The `ArrayBag` class

Last time in lecture we introduced the `ArrayBag` class. Recall:

- it's a *collection* (it's intended to store lots of objects)
- there is no guaranteed *ordering* (items come out randomly)
- duplicates are allowed
- objects can be of any type

We'll review the fields and constructors of the class.

- `Object[]` allows us to store references to any type of object (since `Object` is the ancestor of all classes)
- the default constructor creates an underlying array of size 50
- the `ArrayBag(int maxSize)` constructor takes a value specifying the size

The `add()` method

The `add()` method takes an object and returns `true` if the item was added to the bag.

```
public boolean add(Object item) {
    if (item == null) {
        throw new IllegalArgumentException();
    } else if (this.numItems == this.items.length) {
        return false;
    } else {
        this.items[this.numItems] = item;
        this.numItems++;
        return true;
    }
}
```

- When does it return `false`?
  - When there is no more room (`numItems == items.length`)

The `contains()` method

The `contains()` method returns `true` if the specified object exists in the array, and `false` otherwise.

```
public boolean contains(Object item) {
    for (int i = 0; i < this.numItems; i++) {
        if (this.items[i].equals(item)) {
            return true;
        }
    }

    return false;
}
```

- We use `equals()` instead of `==` when comparing references
- The loop is bound by `numItems`, not `items.length`

Returning inside the loop

What if we modified `contains()` so it returns `false` inside the loop?

```
public boolean contains(Object item) {
    for (int i = 0; i < this.numItems; i++) {
        if (this.items[i].equals(item)) {
            return true;
        } else {
            return false;
        }
    }
}
```

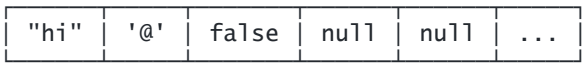
- Would this work?
  - **No!** The loop only runs once. The method will only find the item if it's at index 0.

The `remove()` method

Now write an implementation of `remove()`.

Avoid leaving `null`s in the middle of the array. To remove an item, shift all the items to the left by one position. Suppose we start with this array:

After removing 32, the array should look like this:



Test-driven development

Starting from correct, compiling code:

1. Add a failing test case that represents a desired feature
2. Write the code that makes the test case pass
3. Refactor as needed
    a. If you introduce a bug by accident, undo until your test cases pass again
4. Go to step 1 for another feature

Use this technique to help you implement `remove()`.

Before implementing, write some code that creates an `ArrayBag` with some items, calls `remove()`, and verifies that the item was correctly removed.

The `containsAll()` method

The `containsAll()` method takes another `ArrayBag` and returns `true` if all the items in the other bag are present in this bag.

```
public boolean containsAll(ArrayBag otherBag) {
    if (otherBag == null || otherBag.numItems == 0) {
        return false;
    }
    for (int i = 0; i < otherBag.numItems; i++) {
        if (!this.contains(otherBag.items[i])) {
            return false;
        }
    }
    return true;
}
```

- Note that this method can access the `private` fields of the other `ArrayBag` (this is only allowed inside the `ArrayBag.java` file)

Making a copy (first attempt)

What is happening in memory after these lines of code are executed?

```
ArrayBag b1 = new ArrayBag();
b1.add("hello");

ArrayBag b2 = b1;
b2.add("world");
```

Read the code carefully and come up with a guess. Then open this Java Tutor session and step through the code line by line.

- What are the contents of `b1`? How about `b2`?
  - There is only one bag; `b1` and `b2` contain the same reference (memory address)
  - The contents are `{"hello", "world"}`

Making a copy (correctly)

To get a new bag, we need to allocate memory on the heap. This requires the use of the `new` keyword, which calls a constructor.

Write a constructor for the `ArrayBag` class that accepts another `ArrayBag` and copies its references into a new bag's array.

- To allow for more items to be added, make the new array twice the size of the other bag's array
- Use test-driven development
  - Think of concrete cases before writing the implementation
  - Put the concrete cases & your expectations into code
  - Try to think of the smallest possible thing to test; for example, start with a test that checks the array length is correct before taking the next step of copying references

Bonus: to-do list app

Build a to-do list app that uses two bags to keep track of list items: one for unfinished items, and another for finished items.

The app must offer these features:

- Add a to-do list item
- Mark a to-do list item as done
- Delete a to-do list item

Think of how you could use two bags to implement these features. Try to use test-driven development (TDD) to build each feature without needing to write code in `main()` that interacts with a user.