Software Design I (CS 120): D. Mathias, 03 Sept 2019
A Basic Computing System

- Sound
- Video
- Keyboard
- Mouse
- CPU
- Memory
- Network
Hardware: Central Processing Unit (CPU)

- The main electronic chip performing the computation
- The CPU usually performs very simple tasks
  - add/subtract/multiply two numbers at a time
  - compare two numbers to see which is larger
  - move/copy data from one spot to another
  - etc....

- The CPU appears powerful (intelligent?) Why?
  - Because it does all of these things very quickly
Software: Computer Programs

- Software is a collection of instructions and data
- A program tells the CPU what to do
- A program must therefore “speak the language” of the CPU, telling it what to do in terms of a combination of the simple operations it can actually perform
Programming Languages

- A **programming language** lets us:
  1. Write down commands in a way that we can understand at a relatively sophisticated human level
  2. Do so in a way that can be *translated* into “CPU-speak,” at the level of basic machine operations

- A **very great difference** exists between those levels
  - Many degrees of possible language complexity
  - Each language looks different and works somewhat differently at the high level of the programmer
  - However, each gets “translated” into the same simple language of the CPU in order to run the program
Levels of Languages

High Level
Closer to Human Language

LISP, C++, Java, Python

Fortran, C, Pascal

ASSEMBLY

Low Level
Close to CPU
(add, subtract, etc.)

MICROCODE
Compiling a Program

- Programmers write at the higher level of a programming language.
- To make the CPU understand, it is translated to the lower, machine level, CPU Instructions.
- The translator is itself a program, called a compiler.
  - Since each system/CPU will have different ways of doing things, each has its own low-level “language.”
  - The translation will only run on certain specific systems/CPUs.
  - To get the same program to run on a different sort of machine, you have to compile (translate) it again.

C++ (High level)

```cpp
cout << "Hello World";
```

Compiler

```
01111111 01000101
01000011 11111100
01101101 01110111
00000000 00000000
```

CPU Microcode (Low level)
The Process in Java

- Things are slightly different here!
- We have another program, the Java Virtual Machine (JVM)
- The JVM translates Java bytecode into actual CPU instructions
- In Java, the first compiler step actually translates our instructions into this bytecode (middle-level), which is a combination of human-readable and formal constructions
  - **Advantage**: the same bytecode can run on any OS for which a JVM exists (which does its own final translation). Platform independent.
  - **Disadvantage**: someone has to write the JVM for each OS (the same thing is true for compilers, however)
  - **Another (partial/possible) advantage**: the JVM also seeks to verify the bytecode to avoid dangerous bugs and security holes (due to how complex programs may be, this is only partially possible)
Remember: this isn’t really such a bad situation.

Before, we had to write a separate compiler for each platform, anyway.
The Java Programming Model

<table>
<thead>
<tr>
<th>Action</th>
<th>Tool</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmer types in commands</td>
<td>Text Editor</td>
<td>Source code file (className.java)</td>
</tr>
<tr>
<td>Software is translated into computer’s “language” to be run</td>
<td>Java Compiler</td>
<td>Bytecode file (className.class)</td>
</tr>
<tr>
<td>The program executes.</td>
<td>Java Virtual Machine</td>
<td></td>
</tr>
</tbody>
</table>
For This Week

- **Meetings this week:**
  - **Tuesday, Wednesday:** regular classroom
  - **Friday:** in the CS Lab (16 Wing)
    - Important to be there to get oriented with the lab
    - You can bring your own computer if you like, but we will ensure everyone can log in to lab machines properly

- **Please obtain the online text ASAP**

- **First reading assignment due: 12:00 PM, Wednesday 11 Sept.**

- **Office Hours: Wing 212**
  - **Monday/Friday:** 2:15 PM–3:15 PM
  - **Tuesday:** **12:30—1:30 PM** (normally 3:00 PM–4:00 PM)
  - **Wednesday:** 12:05—1:00 PM