# CSE 12 – Basic Data Structures and Object-Oriented Design
# Lecture 7

Greg Miranda & Paul Cao, Winter 2021

This lecture is being recorded

# Announcements

- Quiz 7 due Friday @ 8am
- Survey 3 due Friday @ 11:59pm
- PA2 due tonight @ 11:59pm

## Topics

- Stacks
- Other Topics
  - Adapter Pattern
  - Composition
  - Stacks & Queues with LinkedList

A **stack** has two operations, **push** and **pop**. Pushing adds an element to the **top** of the stack, and **pop** removes the **top** element and returns it.

```
Stack<Integer> s = new ALStack<>();
s.push(4);
s.push(10);
s.push(13);
Integer i = s.pop();
s.push(5);
Integer i2 = s.pop();
```

What number is stored in i?

3 A: 4 — 3 B: 10 — [✓ 66 C: 13] — 2 D: 5

0 E: Something else

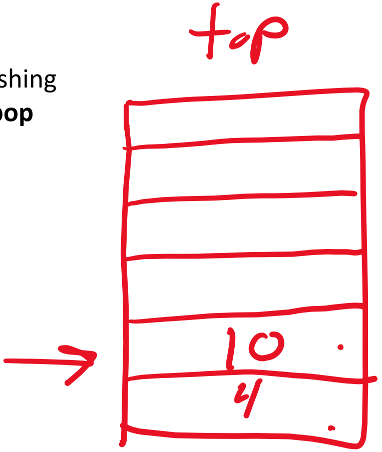
What number is stored in i2?

0 A: 4 — 2 B: 10 — 0 C: 13 — [✓ 71 D: 5]

0 E: Something else

What is the contents of the stack? (starting at the **top**)

4 A. 5, 13, 10, 4
[✓ 65 B. 10, 4]
0 C. 5, 13
2 D. 13, 10, 4
3 E. other



10, 4

```
import java.util.ArrayList;

public interface Stack<E> {
  void push(E element);
  E pop();
  int size();
}
// IDEA: Use array lists to implement both
class ALStack<E> implements Stack<E> {

}
```

## Other Topics

- Adapter Pattern
- Composition

# Queue - Implementation

One option: Implement the methods in the ADT from scratch.

```
public class MyQueue<E>{
  Object[] data;
  int size;
  int front;
  int back;
  public boolean enqueue(E elem){
    //if full resize
    //change front
    //add in the new element
  }
}
```

# Adapter Pattern

# Adapter Pattern

- Lazy Paul needs to implement the Queue Interface with the following methods:
  - void enqueue(E element) – add elements to the back of the queue.
  - E dequeue() – remove element from front of the queue.
  - int size() – return the size of the queue.

- Let’s see what he can do to be as lazy as possible.

# Adapter Pattern

- Paul has access to a data structure implementation that supports the following methods.
  - void add(int index, E value)
  - E remove(int index)
  - int size()

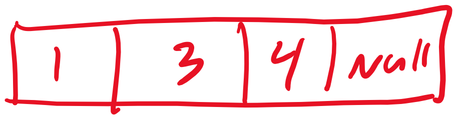
- Let’s call this data structure ..........ArrayList

# Inheritance?

Paul realizes that he can just make Queue extend the ArrayList and write the additional methods by using other existing methods.

Ex:

```
public Queue<E> extends ArrayList<E>
{
  …
  public E dequeue() {
    E toReturn = this.~~contents~~.get(0);
    this.~~contents~~.remove(0);
    return toReturn;
  }
  …
}
```



Pros? Cons?

# Inheritance is not always the right answer

- Paul has access to a data structure implementation that supports the following methods.
  - void add(int index, E value)
  - E remove(int index)
  - int size()

- Let’s call this data structure ..........ArrayList

## Adapter Pattern

Making the ArrayList variable private makes sure that users of the Queue cannot access the ArrayList or its methods.

Only the Queue methods are public and therefore usable by clients.

You can happily use ArrayList within Queue and pass on operations to it.

~~A queue "is-a" ArrayList~~

Composition

A queue has-a ArrayList!

## Adapter Pattern – Example

```
public class Queue<E> implements QueueInterface<E> {

    private ArrayList<E> ~~container~~; contents

    …

    public void enqueue(E element) {

      this.contents.add(this.contents.size(), element);

    }

}
```

This is called **'delegation'**. The enqueue method of Queue is delegating the task to add method of ArrayList

## And no one needs to know..

Every one thinks I implemented Queue from scratch

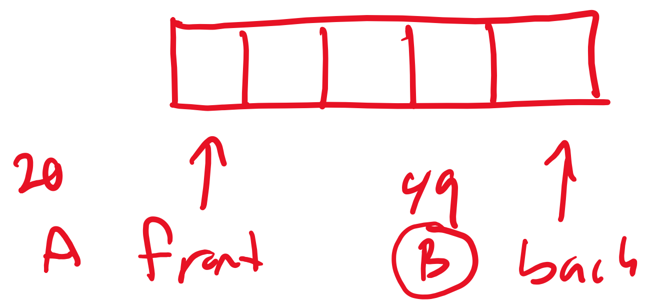
## Stack - Implementation

# Mapping Attributes

- Before deciding on what methods to use, one needs to map the corresponding attributes.

- For example: To use the ArrayList as a Stack, we need to map the Top of the stack to some position in the list (front or back—our choice, but how to choose?)

↑↑



# Mapping methods

- Once this is done, we can map the methods on top of the stack to methods operating on the back of the List.

If we choose the ~~front~~ back….

- push -> add
- pop -> remove
- peek -> get

# Adapter Pattern Summary

You would like to implement an Interface A.

You have an implementation B that implements another interface C which defines methods very much similar to the methods in A but differ slightly (like name).

You use an instance of B inside your class that implements A and delegate tasks to it.

Your class A "has a" class B.

# Topics

- Stacks & Queues with LinkedList