Unit 2: Using Objects

Topic 7 Lab 1: String Methods

Name:	

Create a new IntelliJ project, e.g. LASTNAMEU2T7Lab1,
and add a runner class (name it whatever you want) with a `main` method.

Exploring String Methods

A `String` holds characters in a sequence.

Each character is at a position, or **index,** which starts with **0**. An **index** is a number associated with a position in a `String` (sort of like an array or list, although a string is *not* an array or list). Example:

`String str = "AP CSA is awesome!"`

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

For example, the character "C" is at **index 3**, and the character at **index 11** is a "w".

The **length** of a `String` is the number of characters in it *including any spaces or special characters*, which takes us to the first `String` method that you need to know: **`length()`, which returns an `int`**

Java Quick Reference

Accessible methods from the Java library that may be included in the exam

Class Constructors and Methods	Explanation
String Class	
`String(String str)`	Constructs a new `String` object that represents the same sequence of characters as `str`
`int length()`	Returns the number of characters in a `String` object
`String substring(int from, int to)`	Returns the substring beginning at index `from` and ending at index `to - 1`
`String substring(int from)`	`substring(from, length())`
`int indexOf(String str)`	Returns the index of the first occurrence of `str`; returns `-1` if not found
`boolean equals(String other)`	Returns `true` if `this` is equal to `other`; returns `false` otherwise
`int compareTo(String other)`	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`

method name

return type

All methods above are *instance* methods, so you call them on the `String` object itself.

Example:

```
String myString = "AP CSA is awesome!"; // creating a String object
int len = myString.length(); // calling the length() method on the object
System.out.println(len);
```

Prints: **18** (**not 17**, because it's 0-indexed; the first character is at index 0 and the last at index 17 -- which is *actually* 18 in length! If you don't believe it, count the boxes above for *AP CSA is awesome!*)

Determine the output of this code **without** running it in IntelliJ. Note the escape sequences in 6 & 7!

```
String str1 = "Hello!";
System.out.println(str1.length());

String str2 = " H e l l o ! ";
int len = str2.length();
System.out.println(len);

String str3 = "Is tax 8.5%?";
System.out.println(str3.length());

String str4 = "43";
int len2 = str4.length();
System.out.println(len2);

String str5 = "";
System.out.println(str5.length());

String str6 = "Cat says \"MEOW\"!";
System.out.println(str6.length());

String str7 = "\\\"\"\n\\\n";
System.out.println(str7.length());
```

Capture your predictions:

CONFIRM! Now, run in your IDE to confirm that you counted correctly. **Look carefully at #6 & 7!**

How are the *two* characters that make up an escape sequence (e.g. `\"`) counted in terms of `length()`?

Check

Write some code to create a `String` object holding the string **good morning**, then use the `length` method on your String object to obtain the string's length. Store the length in a variable `strLen`, and then print out `strLen`.

Paste your code here:

confirm

EXPLORATION CONTINUES ON NEXT PAGE

On to the next method! Let's do `indexOf`, since it also returns an `int`

Review the Explanations & Examples:

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`int compareTo(String other)`	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`

Example 1:

```
String myString = "AP CSA is awesome!";
int index = myString.indexOf("is");
System.out.println(index);
```

Prints: 7

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Example 2:

```
String myString = "AP CSA is awesome!";
int index = myString.indexOf("A is a");
System.out.println(index);
```

Prints: 5

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Example 3:

```
String myString = "AP CSA is awesome!";
```

```
int index = myString.indexOf("A");
System.out.println(index);
```

Prints: **0** *Note the explanation of this method:* Returns the index of the first occurrence of `str`;

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

`indexOf` **stops** searching when it finds the **first** occurrence; it never

---

Example 4:

```
String myString = "AP CSA is awesome!";
int index = myString.indexOf("a");
System.out.println(index);
```

Prints: **10**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

`indexOf` is **case sensitive**!
It doesn't read "A" as "a"

Example 5:

```
String myString = "AP CSA is awesome!";
int index = myString.indexOf("B");
System.out.println(index);
```

Prints: **-1** *Note the explanation of this method:* returns -1 if not found

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

EXPLORATION CONTINUES ON NEXT PAGE

AP EXAM Pro Tip!

For the problem below, **grab a piece of paper and pencil (seriously!)** and write the `String`, and *number each character below*, like this:

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

You will have to do this all by hand on the AP Exam -- may as well practice now :)

1. TAKE OUT A SCRAP PIECE OF PAPER!

Write the following string down:

`Hello how are you today?`

Then write the index of each character underneath, similar to this example for the string
`AP CSA is awesome!`

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

2. Now determine the output of the following code using your scrap paper and your brains only:

```
String str1 = "Hello how are you today?";
System.out.println(str1.length());
System.out.println(str1.indexOf("H"));
System.out.println(str1.indexOf("h"));
System.out.println(str1.indexOf("l"));
System.out.println(str1.indexOf("o"));
System.out.println(str1.indexOf("?"));
System.out.println(str1.indexOf("ll"));
System.out.println(str1.indexOf("ello"));
System.out.println(str1.indexOf("lo ho"));
System.out.println(str1.indexOf("a"));
System.out.println(str1.indexOf("W"));
System.out.println(str1.indexOf(" "));
System.out.println(str1.indexOf("how are"));
System.out.println(str1.indexOf("howare"));
System.out.println(str1.indexOf("Are"));
System.out.println(str1.indexOf("Hello how are
you today?"));
System.out.println(str1.indexOf(""));

int x = str1.indexOf("e") + str1.indexOf("E");
System.out.println(x);

String str2 = "how are you?";
System.out.println(str1.indexOf(str2));
```

Jot down the printed output that you expect:

CONFIRM your answers by copying/pasting/running in your

	IDE. Any surprises? **What do *you* think is up with this one: `""` (Mr. Miller isn't so sure himself):** *Check answers*

Write some code to find and print the index of "**you**" in the string below:

```
String str1 = "Hello how are you today?";
```

Then write code to find and print the index of "**You**" (capital Y).
Run it and make sure the output makes sense!

Paste your code below:

confirm

Are "you" and "You" the same in terms of `indexOf`?	

EXPLORATION CONTINUES ON NEXT PAGE

On to the next method, the `substring(int from, int to)` method, which returns a `String`. Note that this is the first of two **overloaded** `substring` methods (same name, different signature).

Review the Explanation & Examples:

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`int compareTo(String other)`	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`

Example 1:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(0, 4);
System.out.println(subString);
```

Prints: **"AP C"**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 0 **to 4**

The substring gets "cut" from the string starting at 0 and going thru 4 - 1 = 3

`substring(0, 4)` makes a *new* `String` made up of the characters at index 0, 1, 2, 3 (but <u>NOT</u> 4)

Using the same string as in the example:

```
String myString = "AP CSA is awesome!";
```

Write some code to obtain the substring containing characters "awe" from `myString` and store it in a new String object named `aweStr`; print out `aweStr` to make sure it is correct.

check

So what happens with the original `myString`? Does using the `substring` method affect it?

Find out! Copy/paste/run the following in your IDE:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(0, 4);
System.out.println(subString);
System.out.println(myString);
```

Did performing `myString.substring()` *modify* `myString`?

Read on to confirm!

AS YOU HOPEFULLY NOTICED: The `substring` method returns a new `String` object containing the substring; **the *original* `String` (`myString`) is *not* affected in any way**!

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(0, 4);
System.out.println(subString);
System.out.println(myString);
```

Prints: **"AP CS"**
"AP CSA is awesome!" `// myString hasn't changed!`

> In fact, `Strings` are **immutable** objects, which means all `Strings` methods invoked on a particular `String` do **not** change the original `String` object itself.

Example 2:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(7, 9);
System.out.println(subString);
```

Prints: **"is"**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 7 **to 9**

The substring gets "cut" from the string starting at 7 and going thru 9 - 1 = 8

Example 3:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(6, 10);
System.out.println(subString);
```

Prints: **" is "** **(note the spaces!)**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 6 **to 10**

The substring gets "cut" from the string starting at 6 and going thru 10 - 1 = 9

Example 4:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(12, 13);
System.out.println(subString);
```

Prints: **"e"**

The substring gets "cut" from the string starting at 12 and going thru 13 - 1 = 12

"From 12 to 12"!

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 12 **to 13**

Calling `substring(12, 13)` makes a new `String` that includes the character at index 12 <u>ONLY</u>! This is how you obtain a *single* character at a specific index!

A string identical to the *single character substring* at position `index` can be created by calling `substring(index, index + 1)`.

Example 5:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(0, 17);
System.out.println(subString);
```

Prints: **"AP CSA is awesome"** (no "!" included)

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 0

to 17

The substring gets "cut" from the string starting at 0 and going thru 17 - 1 =

Example 6:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(0, 18);
System.out.println(subString);
```

Prints: **"AP CSA is awesome!"** (prints the entire string)

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 0

to 18

The substring gets "cut" from the string starting at 0 and going thru 18 - 1 =

Example 7:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(0, 19);
System.out.println(subString);
```

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 0

to 19

19 - 1 = 18

and 18 is past the last index (17)! BAD!

This happens: Kaboom!

```
Exception in thread "main" java.lang.StringIndexOutOfBoundsException:
  at java.base/java.lang.String.checkBoundsBeginEnd(String.java:3756)
```

Explanation:

A `String` object has index values from `0` to `length - 1`. **Attempting to access indices outside this range will result in a runtime error called `IndexOutOfBoundsException`!**

Comment:

If you notice in Example 7, using 19 as the `to` argument tells Java to access index `(19 - 1)`, or 18, but 18 is ***outside*** the `index` range of `myString`, which only goes to 17.

In Example 6, using 18 was OK though, since `18 - 1` = `17`, and 17 is the *last* valid index of the string.

Using the same string as in the example:

```
String myString = "AP CSA is awesome!";
```

Write some code to obtain the substring containing the *single* character "S" from `myString` and store it in a new String object named `s`; print out `s` to make sure it is correct.

Write some more code to obtain the substring containing "awesome!" (including !) from `myString` and store it in a new String object named `awe`; print out `awe` to make sure it is correct.

check

Refer to your scrap paper from before, where you should have written down the index values of each character in the string `"Hello how are you today?"`

Determine the output of this code using your scrap paper and brains:

```
String origStr = "Hello how are you today?";
String str1 = origStr.substring(0, 13);
System.out.println(str1);

String str2 = origStr.substring(8, 11);
System.out.println(str2);

String str3 = origStr.substring(14, 15);
System.out.println(str3);

String str4 = origStr.substring(0, 1);
System.out.println(str4);

String str5 = origStr.substring(9, 10);
System.out.println(str5);

String str6 = origStr.substring(18, 23);
System.out.println(str6);

String str7 = origStr.substring(20, 24);
System.out.println(str7);

String str8 = origStr.substring(10, 26);
System.out.println(str8);
```

Jot down the expected output:

CONFIRM your answers by copying/pasting/running in your IDE. Note what IntelliJ tells you about the last one in the compiler!

Check

Using this string:

```
String origStr = "Hello how are you today?";
```

Write some code that will retrieve the substring "**how**" from `origStr` above and store it in a new variable, `str9`. Then print out `str9` to make sure!

confirm

DEBUG! A student tried the previous problem and wrote 10 instead of 9 for the second parameter:

Explain!

```
String origStr = "Hello how are you today?";
String str9 = origStr.substring(6, 10);
System.out.println(str9);
```

And got this:

CONSOLE

how

So he assumed he was correct. What's going on? Was he correct?

check

Here's a string:

```
String blah = "What's for dinner?";
```

Write a line of code that will retrieve the substring `dinner` from `blah` and store it in a new variable, `ugh`. Print `ugh` to make sure that "dinner" is stored in `ugh`.

Check

Let's kick it up a notch!
What you see below is an example of **method chaining**, a fairly common practice in programming when one method call returns an object that you immediately want to perform another method on. It's cool and handy!

What will this print?

```
String yum = "What's for dinner?";
String din = yum.substring(3, 12).substring(5, 7);
System.out.println(din);
```

Prediction:

Copy/paste/run to confirm!

(click here for explanation on what's happening)

Try this one! Again, note the method chaining; go left to right, and reindex each new `String`

What will this print?

```
String today = "FRIDAY!";
String x = today.substring(3, 7).substring(0, 3).substring(1, 3);
System.out.println(x);
```

Prediction:

Copy/paste/run to confirm!

On to the next method, the `substring(int from)` method, which also returns a `String`.

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`boolean equals(String other)`	Returns `true` if `this` is equal to `other`; returns `false` otherwise
`int compareTo(String other)`	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`

Example 1:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(3);
System.out.println(subString);
```

Prints: **"CSA is awesome!"**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 3 → **All the way to the end!**

`substring(3)` makes a new `String` made up of the characters starting at index 3, and going all the way to the end. It's *equivalent* to `substring(3, myString.length())` which is `myString.substring(3, 18)`

Example 2:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(10);
System.out.println(subString);
```

Prints: **"awesome!"**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 10 →

Example 3:

```
String myString = "AP CSA is awesome!";
```

```
String subString = myString.substring(16);
System.out.println(subString);
```

Prints: **"e!"**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 16

Example 4:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(0);
System.out.println(subString);
```

Prints: **"AP CSA is awesome!"**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 0

Example 5:

```
String myString = "AP CSA is awesome!";
String subString = myString.substring(17);
System.out.println(subString);
```

Prints: **"!"**

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 17

Here's a string:

```
String blah2 = "What's for dinner?";
```

Write a line of code using the ***single parameter*** **`substring` method** that will retrieve the substring `dinner?`

(including ?) from `blah2` and store it in a new variable, `ugh2`. Print `ugh2` to make sure that "dinner?" is stored in `ugh2`.

Then write a line of code using the ***two-parameter* `substring` method** that will retrieve the same substring `dinner?` (including ?) from `blah2` and store it in a new variable, `ugh3`. Print `ugh3` to make sure that "dinner?" is stored in `ugh3`.

confirm

Without using IntelliJ, what will the following print?
*(Recall the AP Exam pro tip -- **write all strings down** and label index numbers!)*

```
String tired = "I'm tired!";
String end = "Of substrings!";

String str0 = end.substring(3);
System.out.println(str0);

String str1 = tired.substring(4) + end.substring(3);
System.out.println(str1);

String str2 = tired.substring(9) + tired.substring(6);
System.out.println(str2);

String str3 = end.substring(0, 1) + " " + end.substring(1, 2);
System.out.println(str3);

String str4 = end.substring(6).substring(2);
System.out.println(str4);

// Tricky!
String fire = "CRACKLE!";
String witch = "CACKLE!";
String str5 = fire.substring(2);
System.out.println(str5);
String str6 = witch.substring(witch.length() - 4);
System.out.println(str6);
int loc = str5.indexOf(str6);
System.out.println(loc);
String str7 = fire.substring(loc, loc + 3);
System.out.println("the hidden word is: " + str7);
```

Expected output:

CONFIRM your answers by copying/pasting/ running in your IDE.

Check

Free Style! Write some code to test out the `substring` method on your own. Come up with your

own strings! Try out **BOTH** versions of `substring`: the one with **TWO** parameters and the one with just **ONE**. Make sure you see the difference!

Copy/paste your free style code below:

Practice AP Question!

Consider the `processWords` method. Assume that each of its two parameters is a `String` of length two or more.

```
public void processWords(String word1, String word2)
{
   String str1 = word1.substring(0, 2);
   String str2 = word2.substring(word2.length() - 1);
   String result = str2 + str1;
   System.out.println(result.indexOf(str2));
}
```

Which of the following best describes the value printed when `processWords` is called?

(A) The value `0` is always printed.

(B) The value `1` is always printed.

(C) The value `result.length() - 1` is printed.

(D) A substring containing the last character of `word2` is printed.

(E) A substring containing the last two characters of `word2` is printed.

Your Answer:

Check your answer!

EXPLORATION CONTINUES ON NEXT PAGE

On to the next method, the `boolean equals(String other)` method, which returns a `boolean`

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`String substring(int from, int to)`	Returns the substring beginning at index `from` and ending at index `to - 1`
`String substring(int from)`	Returns `substring(from, length())`
`int indexOf(String str)`	Returns the index of the first occurrence of `str`; returns `-1` if not found
`boolean equals(String other)`	Returns `true` if `this` is equal to `other`; returns `false` otherwise
`int compareTo(String other)`	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`

Careful!

`equals` returns true if the two `Strings` represent the *same sequence of characters* (e.g. "cat" and "cat"). This is ***not*** a test to see if two variables *reference* the same `String` *object*, however; that's what == is for.

When you want to see if two `Strings` have the same characters (i.e. their character strings are equal), you **MUST USE** **`equals`** -- do ***not*** use == for this!

`equals` is for ***content*** comparison (i.e. same sequence of letters)

== is for ***reference*** comparison (i.e. two variables reference the same object in memory)

Determine the output of this code without an IDE.

```
String str1 = "Hello!";
String str2 = "Hello!";
System.out.println(str1.equals(str2));

String str3 = "hello!";
System.out.println(str1.equals(str3));

String str4 = "HELLO!";
System.out.println(str1.equals(str4));
```

Jot down what you expect the output to be:

```
String str5 = "Hello";
System.out.println(str1.equals(str5));

String str6 = "Hello! ";
System.out.println(str1.equals(str6));
```

CONFIRM your answers by copying/pasting/running in your IDE.

What did you discover about *case sensitivity* and `equals`?

Check!

Just to see why…

☐ **Be forewarned: what you might experience below may be wildly unintuitive and the explanation that follows might be confusing -- that's ok, the thing you need to take away from this is you should NOT EVER use "==" to see if two strings *have the same character sequence*.**

8. Let's explore why you should **NOT EVER** use == to see if two strings have the same character sequence:

```
String str1 = "Hello!";
String str2 = "Hello!";
String str3 = new String("Hello!");
String str4 = new String("Hello!");

System.out.println(str1 == str2);
System.out.println(str1 == str3);
System.out.println(str1 == str4);
System.out.println(str3 == str4);
```

Capture your predictions:

CONFIRM your answers by copying/pasting/ running in your IDE.

MORAL OF THE STORY: When you want to see if two `Strings` have the same characters (i.e. their character strings are equal), you **MUST USE `equals`**. Do ***NOT*** use == for this!

optional read: Wait what? I demand an explanation! (we will discuss this more later)

Free Style! Write some code to test out the `equals` method on your own. Come up with your own strings! Try out `equals` vs. == with strings. Make sure you see why **NOT** to use == for comparing strings!

Copy/paste your free style code below:

EXPLORATION CONTINUES ON NEXT PAGE

On to the **final** method (finally!), the `int compareTo(String other)` method, which returns an `int`

Java Quick Reference

Accessible methods from the Java library that may be included in the exam

Class Constructors and Methods	Explanation
String Class	
`String(String str)`	Constructs a new `String` object that represents the same sequence of characters as `str`
`int length()`	Returns the number of characters in a `String` object
`String substring(int from, int to)`	Returns the substring beginning at index `from` and ending at index `to - 1`
`String substring(int from)`	Returns `substring(from, length())`
`int indexOf(String str)`	Returns the index of the first occurrence of `str`; returns `-1` if not found
`boolean equals(String other)`	Returns `true` if `this` is equal to `other`; returns `false` otherwise
`int compareTo(String other)`	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`

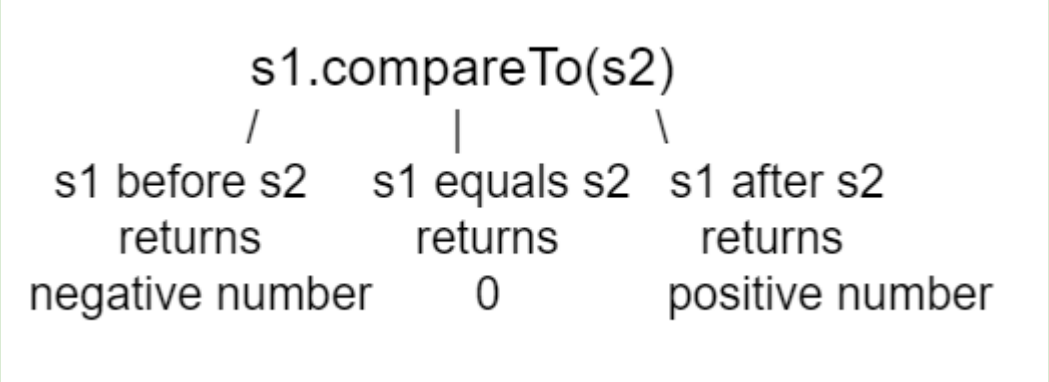
The method `compareTo` compares two strings *alphabetically*, character by character!

If the `strings` are ***equal*** (i.e. if using `equals` on them returns true), `compareTo` returns **0**.

If the first `String` (the one you are performing the method on) is alphabetically ordered **before** the second `String` (the argument of `compareTo`), it returns a **negative** number.

If the first `String` is alphabetically ordered **after** the second `String`, it returns a **positive** number.

Here's a fun little graphic:



Heads up! You will see some strange positive and negative numbers; the actual value that `compareTo` returns **does not matter** -- all you care about is: *positive*, *negative*, or 0 (equal)?

(But if you're curious, it's the distance in the first letter that is different, e.g. A is 7 letters away from H.)

Example:

```
String str1 = "maybe";
String str2 = "apple";
String str3 = "zebra";
String str4 = "maybe";
String str5 = "Maybe";
System.out.println(str1.compareTo(str2));

System.out.println(str2.compareTo(str1));

System.out.println(str1.compareTo(str4));

System.out.println(str1.equals(str4));

System.out.println(str1.compareTo(str3));

System.out.println(str3.compareTo(str1));

System.out.println(str2.compareTo(str3));

System.out.println(str3.compareTo(str2));

Weirdness alert!
System.out.println(str1.compareTo(str5));
```

Prints:

`12:` **positive** because `str1 ("maybe")` comes **AFTER** `str2 ("apple")` alphabetically.

`-12:` **negative** because `str2 ("apple")` comes **BEFORE** `str1 ("maybe")` alphabetically.

`0:` **zero** because `str1 ("maybe")` and `str4 ("maybe")` are equal in terms of their character sequence
(i.e. `str1.equals(str2)` is *true*)

`true:` because the two strings match exactly! Note that `equals` will be true for two strings whenever `compareTo` is `0`.

`-13:` **negative** because `str1 ("maybe")` comes **BEFORE** `str3 ("zebra")` alphabetically.

`13:` **positive** because `str3 ("zebra")` comes **AFTER** `str1 ("maybe")` alphabetically.

`-25:` **negative** because `str2 ("apple")` comes **BEFORE** `str3 ("zebra")` alphabetically.

`25:` **positive** because `str3 ("zebra")` comes **AFTER** `str2 ("apple")` alphabetically.

`32:` **positive** because `str1 ("maybe")` with a lowercase **m** is decidedly **AFTER** `str5 ("Maybe")` with a capital M. When comparing strings, *capitals* come *before lowercase*. So just like `equals`, `compareTo` ***IS CASE SENSITIVE!*** So be careful :)

Again, we don't care about the actual value itself (-25, 13, -12, whatever), we just care if it's positive, negative, or 0. However**,** you might notice that there *is* an alphabetical relationship between the values and the words (e.g. 25 is the distance between "a" and "z" in the alphabet) -- this is cool to know and note, but not generally necessary for using the `compareTo` method.

Determine whether each statement will print a **POSITIVE** number, **NEGATIVE** number, or **0** (you don't have to figure out exactly what the number will be, just if it's positive, negative, or 0):

```
String str1 = "Hello John!";
String str2 = "My name is Jack.";
String str3 = "Hello";
String str4 = "Hello Jack";
String str5 = "My name is jack.";
String str6 = "Hello";

System.out.println(str1.compareTo(str2));
System.out.println(str2.compareTo(str1));
System.out.println(str1.compareTo(str4));
System.out.println(str1.compareTo(str3));
System.out.println(str3.compareTo(str6));
System.out.println(str2.compareTo(str5));
System.out.println(str2.equals(str5));
```

Capture whether you expect each comparison to be a POSITIVE number, a NEGATIVE number, or 0 (don't worry about predicting the exact numeric value if positive or negative):

Now, run in IntelliJ to confirm!

Check with explanations

Free Style! Write some code to test out the `compareTo` method on your own. Come up with your own strings! Make sure to try reversing the order of the strings.

Copy/paste your free style code below:

Exploration continues on the next page

String Info!

Clear out all the test code so far from your `main` method.

Then, write a short program that asks the user to enter a string. Print out how long their string is, as well as show them the "first half" and the "second half" of the word. For example, if the user enters "apples", the length is 6, the first half is "app" and the second half is "les". If the user enters an odd-length word, like "apple," include the extra letter in the *second* half: "ap" and "ple"

Then ask them to enter a *second* string. After they enter their second string, tell the user which of the strings entered was longer, or if they have the same length. Then, tell them if the two strings are the same sequence of characters (i.e. if they are equal or not), and if not, which comes first alphabetically.

Lastly, inform the user at what index the second string is found inside the first string, or "not found" if not found. For example, if the user enters "bananas" for the first string and "nana" for the second string, you should print index 2. If the user enters "apples" for the first string and "nana" for the second string, you should print "not found".

Your program's code should include the use of each of the following string methods *at least once each*:

X	
	`length`
	`indexOf`
	`substring` (*two*-parameter method)
	`substring` (*one*-parameter version)
	`equals`
	`compareTo`

Test case 1:

```
Enter first string: apples
String length: 6
First half: app
Second half: les
Enter second string: bananas
bananas is longer
apples is first alphabetically
bananas is NOT found in apples
```

Test case 2:

```
Enter first string: hello earthlings
String length: 16
First half: hello ea
Second half: rthlings
Enter second string: earth
hello earthlings is longer
earth is first alphabetically
earth is found in hello earthlings at index 6
```

Test case 3:

Test case 4:

```
Enter first string: apple
String length: 5
First half: ap
Second half: ple
Enter second string: apple
Both strings have the same length
Both strings have the exact same characters
apple is found in apple at index 0
```

```
Enter first string: i like cats
String length: 11
First half: i lik
Second half: e cats
Enter second string: i like dogs
Both strings have the same length
i like cats is first alphabetically
i like dogs is NOT found in i like cats
```

Copy/paste your entire program below:

Insert a screenshot showing the output from *another* test case that you came up with on your own:

Want to compare solutions?
Here is how Mr. Miller did it

Done!

Submit in Google Classroom:

Turn in

Answer (back)

Predict (by counting them up manually!) the output of this code. Note the escape sequences in 6 & 7.
 	
`String str1 = "Hello!";`
`System.out.println(str1.length());`
 	
`String str2 = " H e l l o ! ";`
`int len = str2.length();`
`System.out.println(len);`
 	
`String str3 = "Is tax 8.5%?";`
`System.out.println(str3.length());`
 	
`String str4 = "43";`
`int len2 = str4.length();`
`System.out.println(len2);`
 	
`String str5 = "";`
`System.out.println(str5.length());`
 	
`String str6 = "Cat says \"MEOW\"!";`
`System.out.println(str6.length());`
 	
`String str7 = "\\\"\"\n\\\n";`
`System.out.println(str7.length());`
	`6` (punctuation marks like ! count)
	
	`13` (spaces in between *and on the ends* count)
	
	`12` (every letter, number, *or* symbol counts!)
	
	`2` (numbers are characters, too!)
	
	`0` (the "empty string" has no length)
	
	`16` (see note below)
	
	`6` (see note below; this String is made of 6 escape sequences, note that a new line counts as a character!)

How are the *two* characters that make up an escape sequence (e.g. `\"`) counted in terms of `length()`?	Each *pair* of escape sequence characters (`\\`, `\"`, `\n`) is counted as 1 towards the String's length

Answer (back)

1. Your scrap paper should look like this:

H	e	l	l	o		h	o	w		a	r	e		y	o	u		t	o	d	a	y	?
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

2. Determine the output of this code.

```
String str1 = "Hello how are you today?";
System.out.println(str1.length());
System.out.println(str1.indexOf("H"));
System.out.println(str1.indexOf("h"));
System.out.println(str1.indexOf("l"));
System.out.println(str1.indexOf("o"));
System.out.println(str1.indexOf("?"));
System.out.println(str1.indexOf("ll"));
System.out.println(str1.indexOf("ello"));
System.out.println(str1.indexOf("lo ho"));
System.out.println(str1.indexOf("a"));
System.out.println(str1.indexOf("W"));
System.out.println(str1.indexOf(" "));
System.out.println(str1.indexOf("how are"));
System.out.println(str1.indexOf("howare"));
System.out.println(str1.indexOf("Are"));
System.out.println(str1.indexOf("Hello how are
you today?"));
System.out.println(str1.indexOf(""));
```

```
24
0 (first character)
6 (h not the same as H)
2 (finds first instance)
4
23 (last character)
2
1
3
10 (finds first instance)
-1 (not in string)
5  (finds first instance)
6
-1 (not exact!)
-1 (case matters!)
0 (the string is found
   inside of itself!)
0 (um yeah, Mr. Miller
   isn't too sure either)
```

```
int x = str1.indexOf("e") + str1.indexOf("E");
System.out.println(x);
```

```
0 (indexOf("e") returns
   1 and indexOf("E")
   returns -1,
   and 1 + -1 = 0!)
```

```
String str2 = "how are you?";
System.out.println(str1.indexOf(str2));
```

```
-1 (careful about the ? in
str2, it doesn't match
where it is in str1.  If
there wasn't a ? in str2,
it would have printed 6)
```

WHAT (back)

== is for ***reference*** comparison (i.e. two variables reference the same object in memory), and so two objects are considered "==" **only if** they refer to the *SAME STRING OBJECT* -- ***not*** *whether those string objects happen to have the same character sequence.* We will discuss this more in detail later.

8.
 	
`String str1 = "Hello!";`
`String str2 = "Hello!";`
`String str3 = new String("Hello!");`
`String str4 = new String("Hello!");`	

`System.out.println(str1 == str2);`	**true** - this is actually **very surprising!** If == means that two variables refer to the *same* object, shouldn't (str1 == str2) be *FALSE* since str1 and str2 are clearly initialized to two different string literals? You would think, however, in Java, with STRING LITERALS, it actually caches them in such a way that makes == *true* for two string objects that are MADE FROM THE SAME EXACT STRING LITERAL: "Hello!". **CRAZY and confusing and it's why we don't ever mess with == for content comparison!**
`System.out.println(str1 == str3);`	**false** - For the reason you might suspect; str1 and str3 refer to two different String objects, they are not ==. Note that because str3 is made using the String constructor *rather than* a String literal, Java does NOT apply the weird rule described above.
`System.out.println(str1 == str4);`	**false** - For the same reason as the previous false.

`System.out.println(str3 == str4);`	**false** - For the same reason, although this one might be the most obvious to see; clearly str3 and str4 are two different String objects, so they are not ==.

Great, so this is all very confounding.
What's the moral of the story? This:

When you want to see if two `Strings` have the same characters (i.e. their character strings are equal), you **MUST USE** **`equals`**. Do ***NOT*** use == for this!

Solution (back)

H	e	l	l	o		h	o	w		a	r	e		y	o	u		t	o	d	a	y	?
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

3. Determine the output of this code

```
String origStr = "Hello how are you?";
String str1 = origStr.substring(0, 13);
System.out.println(str1);

String str2 = origStr.substring(8, 11);
System.out.println(str2);

String str3 = origStr.substring(14, 15);
System.out.println(str3);

String str4 = origStr.substring(0, 1);
System.out.println(str4);

String str5 = origStr.substring(9, 10);
System.out.println(str5);

String str6 = origStr.substring(18, 23);
System.out.println(str6);

String str7 = origStr.substring(20, 24);
System.out.println(str7);

String str8 = origStr.substring(10, 26);
System.out.println(str8);
```

```
Hello how are

w a

y

H

 ← single space

today

day?
```

IndexOutofBoundsError!
(26 - 1 = 25, which exceeds the last index of 23)

If you run the code, you should see that the "`outOfBoundsException`" is a **runtime** error because the program started to execute (note that other values are printed out before the crash occurs):

```
Hello how are
w a
y
H

today
day?
Exception in thread "main" java.lang.StringIndexOutOfBoundsException Create breakpoint : Range [10, 26) out of bounds for length 24
```

Answer (back)

```
String blah = "What's for dinner?";
String ugh = blah.substring(11, 17);
System.out.println(ugh);
```

CONSOLE

```
dinner
```

Answer (back)

This prints: "or"

EXPLANATION of Method Chaining

What will this print?

```
String yum = "What's for dinner?";
String din = yum.substring(3, 12).substring(5, 7);
System.out.println(din);
```

W	h	a	t	'	s		f	o	r		d	i	n	n	e	r	?
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

In the code segment above, the *first* method, `substring(3, 12)`, is called on `yum`, which returns the new `String` object: `"t's for d"`

This *new* `String`, `"t's for d"`, becomes the object on which the *second* method (the "chained" method), `substring(5, 7)`, is called; `substring(5, 7)` is ***not*** called on `yum`, but rather the `String` *result* of `yum.substring(3, 12)`, which is `"t's for d"`.

So you can think of it working like this:

```
String din = "t's for d".substring(5, 7);
```

And `"t's for d"` is an entirely new `String`, so we need to reindex it:

t	'	s		f	o	r		d
0	1	2	3	4	5	6	7	8

And we can see that calling `substring(5, 7)` on this string will produce the output you see: **`or`**

Answers (back)

Your handwritten string objects should be indexed like this:

tired:

I	'	m		t	i	r	e	d	!
0	1	2	3	4	5	6	7	8	9

end:

O	f		s	u	b	s	t	r	i	n	g	s	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13

fire:

C	R	A	C	K	L	E	!
0	1	2	3	4	5	6	7

witch:

C	A	C	K	L	E	!
0	1	2	3	4	5	6

```
String tired = "I'm tired!";
String end = "Of substrings!";

String str0 = end.substring(3);
System.out.println(str0);

String str1 = tired.substring(4) + end.substring(3);
System.out.println(str1);

String str2 = tired.substring(9) + tired.substring(6);
System.out.println(str2);

String str3 = end.substring(0, 1) + " " + end.substring(1, 2);
System.out.println(str3);

String str4 = end.substring(6).substring(2);
System.out.println(str4);

// TRICKY!
String fire = "CRACKLE!";
String witch = "CACKLE!";
String str5 = fire.substring(2);
System.out.println(str5);
String str6 = witch.substring(witch.length() - 4);
System.out.println(str6);
int loc = str5.indexOf(str6);
System.out.println(loc);
String str7 = fire.substring(loc, loc + 3);
System.out.println("the hidden word is: " + str7);
```

```
substrings!

tired!substrings!

!red!

O f

rings!

ACKLE!

KLE!

2

the hidden word is: ACK
```

AP Answer (back)

Answer: A

If you missed this one, try it with any two strings!
Assume `word1` is, say, "apple", and `word2` is, say, "banana"

`word1`:	`word2`:
a p p l e	b a n a n a
0 1 2 3 4	0 1 2 3 4 5

This line of code would store "**ap**" in `str1`:

```
String str1 = word1.substring(0, 2);
```

This line of code would store "**a**" in `word2`:

```
String str2 = word2.substring(word2.length() - 1);
```

Note that word2.substring(word2.length() - 1) would be word2.substring(5), since word2 has a length of 6, which makes a substring containing just the last letter ("a")

This line of code would concatenate them, str2 ("a") followed by str1 ("ap"), storing "**aap**" in `result`:

```
String result = str2 + str1;
```

This line of code would print where `str2` occurs in `result`; in other words, where "a" appears in "aap" -- this occurs at index 0 (also index 1, but first occurrence returned):

```
System.out.println(result.indexOf(str2));
```

So this prints 0 ***-- no matter what strings you choose for word1 and word2!***

Answer (back)

`equals` is for ***content*** comparison (i.e. same sequence of letters) -- **they MUST BE EXACTLY the same!**

7. Predict the output of this code without Coding Rooms.
 	
`String str1 = "Hello!";`
`String str2 = "Hello!";`
`System.out.println(str1.equals(str2));`
	`true` - the two strings have the *same exact* sequence of characters

`String str3 = "hello!";` `System.out.println(str1.equals(str3));`	**`false`** - "Hello!" Is **NOT** equal to "bello!" because the capitalization doesn't match
`String str4 = "HELLO!";` `System.out.println(str1.equals(str4));`	**`false`** - "Hello!" Is **NOT** equal to "HELLO!" because the capitalization doesn't match
`String str5 = "Hello";` `System.out.println(str1.equals(str5));`	**`false`** - "Hello!" Is **NOT** equal to "Hello" because of a missing exclamation point
`String str6 = "Hello! ";` `System.out.println(str1.equals(str6));`	**`false`** - "Hello!" Is **NOT** equal to "Hello! " because of the extra space
What did you discover about case sensitivity and `equals`?	`equals` **IS** case sensitive!!! "Hello!" and "hello!" are **NOT** "equal"

Answers (back)

```
String str1 = "Hello John!";
String str2 = "My name is Jack.";
String str3 = "Hello";
String str4 = "Hello Jack";
String str5 = "My name is jack.";
String str6 = "Hello";

System.out.println(str1.compareTo(str2));

System.out.println(str2.compareTo(str1));

System.out.println(str1.compareTo(str4));

System.out.println(str1.compareTo(str3));

System.out.println(str3.compareTo(str6));

System.out.println(str2.compareTo(str5));

System.out.println(str2.equals(str5));
```

Again, don't worry about the exact numeric values, we just care about if the result is positive, negative, or zero:

`-5:` **negative** because `str1 ("Hello John!")` comes **BEFORE** `str2 ("My name is Jack.")` alphabetically.

`5:` **positive** because `str2 ("My name is Jack.")` comes **AFTER** `str2 ("Hello John!")` alphabetically.

`14:` **positive** because `str1 ("Hello John!")` comes **AFTER** `str4 ("Hello Jack")` alphabetically. The comparison happens between the *first different* character: "o" and "a"

`6:` **positive** because `str1 ("Hello John!")` comes **AFTER** `str3 ("Hello")` alphabetically.
The comparison is happening between " " (space) and *nothing*, and nothing comes before something alphabetically.

`0:` **zero** because `str3 ("Hello")` and `str6 ("Hello")` are equal in terms of their character sequence.

`-32:` **negative** because `str2 ("My name is Jack.")` comes **BEFORE** `str5 ("My name is jack.")` alphabetically. The comparison happens between the *first different* characters: "J" and "j", and since *capital* letters come *before lowercase* letters alphabetically, J is "before" j

`false:` because as you learned, `equals` is case sensitive, and so `"My name is Jack."` and `"My name is jack."` are **NOT** equal!

Solution (back)

```
String varName = "good morning";
int strLen = varName.length();
System.out.println(strLen);
```

YOU SHOULD GET:

```
CONSOLE
12
```

Solution (back)

```
String str1 = "Hello how are you today?";
System.out.println(str1.indexOf("you"));
System.out.println(str1.indexOf("You"));
```

Output:

```
CONSOLE
14
-1
```

“You” and “you” are NOT the same! “You” is *not* found (-1) but “you” is found (at index 14)

Solution (back)

```
String origStr = "Hello how are you today?";
String str9 = origStr.substring(6, 9);
System.out.println(str9);
```

CONSOLE

```
how
```

Check (back)

DEBUG! A student tried the previous problem and wrote 10 instead of 9 for the second parameter:

```
String origStr = "Hello how are you today?";
String str9 = origStr.substring(6, 10);
System.out.println(str9);
```

And got this:

CONSOLE

```
how
```

So he assumed he was correct. What's going on? Was he correct?

Explain!

He was **NOT** correct because his answer includes the **space** after "how" in the original string:

`how`

Instead of:

`how`

He just didn't notice it in the output!

Confirm (back)

We want "**awe**" which are the characters at index 10, 11, and 12, so we use the substring method with 10 and 13, since it goes *from* 10 up through *13 - 1,* or 12, which is what we want:

A	P		C	S	A		i	s		a	w	e	s	o	m	e	!
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

from 0 to 13

The substring gets "cut" from the string starting at 0 and going thru 13 - 1 =

So your code should look like this:

```
String myString = "AP CSA is awesome!";
String aweStr = myString.substring(10, 13);
System.out.println(aweStr);
```

Confirm (back)

Using the same string as in the example:
`String myString = "AP CSA is awesome!";`
Write some code to obtain the substring containing the *single* character "S" from `myString` and store it in a new String object named `s`; print out `s` to make sure it is correct.

Write some more code to obtain the substring containing "awesome!" (including !) from `myString` and store it in a new String object named `awe`; print out `awe` to make sure it is correct.

```
String myString = "AP CSA is awesome!";
String s = myString.substring(4, 5);
System.out.println(s);
String awe = myString.substring(10, 18);
System.out.println(awe);
```

Confirm (back)

Here's a string:
`String blah2 = "What's for dinner?";`

Write a line of code using the ***single parameter* `substring` method** that will retrieve the substring `dinner?` (including ?) from `blah2` and store it in a new variable, `ugh2`. Print `ugh2` to make sure that "dinner?" is stored in `ugh2`.

Then write a line of code using the ***two-parameter* `substring` method** that will retrieve the same substring `dinner?` (including ?) from `blah2` and store it in a new variable, `ugh3`. Print `ugh3` to make sure that "dinner?" is stored in `ugh3`.

```
String blah2 = "What's for dinner?";
String ugh2 = blah2.substring(11); // single-parameter substring method
System.out.println(ugh2);

String ugh3 = blah2.substring(11, 18); // two-parameter substring method
System.out.println(ugh3);
```

Sample solution (back)

```java
import java.util.Scanner;

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

        // obtain first string from user
        System.out.print("Enter first string: ");
        String string1 = scan.nextLine();

        // get string length and print it out
        int string1Length = string1.length();
        System.out.println("String length: " + string1Length);

        // calculate "halfway" index, which is the length divided by 2 (int division!)
        int halfIndex = string1Length / 2;

        // get the first half and second half substrings, then print each out
        String firstHalf = string1.substring(0, halfIndex); // two-parameter version
        String secondHalf = string1.substring(halfIndex);   // one-parameter version
        System.out.println("First half: " + firstHalf);
        System.out.println("Second half: " + secondHalf);

        // obtain second string from user
        System.out.print("Enter second string: ");
        String string2 = scan.nextLine();

        // get second string length, then compare and print which is longer
        int string2Length = string2.length();
        if (string1Length > string2Length) {
            System.out.println(string1 + " is longer");
        } else if (string2Length > string1Length) {
            System.out.println(string2 + " is longer");
        } else {
            System.out.println("Both strings have the same length");
        }

        // determine if strings are "equal", and if so, print that out
        if (string1.equals(string2)) {
            System.out.println("Both strings have the exact same characters");
        } else {  // if NOT, then one must come before the other
            int compare = string1.compareTo(string2);
            if (compare < 0) {  // if string1.compareTo(string2) is negative, string1 is alphabetically first
                System.out.println(string1 + " is first alphabetically");
            } else {   // otherwise, string2 is alphabetically first
                System.out.println(string2 + " is first alphabetically");
            }
        }
```

```java
        // determine index where string2 occurs in string1, then print out appropriate message
        int indexOfSecondString = string1.indexOf(string2);
        if (indexOfSecondString != -1) {
            System.out.println(string2 + " is found in " + string1 + " at index " + indexOfSecondString);
        } else {
            System.out.println(string2 + " is NOT found in " + string1);
        }
    }
}
```