**Introduction**

*Here are some natural questions:*

How does a computer execute a program?

Program $\rightarrow$ computer

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 most common. 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 (µs) = $10^{-6}$ second  
1 nanosecond (ns) = $10^{-9}$ second  
1 picosecond (ps) = $10^{-12}$ second
Questions

My PC has a 3.5 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

PETA FLOPS = $10^{15}$ FLOating point ops Per Sec

What do we do with a TERAFLOP or a PETA FLOP 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 $2^x$ 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!