

CS 152

Computer Programming Fundamentals

Arrays

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Why Arrays?

- Do you remember your math?

$$\bar{x} = \frac{\sum_{i=1}^N x_i}{N}$$

What is this?

- Right. . . The arithmetic mean. . .
- So, if you have N variables, of the same type, but different values, you need N variable declarations in order to store those values.
- And in a loop, a way of accessing all those variables in order

Averaging Numbers in Java

```
double x1;  
double x2;  
double x3;  
double x4;  
  
// initialize values here...  
  
double sum = x1 + x2 + x3 + x4;  
double average = sum / 4;
```

Averaging a few values is easy, but what if we have more?

Averaging Numbers in Java

```
double x1;  
double x2;  
double x3;  
double x4;  
double x5;  
double x6;  
double x7;  
double x8;  
double x9;  
double x10;
```

This is getting ugly...

It would help if we could
loop over the variables

```
// initialize values here...
```

```
double sum = x1 + x2 + x3 + x4 + x5  
            + x6 + x7 + x8 + x9 + x10;  
double average = sum / 10;
```

What is an array?

- An array is basically an indexed variable, just like the formula on the earlier slide.
- Java arrays are 0-based arrays, so array indices always start at 0 (zero).
- The number of elements in the array can be accessed through by reading the `length` variable in the object.

Averaging Numbers in an Array

```
double[] x = new double[10];
```

Create array to
hold 10 doubles

```
// initialize values here...
```

```
double sum = 0;
```

```
for(int i = 0; i < x.length; i++) {
```

```
    sum += x[i];
```

```
}
```

Ask array its length

Access array element at index i

```
double average = sum / x.length;
```

Array declaration

- The standard form is:
`<type>[] <variableName>;`
- You can declare arrays of *any* type you want
- The above doesn't tell you how many elements there should be in the array.
- We haven't initialized the array yet, so the variable refers to `null`

Array declaration

- The standard form is:

```
<type>[] <variableName> = new <type>[<size>];
```

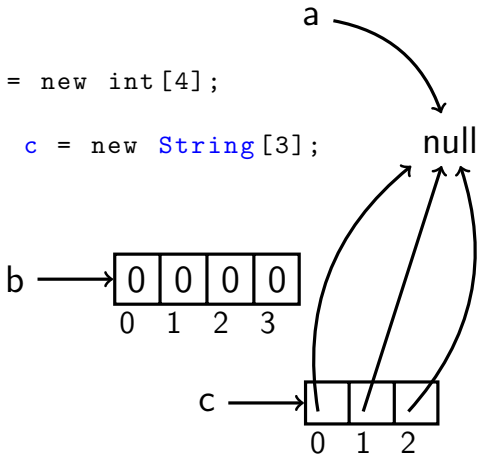
- The size tells us how many elements are in that array
- Arrays are initialized by default (on creation), this means:
 - Arrays of numbers contain all 0's
 - Arrays of reference types contains all null
- If you didn't create the array, you can still find out the length of it by using the `<variableName>.length` expression
 - This means, access the `length` instance variable in the array object referred to by the variable `<variableName>.`

Array declaration

```
int[] a;
```

```
int[] b = new int[4];
```

```
String[] c = new String[3];
```



Accessing array values

- Just like in math, we can read and assign to different indices of our variables.
- In the following example, I'm assuming that indexed variables in math are 1-based, and that appropriate Java arrays (of the right type) have already been created.

Math	Java
x_i	<code>x[i-1]</code>
$y = x_3$	<code>y = x[2];</code>
$x_5 = 15.67$	<code>x[4] = 15.67;</code>
$k = \frac{x_1 - x_2}{y_1 - y_2}$	<code>k = (x[0] - x[1]) / (x[0] - x[1]);</code>

Array Initialization

- Arrays can be directly initialized to values by using what's called "Array Initializers":
 - `int[] arr = {5, 3, 8, 4};`
Creates an int array of length 4 with above values.
 - `String[] sArr = {"Hello", "World"};`
Creates a String array of length 2 with the above values
- Note! Java array structure is *immutable* once created. This means:
 - You can change values of the elements
 - You can not change the length of the array once it's been created.

Assigning arrays to each other

Since Java arrays are reference types we have to take some special considerations when trying to assign one to another:

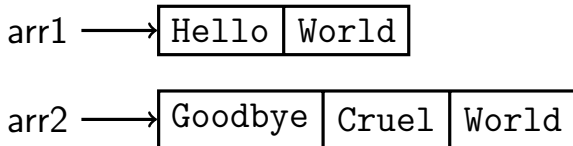
```
String[] arr1 = { "Hello", "World" };  
String[] arr2 = { "Goodbye", "Cruel", "World" };  
arr1 = arr2; // Array assignment
```

- In the above example both variables `arr1` and `arr2` now refer to the second array, and no variable refers to the original `arr1`.
- When an object (in this case an array) no longer has any variables referring to it, its memory is eventually recycled by means of the “garbage collector”.

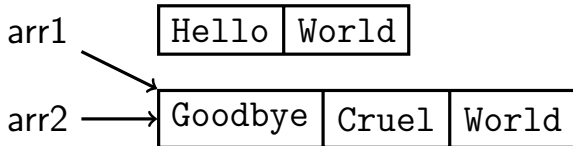
Assigning arrays to each other

```
String[] arr1 = { "Hello", "World" };  
String[] arr2 = { "Goodbye", "Cruel", "World" };  
arr1 = arr2; // Array assignment
```

Before
assignment

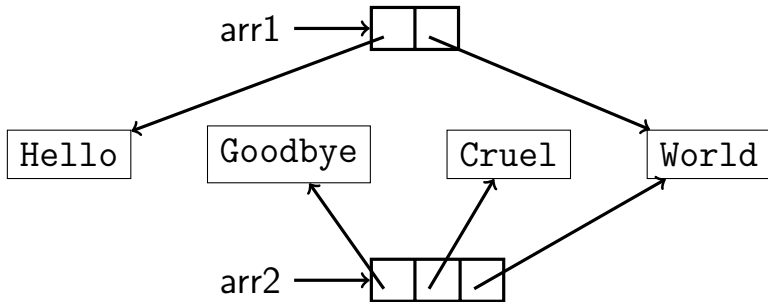


After
assignment



Array of Objects

```
String[] arr1 = { "Hello", "World" };  
String[] arr2 = { "Goodbye", "Cruel", "World" };
```



Array Example

```
public class ArrayExample1 {  
    public static void main ( String[] args ) {  
        int[] a = new int[15]; // Array with 15 elements  
        int[] b = new int[15];  
  
        // Give each element a value  
        for ( int i = 0; i < a.length; i++ ) {  
            a[i] = i;  
            b[i] = a.length - i - 1;  
        }  
        // Print out every element in the array  
        for ( int element: a ) {  
            System.out.println ( element );  
        }  
        // Copy values from one array to the other  
        for ( int i = 0; i < a.length; i++ ) {  
            b[i] = a[i];  
        }  
    }  
}
```

String vs char[]

A String is not the same as an array of chars.

	String s;	char[] a;
Find length	s.length()	a.length
Find i^{th} char	s.charAt(i)	a[i]
Convert to other	s.toCharArray()	new String(a)

Array of Arrays

- An array is a object type, so we could make an array to hold arrays.
- The following code makes an array of arrays of ints.

```
int[] [] arr2d = new int[3][4];
```

This array has three elements, each consisting of an array of four ints.

