

Object-Oriented Programming in

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based on work from:

Ch. Gravier, F. Laforest, J. Subercaze

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While I'm talking :)

If you don't already have another JDK/IDE/Text Editor:

- Download OpenJDK 8+ (LTS) / HotSpot
<https://adoptopenjdk.net/installation.html>
- Download Eclipse IDE 2020-06
<https://www.eclipse.org/downloads/>
- Download a Text Editor with syntax coloring
 - Notepad++ or
 - Atom or
 - GEdit

Who already knows Java?

This course is an **introduction**

- Does **NOT** cover **all** Java
- Goal: give you enough to understand future TD's intros
- Goes up to Java 8
- A more complete course (in French)

<http://jmdoudoux.developpez.com/cours/developpons/java/>

- Thanks Christophe Gravier for the material!



Outline

- 1 Introduction
- 2 Functioning
 - General Compilation Chain¹
 - Keywords
 - Naming Conventions
 - Pointers/References
 - Packages
 - JAR files
 - Classpath
- 3 Your turn
 - Java – Manually
 - Java – with Eclipse
- 4 Resources
- 5 Summary

¹Images from "Java Head First" book.

Java: What & Why

- Created in May **1995**
- It's an **Object-Oriented** language
- Syntax is close to C/C++ [1], similar to C# [2]
- **2nd “most used”** language in August 2020



Java: What & Why

Aug 2020	Aug 2019	Change	Programming Language	Ratings	Change
1	2	⬆️	C	16.98%	+1.83%
2	1	⬆️	Java	14.43%	-1.60%
3	3		Python	9.69%	-0.33%
4	4		C++	6.84%	+0.78%
5	5		C#	4.68%	+0.83%
6	6		Visual Basic	4.66%	+0.97%
7	7		JavaScript	2.87%	+0.62%
8	20	⬆️	R	2.79%	+1.97%
9	8	⬆️	PHP	2.24%	+0.17%
10	10		SQL	1.46%	-0.17%
11	17	⬆️	Go	1.43%	+0.45%
12	18	⬆️	Swift	1.42%	+0.53%
13	19	⬆️	Perl	1.11%	+0.25%
14	15	⬆️	Assembly language	1.04%	-0.07%
15	11	⬆️	Ruby	1.03%	-0.28%
16	12	⬆️	MATLAB	0.86%	-0.41%
17	16	⬆️	Classic Visual Basic	0.82%	-0.20%
18	13	⬆️	Groovy	0.77%	-0.46%
19	9	⬆️	Objective-C	0.76%	-0.93%
20	28	⬆️	Rust	0.74%	+0.29%

Java:What & Why

- In 2011:
 - **97% of machines** have a JVM in enterprises
 - **9 millions+ Java developers** in the world
 - **3 billions+ mobile devices** run Java (Android...)
- In 2020:
 - 3rd in **Job Postings**
 - 3rd in **Average Salary**
- **Many Known Apps**: Minecraft, Wikipedia (search), NASA (Maestro Mars Rover), NSA (**Ghidra!**)



Java IS NOT JavaScript



Characteristics

- Both **Compiled** (to bytecode) & **Interpreted** (on the JVM)
- **Hardware independent** (\Rightarrow truly portable)



- **Strongly Typed**

float
double
boolean
void

- **Object Oriented**

- Java manages the memory

(**NO** explicit **pointers** \o/, Garbage Collector)



There are several **distributions** of Java

- Sun/Oracle vs. OpenJDK vs. Eclipse vs. GNU...
- **JRE**: Java Runtime Environment
 - **Execution** environment only (JVM)
 - ⇒ for **end users**!
- **JDK**: Java Development Kit
 - Tools & APIs to **develop** in Java
 - ⇒ for **devs**!
- **J2EE**: Java Enterprise Edition
 - JDK + tools & APIs for **web development**

Note: Installing a JDK also installs a JRE!

- **Since 2017:** 1 new version every 6 months
 - New Features vs. LTS system
 - Today (2020): latest = Java 14
 - Big changes in Java 8 (Collections, Stream, **Lambdas**)
 - Java is **backward compatible**
- Check installed version (Command Prompt)
`$ java -version`
openjdk version "11.0.8" 2020-07-14

The Java platform has some **specificities**:

- A **single** (public) class per java source file
- **Compiles** source code into bytecode (hardware independent)
- This **bytecode** is executed (**interpreted**) on the **JVM**²
- **No** header files, **no** linking
- **Packages** allow to organize code (**Classes**)
- **jar** (**J**ava **A**Rchive): format to distribute an “executable”
- **CLASSPATH** indicates where to find classes

²Java Virtual Machine

1 Introduction

2 Functioning

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3 Your turn

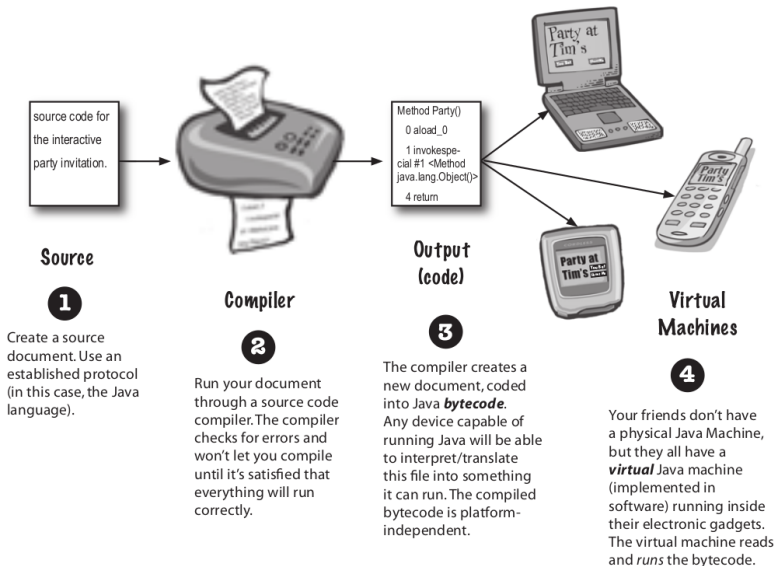
- Java – Manually
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4 Resources

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³Images from "Java Head First" book.

Compilation Chain – User's View



Compilation Chain – Developer's View

```
import java.awt.*;
import java.awt.event.*;

class Party {
    public void buildInvite(){
        Frame f = new Frame();
        Label l = new Label("Party at Tim's");
        Button b = new Button("You bet");
        Button c = new Button("Shoot me");
        Panel p = new Panel();
        p.add(l);
    } // more code here...
}
```

Source

1

Type your source code.

Save as: **Party.java**

```
File Edit Window Help Plead
% javac Party.java
```

Compiler

2

Compile the **Party.java** file by running `javac` (the compiler application). If you don't have errors, you'll get a second document named **Party.class**

The compiler-generated **Party.class** file is made up of *bytecodes*.

```
Method Party()
  0 aload_0
  1 invokespecial #1 <Method
    java.Lang.Object.>
  4 return

Method void buildInvite()
  0 new #2 <Class java.awt.Frame>
  3 dup
  4 invokespecial #3 <Method
    java.awt.Frame.>
```

Output (code)

3

Compiled code: **Party.class**



Virtual Machines

4

Run the program by starting the Java Virtual Machine (JVM) with the **Party.class** file. The JVM translates the bytecode into something the underlying platform understands, and runs your program.

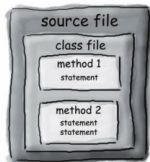
Source code & bytecode

- Source code in `MyClass.java` file⁴
- File name = (public) class name
- Compile with (**java** compiler):
`javac <file>.java`
- Results in `.class` file (bytecode)
- Execute with (JVM):
`java <file>`⁵

⁴One single (public) class per file

⁵NOTE: there is no extension here!

Source File (class \approx C struct + methods)



Put a class in a source file.

Put methods in a class.

Put statements in a method.

What goes in a source file?

A source code file (with the *.java* extension) holds one *class* definition. The class represents a *piece* of your program, although a very tiny application might need just a single class. The class must go within a pair of curly braces.

```
public class Dog {  
  
}
```

class

What goes in a class?

A class has one or more *methods*. In the Dog class, the *bark* method will hold instructions for how the Dog should bark. Your methods must be declared *inside* a class (in other words, within the curly braces of the class).

```
public class Dog {  
    void bark() {  
  
    }  
}
```

method

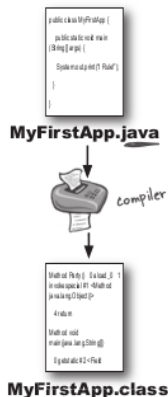
What goes in a method?

Within the curly braces of a method, write your instructions for how that method should be performed. Method *code* is basically a set of statements, and for now you can think of a method kind of like a function or procedure.

```
public class Dog {  
    void bark() {  
        statement1;  
        statement2;  
    }  
}
```

statements

Compilation Chain – First Run



```
public class MyFirstApp {

    public static void main (String[] args) {
        System.out.println("I Rule!");
        System.out.println("The World");
    }

}
```

1 Save

`MyFirstApp.java`

2 Compile

`javac MyFirstApp.java`

3 Run

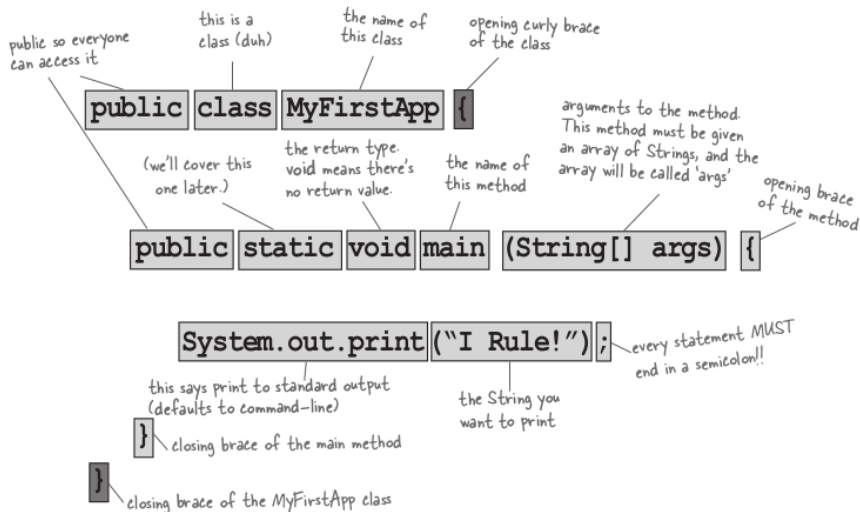
```
File Edit Window Help Screen

%java MyFirstApp

I Rule!

The World
```

My First Class



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⁶Images from "Java Head First" book.

Java Keywords

- **Comments:** `/* comment */`, `/** Java Doc */`, `// single line`
- **(Basic) Types:**
`void`, `boolean`, `char`, `byte`, `short`, `int`, `float`, `long`, `double`, `[]`
`String`, `List`, `Set`, `Map`...
- **Operators:**

<code>+</code> , <code>-</code> , <code>*</code> , <code>/</code> , <code>%</code>	<code>and</code>	<code>++</code> , <code>-</code> , <code>+=</code> , <code>-=</code> , <code>*=</code> , <code>/=</code>
<code>&</code> , <code> </code> , <code>~</code> (bit)	<code>vs.</code>	<code>&&</code> , <code> </code> , <code>!</code> (bool)
- **Control Structures:**
`for`, `while/do`, `break/continue`
`if/else`, `switch/case`
- **Methods:** `return`, `super`
- **Packages:** `package`, `import`
- **Objects:**
`interface/class`, `abstract`, `implements`, `extends`
`new`, `this`
`static`, `final`
- **Visibility:** `private`, `public`, `protected`
- **Exceptions:**
`throw/throws`, `try/catch/finally`

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⁷Images from "Java Head First" book.

Naming Conventions

- **Packages:** lowercase + dots

```
com.sun.eng
```

- **Classes / Interfaces:** (upper) CamelCase

```
class ImageSprite;
```

```
interface RasterDelegate;
```

- **Methods:** dromedaryCase == (lower) camelCase

```
run();
```

```
runFast();
```

- **Variables / Attributes:** dromedaryCase

```
int i;
```

```
char c;
```

```
float myWidth;
```

- **Constants:** ALL CAPS + snake_case

```
static final int MIN_WIDTH = 4;
```


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⁸Images from "Java Head First" book.

Pointers and parameters

Listing 1: MyCode.cpp

```
1  Pair origin;  
2  Pair *p, *q, *r;  
3  origin.x = 0;  
4  p = new Pair;  
5  p -> y = 5;  
6  q = p;  
7  r = & origin;
```

Listing 2: MyCode.java

```
1  Pair origin = new Pair();  
2  Pair p, q, r;  
3  origin.x = 0;  
4  p = new Pair();  
5  p.y = 5;  
6  q = p;  
7  // not possible
```

⚠ Objects in Collections **can be modified!!!**
(behind the hood, the Collection contains references)!!!

No delete?

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- **Pros? Cons?**



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- **Pros? Cons?**



Attila Szegedi

@asz

 Follow

My kids are like Java programs; they assume there's an external garbage collector taking care of stuff they leave around.

RETWEETS
577

FAVORITES
128



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⁹Images from "Java Head First" book.

Example

Listing 3: MyClass.java

```
1 public class MyClass {  
2     public static void main(String[] args) {  
3         System.out.println("Hello World!");  
4     }  
5 }
```

- To compile (creates bytecode into hello.class):
javac MyClass.java
- To execute (no extension! it the class name!):
java MyClass
- Result:
|| Hello World!

Listing 4: HelloWorld.java

```
1 package fr.tse.java;    // Declare Package (name == dir. where stored!!)
2 import java.util.List;  // Refers to another class in another Package
3
4 public class HelloWorld {
5     public static void main(String[] args) {
6         List myList = ...;
7     }
8 }
```

- Source code is organized in « packages »
- Strings separated by points (.)
- Similar to file path: **it is indeed!**
File: fr/tse/java/HelloWorld.java

- To compile:
javac fr/tse/java/MyClass.java
- To execute (FQN):
java fr.tse.java.MyClass

Packages included in Java platform

- `java.lang`: Basic classes *imported automatically*
`String`, `Character`, `Integer`...
- `java.io`: Input/Output
`File`...
- `java.util`: useful structures & methods
`Collections`, `List`, `Set`, `Random`...
- `java.math`: math operations `cos()`, `sin()`...
- ...
- Extensive list in the official doc:
<http://docs.oracle.com/javase/8/docs/api/>

Example of importing `java.util.ArrayList`

Listing 5: `MyArrayList.java`

```
1 package fr.tse.java;
2
3 import java.util.ArrayList;
4
5 public class MyArrayList {
6     public static void main(String[] args) {
7         System.out.println("Bonjour");
8         ArrayList<String> v = new ArrayList<String>();
9         // Remember: Java is strongly typed, hence <...>!
10    }
11 }
```

- Description of Java's `ArrayList` class:

<http://docs.oracle.com/javase/8/docs/api/java/util/ArrayList.html>

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¹⁰Images from "Java Head First" book.

Java ARchive (JAR files)

- Assemble all the .class files into an executable¹¹
`jar -cf MyClass.jar ./fr`

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Java ARchive (JAR files)

- Assemble all the .class files into an executable¹¹
`jar -cf MyClass.jar ./fr`
- Execute this jar file
`java -jar MyClass.jar`
- Requires the name of the main Class (entry point: `main()`):
 - Config file: `./META-INF/MANIFEST.MF`:
`Main-Class: fr.tse.java.MyClass`
 - Add this file to the jar:
`jar -cmvf MyClass.jar ./fr`

¹¹A Java ARchive (JAR) file, with extension `.jar`

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- Context:
 - My code is in a jar file
 - It `imports` library classes from other jar files
- Problem: How do I tell the JVM where to look for `imported` classes?

- Context:
 - My code is in a `jar` file
 - It `imports` library classes from other `jar` files
- Problem: How do I tell the JVM where to look for `imported` classes?
- Solution: The **CLASSPATH**, is a list of all the pathes where to find these librairies (both Java's and our own's)

- **CLASSPATH** = list of pathes to external code
- It is generally stored in an Environment Variable
- Each element can be:
 - A directory (with .class in its sub-directories)
 - A .jar
 - A .zip file (mostly used internally by JVM)
- Separator: “:” (Unices: Linux/MacOS) or “;” (Windows)

Example of a CLASSPATH:

```
./:/home/prog/lib/:/usr/lib/java/log4j-1.2.11.jar:../lib-ext/junit.jar
```

Classpath – Example

`./:/home/prog/lib:/usr/lib/java/log4j-1.2.11.jar:../lib-ext/junit.jar`
is composed of:

- All `.class` in current directory (`.` & subdirs)
- All `.class` in `/home/prog/lib/` (& subdirs)
- Classes from archive `log4j-1.2.11.jar` found in *absolute* path `/usr/lib/java/`
- Classes from archive `junit.jar` found in *relative* path `../lib-ext/`

How to provide the **classpath** compile/run-time?

- Option `-classpath` du compilateur
 - `javac -classpath ./:/home/prog/lib/ MyClass.java`
- Option `-cp` of the JVM
 - `java -cp ./:/home/prog/lib/ MyClass`
 - `java -cp ./:/home/prog/lib/ fr.tse.java.MyClass`

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Sump Up – Running Java Manually

Let's do a live coding demo with Text Editor+Command Line!!!

- Open a text editor
- Create a HelloWorld.java file + Type a HelloWorld class
- Compile with javac
- Run with java
- Create a fr/tse/java dir hierarchy
- Move the class in this directory
- Try to run the class \Rightarrow does not work
- Add the package directive \Rightarrow it works!!
- Create a jar file
- Try to execute it with java -jar \Rightarrow does not work
- Correct it to add ./META-INF/MANIFEST.MF file

Let's do a 2nd live coding demo, with Eclipse IDE!!!

- Start Eclipse
- Select workspace (& accept forever?)
- Create a **Java/Maven Project**
- Observe the Project hierarchy is automatically created
- Create a Package \Rightarrow the dirs are created automatically
- Create a Class \Rightarrow file/class names correspond!
- Use autocompletion to create `main`
- Use autocompletion to enter `System.out.println()`
- Generate a `.jar` file

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Resources

- **Official Docs**
<https://docs.oracle.com/javase/tutorial/>
<https://docs.oracle.com/javase/8/docs/api/>
- **Eclipse Key Bindings CheatSheet**
https://mootse.telecom-st-etienne.fr/pluginfile.php/9061/mod_resource/content/1/EclipseShortcutCheatSheet.pdf
- **A few useful CheatSheets**
<https://dzone.com/refcardz/getting-started-eclipse>
<https://dzone.com/refcardz/core-java>
<https://dzone.com/refcardz/getting-started-java-gui>
<https://dzone.com/refcardz/apache-maven-2>
<https://dzone.com/refcardz/getting-started-git>
<https://www.jrebel.com/system/files/git-cheat-sheet.pdf>
<https://www.jrebel.com/search/results?keys=cheat%20sheet>
- **Tutorials sites**
<https://www.baeldung.com/>
<https://www.tutorialspoint.com/java/index.htm>
- **News sites**
<https://dzone.com/>
<https://jrebel.com/resources/>
<https://www.infoq.com/>
- **Complete course**
<http://jmdoudoux.developpez.com/cours/developpons/java/>
- **Glossary**
<http://mindprod.com/jgloss/jcheat.html>
<https://dzone.com/articles/java-glossary-and-the-core-concepts>
- **Quizzes**
<https://www.w3schools.com/java/>
- **Books: [UK] NoStarch, O'Reilly, Manning, Packt ; [FR] Eyrolles, Dunod**
- **Programming cleanly**
<https://www.worldcat.org/title/java-by-comparison-become-a-java-craftsman-in-70-examples/oclc/1035454599>
<https://github.com/GMTSE/ProjetsJavaMaterial/blob/master/JavaByComparisonSumUp.md>

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¹⁵Images from "Java Head First" book.

- Java follows **OOP** paradigm
- Java is **widely** used
- Code in `.java` files (filename = Class name)
- Code organized in **packages** (many provided in Java platform)
- Compile
`javac MyClass.java`
- Execute
`java MyClass`
- We will learn **Java 8** features
- We will use **Eclipse** to write code
- We will use **Maven** to compile/manage deps