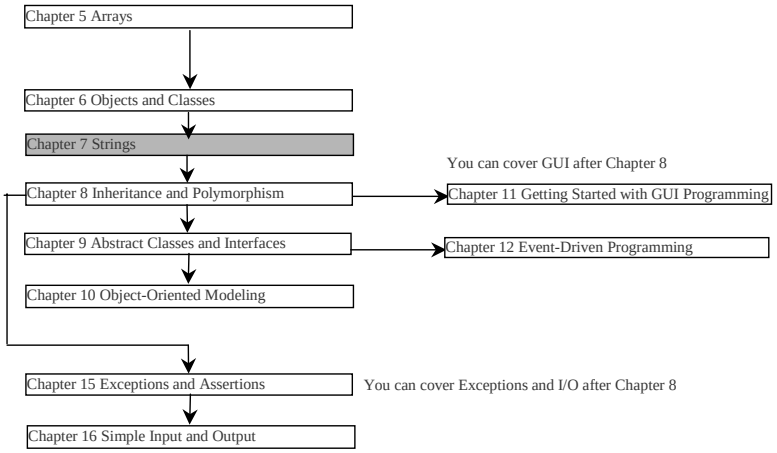
Chapter 7 Strings

Prerequisites for Part II



Objectives

- To use the String class to process fixed strings (§7.2).
- To use the Character class to process a single character (§7.3).
- To use the StringBuffer class to process flexible strings (§7.4).
- To use the StringTokenizer class to extract tokens from a string (§7.5).
- To know the differences among the String, StringBuffer, and StringTokenizer classes (§7.2-7.5).
- To use the JDK 1.5 Scanner class for console input and scan tokens using words as delimiters (§7.6).
- To input primitive values and strings from the keyboard using the Scanner class (§7.7).
- To learn how to pass strings to the main method from the command line (§7.8).

The `String` Class

- Constructing a String:
  - `String message = "Welcome to Java";`
  - `String message = new String("Welcome to Java");`
  - `String s = new String();`
- Obtaining String length and Retrieving Individual Characters in a string String
- String Concatenation (concat)
- Substrings (substring(index), substring(start, end))
- Comparisons (equals, compareTo)
- String Conversions
- Finding a Character or a Substring in a String
- Conversions between Strings and Arrays
- Converting Characters and Numeric Values to Strings

String	
+String()	Constructs an empty string
+String(value: String)	Constructs a string with the specified string literal value
+String(value: char[])	Constructs a string with the specified character array
+charAt(index: int): char	Returns the character at the specified index from this string
+compareTo(anotherString: String): int	Compares this string with another string
+compareToIgnoreCase(anotherString: String): int	Compares this string with another string ignoring case
+concat(anotherString: String): String	Concat this string with another string
+endsWith(suffix: String): boolean	Returns true if this string ends with the specified suffix
+equals(anotherString: String): boolean	Returns true if this string is equal to anther string
+equalsIgnoreCase(anotherString: String): boolean	Checks if this string equals anther string ignoring case
+getChars(int srcBegin, int srcEnd, char[] dst, int dstBegin): void	Copies characters from this string into the destination character array
+indexOf(ch: int): int	Returns the index of the first occurrence of ch
+indexOf(ch: int, fromIndex: int): int	Returns the index of the first occurrence of ch after fromIndex
+indexOf(str: String): int	Returns the index of the first occurrence of str
+indexOf(str: String, fromIndex: int): int	Returns the index of the first occurrence of str after fromIndex
+lastIndexOf(ch: int): int	Returns the index of the last occurrence of ch
+lastIndexOf(ch: int, fromIndex: int): int	Returns the index of the last occurrence of ch before fromIndex
+lastIndexOf(str: String): int	Returns the index of the last occurrence of str
+lastIndexOf(str: String, fromIndex: int): int	Returns the index of the last occurrence of str before fromIndex
+regionMatches(toffset: int, other: String, offset: int, len: int): boolean	Returns true if the specified subregion of this string exactly matches the specified subregion of the string argument
+length(): int	Returns the number of characters in this string
+replace(oldChar: char, newChar: char): String	Returns a new string with oldChar replaced by newChar
+startsWith(prefix: String): boolean	Returns true if this string starts with the specified prefix
+subString(beginIndex: int): String	Returns the substring from beginIndex
+subString(beginIndex: int, endIndex: int): String	Returns the substring from beginIndex to endIndex
+toCharArray(): char[]	Returns a char array consisting characters from this string
+toLowerCase(): String	Returns a new string with all characters converted to lowercase
+toString(): String	Returns a new string with itself
+toUpperCase(): String	Returns a new string with all characters converted to uppercase
+trim(): String	Returns a string with blank characters trimmed on both sides
+copyValueOf(data: char[]): String	Returns a new string consisting of the char array data
+valueOf(c: char): String	Returns a string consisting of the character c
+valueOf(data: char[]): String	Same as copyValueOf(data: char[]): String
+valueOf(d: double): String	Returns a string representing the double value
+valueOf(f: float): String	Returns a string representing the float value
+valueOf(i: int): String	Returns a string representing the int value
+valueOf(l: long): String	Returns a string representing the long value

Constructing Strings

String newString = new String(stringLiteral);

String message = new String("Welcome to Java");

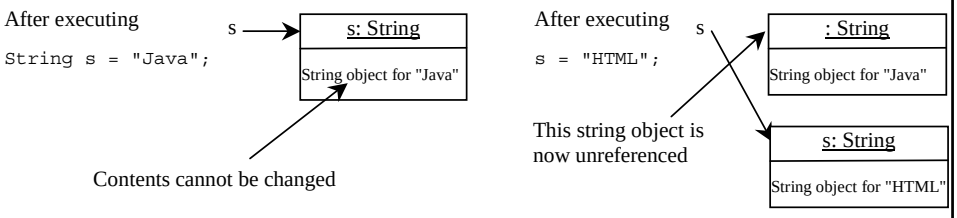
Since strings are used frequently, Java provides a shorthand initializer for creating a string:

String message = "Welcome to Java";

Strings Are Immutable

A String object is immutable; its contents cannot be changed. Does the following code change the contents of the string?

```
String s = "Java";
s = "HTML";
```



Canonical Strings

Since strings are immutable, to improve efficiency and save memory, the JVM stores two String objects in the same object if they were created with the same string literal using the shorthand initializer. Such a string is referred to as a *canonical string*. You can also use a String object's intern method to return a canonical string, which is the same string that is created using the shorthand initializer.

Examples

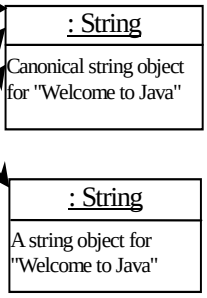
```
String s = "Welcome to Java";

String s1 = new String("Welcome to Java");

String s2 = s1.intern();

String s3 = "Welcome to Java";

System.out.println("s1 == s is " + (s1 == s));
System.out.println("s2 == s is " + (s2 == s));
System.out.println("s == s3 is " + (s == s3));
```



display

s1 == s is false

s2 == s is true

s == s3 is true

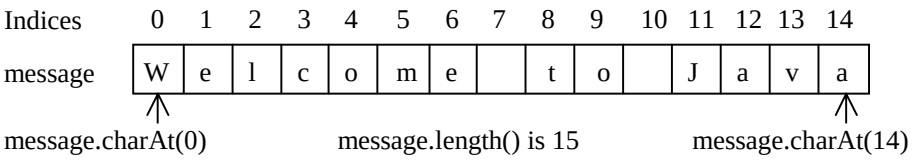
Finding String Length

Finding string length using the `length()` method:

```
message = "Welcome";
message.length() (returns 7)
```


Retrieving Individual Characters in a String

- Do not use `message[0]`
- Use `message.charAt(index)`
- Index starts from `0`



String Concatenation

```
String s3 = s1.concat(s2);
```

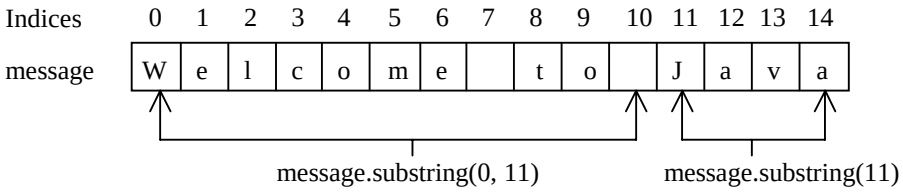
String s3 = s1 + s2;

s1 + s2 + s3 + s4 + s5 same as
(((s1.concat(s2)).concat(s3)).concat(s4)).concat(s5);

Extracting Substrings

`String` is an immutable class; its values cannot be changed individually.

```
String s1 = "Welcome to Java";
String s2 = s1.substring(0, 11) + "HTML";
```



String Comparisons

- equals

```
String s1 = new String("Welcome“);
String s2 = "welcome";

if (s1.equals(s2)){
  // s1 and s2 have the same contents
}

if (s1 == s2) {
  // s1 and s2 have the same reference
}
```


String Comparisons, cont.

- compareTo(Object object)

```
String s1 = new String("Welcome“);
String s2 = "welcome";

if (s1.compareTo(s2) > 0) {
  // s1 is greater than s2
}
else if (s1.compareTo(s2) == 0) {
  // s1 and s2 have the same contents
}
else
   // s1 is less than s2
```

String Conversions

The contents of a string cannot be changed once the string is created. But you can convert a string to a new string using the following methods:

- toLowerCase
- toUpperCase
- trim
- replace(oldChar, newChar)

Finding a Character or a Substring in a String

```
"Welcome to Java".indexOf('W') returns 0.
"Welcome to Java".indexOf('x') returns -1.
"Welcome to Java".indexOf('o', 5) returns 9.
"Welcome to Java".indexOf("come") returns 3.
"Welcome to Java".indexOf("Java", 5) returns
11.
"Welcome to Java".indexOf("java", 5) returns
-1.
"Welcome to Java".lastIndexOf('a') returns
14.
```

Convert Character and Numbers to Strings

The String class provides several static valueOf methods for converting a character, an array of characters, and numeric values to strings. These methods have the same name valueOf with different argument types char, char[], double, long, int, and float. For example, to convert a double value to a string, use String.valueOf(5.44). The return value is string consists of characters '5', '.', '4', and '4'.

Example 7.1 Finding Palindromes

- Objective: Checking whether a string is a palindrome: a string that reads the same forward and backward.

CheckPalindrome

The `Character` Class

Character	
+Character(value: char)	Constructs a character object with char value
+charValue(): char	Returns the char value from this object
+compareTo(anotherCharacter: Character): int	Compares this character with another
+equals(anotherCharacter: Character): boolean	Returns true if this character equals to another
+isDigit(ch: char): boolean	Returns true if the specified character is a digit
+isLetter(ch: char): boolean	Returns true if the specified character is a letter
+isLetterOrDigit(ch: char): boolean	Returns true if the character is a letter or a digit
+isLowerCase(ch: char): boolean	Returns true if the character is a lowercase letter
+isUpperCase(ch: char): boolean	Returns true if the character is an uppercase letter
+toLowerCase(ch: char): char	Returns the lowercase of the specified character
+toUpperCase(ch: char): char	Returns the uppercase of the specified character

Examples

Character charObject = new Character('b');

charObject.compareTo(new Character('a')) returns 1
charObject.compareTo(new Character('b')) returns 0
charObject.compareTo(new Character('c')) returns -1
charObject.compareTo(new Character('d') returns –2
charObject.equals(new Character('b')) returns true
charObject.equals(new Character('d')) returns false

Example 7.2
Counting Each Letter in a String

This example gives a program that counts the number of occurrence of each letter in a string. Assume the letters are not case-sensitive.

CountEachLetter

The `StringBuffer` Class

The `StringBuffer` class is an alternative to the `String` class. In general, a string buffer can be used wherever a string is used.

`StringBuffer` is more flexible than `String`. You can add, insert, or append new contents into a string buffer. However, the value of a String object is fixed once the string is created.

StringBuffer	
+StringBuffer()	Constructs an empty string buffer with capacity 16
+StringBuffer(capacity: int)	Constructs a string buffer with the specified capacity
+StringBuffer(str: String)	Constructs a string buffer with the specified string
+append(data: char[]): StringBuffer	Appends a char array into this string buffer
+append(data: char[], offset: int, len: int): StringBuffer	Appends a subarray in data into this string buffer
+append(v: *aPrimitiveType*): StringBuffer	Appends a primitive type value as string to this buffer
+append(str: String): StringBuffer	Appends a string to this string buffer
+capacity(): int	Returns the capacity of this string buffer
+charAt(index: int): char	Returns the character at the specified index
+delete(startIndex: int, endIndex: int): StringBuffer	Deletes characters from startIndex to endIndex
+deleteCharAt(int index): StringBuffer	Deletes a character at the specified index
+insert(index: int, data: char[], offset: int, len: int): StringBuffer	Inserts a subarray of the data in the array to the buffer at the specified index
+insert(offset: int, data: char[]): StringBuffer	Inserts data to this buffer at the position offset
+insert(offset: int, b: *aPrimitiveType*): StringBuffer	Inserts a value converted to string into this buffer
+insert(offset: int, str: String): StringBuffer	Inserts a string into this buffer at the position offset
+length(): int	Returns the number of characters in this buffer
+replace(int startIndex, int endIndex, String str): StringBuffer	Replaces the characters in this buffer from startIndex to endIndex with the specified string
+reverse(): StringBuffer	Reveres the characters in the buffer
+setCharAt(index: int, ch: char): void	Sets a new character at the specified index in this buffer
+setLength(newLength: int): void	Sets a new length in this buffer
+substring(startIndex: int): String	Returns a substring starting at startIndex
+substring(startIndex: int, endIndex: int): String	Returns a substring from startIndex to endIndex

`StringBuffer` Constructors

- `public StringBuffer()`
  No characters, initial capacity 16 characters.
- `public StringBuffer(int length)`
  No characters, initial capacity specified by the `length` argument.
- `public StringBuffer(String str)`
  Represents the same sequence of characters as the `string` argument. Initial capacity 16 plus the length of the `string` argument.

Appending New Contents into a String Buffer

```
StringBuffer strBuf = new StringBuffer();
strBuf.append("Welcome");
strBuf.append(' ');
strBuf.append("to");
strBuf.append(' ');
strBuf.append("Java");
```


Example 7.3 Checking Palindromes Ignoring Non-alphanumeric Characters

This example gives a program that counts the number of occurrence of each letter in a string. Assume the letters are not case-sensitive.

PalindromeIgnoreNonAlphanumeric

The `StringTokenizer` Class

java.util.StringTokenizer	
+StringTokenizer(s: String)	Constructs a string tokenizer for the string.
+StringTokenizer(s: String, delimiters: String)	Constructs a string tokenizer for the string with the specified delimiters.
+StringTokenizer(s: String, delimiters: String, returnDelimiters: boolean)	Constructs a string tokenizer for the string with the delimiters and returnDelims.
+countTokens(): int	Returns the number of remaining tokens.
+hasMoreTokens(): boolean	Returns true if there are more tokens left.
+nextToken(): String	Returns the next token.
+nextToken(delimiters: String): String	Returns the next token using new delimiters.

Examples 1

```
String s = "Java is cool.";
StringTokenizer tokenizer = new StringTokenizer(s);

System.out.println("The total number of tokens is " +
  tokenizer.countTokens());

while (tokenizer.hasMoreTokens())
  System.out.println(tokenizer.nextToken());
```

The code displays

```
The total number of tokens is 3
Java
is
cool.
```

Examples 2

```
String s = "Java is cool.";
StringTokenizer tokenizer = new StringTokenizer(s, "ac");

System.out.println("The total number of tokens is " +
  tokenizer.countTokens());

while (tokenizer.hasMoreTokens())
  System.out.println(tokenizer.nextToken());
```

The code displays

```
The total number of tokens is 4
J
v
 is
ool.
```


Examples 3

```
String s = "Java is cool.";
StringTokenizer tokenizer = new StringTokenizer(s, "ac",  ture);

System.out.println("The total number of tokens is " +
  tokenizer.countTokens());

while (tokenizer.hasMoreTokens())
  System.out.println(tokenizer.nextToken());
```

The code displays

```
The total number of tokens is 7
J
a
v
a
 is
c
ool.
```

No no-arg Constructor in StringTokenizer

The StringTokenizer class does not have a no-arg constructor. Normally it is a good programming practice to provide a no-arg constructor for each class. On rare occasions, however, a no-arg constructor does not make sense. StringTokenizer is such an example. A StringTokenizer object must be created for a string, which should be passed as an argument from a constructor.

JDK 1.5 Feature

The Scanner Class

The delimiters are single characters in StringTokenizer. You can use the new JDK 1.5 java.util.Scanner class to specify a word as a delimiter.

```
String s = "Welcome to Java! Java is fun! Java is cool!";
Scanner scanner = new Scanner(s);
scanner.useDelimiter("Java");

while (scanner.hasNext())
  System.out.println(scanner.next());
```

Creates an instance of Scanner for the string.

Sets “Java” as a delimiter.

hasNext() returns true if there are still more tokens left.

The next() method returns a token as a string.

```
Welcome to
!
 is fun!
 is cool!
```

Output

JDK 1.5 Feature

Scanning Primitive Type Values

If a token is a primitive data type value, you can use the methods nextByte(), nextShort(), nextInt(), nextLong(), nextFloat(), nextDouble(), or nextBoolean() to obtain it. For example, the following code adds all numbers in the string. Note that the delimiter is space by default.

```
String s = "1 2 3 4";
Scanner scanner = new Scanner(s);

int sum = 0;
while (scanner.hasNext())
  sum += scanner.nextInt();

System.out.println("Sum is " + sum);
```


JDK 1.5 Feature

Console Input Using Scanner

Another important application of the Scanner class is to read input from the console. For example, the following code reads an int value from the keyboard:

```
System.out.print("Please enter an int value: ");
Scanner scanner = new Scanner(System.in);
int i = scanner.nextInt();
```

NOTE: StringTokenizer can specify several single characters as delimiters. Scanner can use a single character or a word as the delimiter. So, if you need to scan a string with multiple single characters as delimiters, use StringTokenizer. If you need to use a word as the delimiter, use Scanner.

Command-Line Parameters

```
class TestMain {
  public static void main(String[] args) {
  ...
  }
}
```

```
java TestMain arg0 arg1 arg2 ... argn
```


Processing Command-Line Parameters

In the main method, get the arguments from `args[0], args[1], ..., args[n]`, which corresponds to `arg0, arg1, ..., argn` in the command line.

Example 7.4
Using Command-Line Parameters

- Objective: Write a program that will perform binary operations on integers. The program receives three parameters: an operator and two integers.

Calculator

java Calculator 2 + 3

java Calculator 2 - 3

java Calculator 2 / 3

java Calculator 2 “*” 3