Introduction to Computer Programming

CS102A Lecture 1

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Instructor

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  - Office hour: 4:00–5:00 pm every Thursday this semester
    - Or by email appointment if needed
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Honor policy

- As a student in the course you are agreeing to the following principles:
  - When there is doubt regarding the honorability of an action, you will ask before doing it.
  - When possible to do so with honor, you will help your fellow classmates learn and improve.
  - You will get help from classmates and course staff before succumbing to frustration.
- Unless otherwise noted, exams and individual assignments will be pledged that you have neither given or received unauthorized help.
- If you have questions on what is allowable, ask!

Course website

- There is a Sakai site for this course
  - `https://sakai.sustech.edu.cn/portal/site/adef56f0-ce71-48dc-aa4b-739298dcd63a/`
  - Or search “CS102A-F20-Bilingual”.
- The syllabus is there (with most of the info in this slide set)
  - And all the lecture notes.
- I will try to post slide sets and lab sheets on the website beforehand.
  - Assignment questions and (maybe) answers are also there.
  - Try to meet the deadlines and late submission policy may apply.
- Computing technologies advance very fast. Search online to learn more by yourself. The lecture notes can guide your self study.
  - Search engines, Stack Overflow, GitHub.

Textbooks

- Main textbook:
  - P. Deitel, H. Deitel, Java: How to Program (10th ed., late object version), Prentice-Hall.
- 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.

Course objective

- 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.

Grading criteria

- 10% Lecture Attendance
- 10% Lab Attendance
- 20% Assignments
  - There will be four assignments.
- 20% Project
- 40% Final examination

Introduction to Computers and Java

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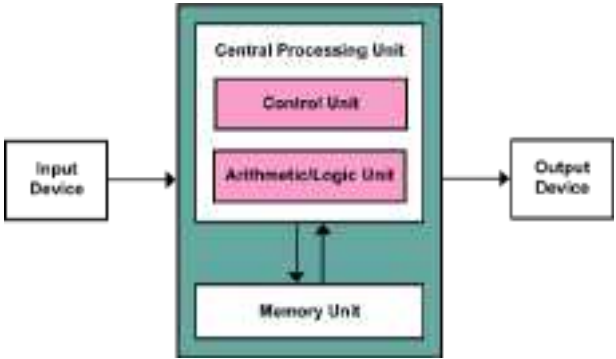
Computer system

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

The von Neumann architecture

- 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)
- Central processing unit (CPU)
- Secondary storage unit

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

- 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 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)

- “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.

Central processing unit (CPU)

- "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) 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 preform a specific task.

What is a (programming) language?

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- 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?

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```
00001001001011100110011001101001011011000110010100001001001000100
01100011001010110001101111010001110101011100100110010100110001001
00110001100100010000010100110011101100011011000110011001001011111
11000110111011110110110101110000011010010110110001100101011001000
11100011101000001010001011100111001101100101010110001101111010001101
10110111101101110000010010010001000101110011101000110010101111000
11010000100010000010100000100100101110011000010110110001101001011
11101101110001000000011010000001010000010010010111001100111011011
01101111011000100110000101101100001000000110110101100001011010010
01110000010100000100100101110011101000111100101110000011001010000
01001000000110110101100001011010010110111000101100001000110110011
11101010110111001100011011101000110100101101111011011100000101000
10010010111001110000011100100110111101100011000010010011000000110
00000101001101101011000010110100101101110001110100000101000001001
```

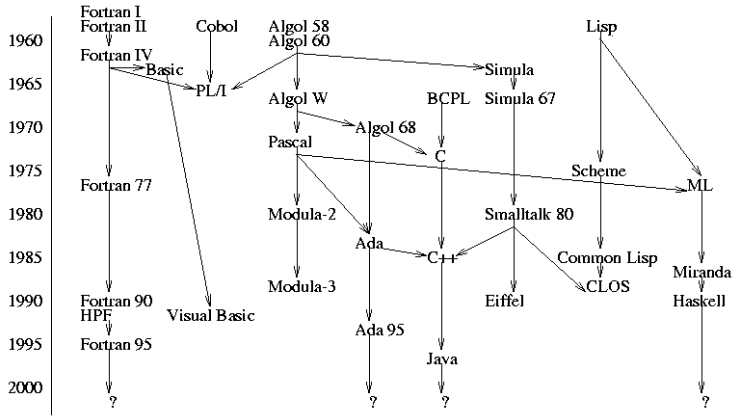
Is it better now?

```
int add() {
  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* is low level.
  - Mnemonic names for machine operations.
  - Explicit manipulation of memory addresses/contents.
  - Machine-dependent.
- *High level language*
  - Readable.
    - Instructions are easy to remember to support faster coding.
    - Less error-prone (fewer bugs?).
  - No mention of memory locations.
  - Machine-independent = portable.

Genealogy of programming languages

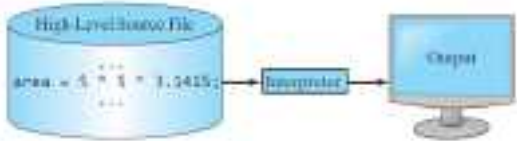


Compilation: From source to executables

- A complier 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.



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.

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 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 (doc-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, Tencent.

We learn Java, why?

- A computer programming language.
- 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.

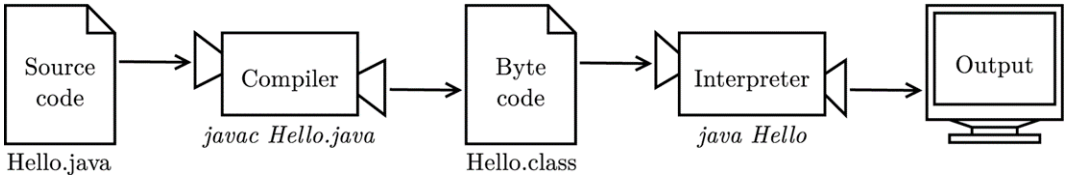
Java editions

- Java Standard Edition 8 (Java SE 8).
  - Initial release on March 18th, 2014.
- 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.

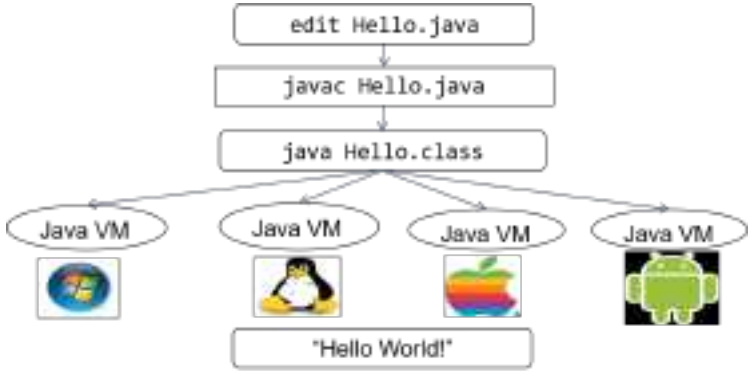
Java programming

- *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)

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- 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 (Java SE Software Development Kit 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?

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- Debugging: tracking down and correcting bugs (errors).
- Three kinds of errors:
  - *Syntax Error*s: 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 Error*s: 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 and Semantics Error*s: The semantics, or meaning of the program, are wrong.
    - e.g. yielding an unexpected result.

Notices

- The lab session will start from this week. Attendance is required.
- Sakai site:
  `https://sakai.sustech.edu.cn/portal/site/adef56f0-ce71-48dc-aa4b-739298dcd63a/`
- **Please remember to attend your lab class. You are highly recommended to bring your own laptop.**