JAVA™

PROGRAMMING

Chapter 9: Advanced Array Concepts

Objectives

- Sort array elements using the bubble sort algorithm
- Sort array elements using the insertion sort algorithm
- Use two-dimensional and other multidimensional arrays
- Use the `Arrays` class
- Use the `ArrayList` class
- Create enumerations

Sorting Array Elements Using the Bubble Sort Algorithm

- **Sorting**
  - The process of arranging a series of objects in some logical order
- **Ascending order**
  - Begin with the object that has the lowest value
- **Descending order**
  - Begin with the object that has the largest value

Sorting Array Elements Using the Bubble Sort Algorithm (cont'd.)

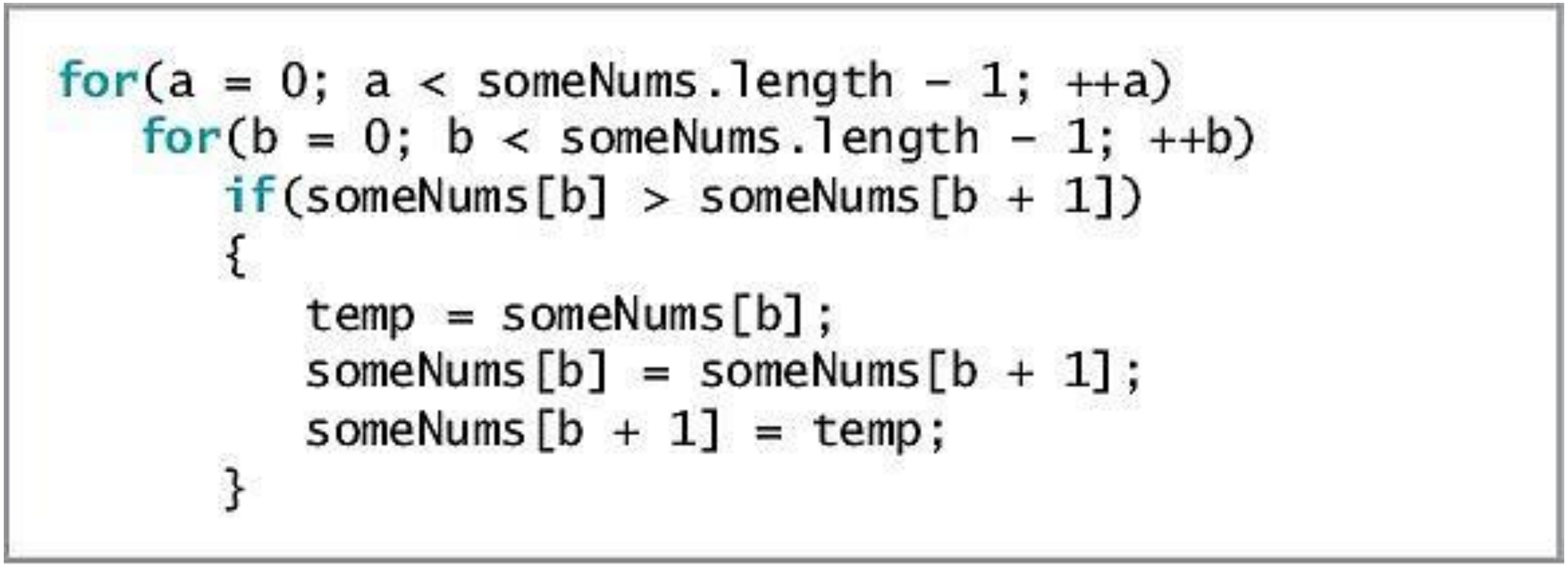
- Simplest possible sort
  - Involves two values that are out of order
  - Swap two values

```
temp = valA; // 16 goes to temp
valA = valB; // 2 goes to valA
valB = temp; // 16 goes to valB
```

Using the Bubble Sort Algorithm

- **Bubble sort**
  - You continue to compare pairs of items, swapping them if they are out of order
  - The smallest items “bubble” to the top of the list, eventually creating a sorted list

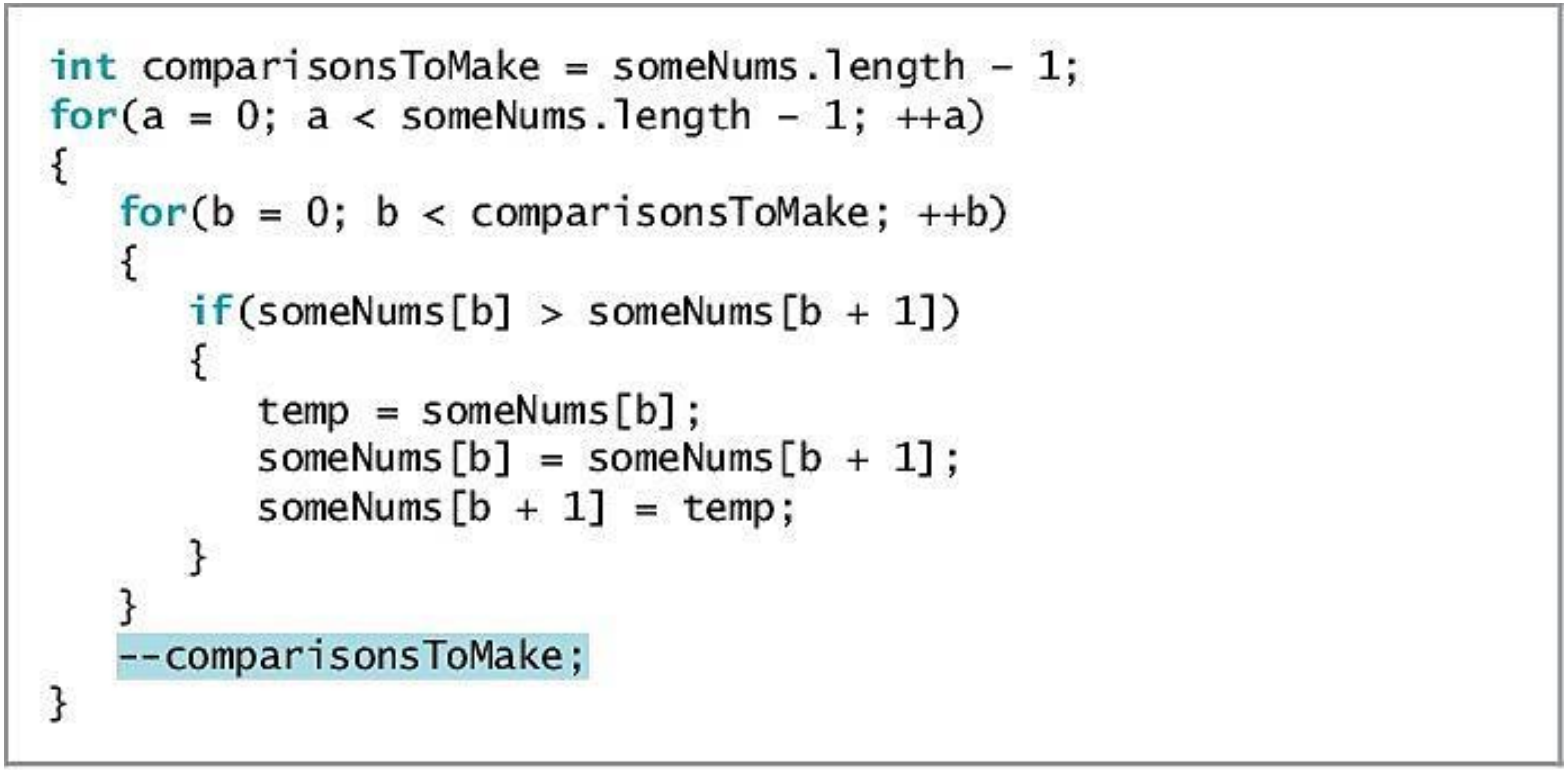
Using the Bubble Sort Algorithm (cont'd.)



```
for(a = 0; a < someNums.length - 1; ++a)
    for(b = 0; b < someNums.length - 1; ++b)
        if(someNums[b] > someNums[b + 1])
        {
            temp = someNums[b];
            someNums[b] = someNums[b + 1];
            someNums[b + 1] = temp;
        }
```

Figure 9-1 Ascending bubble sort of the someNums array elements

Using the Bubble Sort Algorithm (cont’d.)



```
int comparisonsToMake = someNums.length - 1;
for(a = 0; a < someNums.length - 1; ++a)
{
    for(b = 0; b < comparisonsToMake; ++b)
    {
        if(someNums[b] > someNums[b + 1])
        {
            temp = someNums[b];
            someNums[b] = someNums[b + 1];
            someNums[b + 1] = temp;
        }
    }
    --comparisonsToMake;
}
```

Figure 9-2 More efficient ascending bubble sort of the someNums array elements

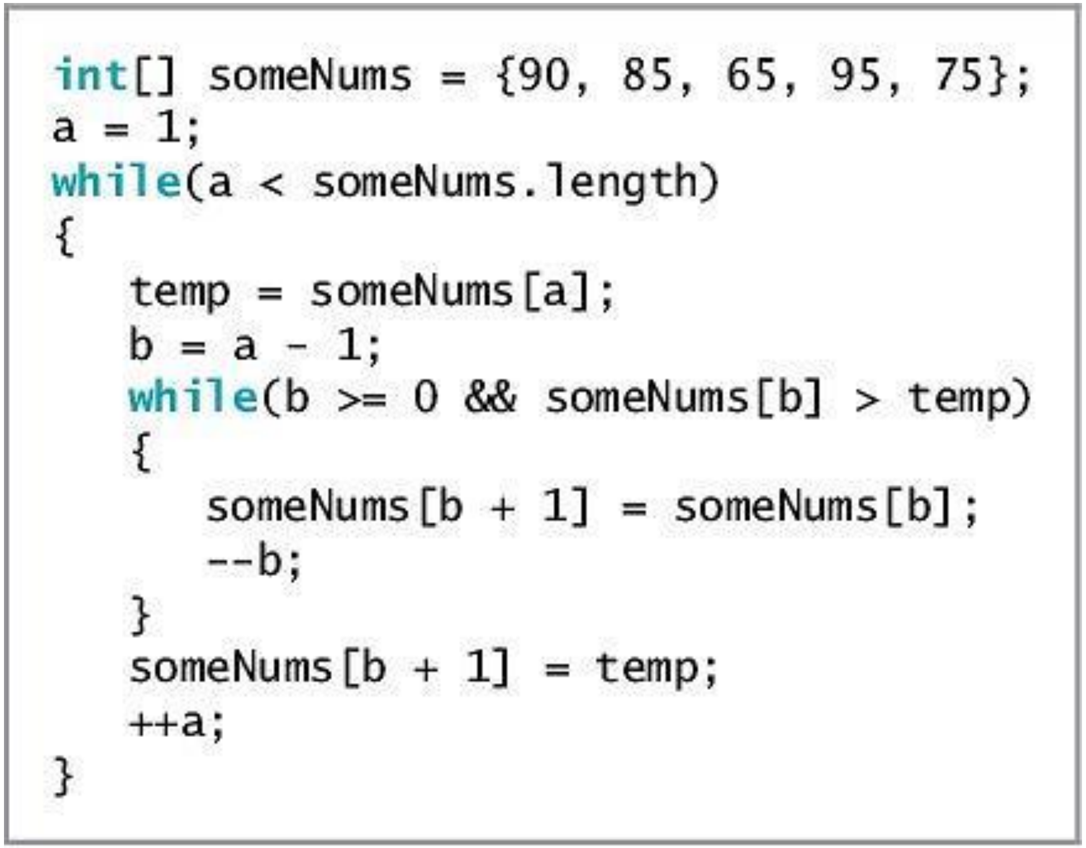
Sorting Arrays of Objects

- You can sort arrays of objects in much the same way that you sort arrays of primitive types
  - Major difference
    - Make the comparison that determines whether to swap two array elements
    - Sort based on a particular object field

Sorting Array Elements Using the Insertion Sort Algorithm

- **Insertion sort**
  - A sorting algorithm that enables you to look at each list element one at a time
  - Move items down if the tested element should be inserted prior to other elements
- Similar to the technique that sorts a group of objects manually

Sorting Array Elements Using the Insertion Sort Algorithm (cont’d.)



```
int[] someNums = {90, 85, 65, 95, 75};
a = 1;
while(a < someNums.length)
{
    temp = someNums[a];
    b = a - 1;
    while(b >= 0 && someNums[b] > temp)
    {
        someNums[b + 1] = someNums[b];
        --b;
    }
    someNums[b + 1] = temp;
    ++a;
}
```

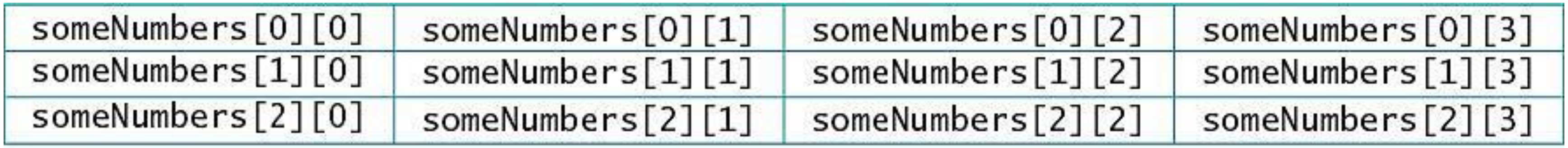
Figure 9-6 The insertion sort

Using Two-Dimensional and Other Multidimensional Arrays

- **One-dimensional** or **single-dimensional array**
  - An array that you can picture as a column of values
  - Elements are accessed using a single subscript
- **Two-dimensional arrays**
  - Have two or more columns of values
  - Have rows and columns
  - Use two subscripts
  - Are often called a **matrix** or **table**

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

Using Two-Dimensional and Other Multidimensional Arrays (cont'd.)



someNumbers[0][0]	someNumbers[0][1]	someNumbers[0][2]	someNumbers[0][3]
someNumbers[1][0]	someNumbers[1][1]	someNumbers[1][2]	someNumbers[1][3]
someNumbers[2][0]	someNumbers[2][1]	someNumbers[2][2]	someNumbers[2][3]

Figure 9-9 View of a two-dimensional array in memory

Using Two-Dimensional and Other Multidimensional Arrays (cont’d.)

```
int[][] rents = { {400, 450, 510},
 {500, 560, 630},
 {625, 676, 740},
 {1000, 1250, 1600} };
```

Passing a Two-Dimensional Array to a Method

- Pass the array name just as you do with a one-dimensional array

```
public static void
displayScores(int[][]scoresArray)
```

Using the `length` Field with a Two-Dimensional Array

- The `length` field holds the number of rows in the array

```
    rents.length
```

- Each row has a `length` field that holds the number of columns in the row

```
    rents[1].length
```

Understanding Ragged Arrays

- **Ragged array**
  - A two-dimensional array with rows of different lengths
- To create a ragged array:
  - Define the number of rows for a two-dimensional array
  - Do not define the number of columns in the rows
  - Then declare the individual rows

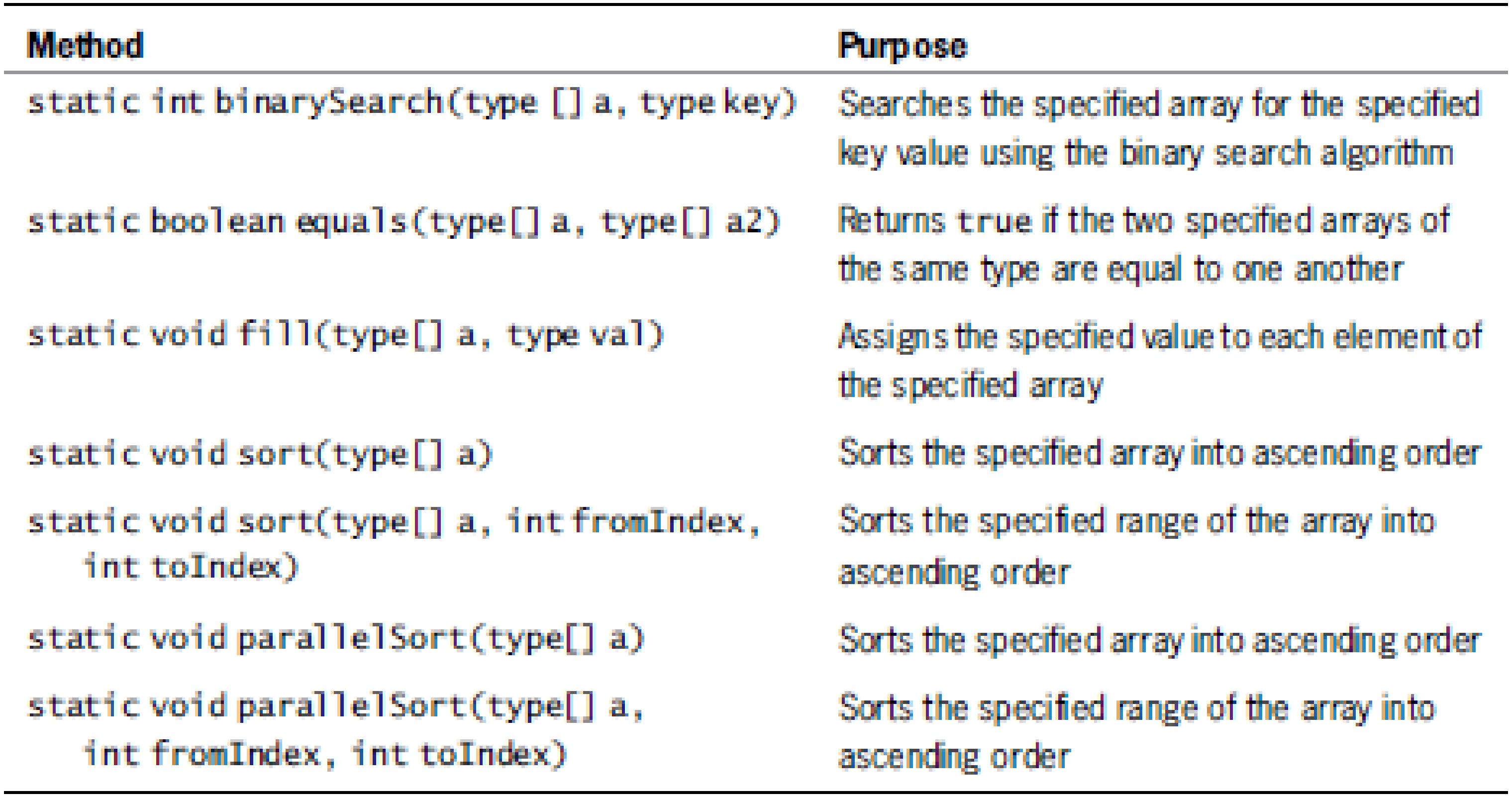
Using Other Multidimensional Arrays

- **Multidimensional arrays**
  - Arrays with more than one dimension
- Create arrays of any size
  - Keep track of the order of variables needed as subscripts
  - Do not exhaust your computer’s memory

Using the `Arrays` Class

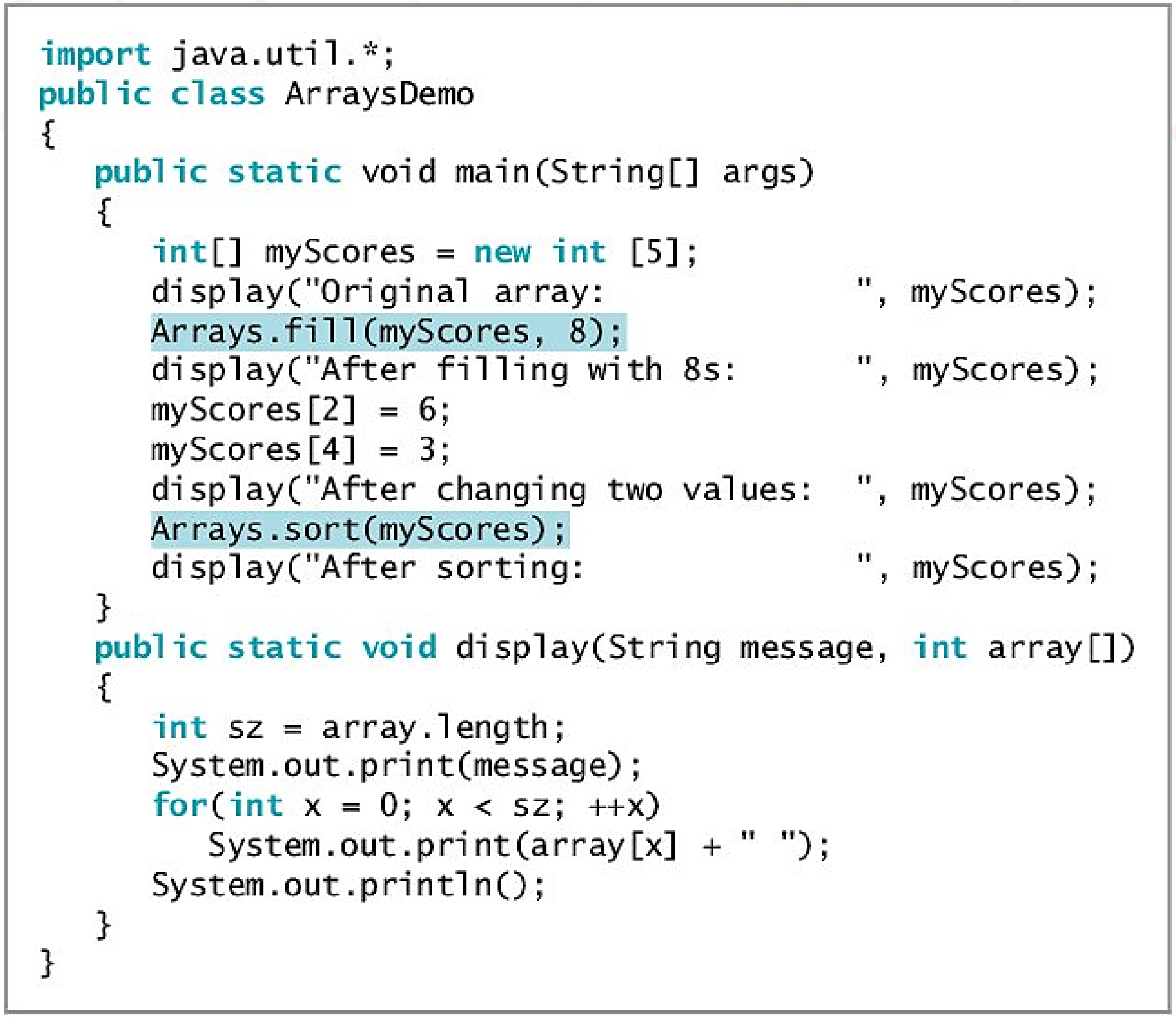
- **`Arrays` class**
  - Contains many useful methods for manipulating arrays
  - `static` methods
    - Use them with the class name without instantiating an `Arrays` object
  - `binarySearch()` method
    - A convenient way to search through sorted lists of values of various data types
    - The list must be in order

Using the `Arrays` Class (cont'd.)



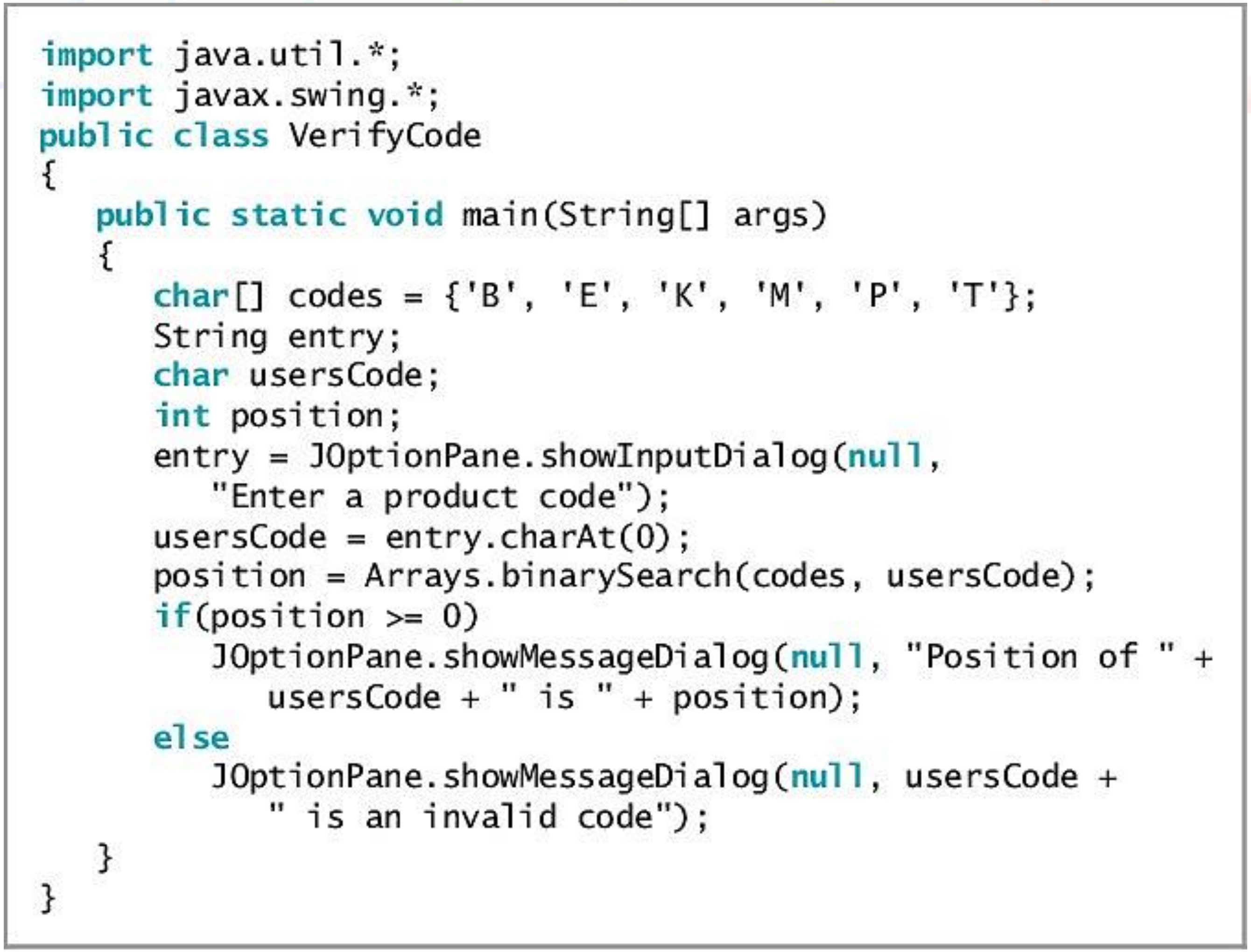
Method	Purpose
`static int binarySearch(type [] a, type key)`	Searches the specified array for the specified key value using the binary search algorithm
`static boolean equals(type[] a, type[] a2)`	Returns `true` if the two specified arrays of the same type are equal to one another
`static void fill(type[] a, type val)`	Assigns the specified value to each element of the specified array
`static void sort(type[] a)`	Sorts the specified array into ascending order
`static void sort(type[] a, int fromIndex, int toIndex)`	Sorts the specified range of the array into ascending order
`static void parallelSort(type[] a)`	Sorts the specified array into ascending order
`static void parallelSort(type[] a, int fromIndex, int toIndex)`	Sorts the specified range of the array into ascending order

Table 9-2 Useful methods of the `Arrays` class



```
import java.util.*;
public class ArraysDemo
{
   public static void main(String[] args)
   {
      int[] myScores = new int [5];
      display("Original array:             ", myScores);
      Arrays.fill(myScores, 8);
      display("After filling with 8s:      ", myScores);
      myScores[2] = 6;
      myScores[4] = 3;
      display("After changing two values:  ", myScores);
      Arrays.sort(myScores);
      display("After sorting:              ", myScores);
   }
   public static void display(String message, int array[])
   {
      int sz = array.length;
      System.out.print(message);
      for(int x = 0; x < sz; ++x)
         System.out.print(array[x] + " ");
      System.out.println();
   }
}
```

Figure 9-15 The ArraysDemo application



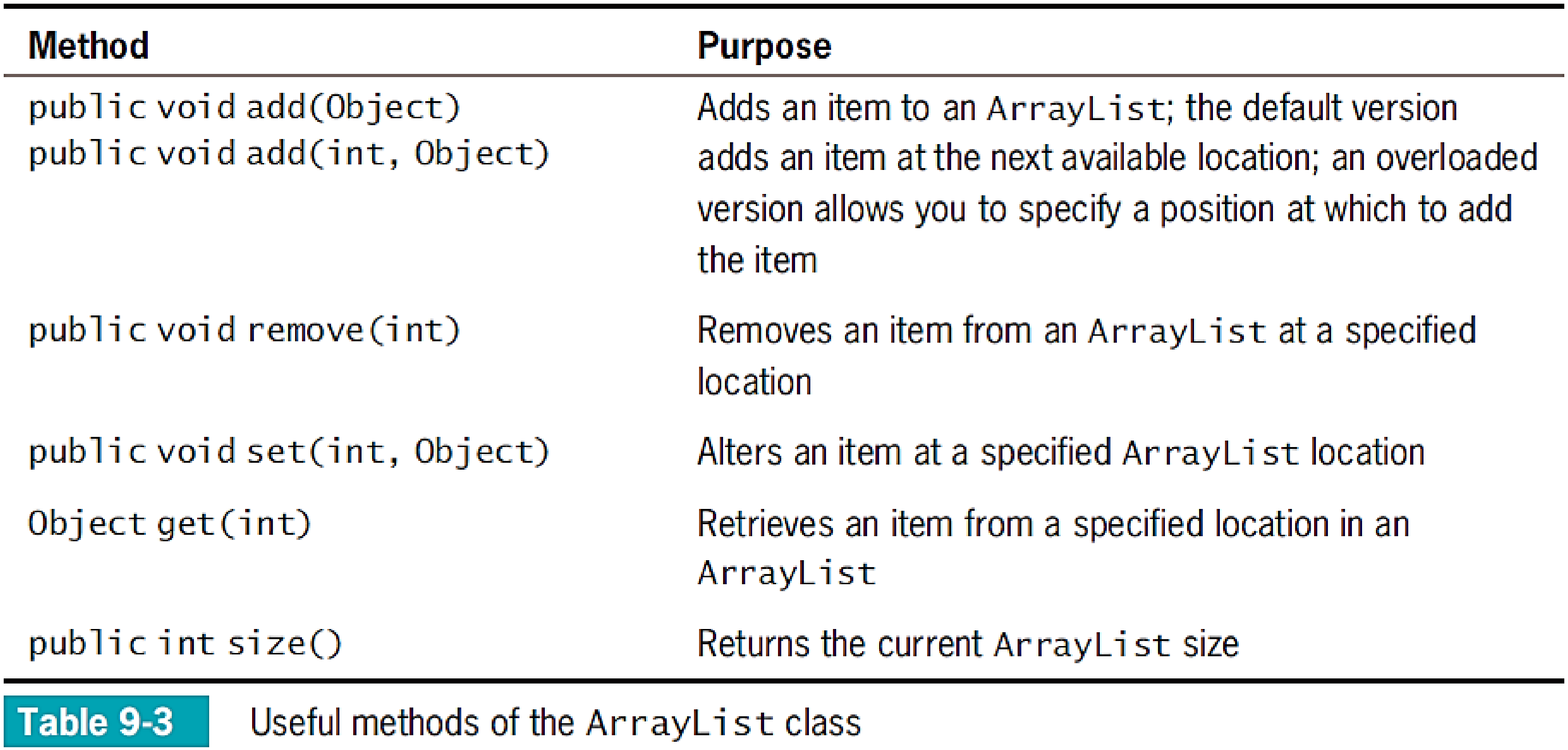
```java
import java.util.*;
import javax.swing.*;
public class VerifyCode
{
   public static void main(String[] args)
   {
      char[] codes = {'B', 'E', 'K', 'M', 'P', 'T'};
      String entry;
      char usersCode;
      int position;
      entry = JOptionPane.showInputDialog(null,
         "Enter a product code");
      usersCode = entry.charAt(0);
      position = Arrays.binarySearch(codes, usersCode);
      if(position >= 0)
         JOptionPane.showMessageDialog(null, "Position of " +
            usersCode + " is " + position);
      else
         JOptionPane.showMessageDialog(null, usersCode +
            " is an invalid code");
   }
}
```

Figure 9-17 The VerifyCode application

Using the `ArrayList` Class

- The **`ArrayList` class** provides some advantages over the `Arrays` class
  - **Dynamically resizable**
  - Can add an item at any point in an `ArrayList` container
  - Can remove an item at any point in an `ArrayList` container
- **Capacity**
  - The number of items an `ArrayList` can hold without having to increase its size

Using the `ArrayList` Class (cont'd.)



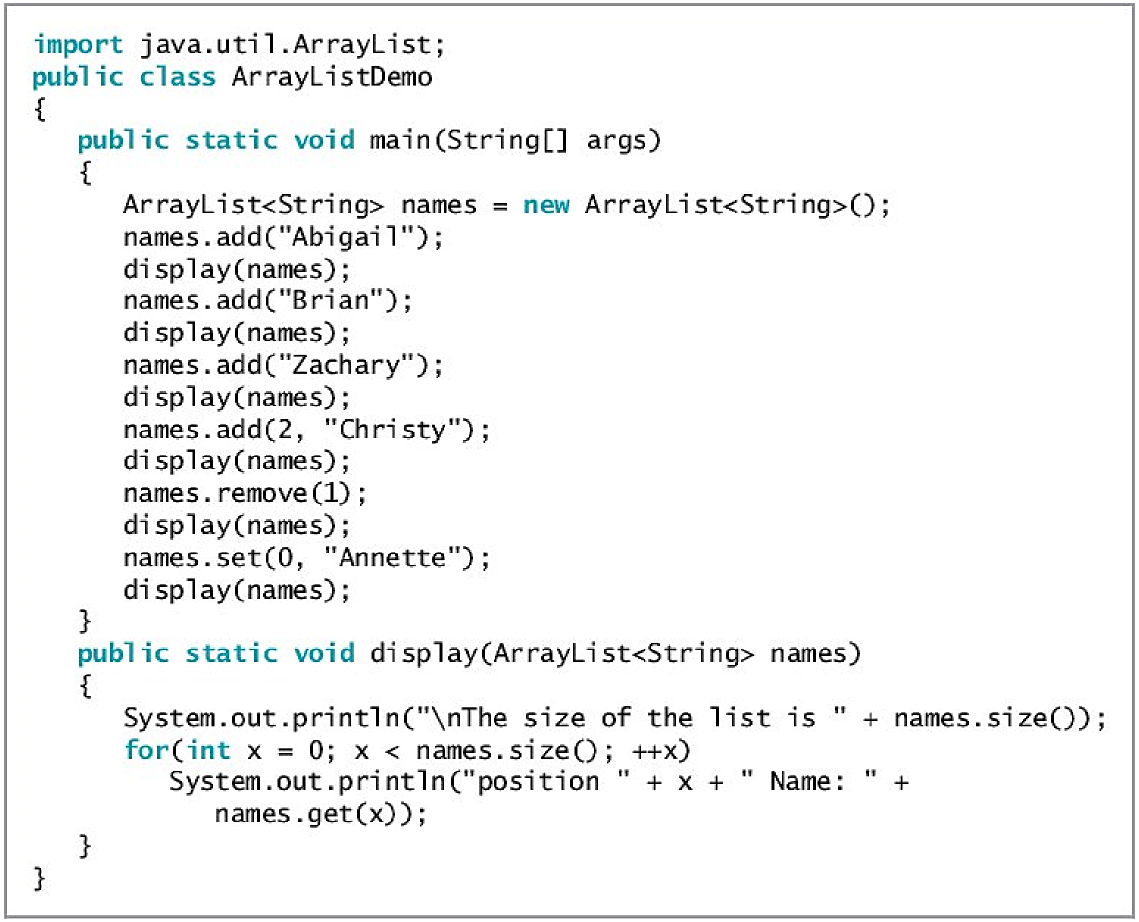
Method	Purpose

`public void add(Object)`
`public void add(int, Object)`
	Adds an item to an `ArrayList`; the default version adds an item at the next available location; an overloaded version allows you to specify a position at which to add the item

`public void remove(int)`	Removes an item from an `ArrayList` at a specified location
`public void set(int, Object)`	Alters an item at a specified `ArrayList` location
`Object get(int)`	Retrieves an item from a specified location in an `ArrayList`
`public int size()`	Returns the current `ArrayList` size

Table 9-3 Useful methods of the `ArrayList` class

Using the `ArrayList` Class (cont'd.)



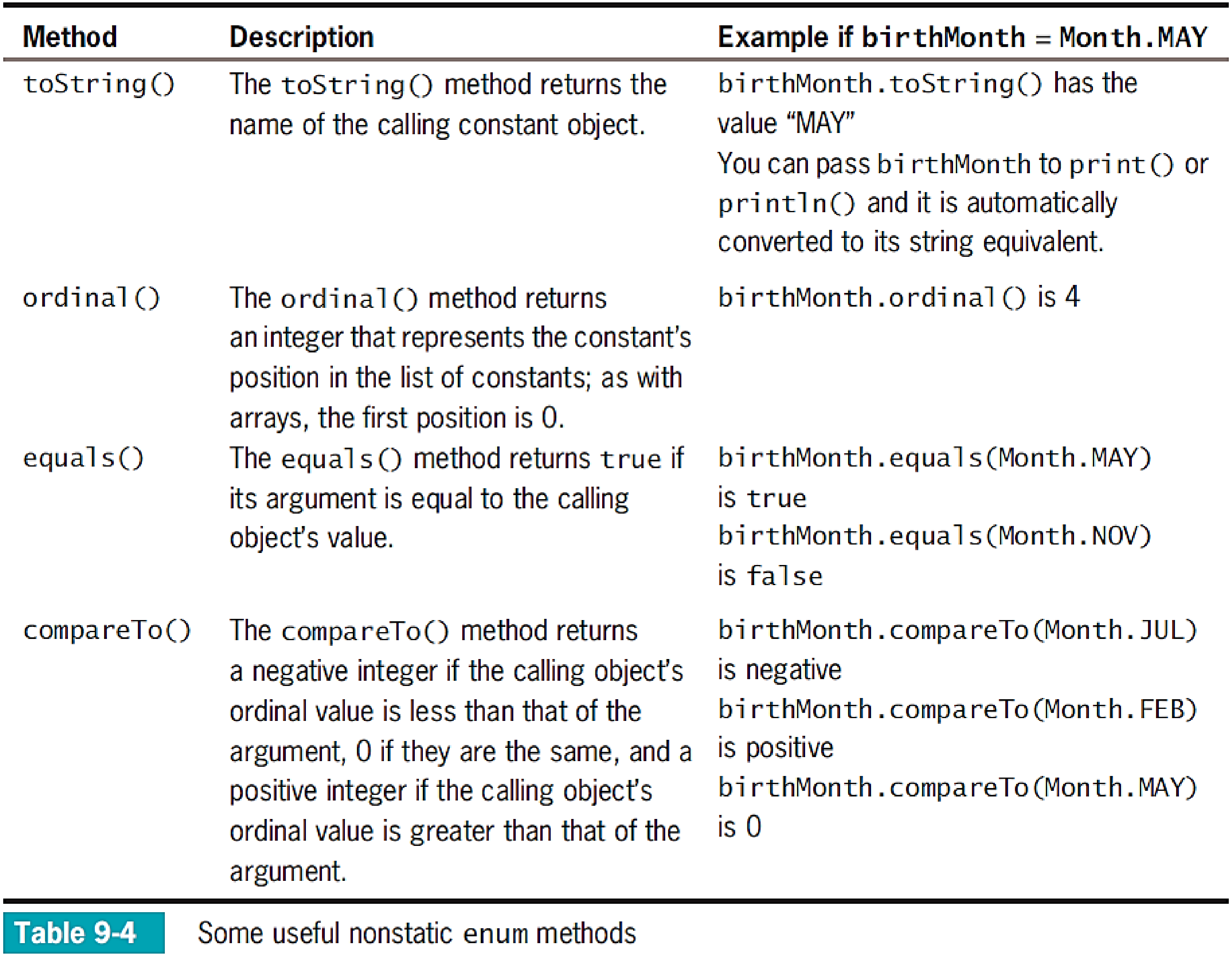
```
import java.util.ArrayList;
public class ArrayListDemo
{
   public static void main(String[] args)
   {
      ArrayList<String> names = new ArrayList<String>();
      names.add("Abigail");
      display(names);
      names.add("Brian");
      display(names);
      names.add("Zachary");
      display(names);
      names.add(2, "Christy");
      display(names);
      names.remove(1);
      display(names);
      names.set(0, "Annette");
      display(names);
   }
   public static void display(ArrayList<String> names)
   {
      System.out.println("\nThe size of the list is " + names.size());
      for(int x = 0; x < names.size(); ++x)
         System.out.println("position " + x + " Name: " +
            names.get(x));
   }
}
```

Figure 9-20 The `ArrayListDemo` program

Creating Enumerations

- **Enumerated data type**
  - A programmer-created data type with a fixed set of values
- To create an enumerated data type, use:
  - The keyword `enum`
  - An identifier for the type
  - A pair of curly braces that contain a list of the **`enum` constants**

```
enum Month {JAN, FEB, MAR, APR, MAY, JUN,
     JUL, AUG, SEP, OCT, NOV, DEC};
```



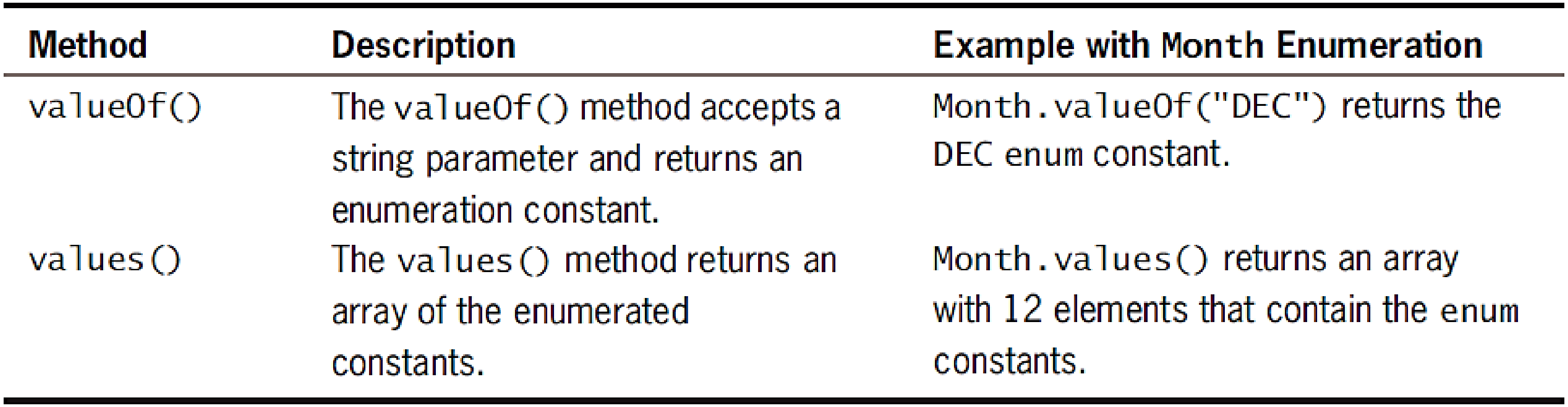
Method	Description	Example if `birthMonth` = `Month.MAY`
`toString()`	The `toString()` method returns the name of the calling constant object.	`birthMonth.toString()` has the value “MAY” You can pass `birthMonth` to `print()` or `println()` and it is automatically converted to its string equivalent.
`ordinal()`	The `ordinal()` method returns an integer that represents the constant’s position in the list of constants; as with arrays, the first position is 0.	`birthMonth.ordinal()` is 4

`equals()`	The `equals()` method returns `true` if its argument is equal to the calling object’s value.	`birthMonth.equals(Month.MAY)` is `true`
		`birthMonth.equals(Month.NOV)` is `false`

`compareTo()`	The `compareTo()` method returns a negative integer if the calling object’s ordinal value is less than that of the argument, 0 if they are the same, and a positive integer if the calling object’s ordinal value is greater than that of the argument.	`birthMonth.compareTo(Month.JUL)` is negative `birthMonth.compareTo(Month.FEB)` is positive `birthMonth.compareTo(Month.MAY)` is 0

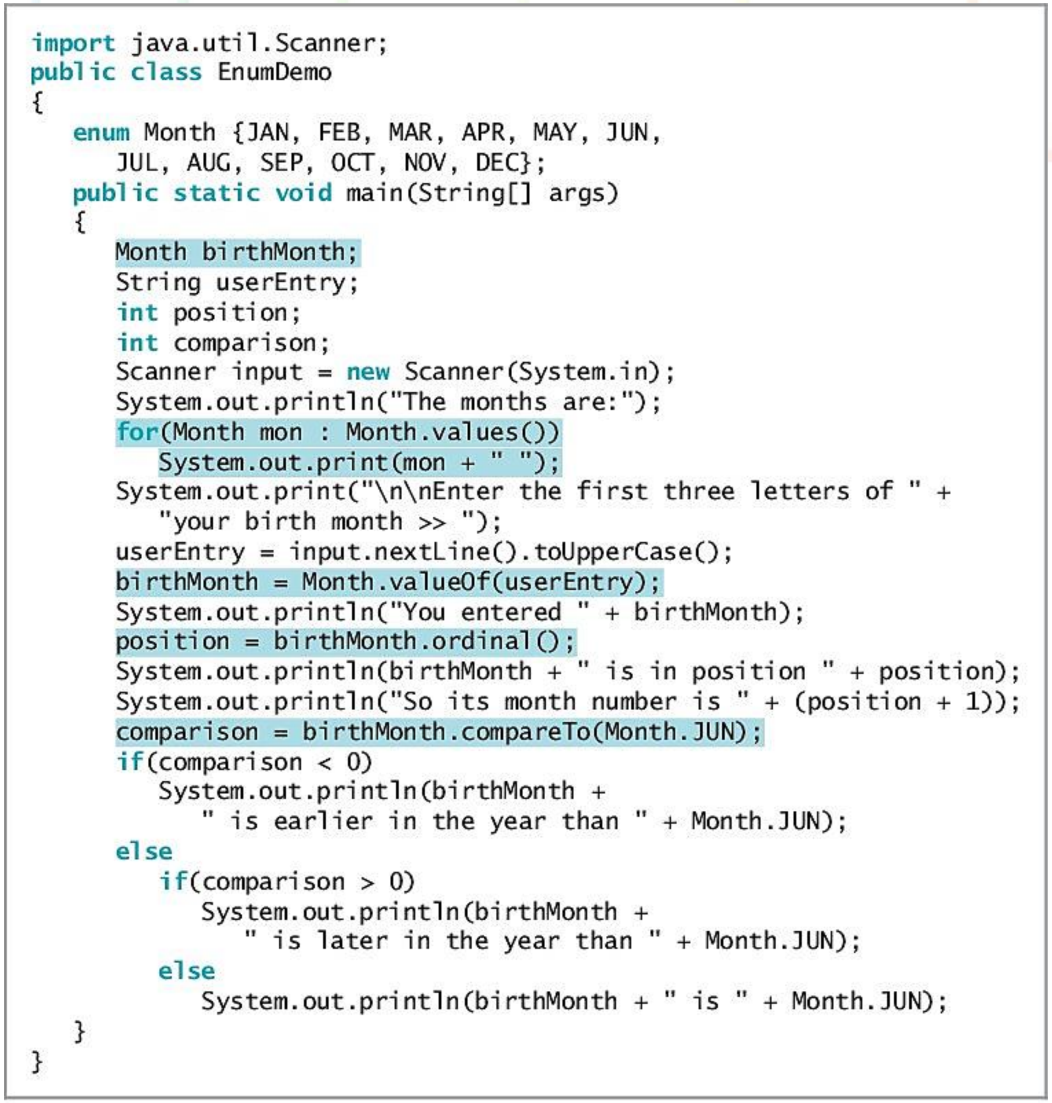
Table 9-4 Some useful nonstatic enum methods

Creating Enumerations (cont'd.)



Method	Description	Example with Month Enumeration
`valueOf()`	The `valueOf()` method accepts a string parameter and returns an enumeration constant.	`Month.valueOf("DEC")` returns the DEC `enum` constant.
`values()`	The `values()` method returns an array of the enumerated constants.	`Month.values()` returns an array with 12 elements that contain the `enum` constants.

Table 9-5 Some static `enum` methods

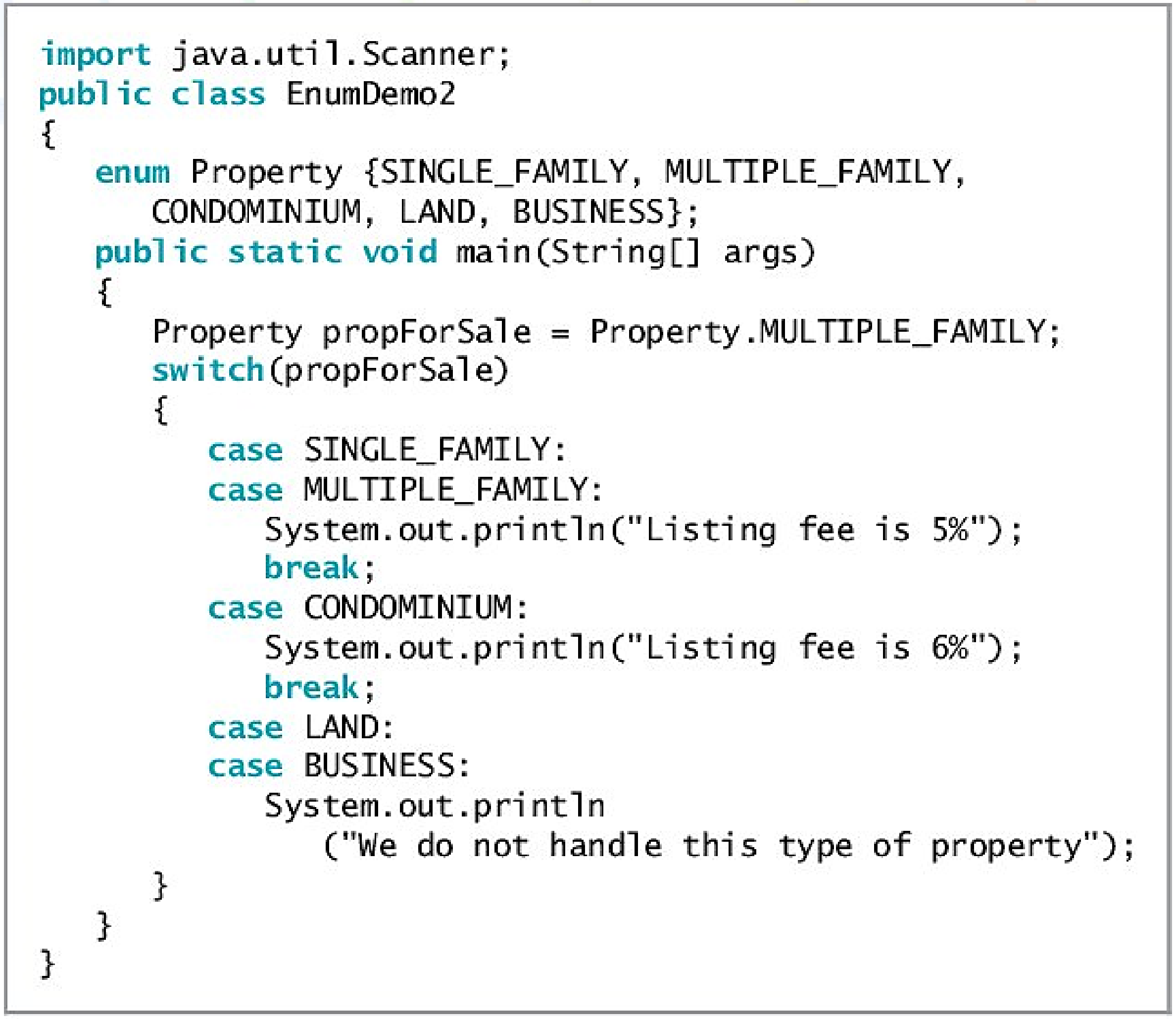


```
import java.util.Scanner;
public class EnumDemo
{
   enum Month {JAN, FEB, MAR, APR, MAY, JUN,
      JUL, AUG, SEP, OCT, NOV, DEC};
   public static void main(String[] args)
   {
      Month birthMonth;
      String userEntry;
      int position;
      int comparison;
      Scanner input = new Scanner(System.in);
      System.out.println("The months are:");
      for(Month mon : Month.values())
         System.out.print(mon + " ");
      System.out.print("\n\nEnter the first three letters of " +
         "your birth month >> ");
      userEntry = input.nextLine().toUpperCase();
      birthMonth = Month.valueOf(userEntry);
      System.out.println("You entered " + birthMonth);
      position = birthMonth.ordinal();
      System.out.println(birthMonth + " is in position " + position);
      System.out.println("So its month number is " + (position + 1));
      comparison = birthMonth.compareTo(Month.JUN);
      if(comparison < 0)
         System.out.println(birthMonth +
            " is earlier in the year than " + Month.JUN);
      else
         if(comparison > 0)
            System.out.println(birthMonth +
               " is later in the year than " + Month.JUN);
         else
            System.out.println(birthMonth + " is " + Month.JUN);
   }
}
```

Figure 9-24 The EnumDemo class

Creating Enumerations (cont'd.)

- You can declare an enumerated type in its own file
  - Filename matches the type name and has a .java extension
- Starting with Java 7, you can use comparison operators with enumeration constants
- You can use enumerations to control a switch structure



```java
import java.util.Scanner;
public class EnumDemo2
{
   enum Property {SINGLE_FAMILY, MULTIPLE_FAMILY,
      CONDOMINIUM, LAND, BUSINESS};
   public static void main(String[] args)
   {
      Property propForSale = Property.MULTIPLE_FAMILY;
      switch(propForSale)
      {
         case SINGLE_FAMILY:
         case MULTIPLE_FAMILY:
            System.out.println("Listing fee is 5%");
            break;
         case CONDOMINIUM:
            System.out.println("Listing fee is 6%");
            break;
         case LAND:
         case BUSINESS:
            System.out.println
               ("We do not handle this type of property");
      }
   }
}
```

Figure 9-26 The EnumDemo2 class

Creating Enumerations (cont'd.)

- Advantages of creating an enumeration type:
  - Only allowed values can be assigned
  - Using `enum`s makes the values type-safe
  - Provides a form of self-documentation
  - You can also add methods and other fields to an `enum` type
- **Type-safe**
  - Describes a data type for which only appropriate behaviors are allowed

You Do It

- Using a Bubble Sort
- Using an Insertion Sort
- Using a Two-Dimensional Array
- Using `Arrays` Class Methods
- Creating Enumerations

Don’t Do It

- Don’t forget that the first subscript used with a two-dimensional array represents the row, and that the second subscript represents the column
- Don’t try to store primitive data types in an `ArrayList` structure
- Don’t think `enum` constants are strings; they are not enclosed in quotes

Summary

- Sorting
  - The process of arranging a series of objects in some logical order
- Two-dimensional arrays
  - Both rows and columns
- `Arrays` class
- `ArrayList` class
- A programmer-created data type with a fixed set of values is an enumerated data type