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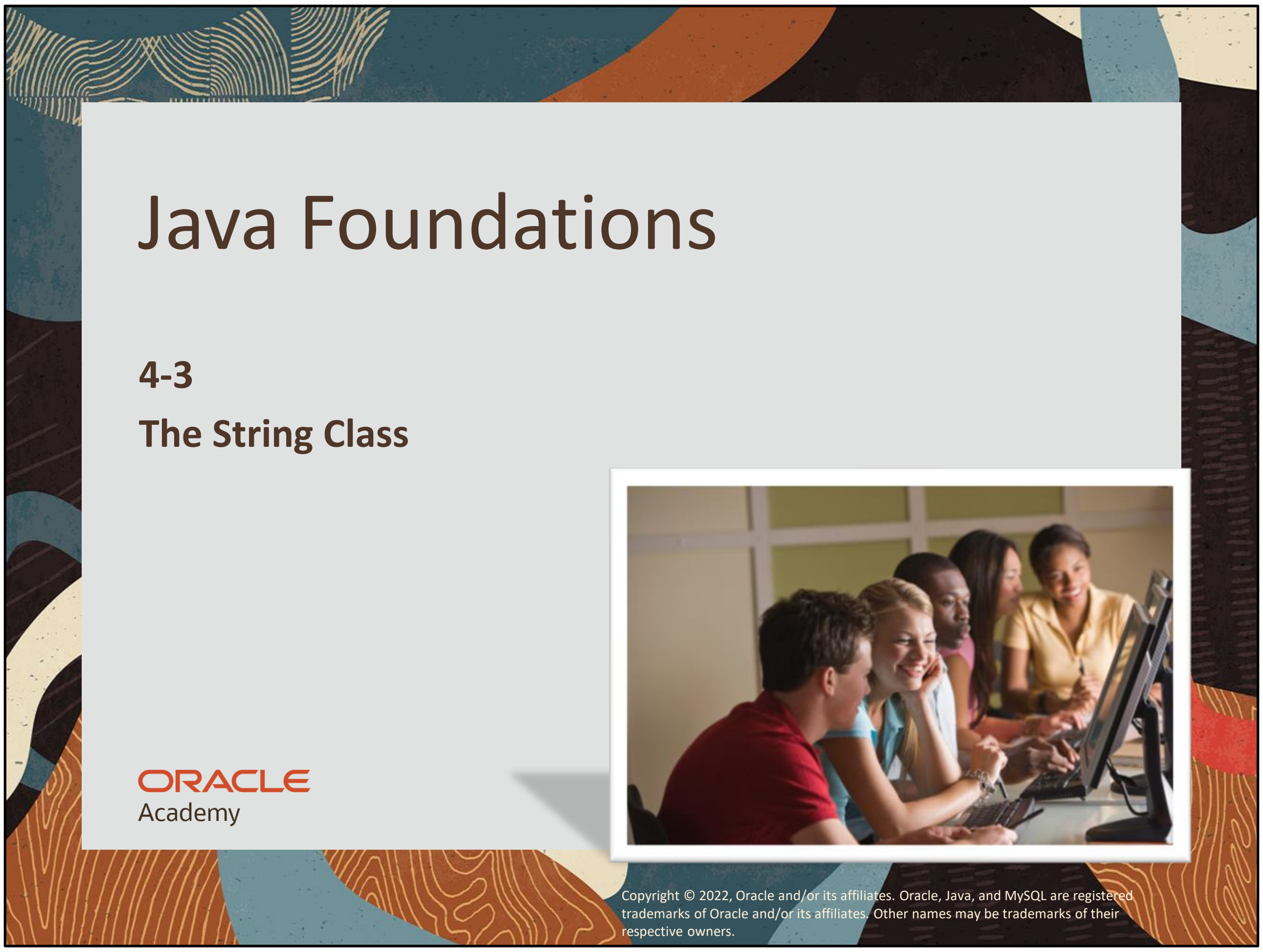

Java Foundations

4-3
The String Class

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Objectives

- This lesson covers the following objectives:
  - Locate the String class in the Java API documentation
  - Understand the methods of the String class
  - Compare two String objects lexicographically
  - Find the location of a substring in a String object
  - Extract a substring from a String object

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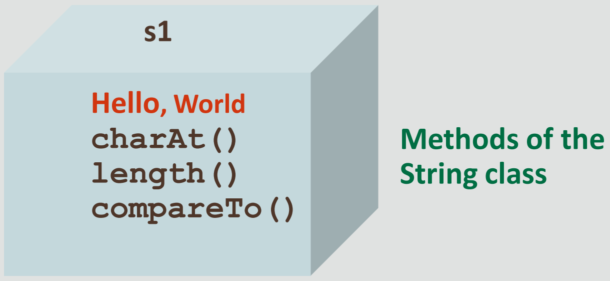
What’s a String?

- A string is a sequence of characters including alphabet letters, special characters, and white space
- For example:
  - “How are you?” is a string that contains letters, white space, and a special character (‘?’)
- In Java, strings are not a primitive data type
- Instead, they are objects of the String class

Representing Strings in Java

- In Java, strings are objects of the class named java.lang.String
- Example:
  - String s1= “Hello, World”;



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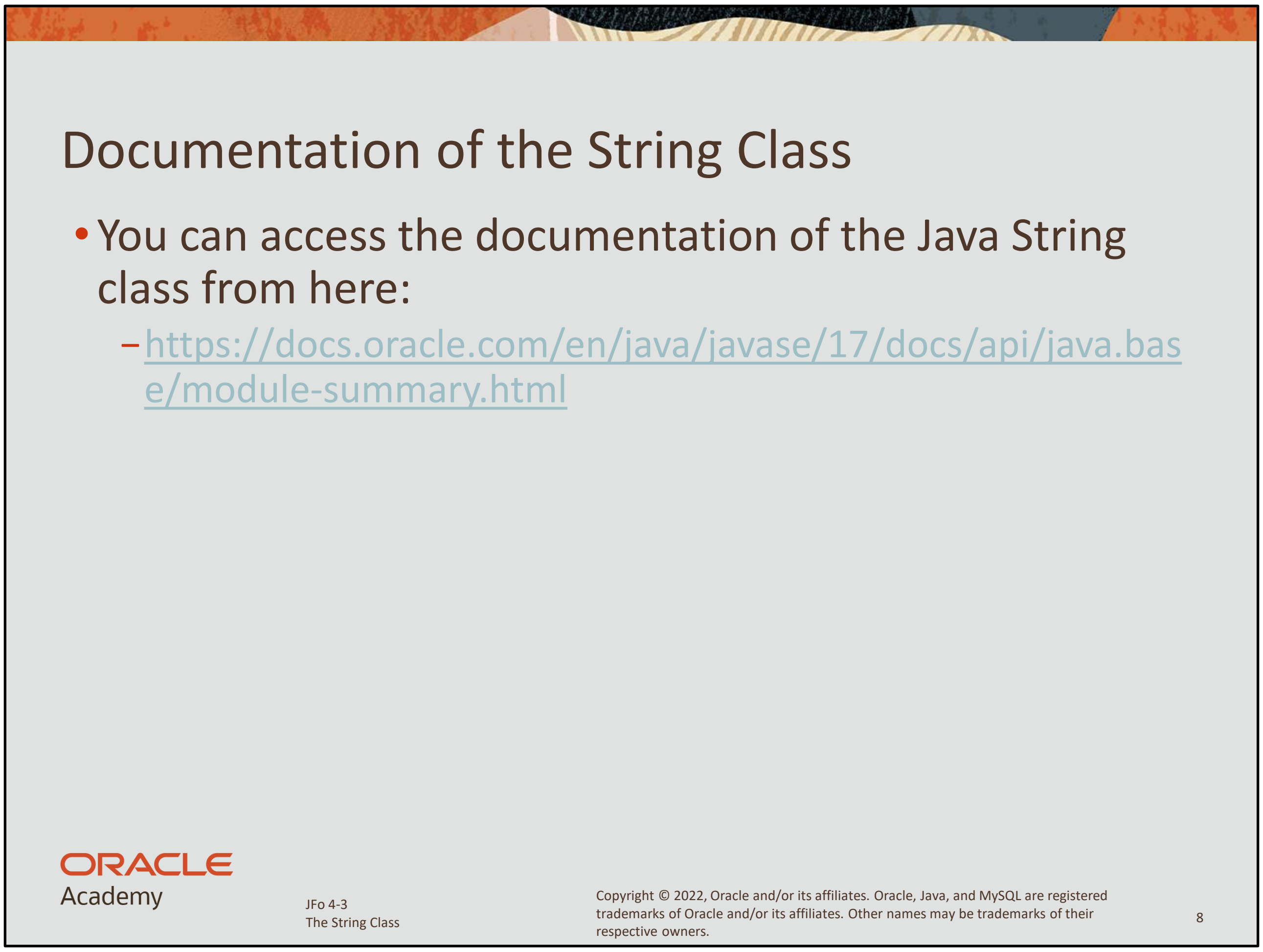
Representing Strings in Java

- A string in Java is more abstract
- That is, you aren’t supposed to know about its internal structure, which makes it easy to use
- Its methods allow a programmer to perform operations on it

Using the String Class

- The String class:
  - Is one of the many classes included in the Java class libraries.
  - Is part of java.lang.package
  - Provides you with the ability to hold a sequence of characters of data
- You will use the String class frequently throughout your programs
- Therefore, it's important to understand some of the special characteristics of strings in Java



Documentation of the String Class

- You can access the documentation of the Java String class from here:
  - https://docs.oracle.com/en/java/javase/17/docs/api/java.base/module-summary.html

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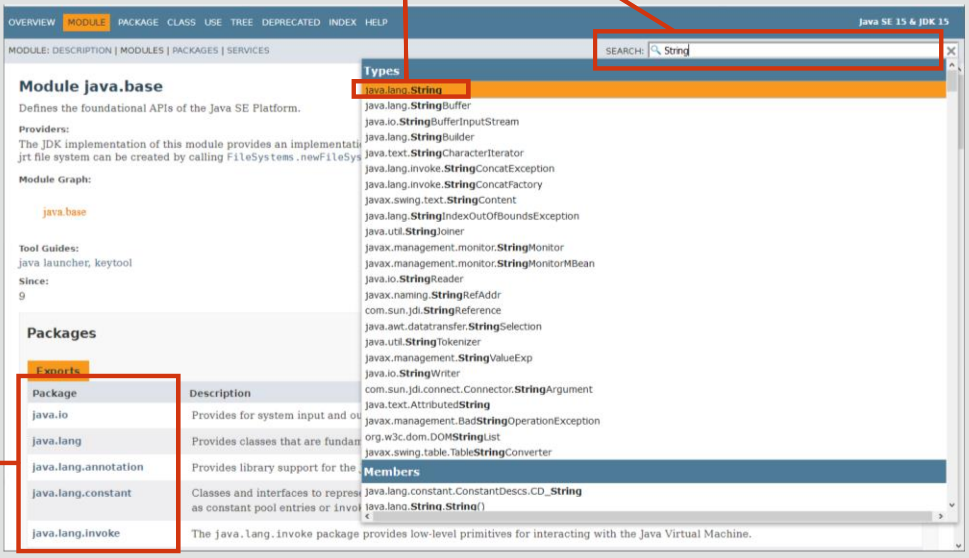
Java Platform SE 17 Documentation for the String Class

Search for a package here. Type String in the search box and from the Types displayed, select java.lang.String

Scroll down and select packages here


OVERVIEW MODULE PACKAGE CLASS USE TREE DEPRECATED INDEX HELP
Java SE 15 & JDK 15
MODULE: DESCRIPTION | MODULES | PACKAGES | SERVICES
SEARCH: String

Module java.base

Defines the foundational APIs of the Java SE Platform.

Providers:

The JDK implementation of this module provides an implementati
jrt file system can be created by calling FileSystems.newFileSys

Module Graph:

java.base

Tool Guides:

java launcher, keytool

Since:

9

Packages

Exports

Package	Description
java.io	Provides for system input and ou
java.lang	Provides classes that are fundam
java.lang.annotation	Provides library support for the
java.lang.constant	Classes and interfaces to repres as constant pool entries or invol
java.lang.invoke	The `java.lang.invoke` package provides low-level primitives for interacting with the Java Virtual Machine.

Types

java.lang.**String**
java.lang.**String**Buffer
java.io.**String**BufferInputStream
java.lang.**String**Builder
java.text.**String**CharacterIterator
java.lang.invoke.**String**ConcatException
java.lang.invoke.**String**ConcatFactory
javax.swing.text.**String**Content
java.lang.**String**IndexOutOfBoundsException
java.util.**String**Joiner
javax.management.monitor.**String**Monitor
javax.management.monitor.**String**MonitorMBean
java.io.**String**Reader
javax.naming.**String**RefAddr
com.sun.jdi.**String**Reference
java.awt.datatransfer.**String**Selection
java.util.**String**Tokenizer
javax.management.**String**ValueExp
java.io.**String**Writer
com.sun.jdi.connect.Connector.**String**Argument
java.text.Attributed**String**
javax.management.Bad**String**OperationException
org.w3c.dom.DOM**String**List
javax.swing.table.Table**String**Converter

Members

java.lang.constant.ConstantDescs.CD_**String**
java.lang.**String**.**String**()

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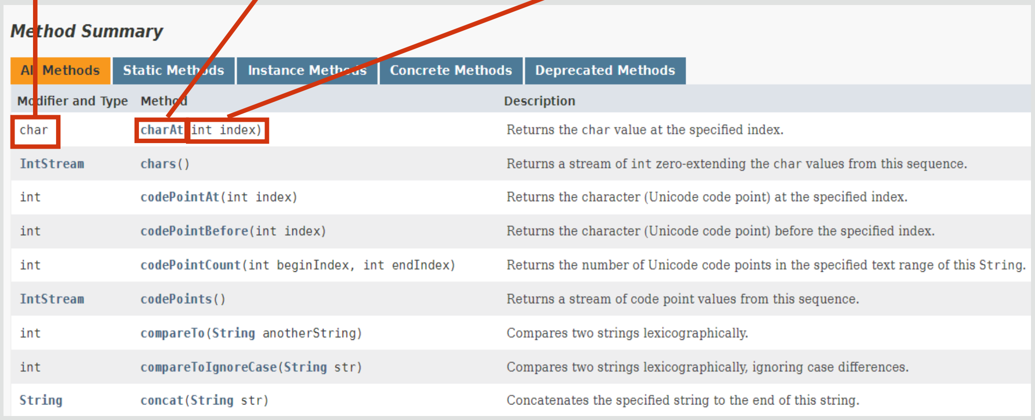
String Class Documentation: Method Summary

- `public int charAt(int index)`

Return type of the method

Name of the method

Data type of the parameter that must be passed into the method



Method Summary

Modifier and Type	Method	Description
`char`	`charAt(int index)`	Returns the char value at the specified index.
`IntStream`	`chars()`	Returns a stream of int zero-extending the char values from this sequence.
`int`	`codePointAt(int index)`	Returns the character (Unicode code point) at the specified index.
`int`	`codePointBefore(int index)`	Returns the character (Unicode code point) before the specified index.
`int`	`codePointCount(int beginIndex, int endIndex)`	Returns the number of Unicode code points in the specified text range of this `String`.
`IntStream`	`codePoints()`	Returns a stream of code point values from this sequence.
`int`	`compareTo(String anotherString)`	Compares two strings lexicographically.
`int`	`compareToIgnoreCase(String str)`	Compares two strings lexicographically, ignoring case differences.
`String`	`concat(String str)`	Concatenates the specified string to the end of this string.

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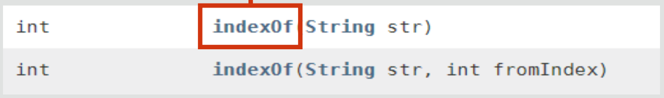
If you keep scrolling through the details of the String class, you will come to the list of methods (only a small subset of this list is shown here).
This master list of methods gives the basic details for the method. In this case, you can see that the name of the method is charAt, its type is char, and it requires an index parameter (of type int) to be passed in. There's also a brief description that this method returns the char value at a particular index in the string. For each method, the method name and the parameter types are hyperlinked so that you can get more details.

String Class Documentation: Method Detail

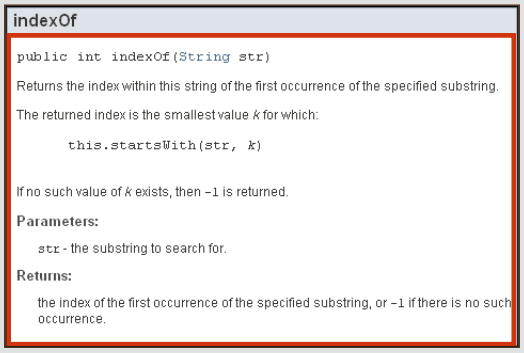
Click here to get the detailed description of the method



int	indexOf(String str)
int	indexOf(String str, int fromIndex)

Detailed description of the indexOf() method

Further details about parameters and return value are shown in the method list



indexOf

```
public int indexOf(String str)
```

Returns the index within this string of the first occurrence of the specified substring.

The returned index is the smallest value *k* for which:

```
    this.startsWith(str, k)
```

If no such value of *k* exists, then -1 is returned.

Parameters:

str - the substring to search for.

Returns:

the index of the first occurrence of the specified substring, or -1 if there is no such occurrence.

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For any of the methods, the method name and the parameter types are hyperlinked so that you can get more details. The example here shows the detailed description for one of the indexOf() methods of String.

String Methods: length

- You can compute the length of a string by using the length method defined in the String class:
  - Method: name.length()
  - Returns the length, or the number of characters, in name as an integer value
- Example:

```
String name = "Mike.W";
System.out.println(name.length()); //6
```

Accessing Each Character in a String

- You can access each character in a string by its numerical index
- The first character of the string is at index 0, the next is at index 1, and so on
- For example:
- `String str = "Hello, World";`

H	e	l	l	o	,		W	o	r	l	d
0	1	2	3	4	5	6	7	8	9	10	11

  – str has 0 to 11 indexes; that is, between 0 to str.length()-1

String Methods: indexOf()

- Each character of a string has an index
- You can retrieve the index value of a character in the string by using the indexOf method:

Method	Description
`str.indexOf(char c)`	Returns the index value of the first occurrence of c in String str
`s1.indexOf(char c, int beginIdx)`	Returns the index value of the first occurrence of c in String s1, starting from beginIdx to the end of the string

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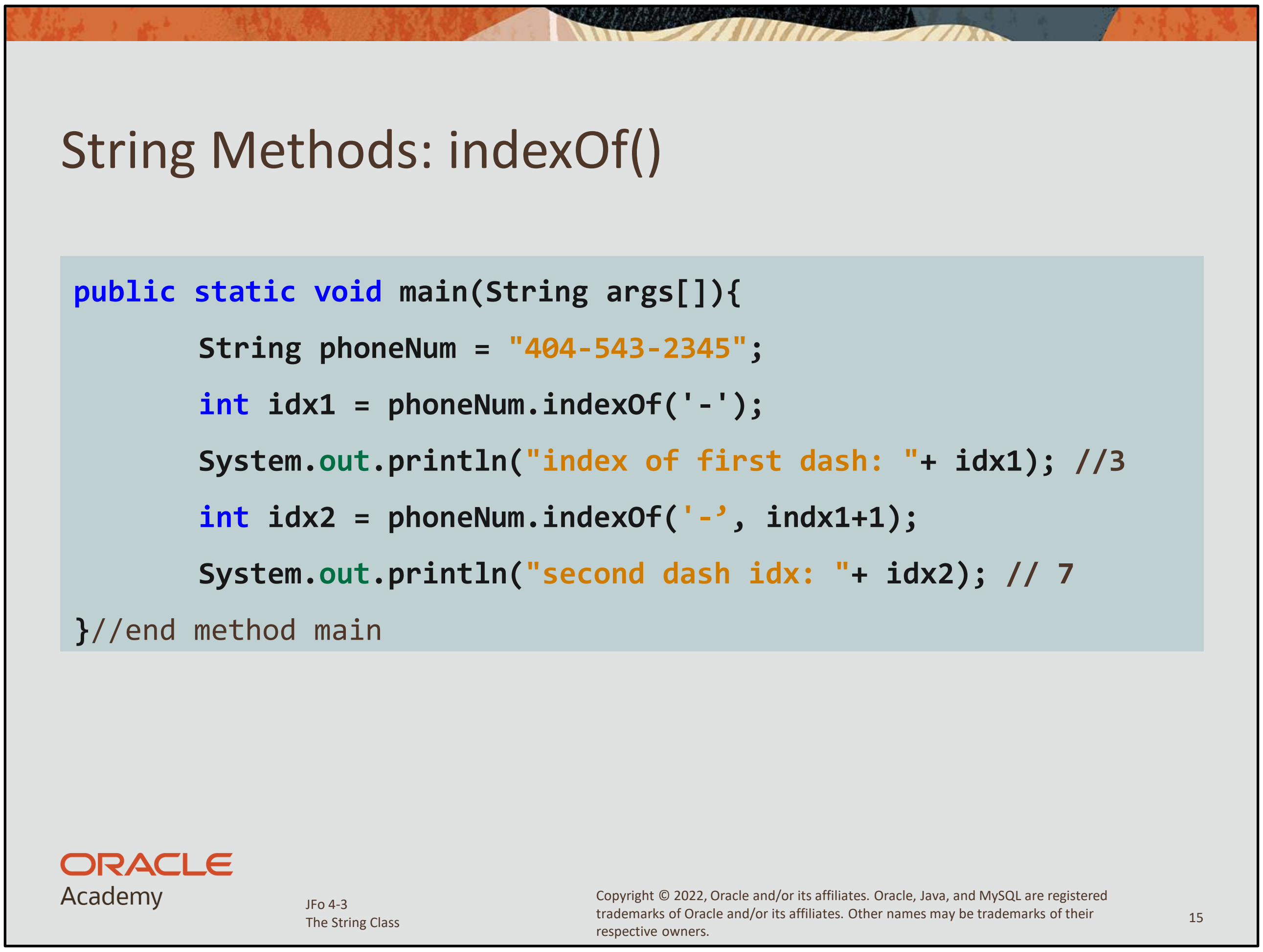

String Methods: indexOf()

```
public static void main(String args[]){
        String phoneNum = "404-543-2345";
        int idx1 = phoneNum.indexOf('-');
        System.out.println("index of first dash: "+ idx1); //3
        int idx2 = phoneNum.indexOf('-’, indx1+1);
        System.out.println("second dash idx: "+ idx2); // 7
}//end method main
```

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String Methods: charAt

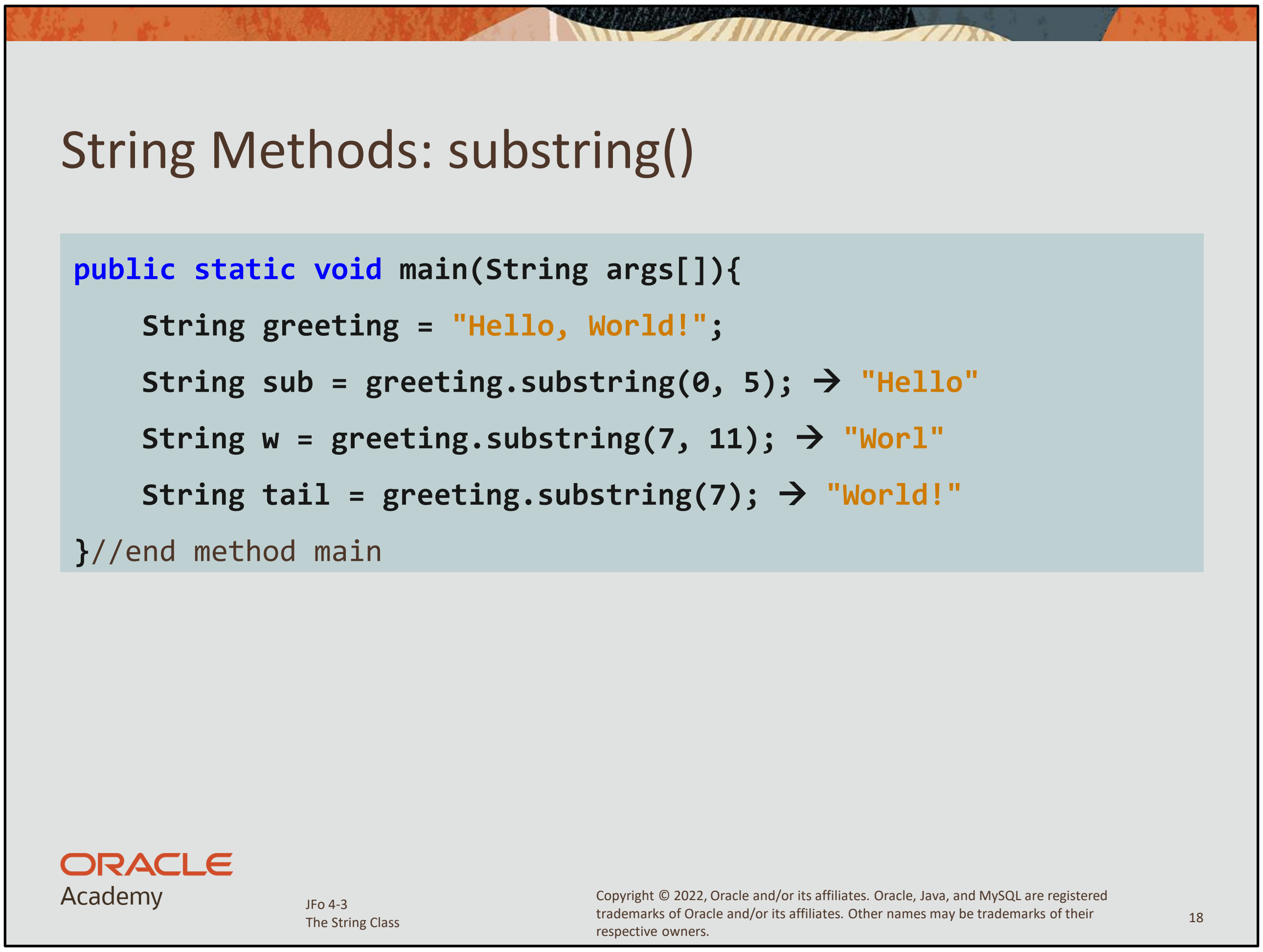
- Returns the character of the string located at the index passed as the parameter
- Method: str.charAt(int index)

```
String str = "Susan";
System.out.println(str.charAt(0));  //S
System.out.println(str.charAt(3));  //a
```

String Methods: substring()

- You can extract a substring from a given string
- Java provides two methods for this operation:

Method	Description
`str.substring(int beginIdx)`	Returns the substring from beginIdx to the end of the string
`str.substring(int beginIdx, int endIdx)`	Returns the substring from beginIdx up to, but not including, endIdx



String Methods: substring()

```
public static void main(String args[]){
    String greeting = "Hello, World!";
    String sub = greeting.substring(0, 5); → "Hello"
    String w = greeting.substring(7, 11); → "Worl"
    String tail = greeting.substring(7); → "World!"
}//end method main
```

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The String Class

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From the previous example, how could you use the substring method to rewrite the following:

```
String str = "Susan";
System.out.println(str.charAt(0));   //S
System.out.println(str.charAt(3));   //a
```

```
Answer:
String str = "Susan";
System.out.println(str.substring(0, 1));   //S
System.out.println(str.substring(3, 4));   //a
```

String Methods: replace()

- This method replaces all occurrences of matching characters in a string
- Method: replace(char oldChar,char newChar)
- Example:

```
public static void main(String args[]) {
    String str = "Using String replace to replace character";
    String newString = str.replace("r", "R");
    System.out.println(newString);
}//end method main
```

  - Output: Using String Replace to Replace ChaRacteR
  - All occurrences of a lowercase “r” are replaced with a capital "R"

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String Methods: replaceFirst()

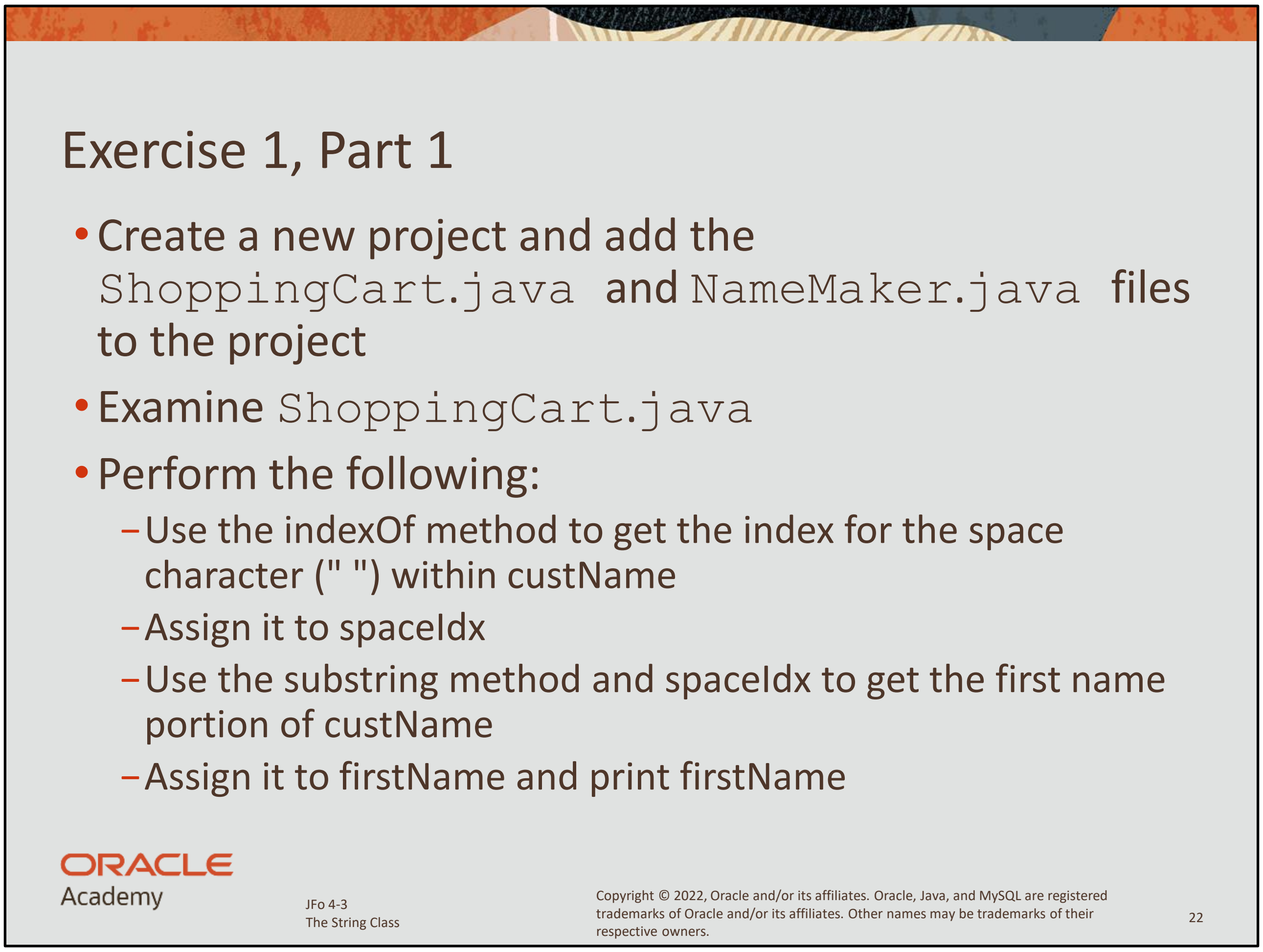
- This method replaces only the first occurrence of a matching character pattern in a string
- Method: replaceFirst(String pattern, String replacement)

String Methods: replaceFirst()

- Example:

```
public static void main(String args[]) {
    String replace = "String replace with replaceFirst";
    String newString = replace.replaceFirst("re", "RE");
    System.out.println(newString);
}//end method main
```

- Output:
  - String REplace with replaceFirst
- Only the first occurrence of "re" is replaced with "RE"
- The second occurrence isn’t changed



Exercise 1, Part 1

- Create a new project and add the `ShoppingCart.java` and `NameMaker.java` files to the project
- Examine `ShoppingCart.java`
- Perform the following:
  - Use the indexOf method to get the index for the space character (" ") within custName
  - Assign it to spaceIdx
  - Use the substring method and spaceIdx to get the first name portion of custName
  - Assign it to firstName and print firstName

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The String Class

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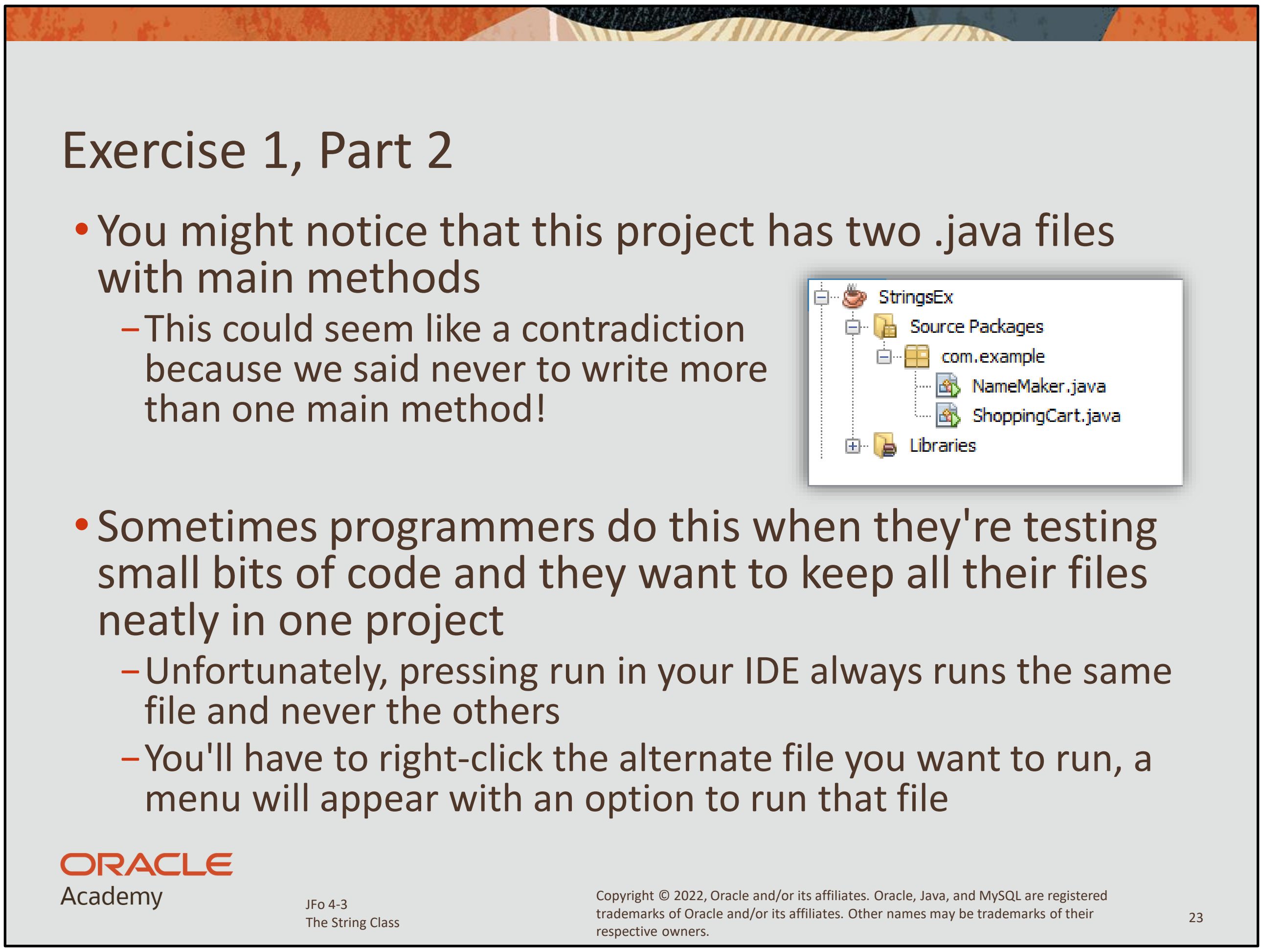
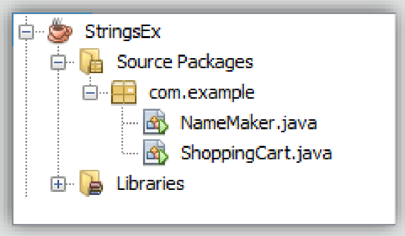
Both of the classes in the project contain main methods, to run the ShoppingCart.java file, right click on the file in the project explorer and click "Run File". This is explained further on the next slide.



Exercise 1, Part 2

- You might notice that this project has two .java files with main methods
  - This could seem like a contradiction because we said never to write more than one main method!



```
StringsEx
  Source Packages
    com.example
      NameMaker.java
      ShoppingCart.java
  Libraries
```

- Sometimes programmers do this when they're testing small bits of code and they want to keep all their files neatly in one project
  - Unfortunately, pressing run in your IDE always runs the same file and never the others
  - You'll have to right-click the alternate file you want to run, a menu will appear with an option to run that file

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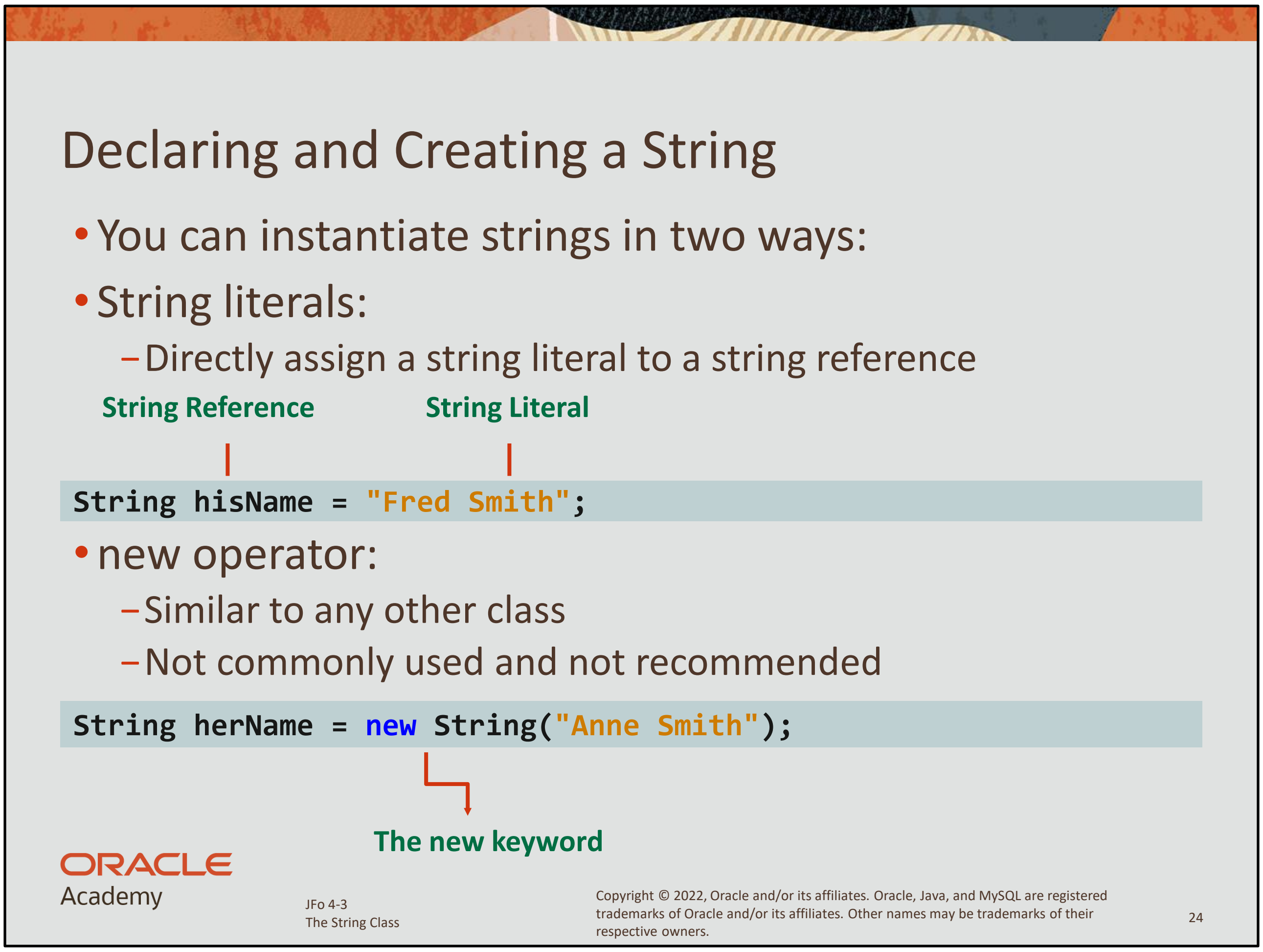
The String Class

To run a file in other IDEs, the process may differ, consult the documentation for the steps.



Declaring and Creating a String

- You can instantiate strings in two ways:
- String literals:
  - Directly assign a string literal to a string reference

String Reference
String Literal

```
String hisName = "Fred Smith";
```

- new operator:
  - Similar to any other class
  - Not commonly used and not recommended

```
String herName = new String("Anne Smith");
```

The new keyword

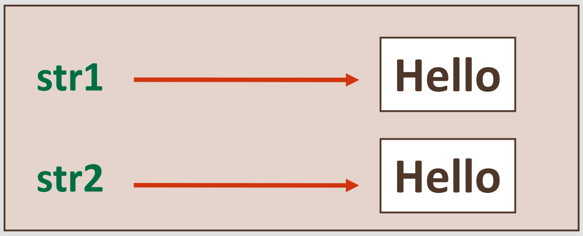
Although you can use the new operator to create a string, don’t use it. You’ll learn why later in the course.

Strings Are Immutable

- A String object is immutable; that is, after a String object is created, its value can't be changed
- Because strings are immutable, Java can process them very efficiently
  - Consider the following:

```
String str1 = "Hello";
String str2 = "Hello";
```

  - We expect this ...



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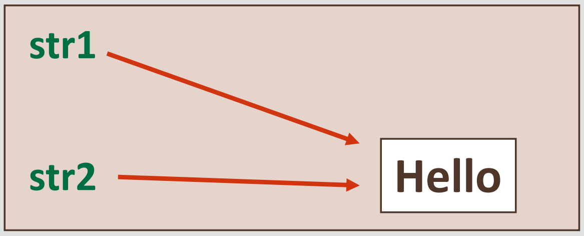
Strings Are Immutable

- But this is what happens …



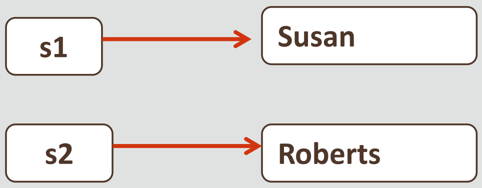
- The Java runtime system knows that the two strings are identical and allocates the same memory location for the two objects

Concatenating Strings

- In Java, string concatenation forms a new string that's the combination of multiple strings
- You can concatenate strings in Java two ways :
  - **+** string concatenation operator
  - **concat()** method

Using the + Operator (Before Concatenation)

```
public static void main(String args[]) {
    String s1 = "Susan";
    String s2 = "Roberts";
}//end method main
```



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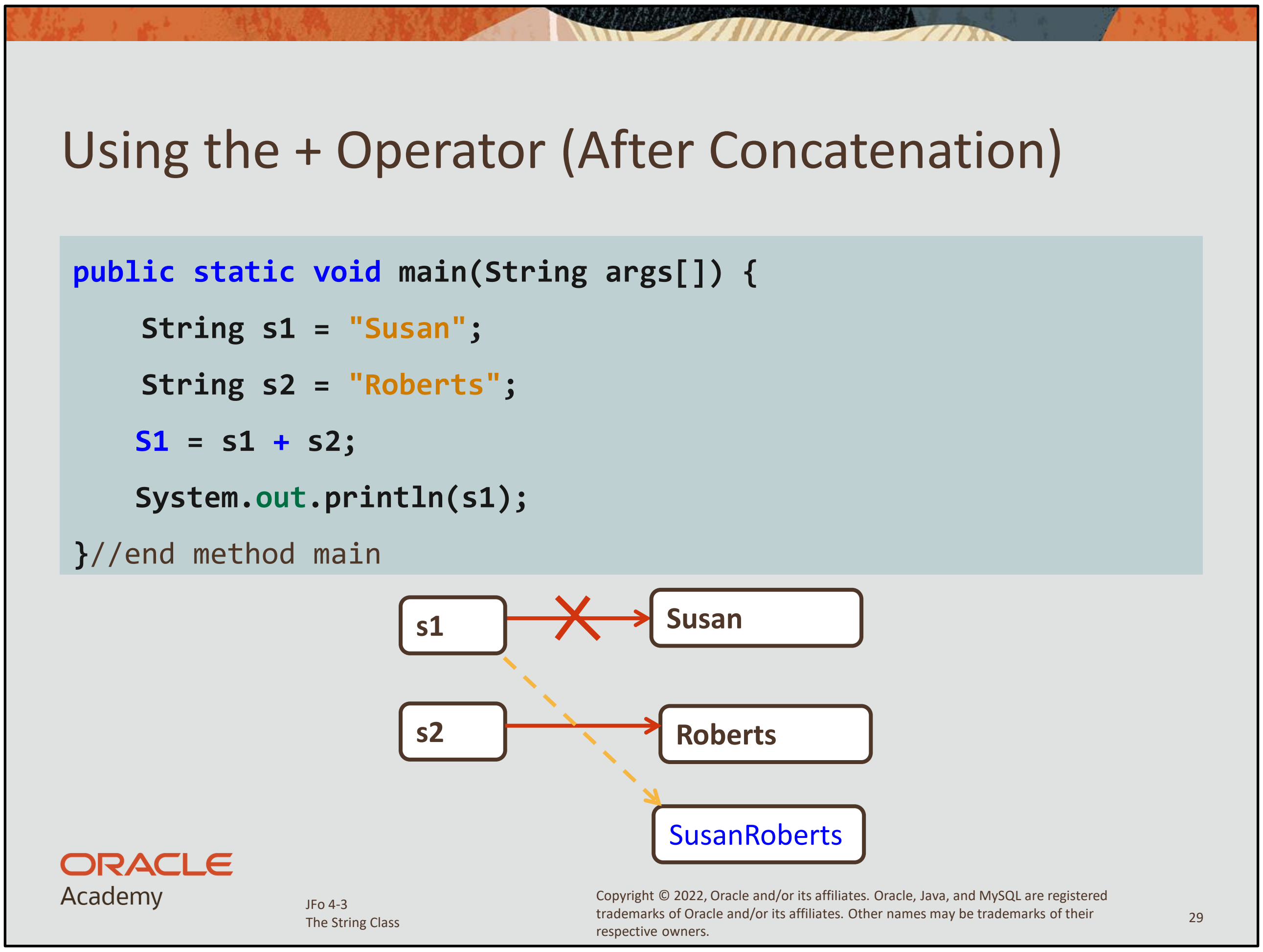
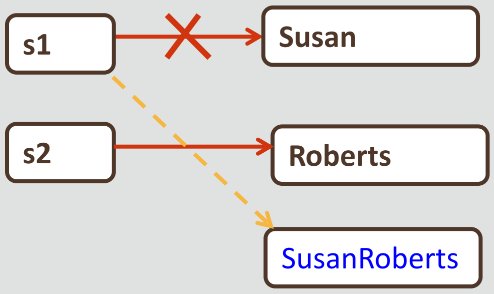


Using the + Operator (After Concatenation)

```
public static void main(String args[]) {
    String s1 = "Susan";
    String s2 = "Roberts";
   S1 = s1 + s2;
   System.out.println(s1);
}//end method main
```



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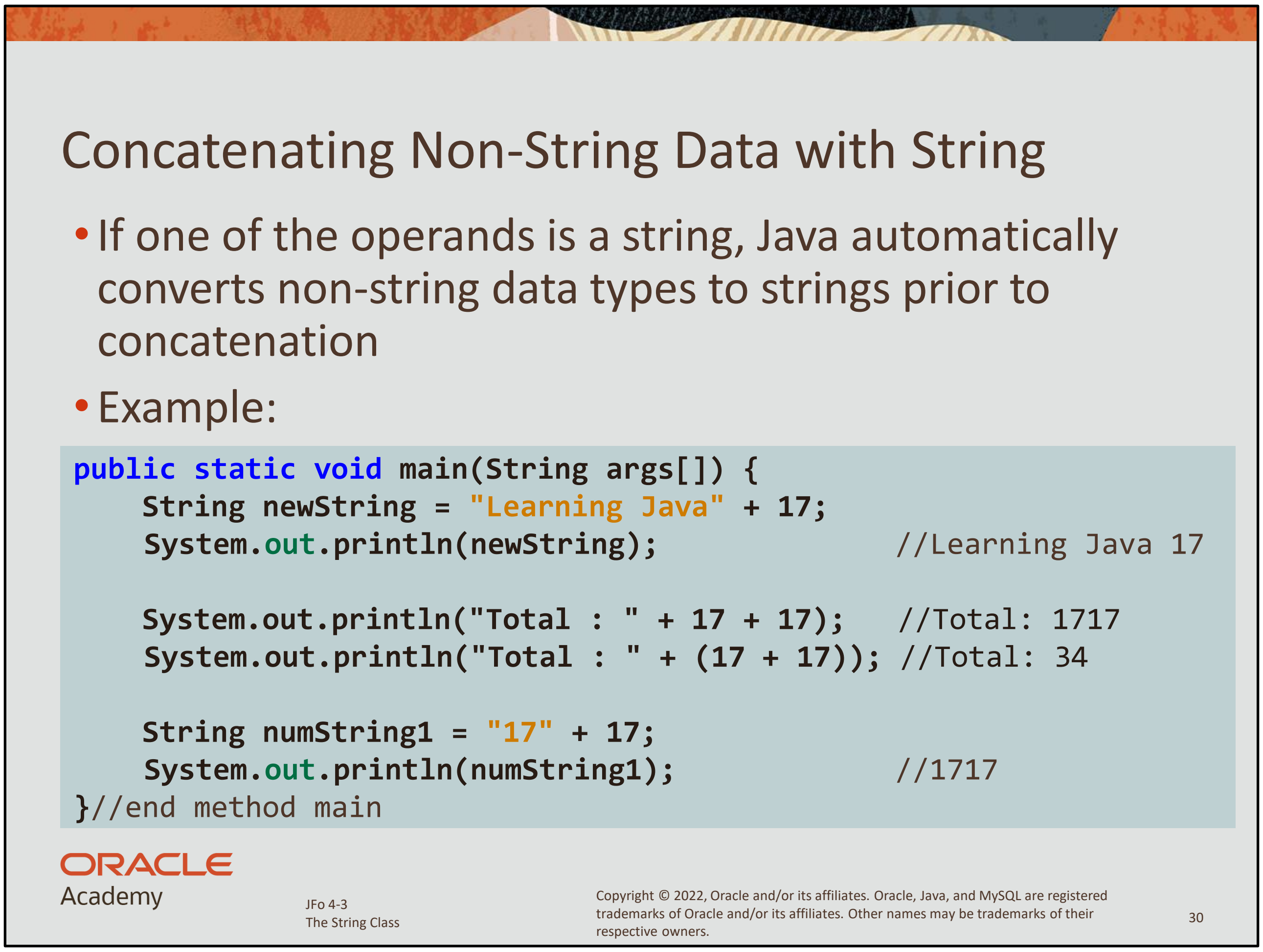
After the string concatenation operation, a new String object, “SusanRoberts,” is created and s1 points to that because of the immutable property of Strings. Because there are no references to string, Susan is removed from memory.



Concatenating Non-String Data with String

- If one of the operands is a string, Java automatically converts non-string data types to strings prior to concatenation
- Example:

```
public static void main(String args[]) {
    String newString = "Learning Java" + 17;
    System.out.println(newString);              //Learning Java 17

    System.out.println("Total : " + 17 + 17);   //Total: 1717
    System.out.println("Total : " + (17 + 17)); //Total: 34

    String numString1 = "17" + 17;
    System.out.println(numString1);             //1717
}//end method main
```

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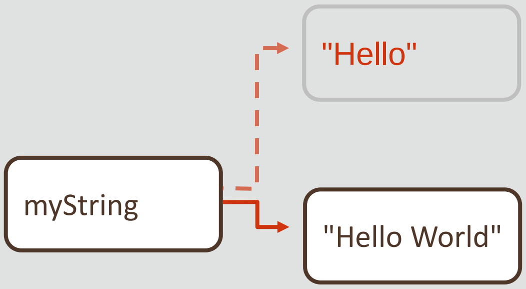
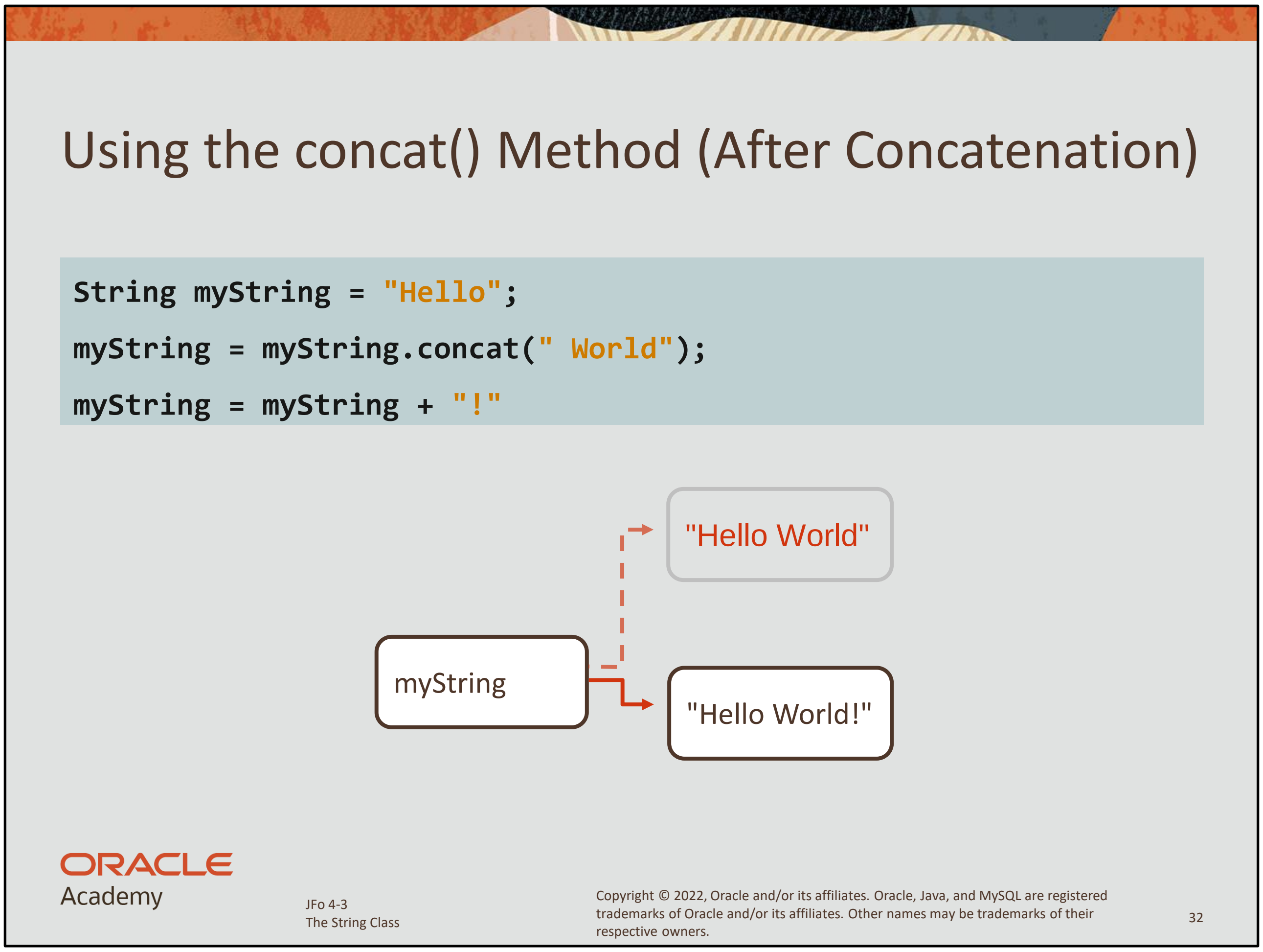
The slide example demonstrates concatenating a String literal and an integer by using the + operator. Java automatically converts non-String data types to strings before concatenation.

Using the concat() Method (Before Concatenation)

```
String myString = "Hello";
myString = myString.concat(" World");
```

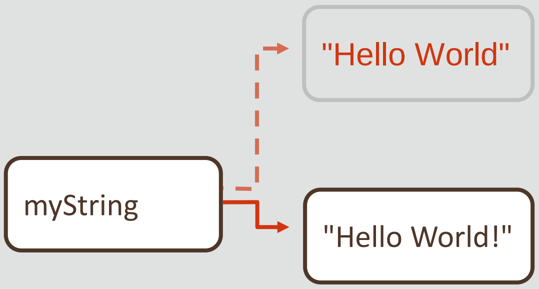


In this example, the “World” string is being concatenated to the original string. The concat method is used here, but whether you use that or the concatenation operator (+), a new String object is created and the returned new String reference points to this new object.
In the diagram, the myString String reference no longer refers to “Hello,” and it will be removed from memory.



Using the concat() Method (After Concatenation)

```
String myString = "Hello";
myString = myString.concat(" World");
myString = myString + "!"
```



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In this example, after the concat method is called, a new object (HelloWorld) is created and the reference for this object is assigned to myString.
Finally, on concatenating another string, this time using the concatenation operator, the same thing happens again. A new object (HelloWorld!) is created and the reference for this object is assigned to myString.

Exercise 2

- Open the project you created in Exercise 1
- Examine `NameMaker.java`
- Perform the following:
  - Declare String variables: firstName, middleName, lastName, and fullName
  - Prompt users to enter their first, middle, and last names and read the names from the keyboard
  - Set and display the fullName as firstName+a blank char+middleName+a blank char+lastName

Exercise 2

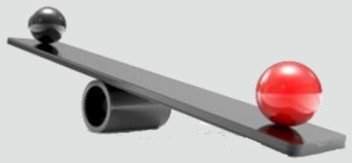
- Which do you think is preferable for this scenario?
- That is, the string concatenation operator or the concat() method?

What's the Preferred Way to Concatenate Strings?

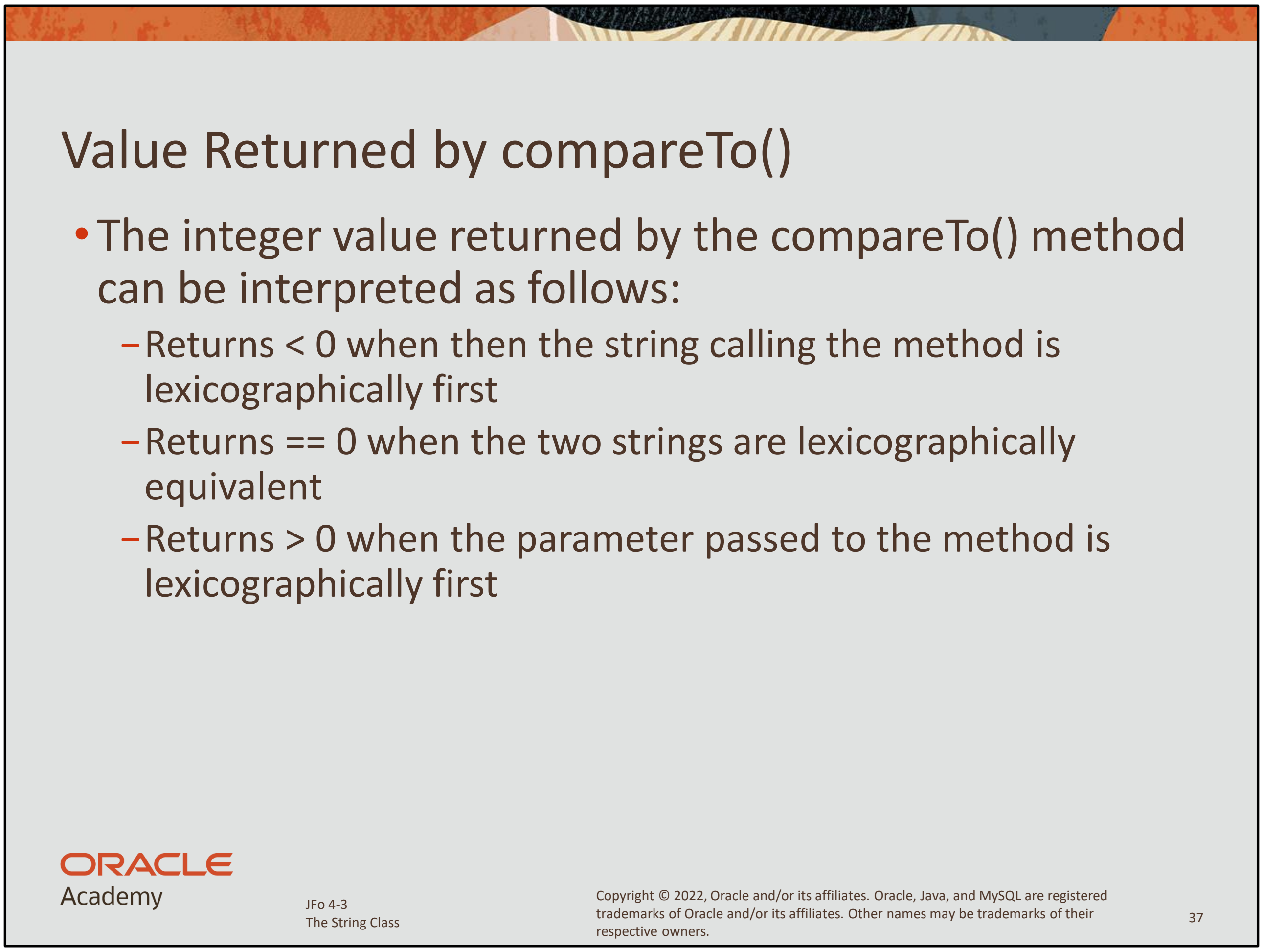
- As you observed in the previous exercise:
- + operator:
  - Can work between a string and a string, char, int, double or float data type value
  - Converts the value to its string representation before concatenation
- concat()method:
  - Can be called only on strings
  - Checks for data type compatibility, and a compile time error is produced if they don't match

How Do You Compare String Objects?

- You can compare two String objects by using the compareTo() method
- This method compares based on the lexicographical order of strings
- Lexicographic comparisons are similar to the ordering found in a dictionary
- The strings are compared character by character until their order is determined or until they prove to be identical
- Syntax: **s1.compareTo(s2)**
- Returns an integer value that indicates the ordering of the two strings



Strings are compared lexicographically, not alphabetically. Lexicographic comparisons are similar to the ordering that one might find in a dictionary.



Value Returned by compareTo()

- The integer value returned by the compareTo() method can be interpreted as follows:
  - Returns < 0 when then the string calling the method is lexicographically first
  - Returns == 0 when the two strings are lexicographically equivalent
  - Returns > 0 when the parameter passed to the method is lexicographically first

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Using the compareTo() Method

- Let’s look at some examples:
  - "computer".compareTo("comparison")
    - Returns an integer > 0 because the "comparison" parameter is lexicographically first
  - "cab".compareTo("car")
    - Returns an integer < 0 because the “cab” string calling the method is lexicographically first
  - "car".compareTo("car")
    - Returns an integer equal to 0 because both are lexicographically equivalent

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Using the compareTo() method: Example

- Let’s write a program to compare names by using the compareTo() method:

```
public static void main(String[] args) {

    String s1 = "Susan";
    String s2 = "Susan";
    String s3 = "Robert";

    //Returns 0 because s1 is identical to s2
    System.out.println(s1.compareTo(s2)); //Output is 0

    //Returns >0 because ‘S’ follows‘R’
    System.out.println(s1.compareTo(s3)); // Output is 1

    //Returns <0 because ‘R’ precedes ‘S’
    System.out.println(s3.compareTo(s1)); // Output is -1
}//end method main
```

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Summary

- In this lesson, you should have learned how to:
  - Locate the String class in the Java API documentation
  - Understand the methods of the String class
  - Compare two String objects lexicographically
  - Find the location of a substring in a String object
  - Extract a substring from a String object

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