Northeastern University

Lecture 10: Object Oriented Programming - 5

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Liang, Y. Daniel. Introduction to Java Programming, Comprehensive Version, 12th edition, Pearson, 2019.

Outline

- Objects and Classes
- Thinking in Objects

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- Thinking in Objects

The `String` Class

Strings Are Immutable

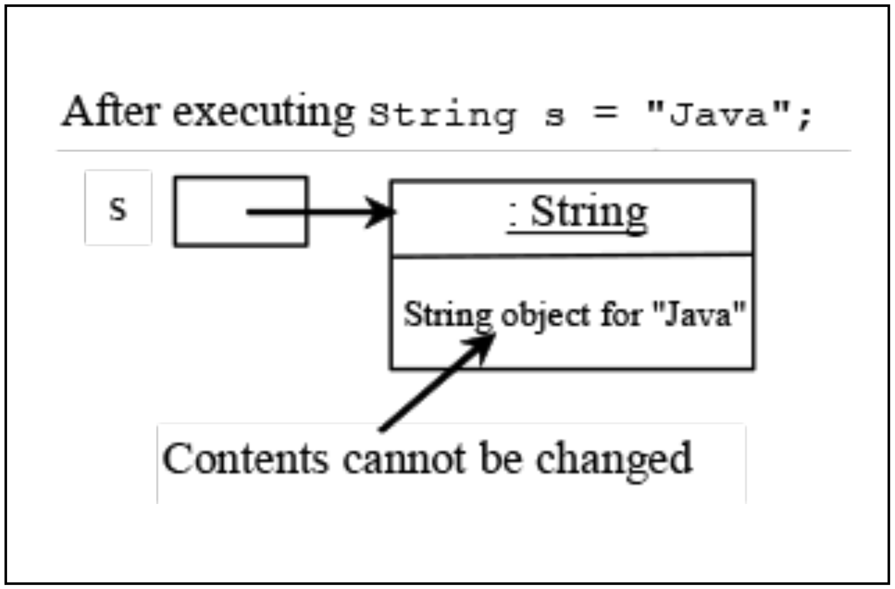
- A String object is immutable; its contents cannot be changed.
- Does the following code change the contents of the string?

```
String s = "Java";

s = "HTML";
```

- The answer is no. Why?

Trace Code

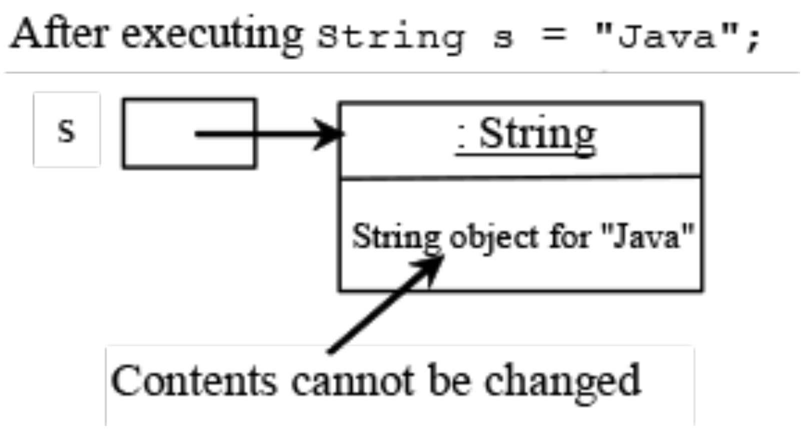
```
String s = "Java";

s = "HTML";
```

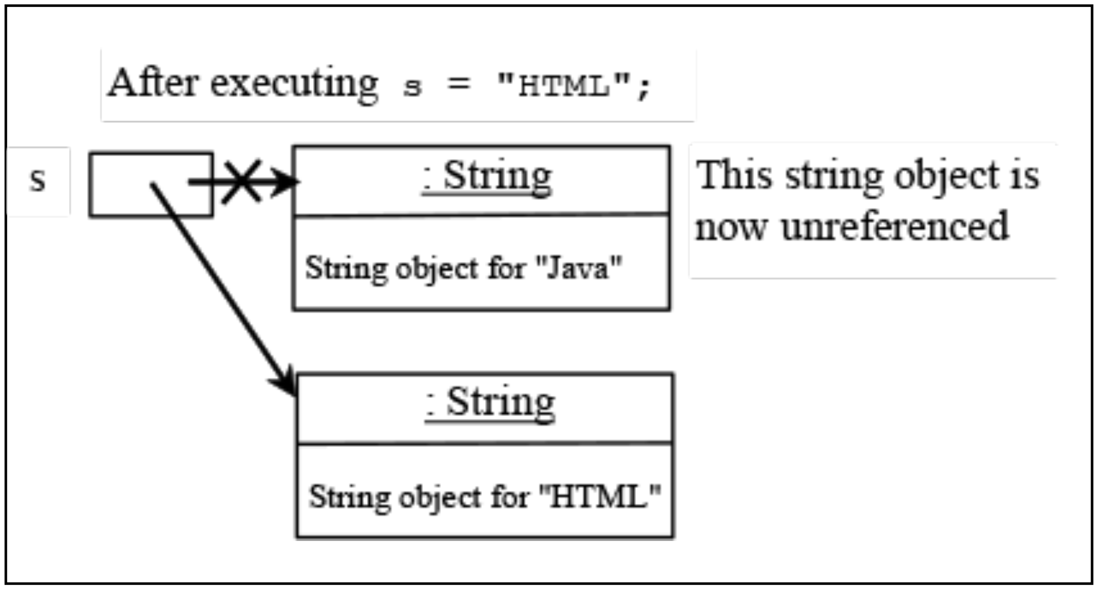

After executing String s = "Java";
s
: String
String object for "Java"
Contents cannot be changed

Trace Code

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

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


After executing String s = "Java";
s
: String
String object for "Java"
Contents cannot be changed

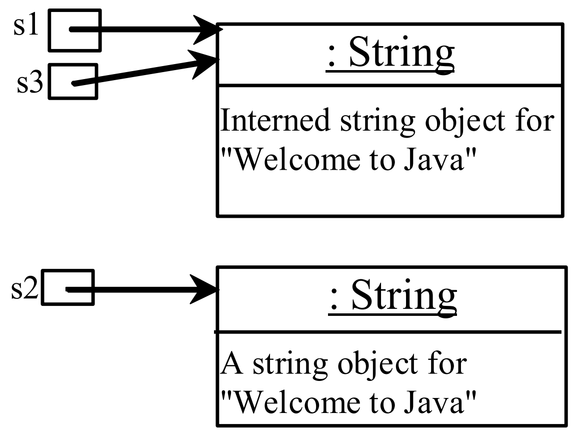

After executing s = "HTML";
s
: String
String object for "Java"
This string object is now unreferenced
: String
String object for "HTML"

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));
```



s1
s3
: String
Interned string object for "Welcome to Java"
s2
: String
A string object for "Welcome to Java"

display

s1 == s2 is false

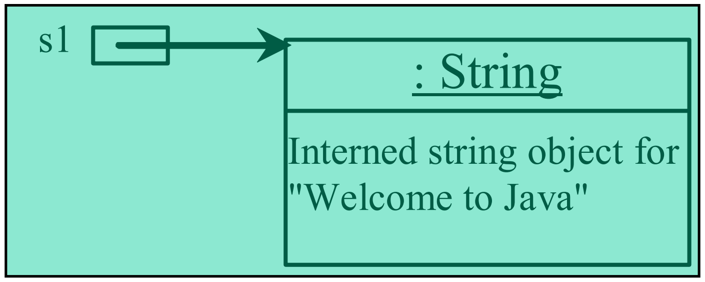
s1 == s3 is true

A new object is created if you use the new operator.

When you use the string initializer, no new object is created if the interned object is already created.

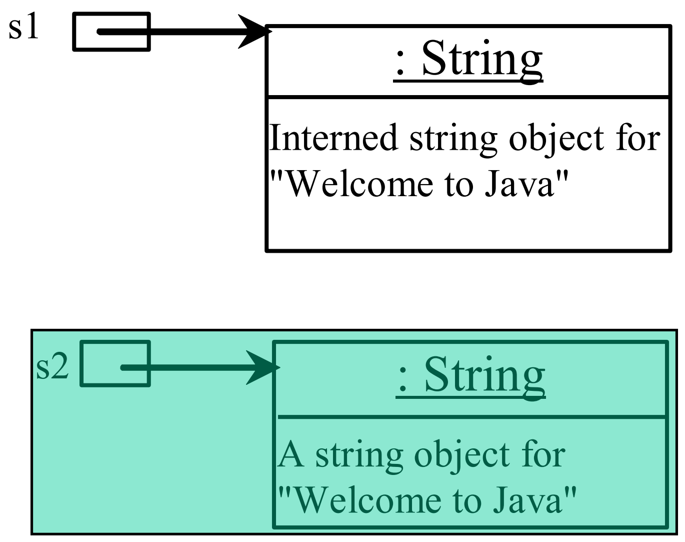
Trace Code

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

String s2 = new String("Welcome to Java");

String s3 = "Welcome to Java";
```



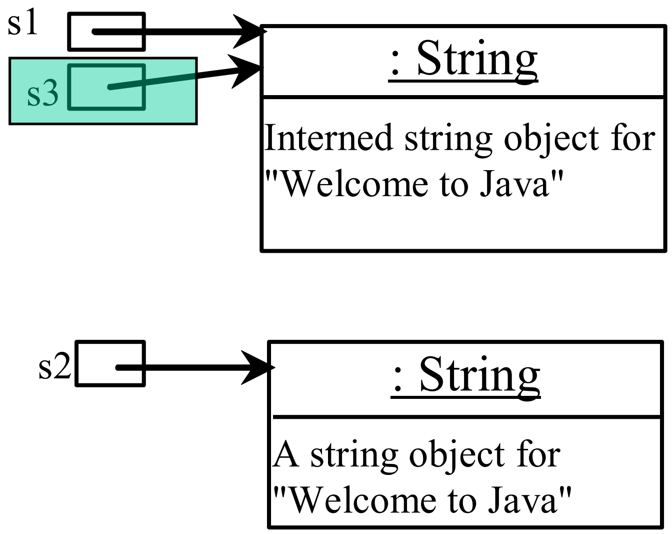
Trace Code

```
String s1 = "Welcome to Java";
String s2 = new String("Welcome to Java");
String s3 = "Welcome to Java";
```


s1
: String
Interned string object for "Welcome to Java"
s2
: String
A string object for "Welcome to Java"

Trace Code

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

String s2 = new String("Welcome to Java");

String s3 = "Welcome to Java";
```


s1
s3
: String
Interned string object for "Welcome to Java"
s2
: String
A string object for "Welcome to Java"

Replacing and Splitting Strings

java.lang.String	
+replace(oldChar: char, newChar: char): String	Returns a new string that replaces all matching character in this string with the new character.
+replaceFirst(oldString: String, newString: String): String	Returns a new string that replaces the first matching substring in this string with the new substring.
+replaceAll(oldString: String, newString: String): String	Returns a new string that replace all matching substrings in this string with the new substring.
+split(delimiter: String): String[]	Returns an array of strings consisting of the substrings split by the delimiter.

Example

```
"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.

"Welcome".replace("el", "AB”)                // returns a new string, WABcome.
```

Splitting a String

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

Output:

```
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*.
- Regular expression is complex to beginning students. For this reason, two simple patterns are used in this section.

```
"Java".matches("Java");          //true
"Java".equals("Java");           //true

"Java is fun".matches("Java.*");    //true
"Java is cool".matches("Java.*");   //true
```

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 aNNNbNNNNNNc.

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]);
```

Output:

```
Java
C
C#
C++
```

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’.

Exercise (10 mins)

- Given two strings, write a method to decide if one is a permutation of the other.

```
hello vs. elolh
```

Answer

```java
import java.util.Scanner;

public class ClassExercise {

    public static void main(String[] args) {
        Scanner input = new Scanner(System.in);

        System.out.print("1st string: ");
        String string1 = input.next();

        System.out.print("2nd string: ");
        String string2 = input.next();

        boolean result = PermutationCheck(string1, string2);

        if(result) {
            System.out.println("Permutation: Yes");
        }else {
            System.out.println("Permutation: No");
        }

        input.close();
    }

    public static String sort(String s) {
        char[] content = s.toCharArray();
        java.util.Arrays.sort(content);
        return new String(content);
    }

    public static boolean PermutationCheck(String a, String b) {

        if(a.length() != b.length()) {
            return false;
        }

        return sort(a).equals(sort(b));
    }
}
```

The `StringBuilder and StringBuffer` Classes

`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.
- However, `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.

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: *aPrimitiveType*): 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: *aPrimitiveType*): 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.

Exercise

```
StringBuilder stringBuilder = new StringBuilder();
stringBuilder.append("Welcome”);
stringBuilder.append(' ');
stringBuilder.append("to");
stringBuilder.append(' ');
stringBuilder.append("Java");   // "Welcome to Java"
```

```
stringBuilder.insert(11, "HTML and ")     // "Welcome to HTML and Java”
stringBuilder.delete(8, 11)               // "Welcome HTML and Java”

stringBuilder.deleteCharAt(8)             // "Welcome o Java”
stringBuilder.reverse()                   // "avaJ ot emocleW”
stringBuilder.replace(11, 15, "HTML")     // "Welcome to HTML”
stringBuilder.setCharAt(0, 'w')           // "welcome to Java"
```

Exercise (10 mins)

- Given a String[] of words: Dog, Cat, Fish, Bird, Horse

```
String[] myWords = {"Dog", "Cat", "Fish", "Bird", "Horse"};
```

- Please write a method `makeSentence()` that takes this String[] as an input parameter.
- Inside the method, please use `StringBuffer` to concatenate all words as a String and return it back.
- Print out the concatenated string

Answer

```java
public class ClassExercise {

    public static void main(String[] args){
        String[] myWords = {"Dog", "Cat", "Fish", "Bird", "Horse"};
        System.out.println(makeSentence(myWords));
    }

    public static String makeSentence(String[] words){

        //You can replace StringBuilder with StringBuffer
        StringBuffer sentence = new StringBuffer();

        for(String w: words){
            sentence.append(w);
        }

        return sentence.toString();
    }
}
```

Exercise (offline)

- Implement a method to perform basic string compression using the counts of repeated characters.
- For example, the string aabccccbbb would become a2b1c4b3.
- If the "compressed" string would not become smaller than the original string, your method should return the original string.
- You can assume the string has only uppercase and lowercase letters (a-z).