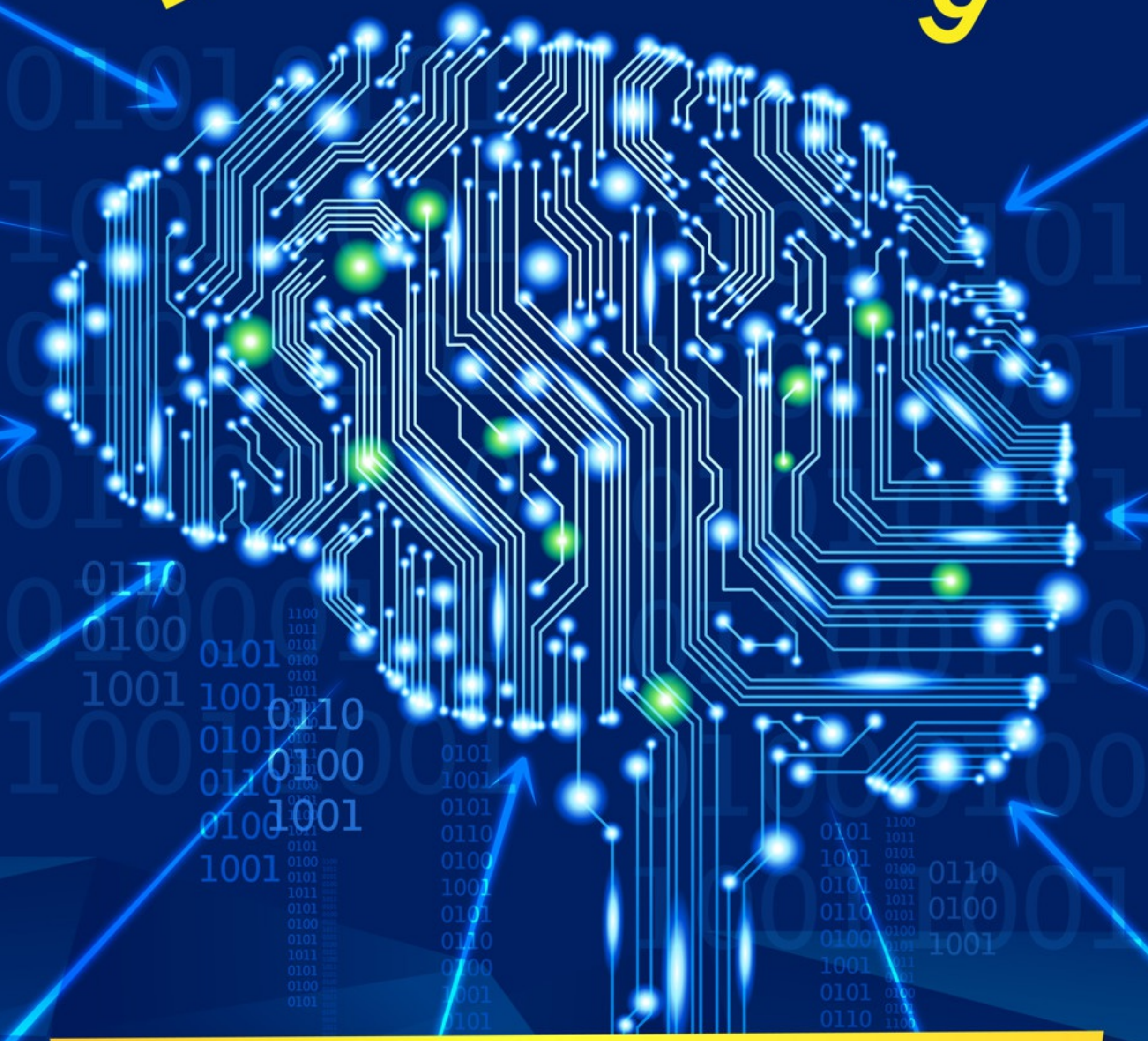
Logical thinking



David Cárdenas • Martha Esparza • Arturo Muñoz
Octavio Muñoz • Selenia Quezada • Verónica del Vivar

EDITORIAL DIGITAL
TECNOLÓGICO DE MONTERREY

2nd Edition

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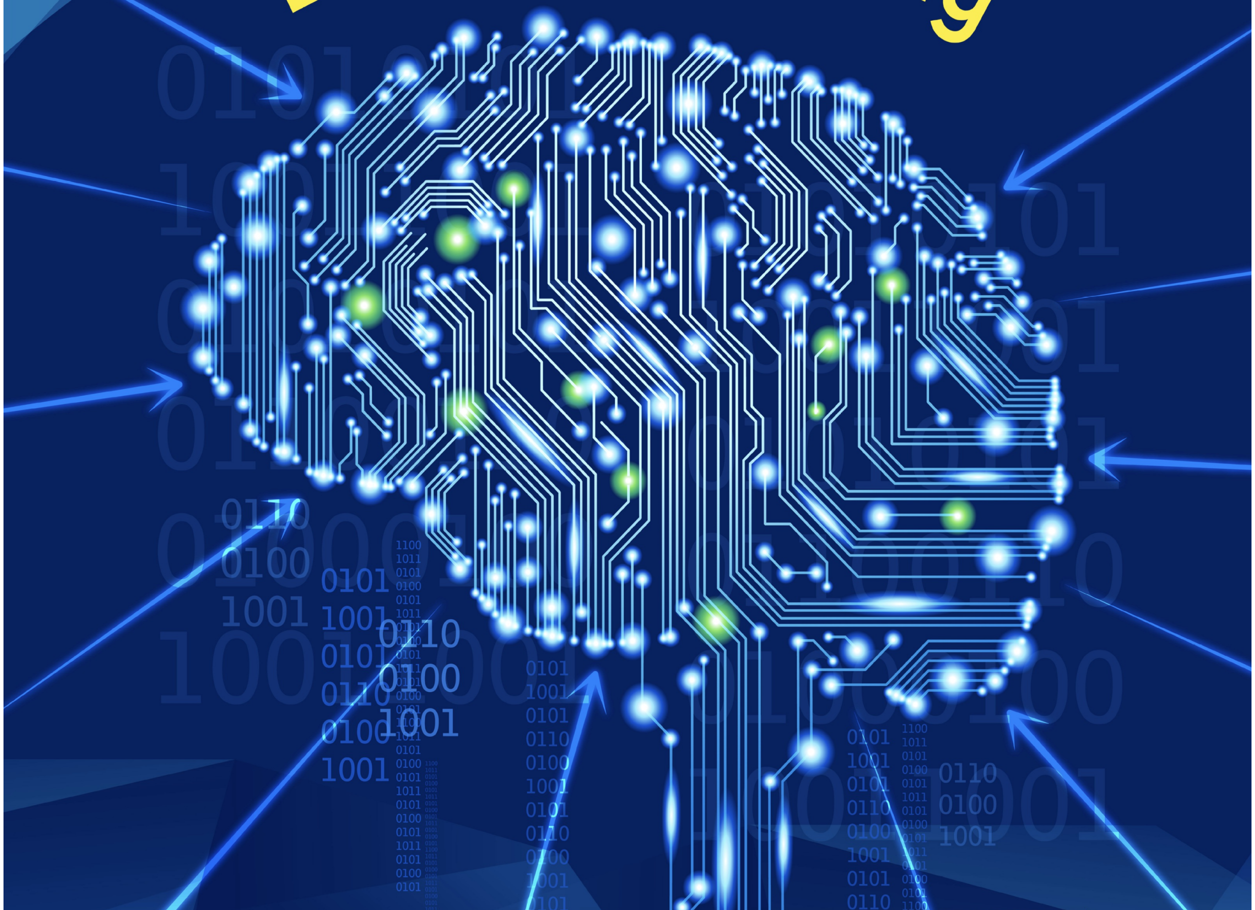

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About the eBook

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Logical Thinking

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About the Authors

Click here to see the welcome video.

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He was a professor at the high school of the Tecnológico de Monterrey (Eugenio Garza Lagüera) since August, 1999.

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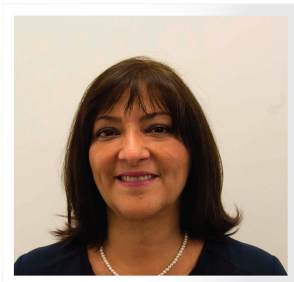

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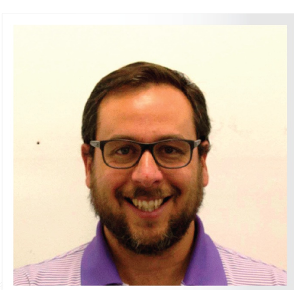

He is a professor at the high school of the Tecnológico de Monterrey (Querétaro) since August 2003.

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Since 2011, he has participated in five different events as a head coach for FIRST (For Inspiration and Recognition of Science and Technology) and has won different awards such as the Entrepreneurship Award in the regional event held in San Jose, California in his second year of participation, and the Chairman's Award (considered the most important prize at this level) in the regional event in Calgary in the third year. In that same year, he received the Judges' Award and a safety award in the world event held in Saint Louis Missouri. In 2014 he received the Chairman's Award in the regional event in Fort Lauderdale, Florida. During the last year of his participation, he was officially recognized as an inspiring mentor thanks to the praise of his students on FIRST's website.

He is now part of the Tec 21 curriculum design committee in the department of Design, Art, and Technology, and he is also a member of the Multichannel Learning Ecosystem (EAM for its acronym in Spanish) and curricular activities in the high school committees.

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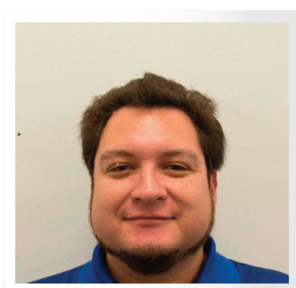

He is a professor at the high school of the Tecnológico de Monterrey (Estado de México). He holds a major in Computing and Administrative Systems, and has a master’s degree in Educational Technology from the Virtual University of the Tecnológico de Monterrey.

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He is currently coordinating the classes of the Design, Art and Technology Department in Ciudad de México. He is the author of the book *Development of Multimedia Applications*, and he is a joint author of the books *Introduction to Information Technologies, Creativity and Digital Design, and Digital Expression* (the two latter ones published by Editorial Digital from the Tecnológico de Monterrey). Also, he participated in the study plan committee for 2014 of the high school program of Design, Art and Technology of the Tecnológico de Monterrey.

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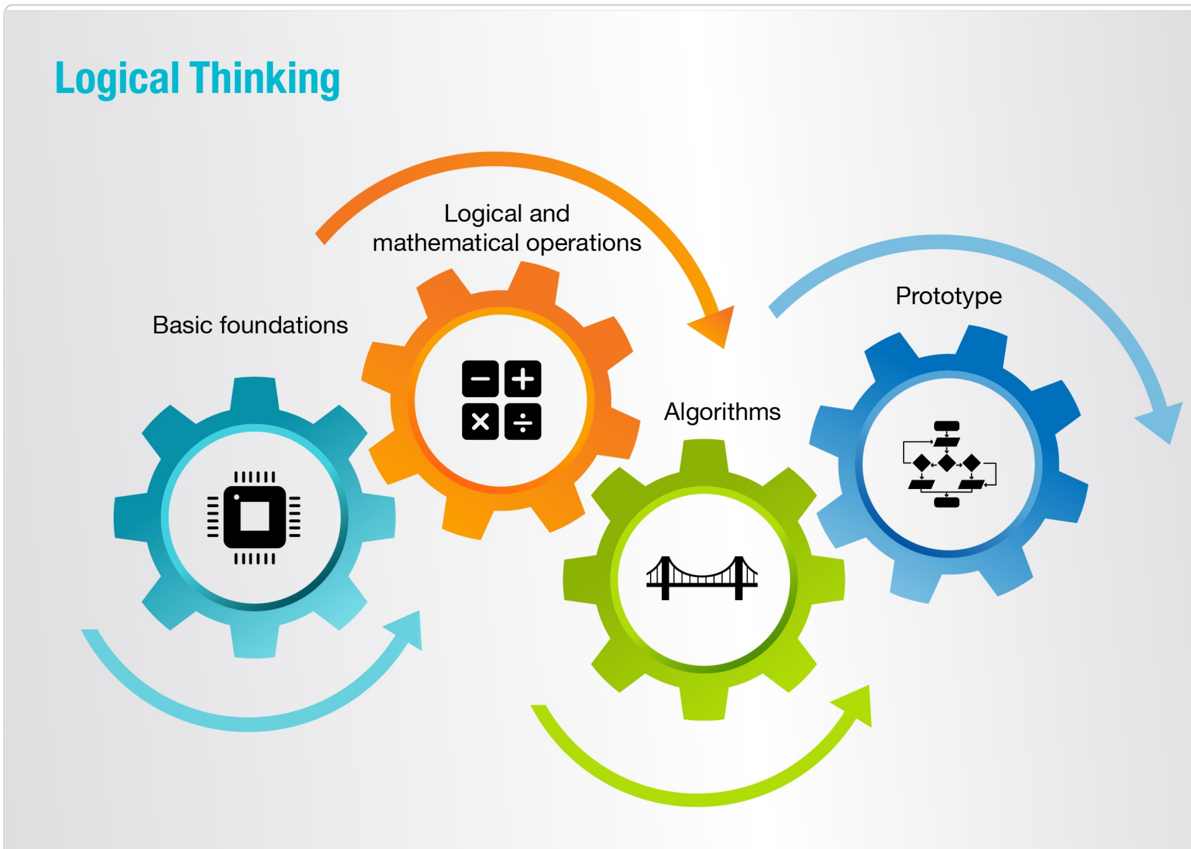
She has participated in the redesign of the computer classes, and she is now part of the Tec 21 curriculum design committee. She is currently a part time professor that teaches the classes of Creativity and Digital Design, and Digital Expression.

Content Map


Logical Thinking
Logical and
mathematical operations
Basic foundations
Prototype
Algorithms

Introduction

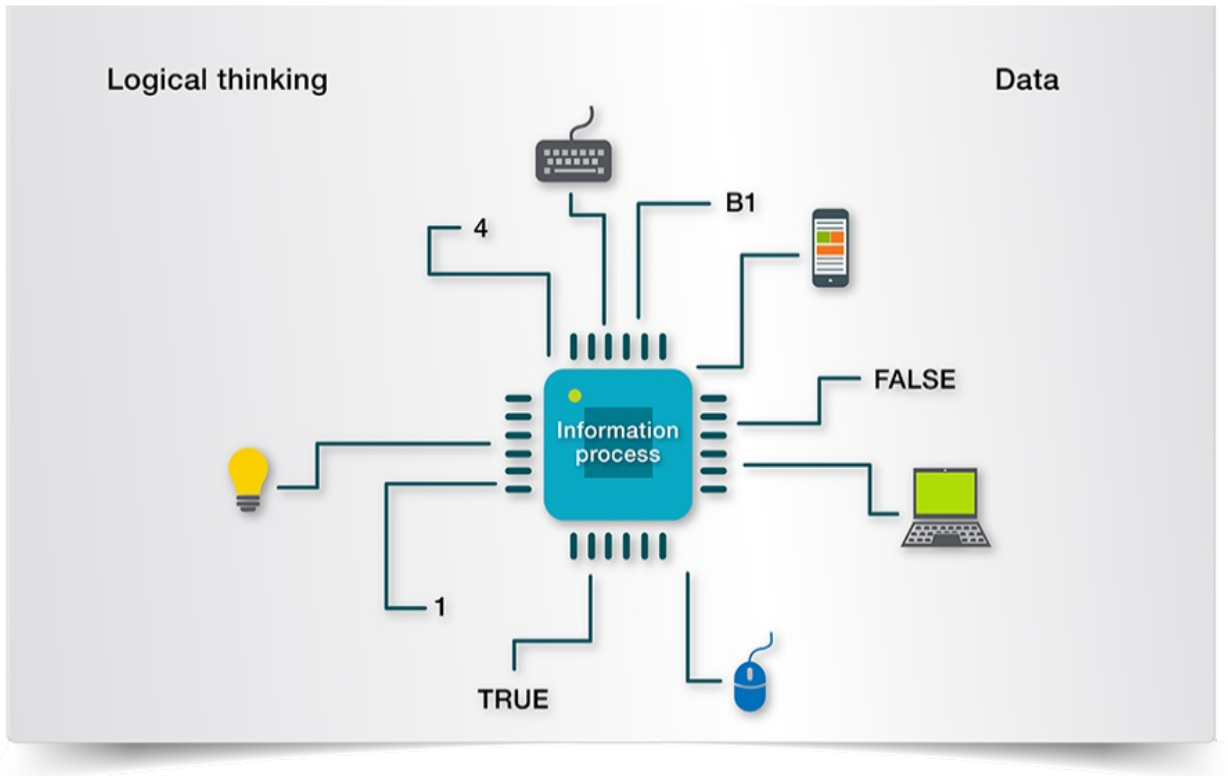
Logical Thinking will provide you the necessary concepts to develop basic processes of structured and logical reasoning that can be applied in the solution of everyday problems, such as deciding where to go on vacation, what computer to buy, how to make a budget for a family reunion, or how to plan the activities for a student fair. It can even help you solve some issues that require the use of a computer.

In chapter one you will learn about the internal functioning of a computer in order for you to understand the way input data are processed and stored. You will also see how these data are displayed to the final user through an output device. You will also find the definition of computational thinking, and you will learn different methodologies for problem solving which will be reinforced by answering some exercises using them.

In chapter two you will learn about the types of operators and the importance of their hierarchy. You will see examples of logical and mathematical operations that will help you understand the steps to follow. You will also learn the basics of constants and variables as well as the assignation of value in the latter.

The third chapter deals with the concept of algorithm and its characteristics. It will help you identify inputs, processes and outputs of sequential, selective and repetitive structures that will be useful in chapter four since you will see them as a flowchart; in a few words, you will be able to recognize the control structures in order to translate them into programming language.

These are the reasons why this eBook is a tool that will help you develop your skills on problem abstraction, information synthesis, and efficient problem solving. This can then become a good start point for those who might eventually want to learn how to develop applications.



Introduction

Computers are very useful machines. They enhance the human potentiality by performing those repetitive activities that require several mental processes, and that would take large amounts of time for men to do with a high probability of committing mistakes.

A computer can be defined as a "device that accepts input, processes **data**, stores them, and produces an output" (Oja & Parsons, 2007). Some of the main functions these devices perform are the creation of payrolls or account sheets, the creation of book catalogs for great libraries, the control of smart buildings, medical activities, and many more. The main difference between the manual creation of data and their automatic process is that in the second one, the electronic devices perform the tasks more rapidly and more precisely.

In order to utilize a computer equipment effectively and transform it into a tool that helps us in our daily life, it is important to know what it does, how it works, and how we can use it. Through this chapter, you will learn the functions and the main components of a computer, and you will learn how **information** is stored. On the other hand, you will be able to define computational thinking and explore its characteristics as well as to learn the two methodologies used to solve problems.

You will learn this through solving some problems and answering some exercises that will help you develop this skill.

You are about to embark on a journey that will prepare you to know more about logical and computational thinking and to build algorithms, flowcharts, and programs in pseudocode to solve a problem.

1.1 Information process

In 1848, a man came up with the idea of creating a mechanic device that would solve math operations. To do it, he thought about a component that would enter the data, another one that would show the results, and one that would store the information. The result was the Analytic Machine, created by Charles Babbage, a pioneer in computing.

What Charles Babbage thought and put on paper 150 years before is now a reality: the concept of input, processing, output and storage is still on, in a number of devices that we now call computers.

Did you know...?

In 1985, Engineer Doron Swade built the Analytic Machine of Charles Babbage. It took him 17 years to do it. If you want to learn more about this device, click here.

1.1.1 Basic computer components

A computer is made up of two parts: software and **hardware**. The first one is logical since it refers to the programs which are the instructions that tell the device what to do step by step. The second one is physical since it contains the electrical, mechanical and electronic components. According to their function, these components can be called input, output, and storage devices, and system units. We will now talk about them in detail.

Input devices

Input devices are the components that allow the data and instructions enter the computer. The most important components are the keyboard and pointers.

1.

The keyboard has around 105 keys with the QWERTY design of typewriters. Its name refers to the first 6 letters that are found on the left hand side of the keyboard. Besides, the device contains several keys that are used for specific functions: numbers, arrows, start, end, page up, page down, delete, insert, functions (F1 to F12), and print screen.

There are other variations of keyboards like the ones for tablets and cellphones whose touch screens act as an access function. Another form of keyboard is the one that is projected on any surface through the use of Bluetooth, with a sensor that detects the key the user is touching. It can also work as a mouse.

Did you know...?

In March 2015, Microsoft presented a foldable CD case-sized keyboard that is connected via Bluetooth to the devices. It is compatible with Windows, iOS and Android versions. Click here for more information.

2.

A pointer is better known as a mouse. It allows the control of the screen-based systems since it controls the cursor (the object that is used to interact with different options, programs, information, files, and texts among others). Besides the mouse format, we can find trackballs, trackpads, pointing sticks, and joysticks which can be either mechanical or optical.

Did you know...?

If you want to play on your computer, there are padded mice with special buttons to control the characters. Check what is in the market for you by clicking here.

3.

A microphone is an audio input that can either be previously installed on a computer or can be connected externally on a port. To record, it is necessary to have a simple software that is integrated inside the operating system which allows the voice to be saved on a disk file.

4.

Just like the microphone, a video camera can be integrated on the computer or it can be external. It is commonly known as a webcam.

Microphones and cameras require a conversion from **analog signals** to **digital signals** or vice versa. We call this process digitalization, and it is done internally in the video or audio cards.

5.

Digital cameras capture images electronically; they digitalize them, compress them, and store them in a memory card. Some computers have special slots to read the memory card without connecting the device through a cable, as it is normally done. The storage capability depends on the memory they use and the characteristics chosen to take the pictures (high or low definition).

Digital video cameras came out in the mid-nineties, and just like photo cameras, the product can be transferred to the computer to modify it with an editing program and save it on the hard drive, CD, or DVD.

6.

Scanners are photosensitive and transform images or text into formats that can be processed through the computer. Some examples are optical scanner, optical reader, barcode reader, RFID reader, and magnetic tape recorder.

7.

Biometric devices read a characteristic of the person to compare it with a previously saved code, identify it, and grant access to the system. Some portable devices already have this system since they recognize a fingerprint or two when necessary. Other examples of biometric devices are facial, voice, iris or retinal recognition devices.

Did you know...?

There is a large number of companies that creates recognition devices to replace the use of a password. If you want to know more about them, enter the FindBiometrics site by clicking here.

8.

Sensors are devices that measure different types of data that are sent to the computer to be processed. Some examples of information they receive from the environment are temperature, light, pressure, humidity, water level, movement, and proximity.

You can easily find sensors in your daily life; some are part of the smartphones and tablets that let you turn the screen and have GPS, or the bracelets and phones that track your workout routine and include your heart rate, calories, pedometer, or the app to use at night to measure the quality and quantity of your sleep.

9.

Digitizing tablets are designed to create art; they have a special pen that controls line width based on how lightly you touch the pen to the tablet's surface. They don't have their own operating system, so they need to be connected to USB interface or to Bluetooth.

Output devices

Output devices are the components that show information to their users. Some examples of them are the monitor, printer, and speakers.

1.

The monitor displays the results of a task process such as text, graphics or video. Some of them have a double classification since they have a touch screen that allows data entry. There are different types of monitors:

- Flat screen monitors:

  - **LCD** *(*Liquid Crystal Display): produces images by manipulating light over a layer of cells with liquid crystal.

  - **Plasma** monitors: create the image through lighting up small panels of fluorescent light.

- **LED** monitors are made up of light emitting diodes (LEDs) that light up when receiving an electric impulse. They stand out for their sharpness, clarity, colorfulness and thin frame. They can project 3D images, and they are energy saving devices.

2.

Printers display text and graphics on paper or transparencies. Laser printers produce the highest quality work, but there are also ink injection, dot matrix, solid ink, thermal transfer, and sublimation printers. These devices differ in their characteristics and in their **printing resolution** which refers to the clarity of the printed images and texts. This clarity is measured in dots per inch (dpi). A good printer offers 900 dpi, and if more quality is required, it is advisable to use one of 2400 dpi or more.

- Ink injection printers are small, light, and cheap. They provide good quality printing text and pictures in black and white or in color. They are ideal for work or home.

-

Laser printers are the priciest; they have excellent black and white or color printing quality. They are used when printing large amounts of material.

- Dot matrix printers are used for text and graphics in black and white since there are very few options for color. They have the alternative of printing carbon copies, and they are used for light work.

- Solid ink printers produce bright colors which are ideal for graphic printing.

- Thermal transfer devices can print color transparencies. Since the paper is very expensive, it is mostly used in companies.

- Ink sublimation printers have great color quality, so they are often used in printing digital photography.

- 3D printers generate a physical model based on a virtual one in three dimensions. They use polymers and special plastics.

3.

Earphones and speakers are utilized to play music and audio. Every computer has a low quality speaker that plays the effects such as the beep of the mouse, and one of higher quality to play games, music, and videos. Audio systems require a card that is in charge of converting digital signals into analog signals and vice versa. This card also contains the output ports.

4.

A fax machine is in charge of encoding and decoding text or images that are sent through a telephone line. It digitalizes what we want to send and the recipient device converts the data into a printable document or into a file to be saved in any storage device.

5.

Multifunction Peripheral devices (**MFP**) perform different tasks like copying, printing, scanning, and faxing. They can also print in black and white or in color. The advantages of having such a device is the little space they take and the price it costs since it offers several services in one same apparatus.

Did you know...?

Google created Chromecast, an output device that sends a monitor signal from a computer to the TV set; you only need to connect the HDMI port and start Wi-Fi communication. If you want to know more, click here.

Storage devices

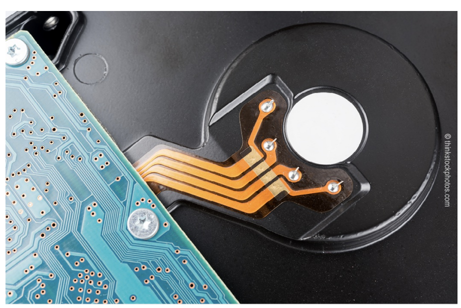
Storage devices are the components that store information permanently. When the computer is turned off, the information is deleted unless it is filed in any of the storage means (also called secondary memory), such as a hard disk, a CD, or a USB memory. These devices are considered hardware components that read and write data, information, and instructions which from now on we will call information elements.

Storage devices can be **magnetic**, **optical** or of **solid state**.

- Magnetic devices store the information by magnetizing microscopic particles in the surface of the disk or tape. Some examples are hard disks and magnetic tapes.

- Optical devices are called like that because the elements are read through a laser light using a powerful microscope.

- Solid state devices store the information through a process called Fowler-Nordheim tunneling which closes or opens some gates that give access to a cell panel that stores the data.



System Unit

It is one of the most important components of a computer. Inside of it there is the **microprocessor** (considered the brain of the computer equipment) the main memories, ports, slots, and expansion cards that will be explained in detail further on.

1.1.2 Information input, process, and output

When we talk about information processing, the first thing that comes to one's mind is a computer; however, this process is made of users, procedures, software, hardware, and data.

When they interrelate, they fulfill the requirement of helping people of an organization to obtain useful information to be communicated in order for others to make effective decisions.

Information systems have input, processing, output, and storage functions. That means that the users enter the data that are processed to be organized in a way they provide useful and understandable information that is presented as a report or any other document that is stored for future use.

Information systems, computers, and humans carry out the same functions of entry, process, output and storage. How does that happen? Look at the following chart:

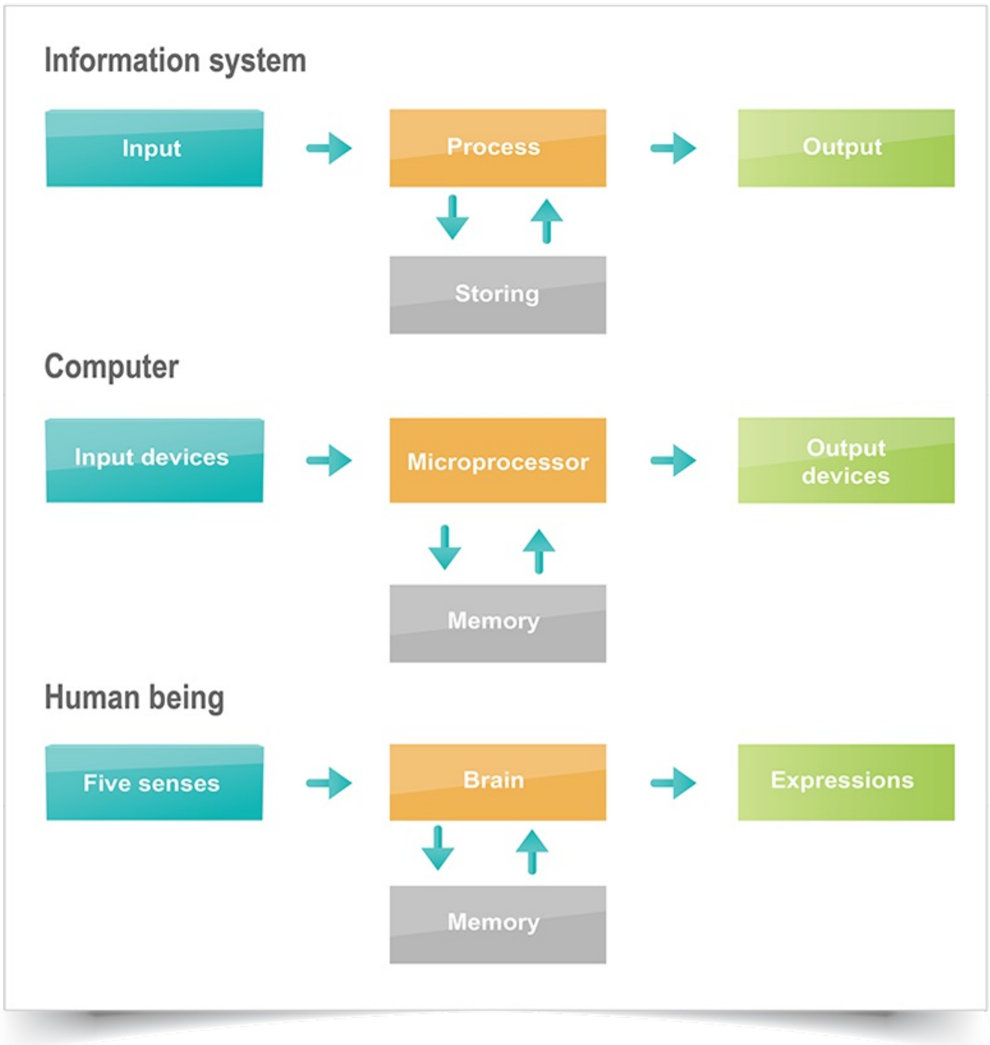


Figure 1.1 Comparison between the functioning of the information systems, the computer, and the human being. Click here to enlarge the picture.

Reflect and imagine that in the same way computers receive data through the different input devices, you receive information through your senses; after that, the microprocessor, just like your brain, analyzes them in order to transform them into content that is presented through the output devices, in your case through talking, music, literature, and others. During the process, the data and the information are kept in the memory. In the case of people, if the information is relevant, the information will be stored in the long term memory which would mean to save the data on a hard drive.

As you could have observed, computers process data (input) to convert them into information (output). It is important to mention that the concepts of information and data are different things: people normally use them as synonyms, but in the computing jargon, data is used by the computers and information by people.

Human dialog is analog because it uses continuous signals (in the form of a wave) that vary in strength and quality to represent the tone, speed, and volume. On the other hand, electric devices only understand two physical states: on and off which allow the use of values 1 and 0 respectively.

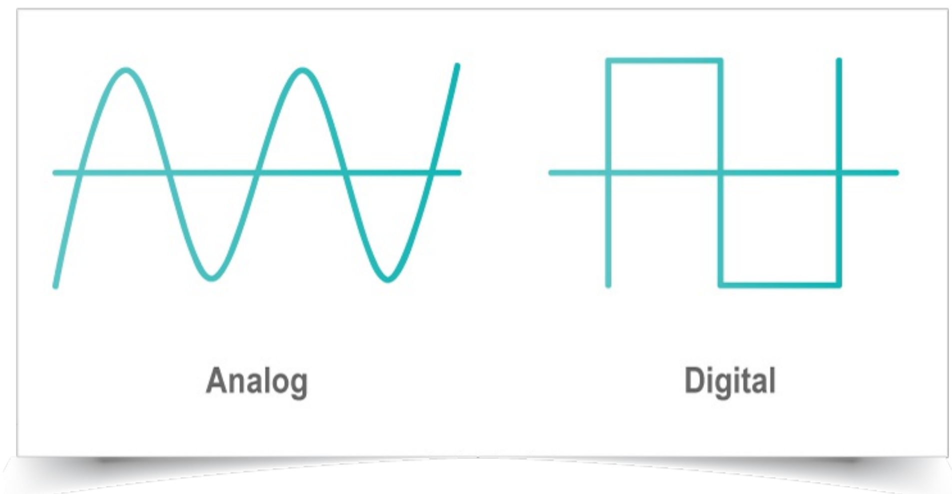


Figure 1.2 Analog and digital waveforms.

Because there are only two values, it is said that computers work with base 2, that is to say, with a **binary system**. Numbers 2 and up do not exist, so in order to represent other numbers, there is an extra 0 on the right, as it can be shown in table 1.1.

Decimal (Base 10)	Binary (Base 2)
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010

Table 1.1 Decimal system conversion and binary system.

In computing, each 1 or 0 is called a **bit** (binary digit), and it is the smallest data unit. A series of 8 bits is a Byte, and it is used to represent information. To distinguish their abbreviations, a bit is represented with a lower case b, and a Byte is represented with a capital letter B.

In order for the data to be processed, they have to be converted into a digital format which means in a sequence of 1 and 0. There is a bit sequence according to what needs to be stored.

- Images can be bitmaps or vectors. Bitmaps are points or pixels that have an assigned color which can be a code composed of a group of 8, 16, 24, or 32 bits. Vectors, on the other hand, are mathematical equations that describe the size, form, width, position, color and lines, so they assign binary numbers to the series of formulas that compose them.
- Video is digitalized like the **bitmaps** with the only difference that in each color, the sharpness is added for each frame.
- Music, voice and sound effects are digitalized when the audio samples are collected at periodic intervals to be stored as numeric data from 8 to 16 bits.
- Numbers are represented in binary system (check table 1.1).
- Letters, symbols, and numbers that aren't used in arithmetic operations such as telephone numbers, are known as characters. For them to be transformed into binary system, you need to represent them through a numeric code. There are different codes that contain a list of the characters that a computer uses so that programs are standardized.

ASCII code

ASCII code stands for American Standard Code for Information Interchange, and it represents 128 characters with a combination of only 8 bits. Among these there are the upper and lower case letters, punctuation symbols and numbers. The extended version of this code requires 8 bits to represent one single character which means that it has 256. The extra ones are used to represent pronunciation, special pronunciations, forms, and graphic symbols.

Click here if you want to see the information on ASCII code in detail, in table 1.2 (García, et al, 2012).

Decimal number	Character	ASCII code	Decimal number	Character	ASCII Code

32	space	0010 0000	80	P	
33	!		81	Q	
34	"		82	R	
35	#		83	S	
					... table 1.2 here

Table 1.2 ASCII code.

Unicode

Unicode is a standard world character codification that is utilized to represent the alphabet of multiple languages such as Chinese, Korean, and Japanese. It uses 16 bits, so it has the capability of having 65,000 representations.

Did you know…?

Unicode showcased version 7.0 on June 16, 2014. It added the currency symbols for Azerbaijan (Azerbaijani New Manat) and Russia (rouble). Click here for more information.

Each stored file contains a **file header** that indicates the type of content; otherwise, the computer wouldn't know what program to suggest to open each one. Since units bit and Byte are not enough for the quantity of data they manipulate, there are other measures to abbreviate the transmission and the storage.

Data transmission		Data storage	
bit	A 1 or a 0	Byte	8 bits
Kilobit	1,024 or 2^{10} bits	Kilobyte	1,024 or 2^{10} Bytes
Megabit	1,048,576 or 2^{20} bits	Megabyte	1,048,576 or 2^{20} Bytes
Gigabit	1,073,741,824 or 2^{30} bits	Gigabyte	1,073,741,824 or 2^{30} Bytes
		Terabyte	2^{40} Bytes
		Petabyte	2^{50} Bytes
		Exabyte	2^{60} Bytes

Table 1.3 Data transmission and storage measures.

In order to be able to dimension these units, it is important to know that nowadays the hard disk of a computer is in general 500 GB, and that the data transmission of Internet is 11 Mb.

1.1.3 Internal functioning of a computer

One of the most important inventions in the evolution of computers was the creation of integrated circuits since the inventions of the multiple devices reduced their size. These are very thin pieces of semi conductive material with microscopic elements such as cables, transistors, capacitors, logic gates, and resistances. Inside a computer they are part of the system unit, and they are the microprocessor, the memory, and the support circuits.

The microprocessor is the most important **integrated circuit**, and it is also known as the CPU (Central Processing Unit). It is designed to interpret and carry out the basic instructions that make a computer work. There are two areas in a CPU: the **control unit** and the **Arithmetic Logic Unit** (ALU).

- The control unit executes each one of the instructions of a program and directs the flow of data, controlling the resources such as the memory and the input and output devices. If the control unit perceives that it needs to execute an arithmetic or a logical operation, it sends a signal to the ALU to make it start the process and wait for the result.

- The arithmetic-logic unit executes the arithmetic operations such as additions, subtractions, multiplication and division; it also executes the logical ones: greater than, less than, equal to. Its storage place is the register, a high speed memory that is part of the microprocessor and is used by the unit to store the data that will be processed or that has been processed in that moment.

The performance of the microprocessors depends on the **clock speed**, the size of the words, the **cache memory**, the group of instructions, and the techniques of the process.

1. The speed is measured in hertz, which means the execution of a cycle per second. That is to say, the number of instructions that are executed in a second. Nowadays, microprocessors use the megahertz measuring unit (MHz) which means millions of cycles per second, or gigahertz (GHz) which means billions of cycles per second. The faster the microprocessor, the faster the process will be done. Microprocessor companies classify them according to their speed, and they assign a name or a number. For instance Intel i7 or AMD FX.

2. The **size of the word** refers to the number of bits that a microprocessor can handle at the same time. One of 32 bits has 32 registers in the arithmetic logic unit which means it will be able to process this number of bits simultaneously. It is based on the number of registers the unit has, and the ability of the circuits to direct them. Current computers have around 32 and 64 bits, which means that their performance will be more efficient and faster.

3

. Cache memory is high speed, and it is found between the RAM memory (also called main memory), and the microprocessor. This provides the user with a faster access to the data since it is near. It acts as a container that stores the most frequent instructions; this way, the microprocessor looks for the data in this memory first, and if it cannot find it, then it goes to the main memory.

The capability of the cache memory varies, and it is measured in kilobytes. There are two kinds of cache: Level 1 (L1) that is inside the microprocessor and Level 2 (L2) which is in a separate chip. Some computers even have Level 3 (L3) that is placed in the motherboard. An example of this is the new family of Intel Core microprocessors second generation.

Cache Memory	
Memory	Capacity
L1	8 KB to 128 KB
L2	256 KB to 512 KB
L3	2 MB to 9 MB

Table 1.4 Capacity of the cache memory.

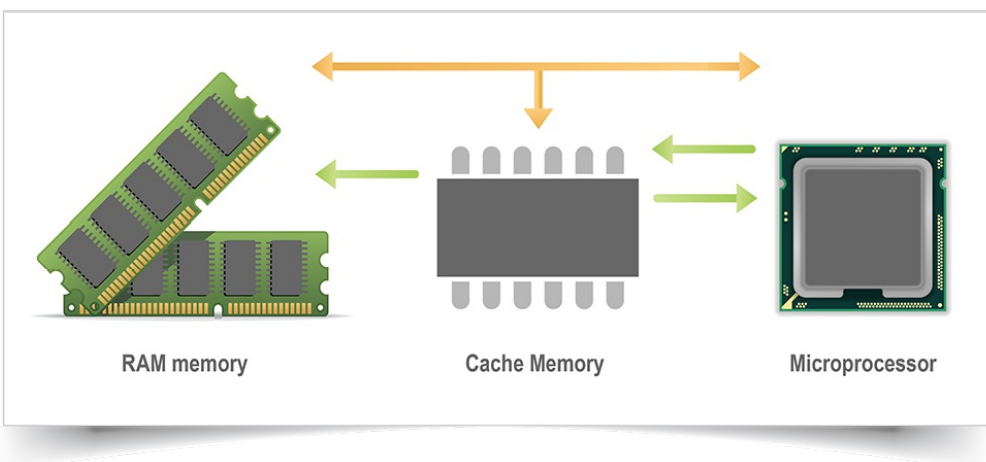


Figure 1.3 Representation of the cache memory. Click here to enlarge the picture.

4

. Microprocessors contain a group of instructions to carry out all the processes that are required from it. **CISC** Technology, (Complex Instruction Set Computer) is a group of complex indications that require different clock cycles to be executed. **RISC** technology (Reduced Instruction Set Computer) is a group of simple commands that require fewer cycles to be executed. Even though RISC is faster, it requires more orders when it carries out the same task of CISC.

5

. The process techniques refer to the continuous execution of the instructions, and they can be either serial or parallel. Serial techniques execute the orders sequentially, and parallel techniques do it simultaneously. There is a third technique which is the segmentation of instruction in which it carries out the indication before the previous one is over.

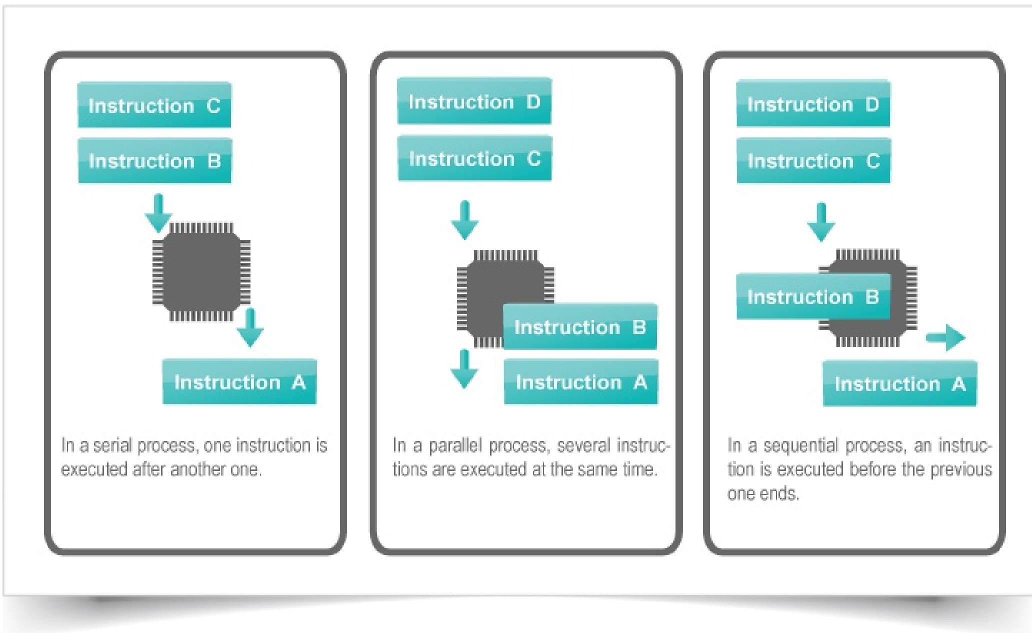


Figure 1.4 Representation of the process techniques. Click here to enlarge the picture.

Intel has been the leader in the industry of microprocessor technology; however, there are other companies that have been created: AMD, Motorola, VIA Technologies and Transmeta.

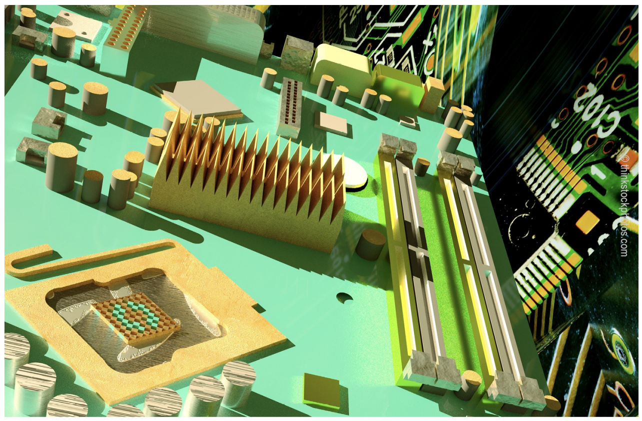
AMD stands for American Micro Devices, and it appeared in 1998. Its AMD-K6 model was cheaper than Intel's microprocessor at the time, and it became famous because it was said that it had a good performance. It attracted the computer makers' attention, and it was then introduced to the market. It is now the second most important microprocessor company.

It is not well known when Motorola microprocessors were introduced into the market, but it is said it was in the middle seventies. M6800 was only placed in Macintosh computers, but just like other companies, they evolved, and these microprocessors are currently installed in different types of computers.

VIA Technologies was founded in 1987, and their main activity was to create integrated circuits (especially memories) for companies such as Intel and AMD. In 1999, after they bought the processor division of National Semiconductor and IDT, the company created its first processor named VIA C3. Microprocessor companies not only create their products for personal computers, they also make microprocessors for all kinds of electronic devices.

Making miniature objects allowed all the mechanic components, circuits, and chips be in one same place. The compartment of a desktop computer which is made of metal or plastic, contains circuit cards, storage devices and the **power source** which is a component of the system that transforms the alternative current (AC) into direct current (DC).

Inside the power source there is a fan that is in charge of cooling down the **motherboard** and other components that host the main chips and provide a connection of these chips to the rest of the hardware. Some chips are welt onto the board, and some others are removable to be repaired or updated, such as the RAM memory.



The microprocessor can only execute instructions, and it requires a place to store all the data, information, or programs that are being used. This is what the memory is used for; it is a chip that is placed on the motherboard. The main memories are the RAM (Random Access Memory), the ROM memory (Read-Only Memory) and the CMOS memory (Complementary Metal Oxide Semiconductor).

Random Access Memory

This is a temporary memory that stores programs and data that are in process as well as the instructions of the operating system that control the basic functions of the computer while it is on. When the computer is off, everything that is inside of it is lost, which is why it is also called volatile memory. It is therefore advisable for the user to save his/her work continuously.

When the RAM memory doesn't have enough capacity to store everything it is asked to, the computer resorts to the virtual memory that is inside the hard disk. It is not advisable to use this memory too much since the access to the mechanic devices is slower than the access to the electronic ones. This area is known as the swap file because it transfers data, information and instructions.

Having a great capacity of RAM memory means to have a faster computer that can store more programs and more data. The storage capacity of the memory is measured in Bytes, and its access speed is measured in nanoseconds or megahertz. One nanosecond equals a billionth of a second.

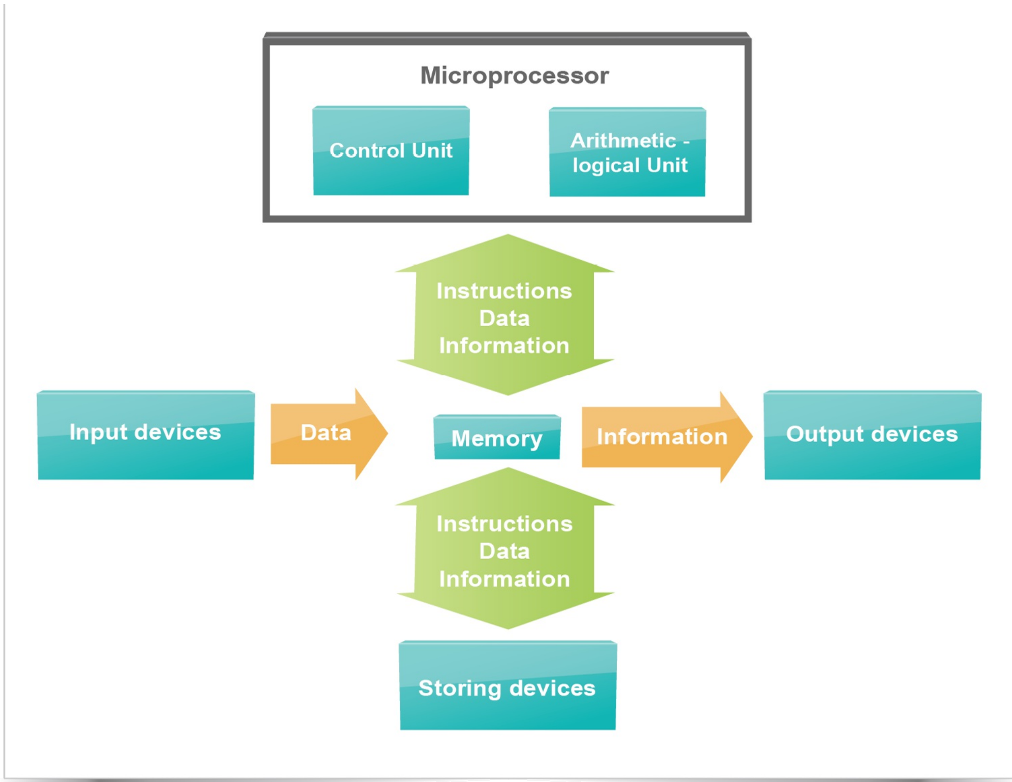


Figure 1.5 Memory and its interface with components and devices. Click here to enlarge the picture.

Read Only Memory

ROM stores data and instructions in a permanent way. It is also known as non-volatile memory. The information it contains is stored from the process of making it. It is impossible thus to be modified or deleted. It can only be replaced by a new one in case necessary.

This memory contains the start up instructions; when the computer is turned on, the microprocessor looks for instructions in the RAM memory, and if nothing is there, it resorts to the ROM where there is a group of instructions called ROM-BIOS basic input/output system. These instructions indicate how to read the data on the hard disk to find the operating system that is charged in the RAM memory. Once done, it verifies that all the hardware devices are working properly to administer the input, output, and storage systems as well as the execution of programs and the access to the data.

Did you know...?

Blinking one's eyes takes a tenth of a second. This equals 100 million nanoseconds. During this time the computer can execute some operations ten million times.

CMOS memory

It is a reading and writing memory which has a small battery that is charged every time the computer is on. It is found in the motherboard. It registers the time and date, along with the characteristics of the installed hardware: storage units, memory capacity, type of processor and screen configuration. If one of these changed, it would be necessary to modify it by restarting the equipment. To do that, it is necessary to press the keys indicated by the system to start the computer.

Flash memory

It is a reading and writing memory, and it can be deleted electronically. It holds data when the device is not on. It is considered the most expensive one and it is mainly used in cell phones, digital cameras, tablets, smartphones, printers, car devices, digital audio players, voice recorders, and beepers among others. They store programs and data such as directories and music.

Did you know…?

Samsung created an external hard disk that is the size of a credit card and can store 1 terabyte. Click here for more information of the Portable SSD1.

Ports, slots and expansion cards

Peripheral devices such as the keyboard, mouse, and monitor among others, are connected through the **ports** which are connectors that send or receive information. There is a great variety of these connectors as it can be seen on table 1.5, but the most commonly used nowadays is the **USB** (Universal Serial Bus) due to its compatibility with the different operating systems, platforms, low installation cost, and easy handling.

Connector	Device	Data transmission
Serial	Keyboard, mouse or modem.	One bit at a time. It can transmit between 115 and 460 kilobits per second.
USB	Modem, keyboard, joystick, scanner, mouse, hard disk, external CD and DVD, digital audio players, digital camera, printer, speakers, etc.	There are different kinds: USB 2.0 which has two lines for data transmission that go from 1.5 to 480 megabits per second. USB 3.0 has four transmission lines and it reaches a speed of 4.8 gigabits per second. Finally the USB-C, reaches 10 gigabits per second.
HDMI	Digital TV set, digital camera, video camera.	3 channels of 8 bits each one. It sends 24 bits at a time.

Table 1.5 Variety of ports.

Did you know…?

There are ports that have the technology to transmit data rapidly, and there are others that have specific functions. Click here to see the most important monitor and television entries. Click on the following links to know more about other important ports: Thunderbolt, MIDI and USB 3.1.

The advantage of USB over other ports is that its system recognizes the devices immediately, without the need to turn the computer off and on. This characteristic is better known as Plug and Play (**PnP**). If the system doesn't recognize the peripheral device it is necessary to install a program called **device driver**. This program is usually found on a CD or it can be downloaded from the Internet. When it is installed, a connection is established for the flow of data that travel from a component to another one through the circuits and cables called **bus**.

This bus transfers the data from input devices to the memory, from the memory to the processor, from the processor to the memory, and from the memory to the output or storage devices.

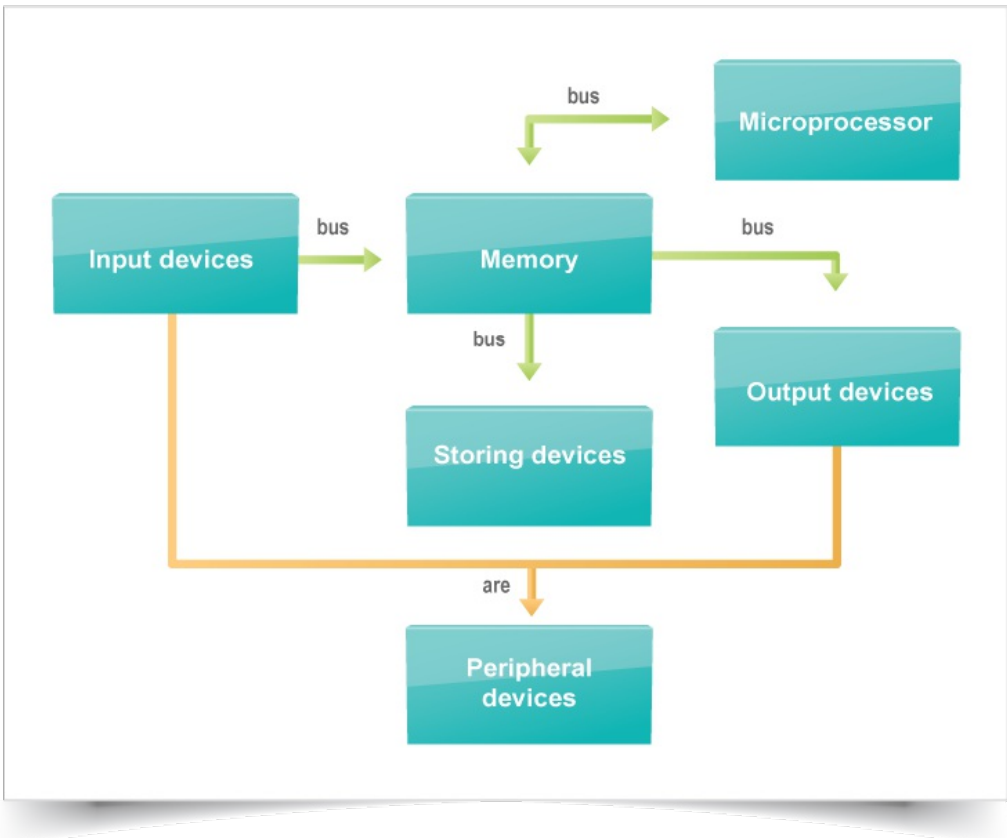


Figure 1.6 Functioning of a bus device. Click here to enlarge the picture.

Computers have two basic types of bus: the one of the system which connects the processor to the memory, and the expansion one which allows the communication between the processor and the peripheral devices.

The system bus has two parts, one of data and one of location. The first one transfers data, and the second one indicates the location where the specific information can be placed. Just like the microprocessor, it works according to the size of the word better known as frontal bus or bus width, which can range from 32 to 64 bits. It also has speed, and it varies between 400 and 800 MHz.

In order for data to flow from one place to the other, they must go through **expansion slots**, cards, ports and cables. Expansion slots are sockets that are on the motherboard where the expansion cards are connected. These cards are circuits that give the computer the ability to control an input, output, or storage device.

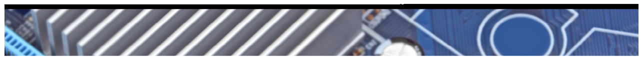


Figure 1.7 Expansion slots in the motherboard.

Expansion cards contain the ports where the keyboard, mouse, monitor, printer, loudspeakers, microphone, earphones, among others, are connected. The cards are installed during assembly, and they are the graphic, modem, audio or network cards.

Card	Function
Graphic	It sends the information to the monitor.
Modem	It transmits data through the telephone line or through a coaxial cable.
Audio	It sends the information to the loudspeakers and receives it from the microphone.
Network	It connects the computer to a net.

Figure 1.6 Variety of expansion cards.

1.2 Types of data

As it was mentioned before, the main function of a computer consists on processing data that generate useful information for the users; this makes data the essential element for which all the computer systems work.

The term data comes from Latin *datum* which means "what is given". According to Oxford Dictionaries, data means "Facts and statistics collected together for reference or analysis" (2015). For Norton (2008), the term refers to "the individual facts or pieces of information that when isolated do not make much sense to the people." For instance, a datum can be the word Jose, number 69, or the picture of your school ID; however, that value or symbol does not make sense alone; when processed properly, it can tell us that 69 refers to the kilos a person weighs, or the picture is the one of the student who won the first prize in a classroom competition. In that moment, it makes sense and becomes information.

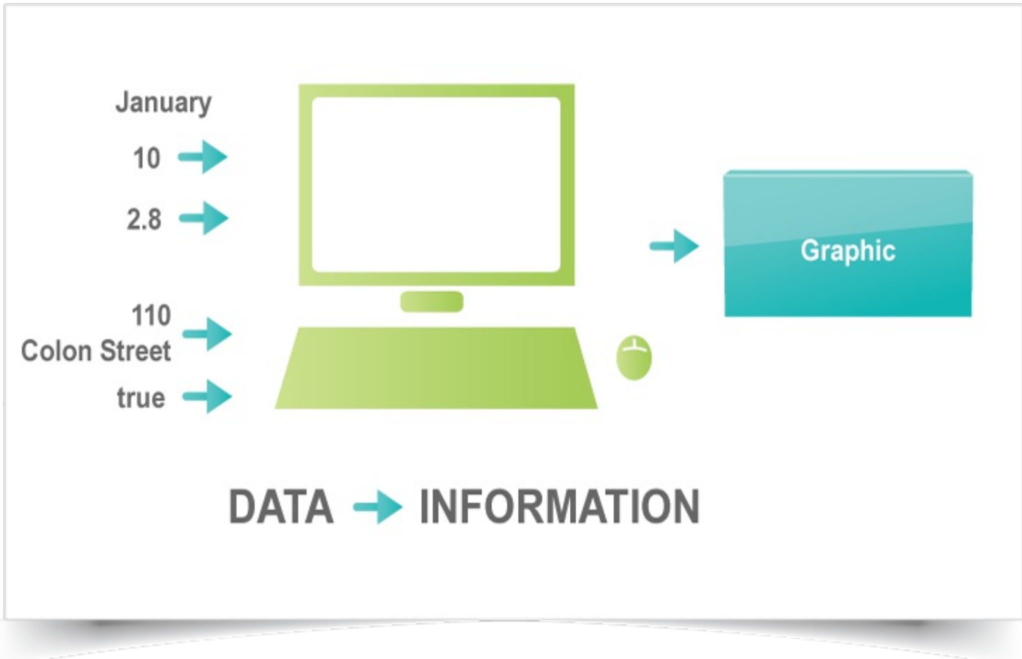


Figure 1.8 Data processing. Click here to enlarge the picture.

1.2.1 How are data entered in the computer?

When you type a document on a word processor, when a cashier in a supermarket scans the barcode of a product, or when you scan the picture of your school ID, data are being introduced to the computer. The data enter through the devices that are connected to the computer such as mouse, keyboard, scanner, optical pen, barcode reader, microphone and others.

In the past, computers used numbers as the main way of data entry; however, with the appearance of a great variety of electronic devices, there are many different data and input methods.

1.2.2 Data classification

The data that are entered into a computer can be classified in number, alphanumeric, audiovisual, or physical according to the following definitions:

1

. Numerical data refers to the integer or decimal, positive or negative numbers that will be used for arithmetic and/or logic operations. Some examples of daily life use are the height and weight of a person, the coefficient equation, miles run by a car, and others.

2

. Alphanumeric (text) refers to those that contain any combination of letter, numbers and special characters that won’t be used for arithmetic operations such as name, sex, marital status, RFC, address, city, and many more.

3. Audiovisual data are the ones we can listen to or watch for instance voice, music graphs, drawings, pictures, video sequences, and more.

4. Physical data are those that can be taken from the environments: light intensity in a room, a building's temperature, a person's blood pressure, and others.

Exercises

Instructions: Download the file and answer exercise #1: data classification.

1.2.3 How are data processed?

In order for the computer to convert the data in information, it is necessary that some processes take place:

1. Data entry. It is the operation that is done through an input device in which the data go straight to the RAM memory to wait for being processed.

2. Data processing. In this step, the processor follows the instructions that a program sent and performs the arithmetic and/or logical operations that are necessary to transform them into information. During this process, partial and final results are stored in the RAM memory.

3. Output generation. Results (information) are displayed through an output device.

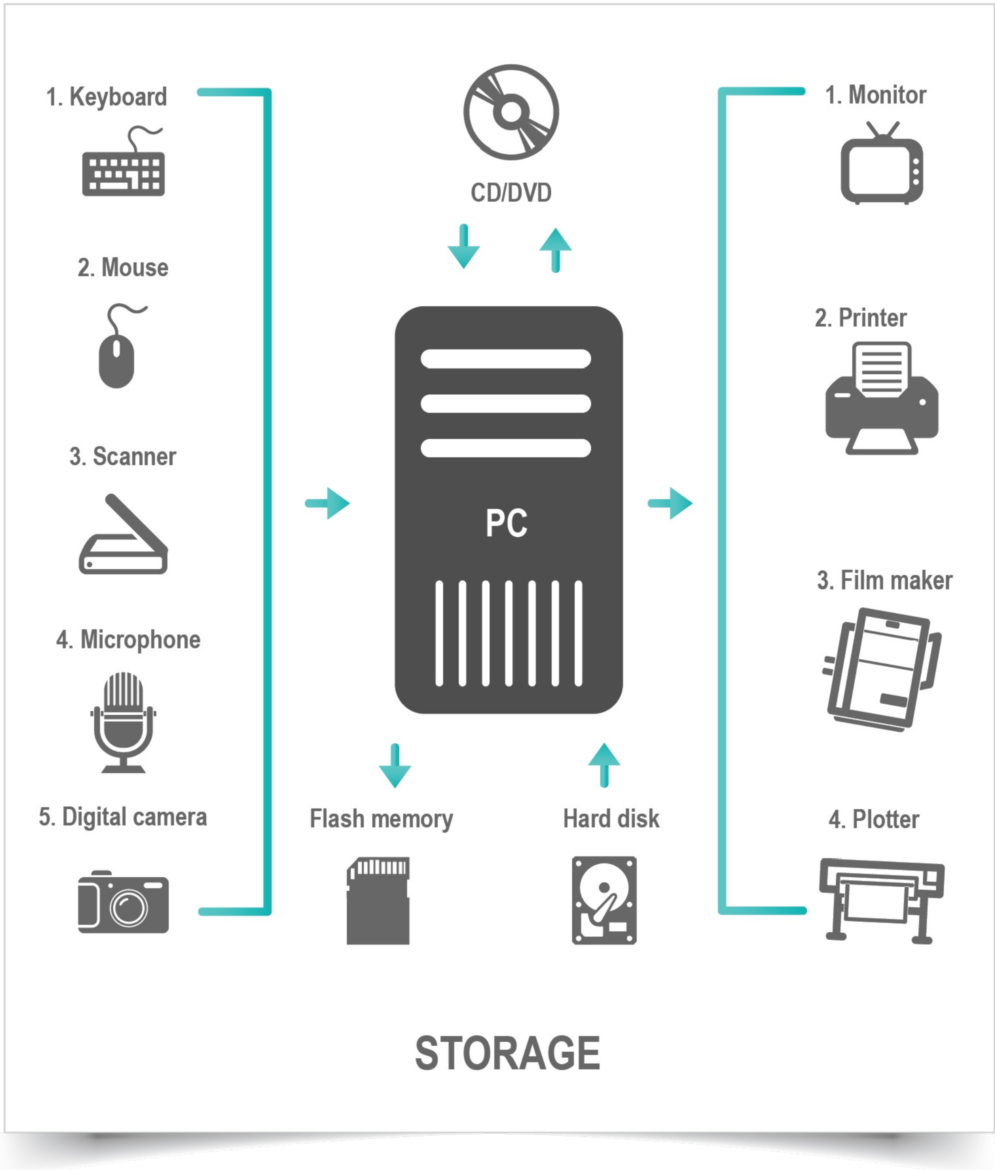


Figure 1.9 Data processing. Click here to enlarge the picture.

1.2.4 How are data stored on a computer?

When the data are entered in a computer, or when they are processed, arithmetic and logical operations create results that need to be stored inside the RAM memory to be utilized later. This memory can be handled through the use of variables and constants.

1.2.4.1 What is a variable?

A **variable** is an identifier that represents the symbolic address of a memory location in which we can save values in a temporary way since its contents may change, but they keep a same value during some time.

Imagine that the main memory is divided in small parts and you give a name to them, as if they were mailboxes. You give each one a name to identify it, and you can save different values, but just one at a time. This is how a PO Box works: it has an identifying name and its content is changing continuously.

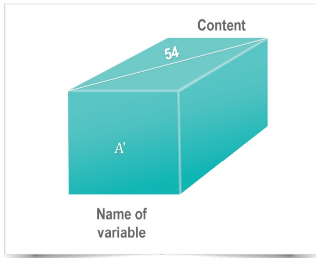


Figure 1.10 Representation of a variable as a PO Box. Click here to enlarge the picture.

1.2.4.2 What is a constant?

There are some values that do not change during the problem resolution process. We call these **constants**. Just like a variable, a constant is an identifier that represents the symbolic address of a memory location that is permanent. Figure 1.11 shows how the content is blocked, and it cannot change through time, opposite to a variable.

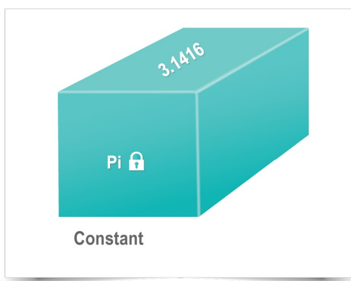


Figure 1.11 Graphic representation of a constant. Click here to enlarge the picture.

1.2.4.3 Guidelines for assigning names to variables and constants

It is important to bear in mind that each variable and constant needs to have a name that identifies it. Depending on the language, the naming rules vary; however, there are some general guidelines that we need to take into account.

- They can only contain alphabetic or numeric characters and underscore.
- They need to start with an alphabetic character.
-

- They should be meaningful; that is to say, they need to be related to the value that is being saved. For instance, the variable “weight” indicates that the content refers to someone’s weight.

- They shouldn’t be longer than 255 characters.

Examples of correct names of variables and constants	Examples of incorrect names and reasons why they are not acceptable

Table 1.7 Examples of name assignation to variables and constants. Full size image here.

Exercises

Instructions: Download the file and answer exercise #2: names of variables and constants.

1.2.5 Types of data

The type of data determines how it is represented on the computer and the types of processes they can have. Generally, there are two types of data: simple (with no structure) that do not come from other types, and complex (structured).

Simple data are essential values in any programming language and are the following ones:

- Numeric: integer and real.

- Logic: Boolean.

-

Character: character and string.

Structured data are more complex values since they derive from the simple ones and have defined relationships among them. We will only review the simple ones since they are the most commonly used on computer processes.

1.2.5.1 Numeric

They handle the data that can be integer or real.

1. Integer numbers do not contain decimal points, and they cover negative and positive numbers. Some examples are 50, 1000, -500, 8500, -15600.

2. Real numbers store very long numbers with a decimal part; they can be positive or negative, and some examples are 5.5, -10, -33.850, 139, and 152000.25.

1.2.5.2 Alphanumeric

They can be character or string.

1. Character data can contain only one character: digits (0, 1, 2, ...9), letters (a, b, c, …z) or special symbols (#, $, ^, *, %, /, !, +, –, ...). As a characteristic, they cannot be used for arithmetic operations.

2. String data combine alphabetic, special and numeric characters. They have to be encased in quotation marks. Some examples are "Los Angeles, CA", "333-441-96-94", "Americas Ave. #123", "John Smith". Just like character data, they cannot be used for arithmetic operations.

1.2.5.3 Logic

Boolean numbers fit into this classification. These data can only take two values: true or false. They are used to represent the choices yes or not for determined conditions, for instance, whether a number is prime or not.

Did you know…?

The Boolean data type was named after George Boole (1815-1864) who was an English mathematician that developed a logical thinking system using variables that only had 2 values. Click here for more information.

Exercises

Instructions: Download the file and answer exercise #3: types of data.

1.2.6 How much space do the data utilize in the memory?

Once the data have been saved in their respective variables, the space they use up depends on the type of data that is being stored. You can see some examples as follows:

Type of data	Space it takes
Character	1 Byte per character
Byte	1 Byte
Short	2 Byte
Int	4 Byte
Long	8 Byte
Float	4 Byte
Double	8 Byte
Boolean	1 Byte

Table 1.8 Data types space usage.

1.2.7 How to assign value to a variable or a constant?

The way in which a value is given to a variable or constant is through the assignation operation. This operation is usually represented with the left arrow symbol (←) and the value to be saved next to it. The general format is as follows:

Name of the variable/constant ← value to assign

The value to assign can be: constant (8.4, "F", "Juarez 210 South"), variable (Weight, GenAverage, Name), expression (X * Y, (A+B+C)/3).

Examples:

•

speed ← distance/time

•

- circle ← pi * R ^2
- double ← number * 2
- payment ← paymentHours * hours
- gender ← “F”

The assignation is done in two steps: first, we assign the value on the right side of the assignation statute (←), if such value is an expression, the final result of evaluating that expression is calculated; second, the value on the variable of the left side of the assignation statute is saved. The operation then substitutes the previous value that had the variable.

In the following assignation **Name ← “Joe”** it means that the variable "Name" has been assigned with the value of "Joe". Variables can only store one value at a time, but this value can change continuously; however, if no other value is assigned, it will keep the one that was assigned previously. As soon as the indication changes Name ← "Rose" or Name ← "Gloria", it will lose the previous one and will save the new one.

Variable "Name"
Joe
Rose
Gloria

Table 1.9 Value assignation to a variable.

The final value of the variable will always be the last one assigned. In the case of the previous example it refers to “Gloria” and the values of “Joe” and “Rose” will have already disappeared.

Exercises

Instructions: Download the file and answer exercise #4: value assignation to a variable.

1.3 Logical and computational thinking

Before we define the concept of computational thinking, check around you, and mentally describe the situations and tasks a computer or any other electronic device has helped you carry out either because you used it for communication or because it provided you with information.

We are sure that you have observed the equipment on which you are reading this eBook; you also thought about your smartphone which tells you the weather and the time on its screen besides helping you communicate with your friends or letting you download some of the thousands or even millions of applications that are available; perhaps you saw a digital camera, an electronic bracelet that measures your workout, a music player, a smart TV set, a movie and series rental device, among many other things.

Now you can be sure that computers and information technologies are everywhere and have let us expand our thinking capabilities to carry out activities and solve problems faster and more efficiently.

Think about the following: How do you think Google Maps ™ services manage to give you the most efficient route to take you from point A to point B? What do you think happens when the cashier at the supermarket scans the articles you selected over a barcode reader and tells you how much it will be? How is it possible that a movement sensor turns on one light when it detects a person coming in and thus saving lots of energy? These examples are inviting you to wonder how computers work and how we can take advantage of their potentiality to help you solve every day problems.

Did you know...?

There are more than 2,500 million apps between Apple and Google stores.

1.3.1 What is computational thinking?

According to the International Society for Technology in Education (ISTE), computational thinking is a process to solve problems through different techniques such as formulation of problems in a way you can use a computer and other tools to solve them; organization and analysis of information in a logic way; representation of information through abstractions such as models, simulations or diagrams; automation of solutions through algorithmic thinking (a structured series of steps); identification, analysis and implementation of possible solutions with the objective of obtaining the most efficient and effective combination of steps and resources; and generalization and transference of this resolution process to a wide range of problems. Let's see those techniques in detail:

1.

Abstraction refers to the process of eliminating what is not necessary for the complex part of the problem we are analyzing. Abstracting helps us generalize a problem and invites us to observe only its most essential part.

2.

Breaking down. Depending on the problem, it can be broken down into smaller or easier to handle pieces. That is to say, a complex problem is regularly the result of smaller ones; for instance, traffic in a big city can be broken down into smaller problems such as traffic education, number of cars in the city, streets and avenues, signals, collective transportation, alternative transportation such as bicycles, and many others. Usually, when many independent problems are solved, a bigger one can be solved.

3.

Simulation plays an important role inside the characteristics of computational thinking. It is through simulations that we can anticipate the result of a problem; for instance flight simulators where trainee pilots can control variables of speed, altitude, temperature, wind, direction, and others in a way they can try many possibilities of piloting before actually doing it.

4.

Algorithm development. It consists on a number of steps that we can replicate to automate processes.

Check the following examples:

Example 1: Use of abstractions or diagrams. If you want to design a solution to solve how an elevator should work, you could make a drawing with three or four floors and mark all the possible operation of the elevator depending on the floor you are in.

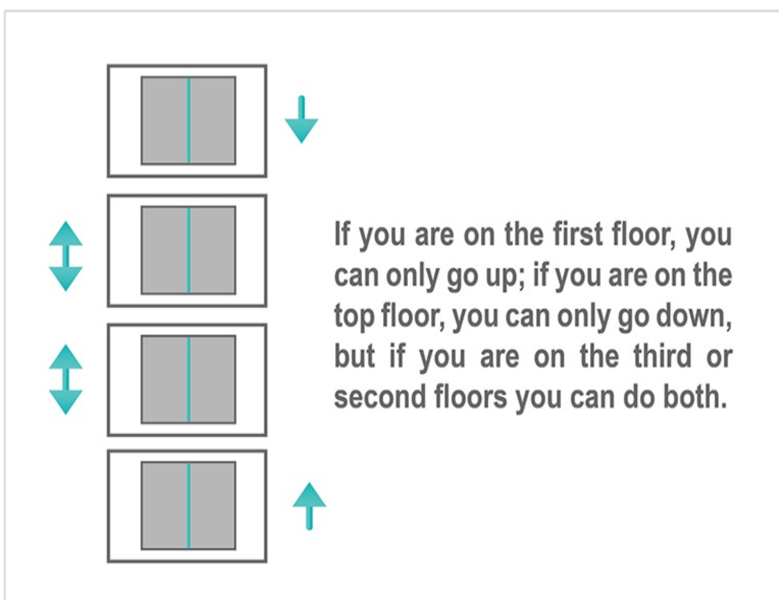


Figure 1.12 Simulation of problem solving through the use of diagrams. Click here to enlarge the picture.

In the previous example, you could add "n" to the number of floors and continue a similar thinking pattern about the possibility of going up or down depending where you are.

Example 2: Algorithmic thinking. An important restaurant chain offers a dish in all of its stores; it is important to be sure that every store offers the same flavor and quality. A possible solution is to have the chef cook the dish in all the stores; however this although possible, it would be very impractical. A better way to face the problem would be to have the chef write the recipe and have everybody follow the instructions exactly as the chef indicated so that all the dishes taste the same no matter the place.

Algorithm to prepare a recipe
Start Step 1: Get the necessary ingredients. Step 2: Mix ingredient A with ingredient B for 20 minutes. Step 3: Add a tablespoon of salt. Step 4… End

1.3.2 What is a problem?

Each day you face situations such as deciding what to have for breakfast, check your priorities in your agenda, determine the route to go to school or work, attend classes punctually, eat, rest, have fun, and start all over again. You always make decisions based on experience and knowledge. Some tasks are easy, and others are not that easy. When do these decisions become a problem?

According to Oxford Dictionaries, a **problem** is "A matter or situation regarded as unwelcome or harmful and needing to be dealt with and overcome" (2015). Based on that, we can make our own definition saying that a problem is a situation that deserves a number of actions to go from undesired to an appropriate state in the future.

We can cite different types of problems; there are academic, financial, social, health, relationship, family, psychological, administrative, etc. Each one of them is faced individually and to solve them we resort to our knowledge and personal abilities. Let’s take the following example:

Problem: In the last month, Luis has had a low performance in math, and he wants to get better grades.

Considering what we said before, we can say that to solve the situation of Luis's problem, he needs to follow some steps such as studying, doing homework, preparing for terms, etc. This way, he will be able to improve his current situation and transform it into a better academic performance in the future.

We will now describe some strategies and methodologies that will help us to understand the steps or phases a problem goes through.

1.3.3 Methodology to define and solve a problem

There is not just one method for solving problems: some authors agree that some techniques are applicable to different areas such as math, physics, sociology, psychology, and others. Among those techniques or strategies, we have the **trial and error** one, abstraction, divide and conquer, development of algorithms and brainstorming. We will now present some methodologies that can be applied:

General methodology

According to Eilders (2014), problem solving goes through four main stages which are the following:

1. Collecting information stage. Understanding the problem is essential to solve it; this is why it is necessary to investigate about it as much as possible. What outcome is needed? What obstacles can there be? A key factor for this stage is to distinguish relevant information from the one that is not.

2. Solution creation stage. In normal circumstances, the more possible answers, the higher chances to solve a conflict since we have a wider range of possibilities to choose from. A very frequent strategy for this stage of the problem is trial and error in which a solution is tried, and if it doesn't work, then a second solution is used, and so on until the situation has been resolved.

3. Solution implementation. It starts with the decision making. Once some alternatives have been proposed, it is necessary to execute one of them. In some situations, the problem can be solved in more than one way; however, some solutions can be better than other ones, because they take less time or they can be more easily or effectively applied.

   This stage implies to carry out an action plan. For many people it is hard to follow it, especially with complex problems; this is why true commitment from the ones involved in the problem is necessary. If there isn't, the intentions and the action plan are meaningless.

4. Evaluation stage. It is the last step in this methodology. Once the solution or action plan have been applied, it is important to consider if the goal has been reached. If not, it is necessary to consider another alternative or action plan. For this it is important to check every action and in case necessary, retake stage two: generation of solutions.

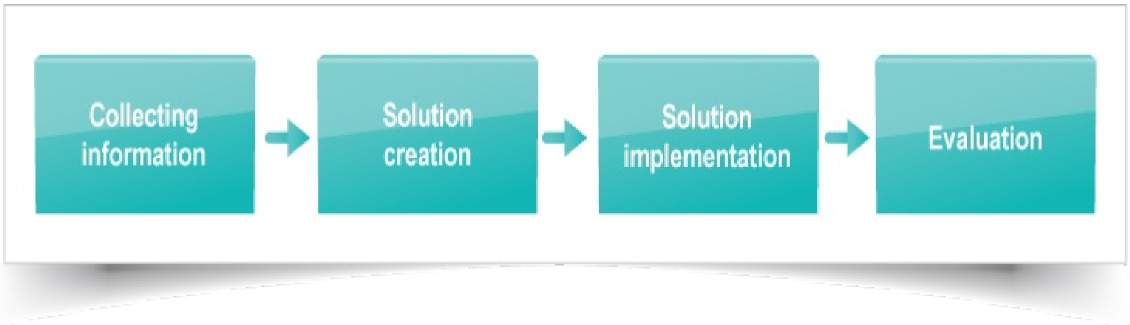


Figure 1.13 Steps to follow in the methodology for solving problems. Click here to enlarge the picture.

Example 1: George's dad has offered him to buy a new game console to play for his birthday. George is not sure which one to choose, and you offer to help him make the right decision.

- Collecting information. The first thing you need to do is collect all the possible information about the consoles that are sold nowadays; consider price, game variety, capacity to play online, accessories, hardware characteristics, etc.
- Generating solutions. By making a contrast of the characteristics of each console, reduce the options to just two of them that fulfill, at least for now, George's needs and likes.
- Solution implementation. Now you know that you have one week to try the products, and if you are not satisfied with what you bought, you can ask for your money back, or change it for another console. With this information you decide to buy the first option for George.
- Evaluation. After a few days you realize that you didn't make the right decision and you have decided to go back to the store to change it for the other console you had considered.

Example 2: You are about to finish your high school, and you would like to become an engineer in computer sciences, but you are not sure what steps you need to follow to achieve your goal.

- Collecting information. The first thing you need to do is get to know the study plan of this degree in different universities and know what makes a system engineer, go to the admission's office of your school to know more about the costs, scholarships, length of the program, job market, etc.

- Generating solutions and implementation (stages 2 and 3). You should now get ready for the admission exam for different schools and design the study plan to cover, making sure you comply with the degree’s requirements.

- Evaluation. If you pass the exam, the solution is on its way; if not, you need to take action such as try it again if the result is not far from the requirement. You could also apply at another university, or even change the main goal, which would mean change the degree you wanted to study for another one that is related.

As you could see in the previous examples, Eilder's methodology was used to solve a common problem.

Polya's methodology

In his book *How to Solve it* (1945), George Polya proposed a four step method to solve mathematical problems:

1. Understand the problem.

2. Define or design a plan.

3. Carry out the plan.

4. Look back.

We will now describe their characteristics:

1. Understand the problem. In order to do this, we need to answer the following questions: Can you describe the problem in your own words? What are you trying to do or find? What don't you know? What information do you have about the problem? What information is missing or irrelevant?

2. Define or design a plan. Look for a pattern, examine related situations and determine if the same technique can be used; examine a simpler case to understand the original problem,

make a chart, a diagram; write an equation, use trial and error, take a step back and find a sub-goal.

3.

Carry out the plan. Implement the strategy or strategies you decided in step 2; as you go along, check each step of the operation you execute; this can be done intuitively or formally, keeping a record of your work.

4.

Look back. Check the results of the original problem and if necessary, get a test and interpret the solutions answering this question: is your answer coherent and reasonable? Determine if there is any other way to find another answer and if it is possible determine more general or related problems where you can apply this technique.

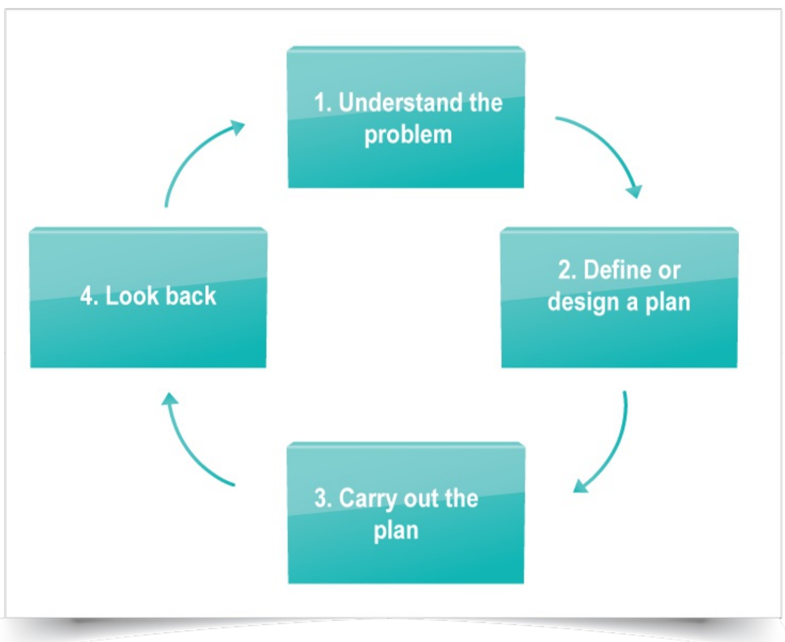


Figure 1.14 Diagram that shows the steps to follow Polya's problem solving methodology. Click here to enlarge the picture.

Example 1 (trial and error/writing an equation): John and his brother were saving money each month for one year. In the end, they got 192 dollars. If John saved three times more than his brother, how much did each one save?

- Understand the problem. Use the following questions from step 1 along with its answers.

Questions	Answers

What are you trying to do or find?	An amount of money.
What don't you know?	How much each one saved.
What information do you have about the problem?	John and his brother saved 192 dollars and John saved three times more than his brother.

- Define or design a plan. Propose two solutions: the first one based on trial and error through a table, and the second one would be to write an equation.

- Carry out the plan.

Trial and error

a)

You can say John's brother saved 40 dollars. Since John saved three times more, we will multiply 40*3 (120 dollars). In this case the total would be 160 dollars which is less than the 192 that were mentioned in the problem.

b)

You can say John's brother saved 50 dollars. Since John saved three times more, we will multiply 50*3 (150 dollars). In this case the total would be 200 dollars which is more than the 192 that were mentioned in the problem.

c)

You can say John's brother saved 48 dollars. Since John saved three times more, we will multiply 44*3 (120 dollars). In this case the total would be 192 dollars which is the correct amount that was mentioned in the problem.

John's brother savings	John's savings	Total	Solution
40	120	160	Less money
50	150	200	More money
48	144	192	The exact amount

Define an equation

"x" represents the quantity that John's brother saved. If John saved three times more, and this adds up to 192 dollars, we can express it as follows:

3x+x=192

Solve the equation:

3x+x=192

4x=192

x=192/4

x=48

As you can see in the table of trial and error we can find that John's brother did save 48 dollars, so our equation is correct.

- Look back. Once you solved the problem, you can make sure the solution is logic, and that you did fulfill the initial goal, since both the table and the equation have the same result. Check how this type of solutions can be used to solve similar problems.

Example 2 (make a diagram): On a car race, the first five cars to cross the goal first were a red one, a green one, a blue one, a white one, and a black one.

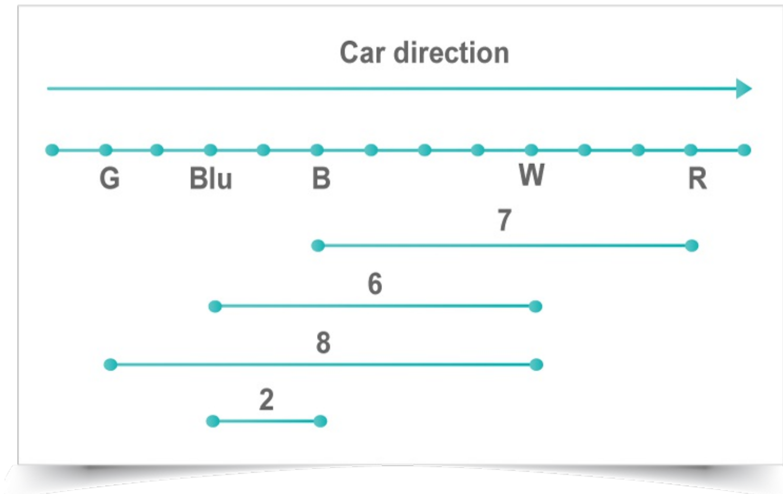
Take the following information into account:

- The red one arrived seven seconds before the black one.
- The blue one arrived six seconds after the white one.
- The green one arrived eight seconds after the white one.
- The black one arrived two seconds before the blue one.

In which order did each car arrive?

- Understand the problem. You want to know the order in which five cars crossed the goal on a car race. We have some information on the time relation there is among them.
- Define or design a plan. Use a diagram that shows the arrival of each one of the cars.
-

Carry out the plan. Draw a diagram that shows the arrival of the cars. Mark here the difference of each one in seconds.



Click here to enlarge the picture.

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Look back. In this case, you not only can see the order in which the cars arrived, but the time there was between each one of them according to the given information.

Exercises

Instructions: Download the file and answer exercise #5: problem solution using Polya's methodology.

Activity: There is an exercise named "Einstein's riddle" or "the zebra riddle". It is said Einstein himself wrote it, but it has not been proved. The enigma shows a number of clues and at the end there is a question you need to answer. Do you think you can you solve it?

There are five houses of different colors. People from different nationalities live in those houses, and these people have cars from different brands, have a different pet, and drink a specific beverage:

Clues:

1. There are five houses.

2. The English man lives in the red house.

3.

The Spanish man has a dog.

4.

The person who lives in the green house drinks coffee.

5.

The German man drinks tea.

6.

The green house is on the right of the pink house.

7.

The owner of the Beetle has fish.

8.

There is a Chevrolet in the yellow house.

9.

The man in the house in the middle drinks milk.

10

. The Norwegian man lives in the first house.

11

. The person who has a Ford lives next to the person who has a fox.

12

. The Chevrolet is next to the house where there is a horse.

13

. The owner of the Chrysler drinks orange juice.

14

. The Japanese man has a Nissan.

15

. The Norwegian man lives next to the blue house.

Answer: Who drinks water and who owns the zebra? Click here to find more exercises and their answers.

Chapter 1. Conclusion

In this chapter you learned that computers are made up of their logic (software) part, and their physical (hardware) part. You also learned about the components in which the physical part is divided and realized there is a number of instruments that let you interact with it in different ways; either entering data through the input devices, or showing information through the output devices.

Remember the microprocessor is the brain of the computer, and it is here where the instructions you ask it to do are executed. The data and the information that are generated before, during and after the process are stored in the memory.

As you may have noticed, both methodologies reviewed here as well as the computational thinking are similar in the number of steps and the way they face a problem.

The examples that were shown address different problems, but they follow a same pattern to solve them. This pattern mainly consists on the following steps:

- Identify a problem and collect the information.
- Design one or more solutions for it.
- Carry out an action plan or implement the possible solutions.
- Check what was done and start again in case necessary, reflecting or restating what was done.

In addition to these methodologies, there are some strategies that can be used such as the following ones:

- Trial and error.

- Use of abstractions.
- Equation design.
- Divide and conquer.
- Brainstorming.
- Algorithm design.
- Means to an end analysis.
- Use of diagrams.

Take into account that in all the cases the most important part of it is to develop the ability of logical and computational thinking to solve every day problems.

Answer to Einstein's riddle:

The Norwegian man drinks water, and the Japanese man has a zebra.

Chapter 1. Integrative Exercise

Click here to solve the exercise.