Introduction to Computers and Programming

- Hardware
- Software
- Computer languages
- Compiling and running
A computer system consists of both *hardware* and *software*.

Hardware - the physical components.

Software - the instructions, or rather, computer programs, that tell the hardware what to do.
Common Hardware Components

- **Processor:**
  - Central Processing Unit (CPU)
  - Interprets and executes program instructions

- **Memory:**
  - Volatile and non-volatile
  - Holds data and instructions

- **Input devices:**
  - Keyboard, mouse, touch-screen
  - Game controllers
  - Sensors

- **Output device(s)**
  - Video display, printer
  - Robotic devices
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At a high-level there are two types of memory:

- **Volatile** – contents are lost when power is turned off:
  - Main memory (stores programs and data during execution)
  - Cache memory
  - Fastest and most expensive form of memory, per byte

- **Non-Volatile** – contents are maintained when power is turned off:
  - Hard drive, hard disk or Solid State Drive (SSD); internal or external
  - CD, DVD
  - Flash drive
  - Tape (still used extensively)
  - Slowest and cheapest form of memory, per byte
- Bit = one binary digit, either 0 or 1
- Byte = 8 bits
- Word = 4 bytes
- Larger groupings: (number of bytes)

<table>
<thead>
<tr>
<th>Name</th>
<th>Approximation</th>
<th>Exact</th>
</tr>
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<tbody>
<tr>
<td>Kilobyte (KB)</td>
<td>$2^{10}$</td>
<td>$10^3$</td>
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<tr>
<td>Megabyte (MB)</td>
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<td>Terabytes (TB)</td>
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<td>Yottabyte (YB)</td>
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Everything in memory is “encoded” in binary, i.e., as a sequence of bits.

“A” => 01000001
45 => 00101101
“DOG” => 01000100 01001111 01000111

Generally, the encoding of an object is unique among all similar objects, e.g., the encoding of “A” is different from the encoding of “B.”

Why?
How many binary sequences are there on $n$ bits?

How many bits are needed to uniquely encode $k$ items?

- $k=8$
- $k=12$
- $k=5$
- $k=1000$
Main Memory Organization

- Main memory:
  - A list of locations, each containing one byte of data.
  - Each location has an associated “number,” which is commonly referred to as its’ *address*.
  - Is said to be *byte addressable*.
  - Also called Random Access Memory (RAM).

- The number of bytes per data item may vary from one item to another, and from one computer system to another.
  - Integer => 4 or 8 bytes (1 word)
  - Character => 1 or 2 bytes
A **program** is a set of instructions for a computer to execute or run.

**System Software** - Part of the computers “infrastructure,” and necessary for the system to operate:
- Operating Systems – DOS, Microsoft Windows, MacOS, Linux, UNIX, etc.
- Database Systems – Oracle, IBM DB2, SQL Server, Access
- Networking Software
- Web Servers
- Application Servers

**User Applications** - Not required for the system to operate:
- Games
- Apps
- Office Applications – Word, Powerpoint, Excel
- Web Browsers
- Text Editors – textedit, vi, emacs, notepad
Various Types of Software Interfaces

- **Graphical User Interface (GUI)**
  - Windows, menus, buttons, sliders, etc.
  - Windows, Word, PowerPoint, most games
  - Sometimes also called “event-driven” interfaces
  - First developed by Xerox Corporation

- **Command-Line:**
  - User types in commands one line at a time
  - DOS (Start -> run -> cmd)
  - Unix xterm

- **Application Program Interface (API)**
  - Allows one program to communicate, interact or “interface” with another, or with some external, physical device.
  - ODBC, JDBC, Swing, AWT
Programs are written, or coded, in a programming language.

There are many different types of programming languages.
High-Level Languages

- High-Level Language (HLL):
  - Java, C, C++, C#, COBOL, FORTRAN, BASIC, Lisp, Ada, etc.
  - closest to natural language - words, numbers, and math symbols
  - relatively easy for people to read (intended for people)
  - sophisticated, multi-line statements/commands
  - not directly understood by hardware
  - “portable” (hardware independent)

- A program in a HLL is frequently referred to as:
  - a *source* program
  - *source* code
  - *source* file
  - *source*
public class SimpleProgram
{
    public static void main(String[] args)
    {
        System.out.println("Hello out there.");
        System.out.println("I will add two numbers for you.");

        int x;
        double d;

        x = 3752;
        d = 3.14156;

        System.out.println("The sum of " + x + " and " + d + " is: ");
        System.out.println(x + d);
    }
}
Machine Languages

- Machine Language:
  - very difficult for humans to read
  - just 0s and 1s
  - primitive single-line commands
  - directly understood by hardware
  - not portable (hardware dependent)

- A program in machine language is frequently referred to as:
  - an *object* program
  - *object* code
  - *executable* program
  - *executable* code
  - *executable*
Machine Language Example

000000
000001
000010
000110
000000
100000
100011
100011
000011
001000
000000
000000
000001
000100
:

:
Getting from Source to Machine Code

- Back in the dark ages, people programmed in machine code…this was a pain!

- Then a really smart person invented HLL’s…this was much better.
  - John Backus => FORTRAN (mid 1950’s)

- HLL programs must be translated to machine code in order to be executed.

- Translating a program in a high-level language to machine code is called compiling.

- A program that compiles programs is called a compiler.