Programming Overview

CSE 114 INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING

Announcements

Reading assignment for this week: Chapter 1 of Downey

What is computer science?

Very broad definition:

- Computer science (CS) is the systematic study of computing systems and computation

Computer science is NOT just programming!

Programming is an important part of CS

- We will be learning to program in Java but much of what you will learn are fundamental CS concepts that apply to nearly any programming language

What do computer scientists do?

Some examples of what computer scientists work on:

- Build computers and their components
- Programming languages
- Operating systems
- Artificial intelligence, machine learning
- Databases
- Networking
- Theory of computation
- Computer graphics
- Robotics
- Biocomputing
- Software engineering
- Many more . . .

What is programming?

Programming is the process of “giving” instructions to a computer or the computer’s central processing unit (CPU)

- Also referred to as ‘Writing code’ or ‘Coding’

Learning to program is similar to learning a "natural" language like Spanish. You have to learn the:

- **Syntax:** The grammar or ‘rules’ of the language
- **Semantics:** The meaning of each word and phrase in the language

But…Computers are pretty dumb

- You have to give super clear and precise instructions
  - A computer will happily do the same thing forever (in an infinite loop) if you tell it to do so, even if you didn't mean to!

Unlike natural languages, programming languages are extremely picky – rules can’t be violated

What is a program?

Program: A sequence of instructions to be carried out by a computer (to perform a computational task)

Program execution: The act of carrying out the instructions contained in a program

An example program is Hello.java

Hello.java

```
public class Hello {
    public static void main (String[] args) {
        System.out.println("Welcome to CS!!!");
        System.out.println("Let's have some fun.");
    }
}
```

- What is the computational task that we perform in this example?

Low-level computer instructions

Machine language

- Binary instruction (1's and 0's)
- Most instructions just move data around or perform simple arithmetic operations

Example: on Intel x86 processors:

- 1011000001100001 means to copy a 97 to a particular register

Binary programming is really hard and tedious but early programmers did exactly this!

“Mid-level” computer instructions

Assembly language

- Symbolic (meaningful) names for binary instructions and memory
- A little more readable
- Feasible for programmers to use

Example:

```
ADD DR, SR1, SR2          ; DR <- (SR1) + (SR2)
LD DR, LABEL              ; DR <= Mem[LABEL]
LDR DR, BaseR, Offset     ; DR <- Mem[BaseR + Offset]
```

High-level computer instructions

High-level language

- Symbolic names for assembly instructions and memory
- Symbolic names for basic operations such as looping
- Symbolic “shorthand” for a group of instructions
- Close to "natural" languages - close to being readable!

Example:

```
        print("Welcome to CS!");
        y = a * x + b;
```

Why use a high-level language?

Concise

- High-level programming languages allow us to express common operations in a concise and readable fashion

Maintainable

- Modifying and maintaining code is much easier when the code is concise and easy to read (as compared to lengthy and difficult to read assembly or binary code)

Portable

- Different CPU's accept different binary instructions
- Writing in a high-level language allows code to be translated or "compiled" into a platform-specific binary code
- Allows your code to be "ported" to another platform

Some modern languages

Procedural languages: programs are a series of commands

- Pascal (1970): designed for education
- C (1972): low-level operating systems and device drivers

Functional languages: functions map inputs to outputs

- Lisp (1958) / Scheme (1975)
- ML (1973)
- Haskell (1990)

Object-oriented languages: programs use interacting “objects”

- Smalltalk (1980): first major object-oriented language
- C++ (1979): “object-oriented” improvement to C
- Java (1995): designed for embedded systems, servers
  - Runs on many platforms (Windows, Mac, Linux, cell phones, . . .)
- Python (1989): general purpose, procedural and objects
- Javascript (~1995): the language of the web, part of every browser

Why Java?

Java is a straightforward and powerful object-oriented language

- Simpler than C++
- Highly productive language

Platform independent (Mac, Windows, ...)

- “Write once, run everywhere.”

Java is used heavily in industry

- Many major companies have utilized Java in their internal technical infrastructure

Java has good support

- Many useful prewritten “packages” available as part of the Java ecosystem such as graphics, multimedia, networking, etc.

The first programming language taught at many universities

Java’s roots

C was developed in the early 1970’s

- C was designed to be small, fast, with little built-in safety

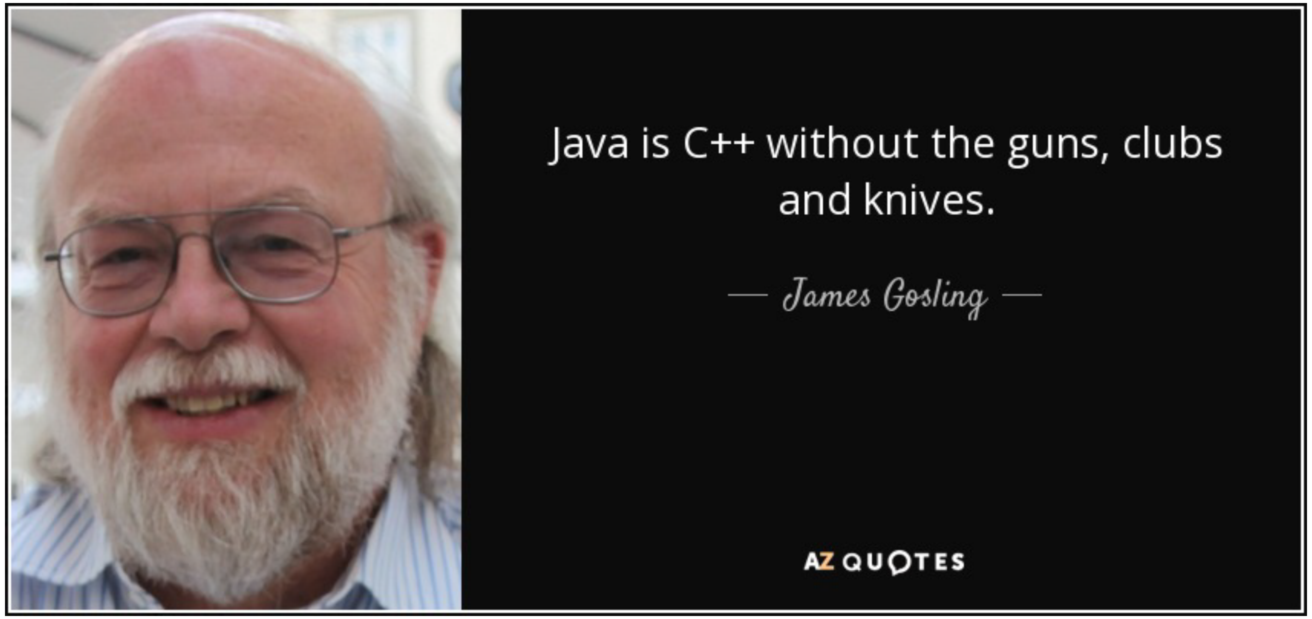
C++ was developed in the late 1970's

- C++ is a superset of C and extends C to include object-oriented concepts

Java was developed in the 1990's

- Borrowed from C/C++ but more concerned about safety and productivity at the cost of some speed
- Designed to be used in the Internet era

James Gosling – Java’s creator



Java is C++ without the guns, clubs and knives.

— James Gosling —

https://www.azquotes.com/quote/596302

Java Introduction

Ex: Hello program (Hello.java)

```
public class Hello {
   public static void main (String[] args) {
      System.out.println("Welcome to CS!!!");
      System.out.println("Let's have some fun.");
   }
}
```

- Black text is required for Java
- Blue text was added as part of the developer’s program
- Note the following features
  - Indentation is optional (but makes the code more readable)
  - Matching parens (and)
  - Matching braces { and }
  - Matching brackets [and]

The coding process

1. Create/Edit source code (.java file)

   Use a text editor to write or edit your code (instructions)

   E.g., vim, but not Word

2. Compile the source file

   The Java compiler creates bytecodes – an intermediate machine independent instructions that target a Virtual Machine

   The javac command

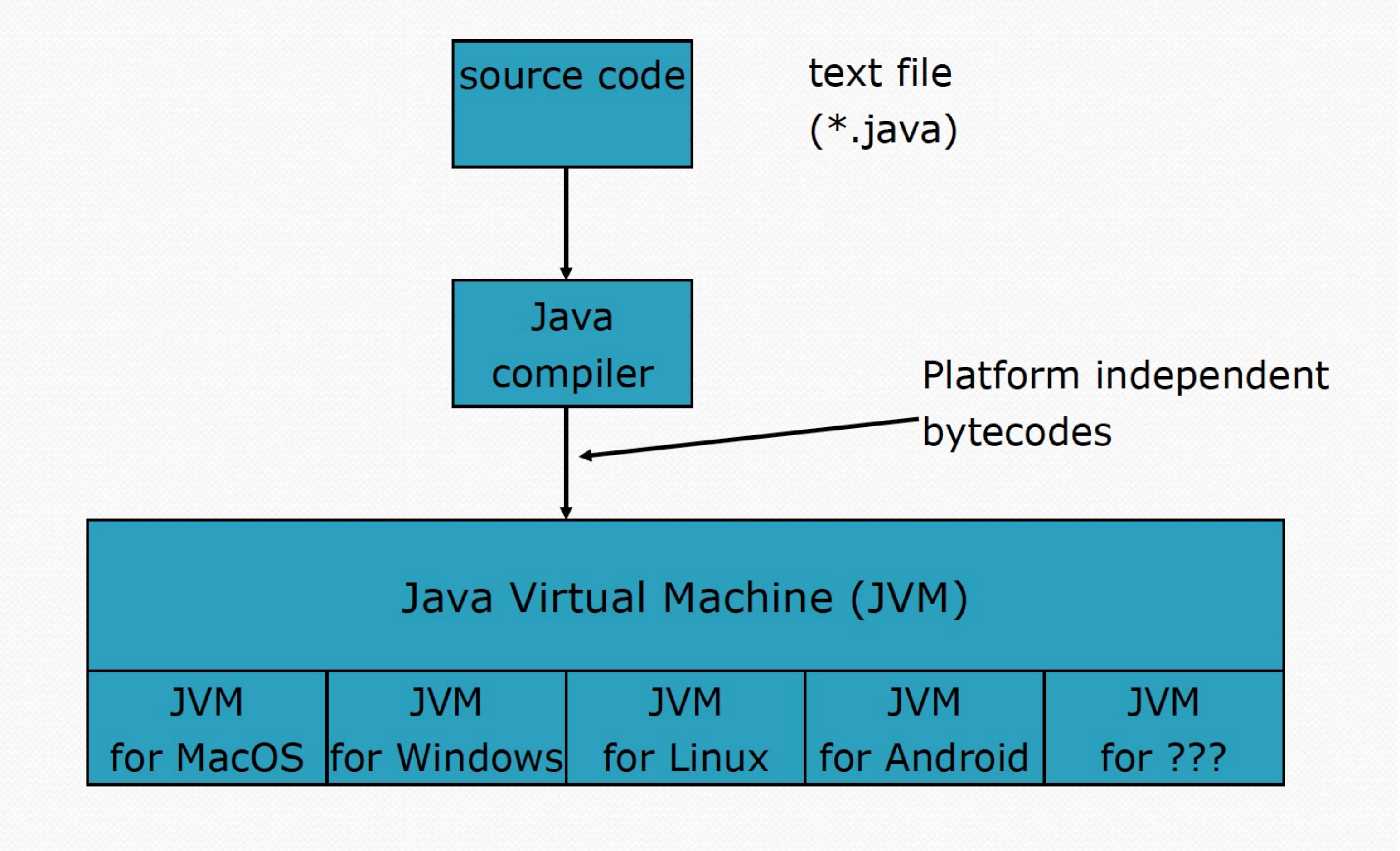
3. Run on the Java Virtual Machine (JVM)

   The java command

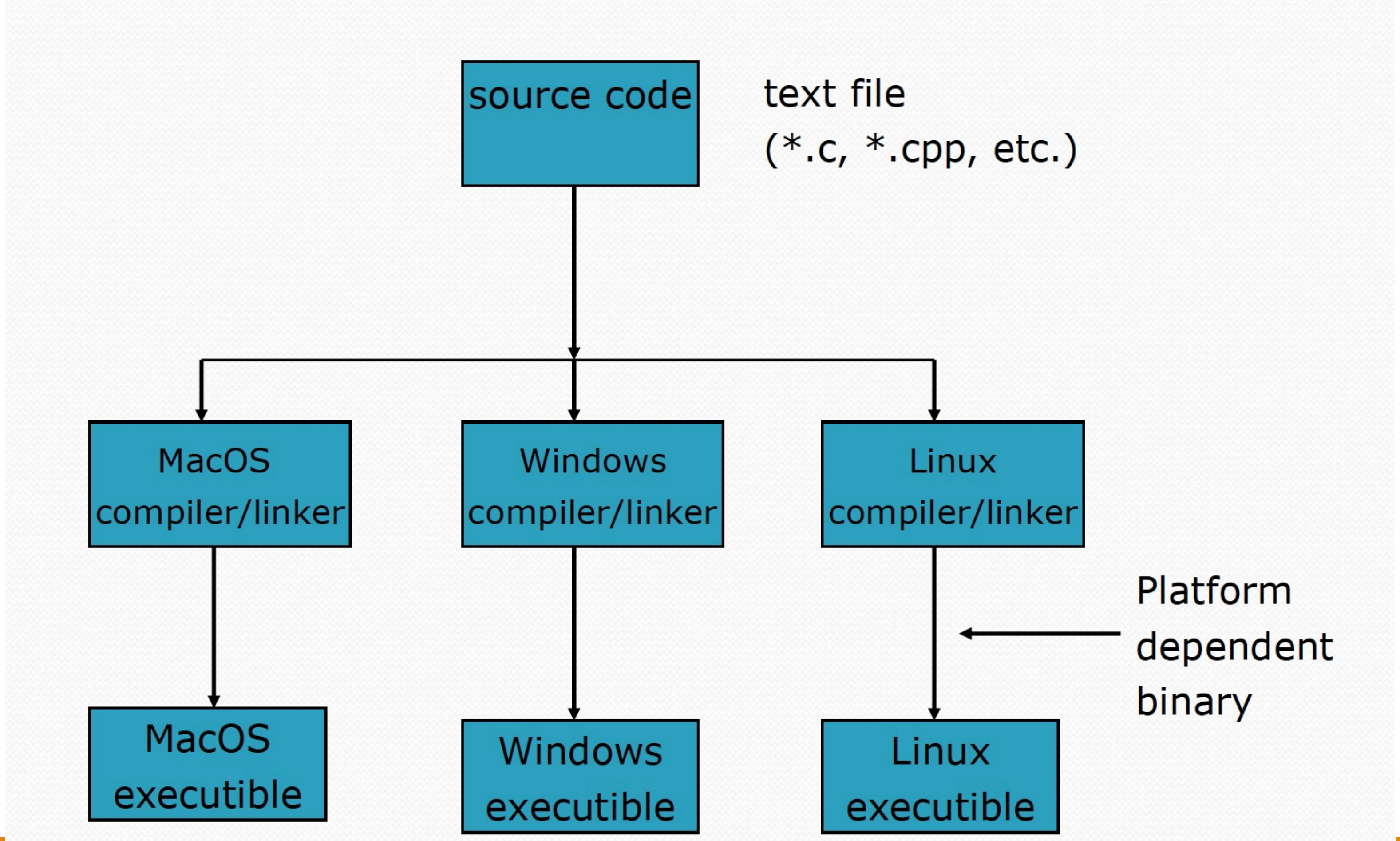
4. Debug your program/application

   Repeat steps 1 – 4 as necessary

Java programming model



Traditional programming model



Summary – bytecodes and the JVM

In order to “write once, run everywhere”, Java uses the notation of a secure universal “Java Virtual Machine” (JVM)

- In Java you do not have to worry about cross-platform issues. . . your program will run “on” the JVM instead

The Java compiler only has to worry about producing one “binary” known as bytecodes

- The JVM runs your program by interpreting or translating your program’s bytecodes into platform specific machine code

There are multiple JVM’s for each supported platform (Mac, Windows, Linux, Android, etc.) but they all understand bytecodes

Editing code

Programmers use a text editor to write code

- Don’t use a word processor such as MS Word, Google Docs, etc.
- Don’t use the default PC/Mac editor

The classic editors (free): vim, emacs

- Both are cross-platform (PC, Mac, Linux), keyboard-centric (minimal GUI)

Standalone GUI-based editors (free):

- PC: Notepad++, Programmer’s Notepad
- Mac: Textmate2, TextWrangler
- Both: Sublime Text 2 (free trial), Atom

You only need one editor that you like!

Text editors do not know how to compile your code!

Java IDE’s

IDE – Integrated Development Environment

- Combines text editor, compiler, debugger into one GUI-based environment

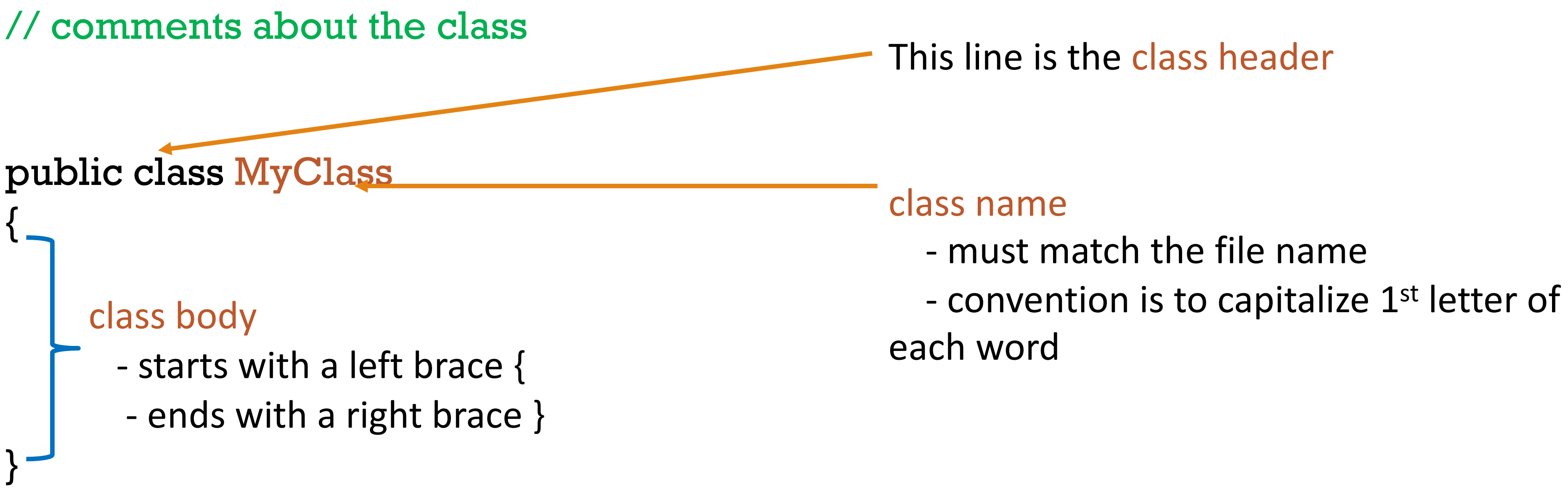
There are several reasonable IDE’s for Java

- IntelliJ IDEA (PC, Mac, Linux)
- Eclipse (PC, Mac, Linux)
- Netbeans (PC, Mac)

We’re going to use IntelliJ IDEA, but not yet

Installation instructions for IntelliJ IDEA will be on the course website

Java program structure: class



```
// comments about the class


public class MyClass
{



}
```

This line is the class header

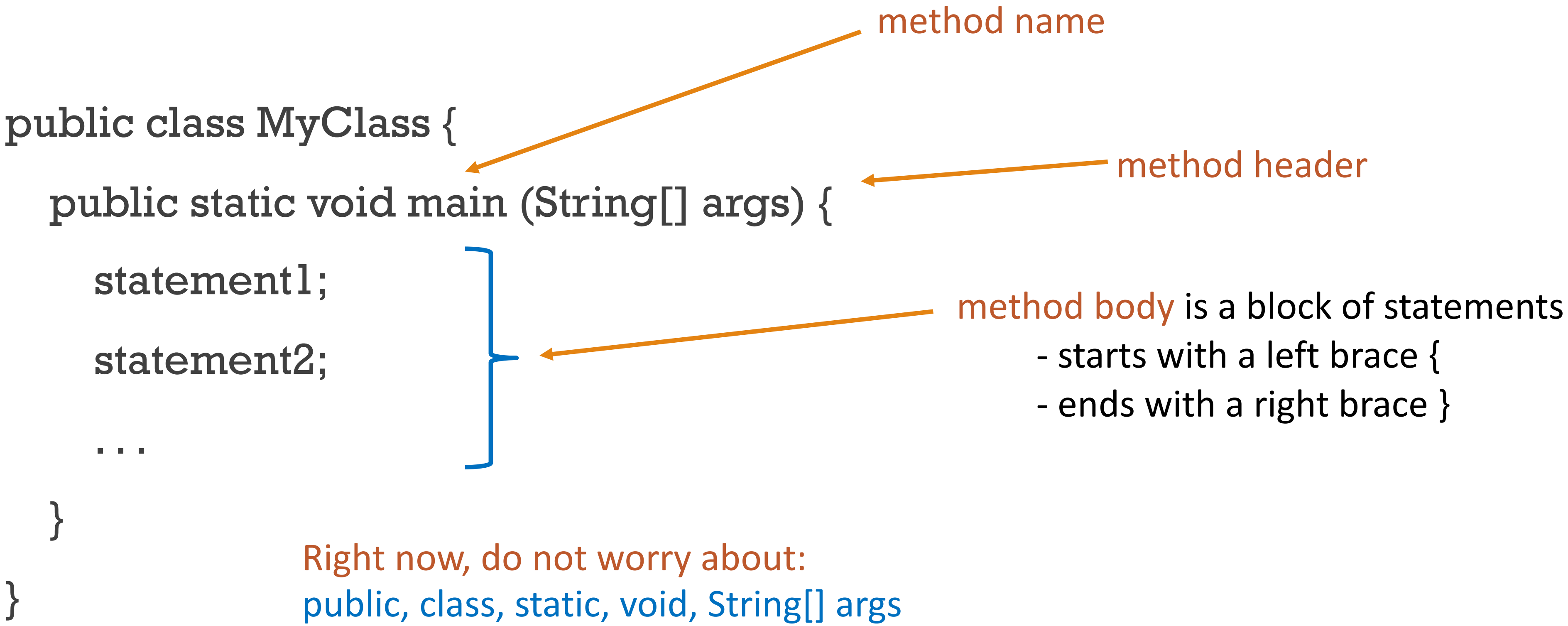
class name

- must match the file name
- convention is to capitalize 1st letter of each word

class body

- starts with a left brace {
- ends with a right brace }

Structure:
Class with a main method



```
public class MyClass {
    public static void main (String[] args) {
        statement1;
        statement2;
        . . .
    }
}
```

method name

method header

method body is a block of statements

- starts with a left brace {
- ends with a right brace }

Right now, do not worry about:

public, class, static, void, String[] args

- Think of them as necessary decoration for now.

Ex: Hello program (Hello.java)

```
public class Hello {
    public static void main (String[] args) {
        System.out.println("Welcome to CS!!!");
        System.out.println(34/10);
    }
}
```

Syntax errors

syntax: the set of legal structures and commands that can be used in a particular language, e.g.,

- Every basic Java statement ends with a semicolon (;)
- The contents of a class or method occur between { and }

syntax error (compiler error): a problem in the structure of a program that causes the compiler to fail, e.g.,

- Missing semicolon
- Too many or two few or unmatched braces { }}
- Illegal identifier for class name, method name, variable name, etc.
- Class and file names do not match

Will use Hello.java to demonstrate some examples

Semantic errors

semantics: the meaning of a language construct

- What is the meaning of 'x = x + 1'?

semantic error (run-time error): a problem in the meaning of a program that causes the run-time execution to fail, e.g.,

- Divide by zero
- Unintended infinite loop
- Unintended piece of code, e.g., mistakenly adding when subtraction was intended
- etc.

Will use Hello.java to demonstrate an example