

# Introduction to Programming

*with Java, for Beginners*

## Intro to Arrays of Primitives (1 Dimensional Array)

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0

## What if we need 10 different ints for storage?

```
int num1;  
int num2;  
int num3;  
int num4;  
int num5;  
int num6;  
int num7;  
int num8;  
int num9;  
int num10;  
...
```

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1

## What if we want to store lots of things...

- But we don't want to declare a separate variable for each one?
- That's what *arrays* are good for

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2

## What is an Array ?

- It's an easy way to declare lots of variables that all have the *same type*

```
type [] variableName = new type [#];
```

E.g. declare an array of integers

```
int[] data = new int[5]; //total ints = 5
```

- When an array of particular primitive type is created, Java initializes the elements to the types default value. E.g. Array of ints – default value is zero

0	0	0	0	0
---	---	---	---	---

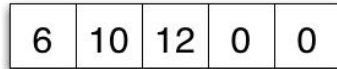
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3

## Array Elements and Indices

- To initialize integer array

- `data[0] = 6;`
- `data[1] = 10;`
- `data[2] = 12;`



- The number within square brackets is called an *index*
- The valid *indices* are 0 thru (array length - 1)
  - 0 : first element of the array
  - n-1: last element of the array

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4

## An Array is an Object

<code>int[] data;</code>	<i>data</i> is a reference variable whose <i>type</i> is <code>int[]</code> , meaning "array of ints". At this point its value is null.
<code>data = new int[5];</code>	The <i>new</i> operator causes a chunk of memory big enough for 5 ints to be allocated on the heap. Here, <i>data</i> is assigned a reference to the heap address.
<code>data[0] = 6;</code> <code>data[1] = 10;</code> <code>data[2] = 12;</code>	Initially, all five ints are 0. Here, three of them are assigned other values.
<code>int[] info = {6, 10, 12, 0, 0};</code>	
<code>int[] info = new int[]{6, 10, 12, 0, -1};</code>	

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5

## Array of Primitives

`int[] data;`

data 

`data = new int[3];`

data  → 

value 500 is indicating address where the array object is stored (heap address)

`data[0] = 5;`  
`data[1] = 10;`

data  → 

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6

## Using Array Elements in Expressions

- An *element* of an array of ints can be used virtually anywhere an expression of type `int` is valid.
- Likewise for arrays of other types

```
int[] data = new int[] {6, 10, 12, 0, 0};
int x = data[0];
data[3] = data[2];
data[4] = data[3] + data[2] * 2;
System.out.println("data[0] is " + data[0]);
data[4] = Math.pow(2, data[4]);
```

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7

## Accessing an Array's Length

- `ArrayName.length` gives size of the array

```
int[] data;
data = new int[5];    // data.length is 5
data[0] = 6;
data[1] = 10;
data[2] = 12;

//How to Sum the contents of an array
int result = 0;
for (int i =0; i < data.length; i++){
    result = result + data[i];
}
```

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8

## Passing arrays

- Methods can take an array as input

```
return-type methodName(int [] data){..}
```

- This gives the function to access each element of the array
- It also gives it ability to change the array
  - Hence we say arrays are passed by **reference** unlike variables that are passed by values

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9

## Returning Array

- Similarly a method can also return an array

```
int [] methodName(..) {
    ...
    return arrayName;
}
```

- **Uses:**
  - Allows any type of method to create an array
  - This may provide access to array that may be declared private

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10

## Complete the sum(..) method

```
public class ArrayToolkit{

    /**
     * Takes an array of ints as an argument.
     * returns the sum of all the integers in the array.
     */
    public static int sum (int [] data ) {
        int result = 0;
        for (int i = 0; i < data.length; i++){
            result = result + data[i];
        }
    }

}

Welcome to DrJava
> int[] data = new int[] {6, 10, 12, 0, 0};
> ArrayToolkit.sum(data)
28
```

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11

## Array Out of Bounds Exceptions

```
public class ArrayToolkit{  
  
    public static int sum(int[] data){  
        int sum = 0;  
        for (int i = 0; i <= data.length; i++){  
            sum = sum + data[i];  
        }  
        return sum;  
    }  
}
```

```
> int[] data = new int[] {6, 10, 12, 0, 0};  
> ArrayToolkit.sum(data)  
ArrayIndexOutOfBoundsException
```

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12

## Declaring & Initializing Arrays of Primitive Type

```
int[] info1 = { 2000, 100, 40, 60};  
int[] info2 = new int[] {2000, 100, 40, 60};
```

```
char[] choices1 = { 'p', 's', 'q'};  
char[] choices2 = new char[] { 'p', 's', 'q'};
```

```
double[] temps1 = {75.6, 99.4, 86.7};  
double[] temps2 = new double[] {75.6, 99.4, 86.7};
```

*Note: The advantage of using the "new type[]" syntax is that it can be used in an assignment statement that is not a variable declaration statement.*

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13

## Complete this method

```
public class ArrayTool{  
  
    /* Returns true if all integers in the  
    data array are positive, false otherwise.  
    */  
    public static boolean allPositive(int[] data){  
  
    }  
}
```

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14

## Finding Max

- Complete max method, that finds the maximum value in the array
  - Assume that input passed is valid, no need for error checking

```
//Dr Java Interactions Pane  
> int[] data = new int[] {6, 10, 12, 0, 0};  
> ArrayTool.max(data)  
12
```

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15

## Finding Max

- Suppose you want to find the largest value in an array called `scores`:

```
int largestScore = 0;
for (int i = 0; i < scores.length; i++) {
    if (scores[i] > largestScore) {
        largestScore = scores[i];
    }
}
```

- What is wrong with this approach ?

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16

## Improved Solution

- To find the largest value in an array scores of (possibly negative) integers:

```
int largestScore = scores[0];
for (int i = 1; i < scores.length; i++) {
    if (scores[i] > largestScore) {
        largestScore = scores[i];
    }
}
```

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17

## Finding Location of Max Value

- Suppose you want to find the location in which you find the largest value in an array `scores`

```
int largestScore = scores[0];
int index = 0;
for (int i = 1; i < scores.length; i++) {
    if (scores[i] > largestScore) {
        largestScore = scores[i];
        index = i;
    }
}
```

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18

## Error Checking

- `int [] a = new int [value]` or
- `int [] a = b;` //where b is of type `int []`
- If value is `<=0` or b is null then we have run time errors
  - If value = 0
    - Creates an array object of size zero
    - But there are no elements
  - If value is negative, then `NegativeArraySizeException` is raised
    - No check value before creating array of size value.
- Check before accessing array elements
  - `if(a == null || a.length == 0)`

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19