



Java Fundamentals

4-4 Strings



Objectives

This lesson covers the following objectives:

- Instantiate (create) a String
- Describe what happens when a String is modified
- Use the + and += operators for concatenating Strings
- Interpret escape sequences in String literals

Overview

This lesson covers the following topics:

- Recognize the difference between a String and a primitive char data type
- Test Strings with the compareTo() and equals() method
- Describe why the == operator does not always work when testing String equality
- Use String methods length(), substring(), indexOf(), and charAt()

What is a String?



- A String is an object that contains a sequence of characters. Declaring and instantiating a String is much like any other object variable.
- However, there are differences:
 - They can be instantiated (created) without using the new keyword.
 - They are immutable.
 - Once instantiated, they are final and cannot be changed.

Modifying a String

- Attempting to modify a String does not modify it, it creates a new String object.
- As a new programmer, you will not notice this difference.
- However, it becomes important in real systems where processing time is a key element in program design.

String Operations Example

```
public class StringOperations{
    public static void main(String[] args){
        String string1 = "Hello";
        String string2="Lisa";
        String string3="";           //empty String or null
        string3="How are you ".concat(string2);
        System.out.println("string3: "+ string3);
        //get length
        System.out.println("Length: "+ string1.length());
        //get substring beginning with character 0, up to, but not
        //including character 5
        System.out.println("Sub: "+ string3.substring(0,5));
        //uppercase
        System.out.println("Upper: "+string3.toUpperCase());
    }
}
```

Class Template

- Use the following class to insert examples from this section.

```
import java.util.Scanner;  
public class StringPractice{  
    public static void main(String[] args){  
  
        //paste practice code here  
  
    }  
}
```


Instantiating a String

- Strings are object reference types.
- They can be instantiated in two ways:
 - The new operator
 - String literals
 - There is no difference between the Strings below.
 - Both methods of instantiation create identical objects.

```
String s1 = new String("abc"); // new operator
String s2 = "abc";             // String literals
```

String References

- When you create a reference to an Object or String, the object does not necessarily exist yet.
- In the code below, since name is not initialized, the program will not compile.
- The variable name is a null pointer.

```
String name;  
System.out.println("My name is " + name);
```



Name = null

String References

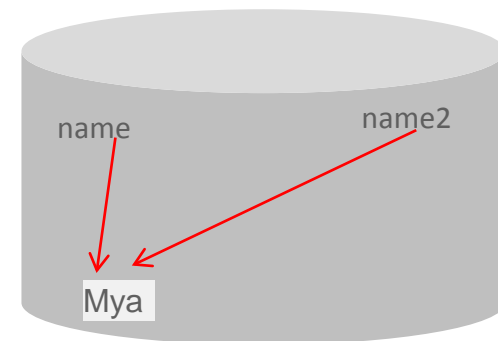
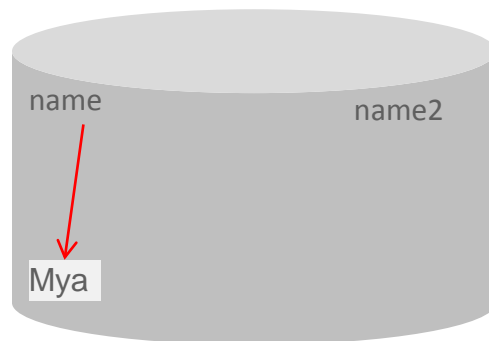
- In this code, one String object exists and name is referencing it. The reference name2 is null.
- How will this line change memory?

```
String name,name2;  
name = "Mya";
```

name2 = null

name = Mya

```
name2 = name;
```



String References

- Executing this line of code changes the name2 reference.

```
name2 = name;
```

- The reference name2 will now refer to the same object as name.



String References

- Executing these lines of code creates two instances of the String Mya in memory.

```
String name, name2;  
name = "Mya";  
name2 = "Mya";
```

- Here the JVM compiler decides to save space and stores only one String Object that holds the String Mya.



String References

- If we run a very similar program but ask the user to enter Strings, we get a different result.

```
Scanner in= new Scanner(System.in);  
String name, name2;  
name=in.next();  
name2=in.next();
```

- If the user types Mya for both Strings, the compiler actually creates two different String Objects.

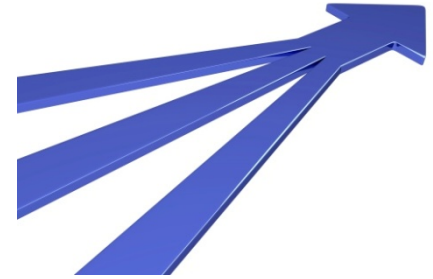


String References

- It is very difficult to predict when Java will create a new String or use an existing object for a String that is identical to the new String.



String Concatenation



- Concatenate two strings together with the + and += operators.
- Symbol + is used to concatenate two strings together.
- Symbol += is used to concatenate two strings together and assign it to itself all in one operation.

```
String s1 = "This is a ";  
String s2 = "string";  
String s3 = s1 + s2;  
String s4 = "This is a " + s2;  
String s1 += s2;
```

To concatenate means to link items together in a chain or series.
String concatenation is the linking together of two or more strings.

Manipulation of Strings

- Each time a String is changed, a new String is created in a new memory location and the reference is moved to the new location.
- Some Strings will point to the same reference object in memory.
- Making a modification to one String that is pointing to the shared reference will not make a modification to the others.
- The one that you modify points to the new memory address that holds the new/modified string and the others still point to the original one.

String Concatenation Example

- What will be the output of s1, s2, s3, and s4 at the end of these statements?

```
String s1 = "This is a ";  
String s2 = "string";  
String s3 = s1 + s2;  
String s4 = "This is a " + s2;  
String s1 += s2;  
System.out.println("s1: " + s1);  
System.out.println("s2: " + s2);  
System.out.println("s3: " + s3);  
System.out.println("s4: " + s4);
```

- Enter these statements in a Java program and check the results. Did you guess correctly?

Escape Sequences



- Escape sequences in string literals allow the user to add characters that would be misinterpreted by the compiler.
- For example, to include a double-quote in your String, the compiler would interpret the double-quote as the beginning or ending of your String rather than including it.
- Use the escape sequence \" to include a double-quote.

```
String s1 = "This is an example of an escape.  
           \n And now we're on a new line. \n \t This is a tab."  
String s2 = "\"This is a quote \"";  
System.out.println(s1);  
System.out.println(s2);
```

Common Escape Sequences in Java

- Here is a list of a few common escape sequences in Java.

Escape Sequence	Representation	Alternate Octal Escape Representation
<code>\"</code>	Double quote	<code>\u0022</code>
<code>\'</code>	Single quote	<code>\u0027</code>
<code>\\</code>	Backslash	<code>\u005c</code>
<code>\t</code>	Horizontal tab	<code>\u0009</code>
<code>\n</code>	Line feed	<code>\u000a</code>
<code>\b</code>	Backspace	<code>\u0008</code>
<code>\r</code>	Carriage return	<code>\u000d</code>
<code>\f</code>	Form feed	<code>\u000c</code>
Octal Escape	Octal value	<code>\u0000</code> to <code>\u00ff</code>

compareTo() Method



- Methods to use when comparing Strings.
 - Method: `s1.compareTo(s2)`
 - Should be used when trying to find the lexicographical order of two strings.
 - Returns an integer.
 - If `s1` is less than `s2`, an `int < 0` is returned.
 - If `s1` is equal to `s2`, `0` is returned.
 - If `s1` is larger than `s2`, an `int > 0` is returned.

equals() Method

- Methods to use when comparing Strings.
 - Method: `s1.equals(s2)`
 - Should be used when you only wish to find if the two strings are equal.
 - Returns a boolean value.
 - If true is returned, s1 is equal to s2.
 - If false is returned, s1 is not equal to s2.



compareTo() and equals() Methods

Example

- What will this compareTo() method print?

```
String s1 = "abc";  
String s2 = "cde";  
System.out.println(s1.compareTo(s2));
```

- What will this equals() method print?

```
String s1 = "abc";  
String s2 = "ABC";  
System.out.println(s1.equals(s2));
```

compareTo() and equals() Methods

Example Solution

- This compareTo method prints an int less than 0.

```
String s1 = "abc";  
String s2 = "cde";  
System.out.println(s1.compareTo(s2));
```

- This equals method prints false.

```
String s1 = "abc";  
String s2 = "ABC";  
System.out.println(s1.equals(s2));
```


Comparing Strings with ==

- Primitive variables can be compared with ==.
- This method of comparison does not always work with Strings and should be avoided unless trying to compare the memory address location of two String objects.
- == compares reference values, not values.
- Will only be true if the two String objects are pointing to the same reference object.

```
String s1 = "This is a String.";
String s2 = new String("This is a String.");
String s3 = "String.";
String s4 = "This is a " + s3;

System.out.println(s1 == s2);
System.out.println(s1 == s4);
```

Comparing Strings with ==

- Which will print true in the example below?
- s1 and s2 will point to the same object. Java notices that they are the same and makes the reference the same.
- s5 will not point to the same object as s1. It is "built" from a combination of two Strings, and therefore, a new object is created.

```
String s1 = "This is a String.";
String s2 = "This is a String.";
String s3 = "This is ";
String s4 = "a String.";
String s5 = s3 + s4;
```

```
System.out.println(s1 == s2);
System.out.println(s1 == s5);
```

Useful String Method: length()

- Method: s1.length()
- Returns the length, or the number of characters, in s1 as an int.
- String length is an accessor method called on a String object that will return the length variable of the String.

```
String s1 = "This is a string.";
int n = s1.length();
//n is 17 because s1 has 17 characters
```

Each String Character Has an Index

- Since Strings are a representation of a sequence of characters, each character of a String has an index.
- An index is a position reference.
- The first character of a String has an index of 0, the second has an index of 1, and so on until the end of the String.



Useful String Method: substring()

- `s2.substring(int beginIndex)`
 - Returns part of the string `s2` from the `beginIndex` to the end of the String.
- `s2.substring(int beginIndex, int endIndex)`
 - Returns part of the string `s2` from the `beginIndex` to the `endIndex` but does not include the character at `endIndex`.
 - What is displayed as a result of this code segment?

```
String s1 = "I eat apples";  
String s2 = "Bananas are my favorite fruit";  
System.out.println(s1.substring(6)+" "+s2.substring(8,23));
```

Useful String Methods: indexOf and charAt

- Method: `s3.indexOf(char c);`
 - Returns the index value of the first occurrence of c in String s3.
- Parameter does not need to be a character, it can also be a String, for example: `s3.indexOf("the");`
- Method: `s4.charAt(int index);`
 - Returns the character of the String located at the index passed as the parameter.
 - Index can be an integer from 0 to s4.length()-1.

Using String Methods Example 1

- Write the Java code that will take an email address as input in the form of a String. This method will return the domain.
- For example, if the user enters john@oracle.com, the method returns oracle.com.
- To solve this problem, first search for the '@' character in the String. Then output the substring portion of the initial String that comes after this position.

```
String domain=""; //no space between the " and "  
int position=email.indexOf('@');  
domain=email.substring(position+1);  
System.out.println(domain);
```

Terminology

Key terms used in this lesson included:

- Concatenation
- Escape sequences
- Instantiate
- Reference object
- String object
- String methods `compareTo()` and `equals()`

Summary

In this lesson, you should have learned how to:

- Instantiate (create) a String
- Describe what happens when a String is modified
- Use the + and += operators for concatenating Strings
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Summary

In this lesson, you should have learned how to:

- Recognize the difference between a String and a primitive char data type
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