

4. Java – Objects & Classes

Java is an Object-Oriented Language. As a language that has the Object-Oriented feature, Java supports the following fundamental concepts:

- Polymorphism
- Inheritance
- Encapsulation
- Abstraction
- Classes
- Objects
- Instance
- Method
- Message Parsing

In this chapter, we will look into the concepts - Classes and Objects.

- **Object** - Objects have states and behaviors. Example: A dog has states - color, name, breed as well as behaviors - wagging the tail, barking, eating. An object is an instance of a class.
- **Class** - A class can be defined as a template/blueprint that describes the behavior/state that the object of its type support.

Objects in Java

Let us now look deep into what are objects. If we consider the real-world, we can find many objects around us, cars, dogs, humans, etc. All these objects have a state and a behavior.

If we consider a dog, then its state is - name, breed, color, and the behavior is - barking, wagging the tail, running.

If you compare the software object with a real-world object, they have very similar characteristics.

Software objects also have a state and a behavior. A software object's state is stored in fields and behavior is shown via methods.

So in software development, methods operate on the internal state of an object and the object-to-object communication is done via methods.

Classes in Java

A class is a blueprint from which individual objects are created.

Following is a sample of a class.

```
public class Dog{
    String breed;
    int ageC
    String color;

    void barking(){
    }

    void hungry(){
    }

    void sleeping(){
    }
}
```

A class can contain any of the following variable types.

- **Local variables:** Variables defined inside methods, constructors or blocks are called local variables. The variable will be declared and initialized within the method and the variable will be destroyed when the method has completed.
- **Instance variables:** Instance variables are variables within a class but outside any method. These variables are initialized when the class is instantiated. Instance variables can be accessed from inside any method, constructor or blocks of that particular class.
- **Class variables:** Class variables are variables declared within a class, outside any method, with the static keyword.

A class can have any number of methods to access the value of various kinds of methods. In the above example, barking(), hungry() and sleeping() are methods.

Following are some of the important topics that need to be discussed when looking into classes of the Java Language.

Constructors

When discussing about classes, one of the most important sub topic would be constructors. Every class has a constructor. If we do not explicitly write a constructor for a class, the Java compiler builds a default constructor for that class.

Each time a new object is created, at least one constructor will be invoked. The main rule of constructors is that they should have the same name as the class. A class can have more than one constructor.

Following is an example of a constructor:

```
public class Puppy{
    public Puppy(){
    }

    public Puppy(String name){
        // This constructor has one parameter, name.
    }
}
```

Java also supports Singleton Classes where you would be able to create only one instance of a class.

Note: We have two different types of constructors. We are going to discuss constructors in detail in the subsequent chapters.

How to Use Singleton Class?

The Singleton's purpose is to control object creation, limiting the number of objects to only one. Since there is only one Singleton instance, any instance fields of a Singleton will occur only once per class, just like static fields. Singletons often control access to resources, such as database connections or sockets.

For example, if you have a license for only one connection for your database or your JDBC driver has trouble with multithreading, the Singleton makes sure that only one connection is made or that only one thread can access the connection at a time.

Implementing Singletons

Example 1

The easiest implementation consists of a private constructor and a field to hold its result, and a static accessor method with a name like getInstance().

The private field can be assigned from within a static initializer block or, more simply, using an initializer. The getInstance() method (which must be public) then simply returns this instance –

```
// File Name: Singleton.java
public class Singleton {

    private static Singleton singleton = new Singleton( );

    /* A private Constructor prevents any other
     * class from instantiating.
     */
    private Singleton(){ }

    /* Static 'instance' method */
    public static Singleton getInstance( ) {
        return singleton;
    }
    /* Other methods protected by singleton-ness */
    protected static void demoMethod( ) {
        System.out.println("demoMethod for singleton");
    }
}
```

Here is the main program file, where we will create a singleton object:

```
// File Name: SingletonDemo.java
public class SingletonDemo {
    public static void main(String[] args) {
        Singleton tmp = Singleton.getInstance( );
        tmp.demoMethod( );
    }
}
```

This will produce the following result –

```
demoMethod for singleton
```

Example 2

Following implementation shows a classic Singleton design pattern:

```
public class ClassicSingleton {  
  
    private static ClassicSingleton instance = null;  
    private ClassicSingleton() {  
        // Exists only to defeat instantiation.  
    }  
    public static ClassicSingleton getInstance() {  
        if(instance == null) {  
            instance = new ClassicSingleton();  
        }  
        return instance;  
    }  
}
```

The ClassicSingleton class maintains a static reference to the lone singleton instance and returns that reference from the static getInstance() method.

Here, ClassicSingleton class employs a technique known as lazy instantiation to create the singleton; as a result, the singleton instance is not created until the getInstance() method is called for the first time. This technique ensures that singleton instances are created only when needed.

Creating an Object

As mentioned previously, a class provides the blueprints for objects. So basically, an object is created from a class. In Java, the new keyword is used to create new objects.

There are three steps when creating an object from a class:

- **Declaration:** A variable declaration with a variable name with an object type.
- **Instantiation:** The 'new' keyword is used to create the object.
- **Initialization:** The 'new' keyword is followed by a call to a constructor. This call initializes the new object.

Following is an example of creating an object:

```
public class Puppy{

    public Puppy(String name){
        // This constructor has one parameter, name.
        System.out.println("Passed Name is :" + name );
    }

    public static void main(String []args){
        // Following statement would create an object myPuppy
        Puppy myPuppy = new Puppy( "tommy" );
    }
}
```

If we compile and run the above program, then it will produce the following result:

```
Passed Name is :tommy
```

Accessing Instance Variables and Methods

Instance variables and methods are accessed via created objects. To access an instance variable, following is the fully qualified path:

```
/* First create an object */
ObjectReference = new Constructor();

/* Now call a variable as follows */
ObjectReference.variableName;

/* Now you can call a class method as follows */
ObjectReference.MethodName();
```

Example

This example explains how to access instance variables and methods of a class.

```
public class Puppy{

    int puppyAge;

    public Puppy(String name){
        // This constructor has one parameter, name.
        System.out.println("Name chosen is :" + name );
    }

    public void setAge( int age ){
        puppyAge = age;
    }

    public int getAge( ){
        System.out.println("Puppy's age is :" + puppyAge );
        return puppyAge;
    }

    public static void main(String []args){
        /* Object creation */
        Puppy myPuppy = new Puppy( "tommy" );

        /* Call class method to set puppy's age */
        myPuppy.setAge( 2 );

        /* Call another class method to get puppy's age */
        myPuppy.getAge( );

        /* You can access instance variable as follows as well */
        System.out.println("Variable Value :" + myPuppy.puppyAge );
    }
}
```

If we compile and run the above program, then it will produce the following result:

```
Name chosen is :tommy
Puppy's age is :2
Variable Value :2
```

Source File Declaration Rules

As the last part of this section, let's now look into the source file declaration rules. These rules are essential when declaring classes, *import* statements and *package* statements in a source file.

- There can be only one public class per source file.
- A source file can have multiple non-public classes.
- The public class name should be the name of the source file as well which should be appended by **.java** at the end. For example: the class name is *public class Employee{}* then the source file should be as `Employee.java`.
- If the class is defined inside a package, then the package statement should be the first statement in the source file.
- If import statements are present, then they must be written between the package statement and the class declaration. If there are no package statements, then the import statement should be the first line in the source file.
- Import and package statements will imply to all the classes present in the source file. It is not possible to declare different import and/or package statements to different classes in the source file.

Classes have several access levels and there are different types of classes; abstract classes, final classes, etc. We will be explaining about all these in the access modifiers chapter.

Apart from the above mentioned types of classes, Java also has some special classes called Inner classes and Anonymous classes.

Java Package

In simple words, it is a way of categorizing the classes and interfaces. When developing applications in Java, hundreds of classes and interfaces will be written, therefore categorizing these classes is a must as well as makes life much easier.

Import Statements

In Java if a fully qualified name, which includes the package and the class name is given, then the compiler can easily locate the source code or classes. Import statement is a way of giving the proper location for the compiler to find that particular class.

For example, the following line would ask the compiler to load all the classes available in directory `java_installation/java/io`:

```
import java.io.*;
```

A Simple Case Study

For our case study, we will be creating two classes. They are `Employee` and `EmployeeTest`.

First open notepad and add the following code. Remember this is the `Employee` class and the class is a public class. Now, save this source file with the name `Employee.java`.

The `Employee` class has four instance variables - name, age, designation and salary. The class has one explicitly defined constructor, which takes a parameter.

```
import java.io.*;

public class Employee{

    String name;
    int age;
    String designation;
    double salary;

    // This is the constructor of the class Employee
    public Employee(String name){
        this.name = name;
    }
    // Assign the age of the Employee to the variable age.
    public void empAge(int empAge){
        age = empAge;
    }
    /* Assign the designation to the variable designation.*/
    public void empDesignation(String empDesig){
        designation = empDesig;
    }
    /* Assign the salary to the variable salary.*/
```

```

public void empSalary(double empSalary){
    salary = empSalary;
}
/* Print the Employee details */
public void printEmployee(){
    System.out.println("Name:" + name );
    System.out.println("Age:" + age );
    System.out.println("Designation:" + designation );
    System.out.println("Salary:" + salary);
}
}

```

As mentioned previously in this tutorial, processing starts from the main method. Therefore, in order for us to run this Employee class there should be a main method and objects should be created. We will be creating a separate class for these tasks.

Following is the *EmployeeTest* class, which creates two instances of the class Employee and invokes the methods for each object to assign values for each variable.

Save the following code in EmployeeTest.java file.

```

import java.io.*;

public class EmployeeTest{
    public static void main(String args[]){
        /* Create two objects using constructor */
        Employee empOne = new Employee("James Smith");
        Employee empTwo = new Employee("Mary Anne");

        // Invoking methods for each object created
        empOne.empAge(26);
        empOne.empDesignation("Senior Software Engineer");
        empOne.empSalary(1000);
        empOne.printEmployee();
        empTwo.empAge(21);
        empTwo.empDesignation("Software Engineer");
        empTwo.empSalary(500);
        empTwo.printEmployee();
    }
}

```

Now, compile both the classes and then run *EmployeeTest* to see the result as follows:

```
C:\> javac Employee.java
C:\> javac EmployeeTest.java
C:\> java EmployeeTest
Name:James Smith
Age:26
Designation:Senior Software Engineer
Salary:1000.0
Name:Mary Anne
Age:21
Designation:Software Engineer
Salary:500.0
```

What is Next?

In the next session, we will discuss the basic data types in Java and how they can be used when developing Java applications.

5. Java – Basic Datatypes

Variables are nothing but reserved memory locations to store values. This means that when you create a variable you reserve some space in the memory.

Based on the data type of a variable, the operating system allocates memory and decides what can be stored in the reserved memory. Therefore, by assigning different datatypes to variables, you can store integers, decimals, or characters in these variables.

There are two data types available in Java:

- Primitive Datatypes
- Reference/Object Datatypes

Primitive Datatypes

There are eight primitive datatypes supported by Java. Primitive datatypes are predefined by the language and named by a keyword. Let us now look into the eight primitive data types in detail.

byte:

- Byte data type is an 8-bit signed two's complement integer
- Minimum value is -128 (-2^7)
- Maximum value is 127 (inclusive) ($2^7 - 1$)
- Default value is 0
- Byte datatype is used to save space in large arrays, mainly in place of integers, since a byte is four times smaller than an integer
- Example: byte a = 100 , byte b = -50

short:

- Short datatype is a 16-bit signed two's complement integer
- Minimum value is -32,768 (-2^{15})
- Maximum value is 32,767 (inclusive) ($2^{15} - 1$)
- Short datatype can also be used to save memory as byte data type. A short is 2 times smaller than an integer
- Default value is 0