Today

• Hardware and Memory
• Programs and Compiling
• Your first program
Before Programming

• You need to know basics of a computer
  – Like learning driving, you should know that it has an engine that burns gasoline and deliver power to wheels
• Understand what your program is doing
• Talk intelligently about computers
Computer – It’s not Magic

Hardware vs Software (Concretely)

• Hardware - physical machine
  – CPU, Memory

• Software - programs that give instructions to the computer
  – Windows 7, Google Chrome, Games, Eclipse
Hardware vs Software (Abstractly)

• Software
  – An organized collection of instructions

• Hardware
  – Circuits that execute, store and interact with instructions
    • Execution: CPU
    • Storage: Memory
    • Interaction: Peripherals, like keyboards, monitors, networks
Instructions

• An instruction is a sequence of 0’s and 1’s that represents a single operation on the computer
  – Example: 00000101 00000001 00000010
  – Means: ADD 1 2
  – The output will be 3

• These 0’s and 1’s are called bits
  – Why only 0 and 1?
    • Because it is easy to make an electrical device that has only two stable states
CPU (Central Processing Unit)

- It is the “brain” of the computer
  - CPU executes the instructions
  - CPU’s working routine
    - read instructions and data from memory
    - do calculation
    - write calculation results back to memory

- Intel Core i7 3.4 GHz
  - Executes at most 3,400,000,000 instructions per second
Memory

• Holds instructions and data for the computer
  – How much the “brain” can remember

• Main Memory
  – For intermediate calculations (program you are running)
  – Disappears when you shut down your computer

• Secondary Memory
  – Hard drives, CDs, Flash drives
  – Exists until you delete it
GB? MB? KB?

• 1 bit = 0 or 1
• 1 byte = 8 bits
  – Smallest addressable unit of memory
• Kilo, Mega, Giga, Tera
  – 1 KB = 1,000 bytes (1 thousand bytes)
  – 1 MB = 1,000 KB = 1,000,000 bytes (1 million bytes)
  – 1 GB = 1,000 MB = 1,000,000,000 bytes (1 billion bytes)
    • The same for GHz (1 Giga Hertz)
  – 1 TB = 1,000 GB = 1,000,000,000,000 bytes!
Main Memory

• Memory address
  – To locate certain memory positions
  – CPU fetches data according to memory address

• Another interesting fact: characters are also saved in bits, and so does everything
Peripherals

- **Input devices**
  - Keyboards, mouses, game controllers......
  - When they get inputs, they save them at certain memory addresses

- **Output devices**
  - Monitors, speakers, printers......
  - They are projected to certain memory addresses
  - When CPU wants to output, it writes to those addresses

- **CPU sees everything as memory**
Programs

• Set of instructions for a CPU to follow
  – Also known as software.

• You will be writing programs
  – We will look at one soon

• Our programs will be in **Java**
Programming Languages

• Why do we need languages when we have instructions?
  – Too hard for humans to write bits directly

Programming Languages

Different languages are good at different aspects

- C/C++: close to instructions, runs fast
- Matlab: good at scientific computation
- Python: relatively easy, fast development

We choose Java

- Not because
  - Best Language (there is no such thing)
  - Easiest to learn 😞

- Because
  - Widely used, incorporate (most) modern features
The translator is called **compiler**
- It is also a program
- From human-readable to machine-readable

```java
class Hello {
    public static void main(String[] arguments) {
        // Program execution begins here
        System.out.println("Hello world.");
    }
}
```
Self-test Questions

• What is a software?
• What are the two kinds of memories?
  – What’s the difference?
• How many bits are there in 1 MB?
• When we enter something from the keyboard, what will happen inside the computer?