Topic 20
Arrays part 2

"42 million of *anything* is a lot."
 -Doug Burger
(commenting on the number of transistors in the Pentium IV processor)

Based on slides for Building Java Programs by Reges/Stepp, found at
http://faculty.washington.edu/stepp/book/

Concept of an array rotation

- Imagine we want to 'rotate' the elements of an array; that is, to shift them left by one index. The element that used to be at index 0 will move to the last slot in the array.

 For example, {3, 8, 9, 7, 5} becomes {8, 9, 7, 5, 3}.

 Before:

```
                [0]   [1]   [2]   [3]   [4]
       +---+   +-----+-----+-----+-----+-----+
  list | +-+---> |  3  |  8  |  9  |  7  |  5  |
       +---+   +-----+-----+-----+-----+-----+
```

 After:

```
                [0]   [1]   [2]   [3]   [4]
       +---+   +-----+-----+-----+-----+-----+
  list | +-+---> |  8  |  9  |  7  |  5  |  3  |
       +---+   +-----+-----+-----+-----+-----+
```

Shifting elements left

- A left shift of the elements of an array:

```
                [0]   [1]   [2]   [3]   [4]
       +---+   +-----+-----+-----+-----+-----+
  list | +-+---> |  3  |  8  |  9  |  7  |  5  |
       +---+   +-----+-----+-----+-----+-----+
                    /     /     /     /
                   /     /     /     /
                  /     /     /     /
                 V     V     V     V
       +---+   +-----+-----+-----+-----+-----+
  list | +-+---> |  8  |  9  |  7  |  5  |  5  |
       +---+   +-----+-----+-----+-----+-----+
```

- Let's write the code to do the left shift.
  - Can we generalize it so that it will work on an array of any size?
  - Can we write a right-shift as well?

Shifting practice problem

- Write a method `insertInOrder` that accepts a sorted array *a* of integers and an integer value *n* as parameters, and inserts *n* into *a* while maintaining sorted order.

  In other words, assume that the element values in *a* occur in sorted ascending order, and insert the new value n into the array at the appropriate index, shifting to make room if necessary. The last element in the array will be lost after the insertion.

  - Example: calling `insertInOrder` on array {1, 3, 7, 10, 12, 15, 22, 47, 74} and value = 11 produces {1, 3, 7, 10, 11, 12, 15, 22, 47}.

String methods with arrays

- These String methods return arrays:

```
String s = "long book";
```

Method name	Description	Example

toCharArray()	separates this String into an array of its characters	s.toCharArray()
		returns {'l', 'o', 'n', 'g', ' ', 'b', 'o', 'o', 'k'}

split(*delimiter*)	separates this String into substrings by the given delimiter	s.split(" ") returns {"long", "book"}
		s.split("o") returns {"l", "ng b", "", "k"}

String practice problems

- Write a method named `areAnagrams` that accepts two Strings as its parameters and returns whether those two Strings contain the same letters (possibly in different orders).
  - `areAnagrams("bear", "bare")` `returns true`
  - `areAnagrams("sale", "sail")` `returns false`
- Write a method that accepts an Array of Strings and counts the number of times a given letter is present in all the Strings

Graphics methods with arrays

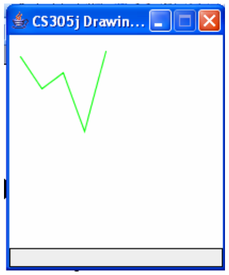
- These Graphics methods use arrays:

Method name
`drawPolygon(int[] xPoints, int[] yPoints, int length)`
`drawPolyline(int[] xPoints, int[] yPoints, int length)`
`fillPolygon(int[] xPoints, int[] yPoints, int length)`

```
int[] xPoints = {10, 30, 50, 70, 90};
int[] yPoints = {20, 50, 35, 90, 15};
g.setColor(Color.GREEN);
g.drawPolyline(xPoints, yPoints, 5);
```

xPoints and yPoints are "parallel" arrays

parallel arrays: two or more separate arrays, usually of the same length, whose elements with equal indices are associated with each other in some way



Arrays of objects

- Recall: when you construct an array of primitive values like ints, the elements' values are all initialized to 0.
  - What is the equivalent of 0 for objects?
- When you construct an array of objects (such as Strings), each element initially stores a special reference value called null.
  - null means 'no object'
  - Your program will crash if you try to call methods on a null reference.
- `String[] words = new String[5];`

index	0	1	2	3	4
value	null	null	null	null	null

The dreaded 'null pointer'

- Null array elements often lead to program crashes:

```
String[] words = new String[5];
System.out.println(words[0]);
words[0] = words[0].toUpperCase();  // kaboom!
```

- Output:

```
null
Exception in thread "main"
java.lang.NullPointerException
        at ExampleProgram.main(DrawPolyline.java:8)
```

- The array elements should be initialized somehow:

```
for (int i = 0; i < words.length; i++) {
    words[i] = "this is string #" + (i + 1);
}
words[0] = words[0].toUpperCase();  // okay now
```

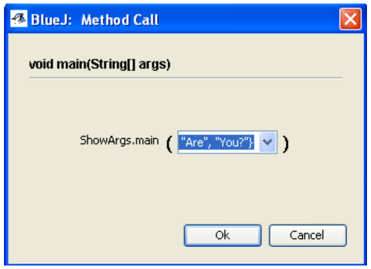
Command-line arguments

- **command-line arguments**: If you run your Java program from the Command Prompt, you can write parameters after the program's name.
  - The parameters are passed into `main` as an array of Strings.

```
public static void main(String[] args) {
    for (int i = 0; i < args.length; i++) {
        System.out.println("arg " + i + ": " + args[i]);
    }
}
```

- Usage:

```
C:\hw6> java ExampleProgram how are you?
Or BlueJ call to main
arg 0: how
arg 1: are
arg 2: you?
```



BlueJ: Method Call

void main(String[] args)

ShowArgs.main ("Are", "You?"})

Java's Arrays class

- The `Arrays` class in package `java.util` has several useful static methods for manipulating arrays:

Method name	Description
binarySearch(*array*, *value*)	returns the index of the given value in this array (-1 if not found)
equals(*array1*, *array2*)	whether the two given arrays contain exactly the same elements in the same order
fill(*array*, *value*)	sets every element in the array to have the given value
sort(*array*)	arranges the elements in the array into ascending order
toString(*array*)	returns a String representing the array

Arrays class example

- Searching and sorting numbers in an array:

```
int[] numbers = {23, 13, 480, -18, 75};
int index = Arrays.binarySearch(numbers, -18);
System.out.println("index = " + index);
```

  - Output:

```
index = 3
```

- Sorting and searching:

```
Arrays.sort(numbers);// now {-18, 13, 23, 75, 480}
index = Arrays.binarySearch(numbers, -18);
System.out.println("index = " + index);
System.out.println(Arrays.toString(numbers));
```

  - Output:

```
index = 0
[-18, 13, 23, 75, 480]
```