

Strings

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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";
```

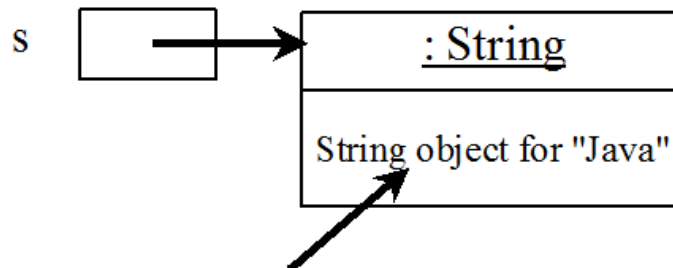
Strings Are **Immutable**

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

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

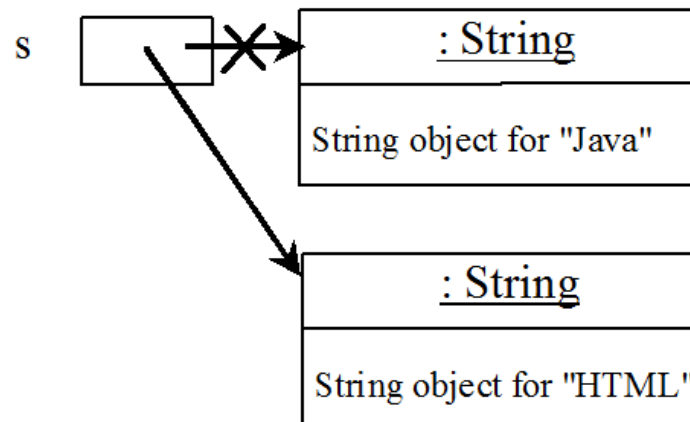
```
s = "HTML";
```

After executing `String s = "Java";`



Contents cannot be changed

After executing `s = "HTML";`



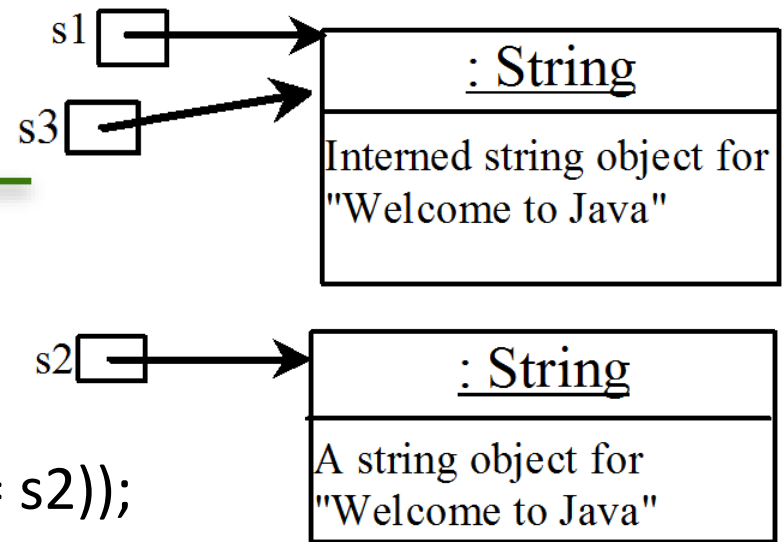
This string object is now unreferenced

Interned Strings

- ❖ Since strings are immutable and are frequently used, **to improve efficiency and save memory**, the **JVM** uses a **unique** instance for string literals with the same character sequence.
- ❖ Such an instance is called **interned**.

Example

```
String s1 = "Welcome to Java";  
String s2 = new String("Welcome to Java");  
String s3 = "Welcome to Java";  
System.out.println("s1 == s2 is " + (s1 == s2));  
  
System.out.println("s1 == s3 is " + (s1 == s3));
```



Display:

```
s1 == s2 is false  
s1 == s3 is true
```

- ❖ A new object is created if you use the **new** operator.
- ❖ If you use the string **initializer**, no new object is created **if** the interned object is already created.

String Comparisons

java.lang.String

+equals(s1: Object): boolean

Returns true if this string is equal to string s1.

+equalsIgnoreCase(s1: String): boolean

Returns true if this string is equal to string s1 case-insensitive.

+compareTo(s1: String): int

Returns an integer greater than 0, equal to 0, or less than 0 to indicate whether this string is greater than, equal to, or less than s1.

+compareToIgnoreCase(s1: String): int

Same as compareTo except that the comparison is case-insensitive.

+regionMatches(toffset: int, s1: String, offset: int, len: int): boolean

Returns true if the specified subregion of this string exactly matches the specified subregion in string s1.

+regionMatches(ignoreCase: boolean, toffset: int, s1: String, offset: int, len: int): boolean

Same as the preceding method except that you can specify whether the match is case-sensitive.

+startsWith(prefix: String): boolean

Returns true if this string starts with the specified prefix.

+endsWith(suffix: String): boolean

Returns true if this string ends with the specified suffix.

String Comparisons

```
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

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 Length, Characters, and Combining Strings

java.lang.String

+length(): int

+charAt(index: int): char

+concat(s1: String): String

Returns the number of characters in this string.

Returns the character at the specified index from this string.

Returns a new string that concatenate this string with string s1.

Finding String **Length**

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

```
message = "Welcome to Java";
```

```
message.length(); // returns 15
```



Retrieving Individual Characters in a String

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

[illegible]

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

`java.lang.String`

`+substring(beginIndex: int): String`

Returns this string's substring that begins with the character at the specified `beginIndex` and extends to the end of the string, as shown in Figure 8.6.

`+substring(beginIndex: int, endIndex: int): String`

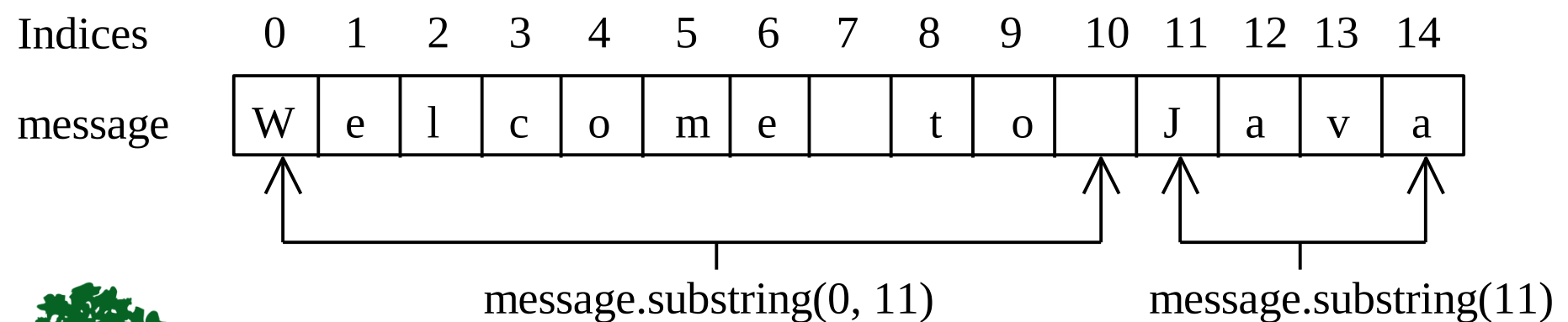
Returns this string's substring that begins at the specified `beginIndex` and extends to the character at index `endIndex - 1`, as shown in Figure 8.6. Note that the character at `endIndex` is not part of the substring.

Extracting Substrings

- ❖ You can extract a single character from a **string** using the **charAt** method.
- ❖ You can also extract a substring from a **string** using the **substring** method in the **String** class.

```
String s1 = "Welcome to Java";
```

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



Converting, Replacing, and Splitting Strings

java.lang.String

+toLowerCase(): String

+toUpperCase(): String

+trim(): String

+replace(oldChar: char,
newChar: char): String

+replaceFirst(oldString: String,
newString: String): String

+replaceAll(oldString: String,
newString: String): String

+split(delimiter: String):
String[]

Returns a new string with all characters converted to lowercase.

Returns a new string with all characters converted to uppercase.

Returns a new string with blank characters trimmed on both sides.

Returns a new string that replaces all matching character in this string with the new character.

Returns a new string that replaces the first matching substring in this string with the new substring.

Returns a new string that replace all matching substrings in this string with the new substring.

Returns an array of strings consisting of the substrings split by the delimiter.

Examples

"Welcome".**toLowerCase()**

returns a new string, **welcome**

"Welcome".**toUpperCase()**

returns a new string, **WELCOME**

" Welcome ".**trim()**

returns a new string, **Welcome**

"Welcome".**replace('e', 'A')**

returns a new string, **WAlcomA**

"Welcome".**replaceFirst("e", "AB")**

returns a new string, **WABlcome**

"Welcome".**replaceAll("e", "AB")**

returns a new string, **WABlcomAB**



Splitting a String

```
String s1 = "Java#HTML#Perl";  
String[] tokens = s1.split( "#" , 0);  
for (int i = 0; i < tokens.length; i++)  
    System.out.println( tokens[i] );
```

Displays:

Java

HTML

Perl

Matching, Replacing and Splitting by Patterns

- ❖ You can **match**, **replace**, or **split** a string by specifying a pattern.
- ❖ This is an extremely useful and powerful feature, commonly known as ***regular expression***.

```
"Java".matches("Java")
```

```
"Java".equals("Java")
```

```
"Java is fun".matches("Java.*")
```

```
"Java is cool".matches("Java.*")
```

Matching, Replacing and Splitting by Patterns

- ❖ The **replaceAll**, **replaceFirst**, and **split** methods can be used with a regular expression.
- ❖ For example, the following statement returns a new string that replaces **\$**, **+**, or **#** in "**a+b\$#c**" by the string **NNN**.

```
String s = "a+b$#c".replaceAll("[$+#]", "NNN");  
System.out.println(s);
```

Here the regular expression **[\$+#]** specifies a pattern that matches **\$**, **+**, or **#**.

So, the output is **aNNNbNNNNNNNc**

Matching, Replacing and Splitting by Patterns

❖ The following statement **splits** the string into an array of strings delimited by some punctuation marks:

```
String[] tokens = "Java,C?C#,C++".split("[.,:;?]");  
for (int i = 0; i < tokens.length; i++)  
    System.out.println(tokens[i]);
```

Java
C
C#
C++

Finding a Character or a Substring in a String

java.lang.String	
+indexOf(ch: char): int	Returns the index of the first occurrence of ch in the string. Returns -1 if not matched.
+indexOf(ch: char, fromIndex: int): int	Returns the index of the first occurrence of ch after fromIndex in the string. Returns -1 if not matched.
+indexOf(s: String): int	Returns the index of the first occurrence of string s in this string. Returns -1 if not matched.
+indexOf(s: String, fromIndex: int): int	Returns the index of the first occurrence of string s in this string after fromIndex. Returns -1 if not matched.
+lastIndexOf(ch: int): int	Returns the index of the last occurrence of ch in the string. Returns -1 if not matched.
+lastIndexOf(ch: int, fromIndex: int): int	Returns the index of the last occurrence of ch before fromIndex in this string. Returns -1 if not matched.
+lastIndexOf(s: String): int	Returns the index of the last occurrence of string s. Returns -1 if not matched.
+lastIndexOf(s: String, fromIndex: int): int	Returns the index of the last occurrence of string s before fromIndex. Returns -1 if not matched.

Finding a Character or a Substring in a String

String s = "Welcome to Java";

s.indexOf('W')	returns 0
s.indexOf('x')	returns -1
s.indexOf('o', 5)	returns 9
s.indexOf("come")	returns 3
s.indexOf("Java", 5)	returns 11
s.indexOf("java", 5)	returns -1
s.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'.



You can convert a numeric string into a number. To convert a string into an `int` value, use the `Integer.parseInt` method, as follows:

```
int intValue = Integer.parseInt(intString);
```

where `intString` is a numeric string such as `"123"`.

To convert a string into a `double` value, use the `Double.parseDouble` method, as follows:

```
double doubleValue = Double.parseDouble(doubleString);
```

where `doubleString` is a numeric string such as `"123.45"`.

If the string is not a numeric string, the conversion would cause a runtime error. The `Integer` and `Double` classes are both included in the `java.lang` package, and thus they are automatically imported.

You can convert a number into a string, simply use the string concatenating operator as follows:

```
String s = number + "";
```

The Character Class

java.lang.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 c = new Character('b');

c.compareTo(new Character('a'))

returns 1

c.compareTo(new Character('b'))

returns 0

c.compareTo(new Character('c'))

returns -1

c.compareTo(new Character('d'))

returns -2

c.equals(new Character('b'))

returns true

c.equals(new Character('d'))

returns false

StringBuilder and StringBuffer

- ❖ The **StringBuilder/StringBuffer** class is an alternative to the **String** class.
- ❖ In general, a **StringBuilder/StringBuffer** can be used wherever a **String** is used.
- ❖ **StringBuilder/StringBuffer** is more **flexible** than **String**.
- ❖ You can **add**, **insert**, or **append** new contents into a string buffer, whereas the value of a **String** object is fixed once the string is created.

StringBuilder Constructors

java.lang.StringBuilder

+StringBuilder()

Constructs an empty string builder with capacity **16**.

+StringBuilder(capacity: int)

Constructs a string builder with the specified capacity.

+StringBuilder(s: String)

Constructs a string builder with the specified string.

Modifying Strings in the Builder

java.lang.StringBuilder	
+append(data: char[]): StringBuilder	Appends a char array into this string builder.
+append(data: char[], offset: int, len: int): StringBuilder	Appends a subarray in data into this string builder.
+append(v: <i>aPrimitiveType</i>): StringBuilder	Appends a primitive type value as a string to this builder.
+append(s: String): StringBuilder	Appends a string to this string builder.
+delete(startIndex: int, endIndex: int): StringBuilder	Deletes characters from startIndex to endIndex.
+deleteCharAt(index: int): StringBuilder	Deletes a character at the specified index.
+insert(index: int, data: char[], offset: int, len: int): StringBuilder	Inserts a subarray of the data in the array to the builder at the specified index.
+insert(offset: int, data: char[]): StringBuilder	Inserts data into this builder at the position offset.
+insert(offset: int, b: <i>aPrimitiveType</i>): StringBuilder	Inserts a value converted to a string into this builder.
+insert(offset: int, s: String): StringBuilder	Inserts a string into this builder at the position offset.
+replace(startIndex: int, endIndex: int, s: String): StringBuilder	Replaces the characters in this builder from startIndex to endIndex with the specified string.
+reverse(): StringBuilder	Reverses the characters in the builder.
+setCharAt(index: int, ch: char): void	Sets a new character at the specified index in this builder.



Examples

```
StringBuilder sb = new StringBuilder("Welcome to ");
```

```
sb.append("Java");
```

```
sb.insert(11, "HTML and ");
```

```
sb.delete(8, 11);
```

*// changes the builder to **Welcome Java***

```
sb.deleteCharAt(8);
```

*// changes the builder to **Welcome o Java***

```
sb.reverse();
```

*// changes the builder to **avaJ ot emocleW***

```
sb.replace(11, 15, "HTML");
```

*// changes the builder to **Welcome to HTML***

```
sb.setCharAt(0, 'w');
```

*// sets the builder to **welcome to Java***



The toString, capacity, length, setLength, and charAt Methods

java.lang.StringBuilder

+toString(): String

Returns a string object from the string builder.

+capacity(): int

Returns the capacity of this string builder.

+charAt(index: int): char

Returns the character at the specified index.

+length(): int

Returns the number of characters in this builder.

+setLength(newLength: int): void

Sets a new length in this builder.

+substring(startIndex: int): String

Returns a substring starting at startIndex.

+substring(startIndex: int, endIndex: int):
String

Returns a substring from startIndex to endIndex-1.

+trimToSize(): void

Reduces the storage size used for the string builder.