Classes and Objects

Object-Orientation

Java uses **O**bject-**O**riented **P**rogramming (OOP), a programming style that is intended to make thinking about programming closer to thinking about the real world.
In OOP, each object is an independent unit with a **unique identity**, just as objects in the real world are.

> An apple is an object; so is a mug. Each has its unique **identity**. It's possible to have two mugs that look identical, but they are still separate, unique objects.

Objects also have **characteristics**, which are used to describe them.
For example, a car can be red or blue, a mug can be full or empty, and so on. These characteristics are also called **attributes**. An attribute describes the current state of an object.
In the real world, each object behaves in its own way. The car moves, the phone rings, and so on. The same applies to objects: **behavior** is specific to the object's type.

> In summary, in object oriented programming, each object has three dimensions: **identity**, **attributes**, and **behavior**.
> Attributes describe the object's current state, and what the object is capable of doing is demonstrated through the object's behavior.

Classes

A **class** describes what the object will be, but is separate from the object itself.
In other words, classes can be described as blueprints, descriptions, or definitions for an object. You can use the same class as a blueprint for creating multiple objects. The first step is to define the class, which then becomes a blueprint for object creation.

Each class has a name, and each is used to define **attributes** and **behavior**.
Some examples of attributes and behavior:

> In other words, an object is an instance of a class.

Methods

Methods define **behavior**. A method is a collection of statements that are grouped together to perform an operation. System.out.println() is an example of a method.
You can define your own methods to perform your desired tasks.
Let's consider the following code:

```
class MyClass {

  static void sayHello() {
    System.out.println("Hello World!");
  }

  public static void main(String[ ] args) {
    sayHello();
  }
}
// Outputs "Hello World!"
```

Try It Yourself

The code above declares a method called "sayHello", which prints a text, and then gets called in **main**.

To call a method, type its name and then follow the name with a set of parentheses.

Calling Methods

You can call a method as many times as necessary.
When a method runs, the code jumps down to where the method is defined, executes the code inside of it, then goes back and proceeds to the next line.
Example:

```
class MyClass {

  static void sayHello() {
    System.out.println("Hello World!");
  }

  public static void main(String[ ] args) {
    sayHello();
    sayHello();
    sayHello();
  }
}

// Hello World!
// Hello World!
// Hello World!
```

Try It Yourself

In cases like the one above, where the same thing is repeated over and over, you can achieve the same result using loops (while or for).

Method Parameters

You can also create a method that takes some data, called **parameters**, along with it when you call it. Write parameters within the method's parentheses.
For example, we can modify our **sayHello**() method to take and output a **String** parameter.

```
class MyClass {

 static void sayHello(String name) {
  System.out.println("Hello " + name);
 }

 public static void main(String[ ] args) {
  sayHello("David");
  sayHello("Amy");
 }

}
// Hello David
// Hello Amy
```

Try It Yourself

The method above takes a String called **name** as a parameter, which is used in the method's body. Then, when calling the method, we pass the parameter's value inside the parentheses.
Methods can take multiple, comma-separated parameters.

> The advantages of using methods instead of simple statements include the following:
> - **code reuse**: You can write a method once, and use it multiple times, without having to rewrite the code each time.
> - **parameters**: Based on the parameters passed in, methods can perform various actions.

The Return Type

The **return** keyword can be used in methods to return a value.
For example, we could define a method named **sum** that returns the sum of its two parameters.

```
static int sum(int val1, int val2) {
  return val1 + val2;
}
```

Notice that in the method definition, we defined the **return type** before we defined the method name. For our sum method, it is **int**, as it takes two parameters of the type **int** and returns their sum, which is also an **int**.

> The **static** keyword will be discussed in a future lesson.

Now, we can use the method in our main.

```
class MyClass {

static int sum(int val1, int val2) {
 return val1 + val2;
}

 public static void main(String[ ] args) {
  int x = sum(2, 5);
  System.out.println(x);
 }
```

```
}
// Outputs "7"
```

Try It Yourself

As the method returns a value, we can assign it to a variable.

When you do not need to return any value from your method, use the keyword **void**. Notice the **void** keyword in the definition of the main method - this means that main does not return anything.

The Return Type

Take a look at the same code from our previous lesson with explaining comments, so you can better understand how it works:

```
// returns an int value 5
static int returnFive() {
  return 5;
}

// has a parameter
static void sayHelloTo(String name) {
  System.out.println("Hello " + name);
}

// simply prints"Hello World!"
static void sayHello() {
  System.out.println("Hello World!");
}
```

Having gained knowledge of method return types and parameters, let's take another look at the definition of the main method.

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

This definition indicates that the **main** method takes an array of Strings as its parameters, and does not return a value.

The Return Type

Let's create a method that takes two parameters of type int and returns the greater one, then call it in **main**:

```
public static void main(String[ ] args) {
  int res = max(7, 42);
  System.out.println(res); //42
}

static int max(int a, int b) {
  if(a > b) {
    return a;
  }
```

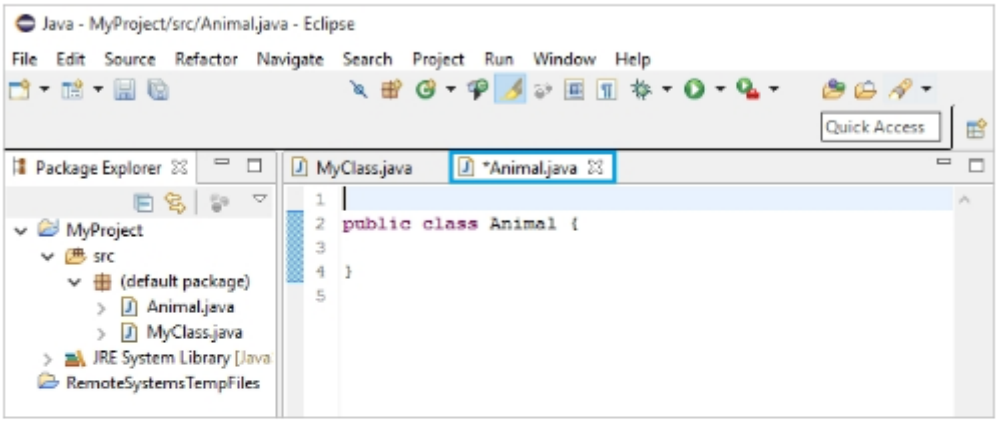
```
  else {
    return b;
  }
}
```

Try It Yourself

A method can have one type of parameter (or parameters) and return another, different type. For example, it can take two doubles and return an int.

Creating Classes

In order to create your own custom objects, you must first create the corresponding classes. This is accomplished by right clicking on the **src** folder in Eclipse and selecting Create->New->Class. Give your class a name and click **Finish** to add the new class to your project:



As you can see, Eclipse has already added the initial code for the class.
Now lets create a simple method in our new class.
Animal.java

```
public class Animal {
  void bark() {
    System.out.println("Woof-Woof");
  }
}
```

We declared a **bark()** method in our **Animal** class.

Now, in order to use the class and it's methods, we need to declare an **object** of that class.

Creating Objects

Let's head over to our **main** and create a new object of our class.
MyClass.java

```
class MyClass {
  public static void main(String[ ] args) {
    Animal dog = new Animal();
    dog.bark();
  }
}
// Outputs "Woof-Woof"
```

Try It Yourself

Now, **dog** is an object of type **Animal**. Thus we can call its **bark**() method, using the name of the object and a **dot**.
The **dot** notation is used to access the object's **attributes** and **methods**.

> You have just created your first object!

Defining Attributes

A class has **attributes** and **methods**. The attributes are basically variables within a class.
Let's create a class called **Vehicle**, with its corresponding attributes and methods.

```
public class Vehicle {
  int maxSpeed;
  int wheels;
  String color;
  double fuelCapacity;

  void horn() {
    System.out.println("Beep!");
  }
}
```

maxSpeed, **wheels**, **color**, and **fuelCapacity** are the attributes of our Vehicle class, and **horn()** is the only method.

> You can define as many attributes and methods as necessary.

Creating Objects

Next, we can create multiple objects of our **Vehicle** class, and use the dot syntax to access their attributes and methods.

```
class MyClass {
  public static void main(String[ ] args) {
    Vehicle v1 = new Vehicle();
    Vehicle v2 = new Vehicle();
    v1.color = "red";
    v2.horn();
  }
}
```

Try It Yourself

> Tap **Try It Yourself** to play around with the code!

Access Modifiers

Now let's discuss the **public** keyword in front of the main method.

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

public is an **access modifier**, meaning that it is used to set the level of access. You can use access modifiers for classes, attributes, and methods.

For classes, the available modifiers are public or default (left blank), as described below:
public: The class is accessible by any other class.
default: The class is accessible only by classes in the same package.

The following choices are available for attributes and methods:
default: A variable or method declared with no access control modifier is available to any other class in the same package.
public: Accessible from any other class.
protected: Provides the same access as the default access modifier, with the addition that subclasses can access protected methods and variables of the superclass (Subclasses and superclasses are covered in upcoming lessons).
private: Accessible only within the declared class itself.

Example:

```
public class Vehicle {
  private int maxSpeed;
  private int wheels;
  private String color;
  private double fuelCapacity;

  public void horn() {
    System.out.println("Beep!");
  }
}
```

It's a best practice to keep the variables within a class private. The variables are accessible and modified using **Getters** and **Setters**.
Tap **Continue** to learn about Getters and Setters.

Getters & Setters

Getters and **Setters** are used to effectively protect your data, particularly when creating classes. For each variable, the **get** method returns its value, while the **set** method sets the value.

Getters start with **get**, followed by the variable name, with the first letter of the variable name capitalized.
Setters start with **set**, followed by the variable name, with the first letter of the variable name capitalized.

Example:

```
public class Vehicle {
  private String color;

  // Getter
  public String getColor() {
    return color;
  }

 // Setter
  public void setColor(String c) {
    this.color = c;
  }
}
```

The **getter** method returns the value of the attribute.
The **setter** method takes a parameter and assigns it to the attribute.

The keyword **this** is used to refer to the current object. Basically, **this.color** is the **color** attribute of the current object.

Getters & Setters

Once our getter and setter have been defined, we can use it in our **main**:

```
public static void main(String[ ] args) {
  Vehicle v1 = new Vehicle();
  v1.setColor("Red");
  System.out.println(v1.getColor());
}

//Outputs "Red"
```

Try It Yourself

Getters and setters allow us to have control over the values. You may, for example, validate the given value in the setter before actually setting the value.

> Getters and setters are fundamental building blocks for **encapsulation**, which will be covered in the next module.

Constructors

Constructors are special methods invoked when an object is created and are used to initialize them.
A constructor can be used to provide initial values for object attributes.

- A constructor name must be same as its class name.
- A constructor must have no explicit return type.

Example of a constructor:

```
public class Vehicle {
  private String color;
  Vehicle() {
    color = "Red";
  }
}
```

The **Vehicle**() method is the constructor of our class, so whenever an object of that class is created, the color attribute will be set to "Red".
A constructor can also take parameters to initialize attributes.

```
public class Vehicle {
  private String color;
  Vehicle(String c) {
    color = c;
  }
}
```

> You can think of constructors as methods that will set up your class by default, so you don't need to repeat the same code every time.

Using Constructors

The constructor is called when you create an object using the **new** keyword.
Example:

```
public class MyClass {
  public static void main(String[ ] args) {
    Vehicle v = new Vehicle("Blue");
  }
}
```

This will call the constructor, which will set the **color** attribute to "Blue".

Constructors

A single class can have multiple constructors with different numbers of parameters.
The setter methods inside the constructors can be used to set the attribute values.

Example:

```
public class Vehicle {
  private String color;

  Vehicle() {
    this.setColor("Red");
  }
  Vehicle(String c) {
    this.setColor(c);
  }

  // Setter
  public void setColor(String c) {
    this.color = c;
  }
}
```

The class above has two constructors, one without any parameters setting the color attribute to a default value of "Red", and another constructor that accepts a parameter and assigns it to the attribute.

Now, we can use the constructors to create objects of our class.

```
//color will be "Red"
Vehicle v1 = new Vehicle();

//color will be "Green"
Vehicle v2 = new Vehicle("Green");
```

Try It Yourself

Java automatically provides a default constructor, so all classes have a constructor, whether one is specifically defined or not.

Value Types

Value types are the basic types, and include byte, short, int, long, float, double, boolean, and char.
These data types store the values assigned to them in the corresponding memory locations.
So, when you pass them to a method, you basically operate on the variable's **value**, rather than on the variable itself.
Example:

```
public class MyClass {
  public static void main(String[ ] args) {
    int x = 5;
    addOneTo(x);
    System.out.println(x);
  }
  static void addOneTo(int num) {
    num = num + 1;
  }
}
// Outputs "5"
```

Try It Yourself

The method from the example above takes the **value** of its parameter, which is why the original variable is not affected and 5 remains as its value.

Reference Types

A **reference type** stores a reference (or address) to the memory location where the corresponding data is stored.
When you create an object using the constructor, you create a reference variable.
For example, consider having a **Person** class defined:

```
public class MyClass {
  public static void main(String[ ] args) {
    Person j;
    j = new Person("John");
    j.setAge(20);
    celebrateBirthday(j);
    System.out.println(j.getAge());
  }
  static void celebrateBirthday(Person p) {
    p.setAge(p.getAge() + 1);
  }
}
//Outputs "21"
```

Try It Yourself

The method **celebrateBirthday** takes a Person object as its parameter, and increments its attribute.
Because **j** is a reference type, the method affects the object itself, and is able to change the actual value of its attribute.

Arrays and **Strings** are also reference data types.

The Math Class

The **JDK** defines a number of useful classes, one of them being the **Math** class, which provides predefined methods for mathematical operations.
You do not need to create an object of the **Math** class to use it. To access it, just type in **Math.** and the corresponding method.

Math.abs() returns the absolute value of its parameter.

```
int a = Math.abs(10);  // 10
int b = Math.abs(-20); // 20
```

Try It Yourself

Math.ceil() rounds a floating point value up to the nearest integer value. The rounded value is returned as a **double**.

```
double c = Math.ceil(7.342);  // 8.0
```

Try It Yourself

Similarly, **Math.floor()** rounds a floating point value down to the nearest integer value.

```
double f = Math.floor(7.343);  // 7.0
```

Try It Yourself

Math.max() returns the largest of its parameters.

```
int m = Math.max(10, 20);  // 20
```

Try It Yourself

Conversely, **Math.min()** returns the smallest parameter.

```
int m = Math.min(10, 20);  // 10
```

Try It Yourself

Math.pow() takes two parameters and returns the first parameter raised to the power of the second parameter.

```
double p = Math.pow(2, 3); // 8.0
```

Try It Yourself

There are a number of other methods available in the Math class, including:
sqrt() for square root, **sin() for** sine, **cos() for** cosine, and others.

Static

When you declare a variable or a method as **static**, it belongs to the class, rather than to a specific instance. This means that only one instance of a **static** member exists, even if you create multiple objects of the class, or if you don't create any. It will be shared by all objects.
Example:

```
public class Counter {
  public static int COUNT=0;
  Counter() {
    COUNT++;
  }
}
```

The **COUNT** variable will be shared by all objects of that class.
Now, we can create objects of our Counter class in **main**, and access the static variable.

```
public class MyClass {
  public static void main(String[ ] args) {
    Counter c1 = new Counter();
    Counter c2 = new Counter();
    System.out.println(Counter.COUNT);
  }
}
//Outputs "2"
```

Try It Yourself

The output is 2, because the **COUNT** variable is static and gets incremented by one each time a new object of the Counter class is created. In the code above, we created 2 objects.
You can also access the static variable using any object of that class, such as **c1.COUNT**.

> It's a common practice to use upper case when naming a static variable, although not mandatory.

Static

The same concept applies to static methods.

```
public class Vehicle {
  public static void horn() {
    System.out.println("Beep");
  }
}
```

Now, the **horn** method can be called without creating an object:

```
public class MyClass {
  public static void main(String[ ] args) {
    Vehicle.horn();
  }
}
```

Try It Yourself

Another example of static methods are those of the **Math** class, which is why you can call them without creating a **Math** object.

> Also, the **main** method must always be **static**.

---

final

Use the **final** keyword to mark a variable constant, so that it can be assigned only once.
Example:

```
class MyClass {
  public static final double PI = 3.14;
  public static void main(String[ ] args) {
    System.out.println(PI);
  }
}
```

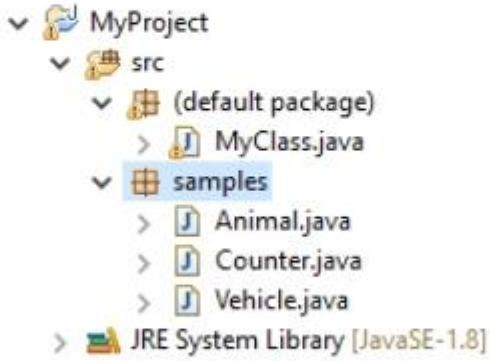
Try It Yourself

PI is now a constant. Any attempt to assign it a value will cause an error.

> Methods and classes can also be marked **final**. This serves to restrict methods so that they can't be overridden and classes so that they can't be subclassed.
> These concepts will be covered in the next module.

Packages

Packages are used to avoid name conflicts and to control access to classes.
A package can be defined as a group made up of similar types of classes, along with sub-packages.
Creating a package in Java is quite easy. Simply right click on your **src** directory and click New->Package. Give your package a name and click **Finish**.
You will notice that the new package appears in the project directory. Now you can move and create classes inside that package. We have moved our **Vehicle**, **Counter** and **Animal** classes to the package **samples**.



When you move/create a class in your package, the following code will appear at the top of the list of files.

```
package samples;
```

This indicates the package to which the class belongs.
Now, we need to import the classes that are inside a package in our main to be able to use them. The following example shows how to use the **Vehicle** class of the **samples** package.

```
import samples.Vehicle;

class MyClass {
  public static void main(String[ ] args) {
    Vehicle v1 = new Vehicle();
    v1.horn();
  }
}
```

Two major results occur when a class is placed in a package. First, the name of the package becomes a part of the name of the class. Second, the name of the package must match the directory structure where the corresponding class file resides.

> Use a wildcard to import all classes in a package.
> For example, **import samples.*** will import all classes in the samples package.

End.