Chapter 9:
Text Processing and More about Wrapper Classes

Starting Out with Java:
From Control Structures through Objects

Fifth Edition

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PEARSON ALWAYS LEARNING

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
- The `StringTokenizer` Class
- 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

- 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

- 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

- 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

- 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

```
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 on page 574.

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 on page 574.

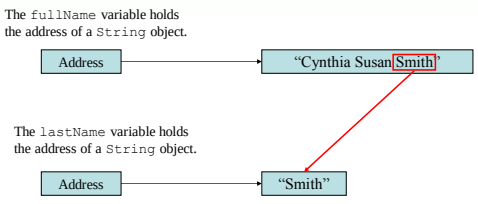
`int lastIndexOf(char ch)`	Searches the calling `String` object for the character passed into *ch*. If the character is found, the position of its last occurrence is returned. Otherwise, –1 is returned.
`int lastIndexOf(char ch, int start)`	Searches the calling `String` object for the character passed 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

- 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



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

- 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

```
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

- 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

- 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

- 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

- 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

- 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

- 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

- 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

- 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();
```


The `StringTokenizer` Class

- The `StringTokenizer` class breaks a string down into its components, which are called *tokens*.
- Tokens are a series of words or other items of data separated by spaces or other characters.
  - "peach raspberry strawberry vanilla"
- This string contains the following four tokens: peach, raspberry, strawberry, and vanilla.

The `StringTokenizer` Class

- The character that separates tokens is a *delimiter*.
  - "17;92;81;12;46;5"
- This string contains the following tokens: 17, 92, 81, 12, 46, and 5 that are delimited by semi-colons.
- Some programming problems require you to process a string that contains a list of items.

The `StringTokenizer` Class

- For example,
  - a date:
    - `"4-2-2010"`
  - an operating system pathname,
    - `/home/rsullivan/data`
- The process of breaking a string into tokens is known as *tokenizing*.
- The Java API provides the `StringTokenizer` class that allows you to tokenize a string.
- The following `import` statement must be used in any class that uses it:
  - `import java.util.StringTokenizer;`

`StringTokenizer` Constructors

Constructor	Description
`StringTokenizer(` **`String str)`**	The string to be tokenized is passed into *str*. Whitespace characters (space, tab, and newline) are used as delimiters.
`StringTokenizer(` **`String str,`** **`String delimiters)`**	The string to be tokenized is passed into *str*. The characters in *delimiters* will be used as delimiters.
`StringTokenizer(` **`String str,`** **`String delimiters,`** **`Boolean returnDelimeters)`**	The string to be tokenized is passed into *str*. The characters in *delimiters* will be used as delimiters. If the *returnDelimiters* parameter is set to true, the delimiters will be included as tokens. If this parameter is set to false, the delimiters will not be included as tokens.

Creating `StringTokenizer` Objects

- To create a `StringTokenizer` object with the default delimiters (whitespace characters):

```
StringTokenizer strTokenizer =
    new StringTokenizer("2 4 6 8");
```

- To create a `StringTokenizer` object with the hyphen character as a delimiter:

```
StringTokenizer strTokenizer =
    new StringTokenizer("8-14-2004", "-");
```

- To create a `StringTokenizer` object with the hyphen character as a delimiter, returning hyphen characters as tokens as well:

```
StringTokenizer strTokenizer =
    new StringTokenizer("8-14-2004", "-", true);
```


`StringTokenizer` Methods

- The `StringTokenizer` class provides:
  - `countTokens`
    - Count the *remaining* tokens in the string.
  - `hasMoreTokens`
    - Are there any more tokens to extract?
  - `nextToken`
    - Returns the next token in the string.
    - Throws a `NoSuchElementException` if there are no more tokens in the string.

Extracting Tokens

- Loops are often used to extract tokens from a string.

```
StringTokenizer strTokenizer =
     new StringTokenizer("One Two Three");
while (strTokenizer.hasMoreTokens())
{
  System.out.println(strTokenizer.nextToken());
}
```

- This code will produce the following output:

```
One
Two
Three
```

- Examples: DateComponent.java, DateTester.java

Multiple Delimiters

- The default delimiters for the `StringTokenizer` class are the whitespace characters.
  - `\n\r\t\b\f`
- Other multiple characters can be used as delimiters in the same string.
  - `joe@gaddisbooks.com`
- This string uses two delimiters: `@` and `.`
- If non-default delimiters are used
  - The `String` class `trim` method should be used on user input strings to avoid having whitespace become part of the last token.

Multiple Delimiters

- To extract the tokens from this string we must specify both characters as delimiters to the constructor.

```
StringTokenizer strTokenizer =
new StringTokenizer("joe@gaddisbooks.com", "@.");
while (strTokenizer.hasMoreTokens())
{
System.out.println(strTokenizer.nextToken());
}
```

- This code will produce the following output:

```
joe
gaddisbooks
com
```


The `String` Class `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
```


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

- 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

```
// 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

- 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

- 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 ArrayLists 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

