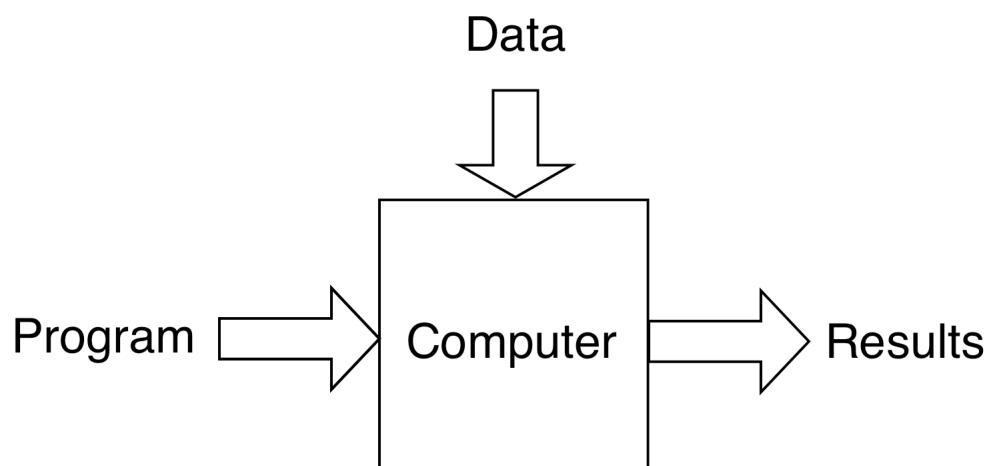


Computer Organization

Introduction

Here are some natural questions:

How does a computer execute a program?



What is there inside a computer?

Are all computer hardwares alike?

What is the difference between a PC and a Mac?

Technologies

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 the most common technology used today. It primarily 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

Units of time

1 second

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

1 microsecond (μ s) = 10^{-6} second

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

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

Questions

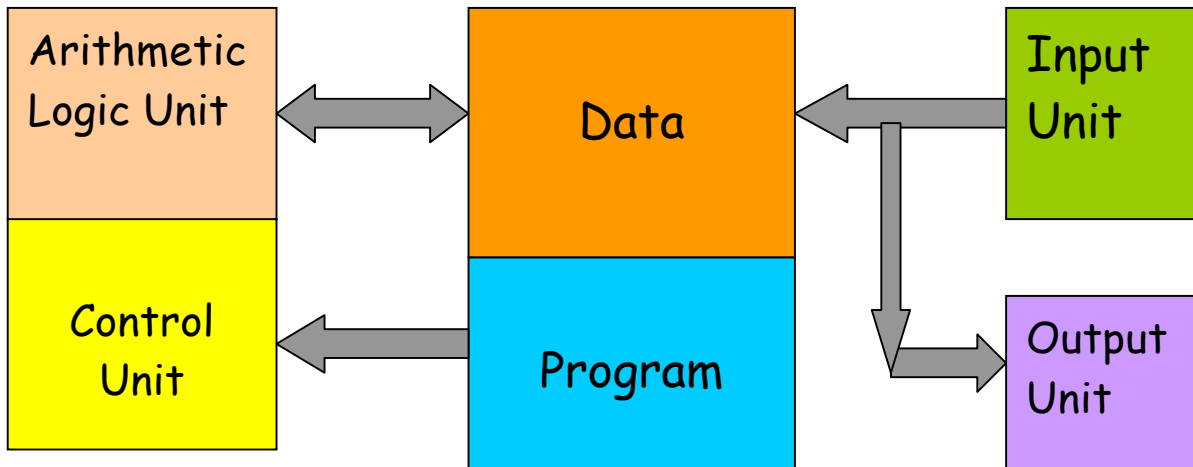
My PC has a 3 GHz clock. What does the clock do?

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 an electronic signal travel in 1 nanosecond?

A Basic Digital Computer



CPU or Processor

MEMORY

I/O

There are different ways of designing the "boxes" or the functional units. At the upper level, we care only about the functionality and not so much about their internal construction.

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 TERAFL0P or a PETAFL0P machine? Do we have enough work for them (other than playing video games)?

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.

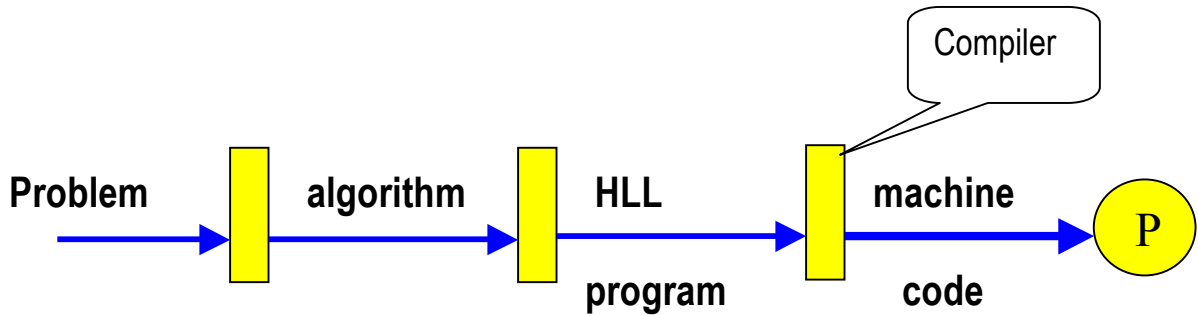
The speed of software halves every 18 months

(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



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!