

Building Java Programs

Chapter 7

Lecture 7-2: Arrays as Parameters

reading: 7.1-7.3



Why did the programmer quit his job?

Because he didn't get arrays.



Array parameter (declare)

```
public static type methodName(type[] name) {
```

- **Example:**

```
// Returns the average of the given array of numbers.
```

```
public static double average(int[] numbers) {  
    int sum = 0;  
    for (int i = 0; i < numbers.length; i++) {  
        sum += numbers[i];  
    }  
    return (double) sum / numbers.length;  
}
```

- You don't specify the array's length (but you can examine it).

Array parameter (call)

methodName (**arrayName**) ;

- Example:

```
public class MyProgram {  
    public static void main(String[] args) {  
        // figure out the average TA IQ  
        int[] iq = {126, 84, 149, 167, 95};  
        double avg = average(iq);  
        System.out.println("Average IQ = " + avg);  
    }  
    ...  
}
```

- Notice that you don't write the [] when passing the array.

Array return (declare)

```
public static type[] methodName(parameters) {
```

- Example:

```
// Returns a new array with two copies of each value.
```

```
// Example: [1, 4, 0, 7] -> [1, 1, 4, 4, 0, 0, 7, 7]
```

```
public static int[] double(int[] numbers) {  
    int[] result = new int[2 * numbers.length];  
    for (int i = 0; i < numbers.length; i++) {  
        result[2 * i] = numbers[i];  
        result[2 * i + 1] = numbers[i];  
    }  
    return result;  
}
```

Array return (call)

type [] name = methodName (parameters) ;

- Example:

```
public class MyProgram {  
    public static void main(String[] args) {  
        int[] iq = {126, 84, 149, 167, 95};  
        int[] doubled = double(iq);  
        System.out.println(Arrays.toString(doubled));  
    }  
    ...  
}
```

- Output:

```
[126, 126, 84, 84, 149, 149, 167, 167, 95, 95]
```

Array reversal question

- Write code that reverses the elements of an array.
 - For example, if the array initially stores:
`[11, 42, -5, 27, 0, 89]`
 - Then after your reversal code, it should store:
`[89, 0, 27, -5, 42, 11]`
 - The code should work for an array of any size.
 - Hint: think about swapping various elements...

Algorithm idea

- Swap pairs of elements from the edges; work inwards:

<i>index</i>	0	1	2	3	4	5
<i>value</i>	89	0	27	-5	42	11
	↑	↑	↑	↑	↑	↑

Swapping values

```
public static void main(String[] args) {  
    int a = 7;  
    int b = 35;  
  
    // swap a with b?  
    a = b;  
    b = a;  
  
    System.out.println(a + " " + b);  
}
```

- What is wrong with this code? What is its output?
- The red code should be replaced with:

```
int temp = a;  
a = b;  
b = temp;
```

Flawed algorithm

- What's wrong with this code?

```
int[] numbers = [11, 42, -5, 27, 0, 89];  
  
// reverse the array  
for (int i = 0; i < numbers.length; i++) {  
    int temp = numbers[i];  
    numbers[i] = numbers[numbers.length - 1 - i];  
    numbers[numbers.length - 1 - i] = temp;  
}
```

- The loop goes too far and un-reverses the array! Fixed version:

```
for (int i = 0; i < numbers.length / 2; i++) {  
    int temp = numbers[i];  
    numbers[i] = numbers[numbers.length - 1 - i];  
    numbers[numbers.length - 1 - i] = temp;  
}
```

Array reverse question 2

- Turn your array reversal code into a `reverse` method.
 - Accept the array of integers to reverse as a parameter.

```
int[] numbers = {11, 42, -5, 27, 0, 89};  
reverse (numbers) ;
```

- How do we write methods that accept arrays as parameters?
- Will we need to return the new array contents after reversal?
- ...

Reference semantics

reading: 7.3

A swap method?

- Does the following `swap` method work? Why or why not?

```
public static void main(String[] args) {  
    int a = 7;  
    int b = 35;  
  
    // swap a with b?  
    swap(a, b);  
  
    System.out.println(a + " " + b);  
}
```

```
public static void swap(int a, int b) {  
    int temp = a;  
    a = b;  
    b = temp;  
}
```

Value semantics

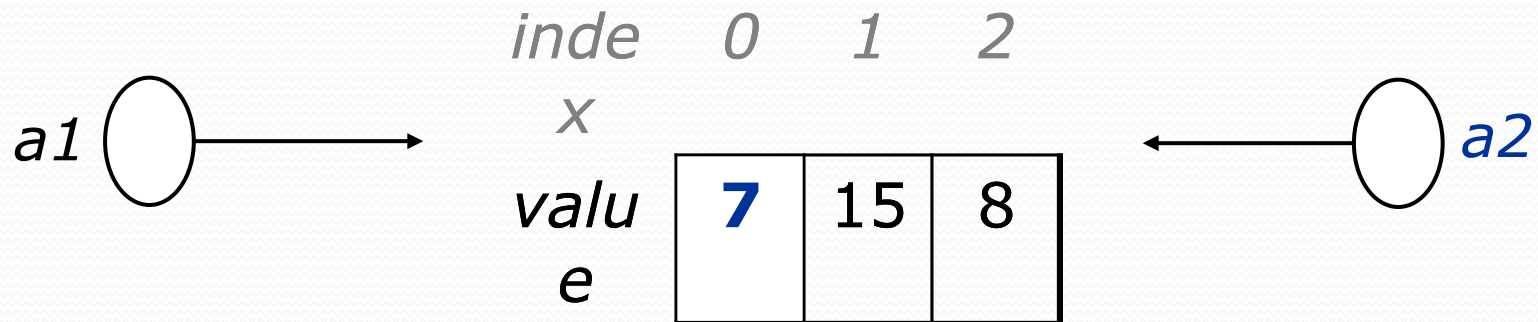
- **value semantics:** Behavior where values are copied when assigned, passed as parameters, or returned.
 - All primitive types in Java use value semantics.
 - When one variable is assigned to another, its value is copied.
 - Modifying the value of one variable does not affect others.

```
int x = 5;  
int y = x;      // x = 5, y = 5  
y = 17;         // x = 5, y = 17  
x = 8;          // x = 8, y = 17
```

Reference semantics (objects)

- **reference semantics:** Behavior where variables actually store the address of an object in memory.
 - When one variable is assigned to another, the object is *not* copied; both variables refer to the *same object*.
 - Modifying the value of one variable *will* affect others.

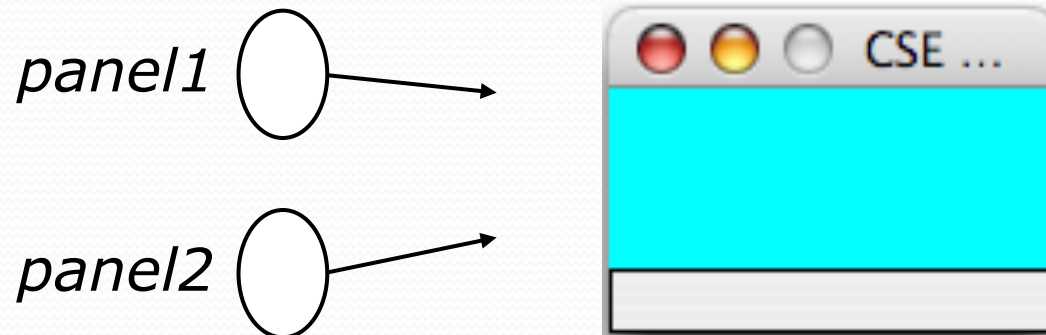
```
int[] a1 = {4, 15, 8};  
int[] a2 = a1;           // refer to same array as a1  
a2[0] = 7;  
System.out.println(Arrays.toString(a1)); // [7, 15, 8]
```



References and objects

- Arrays and objects use reference semantics. Why?
 - *efficiency*. Copying large objects slows down a program.
 - *sharing*. It's useful to share an object's data among methods.

```
DrawingPanel panel1 = new DrawingPanel(80, 50);  
DrawingPanel panel2 = panel1; // same window  
panel2.setBackground(Color.CYAN);
```



Value/Reference Semantics

- Variables of primitive types store values directly:

age 20

cats 3

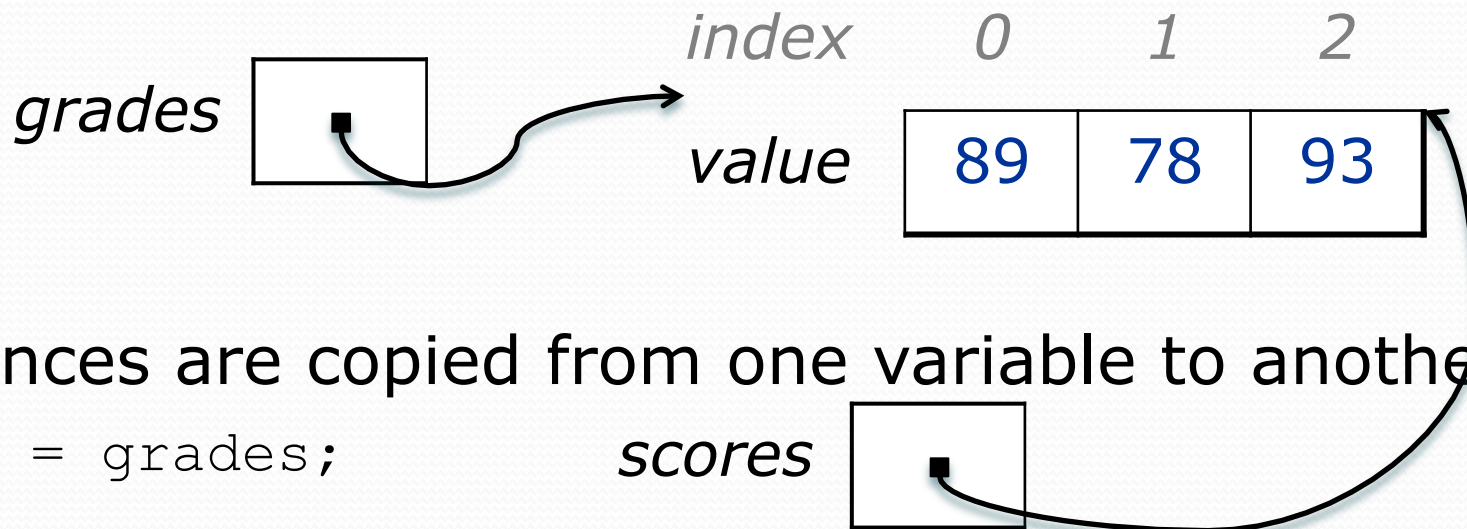
- Values are copied from one variable to another:

`cats = age;`

age 20

cats 20

- Variables of object types store references to memory:



- References are copied from one variable to another:

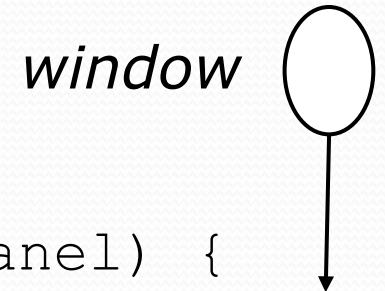
`scores = grades;`

scores □

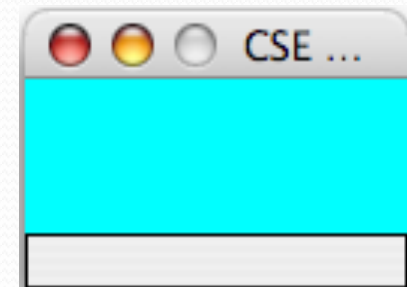
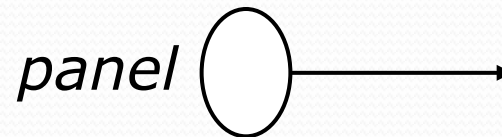
Objects as parameters

- When an object is passed as a parameter, the object is *not* copied. The parameter refers to the same object.
 - If the parameter is modified, it *will* affect the original object.

```
public static void main(String[] args) {  
    DrawingPanel window = new DrawingPanel(80, 50);  
    window.setBackground(Color.YELLOW);  
    example(window);  
}
```



```
public static void example(DrawingPanel panel) {  
    panel.setBackground(Color.CYAN);  
    ...  
}
```

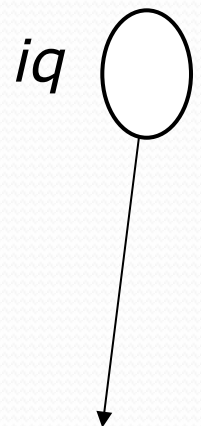


Arrays pass by reference

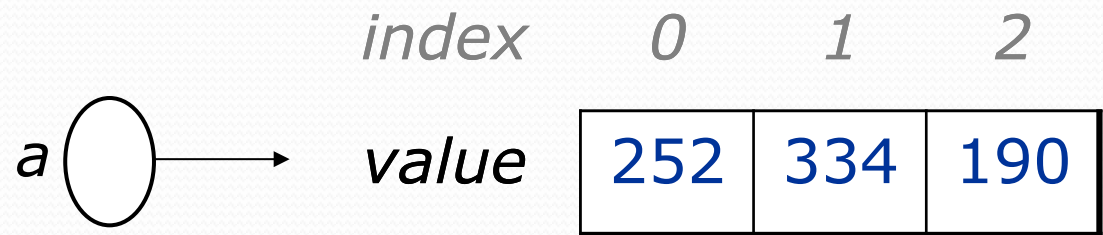
- Arrays are passed as parameters by *reference*.
 - Changes made in the method are also seen by the caller.

```
public static void main(String[] args) {  
    int[] iq = {126, 167, 95};  
    increase(iq);  
    System.out.println(Arrays.toString(iq));  
}
```

```
public static void increase(int[] a) {  
    for (int i = 0; i < a.length; i++) {  
        a[i] = a[i] * 2;  
    }  
}
```



- **Output:**
[252, 334, 190]



Array reverse question 2

- Turn your array reversal code into a `reverse` method.
 - Accept the array of integers to reverse as a parameter.

```
int[] numbers = {11, 42, -5, 27, 0, 89};  
reverse (numbers) ;
```

- **Solution:**

```
public static void reverse(int[] numbers) {  
    for (int i = 0; i < numbers.length / 2; i++) {  
        int temp = numbers[i];  
        numbers[i] = numbers[numbers.length - 1 - i];  
        numbers[numbers.length - 1 - i] = temp;  
    }  
}
```

Array parameter questions

- Write a method `swap` that accepts an arrays of integers and two indexes and swaps the elements at those indexes.

```
int[] a1 = {12, 34, 56};  
swap(a1, 1, 2);  
System.out.println(Arrays.toString(a1)); // [12, 56, 34]
```

- Write a method `swapAll` that accepts two arrays of integers as parameters and swaps their entire contents.
 - Assume that the two arrays are the same length.

```
int[] a1 = {12, 34, 56};  
int[] a2 = {20, 50, 80};  
swapAll(a1, a2);  
System.out.println(Arrays.toString(a1)); // [20, 50, 80]  
System.out.println(Arrays.toString(a2)); // [12, 34, 56]
```

Array parameter answers

// Swaps the values at the given two indexes.

```
public static void swap(int[] a, int i, int j) {  
    int temp = a[i];  
    a[i] = a[j];  
    a[j] = temp;  
}
```

// Swaps the entire contents of a1 with those of a2.

```
public static void swapAll(int[] a1, int[] a2) {  
    for (int i = 0; i < a1.length; i++) {  
        int temp = a1[i];  
        a1[i] = a2[i];  
        a2[i] = temp;  
    }  
}
```


Array return question

- Write a method `merge` that accepts two arrays of integers and returns a new array containing all elements of the first array followed by all elements of the second.

```
int[] a1 = {12, 34, 56};  
int[] a2 = {7, 8, 9, 10};  
  
int[] a3 = merge(a1, a2);  
System.out.println(Arrays.toString(a3));  
// [12, 34, 56, 7, 8, 9, 10]
```

- Write a method `merge3` that merges 3 arrays similarly.

```
int[] a1 = {12, 34, 56};  
int[] a2 = {7, 8, 9, 10};  
int[] a3 = {444, 222, -1};  
  
int[] a4 = merge3(a1, a2, a3);  
System.out.println(Arrays.toString(a4));  
// [12, 34, 56, 7, 8, 9, 10, 444, 222, -1]
```

Array return answer 1

```
// Returns a new array containing all elements of a1  
// followed by all elements of a2.
```

```
public static int[] merge(int[] a1, int[] a2) {  
    int[] result = new int[a1.length + a2.length];  
  
    for (int i = 0; i < a1.length; i++) {  
        result[i] = a1[i];  
    }  
  
    for (int i = 0; i < a2.length; i++) {  
        result[a1.length + i] = a2[i];  
    }  
  
    return result;  
}
```

Array return answer 2

// Returns a new array containing all elements of a1,a2,a3.

```
public static int[] merge3(int[] a1, int[] a2, int[] a3) {  
    int[] a4 = new int[a1.length + a2.length + a3.length];  
  
    for (int i = 0; i < a1.length; i++) {  
        a4[i] = a1[i];  
    }  
    for (int i = 0; i < a2.length; i++) {  
        a4[a1.length + i] = a2[i];  
    }  
    for (int i = 0; i < a3.length; i++) {  
        a4[a1.length + a2.length + i] = a3[i];  
    }  
  
    return a4;  
}
```

// Shorter version that calls merge.

```
public static int[] merge3(int[] a1, int[] a2, int[] a3) {  
    return merge(merge(a1, a2), a3);  
}
```