Basics of Computers and Programs

Dr. 何明昕, He Mingxin, Max

program06 @ yeah.net

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计算机程序设计基础

Introduction to Computer Programming

The way of the program

- Think like a computer scientist who combines some of the best features of:
  - Mathematicians: use formal languages to denote ideas
  - Engineers: design things, assembling components into systems and evaluating tradeoffs among alternatives
  - Scientists: observe the behavior of complex systems, form hypotheses, and test predictions.

Problem-Solving

- The single most important skill for a computer scientist is problem-solving.
- What is problem-solving?
  - the ability to formulate problems, think creatively about solutions, and express a solution clearly and accurately
- The process of learning to program is an excellent opportunity to practice problem-solving skills.

Challenges

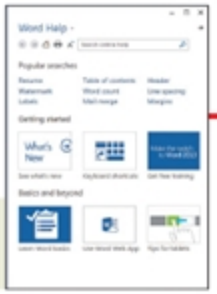
- Need to learn what computers *can* do.
- Need to learn a programming *language*.

Computers: Hardware and Software

- Computer—A device that can perform computations and make logical decisions phenomenally faster than human beings can.
- Computers process data under the control of sets of instructions called computer programs.
- These programs guide the computer through orderly sets of actions specified by people called computer programmers.

Parts of an Information System

People
are end users who use computers to make themselves more productive.



Procedures
specify rules or guidelines for computer operations.

Software
provides step-by step instructions for computer hardware.

Hardware
includes keyboard, mouse, display, system unit, tablets, smartphones, and other devices.

Data
consists of unprocessed facts including text, numbers, images, and sounds.

Internet
allows computers to connect to people and other computers.

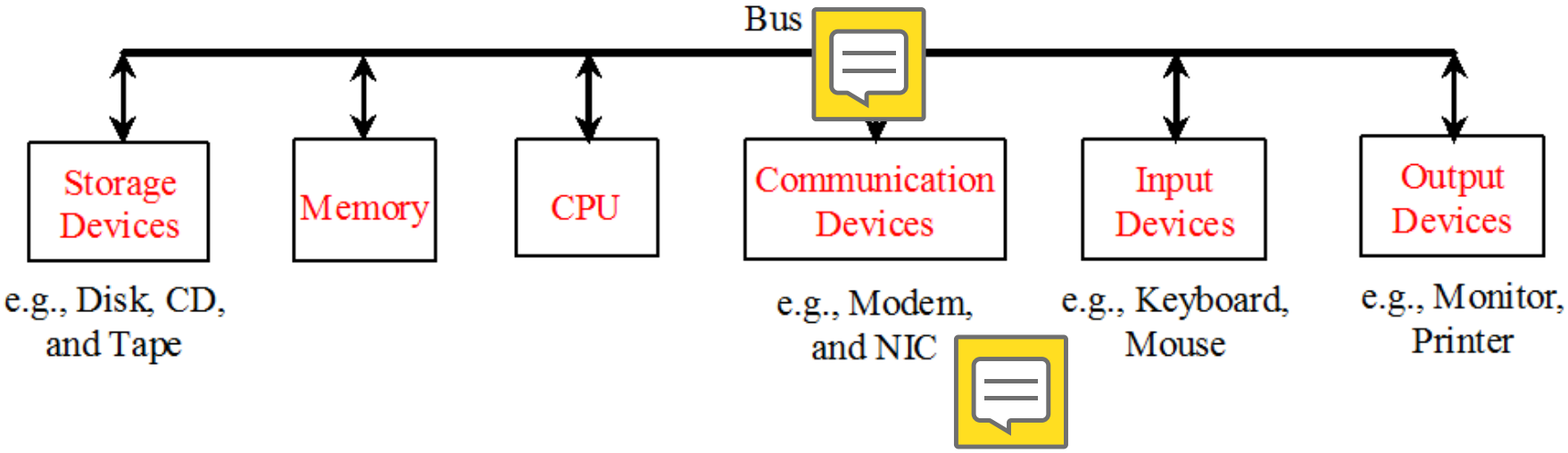
- People
- Procedures
- Software

- Hardware
- Data
- Network

Data vs Information

Hardware

- A computer consists of various devices referred to as hardware
  - e.g., the keyboard, screen, mouse, disks, memory, DVD, CD-ROM and central processing units (CPU)



Computer Organization:
Logical units or sections of a computer

- Input unit. This “receiving” section obtains information (data and computer programs) from input devices and places it at the disposal of the other units so that it can be processed.
- Input devices
  - Keyboard, mouse, microphone, scanner, hard drives, CD drives, DVD drives, USB drives and more

Computer Organization (Cont.)

- Output unit. This “shipping” section takes information that the computer has processed and places it on various output devices to make it available for use outside the computer.
- Output devices
  - Screen, printer, speakers and more

Computer Organization (Cont.)

- Memory unit (内存，主存)
  - Rapid-access, relatively low-capacity “warehouse” section retains information that has been entered through the input unit, making it immediately available for processing when needed.
  - Retains processed information until it can be placed on output devices by the output unit.
  - Information in the memory unit is volatile(易失的)—it’s typically lost when the computer’s power is turned off.
  - Often called either memory or primary memory.

Computer Organization (Cont.)

- Arithmetic and logic unit (ALU) (算术逻辑单元)
  - “Manufacturing” section performs calculations, such as addition, subtraction, multiplication and division.
  - Contains the mechanisms that allow the computer to make decisions.
  - In today’s systems, the ALU is usually implemented as part of the next logical unit, the CPU.

Computer Organization (Cont.)

- Central processing unit (CPU) (中央处理器)
  - “Administrative” section coordinates and supervises the operation of the other sections.
  - Tells the input unit when information should be read into the memory unit.
  - Tells the ALU when information from the memory unit should be used in calculations and tells the output unit when to send information from the memory unit to certain output devices.
  - Many of today’s computers have multiple CPUs—such computers are called multiprocessors.
  - A multi-core processor implements multiprocessing on a single integrated circuit chip.

Computer Organization (Cont.)

- Secondary storage unit (次级存储，永久存储，外存)
  - Long-term, high-capacity “warehousing” section.
  - Programs or data not actively being used by the other units normally are placed on secondary storage devices (e.g., your hard drive) until they are again needed, possibly hours, days, months or even years later.
  - Information on secondary storage devices is persistent—it is preserved even when the computer’s power is turned off.
  - Examples of secondary storage: CDs, DVDs and flash drives

Software

- The programs that run on a computer with data and documents are referred to as software.

What is a program?

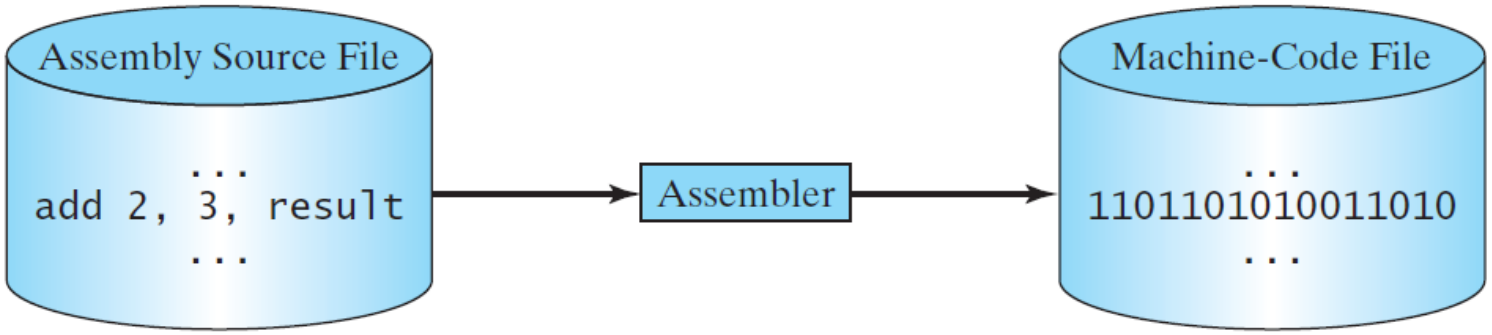
- A sequence of instructions that specifies how to perform a computation.
- Instructions or statements perform:
  - input: get data
  - output: output data
  - math: perform math operations
  - testing: check for conditions, run statements
  - repetition: perform actions

Operating system

- An operating system (OS) is system software that manages computer hardware and software resources and provides common services for computer programs. The operating system is a component of the system software in a computer system. Application programs usually require an operating system to function.
- Typical OS: MS Windows, Mac OS, Android, Linux

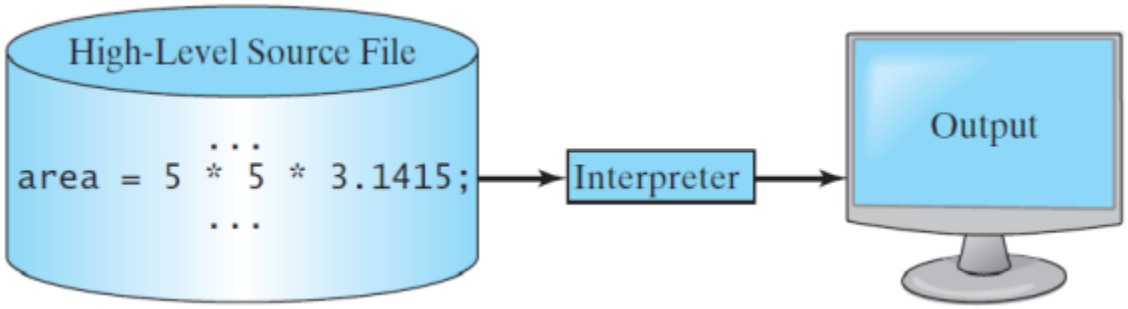
What is a programming language?

- Programs are written using programming languages.
- High-level: Java, Python, C, C++, etc.
  - easier to program; portable; interpret or compile
- Low-level: machine or assembly language:
  - Machine code: `1101101010011010`
  - Assembly instruction: `ADD R1,R2,R3`



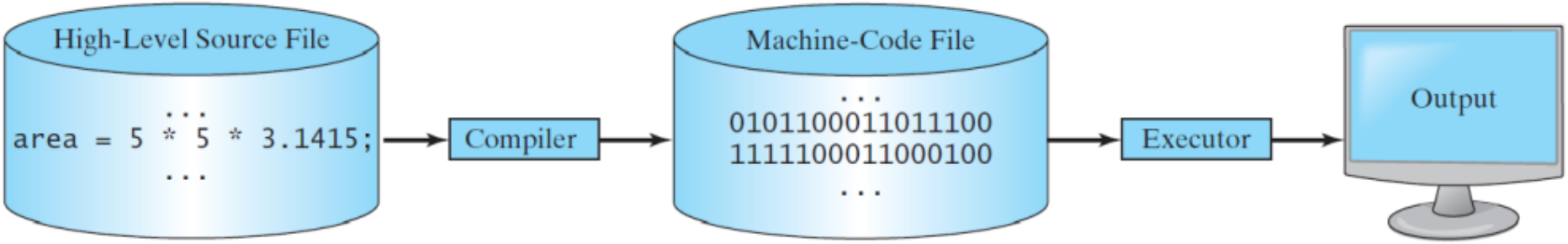
Interpreting Source Code

An interpreter reads one statement from the source code, translates it to the machine code or virtual machine code, and then executes it right away.



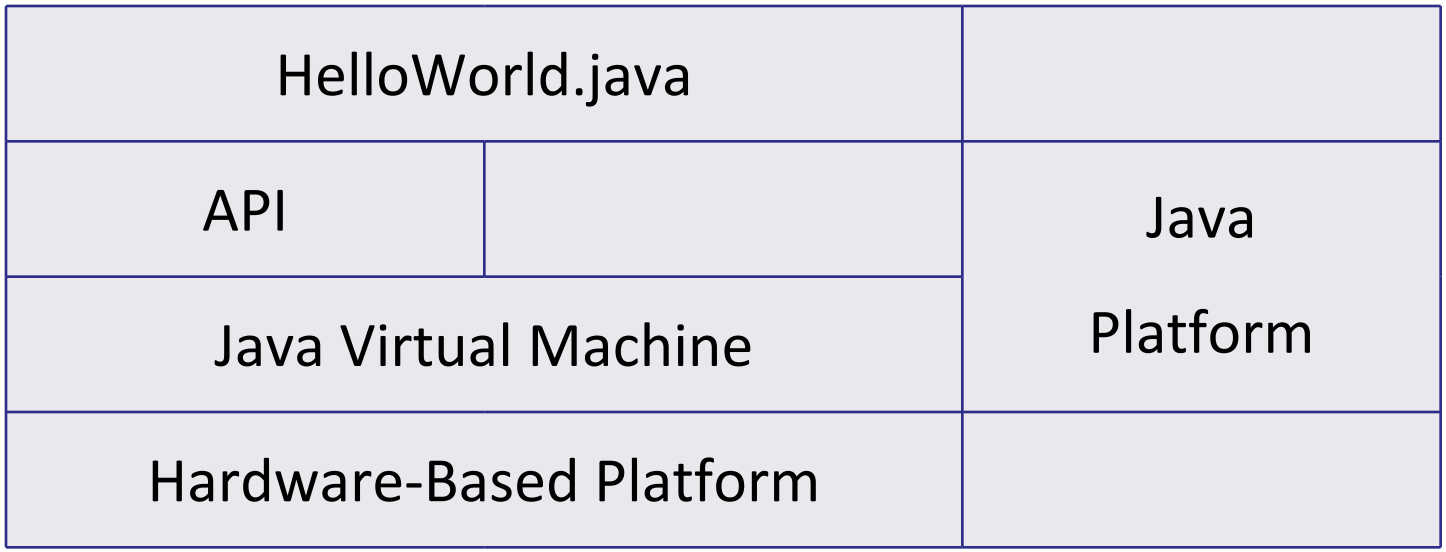
Compiling Source Code

A compiler translates the entire source code into a machine-code file, and the machine-code file is then executed.



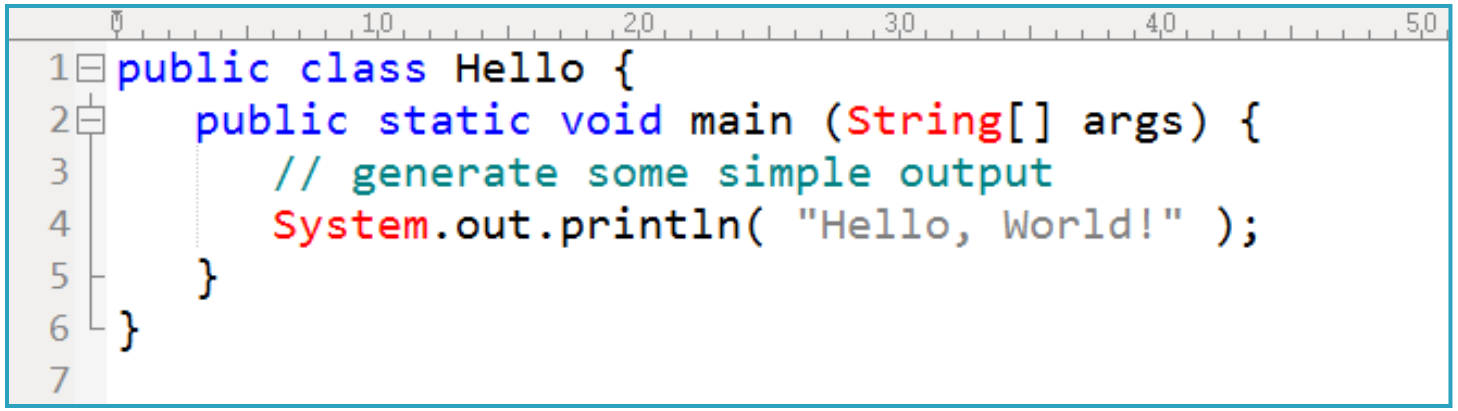
Java Platform

- Java Virtual Machine (JVM)
- Java Application Programming Interface (API) - Java class libraries



The first Java program

- Hello.Java



```
1  public class Hello {
2      public static void main (String[] args) {
3          // generate some simple output
4          System.out.println( "Hello, World!" );
5      }
6  }
7
```

- Java programs are made of class definitions

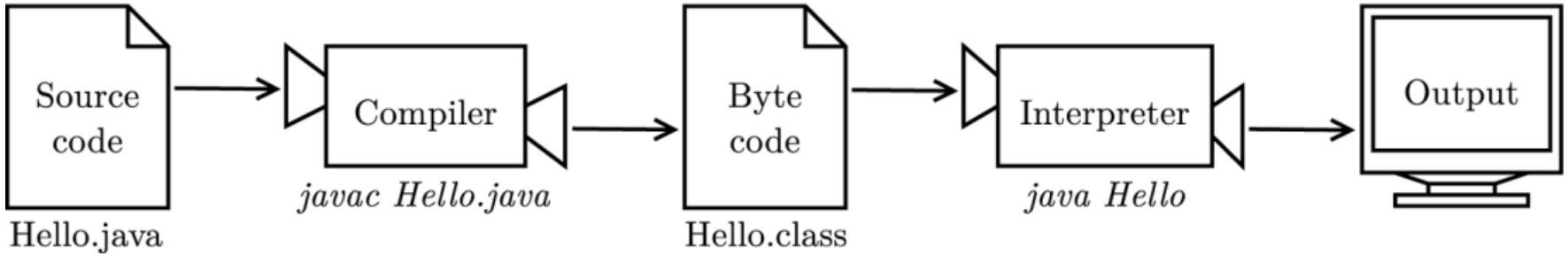
```
public class CLASSNAME {
    public static void main (String[] args) {
        STATEMENTS;
    }
}
```

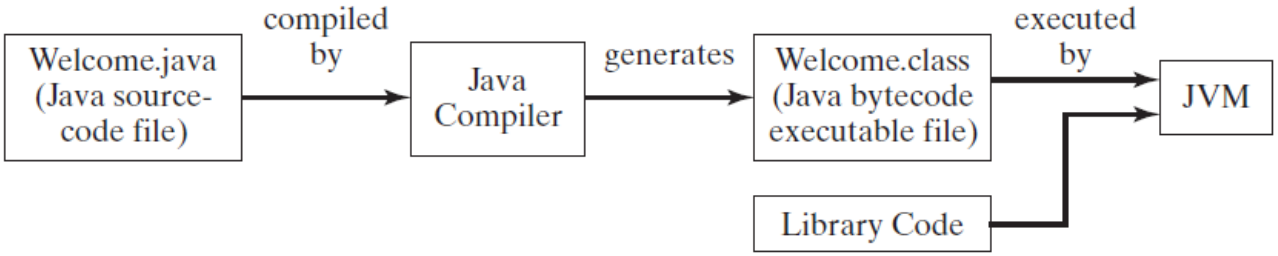
Create and run Java program

- Create a source file
  - edit file: Hello.java
- Compile the source file into .class file
  - `javac Hello.java`
    - Output file: Hello.class
- Run the program
  - `java –classpath . Hello`
    - Output message: “Hello World!”:

- Use different Java IDEs or editors
- In the lab, we may use Eclipse to create and run Java programs.

Java is both compiled and interpreted.





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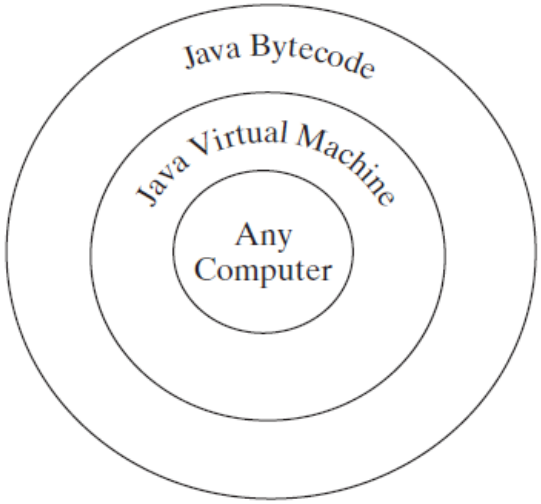

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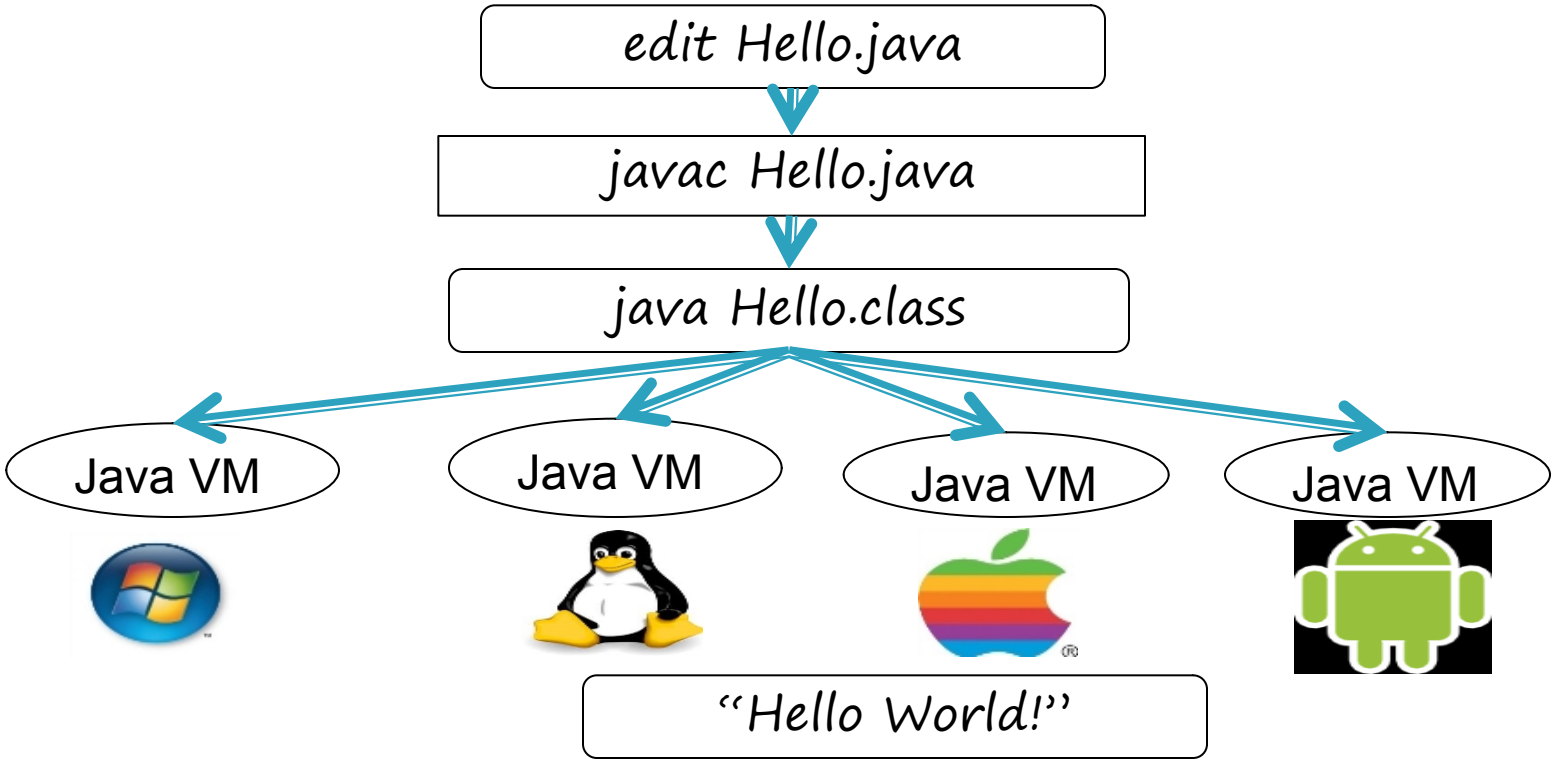
Java on different OS

- Running on different Operating Systems (OS) via Java VM



What is debugging?

- Debugging: tracking down and correcting bugs (errors)
- Three kinds of errors:
  - Syntax Errors:
    - Syntax refers to the structure of your program and the rules about that structure.
    - e.g. omitting the semi-colon at the end of a statement
  - Run-time Errors:
    - In Java, run-time errors (called exceptions) occur when the interpreter is running the byte code and something goes wrong.
    - e.g. an infinite recursion causes a StackOverflowException
  - Logic Errors and Semantics:
    - The semantics, or meaning of the program, are wrong.
    - e.g. yielding an unexpected result

Experimental debugging

- One of the most important skills you will acquire in this class is debugging.
- Debugging is one of the most interesting, challenging, and valuable parts of programming.
- Debugging is like detective work.
- Debugging is like an experimental science. As Sherlock Holmes pointed out, "When you have eliminated the impossible, whatever remains, however improbable, must be the truth." (From A. Conan Doyle's, The Sign of Four).