



2021Fall CS102A

Introduction to Computer Programming

Instructor: Zhuozhao Li (李卓钊)



Information about the Instructor

- ▶ Dr. Zhuozhao Li (Assistant Professor in CSE)
- ▶ Office: Room 516, South Tower, CoE
- ▶ Email: lizz@sustech.edu.cn
- ▶ Homepage: <https://zhuozhaoli.github.io/>
- ▶ Office hour: Tuesday 4-5pm or by email appointment

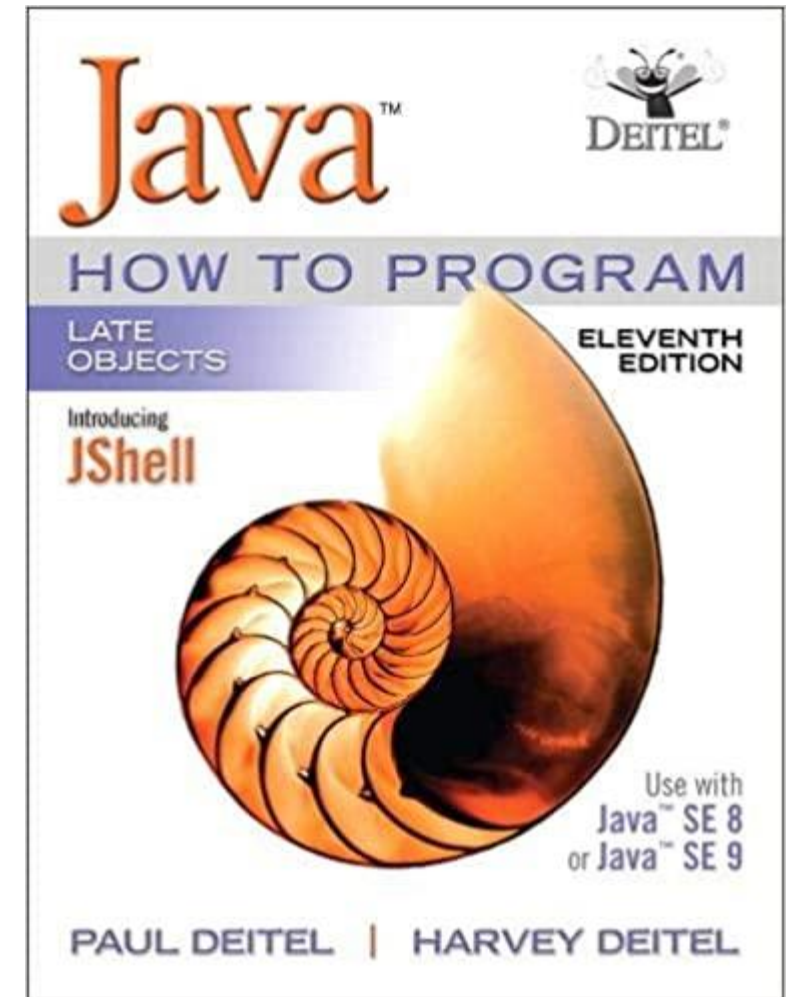
Textbooks

- ▶ Main textbook:

- P. Deitel, H. Deitel, **Java: How to Program** (11th edition), Prentice-Hall, 2017.

- ▶ Reference books:

- Y. Daniel Liang. **Introduction to Java Programming**, 10e, Pearson, Prentice Hall, 2015.
- Allen B. Downey and Chris Mayfield. **Think Java, How to Think Like a Computer Scientist**, O'Reilly, 2016.



Materials for this course

- ▶ Sakai course site:
 - <https://sakai.sustech.edu.cn/portal/site/3a72b64d-3574-49e2-978d-351b489b3ae7/tool/67bbfd4d-4195-4b4a-a18b-a192b10d1ad7>
 - Resources: Labs, Assignments, Slides, etc. The slides may not exactly follow the textbook
 - Only for students in my class
- ▶ Computing technologies advance very fast. Search online to learn more by yourself
 - Google, Baidu, Bing, Stack Overflow, GitHub

Grading

- ▶ 10% Lecture Attendance
- ▶ 10% Lab Attendance (Sign on each lab)
- ▶ 30% Assignments (5 online assignments, every 2-3 weeks)
- ▶ 20% Project
 - Released at the beginning of November
 - 8 weeks to complete
 - Group of 2 members
- ▶ 30% Final examination

Assignments

- ▶ No late assignment will be accepted (not even 1 second)
 - Unless some special situations (e.g., medical leave) which will be reviewed by all the instructors across all Java course sessions
 - The following excuses will NOT be approved for late submissions:
computer crashes, disk crashes, accidental file deletions, lab computer unavailability, and the like. There will be no reply for late assignment submission requests

Honor Code

- ▶ If an undergraduate assignment is found to be plagiarized, the first time the score of the assignment will be 0
- ▶ The second time the score of the course will be 0
- ▶ **OK to:** Discuss on ideas, help colleagues to debug, etc.
- ▶ **NOT OK to:** Take the code of a friend, make a few cosmetic changes (comments, some variable names)
- ▶ Plagiarism Policy on Sakai (Please READ!!! Very important)

Miscellaneous

- ▶ QQ group number: 858529997
- ▶ Some rules are common across all Java course sessions (e.g., no late assignments allowed, exams, assignments, and contents). Some are my own preferences (e.g., attendance)
- ▶ It is highly RECOMMENDED to bring your laptop to the labs
- ▶ Contact: Email is preferred

Course Objectives

- ▶ To learn how to **solve problems** by writing computer programs
- ▶ To learn how to **design** a computer program
- ▶ To learn how to program in **Java**
- ▶ To learn **object-oriented programming**
- ▶ To prepare you for **further courses and career**



Questions?



Chapter 1: Introduction to Computers, the Internet and the Web

Java™ How to Program, 11th Edition

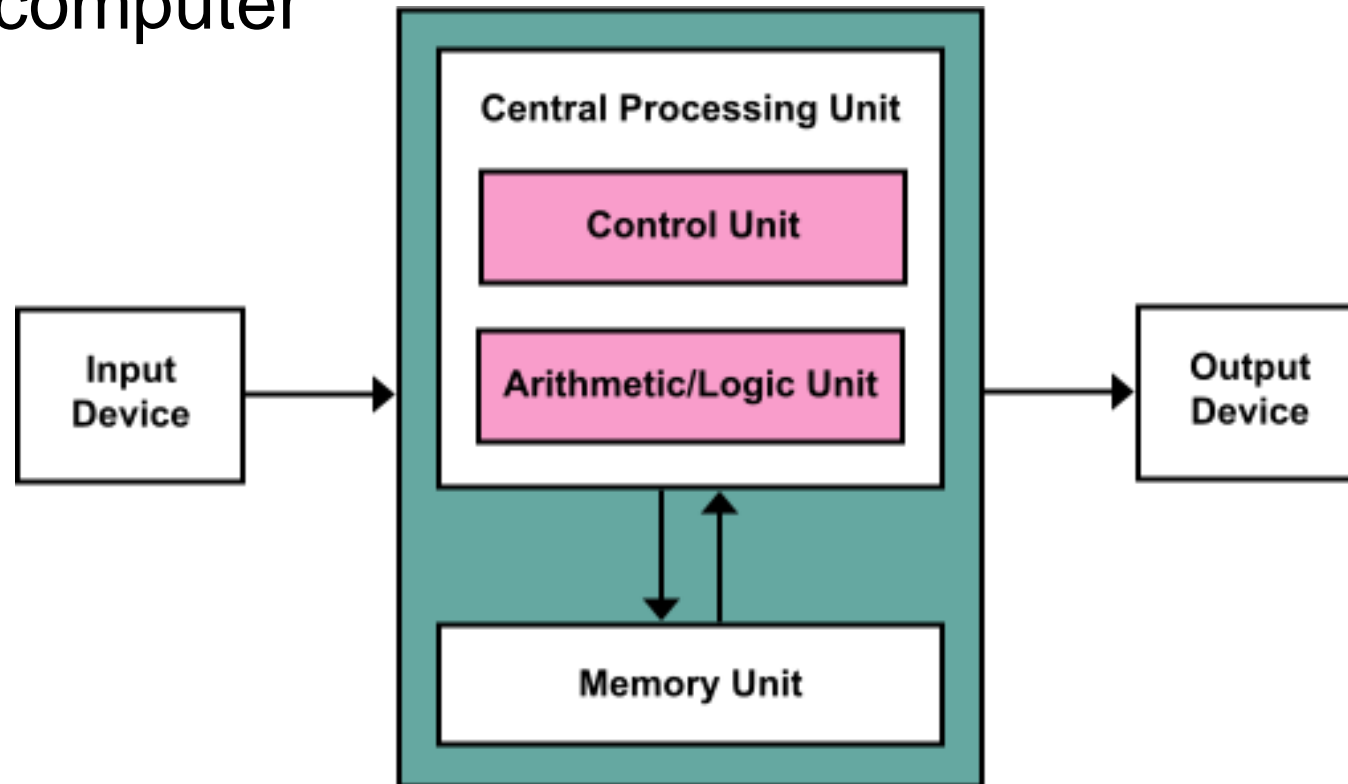


Computer System

- ▶ Hardware (硬件, physical parts, e.g., keyboard, mouse, hard disk, memory, processing units)
- ▶ Software (软件, computer programs, libraries, non-executable data, e.g., documentation)
- ▶ Hardware is directed by software to execute commands (命令) or instructions (指令). A combination of hardware and software forms a usable computer system.

The von Neumann Architecture (冯·诺依曼结构)

- ▶ A design model for a stored-program digital computer



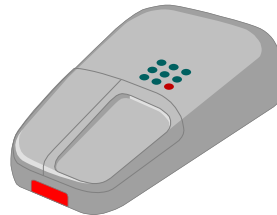
John von Neumann
(1903-1957)
Hungarian-American
mathematician, physicist

Computer Organization

- ▶ Following the von Neumann architecture, modern computers consist of the following logic units/sections:
 - Input unit
 - Output unit
 - Memory unit
 - Arithmetic and logic unit (ALU, 算术逻辑单元)
 - Control unit (控制单元)
 - Secondary storage unit (第二存储单元)

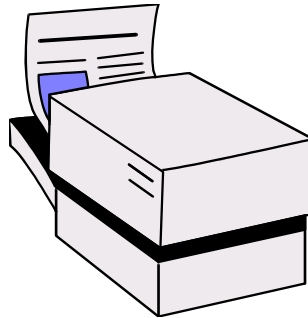
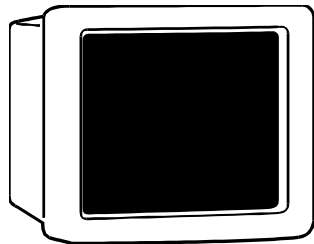
Input Unit

- ▶ The “receiving” section of a computer that obtains **information (data and programs)** from input devices and places it at the disposal of the other units for processing.



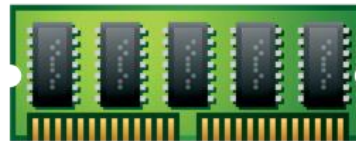
Output Unit

- ▶ The “shipping” section takes the information that the computer has processed and places it on various output devices to make it available for use outside the computer.



Memory Unit (存储器)

- ▶ **Rapid-access**, relatively **low-capacity** “warehouse” section retains information 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** (挥发性的) and will be lost when the computer’s power is turned off.
- ▶ Also known as main memory, primary memory, memory, or RAM (Random Access Memory).



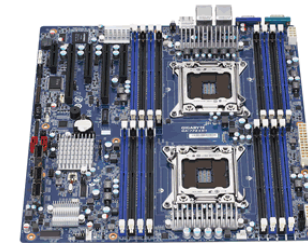


Arithmetic and Logic Unit (ALU, 算术逻辑单元)

- ▶ “Manufacturing” section performs calculations, such as addition, subtraction, multiplication and division.
- ▶ Contains the mechanisms that allow the computer to **make decisions**, e.g., comparing two items from the memory to determine whether they are equal.
- ▶ In today’s computer systems, the ALU is usually implemented as part of a CPU.

Control Unit (控制单元)

- ▶ “**Administrative**” section coordinates and supervises the operations of the other sections ([the brain/heart of a computer](#)).
 - Tells the input unit when information should be read into the memory.
 - Tells the ALU when information from the memory should be used in calculations and tells the output unit when to send information from the memory to certain output devices.
- ▶ Many of today’s computers have multiple CPUs (can perform operations simultaneously). They are called multiprocessors.
- ▶ A multicore processor implements multiprocessing on a single integrated circuit chip (e.g., dual-core, quad-core, octa-core)



Secondary Storage Unit

- ▶ Long-term, high-capacity “warehousing” section.
- ▶ Programs or data **not actively being used** by the other units normally are placed on the secondary storage devices (e.g., your hard drive, 硬盘) until they are again needed, possibly hours, days, months or even years later.
- ▶ Information on secondary storage devices is **persistent** and will be preserved even when the computer is turned off.
- ▶ Storage devices are typically much cheaper than the memory.



Are They Computers

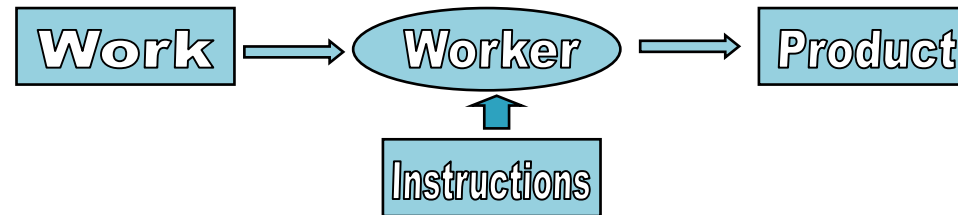


- What is the input and output unit?
- Do they have CPU, RAM and disk?

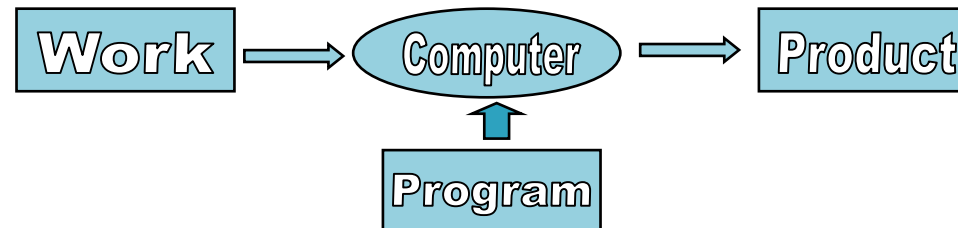
Go check your phone's specification and you will find out the answers 😊

What is a computer program?

- ▶ Human work model

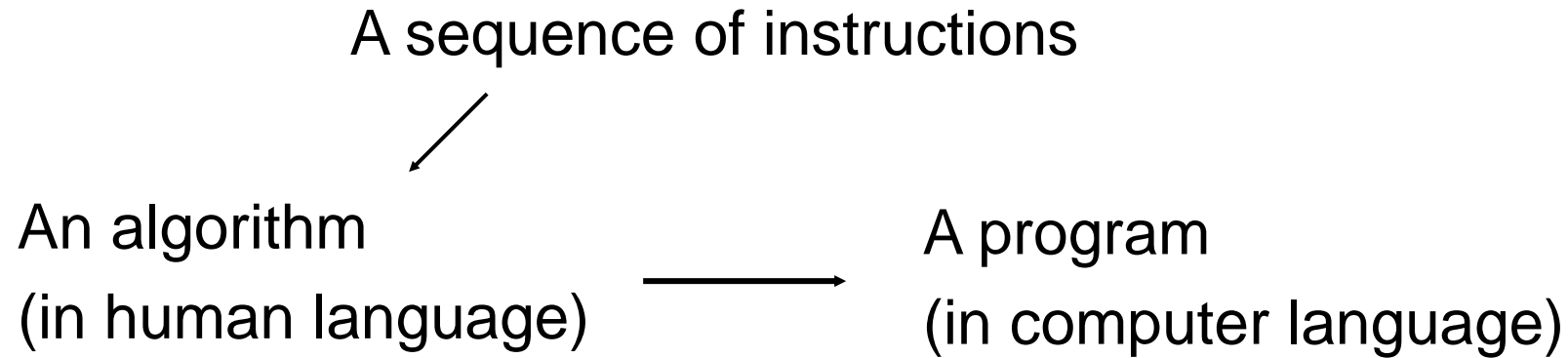


- ▶ Computer work model



- ▶ A **computer program** is a set of **machine-readable instructions** that tells a computer how to perform a specific task.

What is a (programming) language?



- ▶ Programs are written in programming languages
- ▶ There are many programming languages
 - Low-level, understandable by a computer
 - High-level, needs a translator!

Can you understand this?

00001001001011100110011001101001011011000110010100001001001000100110110001100101011
00011011101000111010101110010011001010011000100101110011000110010001000001010011001
11011000110110001100110010010111110110001101101111011011010111000001101001011011000
11001010110010000101110001110100000101000101110011100110110010101100011011101000110
10010110111101101110000010010010001000101110011101000110010101111000011101000010001
00000101000001001001011100110000101101100011010010110011101101110001000000011010000
00101000001001001011100110011101101100011011110110001001100001011011000010000001101
10101100001011010010110111000001010000010010010111001110100011110010111000001100101
00001001001000000110110101100001011010010110111000101100001000110110011001110101011
01110011000110111010001101001011011110110111000001010000010010010111001110000011100
10011011110110001100001001001100000011010000001010011011010110000101101001011011100
01110100000101000001001001000010010001101010000010100100100111101001100010011110100
01110101010101000101001000110010000000110000000010100000100101110011011000010111011
001

How about this?

main:

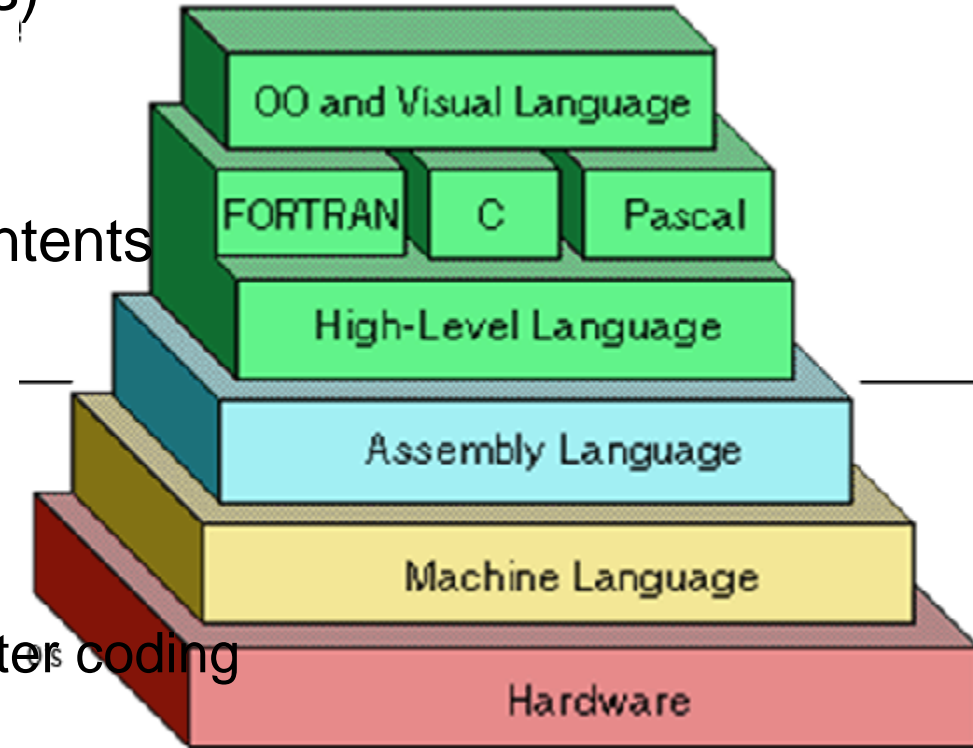
```
!#PROLOGUE# 0
save %sp,-128,%sp
!#PROLOGUE# 1
mov 1,%o0
st %o0,[%fp-20]
mov 2,%o0
st %o0,[%fp-24]
ld [%fp-20],%o0
ld [%fp-24],%o1
add %o0,%o1,%o0
st %o0,[%fp-28]
mov 0,%i0
nop
```

Is it better now?

```
int valueofz( )  
{  
    int x, y, z;  
    x = 1;  
    y = 2;  
    z = x+y;  
    return z;  
}
```

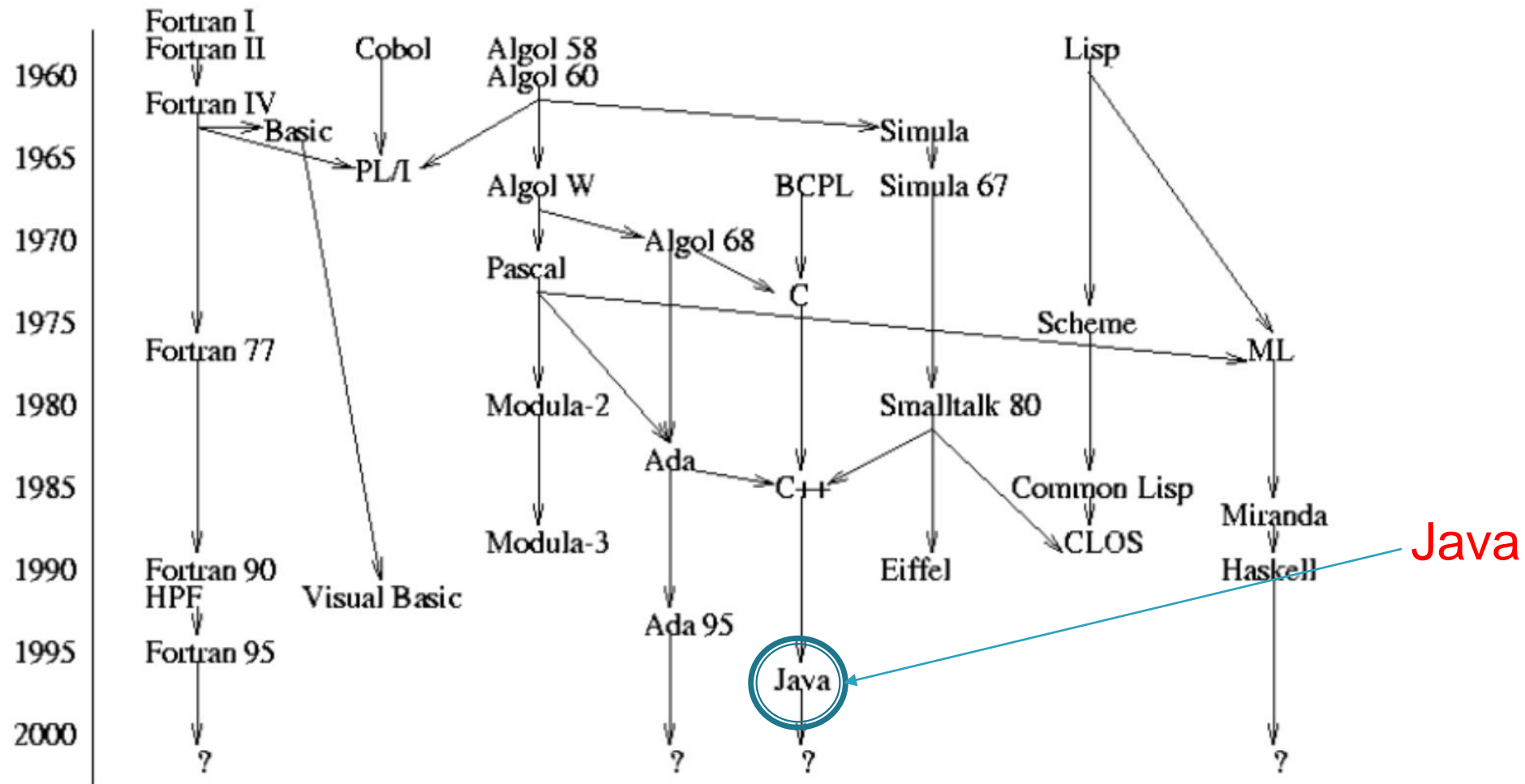
Levels of programming languages

- ▶ **Machine (binary) language** is unintelligible (bits)
- ▶ **Assembly language** (汇编语言) is low level
 - **Mnemonic** names for machine operations
 - Explicit manipulation of memory addresses/contents
 - **Machine-dependent**
每一种机器都对应不同的汇编语言)
- ▶ **High level language** (高级语言)
 - **Readable**
 - Instructions are easy to remember to support faster coding
 - No mention of memory locations
 - **Machine-independent** = **portable**



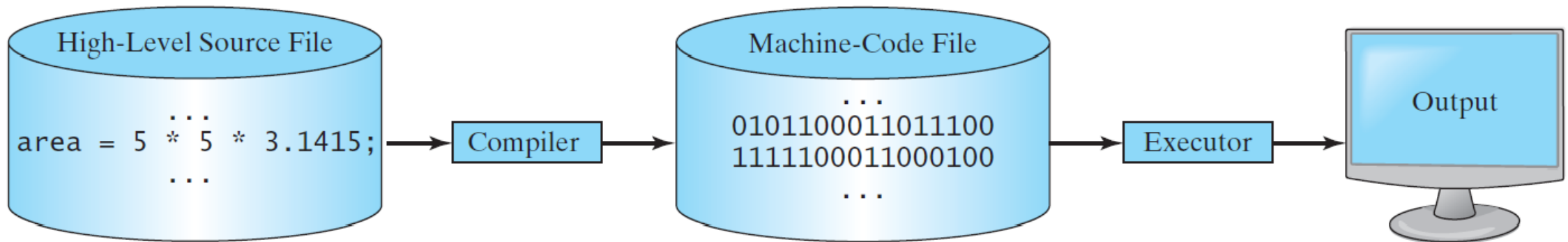
justcode.me

Genealogy of programming languages



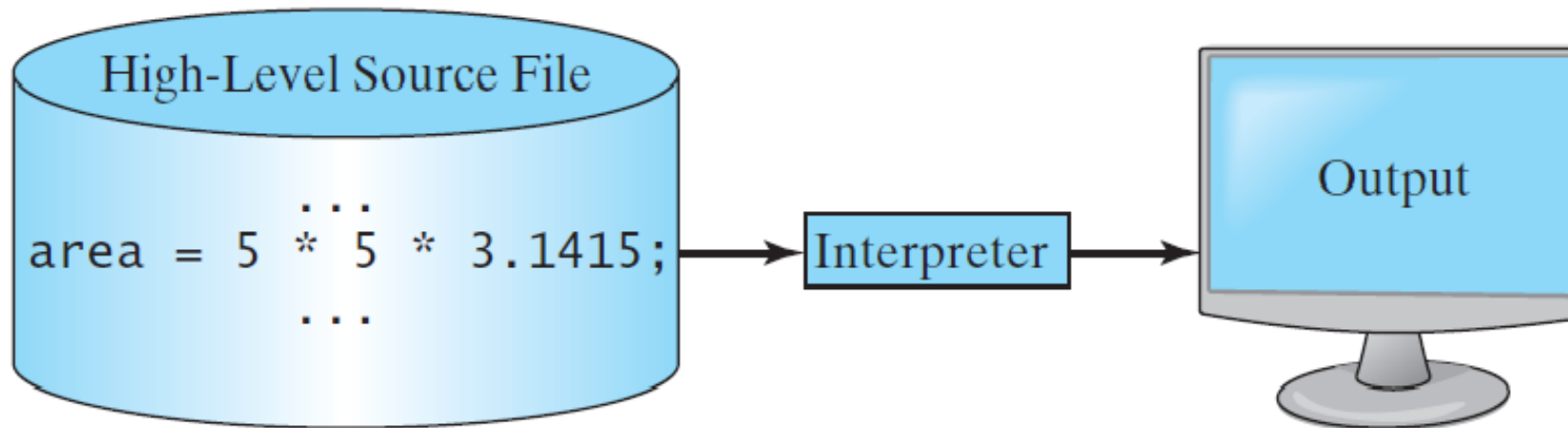
Compilation: from source to executables

- ▶ A **compiler** translates **source programs** into **machine codes** that can run directly on the target computer.



Interpreter

- ▶ An **interpreter** directly translates and executes the statements from source code, without requiring the programs to have been compiled into machine codes.



Compiler vs. Interpreter

| Interpreter | Compiler |
|--|---|
| Translates program one statement at a time. | Scans the entire program and translates it as a whole into machine codes. |
| Takes less time to analyze the source code but the overall execution is usually slower. | Takes more time to analyze the source code but the overall execution is typically faster. |
| Continues translating the program until the first error is met, in which case it stops. Hence debugging is easy. | Generates the error message only after scanning the whole program. Hence debugging is comparatively hard. |
| Programming languages like Python, Ruby use interpreters. | Programming languages like C, C++ use compilers. |

What is software?

A set of programs (also including libraries and non-executable data, e.g., documentation)

▶ Application software

- Programs designed to perform specific tasks and easy to use
 - MS Word, PowerPoint, Chrome, Photoshop, WeChat etc.

▶ System software

- Programs that support the execution and development of other programs. Two major types
 - **Operating systems** (e.g., Windows, Mac OSX, Linux for desktops, and iOS & Android for mobile devices)
 - **Translation systems** (e.g., compilers, linkers, assemblers)

What is the Internet?

- ▶ A global network of computers. It dates back to the research commissioned by the United States Federal Government to build robust, fault-tolerant communication via computer networks (1960s).
- ▶ The linking of commercial networks and enterprises **in the early 1990s** marked the beginning of the transition to the modern Internet, and generated **rapid growth** as institutional, personal, and mobile computers were connected to the network.
- ▶ By the late 2000s, its services and technologies had been incorporated into virtually every aspect of human lives.

<https://en.wikipedia.org/wiki/Internet>

What is the world Wide Web?

- ▶ The World Wide Web, or simply the Web, is **a way of accessing information** over the medium of the Internet. It is an information-sharing model that is built on top of the Internet.
- ▶ The Web uses the **HTTP protocol**, only one of the languages spoken over the Internet, to transmit data. Web services, which use HTTP to allow applications to communicate in order to exchange business logic, use the Web to share information.
- ▶ Users can utilize browsers, such as Internet Explorer or Firefox, to access Web documents called **Web pages** that are linked to each other via hyperlinks. Web documents also contain graphics, sounds, text and video.

Web 2.0



Web 2.0

- ▶ Web usage exploded in the mid-to-late 1990s. During this period, many Internet-based companies, commonly referred to as **dot-coms**, were founded, many of which failed (dot-com economic crisis).
- ▶ Resurgence began in 2004 with Web 2.0, which refers to the websites that emphasize **user-generated content, usability, and interoperability** for end users.
- ▶ A Web 2.0 website may allow users to interact and collaborate with each other in a social media dialogue as creators of user-generated content in a virtual community (**user-centric, sharing, social, interactive, dynamic**)
- ▶ In contrast, on the prior first-generation websites, people were limited to the passive viewing of content.
- ▶ Signature companies: Google, Facebook, YouTube, Tencent



We learn Java, why?

- ▶ A computer programming language (high-level language, 高级语言)
- ▶ An **object-oriented** computer programming language – today's **key** methodology
- ▶ The **most widely used** computer programming language – **billions** of devices
- ▶ **Preferred** for Internet-based applications and devices over a network

A Brief History of Java

- ▶ Microprocessors have a profound impact in **intelligent consumer-electronic devices**.
- ▶ In 1991, recognizing this, Sun Microsystems funded an internal research project, which resulted in a C++-based language named Java. The father of Java: **James Gosling**.
- ▶ In 1993, Sun saw the potential of using Java to add dynamic content to web pages and realized that Java would be ideal for use with web browsers and Java's connection to the internet began
- ▶ In 1995, Java was officially released and the Netscape browser starts to support Java.

Find out more on Wikipedia:
[https://en.wikipedia.org/wiki/Java_\(programming_language\)](https://en.wikipedia.org/wiki/Java_(programming_language))



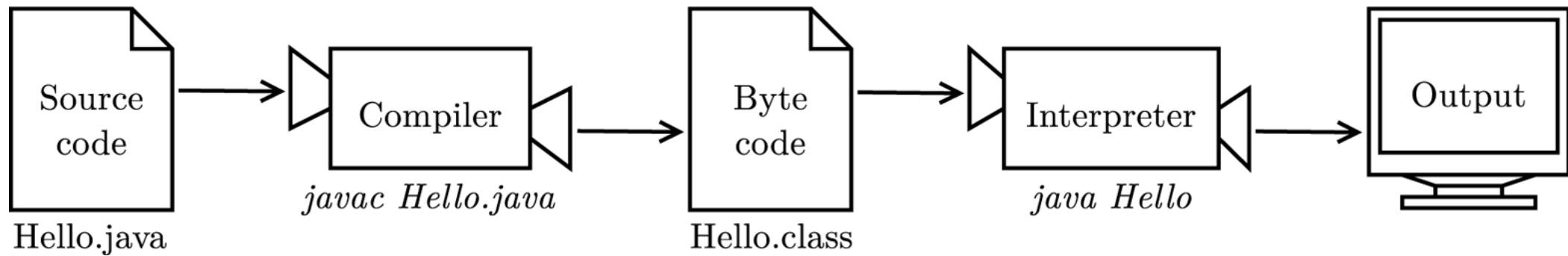
Java Editions

- ▶ Java Standard Edition 9 (Java SE 9)
 - Initial release on September 21, 2017
- ▶ Java Enterprise Edition (Java EE)
 - For large-scale, distributed networking and web-based applications
- ▶ Java Micro Edition (Java ME)
 - For small, memory-constrained devices, e.g., micro controllers, sensors, TV boxes etc.

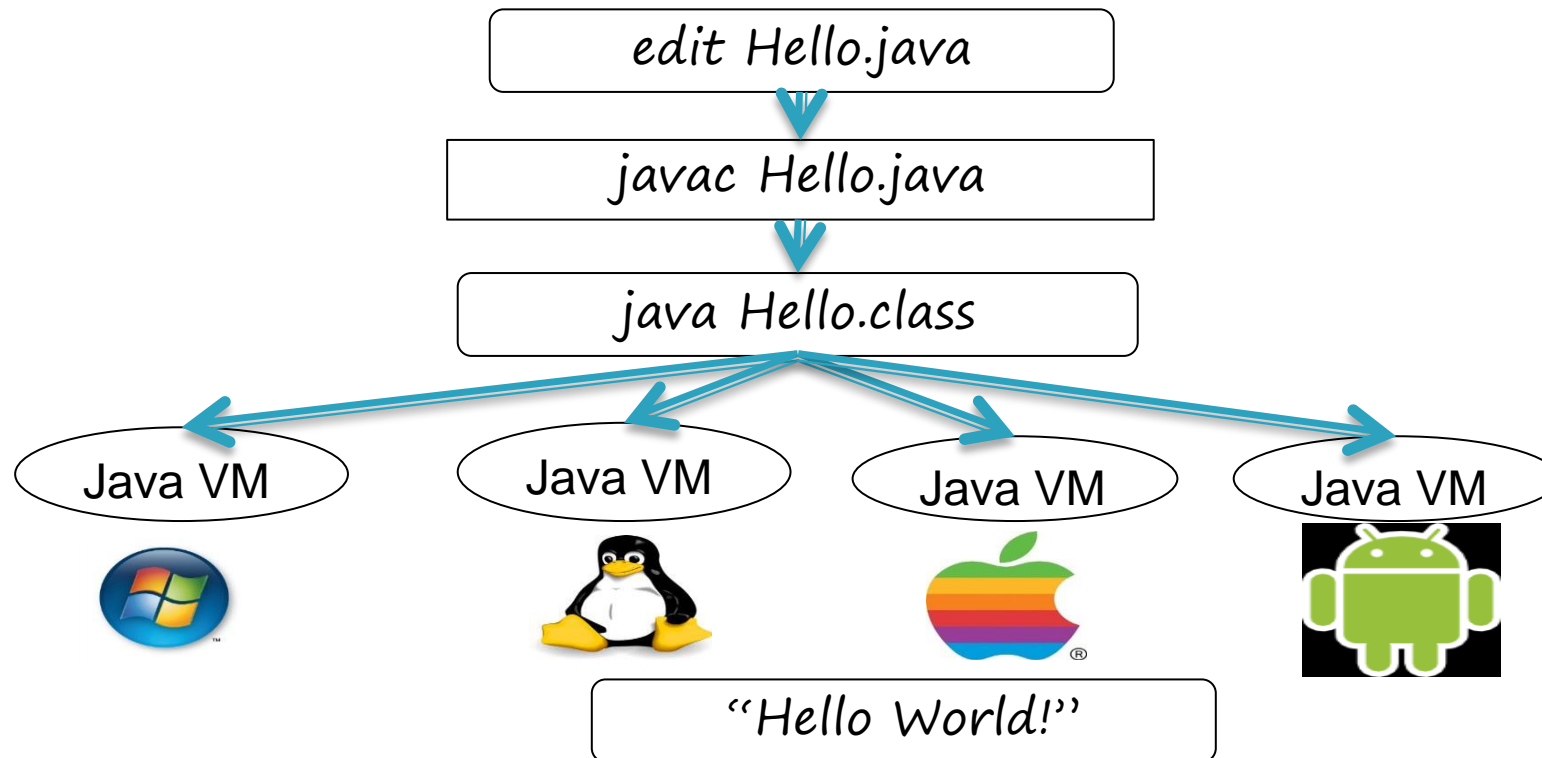
Java programming

- ▶ **Edit** (write the program and store it in the disk .java)
- ▶ **Compile** (create bytecodes and store them in a file .class)
- ▶ **Load** (read .class files and put those bytecodes in memory)
- ▶ **Verify** (confirm the bytecodes are valid and secure)
- ▶ **Execute** (run the program in Java Virtual Machine or **JVM**)

Java is both compiled and interpreted



Java is Platform Independent



Integrated Development Environment (IDE)

- ▶ Combine all the capabilities that a programmer would want while developing software (**Eclipse**, IntelliJ, NetBeans, BlueJ, etc.)
 - Download Eclipse at <http://www.eclipse.org/>
 - BlueJ is designed for beginners (<https://www.bluej.org/>)
- ▶ Before you begin, install **JDK** (**J**ava **S**E **S**oftware **D**evelopment **K**it 8+), set the PATH Environment Variable properly.
 - <http://www.oracle.com/technetwork/java/javase/downloads>

JDK, JRE, and JVM

- ▶ The **Java Development Kit (JDK)** is a software development environment used for developing Java programs. It includes the Java Runtime Environment (JRE), an interpreter/loader (Java), a compiler (javac), an archiver (jar), a documentation generator (Javadoc) and other tools needed in Java development.
- ▶ The **Java Runtime Environment (JRE)** provides the minimum requirements for executing a Java application; it consists of the Java Virtual Machine (JVM), core classes, and supporting files.
- ▶ A **Java Virtual Machine (JVM)** is an abstract computing machine that enables a computer to run a Java program.
- ▶ **JDK = JRE + Development tools, JRE = JVM + Library classes**

What is debugging?

- ▶ Debugging: tracking down and **correcting bugs (errors)**
- ▶ Three kinds of errors:
 - **Syntax Errors (语法错误):**
 - 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 (运行错误) :**
 - 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 (逻辑错误) :**
 - The semantics, or meaning of the program, are wrong.
 - e.g. yielding an unexpected result

Notices

- ▶ The lab sessions will start from this week. Attendance is required. **You are highly recommended to bring your own laptop.**

- ▶ **Sakai site:**
 - <https://sakai.sustech.edu.cn/portal/site/3a72b64d-3574-49e2-978d-351b489b3ae7/tool/67bbfd4d-4195-4b4a-a18b-a192b10d1ad7>
 - **Resource**

- ▶ Instructors and TAs can discuss with on the ideas to start with an assignment, but will not help you debug until the assignment is accepted