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Lecture 19: Stack Implementations - 2

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An Array-Based Implementation

Array-Based Implementation

- Each operation involves the top of stack
  - » `push`
  - » `pop`
  - » `peek`
- End of the array is the easiest to access
  - » Let this be top of stack
  - » Let first entry be bottom of stack

Array-Based Implementation

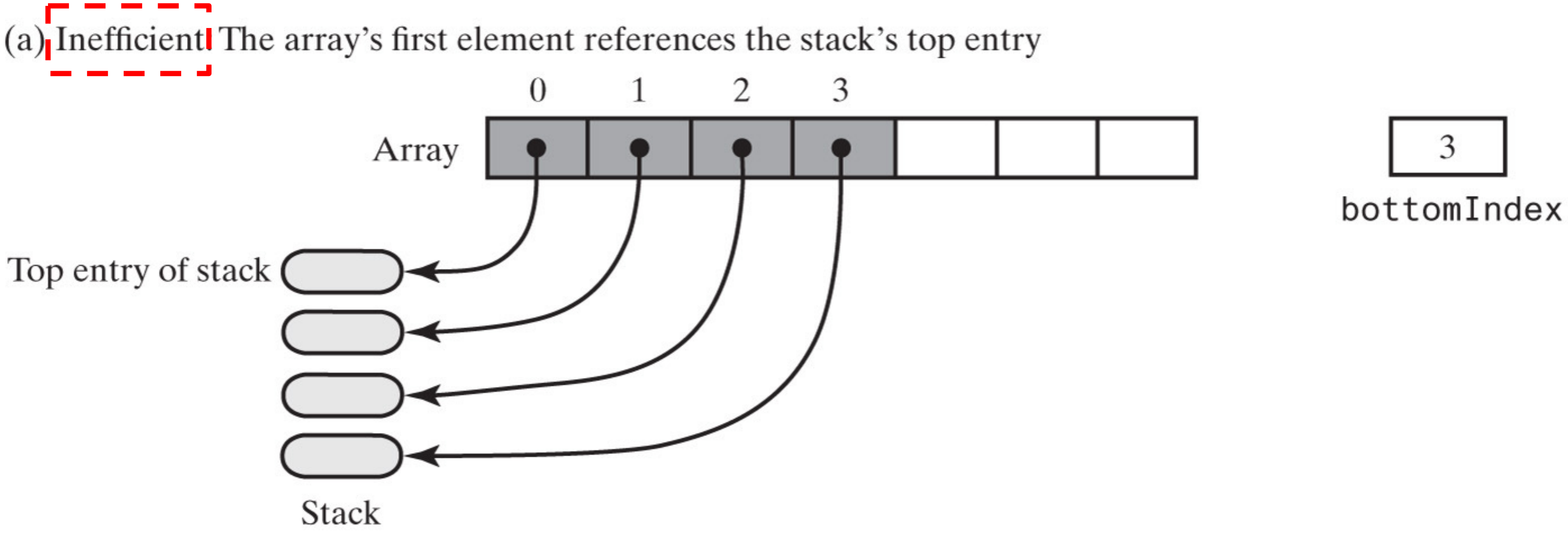

(a) Inefficient The array's first element references the stack's top entry
0
1
2
3
Array
3
bottomIndex
Top entry of stack
Stack

Figure 6-4: An array that implements a stack; its first location references (a) the top entry in the stack;

Array-Based Implementation

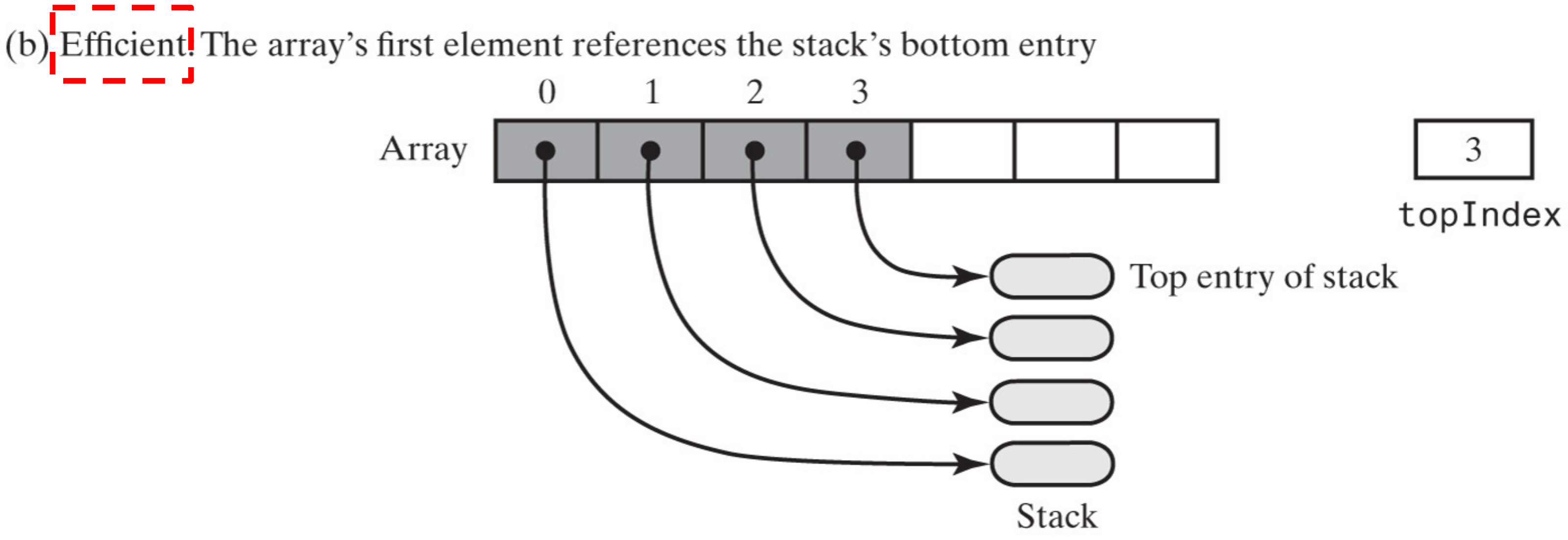

(b) Efficient! The array's first element references the stack's bottom entry
0
1
2
3
Array
3
topIndex
Top entry of stack
Stack

Figure 6-4: An array that implements a stack; its first location references (b) the bottom entry in the stack

Array-Based Implementation

```java
/** A class of stacks whose entries are stored in an array.*/
public final class ArrayStack<T> implements StackInterface<T>
{

   private T[] stack;    // Array of stack entries
   private int topIndex; // Index of top entry
   private boolean integrityOK = false;
   private static final int DEFAULT_CAPACITY = 50;
   private static final int MAX_CAPACITY = 10000;

   public ArrayStack()
   {
      this(DEFAULT_CAPACITY);
   } // end default constructor

   public ArrayStack(int initialCapacity)
   {
      integrityOK = false;
      checkCapacity(initialCapacity);

      // The cast is safe because the new array contains null entries
      @SuppressWarnings("unchecked")
      T[] tempStack = (T[])new Object[initialCapacity];
      stack = tempStack;
      topIndex = -1;
      integrityOK = true;
  } // end constructor

  //  < Implementations of the stack operations go here. >
  //  . . .

} // end ArrayStack
```

Listing 6-2: An outline of an array-based implementation of the ADT stack

Array-Based Implementation

```
public void push(T newEntry)
{
   checkIntegrity();
   ensureCapacity();
   stack[topIndex + 1] = newEntry;
   topIndex++;
} // end push


private void ensureCapacity()
{
   if (topIndex >= stack.length - 1) // If array is full, double its size
   {
      int newLength = 2 * stack.length;
      checkCapacity(newLength);
      stack = Arrays.copyOf(stack, newLength);
   } // end if
} // end ensureCapacity
```

Adding to the top

Array-Based Implementation

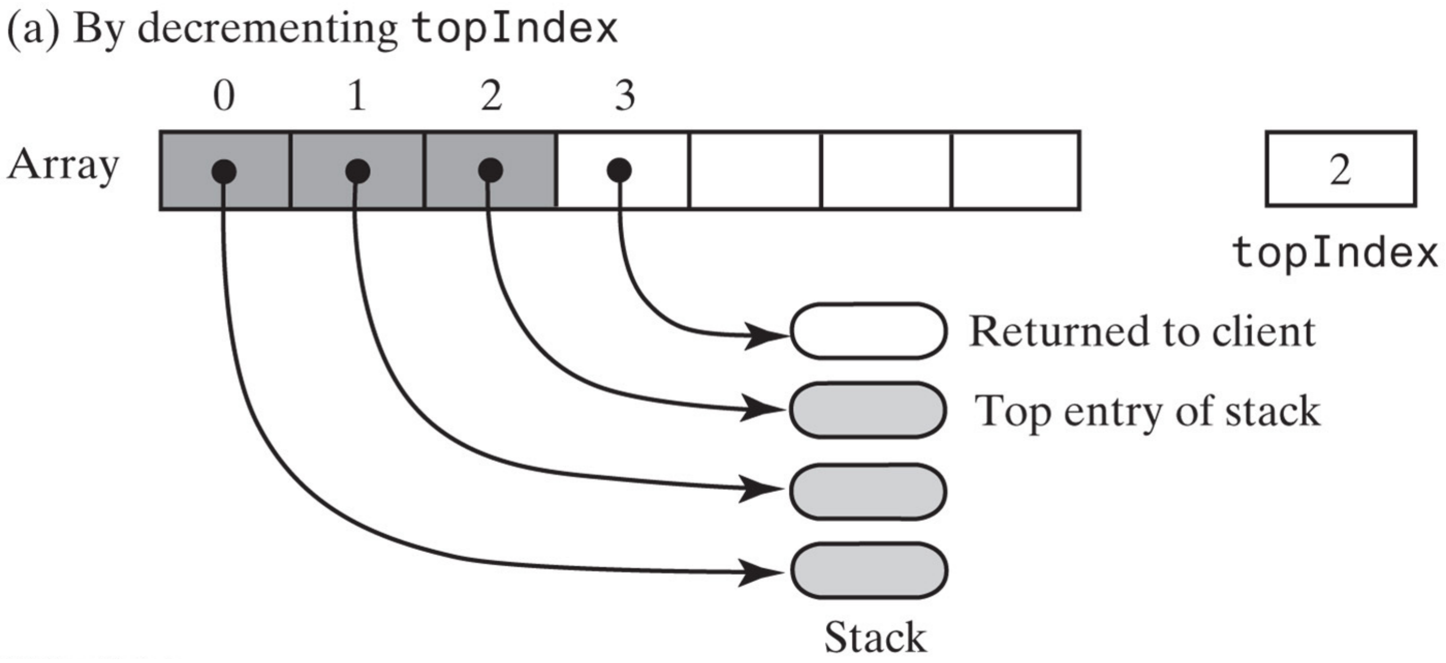


Figure 6-5: An array-based stack after its top entry is removed by (a) decrementing `topIndex`;

Array-Based Implementation

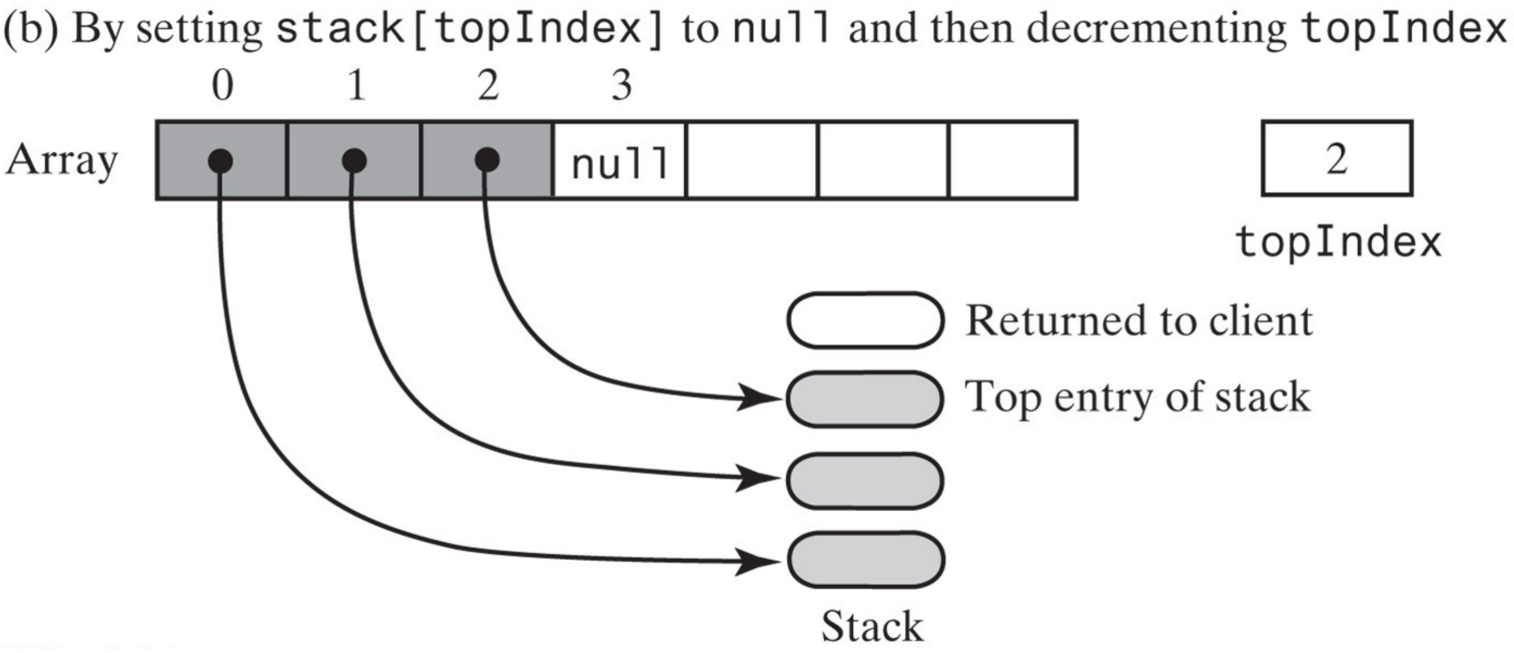

(b) By setting stack[topIndex] to null and then decrementing topIndex
0
1
2
3
Array
null
2
topIndex
Returned to client
Top entry of stack
Stack

Figure 6-5: An array-based stack after its top entry is removed by (b) setting `stack[topIndex]` to null and then decrementing `topIndex`

Array-Based Implementation

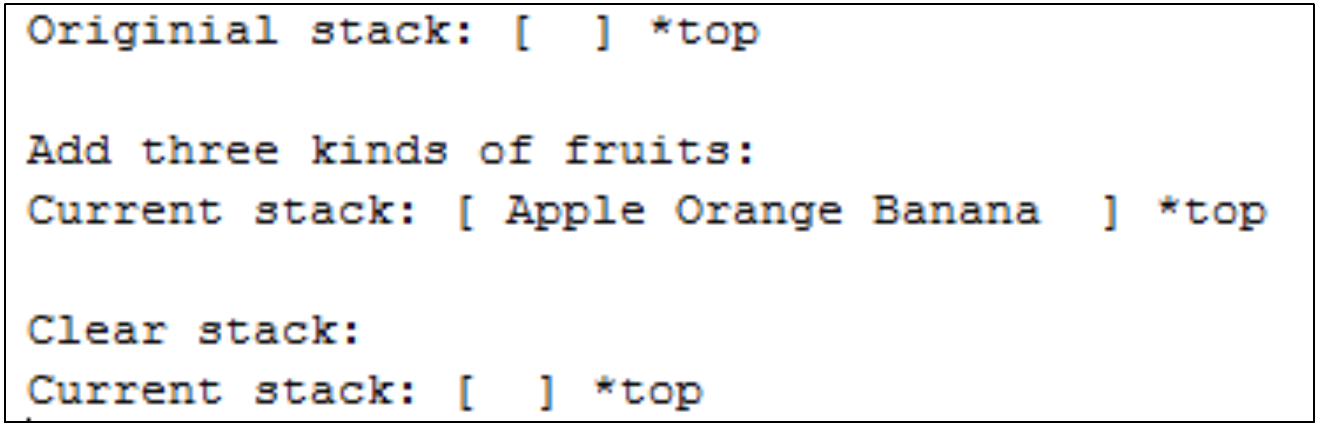
```
public T peek()
{
   checkIntegrity();
   if (isEmpty())
      throw new EmptyStackException();
   else
      return stack[topIndex];
} // end peek

public T pop()
{
   checkIntegrity();
   if (isEmpty())
      throw new EmptyStackException();
   else
   {
      T top = stack[topIndex];
      stack[topIndex] = null;
      topIndex--;
      return top;
   } // end if
} // end pop
```

Retrieving the top, operation is O(1)

Exercise (10 - 15 mins)

- Download “L19_E1” from the Canvas
- Implement `clear()`, `toString()` and `main()` such that you can see following results:

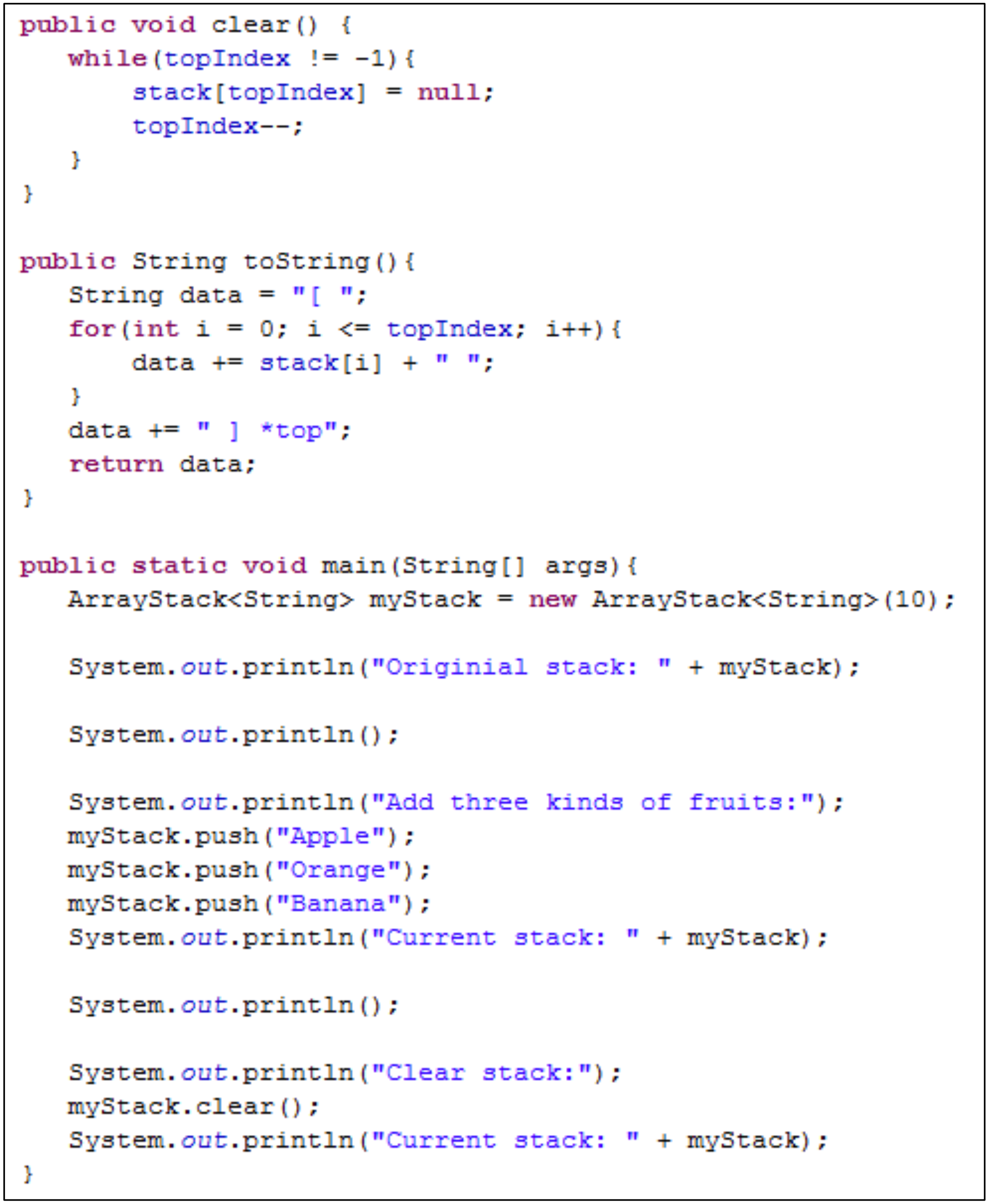


```
Originial stack: [  ] *top

Add three kinds of fruits:
Current stack: [ Apple Orange Banana  ] *top

Clear stack:
Current stack: [  ] *top
```

Answer



```
public void clear() {
   while(topIndex != -1){
       stack[topIndex] = null;
       topIndex--;
   }
}

public String toString(){
   String data = "[ ";
   for(int i = 0; i <= topIndex; i++){
       data += stack[i] + " ";
   }
   data += " ] *top";
   return data;
}

public static void main(String[] args){
   ArrayStack<String> myStack = new ArrayStack<String>(10);

   System.out.println("Originial stack: " + myStack);

   System.out.println();

   System.out.println("Add three kinds of fruits:");
   myStack.push("Apple");
   myStack.push("Orange");
   myStack.push("Banana");
   System.out.println("Current stack: " + myStack);

   System.out.println();

   System.out.println("Clear stack:");
   myStack.clear();
   System.out.println("Current stack: " + myStack);
}
```

A Vector-Based Implementation

Vector-Based Implementation

- Vector: an object that behaves like a high-level array
  - Index begins with 0
  - Methods to access or set entries
  - Size will grow as needed
- Use vector’s methods to manipulate stack

Vector-Based Implementation

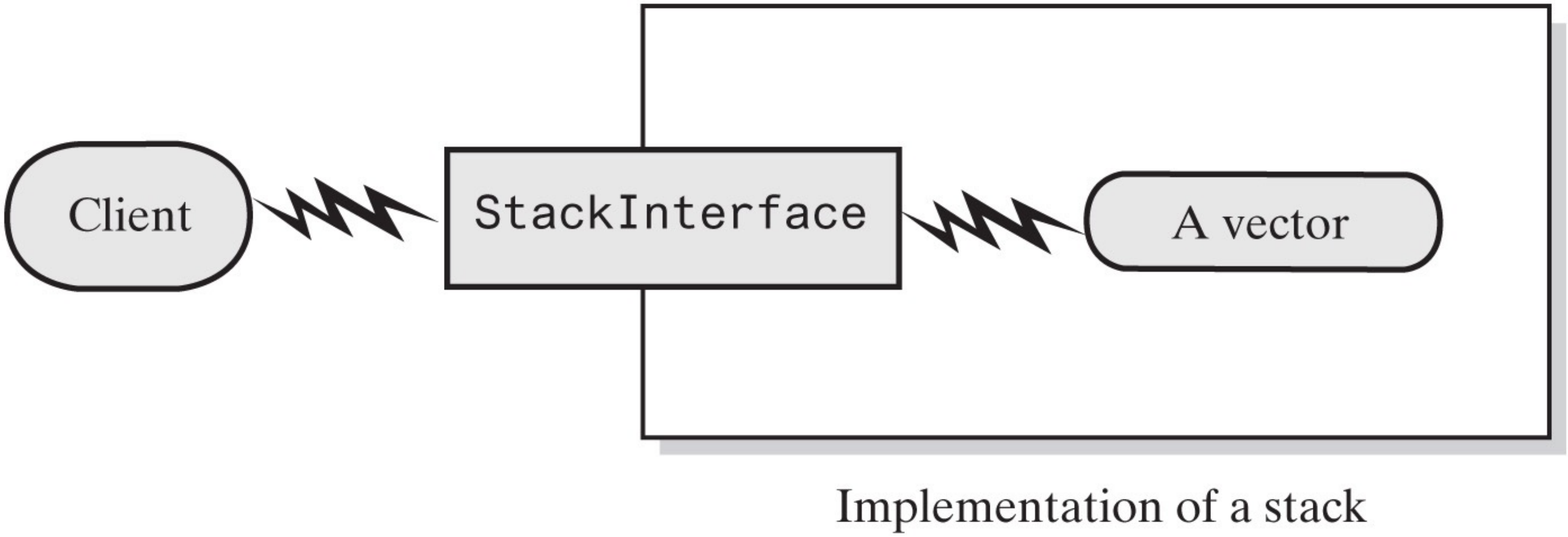


Figure 6-6: A client using the methods given in `StackInterface`; these methods interact with a vector's methods to perform stack operations

The Class `Vector`

- Constructors
- Has methods to add, remove, clear
- Methods to determine
  - Last element
  - Is the vector empty
  - Number of entries

Vector-Based Implementation

```
import java.util.Vector;
/** A class of stacks whose entries are stored in a vector. */
public final class VectorStack<T> implements StackInterface<T>
{
   private Vector<T> stack;   // Last element is the top entry in stack
   private boolean integrityOK;
   private static final int DEFAULT_CAPACITY = 50;
   private static final int MAX_CAPACITY = 10000;

   public VectorStack()
   {
      this(DEFAULT_CAPACITY);
   } // end default constructor

   public VectorStack(int initialCapacity)
   {
      integrityOK = false;
      checkCapacity(initialCapacity);
      stack = new Vector<>(initialCapacity); // Size doubles as needed
      integrityOK = true;
   } // end constructor

   //  < Implementations of checkIntegrity, checkCapacity, and the stack
   //    operations go here. >
   //  . . .
} // end VectorStack
```

Listing 6-3: An outline of a vector-based implementation of the ADT stack

Vector-Based Implementation

```
public void push(T newEntry)
{
   checkIntegrity();
   stack.add(newEntry);
} // end push
```

Adding to the top

Vector-Based Implementation

```
public T peek()
{
   checkIntegrity();
   if (isEmpty())
      throw new EmptyStackException();
   else
      return stack.lastElement();
} // end peek
```

Retrieving the top

Vector-Based Implementation

```
public T pop()
{
   checkInitegrity();
   if (isEmpty())
      throw new EmptyStackException();
   else
      return stack.remove(stack.size() - 1);
} // end pop
```

Removing the top

Vector-Based Implementation

```
public boolean isEmpty()
{
   checkIntegrity();
   return stack.isEmpty();
} // end isEmpty

public void clear()
{
   checkIntegrity();
   stack.clear();
} // end clear
```

The rest of the class.