Introduction

How does a computer execute a program?

Program ⟶ | computer |
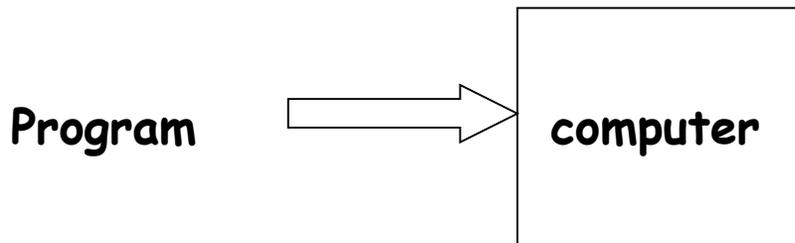
What is there inside a computer?

Are all computer hardwares alike?

What is the difference between a PC and a Mac?

<u>Technologies</u>

A computer is an instruction-execution engine.

Different hardware technologies are possible:

Mechanical

Pneumatic

Electronic

Quantum

Biological

We will focus on **electronic technology** only, which is most common. It uses silicon-based integrated circuits

Classification

General purpose

Your PC

Special purpose

The computers in your car

The computer in your cell phone

The computer inside your camera

The computer in your washing machine

Partial History of modern day computers

Eckert and Mauchley

Moore School of the U. of Pennsylvania, ENIAC

John Von Neumann

Princeton U.

EDVAC, the blueprint of the first stored program

digital computer

Maurice Wilkes

Cambridge U., EDSAC, the first operational stored-

program digital computer

John Vincent Atanasoff

Iowa State University

Designed a machine in 1939-1940 to solve

differential equations. Recognition came much later.

Generations

First generation: vacuum tubes

Second generation: transistors

Third generation: integrated circuits

Fourth generation: LSI and VLSI

Measuring speed

MIPS 10^6 instructions per second

BIPS 10^9 instructions per second

MFLOPS 10^6 floating point ops per second

GFLOPS 10^9 floating point ops per second

TERAFLOPS 10^{12} floating point ops per second

PETAFLOPS 10^{15} floating point ops per second

Units of time

1 second

1 millisecond (ms) $= 10^{-3}$ second

1 microsecond (μs) $= 10^{-6}$ second

1 nanosecond (ns) $= 10^{-9}$ second

1 picosecond (ps) $= 10^{-12}$ second

Questions

How much time does it take to add two integers?

How much time does your computer take to read a

1 MB (megabyte) file from a disk?

What distance does light travel in 1 nanosecond?

A Basic Digital Computer

| Arithmetic Logic Unit | ⟷ | Data | ⟵ | Input Unit |
| Control Unit | ⟵ | Program | → | Output Unit |
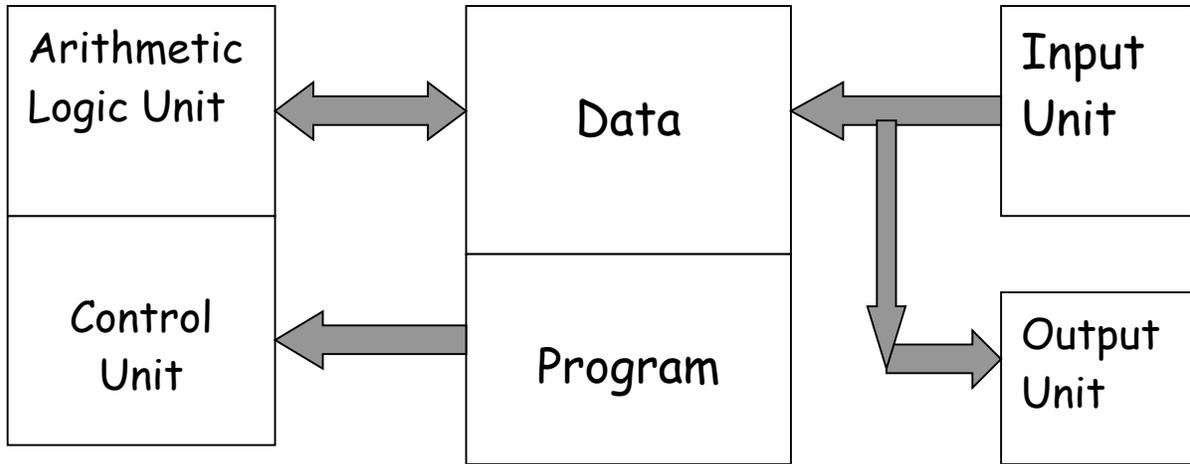
CPU or Processor   MEMORY   I/O

Measuring the Speed

MIPS = Million Instructions Per Second

MFLOPS = Million FLOating point ops Per Sec

GFLOPS = Billion (Giga) FLOating point ops Per Sec

TERAFLOPS = Trillion FLOating point ops Per Sec

PETAFLOPS = 10^{15} FLOating point ops Per Sec

What do we do with a TERAFLOP or a PETAFLOP

machine? Do we have enough work for them?

Laws of Hardware

Signals cannot travel faster than the speed of light.

Memory is always slower than the CPU.

Software is slower than hardware.

Moore's Law.

The packaging density of transistors on an integrated circuit increases 2x every 18 months.

Gates Law.
The speed of software halves every 18 months
(Microsoft is the worst offender. Software bloat almost compensates for hardware improvement due to Moore's law).

Amdahl's law

Concerned with the speedup achievable from an improvement to a computation that affects a fraction of that computation.

Factors influencing computer performance

Problem ▮ algorithm ▮ HLL program ▮ machine code → P
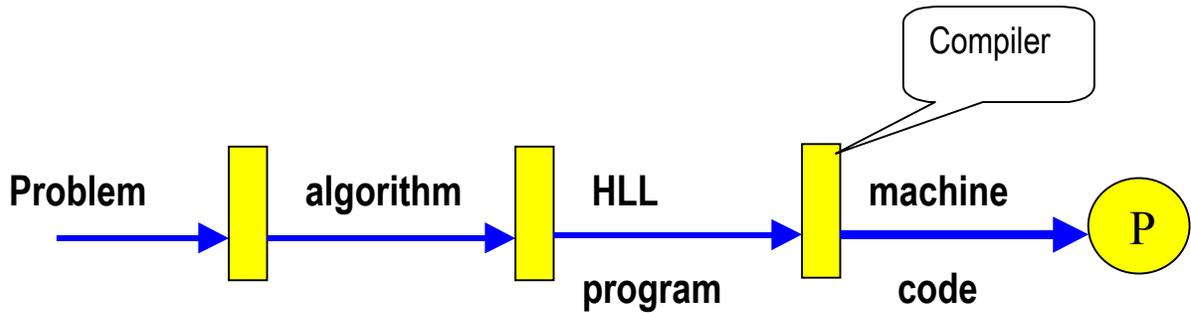
Compiler

How fast can you solve a problem on a machine?

Depends on

The algorithm used

The HLL program code

The efficiency of the compiler

And, of course, it also depends on the target machine. If the algorithm is lousy, then do not blame the computer!