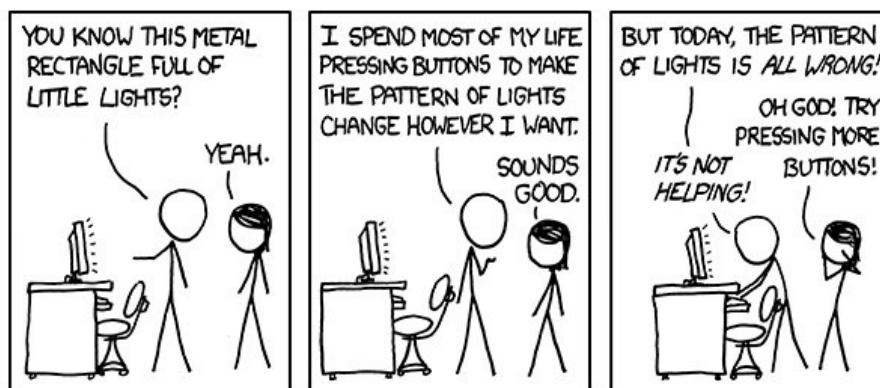# TOPIC 1
INTRODUCTION TO
COMPUTER SCIENCE
AND PROGRAMMING

Notes adapted from Introduction to Computing and Programming with Java: A Multimedia Approach by M. Guzdial and B. Ericson, and instructor materials prepared by B. Ericson.

Outline

- What will you get out of this course?
- What is computation?
- What is Computer Science?
- Roles of Computer Science in our society
- What's in a computer
- What is a program
- What is programming
- What a compiler does
- Lets learn about Java

Why this course?

- Learn how to think like a computer scientist
- Learn problem solving
- Read and write code
- Understand object oriented programming
- Be well prepared for CS1027
- Understand objects and classes
- Know a bit about the computing field

What is computation?

- The tool is the computer – the action is computation
- Computers carry out actions
- Think of a recipe...
  - Place butter in pan
  - Add eggs
  - If you like them cooked all the way
    - Flip over
  - If not, keep cooking while they aren't done yet
  - Eat!!

What is computation?

- A recipe is a set of steps
- A computer carries out a set of steps based on what the programmer tells it
- It can do any set of basic instructions

What is Computer Science?

- The design, analysis, implementation, …
- of algorithms (recipes),
- that **solve problems.**

Roles of Computer Science

- Maintaining the technical infrastructure
  - network, software
- But also many algorithmic challenges
  - Artificial Intelligence (AI) for games
  - search or auction algorithms (Google, Bing)
  - medical imaging
  - cryptology (RIM)
  - low-power chips

Whats in a computer?

- Memory
- CPU – Central processing unit
  - ALU → arithmetic logic unit
  - Program Counter
- Peripherals
- I/O and secondary memory

Memory – Hard disk

- Slow, cheap and huge
- It is a physical item, so it actually has to move to do anything
- Items on the disk get loaded into memory and then the cache if its being executed

Memory - RAM

- Main memory – RAM
  - Random access memory
- **Faster, holds less**
- Disappears when you shut off the computer
- Made of switches that are either 0 or 1
- Holds programs currently executing

Memory - Cache

- In the CPU
- Small
- Fast

Memory - Registers

- Very few, nothing faster
- Called "working registers"
- Say you run a program... gets loaded to RAM, first part goes to cache, then current items go to registers

Peripherals

Outside pieces of a computer that depend on it such as:

- Mouse
- Keyboard
- Speakers
- Printers
- Etc...

External memory and I/O

- **Secondary Memory**: hard disks, CDs, DVDs, USB sticks
  - Provide long-term storage
  - Organized as files, each of which has a file name and a folder (directory) that contains it.
- **Input/Output (I/O) units**: keyboard, mouse, screen, printer, webcam, etc.
  - Used for communications with the user

What is a program?

- **Programs** consist of:
  - Instructions to perform a task
  - Data values used in performing the task

- In CS, the general simplest program is "Hello World", making a computer print "Hello World" to the screen

- For example, in Python it would be:
  - print "Hello, World!"

What is a program?

□ In Java, which we use, its a little more involved:

```
public class HelloWorld {
   public static void main(String[ ] args) {
      System.out.println("Hello World!");
   }
}
```


What is programming?

□ Programming is the process of creating detailed **instructions** that a computer can **execute** to accomplish some task, i.e., to solve some problem (or set of problems)

□ Much like writing out a recipe for someone who only understands explicit instructions

□ Take the recipe or instructions, boil them down to the key steps, and make the computer do these steps

How to Program

- Computers don't understand English

- We as programmers prefer languages that are similar to English
  - Called **"high level languages"**

- Computers prefer low level languages

High-level languages

- **Java**, C, C++, C#, Visual Basic, Turing, Python, Scheme, Lisp, Pascal, Fortran, etc.

- **People-oriented**: We understand them easier than a computer does

- **Machine independent**: Not brand specific – can run on Windows, Mac, Linux, etc

What the computer understands

- Computer is just electricity – either on or off

- If its on, it can be thought of as a 1

- If its off, it can be thought of as a 0

- Computers do not understand English, they understand on or off: 0 or 1

- At the basic level, all computers do is add, subtract or move what is stored in memory locations

Machine language

- The **machine language** consists of the set of instructions that the CPU can execute **directly**
  - Instructions to the CPU are made up of **0's and 1's**

      0001001110000101001001101011111001

  - **Machine dependent:** each type of computer has its own machine language

Binary

- The numbers you are used to using are base 10
  - They go from 0 to 9 then start to repeat in combinations → there are only 9 options to make up all numbers

- Computers only have 2 options to make all numbers with – 0 and 1
 - Because they are limited to on or off

Bits and Bytes

- A bit is a binary digit – a 0 or 1
- A string of 8 bits are a byte
- A kilobit is 1000 bits, a megabit is 1,000,000 and so on
- Computers can only do on or off, and a certain number of these at a time – hence a 64 bit processor a 32 bit processor, etc..

High-level to machine language

High-Level Language
Program (source code)

↓

Compiler

↓

Machine Language
Program (executable code)

↓

CPU
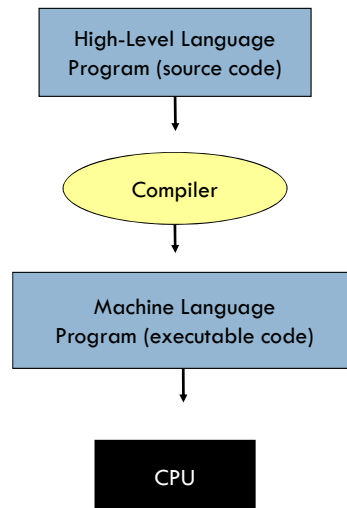
Java

- A high-level language developed by Sun Microsystems in the early 1990s
  - Cross-platform
  - Object-oriented (later)
- Widely used in business, science and education
- One of the fastest-adopted technologies of all time!
- Different from previous high-level languages

JAVA™

From program to execution

Java source code

↓

Java Compiler

↓

Bytecode

→

CPU ← Java Virtual Machine
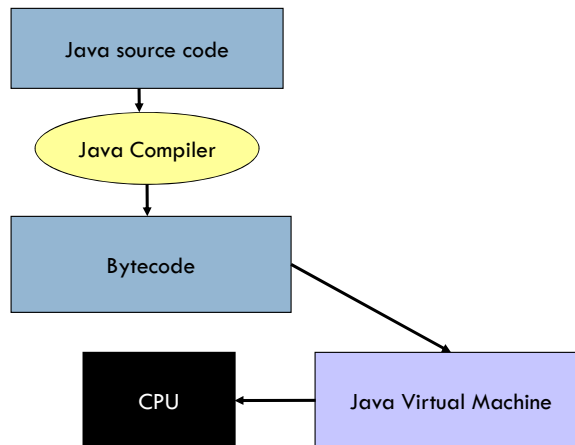
Helpful Hints

☐ Throughout this course there are some tricky topics that make wonderful exams questions

☐ When we are covering something that frequently trips up students, I will put this picture:

Pay attention to this little guy! Work hard to understand concepts where he appears.

Summary

- Terminology introduced:
    - CPU, RAM, ALU
    - Bit
    - Program
    - High-Level Language
    - Machine Language
    - Compiler
    - Bytecode
    - Java Virtual Machine
    - My exam buddy