Java Programming, 9e

Chapter 8

Arrays

CENGAGE

Objectives

- Declare an array
- Initialize an array
- Use variable subscripts with an array
- Declare and use arrays of objects
- Search an array and use parallel arrays
- Pass arrays to and return arrays from methods

Declaring an Array (1 of 4)

- **Array**
  - A named list of data items called **elements**
  - All data items have the same type
- Declare an array variable
  - The same way as declaring any simple variable
  - Insert a pair of square brackets after the type

```
double[] salesFigure;
int[] idNums;
```

Declaring Arrays (2 of 4)

- Still need to reserve memory space

```
        sale = new double[20];
        double[] sale = new double[20];
```

- **Subscript**
  - An integer contained within square brackets
  - Indicates one of the array's variables or elements
  - A subscript that is too small or too large for an array is **out of bounds**
    - An error message is generated

Declaring Arrays (3 of 4)

- An array’s elements are numbered beginning with 0
  - You can legally use any subscript from 0 through 19 when working with an array that has 20 elements
- When working with any individual array element, treat it no differently than a single variable of the same type
  - Example: `sale[0] = 2100.00;`

Declaring Arrays (4 of 4)

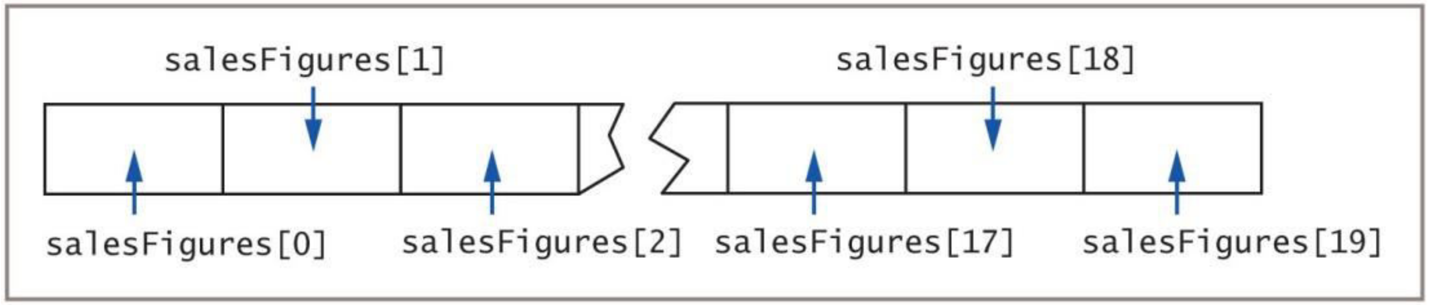


Figure 8-1 The first few and last few elements of an array of 20 `salesFigures` items in memory

Initializing an Array (1 of 3)

- A variable with a reference type, such as an array, holds a memory address where a value is stored
- Array names:
  - Represent computer memory addresses
  - Contain references
- When you declare an array name:
  - No computer memory address is assigned
  - The array has the special value `null`
    - Unicode value ‘\u0000’

Initializing an Array (2 of 3)

- Use the keyword `new` to define an array
  - The array name acquires the actual memory address value
- `int[] someNums = new int[10];`
  - Each element of `someNums` has a value of 0
- `char` array elements
  - Assigned ‘\u0000’
- `boolean` array elements
  - Automatically assigned the value `false`
- `String`s and arrays of objects
  - Assigned `null` by default

Initializing an Array (3 of 3)

- Assign nondefault values to array elements upon creation

```
int[] tenMult = {10, 20, 30, 40, 50, 60};
```

- An **initialization list** initializes an array
  - Values are separated by commas and enclosed within curly braces
- **Populating an array**
  - Providing values for all the elements in an array

Using Variable Subscripts with an Array (1 of 4)

- Power of arrays
  - Use subscripts that are variables rather than constant subscripts
  - Use a loop to perform array operations

```
for (sub = 0; sub < 5; ++sub)
   scoreArray[sub] += 3;
```

Using Variable Subscripts with an Array (2 of 4)

- When an application contains an array:
  - Use every element of the array in some task
  - Perform loops that vary the loop control variable
    - Start at 0
    - End at one less than the size of the array
- It is convenient to declare a symbolic constant equal to the size of the array

```
final int NUMBER_OF_SCORES = 5;
```

Using Variable Subscripts with an Array (3 of 4)

- Field
  - An instance variable
  - Automatically assigned a value for every array created
- **`length` field:** number of elements in the array

```
for(sub = 0; sub < scoreArray.length; ++sub)
    scoreArray[sub] += 3;
```

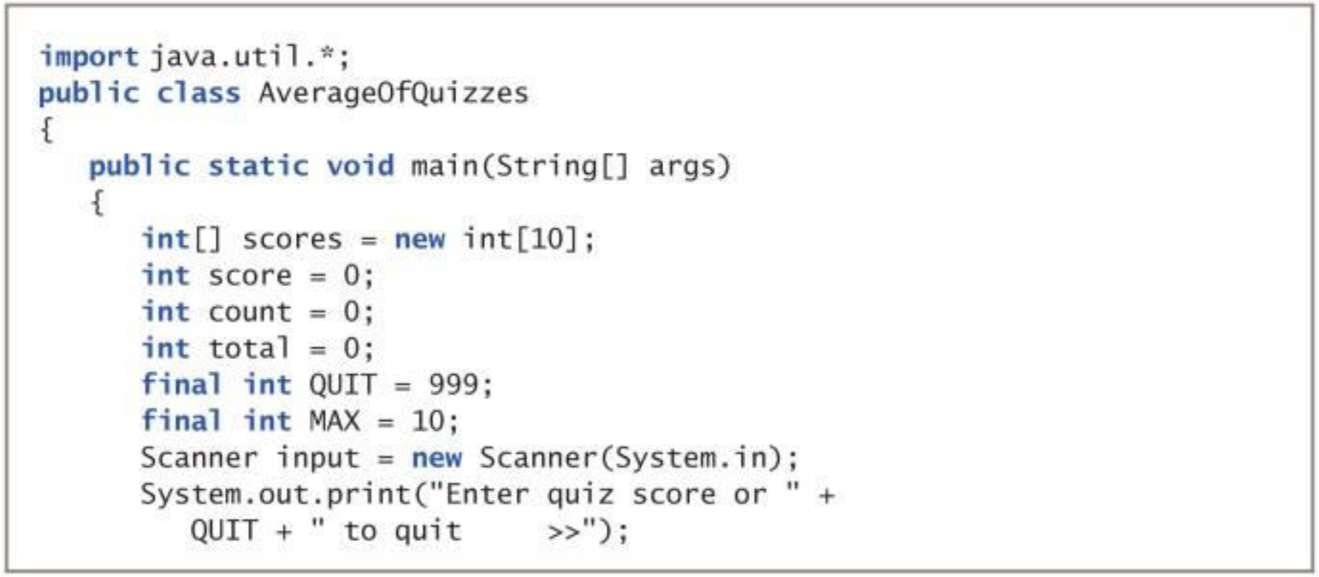
- `length` is a **property** of the object
  - Is a field
  - Cannot be used as an array method

Using Variable Subscripts with an Array (4 of 4)

- **Enhanced `for` loop**
  - Allows you to cycle through an array without specifying starting and ending points for the loop control variable

```
for(int val : scoreArray)
    System.out.println(val);
```

Using Part of an Array (1 of 2)

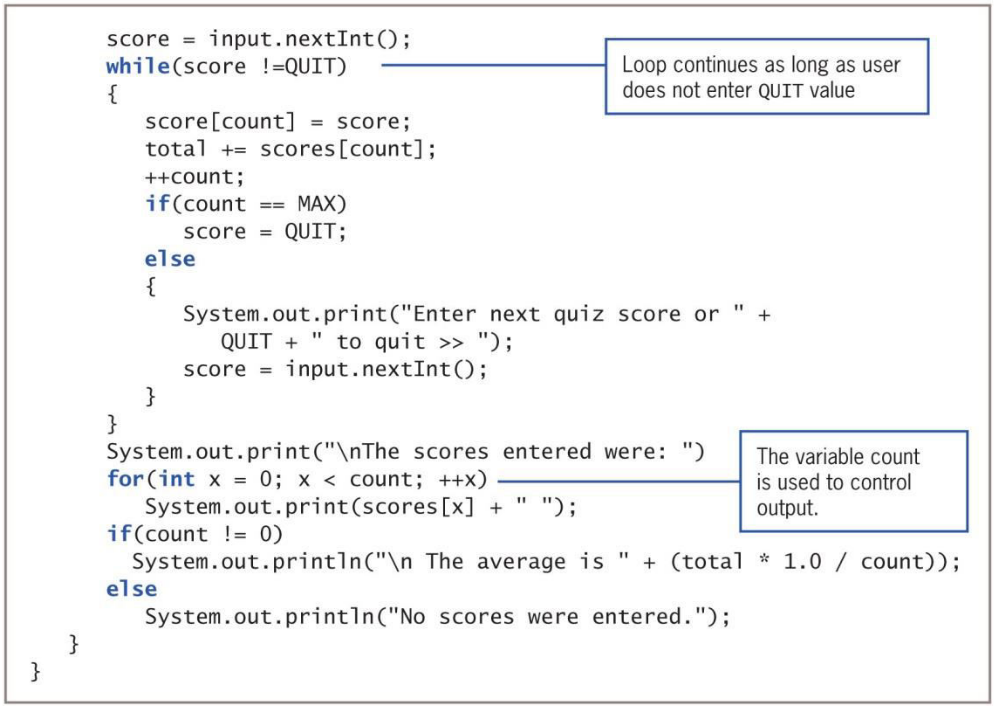


```
import java.util.*;
public class AverageOfQuizzes
{
   public static void main(String[] args)
   {
      int[] scores = new int[10];
      int score = 0;
      int count = 0;
      int total = 0;
      final int QUIT = 999;
      final int MAX = 10;
      Scanner input = new Scanner(System.in);
      System.out.print("Enter quiz score or " +
         QUIT + " to quit     >>");
```

Figure 8-4 The AverageOfQuizzes application (*continues*)

Using Part of an Array (2 of 2)

(continued)



```
        score = input.nextInt();
        while(score !=QUIT)
        {
           score[count] = score;
           total += scores[count];
           ++count;
           if(count == MAX)
              score = QUIT;
           else
           {
              System.out.print("Enter next quiz score or " +
                 QUIT + " to quit >> ");
              score = input.nextInt();
           }
        }
        System.out.print("\nThe scores entered were: ")
        for(int x = 0; x < count; ++x)
           System.out.print(scores[x] + " ");
        if(count != 0)
          System.out.println("\n The average is " + (total * 1.0 / count));
        else
           System.out.println("No scores were entered.");
     }
  }
```

Loop continues as long as user does not enter QUIT value

The variable count is used to control output.

Figure 8-4 The AverageOfQuizzes application

Declaring and Using Arrays of Objects

- Create an array of `Employee` objects

```
Employee[] emp = new Employee[7];
```

  - Must call seven individual constructors

```
final int START_NUM = 101;
final double STARTING_SALARY = 15_000;
for(int x = 0; x < emps.length; ++x)
   emps[x] = new Employee(START_NUM + x,
               STARTING_SALARY);
```

Using the Enhanced `for` Loop with Objects

- Use the enhanced `for` loop to cycle through an array of objects
  - Eliminates the need to use a limiting value
  - Eliminates the need for a subscript following each element

```
for(Employee worker : emps)
       System.out.println(worker.getEmpNum() + " " +
       worker.getSalary();
```

Manipulating Arrays of `Strings`

- Create an array of `Strings`

```
String[] deptNames = {"Accounting", "Human Resources",
"Sales"};
for(int a = 0; a < deptNames.length; ++a)
    System.out.println(deptNames[a]);
```

Searching an Array and Using Parallel Arrays (1 of 2)

- Determine whether a variable holds one of many valid values
  - Use a series of `if` statements
  - Compare the variable to a series of valid values

Searching an Array and Using Parallel Arrays (2 of 2)

- **Searching an array**
  - Compare the variable to a list of values in an array

```
for(int x = 0; x < validValues.length; ++x)
{
   if(itemOrdered == validValues[x])
      isValidItem = true;
 }
```

Using Parallel Arrays (1 of 3)

- **Parallel array**
  - One with the same number of elements as another
  - The values in corresponding elements are related
- An alternative for searching
  - Use the `while` loop

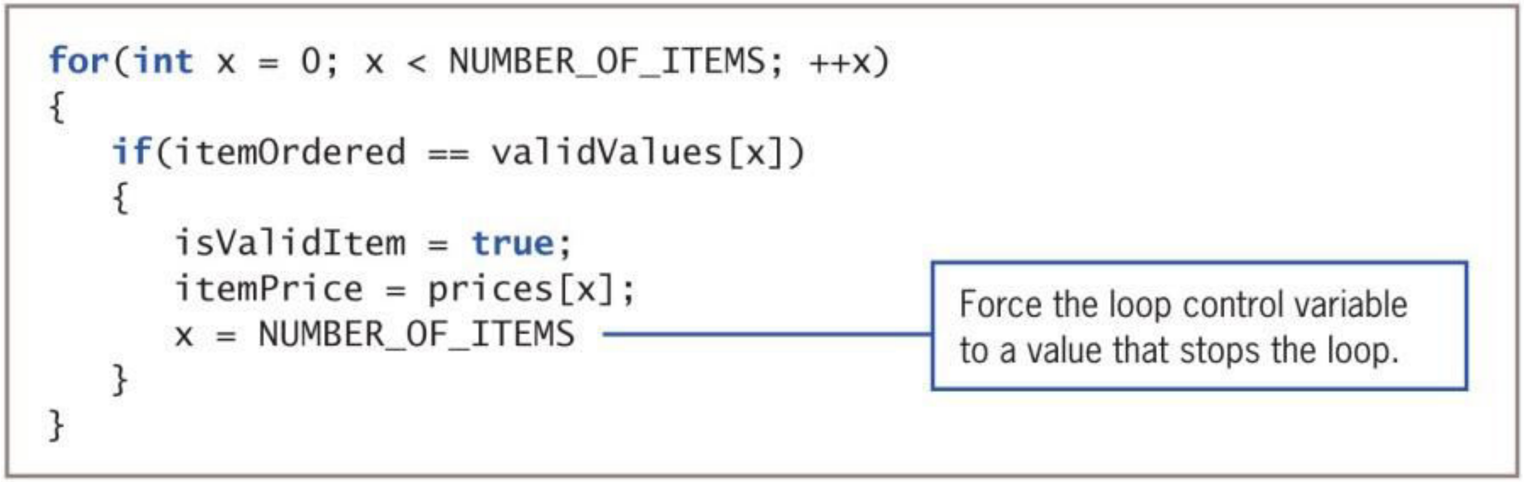
Using Parallel Arrays (2 of 3)

```
import javax.swing.*;
public class FindPrice
{
   public static void main(String[] args)
   {
      final int NUMBER_OF_ITEMS = 10;
      int[] validValues = {101, 108, 201, 213, 266,
         304, 311, 409, 411, 412};
      double[] prices = {0.29, 1.23, 3.50, 0.69, 6.79,
         3.19, 0.99, 0.89, 1.26, 8.00};
      String strItem;
      int itemOrdered;
      double itemPrice = 0.0;
      boolean isValidItem = false;
      strItem = JOptionPane.showInputDialog(null,
         "Enter the item number you want to order");
      itemOrdered = Integer.parseInt(strItem);
      for(int x = 0; x < NUMBER_OF_ITEMS; ++x)
      {
         if(itemOrdered == validValues[x])
         {
            isValidItem = true;
            itemPrice = prices[x];
         }
      }
      if(isValidItem)
         JOptionPane.showMessageDialog(null, The price for item " +
            itemOrdered + " is $" + itemPrice);
      else
         JOptionPane.showMessageDialog(null,
            "Sorry - invalid item entered");
   }
}
```

Corresponding price is pulled from `prices` array

Figure 8-9 The `FindPrice` application that accesses information in parallel arrays

Using Parallel Arrays (3 of 3)



```
for(int x = 0; x < NUMBER_OF_ITEMS; ++x)
{
    if(itemOrdered == validValues[x])
    {
        isValidItem = true;
        itemPrice = prices[x];
        x = NUMBER_OF_ITEMS
    }
}
```

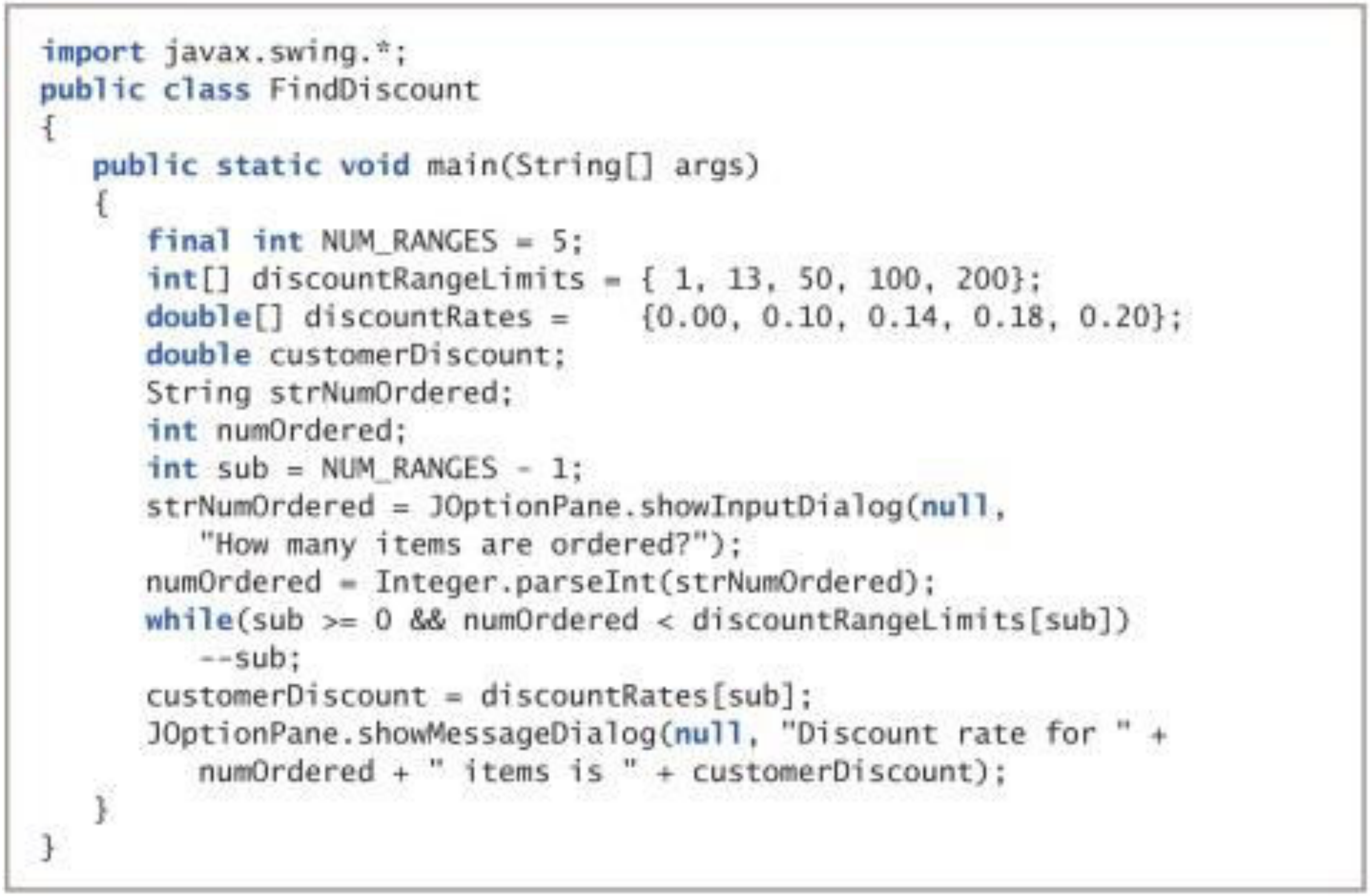
Force the loop control variable to a value that stops the loop.

Figure 8-11 A for loop with an early exit

Searching an Array for a Range Match (1 of 2)

- Searching an array for an exact match is not always practical
- **Range match**
  - Compare a value to the endpoints of numerical ranges
  - Find the category in which a value belongs

Searching an Array for a Range Match (2 of 2)



```
import javax.swing.*;
public class FindDiscount
{
   public static void main(String[] args)
   {
      final int NUM_RANGES = 5;
      int[] discountRangeLimits = { 1, 13, 50, 100, 200};
      double[] discountRates =    {0.00, 0.10, 0.14, 0.18, 0.20};
      double customerDiscount;
      String strNumOrdered;
      int numOrdered;
      int sub = NUM_RANGES - 1;
      strNumOrdered = JOptionPane.showInputDialog(null,
         "How many items are ordered?");
      numOrdered = Integer.parseInt(strNumOrdered);
      while(sub >= 0 && numOrdered < discountRangeLimits[sub])
         --sub;
      customerDiscount = discountRates[sub];
      JOptionPane.showMessageDialog(null, "Discount rate for " +
         numOrdered + " items is " + customerDiscount);
   }
}
```

Figure 8-13 The FindDiscount class

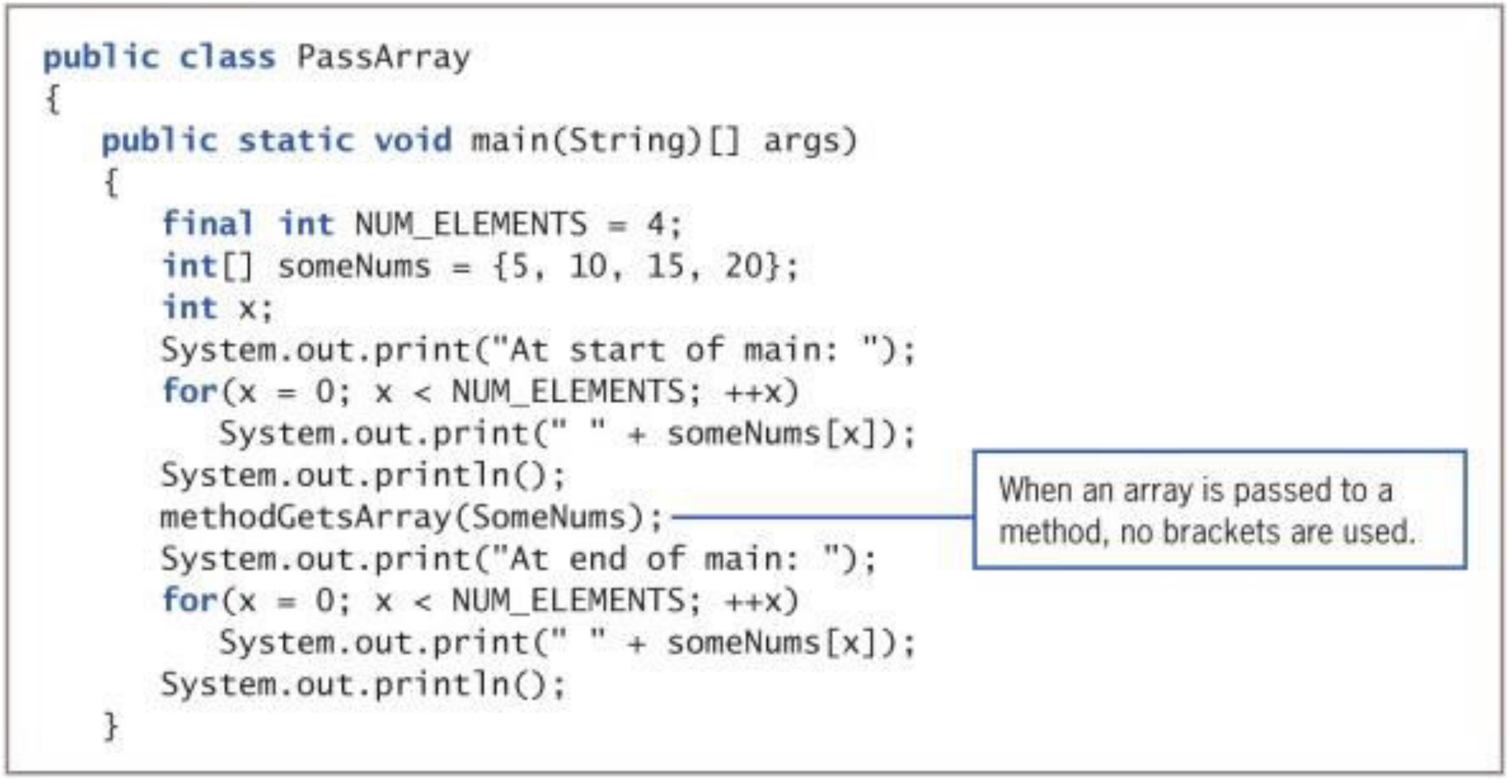
Passing Arrays to and Returning Arrays from Methods (1 of 4)

- Pass a single array element to a method
  - Same as passing a variable
- **Passed by value**
  - A copy of the value is made and used in the receiving method
  - All primitive types are passed this way

Passing Arrays to and Returning Arrays from Methods (2 of 4)

- **Reference types**
  - The object holds a memory address where the values are stored
  - The receiving method gets a copy of the array’s actual memory address
  - The receiving method has the ability to alter the original values in the array elements

Passing Arrays to and Returning Arrays from Methods (3 of 4)



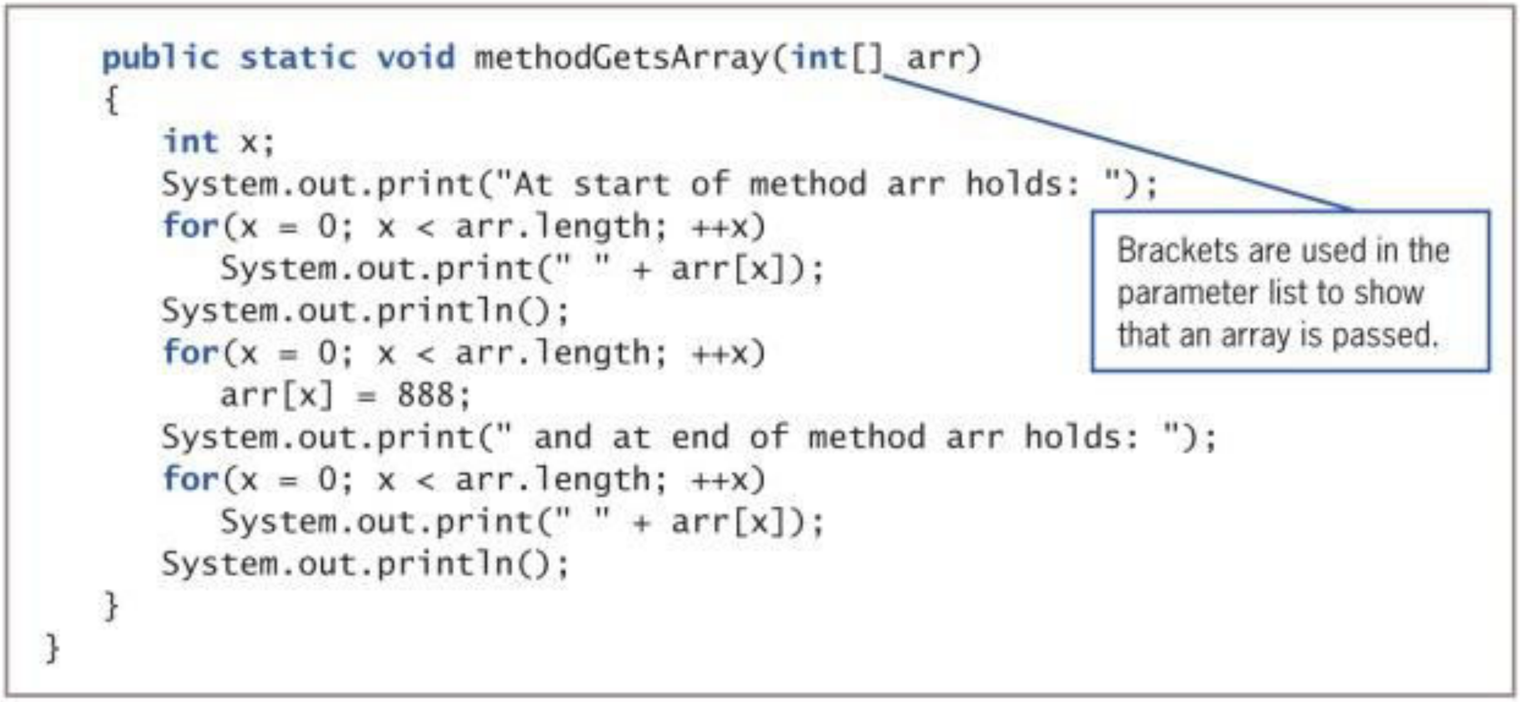
```
public class PassArray
{
   public static void main(String)[] args)
   {
      final int NUM_ELEMENTS = 4;
      int[] someNums = {5, 10, 15, 20};
      int x;
      System.out.print("At start of main: ");
      for(x = 0; x < NUM_ELEMENTS; ++x)
         System.out.print(" " + someNums[x]);
      System.out.println();
      methodGetsArray(SomeNums);
      System.out.print("At end of main: ");
      for(x = 0; x < NUM_ELEMENTS; ++x)
         System.out.print(" " + someNums[x]);
      System.out.println();
   }
```

When an array is passed to a method, no brackets are used.

Figure 8-18 The PassArray class (*continues*)

Passing Arrays to and Returning Arrays from Methods (4 of 4)

(continued)



```
    public static void methodGetsArray(int[] arr)
    {
       int x;
       System.out.print("At start of method arr holds: ");
       for(x = 0; x < arr.length; ++x)
          System.out.print(" " + arr[x]);
       System.out.println();
       for(x = 0; x < arr.length; ++x)
          arr[x] = 888;
       System.out.print(" and at end of method arr holds: ");
       for(x = 0; x < arr.length; ++x)
          System.out.print(" " + arr[x]);
       System.out.println();
    }
}
```

Brackets are used in the parameter list to show that an array is passed.

Figure 8-18 The PassArray class

Returning an Array from a Method

- A method can return an array reference
- Include square brackets with the return type in the method header

Don’t Do It

- Don’t forget that the lowest array subscript is 0
- Don’t forget that the highest array subscript is one less than the length
- Don’t forget the semicolon following the closing curly brace in an array initialization list
- Don’t forget that `length` is an array property and not a method
- Don’t place a subscript after an object’s field or method name when accessing an array of objects
- Don’t assume that an array of characters is a string
- Don’t forget that array names are references
- Don’t use brackets with an array name when you pass it to a method

Summary (1 of 2)

- Array
  - A named list of data items
  - All have the same type
- Array names
  - Represent computer memory addresses
- Shorten many array-based tasks
  - Use a variable as a subscript
- `length` field
  - Contains the number of elements in an array

Summary (2 of 2)

- You can declare arrays that hold elements of any type, including `String`s and other objects
- Search an array to find a match to a value
- Perform a range match
- Pass a single array element to a method