Ferhat Abbas University - Sétif 1

Faculty of Sciences

Computer Science Department

Lecture notes:

Structure Machine 1

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Chapter 4 : Boolean Algebra

1. Definitions

- **Computer Science (computing)**: the science of automatic information processing.
- **Computer:** an electronic machine that is used for processing all types of information (text, image, sound, etc.). There are several types of machines: personal computer (PC), server, supercomputer, embedded computer, PDA (Personal Digital Assistant), smartphones,….
- **Data:** the data are raw and unorganized elements, which have not yet been processed.
- **Information :** when data is processed, organized, structured, or presented in a way that makes it useful or meaningful, it is called information. Therefore, information is a data with associated semantics.

   Example: each student's exam mark is a part of data. The average of a class or the entire school is information that can be obtained from the given data.
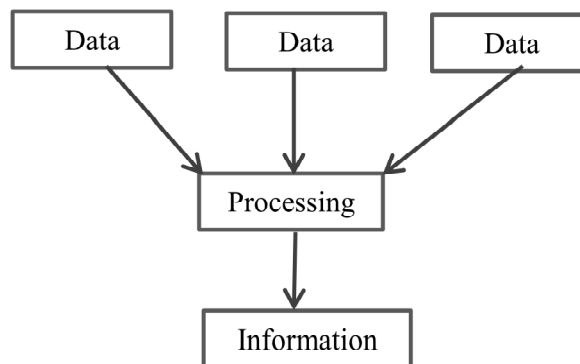
Figure 1.1 : *Data vs information*

2. Computer system

It is the set of programs (software) and components (hardware) necessary for the processing of information.

   a. Software : divided on two parts

- **Operating system (OS)**: programs that manage and control hardware and software resources. The operating system facilitates the user's task by offering him simplified access to machine's resources. It acts as an interface between the computer hardware and the applications that run on it. There are several operating systems: Microsoft Windows, Linux, Unix, Mac OS, Android….

- **Application software:** the application software is a program that performs a specific task. *E.g.* : Microsoft word, excel, video games, Chrome…

      b. Hardware: hardware refers to the physical components (devices) of a computer. *E.g.* : processor, memory devices, monitor, printer, keyboard, mouse, motherboard…

3. Evolution of computers (history)

The evolution of computers has been characterized by the increase in the speed of the processors and the decrease in the size of the components also the increase in the memory's size and the speed of the peripheral input/output components.

The evolution of computers has gone through several generations:

    ~1940 : 1st generation : technology of vacuum tubes (lamps). Example: ENIAC (Electronic Numerical Integrator Analyzer and Computer): 17,468 tubes, 30 tons, 167 m^2, built at the University of Pennsylvania (1946).

    ~1950 : 2nd generation: (invention of transistor) a transistor is an electrical semiconductor component that controls current and voltage. The transistor serves to switch, regulate or amplify currents. Unlike vacuum tubes, transistors are much cheaper, smaller and faster.

    ~1960 : 3rd generation: integrated circuits (microelectronic circuits) are combinations of transistors inside a chip.

    ~1970 : 4th generation : microprocessors are miniaturized processors that manage the execution of computer instructions.

    ~2000 : 5th generation: intelligent machines, artificial intelligence, supercomputers. *E.g*: smart cars, recognize human speech, …..

4. Computer architecture

The architecture of computers follows the model proposed by Von Neumann in 1945, where the computer is divided into four distinct parts:
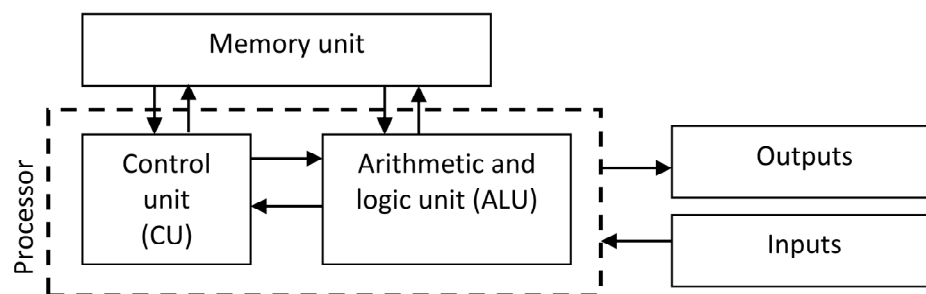
Figure 1.2 : *Von Neumann architecture*

c. Processor (CPU: Central Processing Unit): the brain of the computer, the CPU is an electronic circuit that interprets the instructions and processes the data of a program. The CPU is divided into two parts:

- **CU (control unit)** : responsible for reading from main memory (RAM), interpreting instructions, and sequencing operations to be executed, it controls also how data moves around the system.

- **ALU (Arithmetic and logic unit)**: set of circuits that handles all the calculations the CPU may need, **e.g**. arithmetic (add, sub, div, multipl) and logical (and, or, not, etc.) operations.

d. Memory unit :

The memory unit consists of main memory, called RAM (Random Access Memory) which is fast and also directly accessible by the CPU, and the secondary memory (hard drive, DVD, …).

e. Input/Output devices:

Input devices are peripherals used to provide data to a computer. Output devices are used to send information from a computer.

Notes :

- The mixed peripherals are those devices that operate as input and output. *E.g.* touch screens, modems…

- The several components are connected by communication buses which ensure the transmission of data.

- A CPU is characterized by: the clock frequency expressed in GHz/s (billion cycles per second), the size of its internal registers (8, 16, 32, 64, 128 bits) and the number of computing cores (single core, multi core…)

5. Machine language (binary code)

Machine language is the series of bits (0 or 1) understandable by the machine.

The bit (binary digit) is the smallest unit of information storage (0 or 1). In computing, hardware works on the basis of electrical impulses, so there are only two possible states, active (value 1) or inactive (0). The 1 and 0 are symbolic signs, the physical representation of a bit is based on the distribution of negative and positive charges in the transistor.

6. Data storage units

Unit	abbreviation	value	Approximate value
bit	b	1 or 0	
Byte	B	8 bits	
kilobyte	KB	2^{10} bytes	$\approx 10^3$
Megabyte	MB	2^{20} bytes	$\approx 10^6$
Gigabyte	GB	2^{30} bytes	$\approx 10^9$
Terabyte	TB	2^{40} bytes	$\approx 10^{12}$
Petabyte	PB	2^{50} bytes	$\approx 10^{15}$
Exabyte	EB	2^{60} bytes	$\approx 10^{18}$
Zettabyte	ZB	2^{70} bytes	$\approx 10^{21}$
Yottabyte	YB	2^{80} bytes	$\approx 10^{24}$