Hardware and Software

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Hardware

- **Hardware** refers to the physical parts of the computer.
    - Hardware is sometimes referred to as computer components and peripherals.
    - E.g., Motherboard, Hard Disk/Drive
- **Software** refers to the set(s) of instructions given to the computer to execute one or more tasks.
    - Software is sometimes referred to as programs or applications.
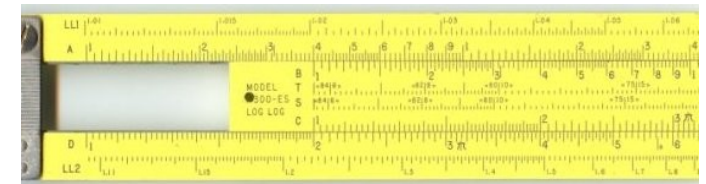   - E.g., Microsoft Office, Firefox

Early Calculation 1/2

Early Chinese abacus can be used to add, subtract, multiply and divide.
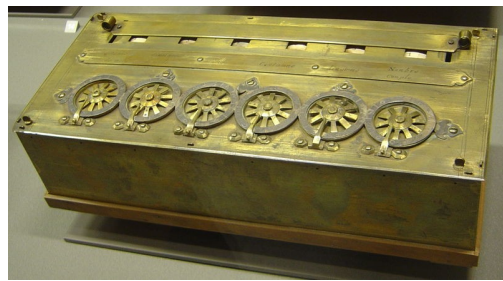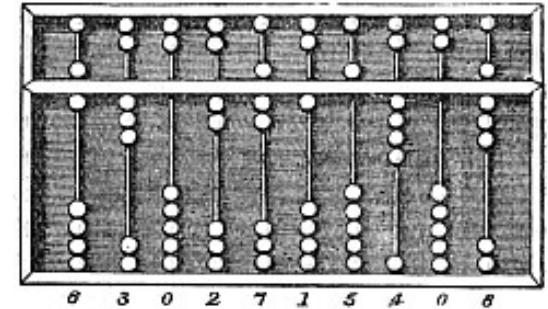
Mechanical calculators invented by Schickard, Pascal, Leibniz, etc. used cogs and wheel to compute.

Slide rules performed multiplication and division using logarithms – in popular use until about 1970.
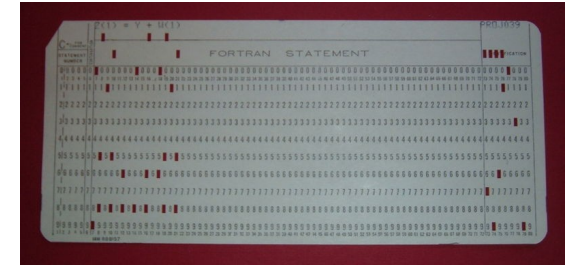
Reference: Wikipedia

Early Calculation 2/2

In early 1800s, Jacquard used punched cards to control a loom.

Hollerith used punched cards for the 1890 US census (his company eventually became IBM!).

Babbage's difference engine (1830) calculated tables of polynomial values.

Analogue Computing

Babbage designed (but never built) the first general-purpose programmable computer – the analytical engine.

Vannevar Bush (1930) built a differential analyzer that used wheels/discs to perform integration.

Vacuum Tubes

ENIAC (1945) was one of many early programmable digital computers, using vacuum tubes for computation and patch cables for manual programming.
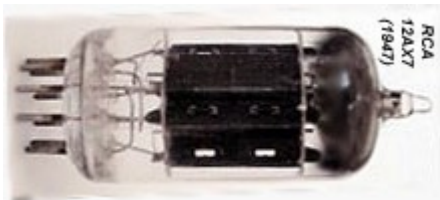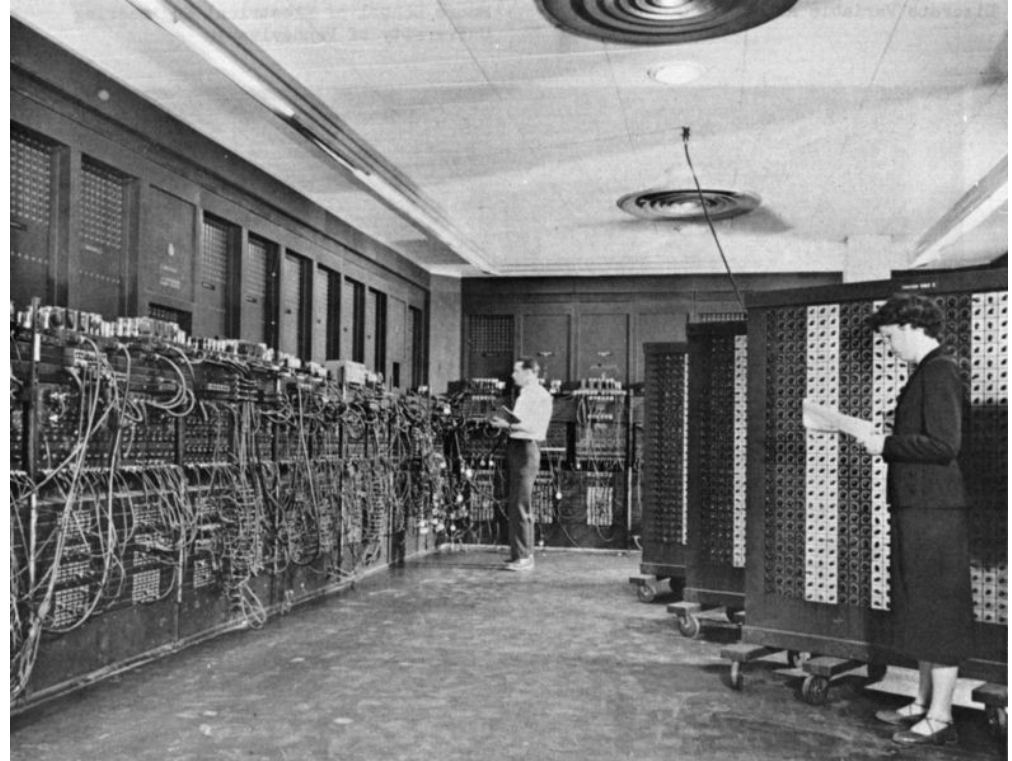
1960s to Present

First transistors and integrated circuits and finally microprocessors, revolutionised computing, made them small, cheaper and more general-purpose.

ZX80 (1980)

IBM PC (1980)

Apple MAC (1985)

The Von Neumann Architecture

- This describes how a conceptual computing device works:

  - **Memory** stores data and instructions.

  - **Control Unit (CU)** obtains and executes instructions.

  - **Arithmetic Logic Unit (ALU)** does calculations.

  - **Accumulator** is internal ALU storage for some data.

  - **Input** is process of getting data into machine.

  - **Output** is process of obtaining data from machine.

- Most modern computers are Von Neumann machines!
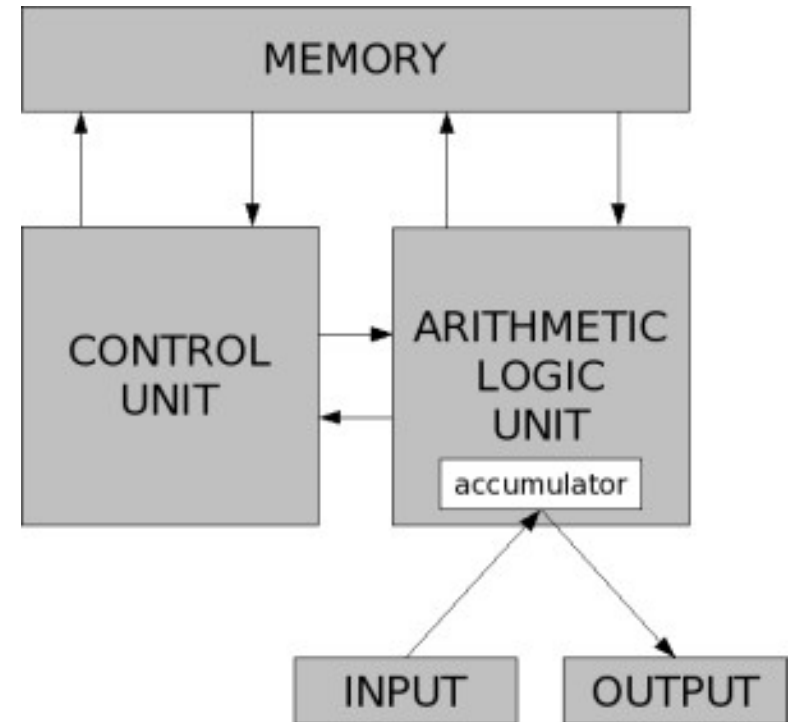
Parts of a Modern Computer 1/2

Monitor: for displaying output →

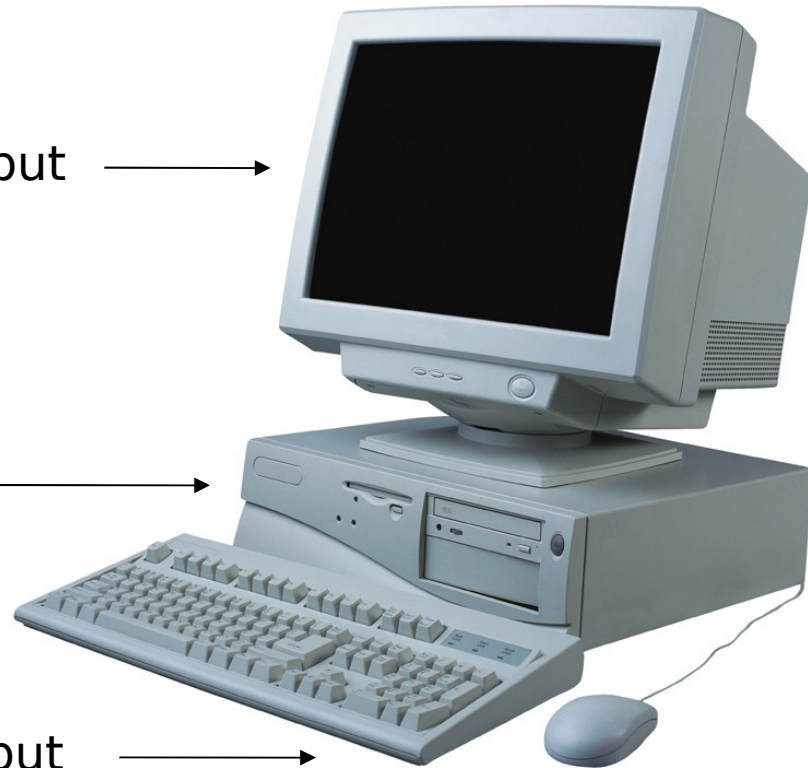System Unit: CPU, Memory, Hard drive, Floppy drive, ... →

Keyboard and Mouse: for input →

Parts of a Modern Computer 2/2

- **Central Processing Unit (CPU)**: microchip that performs core computation. It usually contains the ALU and CU.

- **Memory** (**primary storage**): microchips that store data which can be accessed while computer is switched on.
  - **Random Access Memory (RAM)** is volatile and modifiable.
  - **Read-Only Memory (ROM)** cannot be changed.

- **Hard drive**, **Floppy drive** (**secondary storage**): store data on magnetic discs permanently i.e., the data is not lost when the computer is switched off.

- **Input/Output devices**: transfers data from operator to machine and vice versa.

- **Operating System**: software system that manages resources on computer and executes application programs, e.g., Windows XP, Ubuntu Linux.

The IBM PC and compatibles ...

- Original IBM PC (1981), 8088, 4.77MHz
- XT (1983), 8086, 10MHz
- AT (1984), 80286, 20MHz
- 80386 (1986), 33MHz
- 80486 (1989), 66MHz
- Pentium I (93), 133MHz
  - II (97), 400MHz
  - III (99) 1GHz
  - IV (2000) 3GHz
- Intel Core 2 (2006), 2GHz

Can Computers Get Faster?

- Moore's Law:
  - Number of transistors (speed of computers) doubles every two years.

- Stopped at Pentium 4!

- Not possible to cram more transistors
  - Heat dissipation
  - Power consumption

- Now use more cores per CPU – currently quad-core, but soon possibly many more cores.

- Computer scientists must "think in parallel"!

Programming Languages

Programming Languages Classes

- The language directly understood by a computer is called **machine language**.
  - E.g., B4 4C CD 21 terminates a program on a PC
- **Assembly language** is a low-level language with mnemonics (codes) used for each instruction to make programming easier for humans.
  - E.g.,
    MOV AH,4Ch
    INT 21h
- **Low level languages** are languages geared towards machines (computers).
- **High-level languages** are languages that are easier for humans to use.
  - E.g., Java, C++, Pascal

Popular Programming Languages

- C++
  - Can be used by engineers and scientists for high performance applications.
- Pascal
  - Can be used for teaching computer programming.
- Perl, Python
  - Can be used for rapid application development.
- PHP
  - Can be used for Web-based applications.
- C#
  - Can be used for Windows applications.

Programming Languages Types 1/2

- Imperative Languages
  - Programs state explicitly how problem is to be solved.
  - Programs are broken down into named modules of sequential code.
  - e.g., FORTRAN, COBOL
- Object-Oriented Languages
  - Special case of imperative languages.
  - Real world is modeled as data+actions that can be performed on data.
  - e.g., Java, Smalltalk

Programming Languages Types 2/2

- □ Declarative Languages
  - ■ Programs state what is to be solved – engine seeks out solution!
  - ■ Programs are stated as rules.
  - ■ e.g., Prolog, XSL
- □ Functional Languages
  - ■ Programs state how problem is solved by applying and composing functions.
  - ■ Programs are stated as functions.
  - ■ e.g., LISP, Mathematica

Software for Programming

- A **compiler** is a program that converts/translates a program from a high-level language (what we can understand easily) to a low-level language (what the computer can understand).

- The low-level program is then executed by the CPU directly (if it is already in machine code) or via an **interpreter** or **virtual machine**.

- A **debugger** is a special tool to help find errors in a program.

Other Types of Software

- Systems Software
  - Operating System (Windows XP, Ubuntu Linux, etc.)
  - Development Tools (Java compiler, Jgrasp, etc.)
- Applications Software
  - Office applications (OpenOffice, MSOffice, etc.)
  - Utilities (Zip, Notepad, etc.)
  - Internet applications (Firefox, IE, etc.)
  - Games
  - ...