The University of Chicago
Department of Computer Science

CMSC 15200 – Introduction to Computer Science 2
Summer Quarter 2005
Lab #4 (08/17/2005)

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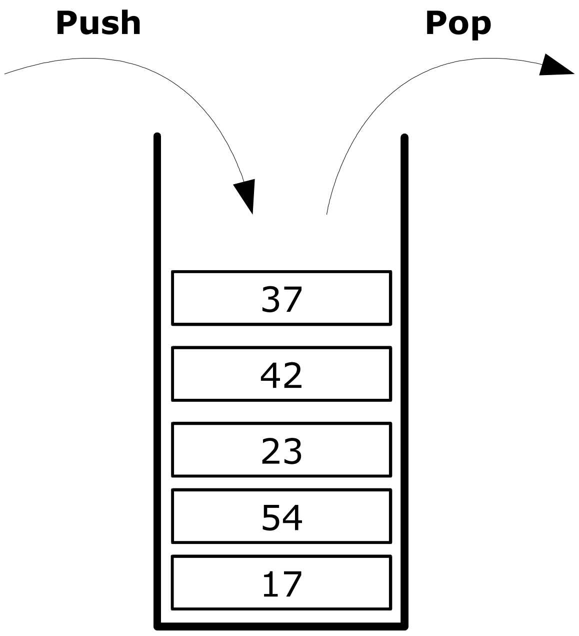
1	2	3	4	5	6	7	TOTAL

Maximum possible points: 35

In this lab you will implement a *stack* data structure, described in class, using the object-oriented features of C++.



The class declarations are the following (stack.h in the lab files):

```
class ListNode {
      private:
              int data;
              ListNode *next;

      public:
              ListNode(int data, ListNode *next);
              int getData();
              void setData(int data);
              ListNode* getNext();
              void setNext(ListNode *next);
};

class Stack {
      private:
              ListNode *head;

              // Private member functions
              void insertHead(int data);
              void deleteHead();

      public:
              // Constructors
              Stack();
              Stack(int a[], int length);
              ~Stack();

              // Member functions
              int pop();
              void push(int data);
              int peek();
              bool isEmpty();
              void printContents(ostream &os);

              // Operator overload
              void operator+(int data);
};
```

A stack.cpp file is provided that includes the implementation of all the ListNode member functions, and of all the Stack *private* member functions.

To test your list implementation, a main.cpp is provided in the lab files. Running this program with a correct stack implementation should yield the following:

```
9 8 7 6 5 4 3 2 1
First element is 9
9 8 7 6 5 4 3 2 1
Popped element 9
8 7 6 5 4 3 2 1
Popped element 8
7 6 5 4 3 2 1
Popped element 7
6 5 4 3 2 1
Popped element 6
5 4 3 2 1
Popped element 5
4 3 2 1
Popped element 4
3 2 1
Popped element 3
2 1
Popped element 2
1
Popped element 1
Stack is empty!
5 4 3 2 1
8 7 6 5 4 3 2 1
```

You should be able to do the following exercises (except the last one) simply by reusing code from a previous list implementation seen in class. Do not *overthink this lab.*

Exercise 1 <<3 points>>

Implement the default constructor:

```
Stack();
```

Exercise 2 <<5 points>>

Implement the following constructor:

```
Stack(int a[], int length);
```

This constructor takes the values in array *a* (of length *length),* and pops them into the stack (starting with the first element in the array, and ending with the last element)

Exercise 3 <<5 points>>

Implement the following standard stack operations (described in class):

```
int pop();
void push(int data);
int peek();
```

These three functions can assume that the stack is not empty.

Exercise 4 <<2 points>>

Implement the `isEmpty` member function:

```
bool isEmpty();
```

This function return true is the stack is empty, and false otherwise.

Exercise 5 <<2 points>>

Implement the `printContents` function:

```
void printContents(ostream &os);
```

This function must print the contents of the stack starting at the top of the stack and ending at the bottom of the stack.

Notice how, unlike previous list traversal functions seen in class, this one expects a parameter of type *ostream*. This is done so the programmer will be able to specify what output stream to use (see the main.cpp file for an example).

Exercise 6 <<3 points>>

Overload the addition operator:

```
void operator+(int data);
```

The addition operator must be overloaded in such a way that the following operation results in having value 17 popped into stack *st*:

```
Stack st;
st + 17;
```

Exercise 7 <<15 points>>

You are asked to do some modifications to your stack implementation. Copy all your files to a new directory called Exercise7 and make your modifications there.

- Rewrite the class declarations in such a way that *Stack* becomes a friend class of *ListNode*, so that the *Stack* member functions don't have to use get/set methods to access the *data* and *next* member variables of a *ListNode* object.
- Eliminate the get/set methods from the *ListNode* class, and modify your *Stack* implementation accordingly.
- Overload the << operator in such a way that you can print out the contents of the stack to an output stream. For example:

```
Stack s1;

s1.push(5);
s1.push(6);
s1.push(7);

cout << s1;  // Should write “7 6 5”
```

A *main_friend.cpp* file is provided to test these modifications. The result of running this file with your stack implementation should yield the same output shown on page 3.