PAPERS TAPED TO THE BOARD

STUDENT OUTLINE

Lesson 36 – Stacks

INTRODUCTION: When studying recursion you were introduced to the concept of a stack. A stack is a linear data structure with well-defined insertion and deletion routines. The stack abstraction has been implemented for you in the *ArrayStack* class. After covering the member methods available in implementing a stack interface, the lab exercise will use stacks to solve a non-recursive *inorder* tree traversal problem.

The key topics for this lesson are:

A. The Stack Abstract Data Type
B. Implementation Strategies for a Stack Type

VOCABULARY:

STACK	POP
PUSH	TOP

DISCUSSION:

A. The Stack Abstract Data Type

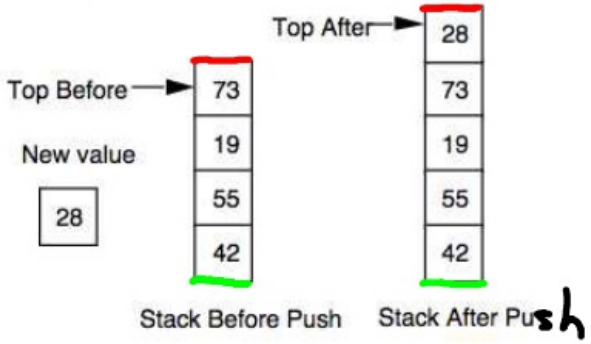
USUALLY THINK OF LINEAR WITH THIS ORIENTATION

1. A stack is a linear data structure, with each node or cell holding the same data type.

2. All additions to and deletions from a stack occur at the top of the stack. The last item pushed onto the stack will be the first item removed. A stack is sometimes referred to as a LIFO structure, which stands for Last-In, First-Out.

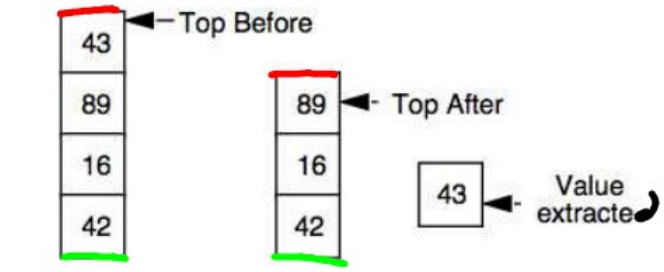
3. Two of the more important stack operations involve *pushing* data onto a stack and *popping* data off the stack.

4. The *push* operation will look like this:



Push Operation

5. The *pop* operation will look like this:



Pop Operation

B. Implementation Strategies for a Stack Type

See Handout H.A.36.1, *Stack Interface*.

1. A `Stack` interface is defined to formalize the stack methods. See Handout H.A.36.1, *Stack Interface* for the details.

```
public interface Stack
{
  boolean isEmpty();
  void push(Object x);
  Object pop();
  Object peekTop();
}
```

2. The `Stack` interface above specifies the `push` and `pop` methods, the `boolean` method `isEmpty`, and an additional method `peekTop` that returns the value of the top element without removing it from the stack.

3. The following listing shows the `Stack` interface implemented in the `ArrayStack` class:

```
public class ArrayStack implements Stack
{
  private java.util.ArrayList array;

  public ArrayStack()
  { array = new java.util.ArrayList(); }
  public boolean isEmpty() { return array.size() == 0; }
  public void push(Object obj) { array.add(obj); }
  public Object pop() { return array.remove(array.size() - 1); }
  public Object peekTop() { return array.get(array.size() - 1); }
}
```

4. The data structure used in the `ArrayStack` class is an `ArrayList`. This allows for resizing of the stack as needed to make it larger.

5. Here is a short program illustrating usage of the `ArrayStack` class.

```
// Example program using the ArrayStack class

public static void main(String[] args)
{
  ArrayStack stack = new ArrayStack();

  for (int k = 1; k <= 5; k++)
    stack.push(new Integer(k));

  while (!(stack.isEmpty()))
  {
    System.out.print(stack.pop() + "  ");
  }
}
```

6. Another approach would be to use a linked list that would support true dynamic resizing. As you push data onto the stack another node is added to the appropriate end of the linked list. When data is popped from the stack, the linked list would be reduced in size. The following listing shows the `Stack` interface implemented in the `ListStack` class as a `java.util.LinkedList`:

```
public class ListStack implements Stack
{
  private java.util.LinkedList list;

  public ListStack() { list = new java.util.LinkedList(); }
  public boolean isEmpty() { return list.isEmpty(); }
  public void push(Object obj) { list.addFirst(obj); }
  public Object pop() { return list.removeFirst(); }
  public Object peekTop() { return list.getFirst(); }
}
```

SUMMARY/ REVIEW: The stack ADT (*Abstract Data Type* – see Lesson 20) is what makes recursive algorithms possible. In the lab exercise you will gain a better understanding of the recursive *inorder* function used to traverse a binary tree.

ASSIGNMENT: Lab Exercise L.A.36.1, *Inorder*