



# Module 1-6

Introduction to Objects (via Strings)

# Objectives

- Explain the concept of an object as a programming construct
- Describe the difference between objects and classes and how those two concepts are related
- Know how to instantiate and use objects
- Should understand the terms Declare, Instantiate and Initialize
- Should understand how objects are stored in RAM
- Explain how the Stack and Heap are used with objects and primitives
- Define the terms Value-type and Reference-type
- Describe the String class, its purpose and use
- Call methods on an object and understand that they return values
- Should understand immutability and what that means for handling certain objects
- Explain object equality and the difference between `==` and `equals()`

# Objects Introduction

- In-memory data structure
  - Combines state and behavior into a usable and useful abstraction
- Each object lives in memory and is separate from every other object
  - Reference type
- We don't write objects, we write classes
  - In order to make objects, we must write definition of that object, which is called a class
  - Class is a blueprint
    - Grouping of variables and methods in source code
  - Defines what object will be like when object is created

# Objects Introduction

```
House houseAt100WestSt = new House(2, 2.5, "Red Brick");
```

- First, declare variable that will hold the object (houseAt100WestSt)
- Then, instantiate a new object from a class
  - Initialize variables with the initial values sent in as arguments (maybe)

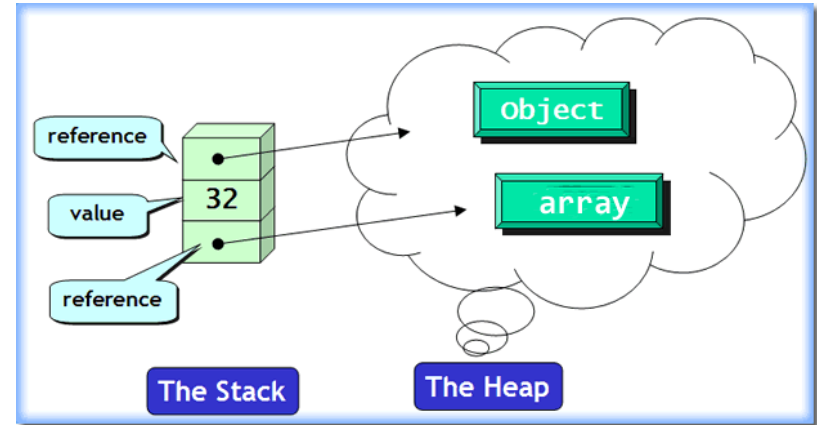
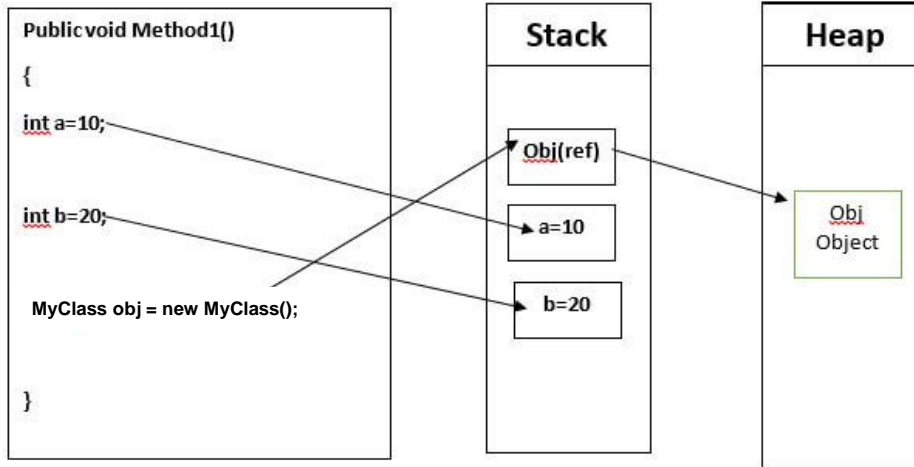
# Reference vs Value Types

- You have now encountered various **primitive data types (value types)**: int, double, boolean, float, char, etc.
  - Allocated on Stack
- We will now discuss **reference types**:
  - You have encountered these already – Scanner, Array and String are reference types.
  - Objects that you instantiate from classes that you write are also reference types.

```
Car myCar = new Car();
```

  - Allocated on Heap

# Stack and Heap



- Primitive variables are stored on Stack
- Arrays and objects are stored on Heap

# Stack vs Heap

Stack	Heap
A linear data structure	A free floating range of memory
High Speed Access	Slower access
Stores simple values of a set size (Primitive Value Types)	Stores complex objects of any size (Reference Types)
Managed by the OS	Managed by the programmer and language
Limited in Size	Unlimited in Size
Fixed Size	Can be resized
Main problem is running out of memory (StackOverflow)	Main problem is memory fragmentation (slower access)



# Properties and Methods

Reference types often have properties (also called members, or data members) and methods.



These vehicles were created from the same blueprint. The blueprint specifies that each vehicle should have a color, **color is therefore a property of the object.**

Objects also have methods. Again, consider some of the things a vehicle can do: start the engine, go in reverse, check how much fuel it has left.

# Initializing an object

- All objects need to be initialized or instantiated
- (Strings are special and have the ability to be instantiated without new)
- `House myHouse;`
  - Object is declared but not instantiated, value will be null
  - Must instantiate before using

# No Value vs Null

0 / empty



null



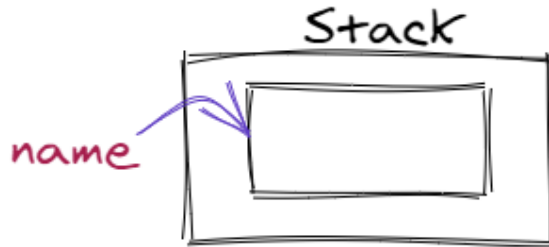
# null

When variables for Reference Types are created they default to ***null***, until they are assigned a reference to an instantiated object.

***null*** is not the same thing as ***empty***. ***null*** refers to no value on the Stack. ***empty*** refers to the value of an existing object on the Heap.

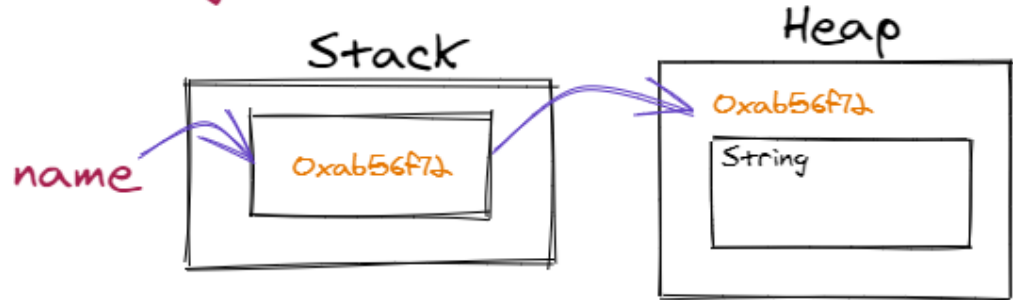
null

String name;



empty

String name = "";



# Objects: Arrays

Let's consider Arrays in the context of objects.

- Arrays have a length **property**: `myArray.length`
- Arrays also have **static methods** (just like wrapper class methods):

```
boolean check = Arrays.equals(oneStringArray, twoStringArray);  
System.out.println(check);
```

To access an object's properties or methods we use the dot operator as observed above. Methods have a set of parentheses.

# Arrays Methods (just a few)

- `Arrays.toString(intArray)` – allows you to print all values of an array without a loop
- `Arrays.copyOf(intArray, 5)` – creates a new array of 5 elements and copies in (first 5) elements of `intArray`
- `Arrays.equals(oneArray, twoArray)` – returns true if all values in the array are equal to one another
- `Arrays.fill(doubleArray, myDouble)` – assigns the value of `myDouble` to all elements in `doubleArray`
- `Arrays.sort(myArray)` – sorts the array in ascending order

Let's code!

# Strings: length method

Unlike arrays, to obtain the length of a string, a method is called. We know this because of the presence of parenthesis.

```
String myString = "Pure Michigan";  
int myStringLength = myString.length();  
System.out.println(myStringLength);  
// The output is 13.
```

- Note that no parameters were taken, nothing goes inside the parenthesis.
- The method's return is an integer, we can assign it to an integer if needed.



# Strings: charAt method

The charAt method for a string returns the character at a given index. The index on a String is similar to that of an Array, namely that it starts at zero.

```
String myString = "Pure Michigan";  
char myChar = myString.charAt(1);  
System.out.println(myChar);  
// The output is u.
```

- Note that charAt takes 1 parameter, the index number indicating the position in the String you want to extract.
- The method's return value is of type char.

# Strings: indexOf method

The indexOf method returns the starting position of a character or String.

```
String myString = "Pure Michigan";  
int position = myString.indexOf('u');  
int anotherPosition = myString.indexOf("Mi");  
  
System.out.println(position); // 1  
System.out.println(anotherPosition); // 5
```

- Note that indexOf takes one parameter, what you're searching for.
- The method's return is an integer, if nothing is found it will return a -1. If there are multiple matches, it will return the index corresponding the first one.

# Strings: substring method

The substring method returns part of a larger string.

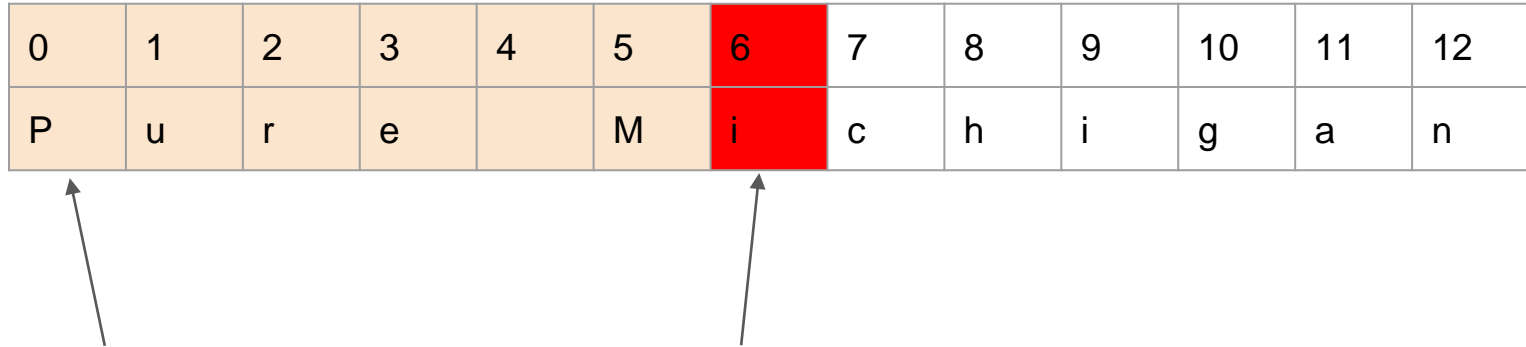
```
String myString = "Pure Michigan";  
String mySubString = myString.substring(0, 6);  
System.out.println(mySubString);  
// output: Pure M
```

- Substring requires two parameters, the first is the starting point. The second parameter is a non-inclusive end point (more on this on the next slide).
- It returns a String, so you can assign the output to a String.

# Strings: substring method

Just like with arrays, drawing a table of elements or position is a great way to visualize these concepts. Consider the following method call `substring(0, 6)`

0	1	2	3	4	5	6	7	8	9	10	11	12
P	u	r	e		M	i	c	h	i	g	a	n



The first parameter is 0, denoting we will start the new String from the 0th position.

The second parameter is the stopping point. The stopping point (6th element) is not included in the final String.

Hence, the output from the previous page is:  
**Pure M**

Let's code!

# Strings: mutability

Let's look at the same example, but print out the original String instead. What do you think is the output now?

```
String myString = "Pure Michigan";  
myString.substring(0, 6);  
System.out.println(myString);
```

The output will be "Pure Michigan" not "Pure M"!

- Strings are **immutable**, once created they cannot be changed. The result of the substring operation has no bearing on the original String.
- The only way to get a new String value containing the smaller String is by re-assigning myString using the = operator to a new variable.

# Strings: mutability

Here is how to get around this:

```
String myString = "Pure Michigan";  
myString = myString.substring(0, 6);  
System.out.println(myString); // Pure M
```

# Let's code!



# Strings: Comparisons

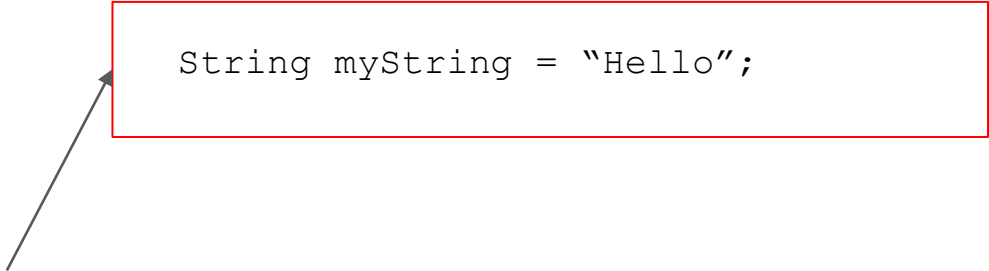
The proper way to compare Strings is to use the equals() method.

```
String myString = "Pure Michigan";  
String myOtherString = "Pure Michigan";  
String yetAnotherString = "Ohio so much  
to discover";  
  
if (myString.equals(myOtherString)) {  
    System.out.println("match");  
}
```

**Do not use == to compare Strings!**

# Objects: References

The previous discussion on why `==` should not be used with Strings illustrates an important concept concerning assigning objects (like Strings and Arrays) to variables.



```
String myString = "Hello";
```

myString is a  
reference to  
where "Hello" is  
stored in memory  
(in the heap).

A reference does not actually store an object, it only tells you where it is in memory.

# Objects: Key & Locker Analogy

One way to think about it is like this: a reference is like a key with a number tag, it does not store anything by itself, but there is a locker with that number on it that holds the actual object. With this analogy, the key with the number 7 is called `myString`.



“Hello”

# The “new” keyword

- Java is built around thousands of “blueprints” called classes and provides you with the ability to create your own classes.
- The **new** keyword is typically used to create an instance of a class.
- We refer to these instances as **objects** of a specific class.
- We have already seen this before, consider the declaration of an array.

```
int [] scores = new int[5];
```

- If we use the concepts we just learned, the above statement means, create a reference (key) of type integer array. Proceed to create a new instance of this array of length 5.
- Strings aren’t required to follow this convention... but if you want to you can:

```
String aString = new String("Hello");
```

# Null objects

- If a reference type is declared without an equal sign, its value will be **null**.

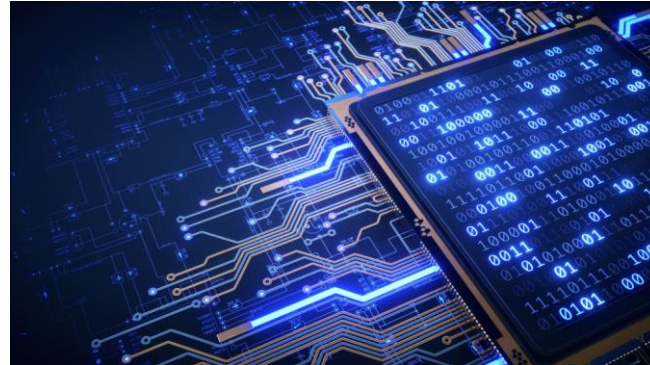
```
int [] scores;
```

- This is difficult to simulate with the two reference types you know, as the compiler will not allow you to get away with this, we will discuss this in more detail in later modules.

# Objectives

- Explain the concept of an object as a programming construct

In-memory data structure  
Combines state and behavior



# Objectives

- Explain the concept of an object as a programming construct
- Describe the difference between objects and classes and how those two concepts are related

Class describes a car  
Using variables and methods



# Objectives

- Explain the concept of an object as a programming construct
- Describe the difference between objects and classes and how those two concepts are related
- Know how to instantiate and use objects

```
Scanner input = new Scanner(System.in);
```

```
String name = "Bob";
```



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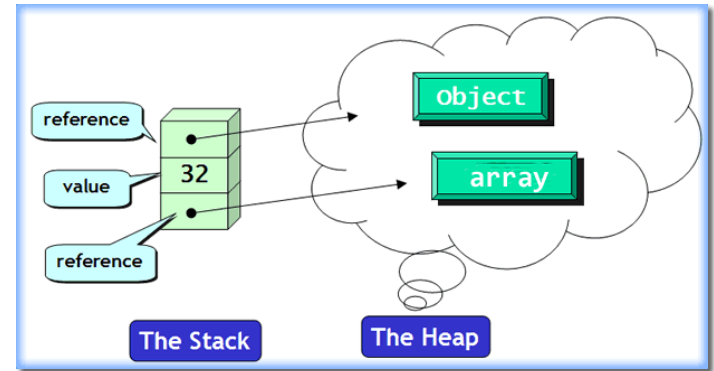
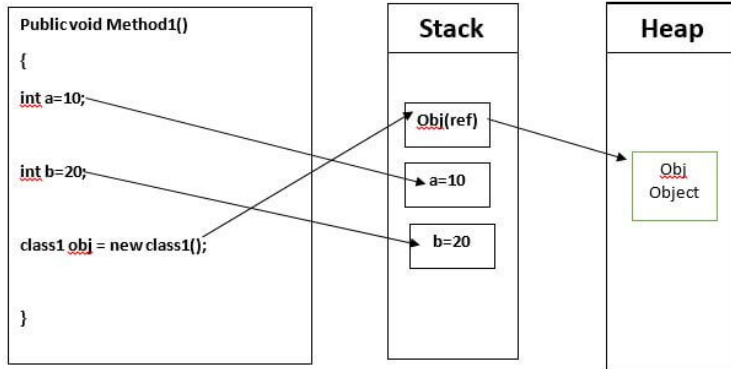
Declare

Instantiate

Initialize

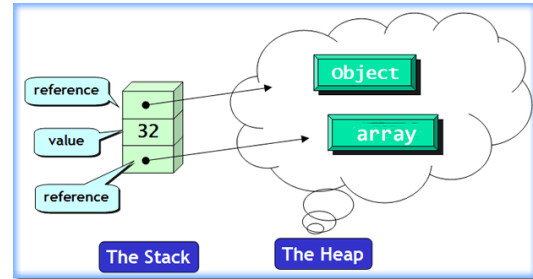
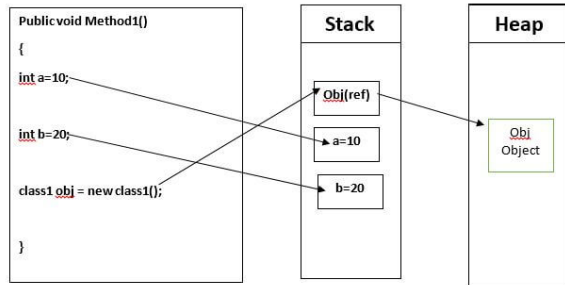
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- Should understand how objects are stored in RAM



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- Explain how the Stack and Heap are used with objects and primitives



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- Define the terms Value-type and Reference-type

Value type => primitive data (int, double, char)

Reference type => arrays and objects

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- Describe the String class, its purpose and use

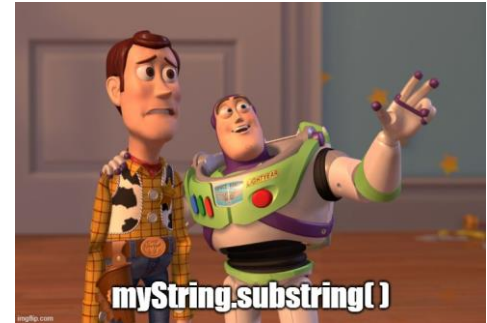


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- Describe the String class, its purpose and use
- Call methods on an object and understand that they return values



`myString.charAt( )`

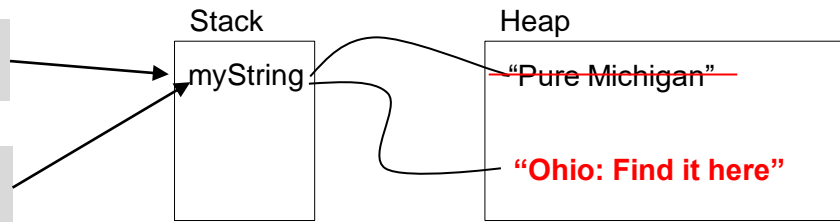


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```
String myString = "Pure Michigan";
```

```
myString = "Ohio: Find it here";
```



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- Should understand immutability and what that means for handling certain objects
- Explain object equality and the difference between == and equals()

== used for comparing primitive data (int, double, char)

.equals used for comparing objects