - pop N   0(n)
t - top   0(1)      m - min,max 0(n)
s - show [HEAD/TAIL] n - n items per line
c - clear 0(n)
Command[q to quit]: P
Enter number of nodes to push?: 20
cpu: 0 sec
-> 19 -> 18 -> 17 -> 16 -> 15 -> 14 -> 13 -> 12 -> 11 -> 10
-> 9 -> 8 -> 7 -> 6 -> 5 -> 4 -> 3 -> 2 -> 1 -> 0

Stack(nodes:20, show:ALL, show_n:10) MENU
p - push  0(1)      P - push N  0(n)
o - pop   0(1)      O - pop N   0(n)
t - top   0(1)      m - min,max 0(n)
s - show [HEAD/TAIL] n - n items per line
c - clear 0(n)
Command[q to quit]:
  
```

## Step 1: push(), pop(), and top()

First of all, you must read **stack.h** file so that you may see the whole picture of the task. The **push()** is supposed to insert a node or N nodes in front of the list.

```
// pushes a new node with val at the beginning of the list or
// onto the top of the stack and returns the new first node.
pNode push(pNode s, int val, int N = 1);
```

The skeleton code inserts one node ( $N = 1$  by default). If  $N$  is not 1,  $N$  nodes are added from the starting value of `val` which are passed from the driver. For instance, if  $val=10$  and  $N=5$ , the five nodes added must be 10, 11, 12, 13, and 14.

Since we don't have any extra header structure to maintain, the first node always acts like the head node which we consider as the top of the stack. Since the new node is inserted at the front or the top of the stack, the function must return the new pointer to the head node to the caller. The caller must reset the first node (or the top of the stack) information. This is  $O(1)$  operation.

This **pop()** is supposed to remove the top (or head) node or  $N$  nodes from the stack.

```
// removes N nodes in the list and returns the new first node.
// This deallocates the removed node, effectively reduces its size by N.
pNode pop(pNode p, int N = 1)
```

The function removes one or  $N$  nodes ( $N = 1$  by default). After it removes one or  $N$  nodes from the list, it returns the new pointer of the list if there is at least one node. It is now the top of stack if it is not an empty list. If empty, returns nullptr, This is  $O(1)$  operation.

The **top()** function returns the top elements of the stack or head (first) node in the linked list unless the stack is empty. If empty, it returns nullptr. This is  $O(1)$  operation.

## Step 2: size(), empty(), and minmax()

The **size()** function returns the number elements (or nodes) in the stack (or linked list).

The **empty()** function returns true, if the stack is empty, false otherwise.

The **minmax()** function finds the minimum and maximum values in stack.

```
// sets the min and max values which are passed as references in the list
void minmax(pNode p, int& min, int& max);
```

## Step 3: clear()

The **clear()** function deallocates all the nodes in the list. Make sure that you call "delete"  $N$  times where  $N$  is the number of nodes.

To remove a node with  $x$ , you must have both the previous node of the node  $x$  and the node  $x$  itself. Since the exactly same thing is used during **clear()**, you may refer to the code example in **clear()** provided.

The good new is ..... This function is already implemented for you. It is a grace~.

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## Step 4: show()

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The **show()** displays the stack, or the linked list of nodes from top to bottom. The function has an optional argument called **bool show\_all = true**. Through the menu option in the driver, the user can toggle between "show [all]" and "show [head/tail]". This functionality is useful when you debug your code.

It has another optional argument **int show\_n = 12**. If the size of the list is less than or equal to  $show\_n * 2$ , then it displays all the items in the list. If "show [ALL]" option is chosen, it toggles to "show [HEAD/TAIL]" option and vice versa. The [HEAD/TAIL] option displays the  $show\_n$  items at most from the beginning and the end of the list.

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## Step 5: Stress test – "P" and "O"

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Do not start this step unless you finish Step 1 through Step 3, completely.

We want to implement a piece of code that tests your implementation of functions you have done so far.

- These two options ask the user to specify the number of nodes to add or remove. Then perform the operation N times repeatedly.
- If the user specifies a number out of the range in O option, it simply removes all the nodes.

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## Submitting your solution

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- Include the following line at the top of your every source file with your name signed.  
**On my honor, I pledge that I have neither received nor provided improper assistance in the completion of this assignment.**  
Signed: \_\_\_\_\_ Section: \_\_\_\_\_ Student Number: \_\_\_\_\_
- Make sure your code **compiles** and **runs** right before you submit it. Every semester, we get dozens of submissions that don't even compile. Don't make "a tiny last-minute change" and assume your code still compiles. You will not get sympathy for code that "almost" works.
- If you only manage to work out the problem sets partially before the deadline, you still need to turn it in. However, don't turn it in if it does not compile and run.
- Place your source files in the folder you and I are sharing.
- After submitting, if you realize one of your programs is flawed, you may fix it and submit again as long as it is **before the deadline**. You will have to resubmit any related files together, even if you only change one. You may submit as often as you like. **Only the last version** you submit before the deadline will be graded.

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## Files to submit

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Submit **one** file listed below.

- stack.cpp
- Upload your file **mid1** folder in Piazza.

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## Due and Grade

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- Due: 11:55 pm,
- Grade: 1 point per step.
- Finish Step 1 & 2 successfully, you get Step 3 as a bonus point + 1.