In Java, if you make edits to a source file, you do not necessarily need to recompile all the code.

When you compile a Java source file, it is compiled into bytecode, which is a platform-independent representation of the code. This bytecode is then executed by the Java Virtual Machine (JVM).

If you make changes to a single Java source file, you only need to recompile that file. The Java compiler will automatically detect any dependencies and compile those files as well, if needed.

However, if you make changes to a shared library or a base class that is used by multiple classes, then those classes that depend on it will need to be recompiled.

In general, it is a good practice to recompile your entire project whenever you make significant changes, such as upgrading to a new version of a library or changing the project configuration. This helps to ensure that all the parts of the project are consistent with each other.

The Java Environment

Object Oriented Programming

SoftEng
http://softeng.polito.it

Version 3.3.0
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Java Timeline

- 1991: Sun microsystems develops a programming language for cable TV set-top boxes
  - Simple, OO, platform independent
- 1994: Java-based web browser (HotJava),
  - The idea of "applet" appears
- 1996: first version of Java (1.0)

See also: http://oracle.com.edgesuite.net/timeline/java/

Java timeline (cont’d)

- 1996: Netscape supports Java
  - Java 1.02 released,
- 1997: Java 1.1 released, major leap over for the language
- 1998: Java 2 platform (v. 1.2) released (libraries)
- 2000: J2SE 1.3 (platform enhancements, HotSpot)

Java timeline (cont’d)

- 2002: J2SE 1.4 (several new APIs), e.g.
  - XML
  - Logging
- 2005: J2SE 5.0 (Language enhancements)
  - Generics
- 2006: Java SE 6 (Faster Graphics),
  - goes open source
- 2010: Acquisition by ORACLE®
- 2011: Java SE 7 (I/O improvements)

Java timeline (cont’d)

- 2014: Java SE 8 (Lang evolution, LTS)
  - Lambda expressions
  - Functional paradigm
- 2017: Java 9 released
  - Modularization (Jigsaw),
  - **`jshell`** (REPL)
- 2018: Java 10, Java 11 (LTS)
  - Local **`var`** type inference
- 2019: Java 12, Java 13
  - Switch expressions (preview)
  - Text blocks

Start 6-month release plan

Java timeline (cont' d)

- 2020: Java 14, Java 15
  - Text blocks
- 2021: Java 16, Java 17 (LTS)
  - Records
  - Jpackage
- 2022: Java 18, Java 19
  - Simple web server
- Latest release Java 19: September 2022
- Next release Java 20: March 2023
  - Virtual threads

Note: between versions it changes a lot!

OO language features

- OO language provides constructs to:
  - Define classes (types) in a hierarchic way (inheritance)
  - Create/destroy objects dynamically
  - Send messages (w/ dynamic binding)
- No procedural constructs (pure OO language)

classes are declared with first uppercase letter
variables are declared with first lowercase letter

  - no functions, class methods only
  - no global vars, class attributes only

Java features

- Platform independence (portability)
  - Write once, run everywhere
  - Translated to intermediate language (bytecode)
  - Interpreted (with optimizations, i.e. JIT)
- High dynamicity
  - Run time loading and linking
  - Dynamic array sizes

Java features (cont'd)

- Robust language, less error prone
  - Strong type model and no explicit pointers
    - Compile-time checks
  - Run-time checks
    - No array overflow
  - Garbage collection
    - No memory leaks
  - Exceptions as a pervasive mechanism to check errors

Java features (cont’d)

- Shares many syntax elements w/ C++
  - Learning curve is less steep for C/C++ programmers
- Quasi-pure OO language
  - Only classes and objects (no functions, pointers, and so on)
  - Basic types deviates from pure OO...
- Easy to use

Java features (cont' d)

- Supports "*programming in the large*"
  - JavaDoc
  - Class libraries (Packages)
- Lots of standard utilities included
  - Concurrency (thread)
  - Graphics (GUI) (library)
  - Network programming (library)
    - socket, RMI
    - applet (client side programming)

Java features – Classes

- There is only one first level concept: the class

```
public class First {
}
```

- The source code of a class sits in a *.java* file having the *same name*
  - Rule: one file per class
  - Enforced automatically by IDEs
  - Case-wise name correspondence

Java features – Methods

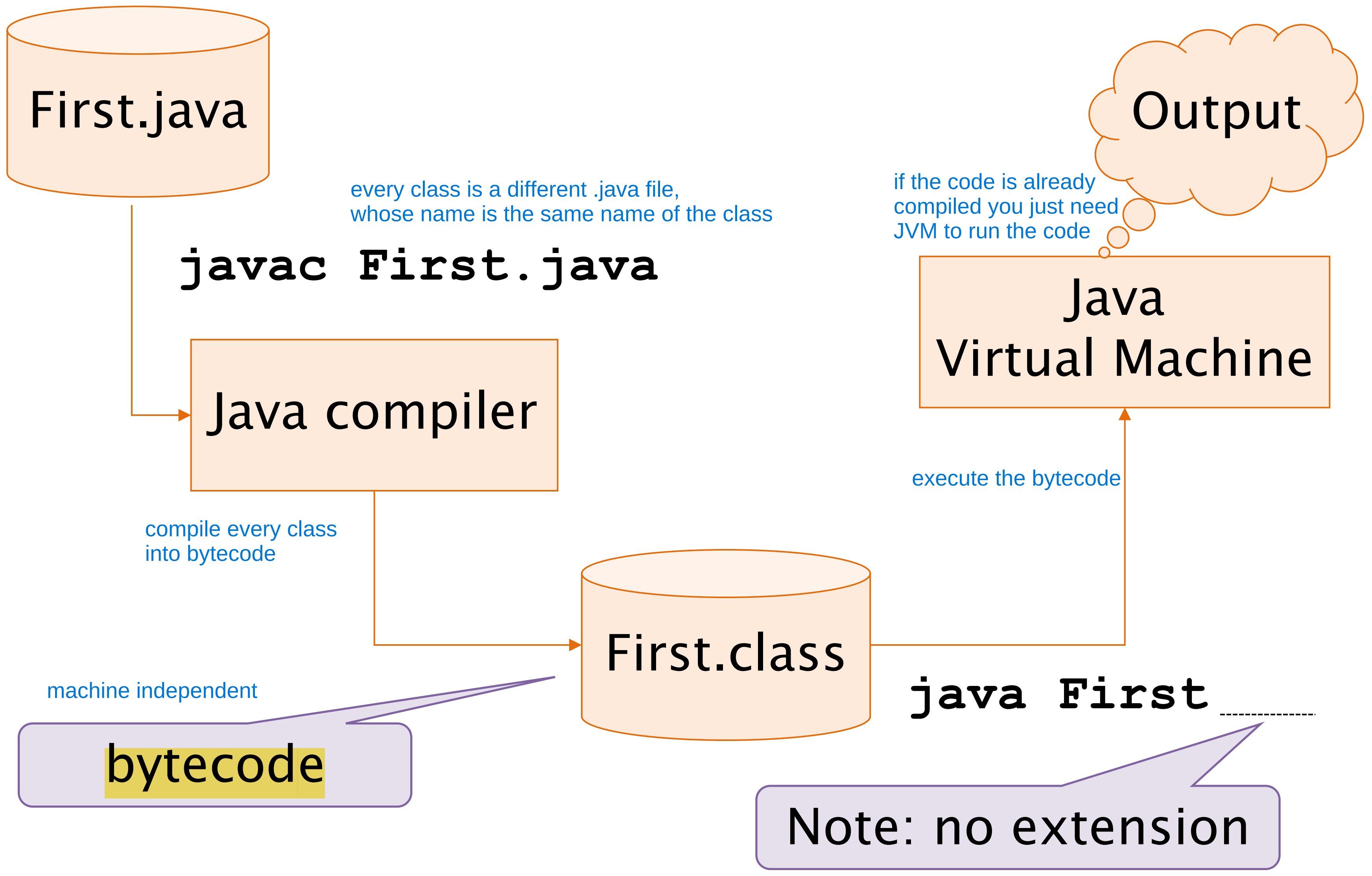
- In Java there are no functions, but only methods within classes
- The execution of a Java program starts from a special method:

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

In C: `int main(int argc, char* argv[])`

- Note
  - return type is **`void`**
  - **`args[0]`** is the first argument on the command line (after the program name)

Build and run



Cafe Babe

- Magic number
  - Specific initial sequence of a file that let identify the type of the file
  - E.g. PDF files starts with chars "**`%PDF`**"
- Java class files starts with the following 4 bytes:

`0xCAFEBABE`

Java Ecosystem

- Java language
- Java platform
  - JVM
  - Class libraries (API)
  - SDK

Dynamic class loading

- JVM loading is based on the classpath:
  - locations whence classes can be loaded
- When class X is required:
  - For each location in the classpath:
    - Look for file X.class
    - If present load the class
    - Otherwise move to next location

Example: source code

File: First.java:

```
public class First {
   public static void main(String[] args){
      int a;
      a = 3;
      System.out.println(a);
   }
}
```

Example: execution

Name of the class

- Command: **`java First`**
  - Take the name of the class (**`First`**)
  - Look for the bytecode for that class
    - In the classpath (and '.' eventually)
  - Load the class's bytecode
    - An perform all due initializations
  - Look for the **`main()`** method
  - Start execution from the **`main()`** method

Types of Java programs

- Application
  - It's a common program, similarly to C executable programs
  - Runs through the Java interpreter (**`java`**) of the installed Java Virtual Machine

```
public class HelloWorld {
public static void main(String args[]){
   System.out.println("Hello world!");
}
}
```

Types of Java programs

Deprecated since Java 9

- Applet (client browser)
  - Java code dynamically downloaded
  - Execution is limited by “sandbox”
- Servlet (web server)
  - In J2EE (Java 2 Enterprise Edition)
- Midlet (mobile devices)
  - In J2ME (Java 2 Micro Edition)
- Android App (Android device)
  - Java

Java development environment

- Java SE 17 (http://www.oracle.com/technetwork/java/javase)
  - **javac** compiler
  - **jdb** debugger
  - **JRE** (Java Run Time Environment)
    - JVM
    - Native packages (awt, swing, system, etc)
- Docs
  - http://docs.oracle.com/javase/8/
- Eclipse: http://www.eclipse.org/
  - Integrated development environment (IDE)
  - Eclipse IDE for Java Developers https://www.eclipse.org/downloads/packages/release/2022-12/r

Coding conventions

- Use **`camelBackCapitalization`** for compound names, not underscore
- Class name must be **C**apitalized
- Method names, object instance names, attributes, method variables must all start in lowercase
- Constants must be all uppercases (w/ underscore)
- Indent properly

Coding conventions (example)

```
class ClassName {

final static double PI = 3.14;

private int attributeName;

     public void methodName {
          int var;
          if ( var==0 ) {
          }
     }
}
```

Deployment – Jar

- Java programs are packaged and deployed in jar files.
- Jar files are compressed archives
  - Like zip files
  - Contain additional meta-information
- It is possible to directly execute the contents of a jar file from a JVM
  - JVM can load classes from within a JAR

Jar command

- A jar file can be created using:

```
jar cvf my.jar *.class
```

- The contents can be seen with:

```
jar tf my.jar
```

- To run a class included in a jar:

```
java -cp my.jar First
```

  - The "`-cp my.jar`" option adds the jar to the JVM classpath

Jar Main class

- When a main class for a jar is defined, it can executed simply by:

```
java -jar my.jar
```

- To define a main class, a manifest file must be added to the jar with:

```
jar cvfm my.jar manifest.txt
```

```
Main-Class: First
```

FAQ

- Which is more “powefull”: Java or C?
  - Performance: C is better though non that much better (JIT)
  - Ease of use: Java
  - Error containment: Java
- How can I generate an “.exe” file?
  - You cannot. Use an installed JVM to execute the program
  - GCJ: http://gcc.gnu.org/java/

FAQ

- I downloaded Java on my PC but I cannot compile Java programs:
  - Check you downloaded Java SDK (including the compiler) not Java RTE or JRE (just the JVM)
  - Check the path includes *pathToJava*/bin
- Note: Eclipse uses a different compiler than javac

FAQ

- Java cannot find a class (ClassNotFoundException)
  - The name of the class must not include the extension .class:
    - Es. java First
  - Check you are in the right place in your file system
    - java looks for classes starting from the current working directory

Wrap-up

- Java is a quasi-pure OO language
- Java is interpreted
- Java is robust (no explicit pointers, static/dynamic checks, garbage collection)
- Java provides many utilities (data types, threads, networking, graphics)
- Java can used for different types of programs
- Coding conventions are not “just aesthetic”