Java Basics: What is Java?

CPSC 233: Introduction to Computer Science for Computer Science Majors II
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Java

- **Java 16 is the official programming language for this course.**
- **We will teach syntax for Java 11 (12+ just adds more on top)**
  - Java used to be version 1.6, 1.7, 1.11
  - 1.16 -> Java 16 is latest OpenJDK version
  - 1.17 -> Java 17 is latest Oracle version
  - These are minor changes like going Python 3.8 to Python 3.9 (old syntax is maintained)
  - We need Java 11 to do JavaFX (OpenJDK Java 16 is on UofC Windows machines, linux compute server is OpenJDK Java 11)

- We encourage the use of IDE
  - such as Eclipse/IntelliJ/Netbeans/VSCode etc.
- We encourage direct interaction with the computer systems (command line)

Java Programming Language

Python vs Java

Python

- Flexible and implicit syntax
- Ability to quickly create small programs and applications
  - Implicit syntax makes scaling harder
- Syntax is sparse and clear
- Can be interpreted, or compiled to bytecode

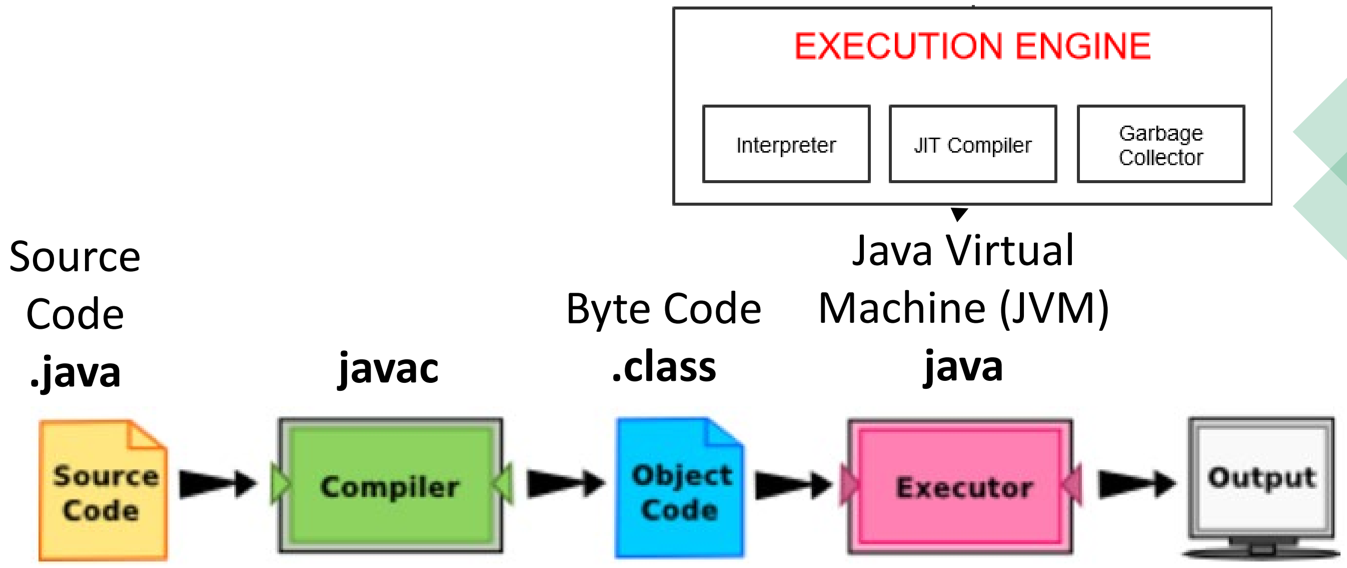
Java

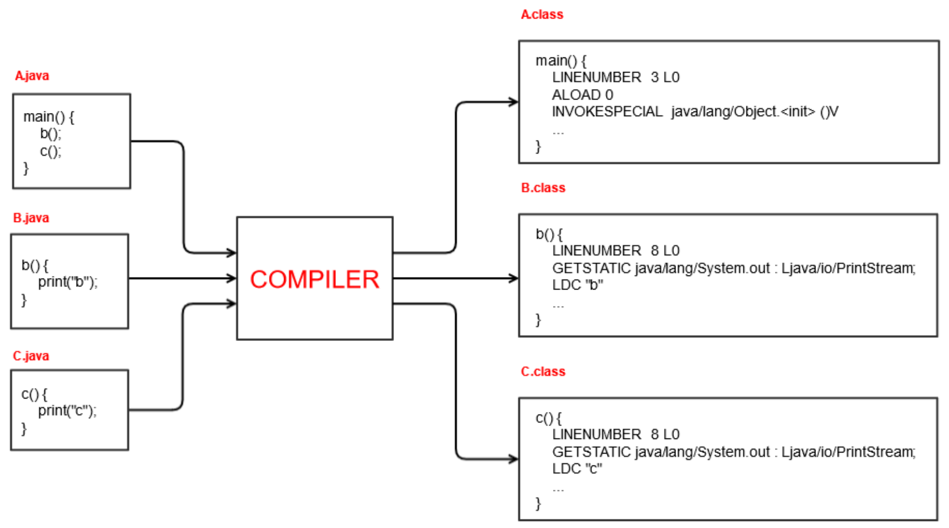
- Formal and explicit syntax
- Designed for any project (no matter the size)
  - Explicit syntax makes scaling clearer to manage (still takes time)
- Syntax more ‘computer-like’
- Compiled (code always converted to bytecode before running)

Compiler (Java)

- A **compiler**:
  - Is like **translating an entire book** and give it to a reader.
  - A compiler reads the program and translates it completely before the program starts running

- For Java the **byte code is stored in .class files**.
  - Unlike in Python where you generally shared your .py files
  - In Java we often just shared these .class files with people who want to run our code
  - (not as easy for a human to read these files)





```
main() {
    b();
    c();
}
```

```
b() {
    print("b");
}
```

```
c() {
    print("c");
}
```

```
main() {
    LINENUMBER  3 L0
    ALOAD 0
    INVOKESPECIAL  java/lang/Object.<init> ()V
    ...
}
```

```
b() {
    LINENUMBER  8 L0
    GETSTATIC java/lang/System.out : Ljava/io/PrintStream;
    LDC "b"
    ...
}
```

```
c() {
    LINENUMBER  8 L0
    GETSTATIC java/lang/System.out : Ljava/io/PrintStream;
    LDC "c"
    ...
}
```

Compiled or Interpreted (Both)

- Many modern languages use both processes.
- Java uses both processes.
- Java is a **compiled interpreted language**

- Java is first compiled into a lower-level language, called **byte code**, and then interpreted by a program called a **virtual machine**.
  - (**byte code is higher level than machine code**, we can still move it between machine types Ex. Win/MacOS. Machine code can only move within same type.)
  - Often we zip up .class files into a compressed .zip file we rename a **.jar file**
  - A **virtual machine** is created for each operating system type Windows, Mac, linux, etc.

  - https://www.baeldung.com/java-compiled-interpreted (more details if you are interested)

Just In Time - Compiler

- Most modern Java also uses a JIT (Just In Time – Compiler) this recognizes when certain byte-code is often re-interpreted over and over (like a function) and converts it into stored machine native code (rather than re-interpreting)
- This is a runtime optimization (makes for interesting runtime speed testing as your program can speed up the longer it runs!)
- One performance result (not universal!)
  - **Java using JIT compiler – 2726 ns – fastest**
  - C++ with O2 optimization – 3639 ns – 33% slower
  - C++ without O2 optimization – 9435 ns – 246% slower
  - **Java without JIT compiler – 17965 ns – 559% slower**
  - *JavaScript (web/browser language) – 22998 ns – 743% slower*

Running Java Program

Command lines and files

You can check your LAPTOP version using

java –version

javac –version

If the result is not 11.X.X+ then

UofC linux is 11.0.13 right now

UofC Windows lab machines 16.0.2

Then you need to install at least Java 11

(OpenJDK 11)

Often most students install Java 16 (or 17)

(OpenJDK 16)

Running a simple Java file from command line

***Source code* is a file containing your code often referred to as a *program*. We use words with upper case first letters for Java source code files.**

- The filename ends with a *.java* suffix

e.g. **Main.java**

- To execute from terminal/shell (make Main.class via compiling Main.java, then run it):

javac Main.java

java Main

- To pipe the output into a file output.txt:

java Main **> output.txt**

Onward to … variables.

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