Java Fundamentals for Android Development

Version B

By: Android ATC Team

- Java Fundamentals topics.
- Lessons target beginners and allows a smooth start with Android programming.
- Practical lessons and instructions accompanied by relevant snapshots.
Java Fundamentals for Android™ Development

version B

Copyrights © 2013 Android ATC
Published by : Android ATC
First Printing October 2013.
ISBN : 978-0-9900143-1-7

Information in this book, including URL and other Internet Web site references, is subject to change without notice. Complying with all applicable copyright laws is the responsibility of the user. Without limiting the rights under copyright, no part of this document may be reproduced, stored in or introduced into a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise), or for any purpose, without the express written permission of Android ATC company.

Android ATC company is not responsible for webcasting or any other form of transmission received from any linked site.

Android ATC company is providing these links to you only as a convenience, and the inclusion of any link does not imply endorsement of Android ATC of the site or the products contained therein.

Android ATC company may have patents, patent applications, trademarks, copyrights, or other intellectual property rights covering subject matter in this document. Except as expressly provided in any written license agreement from Android ATC company, the furnishing of this document does not give you any license to these patents, trademarks, copyrights, or other intellectual property.

Warning and Disclaimer:
This book is designed to provide information about Java fundamentals for Android development course. Every effort has been made to make this book as complete and as accurate as possible, but no warranty or fitness is implied.

Trade Mark Acknowledge :
All terms mentioned in this book are known to be trademarks or service marks have been appropriately capitalized. Use of a term in this book should not be regarded as affecting the validity of any trade mark or service mark.
Feedback Information:

As Android ATC, our goal is to create in-depth technical books of the highest quality and value. Each book is crafted with care and precision, undergoing rigorous development that involves the unique expertise of members from professional technical community.

Readers’ feedback is natural continuation of this process. If you have any comments regarding how we could improve the quality of this book, or otherwise alter it to better suite you needs, you can contact us through email at: info@androidatc.com. Please make sure to include the book title and ISBN in your message.

We greatly appreciate your assistance.

Android ATC Team.
Table of Contents

Introduction ........................................................................................................................................... 1
Intended Audience ................................................................................................................................. 1
Lesson 1: Java Basics .............................................................................................................................. 3
    Introduction ....................................................................................................................................... 3
    Java Programming Language .......................................................................................................... 3
    Java Virtual Machine ......................................................................................................................... 3
    JDK and JRE ..................................................................................................................................... 3
    Setting up your machine for Java programming .................................................................................. 4
    Hello World in Java .......................................................................................................................... 5
        Using a text Editor ......................................................................................................................... 5
        Using an IDE .................................................................................................................................. 6
    Java Primitive Data Type .................................................................................................................. 7
    Naming .............................................................................................................................................. 7
    Arrays ................................................................................................................................................. 7
    Control Flow ...................................................................................................................................... 8
        If/Else and Switch .......................................................................................................................... 8
        Switch statement ........................................................................................................................... 9
        While loop ...................................................................................................................................... 9
        For Loop ....................................................................................................................................... 10
        Lab 1 ............................................................................................................................................. 11
Lesson 2: Object Oriented Programming ................................................................................................. 18
    Introduction ....................................................................................................................................... 18
    Object Oriented Programming .......................................................................................................... 18
        Objects ......................................................................................................................................... 18
        Classes ......................................................................................................................................... 18
        Getters and setters ......................................................................................................................... 19
Inheritance .............................................................................................................. 20
Keywords this and super ....................................................................................... 21
Interface .................................................................................................................. 21
Access Modifiers ..................................................................................................... 22
Constructors ............................................................................................................ 22
Method overriding and overloading ....................................................................... 23
Polymorphism .......................................................................................................... 23
Lab 2 ......................................................................................................................... 26

Lesson 3: More Java Programming ....................................................................... 30
Introduction ............................................................................................................. 30
Exceptions ............................................................................................................... 30
Java Collections ...................................................................................................... 32
  Interfaces ............................................................................................................... 33
  Implementations ................................................................................................. 33
  Lab 3 ..................................................................................................................... 37
Introduction ............................................................................................................. 42
  Nested Classes .................................................................................................... 42
  Benefits of inner classes .................................................................................... 42
Class Variables (static) .......................................................................................... 43
Class Methods ........................................................................................................ 44
Enumerated types ..................................................................................................... 44
Serialization ............................................................................................................ 45
Deserializing ........................................................................................................... 46
Lab 4 ......................................................................................................................... 48
**Introduction**

Since the Android software development kit (Android SDK) is built in Java programming language, this book serves as a mini-course made up of three lessons on the fundamentals of Java programming.

The course will teach you the basics of Java programming language and object oriented programming (OOP) concepts required for the development of Android applications.

If you are already an experienced Java programmer who wants to learn development of Android applications, you can skip reading this book and move directly to reading the book titled “Android Application Development” – a companion to the Android application development course. For everyone else, reading the book and practicing its exercises is a must. It will simply prepare you for Android development.

**Intended Audience**

This book is for anyone interested in learning the basics of Java programming language, but ultimately looking for learning Android application development. All professionals seeking a certification in any Android-related course provided by Android ATC, should thoroughly understand the contents of this Java crash course.

Although there is no specific Android ATC exam tied to this course, taking any other Android programming course (like AND-401) requires sufficient knowledge the contents of this course.
Lesson 1: Java Basics

Introduction

Java programming language

Java Virtual Machine

JDK and JRE

Setting up your machine for Java programming

Hello World in Java

Using a text Editor

Using an IDE

Java Primitive Data Type

Naming

Arrays

Control Flow

If/Else and Switch

Switch statement

While loop

For Loop

Lab 1
Lesson 1: Java Basics

Introduction

This lesson introduces the Java programming language. It starts with the basic syntax of the language, and ends with a guide on setting up your machine for Java and Android programming.

Java Programming Language

Java programming language was originally developed at Sun Microsystems and released in 1995. Java applications are typically compiled to byte code (class file) that can run on any Java virtual machine (JVM) regardless of the operating system running on it. Java is a general-purpose, object-oriented language. It was designed to let developers "write once, run anywhere" (WORA), meaning that code that runs on one platform does not need to be recompiled to run on another. Java is, one of the most popular programming languages in use.

Java Virtual Machine

The Java virtual machine (JVM) is the component of Java framework that executes the compiled Java code. When a developer compiles a Java file successfully, the Java compiler produces a bytecode file and has a .class extension. A Java byte code is an intermediate language produced by a Java compiler and only executed on a JVM.

JDK and JRE

To be able to start programming in Java, a developer needs to main components: Java development kit and Java Runtime environment. The development kit (JDK) provides a Java...
compiler in addition to other tools. These tools allow a programmer to write Java code and convert it to a bytecode file to be executed by a JVM. The program that compiles Java code is *javac*. The Java Runtime environment is the execution environment for Java programs. These programs are compiled into a portable binary format (.class files) by the compiler – a program called *java*.

If you install on your machine the JRE, then your system can run Java programs. To start writing Java programs you need to setup JDK as well.

**Setting up your machine for Java programming**

To Start Java Programming, you should install the Java development kit on your machine. You can do so by downloading it from Java SE downloads webpage on Oracle.com – the owner of Java. Make sure to download the correct version compatible to your machine (32bit or 64bit installer). After downloading the installer and setting up your machine, you’ll get the following message:

To verify you have successfully installed JDK on your machine, do the following:

1. Open a command prompt by clicking **start → run**, then typing `cmd`
2. In the windows that opens, type `java --version`.
3. You should information similar to the following:
Hello World in Java

We will see in this section how to write a hello-world program in Java using a plain text editor (like Notepad) or an integrated development environment (like Eclipse).

Using a text Editor

1. Open a simple text editor (like Notepad), and type the following Java code:

   ```java
   public class AndroidATCLesson1 {
       public static void main(String[] args) {
           System.out.println("Hello World from Android ATC!");
       }
   }
   ```

2. Save the file as Lesson1.java under the path c:\.
   Notice that the file name is the same as the class name in the code.

3. Open a command prompt and compile the code by typing `javac AndroidATCLesson1.java`

4. If you don’t see any error displayed by the compiler, it means the compile is successful and you can run the program. To run it type `java AndroidATCLesson1`

5. The line “Hello World from Android ATC!” should be printed.
Once you compile a Java file successfully, another file of extension .class is created. This is the byte code file that is executed by JVM.

Using an IDE

An integrated development environment (IDE) is an application that provides a set of tools to help a developer accomplish many tasks more efficiently. The following steps describe how to create, compile and run the simple Hello-World Java program using the Eclipse IDE.

1. Create and Eclipse project which will contain Java file. Click on File ➔ New ➔ Java Project.
2. Enter project name then click Finish.
3. On the left pane, under Package Explorer, expand the project then right click on src.
4. Move cursor to New, then click on Class
5. In Name field, enter the class name: Lesson1.java then click finish
6. In the file editor, the file Lesson1.java will open. Type in the same code as the previous section.
7. Click on the Run button.
8. The “Hello World!” should display in the Console view.
Java Primitive Data Type

All variables in Java must be declared before they can be used. This is done by specifying the type of the variable and the variable's name:

\[\text{int someVar} = 1;\]

Java supports eight different primitive data types:

1. **byte**: The byte data type is an 8-bit signed integer.
2. **short**: The short data type is a 16-bit signed integer.
3. **int**: The int data type is a 32-bit signed integer. It has a maximum value of 2,147,483,647.
4. **long**: The long data type is a 64-bit signed integer.
5. **float**: The float data type is a single-precision 32-bit floating point.
6. **double**: The double data type is a double-precision 64-bit floating point.
7. **boolean**: The boolean data type has only two possible values: true and false.
8. **char**: The char data type is a single 16-bit Unicode character.

**Naming**

Java has the following rules and conventions for naming variables:

- Variable names are case-sensitive
- Beginning with a letter, the dollar sign "$", or the underscore character "_" is allowed
- Subsequent characters may be letters, digits, dollar signs, or underscore characters.
- By convention, you should name your variables using “camel case”, i.e. if the name consists of only one word, it is all lowercase letters. If it consists of more than one word, the first letter of each subsequent word is capitalized.
- Also by convention, constants are all capitalized and contain underscore.

**Arrays**

Arrays are containers that hold a fixed number of values of a certain type. The length of an array is fixed and is declared when the array is created.

To declare and array of ten integer elements:

\[\text{int[]} \text{myArray} = \text{new int}[10];\]
Each item in an array is called an element, and each element is accessed by its numerical index. Index numbering in arrays begins with 0. The 10th element, for example, is therefore accessed by index number 9. You can assign a value to an array element using the following syntax:

The following program, Lesson1Array, creates an array of integers, puts some values in it, and prints each value to standard output.

```java
class Lesson1Array {
    public static void main(String[] args) {
        // Allocate memory for 5 integers
        int[] anArray;
        anArray = new int[5];

        // Initialize elements
        anArray[0] = 10;
        anArray[1] = 20;
        anArray[2] = 30;
        anArray[3] = 40;
        anArray[4] = 50;

        System.out.println("Value at index 0: " + anArray[0]);
        System.out.println("Value at index 1: " + anArray[1]);
        System.out.println("Value at index 2: " + anArray[2]);
        System.out.println("Value at index 3: " + anArray[3]);
        System.out.println("Value at index 4: " + anArray[4]);
    }
}
```

**Control Flow**

Statements in Java code are executed sequentially - from top to bottom - in the order that they appear. However, a programmer can control the flow of execution using conditional statement, loops, and branches. This section describes the usage of decision-making statements (if/else and switch), loops (for, while), and the branching statements (break, continue, return).

**If/Else and Switch**

If/else statements tell your program to execute a certain section of code only if a particular condition is true.

```java
if (someExpression)
    statement1
else
    statement2
```
If `someExpression` evaluates to `true`, then `statement1` is executed. If `someExpression` evaluates to false, then `statement2` is executed.

**Switch statement**

Unlike if/else statements, the switch statement can have a number of possible execution paths. A switch works with the `byte, short, char, and int` primitive data types.

The following is an example of switch statement that prints outputs based on the age variable:

```java
int dayOfWeek = 1;
String dayString="";
switch (dayOfWeek) {
    case 1:  dayString = "Monday";
        break;
    case 2:  dayString = "Tuesday";
        break;
    case 3:  dayString = "Wednesday";
        break;
    case 4:  dayString = "Thursday";
        break;
    case 5:  dayString = "Friday";
        break;
    case 6:  dayString = "Saturday";
        break;
    case 7:  dayString = "Sunday";
        break;
}
System.out.println(dayString);
```

**While loop**

A while loop statement continually executes a block of code while a particular condition is `true`. Its syntax can be expressed as:

```java
while (expression) {
    statement(s)
}
```
Expression is a statement that must evaluate to a Boolean value (either true or false). If it evaluates to true then the following block will execute repeatedly until expression becomes false.

The following code snippet will print out the value of variable counter 10 times until it become equal to 11:

```java
int counter = 1;
while (counter < 11) {
    System.out.println("Count is: "+ counter);
    counter++;
}
```

**For Loop**

The `for` statement provides a compact way to iterate over a range of values. Programmers often refer to it as the "for loop" because of the way in which it repeatedly loops until a particular condition is satisfied. The general form of the `for` statement can be expressed as follows:

```java
for (initialization; termination-condition; increment) {
    statement(s)
}
```

The following code uses the general form of the `for` statement to print the numbers 1 through 10 to standard output:

```java
for (int i = 1; i <= 10; i++) {
    System.out.println("Value of i is: "+ i);
}
```
Lab 1

Objectives

- Create a new Java project under Eclipse
- Practice control statements in Java

Pre-requisites

You need to create a new Java project under Eclipse before solving these exercises. Follow the steps in the section below.
Creating a Java project

Create a Java project under Eclipse following these steps

1. Open Eclipse IDE.
2. On the File menu, point to New, and then choose Java Project.

3. In the New Java Project Dialog, enter AndroidATCLesson1 in Project name field.
4. Click on Finish, keeping all values as default.

Now you will have a new empty Java project created.

Exercise

Write the Java code that prints numbers from 1 to 10, each on a separate line.

In this exercise, you will create a new Java project under Eclipse and write required code then run the program.

- Create a Java project under Eclipse
  Follow the steps from 1 to 4 in section “Creating a Java project” above.

- Create a Java package
  a. In the Navigator view to the left of you Eclipse editor, right click on folder src
  b. In menu that shows up, point to New, and then choose Package.
c. In the “New Java Package” dialog, type in the field Name the following: `com.androidatc.lesson1`

![New Java Package Dialog](image)

- Click on Finish

- **Create a Java class to write your code in**

  a. In the Navigator view to the left of you Eclipse editor, right click on folder `src`
  b. From the menu that shows up, point to New, and then click on Class

![Navigator View](image)
c. In the “New Java Class” Dialog, type *Exercise1* in field Name, click the checkbox next to “public static void main(String[] args)”

![New Java Class Dialog]

---

d. Click on Finish
Write the Java code to solve the exercise

a. Eclipse automatically generates the following code and puts it in file Exercise1.java

```java
package com.androidatc.lesson1;

public class Exercise1 {
    public static void main(String[] args) {
        // TODO Auto-generated method stub
    }
}
```

b. Inside method main(), type the following lines of code:

```java
for (int i=1; i<=10; i++) {
    System.out.println(i);
}
```

c. Click on save button to save your file.

Run your Java program

a. Right-click on the project name under the Navigator pane.

b. In the Menu that shows up, point to “Run As”, then click on Java Application
c. Check the console view. You should see the numbers printed out
Lesson 2: Object Oriented Programming

Introduction

Java is an object-oriented programming (OOP) language. This lesson will cover the basic principles and features of OOP and provides some code examples.

Object Oriented Programming

Java is an object oriented programming (OOP) language. It shares with other OOP languages the same concepts and features. This lesson will introduce you to objects, classes, inheritance, and interfaces.

Objects

An object is a software bundle of related state and behavior. Software objects are often used to represent real-world objects we find in real life. Objects are essential to understanding object-oriented programming. Real world objects share two characteristics: state and behavior. For example, a car has a state (current model, maker, color) and behavior (driving, changing gear...etc.)

Building your code into a separate software object provides many benefits, including code re-use, information hiding, ease of debugging...etc.

Classes

A class is a prototype from which objects are created. This section defines a class that models the state and behavior of a real-world object. Classes provide a clean way to model the state and behavior of real world objects.

Two main properties of define a class: a set of member variables (also called fields), and a set of member methods (or functions).

Methods and functions means the same thing in the context of object oriented programming and they are used interchangeably in this course.

To represent an object’s state in classes, add member variables to a class. Behaviors of objects are represented using methods. The following is a simple Java class called Vehicle.
The state of the Vehicle object is represented with the variables speed and gear. The behavior of the object can be changed using the two methods `changeGear()` and `speedUp()`.

**Getters and setters**

A set of methods are usually created in a class to specifically read/write the values of member variables. These are called getters - used to get the values - and setters – used to change the values of member variables.

Getters and setters are crucial in Java classes as they are used to manage the state of an object. In the Vehicle class provided previously, we can add two methods (a getter and a setter) for each member variable. The following is the full code of the class after adding the getters and setters:

```java
class Vehicle {
    int speed = 0;
    int gear = 1;

    // Start of getters and setters
    public int getSpeed() {
        return speed;
    }

    public void setSpeed(int s) {
        speed = s;
    }

    public int getGear() {
        return gear;
    }

    public void setGear(int g) {
        gear = g;
    }
    // End of getters and setters

    void changeGear(int newGear) {
    }
    void speedUp(int increment) {
        speed = speed + increment;
    }
    void printStates() {
        System.out.println(" speed:" + speed + " gear:" + gear);
    }
}
```
    gear = newGear;
}

void speedUp(int increment) {
    speed = speed + increment;
}

void printStates() {
    System.out.println(" speed:" + speed + " gear:" + gear);
}

You can let Eclipse generate getters and setters for you. Right click inside a class code and choose Source then Generate Getters and Setters, as in the screen capter:

**Inheritance**

Inheritance provides a powerful and natural mechanism for organizing and structuring your software. It set a parent-child relationship between two different objects.

Object-oriented programming allows classes to inherit commonly used state and behavior from other classes. In following example, Vehicle becomes the parent (superclass) of Truck and Car. In the Java programming language, each class is allowed to have one direct superclass, and each superclass has the potential for an unlimited number of subclasses.

    public class Car extends Vehicle {
        int numOfSeats;
        //Set of statements defining
        //a car’s state and behavior
    }

    public class Truck extends Vehicle {
        public int loadWeight;
        //Set of statements defining
        //a truck’s state and behavior
    }

The Car and Truck now share the same state and behavior defined in class vehicle.
Keywords this and super

Two Java keywords you might encounter when writing you class code with inheritance: **this** and **super**. Keyword **this** is used as a reference to the current class itself, while **super** is a reference to the parent class that **this** class inherent from. In other words, **super** is used to access member variables and methods of the parent class.

Keyword **super** is especially useful when you want to override a superclass's method in a child class but you want to invoke the superclass’s method. For example, in class Car, you can override method **printStates()** and call Vehicle’s **printStates()**:

```
public class Car extends Vehicle {
    int numOfSeats;

    void printStates() {
        super.printStates();
        System.out.println(" Number of Seats:" + numOfSeat);
    }
}
```

Calling Car’s **printStates()** method will invoke first Vehicle’s **printStates()**, then the print out statement.

**Interface**

An interface is a contract between a class and the outside world. When a class implements an interface, it must provide the behavior specified by that interface. Let’s take the Vehicle example above, and create an interface for it.

```
public interface IVehicle {
    void changeGear(int newValue);
    void speedUp(int increment);
}
```

Then the Vehicle class implements the IVehicle interface using following syntax:

```
public class Vehicle implements IVehicle {
    int speed = 0;
    int gear = 1;

    public void changeGear(int newValue) {
        gear = newValue;
    }

    public void speedUp(int increment) {
        speed = speed + increment;
    }

    void printStates() {
        System.out.println(" speed:" + speed + " gear:" + gear);
    }
}
```
Note that class Car must provide and implementation for methods `changeGear()` and `speedUp()`.

**Access Modifiers**

Access modifiers determine whether other classes can use a particular field or invoke a particular method. There are four types of access control:

- At the class level—public, or default (no explicit modifier).
- At the member level—public, private, protected, or default (no explicit modifier).

A class may be declared with the modifier public, in which case that class is visible to all classes everywhere. If a class has no modifier (the default), it is visible only within its own package (packages are named groups of related classes.)

At the member level, in addition to the public modifier or no modifier (package-private), there are two additional access modifiers: private and protected. The private modifier specifies that the member can only be accessed in its own class. The protected modifier specifies that the member can only be accessed within its own package and, in addition, by any other subclass of its class.

<table>
<thead>
<tr>
<th>Access Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modifier</strong></td>
</tr>
<tr>
<td>public</td>
</tr>
<tr>
<td>protected</td>
</tr>
<tr>
<td>Default</td>
</tr>
<tr>
<td>private</td>
</tr>
</tbody>
</table>

**Constructors**

Constructors are invoked to create objects. They are similar to functions but differentiated by the following:

- Constructors have the same name as the class
- They do not have any return type.

Calling a constructor to create a new object would initialize an object’s members. Suppose Vehicle has the following constructor:
```java
public Vehicle(int s, int g){
    speed = s;
    gear = g;
}
```

Creating a new object of type Vehicle would require invoking the constructor with the `new` keyword:

```java
Vehicle vehicle = new Vehicle(4, 2);
```

This line will create an object of type Vehicle and has its two members speed and gear initialized to 4 and 2 consecutively.

**Method overriding and overloading**

Within the same class, you can create two methods of the same name but differs in the number of arguments and their types. This is called method overloading. Note that changing the return type alone is not allowed to overload a method. You should change the parameters signature if needed.

Method overriding occurs when a class inherits a method from a super class but provides its own implementation of that method. In the following code, class Car overrides method `speedUp()` defined in class Vehicle.

```java
public class Car extends Vehicle {
    int numOfSeats;
    public void speedUp(int increment) {
        speed = speed + increment + 2;
    }
}
```

Suppose you create an object of type car and called the `speedUp()`. Then, the Vehicle’s method is ignored and the one inside class Car is executed:

```java
Car car = new Car();
car.speedUp(2);
```

**Polymorphism**

In the context of object-oriented programming, polymorphism means that different subclasses of the same parent class can have different behaviors, yet share some of the functionalities of the parent class.
To demonstrate polymorphism, we will add method showInfo() to class Vehicle. This method prints all info in an object of type Vehicle:

```java
public void showInfo() {
    System.out.println("The vehicle has a speed of: " + this.speed + " and at gear " + this.gear);
}
```

However, if the Truck subclass uses this method, the member variable loadWeight will not be printed out, since it’s not a member of the parent class Vehicle. We resolve this, we can override method showInfo() as follows:

```java
public void showInfo() {
    super.showInfo();
    System.out.println("The truck has is carrying a load of: " + this.loadWeight);
}
```

Notice that Truck’s method showInfo(), will call the parent’s showInfo() and add to it its own behavior – which prints the value of loadWeight.

We can do the same thing with class Car.

```java
public void showInfo() {
    super.showInfo();
    System.out.println("The car has " + this.numOfSeats + " seats.");
}
```

Now, to test the polymorphic behavior, we will create 3 objects, each of different type of Vehicle:

```java
class Lesson1Array {
    public static void main(String[] args) {

        Vehicle vehicle1, vehicle2, vehicle3;

        vehicle1 = new Vehicle(50, 2);
        vehicle2 = new Car(50, 2, 4);
        vehicle3 = new Truck(40, 2, 500);

        System.out.println("Vehicle 1 info:");
        vehicle1.showInfo();

        System.out.println("\nVehicle 2 info:");
        vehicle2.showInfo();
```
System.out.println("\nVehicle 3 info:");
vehicle3.showInfo();
}

Once we run this class, we have three different output statements.

Vehicle 1 info:
The vehicle has a speed of: 50 and at gear 2

Vehicle 2 info:
The vehicle has a speed of: 50 and at gear 2
The car has 4 seats.

Vehicle 3 info:
The vehicle has a speed of: 40 and at gear 2
The truck has is carrying a load of: 500

In the above example, JVM has called each object’s method instead of calling Vehicle’s object for all three objects.
Lab 2

Objectives

- Implement parent-child relationship in Java
- Understand method overriding
- Understand method overloading

Pre-requisites

You need to create a new Java project under Eclipse before solving these exercises. Follow the steps detailed in Lesson 1 of this book.
Exercise

Create a Java project made up of two classes and one interface: Parent class that implements the interface, and Child class which extends Parent. Override a method in Parent, and overload another one in Child.

➢ Create a new Java project under Eclipse
  a. Follow the steps to create a new project as explained in section “Creating a Java project” of Lab 1.

➢ Create a Java package
  a. In the Navigator view to the left of you Eclipse editor, right click on folder src.
  b. In menu that shows up, point to New, and then choose Package.
  c. In the “New Java Package” dialog, type in the field Name the following: com.androidatc.lesson2
  d. Click on Finish
- **Create two Java classes to write your code in**
  
  a. In the Navigator view to the left of you Eclipse editor, right click on folder `src`.
  
  b. From the menu that shows up, point to New, and then click on Class

  ![Create Java Classes](image)

  c. In the “New Java Class” Dialog, type `Parent` in field Name
  
  d. Click Finish
  
  e. Repeat steps a to d, but in step c type `Child` in field Name

- **Create a Java interface**

  a. In the Navigator view to the left of you Eclipse editor, right click on folder `src`.
  
  b. From the menu that shows up, point to New, and then click on Interface

  ![Create Java Interface](image)
c. In the “New Java Interface” Dialog, type IParent in field Name
d. Click Finish

➢ Write the Java code to solve the exercise

a. Open file Parent.java
b. Type in the following code

```java
package com.androidatc.lesson1;
public class Parent implements IParent {

    public void firstMethod(int i) {
    }
    public void secondMethod(int i) {
    }
}
```

c. Open file Child.java
d. Type in the following code

```java
package com.androidatc.lesson1;
public class Child extends Parent {

    public void firstMethod(int i) {
    }
    public void thirdMethod(int i) {
    }
    public void thirdMethod(int i, int n) {
    }
}
```
e. Open file IParent.java
f. Type in the following code

```java
package com.androidatc.lesson1;
public interface IParent {
    void secondMethod(int i);
}
```

Method firstMethod() in class Child overrides method firstMethod() of class Parent.

Method thirdMethod() in class Child is overloaded.
Introduction

After covering the basic object oriented programming principles in the previous lesson, this lesson will cover additional topics you would probably face during Java coding.

Exceptions

Handling errors is an essential part of writing a robust code. Java uses exceptions to handle errors. This section explains exceptions and how to use them.

When an error occurs, the Java runtime environment handles an error object that is created by the method where the error occurs. This object is called exception, and contains basic information about the error (like the type of the error, the location, the stack of methods that lead to the error...etc.). The process of creating an exception object and handling it by the system is called throwing an exception.

The list of methods that lead to the error is called “the call stack”. When handling the error, the system searches through that stack to find an error handler in the code; i.e. exception handler. All exception objects are children of the parent class Exception. The different types or errors thrown are children of class Exception.

Exceptions in Java can be categorized into three types:

<table>
<thead>
<tr>
<th>Exception Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checked Exception</td>
<td>These are errors inside the application’s code and a programmer who intends to create a robust well-written code is expected to recover from these errors. For example, reading from a file on the disk, a programmer should expect is nonexistent. In this case, the programmer should expect a java.io.FileNotFoundException, thrown, and thereafter catch this exception and notify the user of a proper action.</td>
</tr>
<tr>
<td>Unchecked Exception</td>
<td>These come in two types themselves: Errors and Runtime exceptions. They are grouped in one category because both cannot be anticipated or recover from by a programmer. Errors are external to the applications. For example, suppose that an application successfully opens a file for input, but is</td>
</tr>
</tbody>
</table>
unable to read the file because of a hardware or system malfunction. The unsuccessful read will throw
java.io.IOException, and it makes sense for the program to
print a stack trace and exit. Errors are those exceptions of type
Error class and its sub-classes.

Runtime exceptions usually indicate programming bugs such
as logic errors. They are or type RuntimeException class and
its subclasses.

Handling errors (exceptions) in Java is done through the try-catch-finally blocks. While the
finally block is optional, the try and catch are obligatory to fulfill error handling.

Let’s look at the following code:

```java
1. public class AndroidATCLesson3 {
2.   public static void main(String[] args) {
3.       System.out.println("Hello World from Android ATC!");
4.       String nullString = null;
5.       System.out.println("Entered try statement");
6.       String partialString = nullString.substring(1);
7.       // Execution will break before reaching this line
8.       System.out.println("Partial string is: " + partialString);
9.   }
10. }
```

Running the code above will result in an error thrown of type NullPointerException, specifically
at line 6, where we are trying to read from a string object that is null (not initialized)

To properly handle this error, we should modify the above code to become:

```java
1. public class AndroidATCLesson3 {
2.   public static void main(String[] args) {
3.       System.out.println("Hello World from Android ATC!");
4.       String nullString = null;
5.       try {
6.           System.out.println("Entered try statement");
7.           String partialString = nullString.substring(1);
8.           // Execution will continue in the exception block
9.           System.out.println("Partial string is: "+partialString);
10.     }
```

Handling errors (exceptions) in Java is done through the try-catch-finally blocks. While the
finally block is optional, the try and catch are obligatory to fulfill error handling.

Let’s look at the following code:

```java
1. public class AndroidATCLesson3 {
2.   public static void main(String[] args) {
3.       System.out.println("Hello World from Android ATC!");
4.       String nullString = null;
5.       System.out.println("Entered try statement");
6.       String partialString = nullString.substring(1);
7.       // Execution will break before reaching this line
8.       System.out.println("Partial string is: " + partialString);
9.   }
10. }
```

Running the code above will result in an error thrown of type NullPointerException, specifically
at line 6, where we are trying to read from a string object that is null (not initialized)

To properly handle this error, we should modify the above code to become:

```java
1. public class AndroidATCLesson3 {
2.   public static void main(String[] args) {
3.       System.out.println("Hello World from Android ATC!");
4.       String nullString = null;
5.       try {
6.           System.out.println("Entered try statement");
7.           String partialString = nullString.substring(1);
8.           // Execution will continue in the exception block
9.           System.out.println("Partial string is: "+partialString);
```
Instead of breaking the code execution and halting the program, this code will handle the `NullPointerException` properly by printing the error details and continuing execution past the catch block.

The finally block can be used after the exception block. This block of code will always run whether there is an exception thrown or not.

```
try {
    System.out.println("Entered try statement");
    String partialString = nullString.substring(1);
    // Execution will break before reaching this line
    System.out.println("Partial string is: "+partialString);
} catch (Exception e) {
    System.out.println("Error occurred: "+e.getMessage());
    e.printStackTrace();
} finally {
    System.out.println("This line of code will always run!");
}
```

We use `finally` block in many cases where there is some resources that need be freed but an exception might prevent us from doing so. For example, when reading from a file, a well written program should close the file after finishing reading and/or writing into it. If an exception was thrown, the line of code that closes the file might be skipped. The `finally` block would be the best place to close the file in.

**Java Collections**

Java provides a set of classes and interfaces to help developers handle a collection of objects. These collection classes similar to an array, except their size can grow dynamically during run time. This section will provide an overview of some of the more popular Java collection classes.
Interfaces

Java collections are mainly located in package java.util. It provides two main Interfaces: Collection and Map. These two are the core of the Java Collection framework. Other interfaces inherit from these two. For example, the List and Set interfaces inherit from Collection interface. All of these interfaces are generic; i.e. the type of the object contained in the collection should be specified by the programmer. There is a main difference between subclasses of Collection interface and those of Map interface.

The collection contains a group of objects that can be manipulated and passed around. The elements can be duplicated or unique, depending on the type of sub-class. For example, a Set only contains unique objects.

The Map interface, however, maps keys to values and cannot contain duplicate keys and each key can only map one value at most.

Implementations

Implementations are the data objects used to store collections, which implement the previous section. This lesson describes the following implementations:

ArrayList

An ArrayList is a resizable-array implementation of the List interface. It implements all optional list operations, and permits all elements, including null. It also provides methods to manipulate the size of the array that is used internally to store the list.

```java
import java.util.*;

class TestArrayList {
    public static void main(String args[]) {
        // Creating an array list
        ArrayList<String> androids = new ArrayList<String>();
        // Adding elements
        androids.add("Cupcake");
        androids.add("Donut");
        androids.add("Eclair");
        androids.add("Froyo");
        androids.add("Gingerbread");
        androids.add("Honeycomb");
        androids.add("Ice Cream Sandwich");
        androids.add("Jelly Bean");

        System.out.println("Size of ArrayList: " + androids.size());
        // Display the contents of the array list
        System.out.println("The ArrayList has the following elements: " + androids);
        // Remove elements from the array list
```
System.out.println("Deleting second element...");
androids.remove(3);
System.out.println("Size after deletions: " + androids.size());
System.out.println("Contents after deletions: " + androids);
}

The following is the output of the program:

Size of ArrayList: 8
The ArrayList has the following elements: [Cupcake, Donut, Eclair, Froyo, Gingerbread, Honeycomb, Ice Cream Sandwich, Jelly Bean]
Deleting second element...
Size after deletions: 7
Contents after deletions: [Cupcake, Donut, Eclair, Gingerbread, Honeycomb, Ice Cream Sandwich, Jelly Bean]

**HashSet**

This class implements the `Set` interface and permits the null element. This collection does not allow duplicates. It creates a collection that uses a hash table for storage. A hash table stores information by using a mechanism called hashing where the value stored is used to determine a unique key, which is used as the index at which the data is stored. The advantage of hashing is that it allows fast execution times for basic operations, like add() and remove().

The following is an example of HashSet.

```java
class TestHashSet {
    public static void main(String args[]) {
        // Creating a HashSet
        HashSet<String> androids = new HashSet<String>();
        // Adding elements
        androids.add("Cupcake");
        androids.add("Cupcake");
        androids.add("Eclair");
        androids.add("Eclair");
        androids.add("Gingerbread");
        androids.add("Honeycomb");
        androids.add("Ice Cream Sandwich");
        androids.add("Jelly Bean");
```
System.out.println("The contents of the HashSet: "+androids);
}
}

The output of the program is:

The contents of the HashSet: [Eclair, Cupcake, Honeycomb, Ice Cream Sandwich, Jelly Bean, Gingerbread]

Notice that there is one “Cupcake” element and one “Éclair” element in the HashSet although each was added twice in the code.

HashMap

This is a hash table based implementation of the Map interface. It allows null elements and does not add any methods of its own.

The following program illustrates HashMap. It maps names to account balances.

```java
import java.util.*;

class TestHashMap {
    public static void main(String args[]) {
        // Creating a HashMap
        HashMap<String,Double> androids = new HashMap<String,Double>();
        // Adding elements
        androids.put("Cupcake", new Double(1.5) );
        androids.put("Donut", new Double(1.6));
        androids.put("Eclair", new Double(2.1));
        androids.put("Froyo", new Double(2.2));
        androids.put("Gingerbread", new Double(2.3));
        androids.put("Honeycomb", new Double(3.1));
        androids.put("Ice Cream Sandwich", new Double(4.0));
        androids.put("Jelly Bean", new Double(4.1));
        // Get a set of the entries
        Set<Map.Entry<String, Double>> set = androids.entrySet();
        // Get an iterator
        Iterator<Map.Entry<String, Double>> i = set.iterator();
        // Display elements
        while (i.hasNext()) {
            Map.Entry<String, Double> me = (Map.Entry<String,Double>)
                i.next();
        }
    }
}
```
System.out.print(me.getKey() + " ": ");
System.out.println(me.getValue());
}
System.out.println();
// Increase version number of Eclair
Double version = androids.get("Eclair");
androids.put("Eclair", new Double(version + 0.1));
System.out.println("New version number of Eclair: "
    + androids.get("Eclair");
}
}

The output of the program is:

Eclair: 2.1
Cupcake: 1.5
Honeycomb: 3.1
Froyo: 2.2
Donut: 1.6
Ice Cream Sandwich: 4.0
Jelly Bean: 4.1
Gingerbread: 2.3

New version number of Eclair: 2.2
Lab 3

Objectives

- Write code that uses ArrayList methods.
- Read strings from a file
- Learning the benefits of the Set collection.

Pre-requisites

You need to create a new Java project under Eclipse before solving these exercises. Follow the steps detailed in Lesson 1 of this book.
Exercise

Write a program that saves ten strings in an ArrayList. The strings have the following format: “Element – X”, where X is a number between 1 and 10. Demonstrate the usage of methods: add(), remove(), and indexOf().

➢ Create a new Java project under Eclipse
  a. Follow the steps to create a new project as explained in section “Creating a Java project” of Lab 1

➢ Create a Java package
  a. In the Navigator view to the left of you Eclipse editor, right click on folder src
  b. In menu that shows up, point to New, and then choose Package.
  c. In the “New Java Package” dialog, type in the field Name the following: com.androidatc.lesson3
  d. Click on Finish
Create a Java class to write your code in

a. In the Navigator view to the left of you Eclipse editor, right click on folder src.

b. From the menu that shows up, point to New, and then click on Class

c. In the “New Java Class” Dialog, type Exercise3 in field Name, click the checkbox next to “public static void main(String[] args)”

d. Click on Finish
➢ **Write the Java code to solve the exercise**
   
a. Open file Exercise3.java  
b. Type inside method main() the following code:

```java
ArrayList<String> arrayList = new ArrayList<String>();
for (int i = 1; i <= 10; i++) {
    arrayList.add("Element - " + i);
}
System.out.println("Index of Element 6: "+arrayList.indexOf("Element - 6"));
arrayList.remove(4);
System.out.println("Index of Element 6: "+ arraylist.indexOf("Element - 6"));
```

➢ **Run your Java program**
   
a. Right-click on the project name under the Navigator pane.  
b. In the Menu that shows up, point to “Run As”, then click on Java Application
➢ **Check the console view.**

You should see the desired output.

![Console View](image-url)
Lesson 4: Java Topics

Introduction

This lesson will delve into another set of OOP features and Java-specific topics.

Nested Classes

Using Java, you can define a class within another class. These are called nested classes:

class OuterClass {
    ...
    class NestedClass {
        ...
    }
}

Nested classes can be static and called static inner classes.

    class OuterClass {
        ...
        static class StaticInnerClass {
            ...
        }
        class InnerClass {
            ...
    }

A nested class is a member of its enclosing class. Non-static inner classes have access to other members of the outer class, even if they are declared private. However, static inner classes do not. Similar to member variables and methods, an inner class can be declared private, public, protected, or package private.

Benefits of inner classes

The following are some reasons that tempt a programmer to use inner classes:

- **Improve logical grouping of classes** that are only used in one place. If a class B is useful to only one other Class A, then it is logical to make class B an inner class of class A.
• **Increase encapsulation.** If class B needs to access private members of class A, a programmer can hide class B inside A and keep all members of A private, and at the same time hide class B from external classes.

• **Improve code readability and maintainability.** Creating inner classes within an outer class provides a clearer placement of code.

**Class Variables (static)**

When we create several objects of the same class, each object (instance) has its own distinct copy of member variables. Sometimes, we might want a variable that is common to all objects of the same class. To achieve this we use `static` modifier.

Member variables that have the `static` modifier in their declaration are called *static fields* or *class variables*. They are associated with the class, rather than with any object. Every instance of the class shares a class variable, which is saved in a fixed memory location. Any object can change the value of a class variable, but class variables can also be manipulated without creating an instance of the class.

For example, let’s modify the *Car* class of the previous lesson by adding a class variable. The member variable `numOfSeats` might have different values for different objects of type *Car*. However, we can add a class variable called `numberOfCars` which will be used to keep track of the number of *Car* objects created.

```java
public class Car extends Vehicle {
    public int numOfSeats;
    // A class variable for the number of Car objects created
    public static int numberOfCars;
    ...
}
```

Class variables are referenced by the class name itself to make it clear they are class variables, as in:

```java
Car.numberOfCars;
```

You can call static variables with an object variable:

```java
car1.numberOfCars;
```

... but this is not recommended since the class variable will look like a regular member variable.
Class Methods

Java also supports static methods as well as static variables. Static methods, which have
the static modifier in their signature, should be invoked with the class name, without the need
for creating an instance of the class, as in

```
ClassName.methodName(args)
```

You can also call static methods with an object reference:

```
   car1.getNumberofCars();
```

... but this is not recommended since the class variable will look like a regular
member variable.

A common use for static methods is to access static fields. For example, let's modify the Car class
by adding a static method that returns the numOfCars static variable:

```
public static int getNumberOfCars(){
    return numberOfCars;
}
```

Class methods **cannot** access instance variables or instance methods directly—they must use an
object reference. Also, class methods cannot use the this keyword as there is no instance
for this to refer to.

Enumerated types

An enumerated type (also called enumeration or enum) is a data type consisting of a set of named
constants called elements or enumerators of the type. The enumerator names behave as
constants in the language. A common example of enumeration is the days of the week. Because
they are constants, the names of an enum type's fields are in uppercase letters.

To define an enum type in Java, we use the enum keyword. For example, the following enum type
defines a set of employee title enumerations:

```
public enum Title {
    PROJECT_MANAGER, TECHNICAL_LEADER, MANAGING_DIRECTOR, CEO, CFO
}
```
Enum types should be used whenever a fixed set of constants need to be represented.

**Serialization**

Serialization is the process of converting an object into a format that can be stored and then converted back later to an object in the same or another computer environment.

Java provides automatic serialization which requires that the object implement the java.io.Serializable interface. Java then handles serialization internally.

The following is a Java class called Employee. It is serializable, and has three member variables: a name, an address and the enumerated type title.

```java
import java.io.Serializable;

public class Employee implements Serializable {
    private String name;
    private String address;
    private Title title;

    public String getName() {
        return name;
    }

    public void setName(String name) {
        this.name = name;
    }

    public String getAddress() {
        return address;
    }

    public void setAddress(String address) {
        this.address = address;
    }

    public Title getTitle() {
        return title;
    }

    public void setTitle(Title title) {
        this.title = title;
    }
}
```

Now that we have a serializable object, we can test the serialization process by writing the object to a file on the disk. The following program writes an Employee object to a file called employee.ser

```java
import java.io.FileOutputStream;
import java.io.IOException;
import java.io.ObjectOutputStream;
import java.util.ArrayList;
```
public class SerializeDemo {
    public static void main(String[] args) {
        Employee e = new Employee();
        e.setName("Joe");
        e.setAddress("Main Street, Joeville");
        e.setTitle(Title.PROJECT_MANAGER);

        try {
            FileOutputStream fileOut = new FileOutputStream("c:\employee.ser");
            ObjectOutputStream out = new ObjectOutputStream(fileOut);
            out.writeObject(e);
            System.out.println("Serialized...");
            out.close();
            fileOut.close();
        } catch (IOException i) {
            i.printStackTrace();
        }
    }
}

Once you run the program, you can find a file called employee.ser under the C: drive on a Windows machine.

Deserializing

We can now build an Employee object back from the file we have on disk, using a totally different program. All we need is to access the saved file employee.ser.

The following DeserializeDemo program deserializes the Employee object created in the previous section.

```java
import java.io.FileInputStream;
import java.io.IOException;
import java.io.ObjectInputStream;
import java.util.ArrayList;
public class DeserializeDemo {
    @SuppressWarnings("unchecked")
    public static void main(String[] args) {
        Employee employee = new Employee();
        try {
            FileInputStream fileIn = new FileInputStream("c:\employee.ser");
            ObjectInputStream in = new ObjectInputStream(fileIn);
            employee = (Employee) in.readObject();
            in.close();
            fileIn.close();
        } catch (IOException i) {
            i.printStackTrace();
            return;
        } catch (ClassNotFoundException c) {
            System.out.println("Employee class not found.");
            c.printStackTrace();
            return;
        } finally {
        }
        if (employee instanceof Employee) {
```
System.out.println("---------------------");
System.out.println("Deserialized Employee object...");
System.out.println("Name: " + employee.getName());
System.out.println("Address: " + employee.getAddress());
System.out.println("Address: " + employee.getTitle());
System.out.println("---------------------");
}
}

Once you run the DeserializeDemo program, you will get the following output:

---------------------
Deserialized Employee object...
Name: Joe
Address: Main Street, Joeville
Address: PROJECT_MANAGER
---------------------
Lab 4

Objectives

- Coding and using static variable and methods
- Creating Enum types

Pre-requisites

You need to create a new Java project under Eclipse before solving these exercises. Follow the steps detailed in Lesson 1 of this book.
Exercise

Create a Java class that represents a Football object. Each football is defined by three member variables: volume, weight and color (where color is only limited to three values: black, white, and blue). Also, add to the class one static variable and one static method that accesses the static variable.

- **Create a new Java project under Eclipse**
  a. Follow the steps to create a new project as explained in section “Creating a Java project” of Lab 1

- **Create a Java package**
  a. In the Navigator view to the left of you Eclipse editor, right click on folder `src`
  b. In menu that shows up, point to New, and then choose `Package`.
  c. In the “New Java Package” dialog, type in the field Name the following: `com.androidatc.lesson4`
  d. Click on Finish
Create the Football class

a. In the Navigator view to the left of you Eclipse editor, right click on folder `src`.

b. From the menu that shows up, point to New, and then click on Class.

c. In the “New Java Class” Dialog, type `Football` in field Name.

d. Click on Finish

Create Color Enum type

a. In the Navigator view to the left of you Eclipse editor, right click on folder `src`.

b. In menu that shows up, point to New, and then choose `Enum`.
c. In the "New Enum Type" dialog, type Color in the field Name.

![Image of the "New Enum Type" dialog](image)

d. Click on Finish

➢ Write the Java code to solve the exercise

a. Open file Football.java

b. Type in it the following code:

```java
package com.androidatc.lesson4;

public class Football {
    private float volume;
    private float weight;
    private Color color;

    public static int numOfBalls = 0;

    public Football() {
        volume = 10;
        weight = 5;
        color = Color.WHITE;
    }

    public static int getNumOfBalls() {
        return numOfBalls;
    }

    public static void setNumOfBalls(int numOfBalls) {
        Football.numOfBalls = numOfBalls;
    }

    public float getVolume() {
        return volume;
    }

    public void setVolume(float volume) {
        this.volume = volume;
    }

    public float getWeight() {
```

    return weight;
    }

    public void setWeight(float weight) {
        this.weight = weight;
    }

    public Color getColor() {
        return color;
    }

    public void setColor(Color color) {
        this.color = color;
    }
}

c. Open file Color.java
d. Type in the following code:

    package com.androidatc.lesson4;

    public enum Color {
        BLACK, WHITE, BLUE
    }