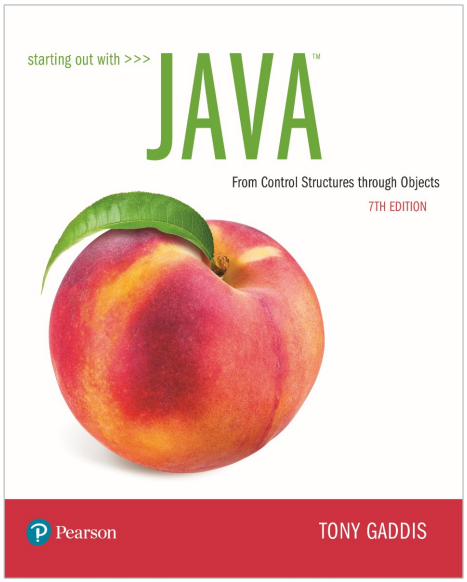
STARTING OUT WITH JAVA™

7th Edition



Chapter 9

Text Processing and More about Wrapper Classes

Chapter Topics

Chapter 9 discusses the following main topics:

- Introduction to Wrapper Classes
- Character Testing and Conversion with the Character Class
- More `String` Methods
- The `StringBuilder` Class
- Tokenizing Strings
- Wrapper Classes for the Numeric Data Types
- Focus on Problem Solving: The `TestScoreReader` Class

Introduction to Wrapper Classes

- Java provides 8 primitive data types.
- They are called “primitive” because they are not created from classes.
- Java provides wrapper classes for all of the primitive data types.
- A *wrapper class* is a class that is “wrapped around” a primitive data type.
- The wrapper classes are part of `java.lang` so to use them, there is no `import` statement required.

Wrapper Classes

- Wrapper classes allow you to create objects to represent a primitive.
- Wrapper classes are immutable, which means that once you create an object, you cannot change the object’s value.
- To get the value stored in an object you must call a method.
- Wrapper classes provide static methods that are very useful

Character Testing and Conversion With The `Character` Class

- The `Character` class allows a char data type to be *wrapped* in an object.
- The `Character` class provides methods that allow easy testing, processing, and conversion of character data.

The `Character` Class

Method	Description
`boolean isDigit( char ch)`	Returns true if the argument passed into *ch* is a digit from 0 through 9. Otherwise returns false.
`boolean isLetter( char ch)`	Returns true if the argument passed into *ch* is an alphabetic letter. Otherwise returns false.
`boolean isLetterOrDigit( char ch)`	Returns true if the character passed into *ch* contains a digit (0 through 9) or an alphabetic letter. Otherwise returns false.
`boolean isLowerCase( char ch)`	Returns true if the argument passed into *ch* is a lowercase letter. Otherwise returns false.
`boolean isUpperCase( char ch)`	Returns true if the argument passed into *ch* is an uppercase letter. Otherwise returns false.
`boolean isSpaceChar( char ch)`	Returns true if the argument passed into *ch* is a space character. Otherwise returns false.

Character Testing and Conversion With The `Character` Class

- Example:

  CharacterTest.java

  CustomerNumber.java
- The `Character` class provides two methods that will change the case of a character.

Method	Description
`char toLowerCase( char ch)`	Returns the lowercase equivalent of the argument passed to *ch*.
`char toUpperCase( char ch)`	Returns the uppercase equivalent of the argument passed to *ch*.

See example: CircleArea.java

Substrings

- The `String` class provides several methods that search for a string inside of a string.
- A *substring* is a string that is part of another string.
- Some of the substring searching methods provided by the `String` class:

```
boolean startsWith(String str)
    boolean endsWith(String str)
    boolean regionMatches(int start, String str, int
start2, int n)
    boolean regionMatches(boolean ignoreCase, int start,
                String str, int start2, int n)
```

Searching Strings (1 of 5)

- The `startsWith` method determines whether a string begins with a specified substring.

```
String str = "Four score and seven years ago";
     if (str.startsWith("Four"))
     System.out.println("The string starts with Four.");
     else
     System.out.println("The string does not start with
    Four.");
```

- `str.startsWith("Four")` returns true because `str` does begin with “Four”.
- `startsWith` is a case sensitive comparison.

Searching Strings (2 of 5)

- The `endsWith` method determines whether a string ends with a specified substring.

```
String str = "Four score and seven years ago";
     if (str.endsWith("ago"))
     System.out.println("The string ends with ago.");
     else
     System.out.println("The string does not end with
ago.");
```

- The `endsWith` method also performs a case sensitive comparison.
- Example: PersonSearch.java

Searching Strings (3 of 5)

- The `String` class provides methods that will if specified regions of two strings match.
  - `regionMatches(int start, String str, int start2, int n)`
    - returns true if the specified regions match or false if they don’t
    - Case sensitive comparison
  - `regionMatches(boolean ignoreCase, int start, String str, int start2, int n)`
    - If *ignoreCase* is true, it performs case insensitive comparison

Searching Strings (4 of 5)

- The `String` class also provides methods that will locate the position of a substring.
  - `indexOf`
    - returns the first location of a substring or character in the calling `String` Object.
  - `lastIndexOf`
    - returns the last location of a substring or character in the calling `String` Object.

Searching Strings (5 of 5)

```
String str = "Four score and seven years ago";
int first, last;
first = str.indexOf('r');
last = str.lastIndexOf('r');
System.out.println("The letter r first appears at "
                   + "position " + first);
System.out.println("The letter r last appears at "
                   + "position " + last);
```

```
String str = "and a one and a two and a three";
int position;
System.out.println("The word and appears at the "
                   + "following locations.");

position = str.indexOf("and");
while (position != -1)
{
  System.out.println(position);
  position = str.indexOf("and", position + 1);
}
```


`String` Methods For Getting Character Or Substring Location

See Table 9-4

Table 9-4 `String` methods for getting a character or substring's location

Method	Description
int indexOf(char *ch*)	Searches the calling `String` object for the character passed into *ch*. If the character is found, the position of its first occurrence is returned. Otherwise, -1 is returned.
int indexOf(char *ch*, int *start*)	Searches the calling `String` object for the character passed into *ch*, beginning at the position passed into *start* and going to the end of the string. If the character is found, the position of its first occurrence is returned. Otherwise, -1 is returned.
int indexOf(String *str*)	Searches the calling `String` object for the string passed into *str*. If the string is found, the beginning position of its first occurrence is returned. Otherwise, -1 is returned.
int indexOf(String *str*, int *start*)	Searches the calling `String` object for the string passed into *str*. The search begins at the position passed into *start* and goes to the end of the string. If the string is found, the beginning position of its first occurrence is returned. Otherwise, -1 is returned.

`String` Methods For Getting Character Or Substring Location

See Table 9-4

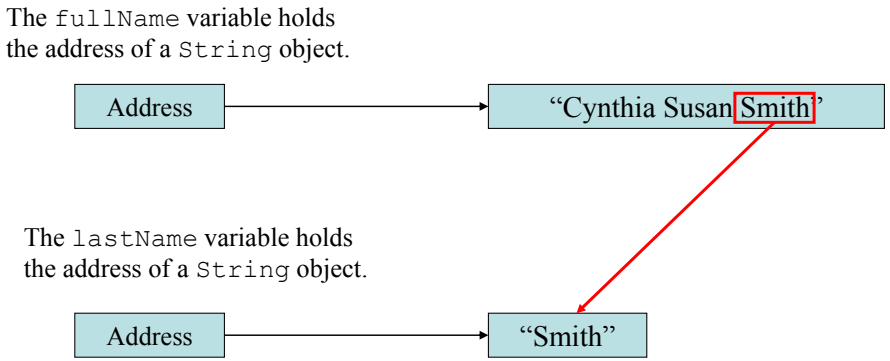
Method	Description
int lastIndexOf(char *ch*)	Searches the calling `String` object for the character passed into *ch*. If the character is found, the position of its last occurrence is returned. Otherwise, -1 is returned.
int lastIndexOf(char *ch*, int *start*)	Searches the calling `String` object for the character passed into *ch*, beginning at the position passed into *start*. The search is conducted backward through the string, to position 0. If the character is found, the position of its last occurrence is returned. Otherwise, -1 is returned.
int lastIndexOf(String *str*)	Searches the calling `String` object for the string passed into *str*. If the string is found, the beginning position of its last occurrence is returned. Otherwise, -1 is returned.
int lastIndexOf(String *str*, int *start*)	Searches the calling `String` object for the string passed into *str*, beginning at the position passed into *start*. The search is conducted backward through the string, to position 0. If the string is found, the beginning position of its last occurrence is returned. Otherwise, -1 is returned.

Extracting Substrings (1 of 2)

- The `String` class provides methods to extract substrings in a `String` object.
  - The `substring` method returns a substring beginning at a start location and an optional ending location.

```
String fullName = "Cynthia Susan Smith";
String lastName = fullName.substring(14);
System.out.println("The full name is "
                   + fullName);
System.out.println("The last name is "
                   + lastName);
```

Extracting Substrings (2 of 2)



Extracting Characters to Arrays

- The `String` class provides methods to extract substrings in a `String` object and store them in `char` arrays.
  - `getChars`
    - Stores a substring in a `char` array
  - `toCharArray`
    - Returns the `String` object's contents in an array of `char` values.
- Example: StringAnalyzer.java

Returning Modified Strings

- The `String` class provides methods to return modified `String` objects.
  - `concat`
    - Returns a `String` object that is the concatenation of two `String` objects.
  - `replace`
    - Returns a `String` object with all occurrences of one character being replaced by another character.
  - `trim`
    - Returns a `String` object with all leading and trailing whitespace characters removed.

The `valueOf` Methods (1 of 2)

- The `String` class provides several overloaded `valueOf` methods.
- They return a `String` object representation of
  - a primitive value or
  - a character array.

```
String.valueOf(true) will return "true".
String.valueOf(5.0) will return "5.0".
String.valueOf('C') will return "C".
```

The `valueOf` Methods (2 of 2)

```
boolean b = true;
char [] letters = { 'a', 'b', 'c', 'd', 'e' };
double d = 2.4981567;
int i = 7;
System.out.println(String.valueOf(b));
System.out.println(String.valueOf(letters));
System.out.println(String.valueOf(letters, 1, 3));
System.out.println(String.valueOf(d));
System.out.println(String.valueOf(i));
```

- Produces the following output:

```
true
abcde
bcd
2.4981567
7
```


The `StringBuilder` Class

- The `StringBuilder` class is similar to the `String` class.
- However, you may change the contents of `StringBuilder` objects.
  - You can change specific characters,
  - insert characters,
  - delete characters, and
  - perform other operations.
- A `StringBuilder` object will grow or shrink in size, as needed, to accommodate the changes.

`StringBuilder` Constructors

- `StringBuilder()`
  - This constructor gives the object enough storage space to hold 16 characters.
- `StringBuilder(int` *`length`*`)`
  - This constructor gives the object enough storage space to hold *`length`* characters.
- `StringBuilder(String` *`str`*`)`
  - This constructor initializes the object with the string in *`str`*.
  - The object will have at least enough storage space to hold the string in *`str`*.

Other `StringBuilder` Methods

- `The String` and `StringBuilder` also have common methods:

```
char charAt(int position)
void getChars(int start, int end,
              char[] array, int arrayStart)
int indexOf(String str)
int indexOf(String str, int start)
int lastIndexOf(String str)
int lastIndexOf(String str, int start)
int length()
String substring(int start)
String substring(int start, int end)
```

Appending to a `StringBuilder` Object (1 of 4)

- The `StringBuilder` class has several overloaded versions of a method named `append`.
- They append a string representation of their argument to the calling object's current contents.
- The general form of the `append` method is:

```
object.append(item);
```

  - where *`object`* is an instance of the `StringBuilder` class and *`item`* is:
    - a primitive literal or variable.
    - a char array, or
    - a `String` literal or object.

Appending to a `StringBuilder` Object (2 of 4)

- After the `append` method is called, a string representation of *`item`* will be appended to *`object`*'s contents.

```
StringBuilder str = new StringBuilder();

   str.append("We sold ");
   str.append(12);
   str.append(" doughnuts for $");
   str.append(15.95);

   System.out.println(str);
```

- This code will produce the following output:

```
We sold 12 doughnuts for $15.95
```


Appending to a `StringBuilder` Object (3 of 4)

- The `StringBuilder` class also has several overloaded versions of a method named `insert`
- These methods accept two arguments:
  - an `int` that specifies the position to begin insertion, and
  - the value to be inserted.
- The value to be inserted may be
  - a primitive literal or variable.
  - a `char` array, or
  - a `String` literal or object.

Appending to a `StringBuilder` Object (4 of 4)

- The general form of a typical call to the `insert` method.
  - *`object`*`.insert(`*`start, item`*`);`
    - where *`object`* is an instance of the `StringBuilder` class, *`start`* is the insertion location, and *`item`* is:
      - a primitive literal or variable.
      - a `char` array, or
      - a `String` literal or object.
- Example:

Telephone.java
TelephoneTester.java

Replacing a Substring in a `StringBuilder` Object (1 of 2)

- The `StringBuilder` class has a `replace` method that replaces a specified substring with a string.
- The general form of a call to the method:
  - *object*`.replace(`*start*`, `*end*`, `*str*`);`
    - *start* is an `int` that specifies the starting position of a substring in the calling object, and
    - *end* is an `int` that specifies the ending position of the substring. (The starting position is included in the substring, but the ending position is not.)
    - The `str` parameter is a `String` object.
  - After the method executes, the substring will be replaced with `str`.

Replacing a Substring in a `StringBuilder` Object (2 of 2)

- The `replace` method in this code replaces the word "Chicago" with "New York".

```
StringBuilder str = new StringBuilder(
        "We moved from Chicago to Atlanta.");
str.replace(14, 21, "New York");
System.out.println(str);
```

- The code will produce the following output:

```
We moved from New York to Atlanta.
```


Other `StringBuilder` Methods (1 of 2)

- The `StringBuilder` class also provides methods to set and delete characters in an object.

```
StringBuilder str = new StringBuilder(
                    "I ate 100 blueberries!");
// Display the StringBuilder object.
System.out.println(str);
// Delete the '0'.
str.deleteCharAt(8);
// Delete "blue".
str.delete(9, 13);
// Display the StringBuilder object.
System.out.println(str);
// Change the '1' to '5'
str.setCharAt(6, '5');
// Display the StringBuilder object.
System.out.println(str);
```


Other `StringBuilder` Methods (2 of 2)

- The `toString` method
  - You can call a `StringBuilder`'s `toString` method to convert that `StringBuilder` object to a regular `String`

```
StringBuilder strb = new StringBuilder("This is a test.");
String str = strb.toString();
```

Tokenizing Strings

- Use the `String` class's `split` method
- Tokenizes a `String` object and returns an array of `String` objects
- Each array element is one token.

```
// Create a String to tokenize.
String str = "one two three four";
// Get the tokens from the string.
String[] tokens = str.split(" ");
// Display each token.
for (String s : tokens)
   System.out.println(s);
```

- This code will produce the following output:

```
one
two
three
four
```


Wrapper Classes

- *Wrapper classes* provide a class type corresponding to each of the primitive types
  - This makes it possible to have class types that behave somewhat like primitive types
  - The wrapper classes for the primitive types **`byte`**, **`short`**, **`long`**, **`float`**, **`double`**, and **`char`** are (in order) **`Byte`**, **`Short`**, **`Long`**, **`Float`**, **`Double`**, and **`Character`**
- Wrapper classes also contain a number of useful predefined constants and static methods

Wrapper Classes

- *Boxing*: the process of going from a value of a primitive type to an object of its wrapper class
  - To convert a primitive value to an "equivalent" class type value, create an object of the corresponding wrapper class using the primitive value as an argument
  - The new object will contain an instance variable that stores a copy of the primitive value
  - Unlike most other classes, a wrapper class does not have a no-argument constructor

```
Integer integerObject = new Integer(42);
```

Wrapper Classes

- *Unboxing*: the process of going from an object of a wrapper class to the corresponding value of a primitive type
  - The methods for converting an object from the wrapper classes **`Byte`**, **`Short`**, **`Integer`**, **`Long`**, **`Float`**, **`Double`**, and **`Character`** to their corresponding primitive type are (in order) **`byteValue`**, **`shortValue`**, **`intValue`**, **`longValue`**, **`floatValue`**, **`doubleValue`**, and **`charValue`**
  - None of these methods take an argument

```
int i = integerObject.intValue();
```

Automatic Boxing and Unboxing

- Starting with version 5.0, Java can automatically do boxing and unboxing
- Instead of creating a wrapper class object using the **new** operation (as shown before), it can be done as an automatic type cast:

```
Integer integerObject = 42;
```

- Instead of having to invoke the appropriate method (such as **intValue**, **doubleValue**, **charValue**, etc.) in order to convert from an object of a wrapper class to a value of its associated primitive type, the primitive value can be recovered automatically

```
int i = integerObject;
```

Constants and Static Methods in Wrapper Classes

- Wrapper classes include useful constants that provide the largest and smallest values for any of the primitive number types
  - For example, **Integer.MAX_VALUE**, **Integer.MIN_VALUE**, **Double.MAX_VALUE**, **Double.MIN_VALUE**, etc.
- The **Boolean** class has names for two constants of type **Boolean**
  - **Boolean.TRUE** and **Boolean.FALSE** are the Boolean objects that correspond to the values **true** and **false** of the primitive type **boolean**

Constants and Static Methods in Wrapper Classes

- Wrapper classes have static methods that convert a correctly formed string representation of a number to the number of a given type
  - The methods **Integer.parseInt**, **Long.parseLong**, **Float.parseFloat**, and **Double.parseDouble** do this for the primitive types (in order) **int**, **long**, **float**, and **double**
- Wrapper classes also have static methods that convert from a numeric value to a string representation of the value
  - For example, the expression

    ```
    Double.toString(123.99);
    ```

    returns the string value **"123.99"**
- The **Character** class contains a number of static methods that are useful for string processing

Some Methods in the Class **Character** (Part 1 of 3)

Display 5.8 Some Methods in the Class Character

The class `Character` is in the `java.lang` package, so it requires no `import` statement.

`public static char toUpperCase(char argument)`

Returns the uppercase version of its `argument`. If the `argument` is not a letter, it is returned unchanged.

EXAMPLE

`Character.toUpperCase('a')` and `Character.toUpperCase('A')` both return `'A'`.

`public static char toLowerCase(char argument)`

Returns the lowercase version of its `argument`. If the `argument` is not a letter, it is returned unchanged.

EXAMPLE

`Character.toLowerCase('a')` and `Character.toLowerCase('A')` both return `'a'`.

`public static boolean isUpperCase(char argument)`

Returns `true` if its `argument` is an uppercase letter; otherwise returns `false`.

EXAMPLE

`Character.isUpperCase('A')` returns `true`. `Character.isUpperCase('a')` and `Character.isUpperCase('%')` both return `false`.

(continued)

Some Methods in the Class `Character` (Part 2 of 3)

Display 5.8 Some Methods in the Class Character

`public static boolean isLowerCase(char argument)`

Returns `true` if its `argument` is a lowercase letter; otherwise returns `false`.

EXAMPLE

`Character.isLowerCase('a')` returns `true`. `Character.isLowerCase('A')` and `Character.isLowerCase('%')` both return `false`.

`public static boolean isWhitespace(char argument)`

Returns `true` if its `argument` is a whitespace character; otherwise returns `false`. Whitespace characters are those that print as white space, such as the space character (blank character), the tab character (`'\t'`), and the line break character (`'\n'`).

EXAMPLE

`Character.isWhitespace(' ')` returns `true`. `Character.isWhitespace('A')` returns `false`.

(continued)

Some Methods in the Class `Character` (Part 3 of 3)

Display 5.8 Some Methods in the Class Character

`public static boolean isLetter(char argument)`

Returns `true` if its `argument` is a letter; otherwise returns `false`.

EXAMPLE

`Character.isLetter('A')` returns `true`. `Character.isLetter('%')` and `Character.isLetter('5')` both return `false`.

`public static boolean isDigit(char argument)`

Returns `true` if its `argument` is a digit; otherwise returns `false`.

EXAMPLE

`Character.isDigit('5')` returns `true`. `Character.isDigit('A')` and `Character.isDigit('%')` both return `false`.

`public static boolean isLetterOrDigit(char argument)`

Returns `true` if its `argument` is a letter or a digit; otherwise returns `false`.

EXAMPLE

`Character.isLetterOrDigit('A')` and `Character.isLetterOrDigit('5')` both return `true`. `Character.isLetterOrDigit('&')` returns `false`.

Numeric Data Type Wrappers

- Java provides wrapper classes for all of the primitive data types.
- The numeric primitive wrapper classes are:

Wrapper Class	Numeric Primitive Type It Applies To
`Byte`	`byte`
`Double`	`double`
`Float`	`float`
`Integer`	`int`
`Long`	`long`
`Short`	`short`

Creating a Wrapper Object

- To create objects from these wrapper classes, you can pass a value to the constructor:

```
Integer number = new Integer(7);
```

- You can also assign a primitive value to a wrapper class object:

```
Integer number;

number = 7;
```

The Parse Methods (1 of 2)

- Recall from Chapter 2, we converted `String` input (from `JOptionPane`) into numbers. Any `String` containing a number, such as "127.89", can be converted to a numeric data type.
- Each of the numeric wrapper classes has a static method that converts a string to a number.
  - The `Integer` class has a method that converts a `String` to an `int`,
  - The `Double` class has a method that converts a `String` to a `double`,
  - etc.
- These methods are known as *parse methods* because their names begin with the word "parse."

The Parse Methods (2 of 2)

```
// Store 1 in bVar.
byte bVar = Byte.parseByte("1");
// Store 2599 in iVar.
int iVar = Integer.parseInt("2599");
// Store 10 in sVar.
short sVar = Short.parseShort("10");
// Store 15908 in lVar.
long lVar = Long.parseLong("15908");
// Store 12.3 in fVar.
float fVar = Float.parseFloat("12.3");
// Store 7945.6 in dVar.
double dVar = Double.parseDouble("7945.6");
```

- The parse methods all throw a `NumberFormatException` if the `String` object does not represent a numeric value.

The `toString` Methods

- Each of the numeric wrapper classes has a static `toString` method that converts a number to a string.
- The method accepts the number as its argument and returns a string representation of that number.

```
int i = 12;
double d = 14.95;
String str1 = Integer.toString(i);
String str2 = Double.toString(d);
```


The `toBinaryString`, `toHexString`, and `toOctalString` Methods

- The `Integer` and `Long` classes have three additional methods:
  - `toBinaryString`, `toHexString`, and `toOctalString`

```
int number = 14;
System.out.println(Integer.toBinaryString(number));
System.out.println(Integer.toHexString(number));
System.out.println(Integer.toOctalString(number));
```

- This code will produce the following output:

```
1110
e
16
```

MIN_VALUE and MAX_VALUE

- The numeric wrapper classes each have a set of static final variables
  - `MIN_VALUE` and
  - `MAX_VALUE`.

- These variables hold the minimum and maximum values for a particular data type.

```
System.out.println("The minimum value for an "
                   + "int is "
                   + Integer.MIN_VALUE);
System.out.println("The maximum value for an "
                   + "int is "
                   + Integer.MAX_VALUE);
```


Autoboxing and Unboxing (1 of 2)

- You can declare a wrapper class variable and assign a value:

```
Integer number;

number = 7;
```

- You nay think this is an error, but because number is a wrapper class variable, *autoboxing* occurs.

- *Unboxing* does the opposite with wrapper class variables:

```
Integer myInt = 5;          // Autoboxes the value 5
int primitiveNumber;
primitiveNumber = myInt;    // unboxing
```


Autoboxing and Unboxing (2 of 2)

- You rarely need to declare numeric wrapper class objects, but they can be useful when you need to work with primitives in a context where primitives are not permitted
- Recall the `ArrayList` class, which works only with objects.

```
ArrayList<int> list =
      new ArrayList<int>();      // Error!
ArrayList<Integer> list =
      new ArrayList<Integer>(); // OK!
```

- Autoboxing and unboxing allow you to conveniently use `ArrayList`s with primitives.

Problem Solving

- Dr. Harrison keeps student scores in an Excel file. This can be exported as a comma separated text file. Each student's data will be on one line. We want to write a Java program that will find the average for each student. (The number of students changes each year.)
- Solution: TestScoreReader.java, TestAverages.java

Copyright