

Unit 2: Using Objects

Strings

Adapted from:

- 1) Building Java Programs: A Back to Basics Approach
by Stuart Reges and Marty Stepp
- 2) Runestone CSAwesome Curriculum

Strings

- **string**: An object storing a sequence of text characters.

- String is not a primitive type. String is an object type.

- Three ways to initialize a string:

1. `String a = new String("text");`

2. `String b = "text";`

3. `String c = expression;`

- Examples:

```
String a = new String("John Smith");
```

```
String b = "John Smith";
```

```
String c = "John" + "Smith";
```

The String class is part of the java.lang package. Classes in the java.lang package are available by default.

Indexes

- Characters of a string are numbered with 0-based *indexes*:

```
String a = "J. Smith";
```

index	0	1	2	3	4	5	6	7
character	J	.		S	m	i	t	h

- First character's index : 0
- Last character's index : 1 less than the string's length

String concatenation

string concatenation: primitive values can be concatenated with a String object using `+`. This causes implicit conversion of the values to String objects.

```
"hello" + 42    is    "hello42"
1 + "abc" + 2   is    "1abc2"
"abc" + 1 + 2   is    "abc12"
1 + 2 + "abc"   is    "3abc"
"abc" + 9 * 3   is    "abc27"
"1" + 1         is    "11"
4 - 1 + "abc"   is    "3abc"
```

Use `+` to print a string and an expression's value together.

```
- System.out.println("Grade: " + (95.1 + 71.9) / 2);
```

- Output: Grade: 83.5

Escape sequences

escape sequence: A special sequence of characters used to represent certain special characters in a string.

`\n` new line character
`\"` quotation mark character
`\\` backslash character

– **Example:**

```
System.out.println("\\hello\nhow are \"you\"?\\\\\");
```

– **Output:**

```
\hello  
how are "you"?\\
```

Questions

- What is the output of the following `println` statements?

```
System.out.println("\\\\");  
System.out.println("'");  
System.out.println("\\""\\"");
```

- Write a `println` statement to produce this output:

```
/ \ // \\ /// \\\
```

Answers

- Output of each `println` statement:

```
\\  
'  
""
```

- `println` statement to produce the line of output:

```
System.out.println("/  \\  //  \\\\  ///  \\\\\\\");
```

String methods

Method name	Description
<code>String(String str)</code>	Constructs a new String object that represents the same sequence of characters as <code>str</code>
<code>int length()</code>	Returns number of characters in this string
<code>substring(index1, index2)</code> or <code>substring(index1)</code>	Returns the characters in this string from <i>index1</i> (inclusive) to <i>index2</i> (<u>exclusive</u>); if <i>index2</i> is omitted, grabs till end of string
<code>boolean equals(String other)</code>	Returns true if this is equal to other; returns false otherwise
<code>int compareTo(String other)</code>	Returns a value < 0 if this is less than other; returns zero if this is equal to other; returns a value > 0 if this is greater than other
<code>indexOf(str)</code>	Returns index where the start of the given string appears in this string (-1 if not found)

String method examples

```
// index      0123456789012345678
String s1 = "programming in java";
System.out.println(s1.length());
// 19
System.out.println(s1.indexOf("i")); // 8
System.out.println(s1.indexOf("gram")); // 3
System.out.println(s1.indexOf("hi")); // -1

System.out.println(s1.substring(7, 10)); // "min"
System.out.println(s1.substring(12)); // "in java"
System.out.println(s1.substring(2,3)); // "o"
System.out.println(s1.substring(2,2));
// "", empty string

String s2 = s1.substring(10, 17); // "g in ja"
```

String method examples

Given the following string:

```
// index      0123456789012345678901
String book = "Building Java Programs";
```

How would you extract the word "Java" ?

```
String word = book.substring(9,13);
```

String's equals:

```
String a = "hello", b = "Hello";
System.out.println(a.equals(b)); // false
System.out.println(a.equals("hello")); // true
```

Comparing strings

When the operator `==` is used with object variables it returns true when the two variables *refer to the same object*. These variables are called **aliases** for the same object and **object references**.

With strings this happens when one string variable is set to another or when strings are set to the same string literal.

```
String a = "hi"; //String literal
String b = "hi";
System.out.println(a == b); /* true
the Java run-time will check if that string
literal already exists as an object in memory, and
if so reuse it. So a and b will refer to the same
string object. */
String c = b;
System.out.println(b == c); //true
```

Comparing strings

With String objects, you must use the equals method to test if two strings have the same characters in the same order instead of == which is used for primitive types.

If you use the **new** keyword to create a string it will create a new string object. So, even if we create two string objects with the same characters using the new operator they will not refer to the same object.

```
String a = new String("hi");  
String b = new String("hi");  
System.out.println(a == b); //false, not same objects  
System.out.println(a.equals(b)); //true, same characters & order
```

compareTo

The compareTo method compares strings in dictionary (lexicographical) order:

- If `string1.compareTo(string2) < 0`, then string1 precedes string2 in the dictionary.
- If `string1.compareTo(string2) > 0`, then string1 follows string2 in the dictionary.
- If `string1.compareTo(string2) == 0`, then string1 and string2 are identical. (This test is an alternative to `string1.equals(string2)`.)

All you need to know is that all digits precede all capital letters, which precede all lowercase letters. Thus "5" comes before "R", which comes before "a".

compareTo

```
String s1 = "HOT", s2 = "HOTEL", s3 = "dog";  
String s4 = "hot";
```

```
System.out.println(s3.compareTo(s4) < 0);  
//true, "d" comes before "h".
```

```
System.out.println(s1.compareTo(s2) < 0);  
//true, s1 terminates first
```

```
System.out.println(s1.compareTo(s3) > 0);  
//false, "H" comes before "d"
```

Modifying strings

- Methods like `substring` build and return a new string, rather than modifying the current string.
 - String is **immutable**; once created, its value cannot be changed.

```
String s = "kendrick";  
s = "snoop dog";  
// "kendrick" is discarded and a new String  
// object "snoop dog" is created.  
  
s.substring(0, 5); // returns snoop, not stored  
System.out.println(s);  
// snoop dog, s is not changed
```

Modifying strings

- To modify a variable's value, you must reassign it:

```
String s = "lil bow wow";  
s = s.substring(0,3);  
System.out.println(s);    // lil
```


Value semantics

Value semantics: String is the only object class that follows value semantics. Modifying the parameter will not affect the variable passed in.

```
public class MyClass{
    public static void main(String[] args){
        String x = "hi";
        changeMe(x);
        System.out.println(x); // hi
    }
    public static void changeMe(String x){
        x = "hello";
    }
}
```

Note: The value of x in main did not change.

References

1) Building Java Programs: A Back to Basics Approach by Stuart Reges and Marty Stepp

2) Runestone CSAwesome Curriculum:

<https://runestone.academy/runestone/books/published/csawesome/index.html>

For more tutorials/lecture notes in Java, Python, game programming, artificial intelligence with neural networks:

<https://longbaonguyen.github.io>