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DIGITAL TRANSFORMATION IN ADVANCED MANUFACTURING

Introduction

Basic concepts of Information Technology

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1. To Start – Definitions

By **Information Technology** we literally mean computer technology.

This term includes various types of technological forms aimed at the conception, storage and use of information in its many forms (data, images, multimedia presentations).

The **processing system** is the entirety of the parts machine materials and programs that allow it to function.

Hardware

The material components of the computer are called **hardware**. What does this mean? Hardware is the **physical part** of the computer, the one that you can touch.

The hardware consists of **boards with electronic circuits** that physically allow the computer to start up and work. Motherboard, video card, printer, mouse, keyboard… these are all hardware components of the computer.

Software

The other fundamental component of a computer is **software**, a term by which we mean the **programs of a compute**r. A program is a set of **instructions** which, processed and elaborated by a computer, allows it to operate. The most commonly used programs to create documents, develop images, manage the accounting of a company are nothing more than software. The operating system (such as Windows, Linux, etc.), the basic system, is also software, without which all other programs could not be used by the computer.

Personal Computer
The predecessors of Personal Computers were born in California at the end of the 70s.
Small computers were designed for the personal use of each single recipient.

In 1981, IBM introduced the first real **Personal Computer**. Thanks to advances in microelectronics over the years, millions of people own machines that can process data, documents and create images. Today the Personal Computer asserts itself on a world scale in a rampant way.

The prices of a personal computer vary, on average, from a few hundred euros to over five thousand euros. The **PC is used predominantly in the workplace**, for the processing of documents, the preparation of accounting, and for applications of the electronic spreadsheet and database management.

It is also widely used at home; once mainly for **recreational purposes** and today thanks to the spread of the Internet and teleworking, it is used as a **work tool**.

The Laptop Computer or Notebook
The affirmation of increasingly advanced and sophisticated technologies leads to the generation of ever **smaller and lighter computers**, right up to the **laptop computer** (also called **notebook** computer or even more commonly laptop). A laptop is a PC with various characteristics: **portable battery**, **small size**, so much so that it can comfortably fit into a briefcase, and **performances** similar to those of the research laboratory computers of a few years ago.

The cost of a laptop is about two times higher than that of a normal PC of equivalent power, due to the greater refinement and refinement of design and processing.

The primary difference between a laptop and a personal computer is not only the size, considerably smaller in the laptop computer, but also the **display screen** that is **flat** in laptops and the **weight**. Another main difference is the connection of the mouse, which in the laptop is equipped with the common serial port and also of other devices for connecting the mouse to the keyboard, such as the trackball and the touchpad.

It is true that while a laptop delivers considerable advantages, it also has several disadvantages. Let's examine them:

BENEFITS: It is light and easy to handle; It works for hours without the need to a power supply; Consequently, it can be carried very easily on a trip or on vacation.

DISADVANTAGES: Economically, it is more expensive than a normal PC.

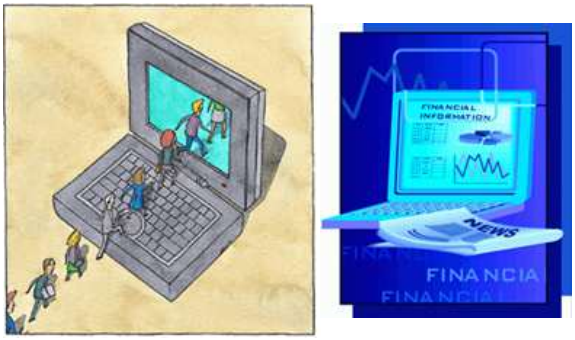
2. Structure of Computer

A computer is comparable to a large box where **data is entered**, which after being **stored**, **processed**, is **returned** by the processor in the form of **results**. In technical jargon, the series of data entered is called input and the set of results, that is, the data that is returned, is called output.

Let's try to make a practical example of the above. Let's imagine that a citizen comes to our offices to issue a certificate. After asking him for his personal details, we insert them into the computer, transcribing them with the keyboard.

The computer searches for the desired data and processes it.

The result is the printed document that we requested.



Input unit

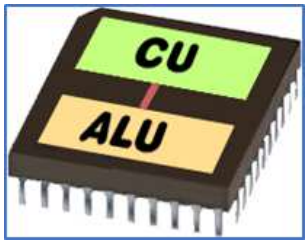
Input units are the components of the computer which **receive data** from the outside. Examples are:
the keyboard, mouse, scanner, touchpad, touch screen etc.

All input units have a fundamental characteristic that unites them; they process the data entered in sequences of zeros and ones, that is, in digital code, and act as a conduit for entering data into the computer.

Processing Unit

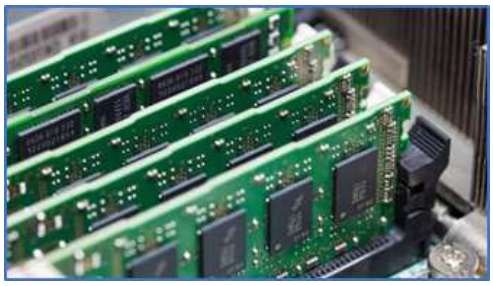
The main task of a PC is to **process** the acquired information.

The component responsible for doing this is the **CPU**, **Central Process Unit** (which stands for central processing unit) or processor.
The CPU (Central Processing Unit) it is the **most important part** of the system, the brain of the computer.
Its function is that to read and carry out the indications contained in the main memory.
The **CPU** consists of two basic units:
The **CU (control unit)**, which directs and coordinates the work of all the component parts of the computer,
The **ALU (calculation unit)**, which processes the data provided by the control unit



Computer memories

The **central memory** of the computer is the place where **all the information** necessary for the functioning of the PC **resides**. We could compare the central memory to a huge table, where each cell is a memory cell or more properly a memory location. Very similar to humans, computers have a memory that can be defined as "long term" and as "short term". These memories are called: central memory and secondary memories.



The main memory consists of two fundamentals parts: the ROM and RAM

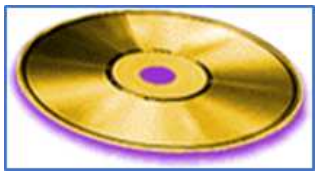
RAM
RAM is **volatile memory**. This means its content is lost if the computer is turned off.

ROM
The content of the ROM consists of information that is essential for **starting the computer**. ROM memory is a **permanent memory**, which retains information even after the computer is turned off.

Mass memories

Mass memories, also called secondary or auxiliary, are an **essential component** of any computer: all application software and not, all our works, our images and anything else that can be stored, finds its place on mass memory .

Among these memories, the **hard disk** plays the most important role, in how much the operating system stores. Other examples of mass memoirs are: CD-ROM, DVD, Pendrive etc.



Removable supports

Other storage systems are so-called portable devices and **removable storage**.
Among the most widespread, we can find movable hard drives.

Output Unit

The task of the output units is to **display the information processed** by the computer and represent the last link in the chain of input / output processes.

Monitors and **printers** are the two main output devices. The main difference is given by the display which on the monitor is only transitory (we no longer display anything, from the moment we turn off the computer) while with printers it is permanent (remains on paper).

The units of input, output and external memory devices are defined as **peripheral devices**, or more commonly peripherals.

3. Interfaces

USB (Universal Serial Bus)

The USB interface can connect peripherals such as the mouse, keyboards, image scanners, digital cameras, printers, speakers, microphones and more. Nowadays, for multimedia components, the USB standard is the method of connection most widely used while in printers there are still models equipped with a parallel port for compatibility reasons.
The USB system consists of multiple peripherals connected by a tree-like structure and a single manager. The standard stipulates that the connector also carries a signal to power the low consumption peripherals. Peripherals that have high energy demands must be powered separately.

WiFi: WIreless FIdelity

WiFi is the **IEEE 802.11** standard for **wireless networks**, through which you can connect to LANs, WANs or the Internet. Access to a WiFi network can be free or protected via **encryption** so that only authorized users with passwords are allowed.
Smartphones currently also have a WiFi interface for accessing the Network services.

4. Central Processing Unit

What is the CPU?

When describing a PC, the first hardware component to be called into question is always the **processor**, or CPU, which in fact can be correctly described as "the brain of the computer", its **"thinking" part**.
The term CPU, stands for Central Processing Unit, and is the main processor of a computer.
The CPU decrypts and executes the instructions which reside in the main memory thanks to two units called:

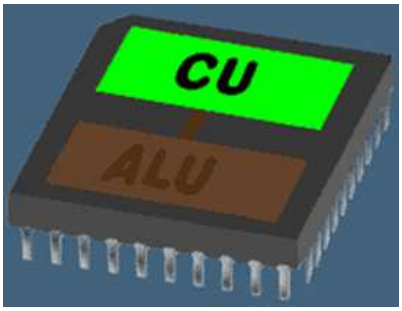
- **CU** or Unit of control (Control Unit)
- **ALU** or Arithmetic Logic Unit

4.1. CPU functions

Let's examine the function of two components of the CPU in more detail.

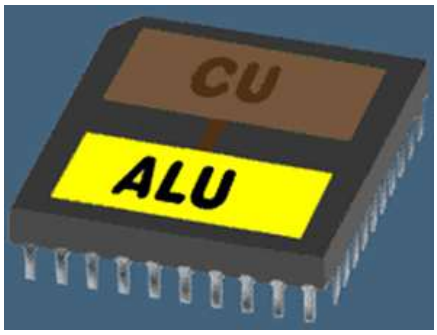
The **control unit (CU)** is the part of the CPU responsible for **controlling and organizing** the activities carried out by the devices connected to the computer. Its function is to extrapolate all instructions from memory, decrypt and execute them.

Basically it presides over the activity of the other parts of the computer by coordinating them in order to tell them what to do and when.
Its functions are therefore of decision making.



On the other hand, the functions of the **ALU (Arithmetic Logic Unit)** are executive type.
The ALU is none other than the **logical arithmetic unit**, in which the arithmetic and logical calculations present in the program instructions are performed.

In summary, the role performed by the CPU is comparable to that of a factory that continuously processes data in binary code (represented by long chains of '0' and '1').
Through the communication routes, the raw material arrives from the outside in the form of incoming binary data; it is then processed according to the program instructions and is redirected outwards.



4.2. CPU Speed

CPU **speed** is the core element of a computer's performance. While many people use a CPU's clock speed to measure performance, this isn't the only variable to consider. Elements like the front side bus and cache also play a big part in CPU speed.

The most **common measure** of CPU speed is **clock speed**, which is measured in megahertz or gigahertz. One GHz equals 1,000 MHz, so a speed of 2.4 GHz can also be expressed as 2,400 MHz. The higher the clock speed, the more operations the CPU can perform per second.

It is important to realize that the clock speed of a CPU is not the only factor that determines performance. Due to differences in chip architecture, one processor may be able to perform more operations than another in a cycle. Therefore, even if the first processor has a lower clock speed than the second, it could actually be faster.

Some processors are **"multi core"**. These terms mean the use of **multiple CPUs** present on a single circuit. The idea behind this concept is to improve processing speed by using two or more processors which can run independently or cooperatively. The actual advantage over a single processor core varies because software usually has to be optimized for multi-core processors in order to gain a significant speed advantage.

5. Input devices

By unit of input we mean the set of those units responsible for **transferring data** between the computer and its **peripheral devices**, disk units, terminals and printers. Such units are: mouse, keyboard, trackball, touchpad, joystick, scanner, webcam, etc.

5.1. Mouse

The **mouse** is an essential device working with personal computer.
At the top of the mouse are two buttons: the left button and the right button.

At the bottom there is a optical sensor or a small sphere that sends the movements made by dragging the mouse to the computer.
As you move the mouse, you move an arrow around the screen, which is called the **"pointer"**.

Through the combination of pointer movements and left and right button presses, many commands can be transmitted to the system, such as deleting, copying or moving a file.

5.2. The keyboard

The computer **keyboard** is made up of letters and numbers, like a common typewriter, and some special keys (function keys, arrow keys, Enter keys, Ctrl, etc.)
Let's go and describe them!
Among the particular keys, we find the Ctrl, which, combined with other keys, allows you to perform various operations.
For example, in all Microsoft Office programs the combinations:

Ctrl + C: allow you to copy an element (files, sections of text, etc.)

Ctrl + V: they allow you to paste the element copied

The Alt key also allows you to execute different commands, depending on the key it is associated to.

Example:
Alt + F4: allows you to exit a program.

In the alphanumeric part of the keyboard we also find:

- **Backspace**, to delete the character on the left of the cursor;

- **Tab**, which moves the cursor by a tabulator. In database management programs this key moves the cursor to the next field;

- Shift, if pressed together with an alphanumeric key, it writes the capital letter, number and special character represented at the top of the key;

- Caps Lock, allows you to write all the letters in capital letters, except for accented ones.

Also to be remembered are the **function keys** (F1, F2,…) so called because a certain function is associated with them depending on the program currently in use.

However, in a large part of the programs, for example, by pressing F1 we will see a Help (Help) appear, that is a list of instructions that can sometimes prove to be an essential guide in facing any difficulties when using the program.

The **Enter** key has several functions: confirm a command or, within a text, go to the top. Finally, the arrow keys and the numeric keypad are still to be remembered.

The **Arrow** keys (or cursor keys) are used to move quickly within a text or to select commands in the program menus.

The numeric keypad located on the right side of the keyboard, it is similar to a calculator and allows the entry of numerical data.

5.3. The trackball and touchpad

The **trackball** is a **pointing device** like the mouse. It differs from the first in a substantial way as it is not necessary to drag. It is sufficient to rotate the sphere inside it with the fingers. The trackball can be equipped with two or three buttons that have the same functions as those of the mouse.
Because it doesn't need to be dragged, this device doesn't need a flat surface for its functionality.

The **touchpad** is a usually rectangular in shape, **sensitive to contact**, and present in Macs and laptops which, in place of the mouse, allows you to move the pointer with the single pressure of the finger, on the underlying surface.

5.4. The joystick

The **joystick**, or **control lever**, consists of a manually operated never with two or more buttons.

It is mainly used in **video games**. The operating principle is similar to that of the mouse: each movement of the lever corresponds to an event on the screen.

5.5. The scanner

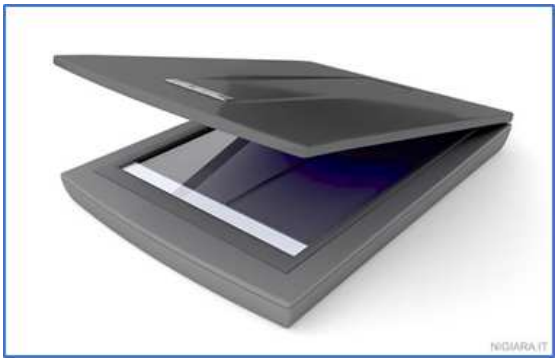
A **scanner** is an external device of the computer which allows you to digitally **acquire images**, **photos**, **drawings** and **texts** inside it, and process them with special software in the form of image files.

Images scanned with the scanner can be subsequently retouched with graphics programs.
The best known of such programs is Adobe Photoshop.

The scanner converts the scanned image into a sequence of 0 and 1, in digital format.
The scanner can also be used for scanning documents, which once entered, however, cannot be processed as such because the computer has registered them in memory as pictures.

Qualitatively a scanner is characterized by the resolution and dynamic range.

Resolution is the number of pixels per inch (ppi): the clearer the image the higher this number is.
Dynamic range measures the ability to capture all gradations of the image in bits



6. Output devices

Output devices are those that generate the **final information**, also considered the results.
Output units are: the monitor, the printer, the loudspeakers, the speech synthesizers, the plotter.

Let's analyze the requirements of the most important units.

6.1. The monitor

The **monitor**, also called VDU (Visual Display Unit), is the video unit.

Its operation is very similar to that of a television: it receives data from the PC graphics card and **translates it into images**. The image is made up of bright dots called pixels.

The number of pixels the computer can display represents the so called "**screen resolution**".

An example of resolution, which is also the one most commonly used by those who work in a Windows environment, is 1920x1080 pixels.
Another peculiarity of the screen is represented by the **number of colors** displayed simultaneously.

256, 65536... up to millions of colors, in relation to the graphics card installed on our PC. The various numbers of colors are all powers of two, that is, they are the result obtained by multiplying the number two by itself for "n" number of times.

The unit in which the **dimensions** of a monitor are measured is the **inch**, which is equivalent to 2.54 centimeters.

The larger the size of a monitor the higher the image quality will be.

When a computer is used at a professional level, such as in design or graphics systems, it is advisable to use monitors that are larger than standard sizes.

6.2. The printer

The **printer** allows the user to obtain a **hard copy** of the data processed by the computer. And therefore extremely useful. There are various types of printers.

The most commonly used ones they are **inkjet** and **laser.** Others are the dot matrix printer (obsolete) and the sublimation printer, used in the graphic field.

6.3. The plotter

The **plotter** is a printer-like device that allows you to print on **large sheets**. It works by drawing lines on a sheet of paper using a pen moved by a mechanical arm. The main difference from the printer is that it can track solid lines, while the printer can only reproduce them through a series of closely spaced dots.

Commonly, plotters are mainly used in the scientific field for the production of two-dimensional graphics (such as the recording of a seismic event), or in computer graphics.
They are considerably more expensive than printers.

7. Memory devices Mass

Mass memories or secondary memories are devices of memory characterized by a very **high capacity,** thanks to which the information, programs, data present in the RAM memory can be permanently stored.
The following are secondary memories:
- The **hard disk**,
- **CD-ROMs, DVDs**,
- The Hardware **keys**

7.1. Hard disk

The **hard disk** or hard drive is the most important example of secondary memory in terms of size.

The hard disk contains an **operating system** and **information** and **programs** that make it possible for the computer to process data.

The hard disk can store **large amounts of data** (currently up to 1000 Gigabytes = 1 Terabyte).

It consists of hard magnetic disks placed inside a protective coating. The data is recorded in magnetic form.
At first hard disks were not removable, which is why the hard disk was also called a "hard disk".
Today, however, there are external hard drives to be connected to the computer that can be removed and moved.
On the market, however, it is possible to find a large choice of secondary memories, removable disk drives, easier than the external hard disk.

Solid state hard drives are widely used nowadays.
A solid-state memory unit (in acronym SSD from the corresponding English term solid-state drive) is a semiconductor-based mass memory device, which uses solid-state storage, in particular flash memory, to store data.

7.2. CD-Rom

A **CD-Rom** is materially identical to a music CD.
Its main function, however, is not to play music, but to **store data** and programs. A large amount of data can be stored on a CD-Rom number (about **650 MB**).

The CD-Rom, in order to be used, must be inserted into the reader, which reads the information through a laser beam.

Three different types of CDs exist:

CD-Roms (Compact Discs - Read only memory) are easy to read discs and cannot be used as a storage medium.

CD-R (Compact Disc - Recordable, i.e. recordable Compact Disc), having the characteristic of being able to be written only once but read an unlimited number of times. After being written, the existing data cannot be deleted or overwritten.
Media is required to write data to a CD-R called a CD-R drive, commonly known as a burner.

Data stored on a CD-R can be read by a normal CD player. Compact Disk Re-Writable (**CD-RW**) that can be rewritten multiple times.

7.3. DVD

The term **DVD** stands for **Digital Versatile Disk** and indicates digital discs with capacities ranging from **4.7 to 17 GB.**
A DVD therefore has a storage capacity equal to that of 7 or 8 CD-Roms. A DVD looks similar to a CD Rom.

There are different types: writable, non-writable and pre-sign in.

The latter are the most common on the market because they normally contain films and have a coded track that allows them to be read only in the geographical area for which it was produced (anti-piracy system).

But the most innovative feature of a DVD is its standard. In fact, despite having the same physical format as a CD-Rom, a DVD has two sides and can record on each of these, contrary to a simple CD which has only one side, and consequently less capacity.

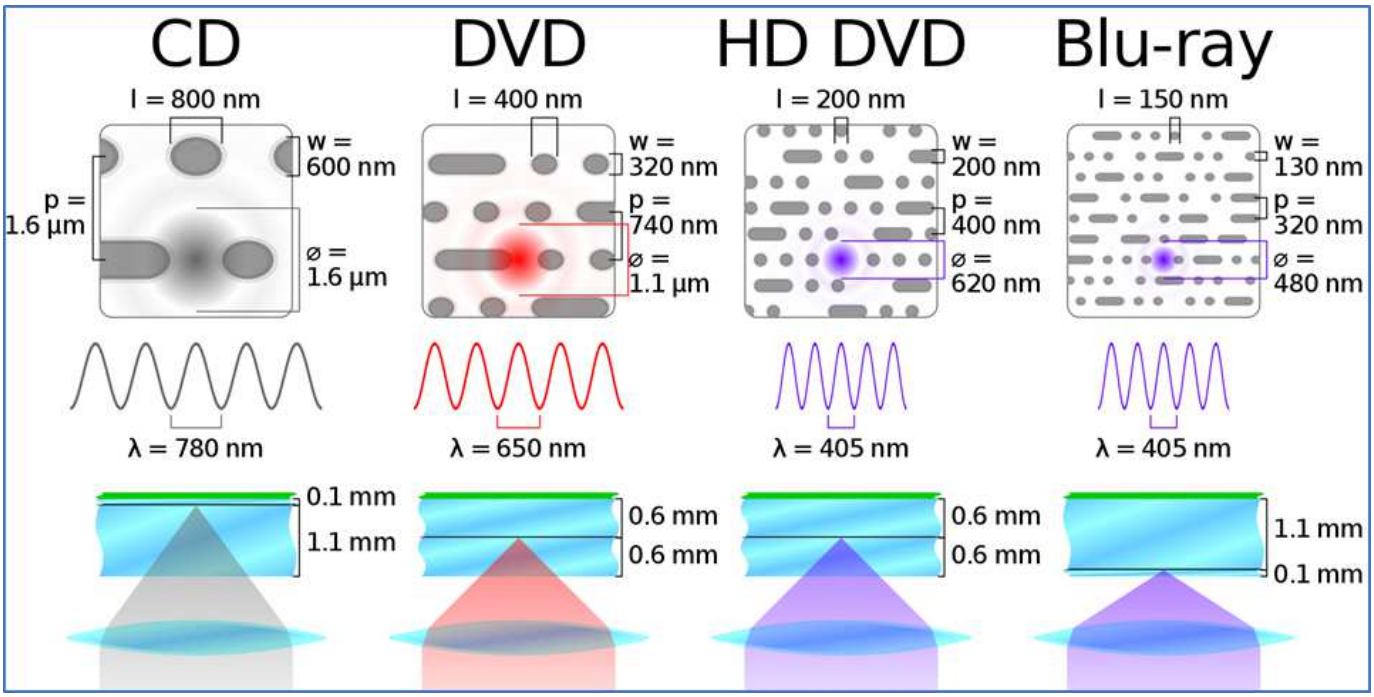
A DVD can contain audio, video, and other multimedia types; this is the reason why the connoisseurs market expect DVDs to replace CD-Roms, VHS videotapes and laser discs.
In order to be read, the DVD needs a special reader as for CD-Roms and floppy disks.

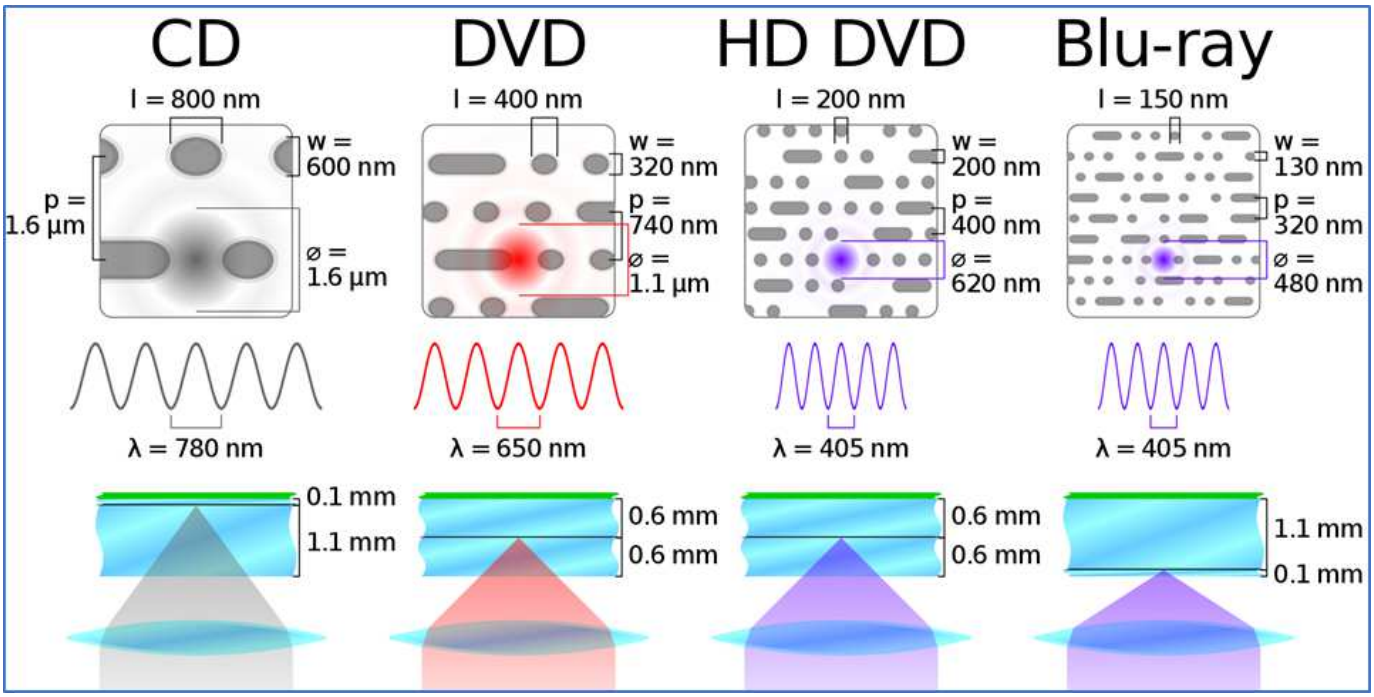
7.4. Blu-ray

The **Blu-ray** or **Blu-ray Disc** (official abbreviation BD) is an optical type of memory medium.

Designed by Sony as a successor to DVD, it is capable of storing **Full HD (1080p) and Ultra HD (2160p) content**. The plastic disc is 120mm in diameter and 1.2mm thick, the same size as CDs and DVDs.

The name "Blu-ray" refers to the blue laser used to read the disc, which stores information with a higher density than the red laser used for DVDs.
Thanks to the use for reading and writing of a blue light laser (405 nm), with a shorter wavelength than CD (780 nm) and DVD (650 nm), Blu-ray can contain up to **200 GB** of data, which is almost 40 times more than a Single Layer-Single Side DVD (4.7 GB). A 25 GB disc is insufficient to hold about 2 hours of high definition video using the traditional MPEG-2 codec: for this reason, in addition to the use of double-layer discs (over 50 GB), the use of more sophisticated codecs such as MPEG-4 AVC or Windows Media Video 9 (standardized as VC-1) that allow, in theory, to double the compression factor compared to MPEG-2, consequently halving the space requirement, without significantly affecting video quality.
The term "Blu" was used instead of the correct English form Blue since the latter, being in common use in the English language, cannot be registered as a trademark. The first device to use this technology commercially was the PlayStation 3, after the producers involved in the Blu-ray project on 12 August 2004 declared that they had approved version 1.0 of the specifications for BD-ROM discs. The official presentation of the new support available for High Definition cinema took place on May 23, 2006 in the United States. The first "consumer" device that arrived in Japanese stores on April 10, 2003 was the Sony BDZ-S77, a player and recorder later sold in America for $ 3,800.




CD
DVD
HD DVD
Blu-ray
l = 800 nm
l = 400 nm
l = 200 nm
l = 150 nm
w = 600 nm
p = 1.6 µm
⌀ = 1.6 µm
w = 320 nm
p = 740 nm
⌀ = 1.1 µm
w = 200 nm
p = 400 nm
⌀ = 620 nm
w = 130 nm
p = 320 nm
⌀ = 480 nm
λ = 780 nm
λ = 650 nm
λ = 405 nm
λ = 405 nm
0.1 mm
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0.6 mm
0.6 mm
1.1 mm
0.1 mm

7.5. Hardware keys

The **pen drives** (or USB sticks) contain a USB interface for communication with the PC and a s**olid-state Flash-type memory** for storing data; they can currently reach capacities of the order of **several GB.** Due to the high data transfer speed and the considerable storage capacity they have completely replaced floppy disks.

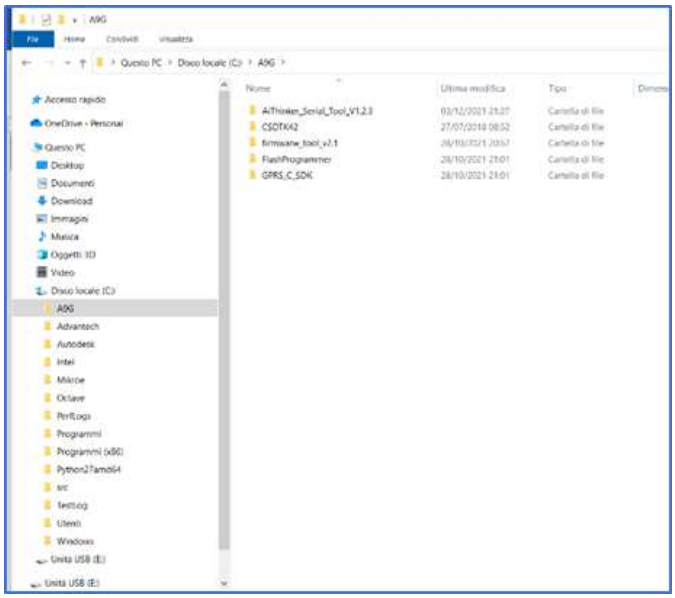
8. Files and Folders

Documents, images, programs and numerical data are saved and stored as **files.**

A file is identified by an **icon, name and extension** (usually a group of three or four standard characters at the end of the file name). Each software application uses files with a different extension. For example, documents created with Microsoft Word have files with the .doc extension.

Imagining the desktop as the desk of our computer, the first thing we find are the folders or directories, which figuratively can be imagined as the big card binders that are the files.

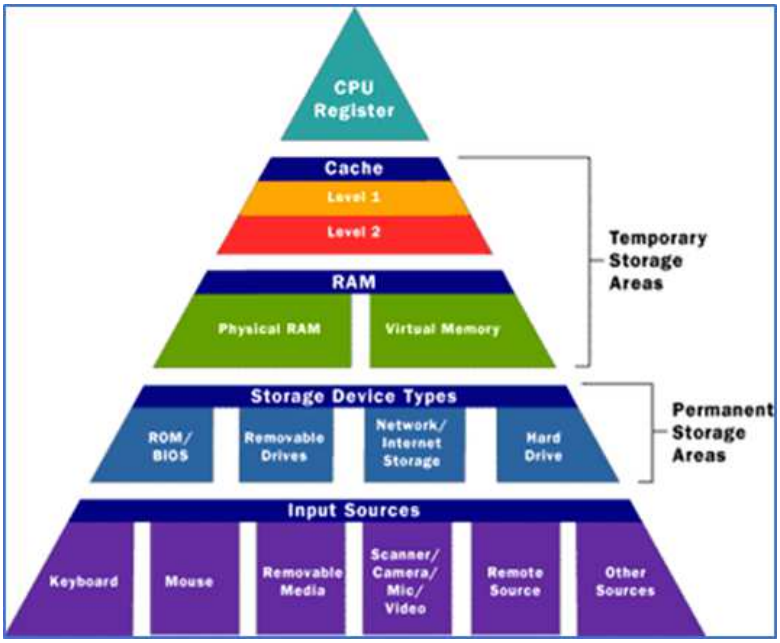
Folders may **contain files** and **other folders**, having dimensions that can reach several gigabytes.



This explains why it is often possible to saturate the size of hard disks of considerable capacity.

9. Quick memories

The **task** of the **memory** is to **store data** information and **programs** developed by a computer. The storage methods differ and a computer uses the storage devices available in different ways. A computer generally has two different types of memories: **permanent** or 'long-term' memory and a **provisional**, so-called 'short-term' temporary memory. These memories are respectively called central memory and secondary memories



CENTRAL MEMORY = RAM + ROM

The central memory of a computer, also called fast memory, consists of two basic units: **RAM (Random Access Memory)** and **ROM (Read Only Memory).**
Let's go and examine their meanings.

9.1. RAM

RAM (Random Access Memory), or memory random access, is the **main memory** of a computer. Its main feature is the temporary nature of the data stored on it, which is lost once the computer is turned off.

RAM is called **working memory**, because it acts as a **temporary storage** for the programs in development and for the data necessary for these programs.
In RAM, the operating system is loaded and the data we work on is stored.

In summary, the RAM retains the data processed by the computer when it is turned on

9.2. The cache

The term **cache**, in computer science, indicates an **extremely fast memory area** but usually of a low order of magnitude of capacity. Its purpose is to **speed up the execution** of programs.
One example is the cache memory used to quickly retrieve data and programs that are expected to be used in the short term.

A cache is associated with main memory, where data resides. It typically has a smaller capacity than the main memory, but its use is more convenient in terms of access time and / or system load.

When access to data is required, a copy of it is first searched in the cache: if it is present and valid, this copy is used; otherwise the data is retrieved from the main memory, and stored in the cache, in case it can be used later.

Main memory can be hardware like a RAM (processor main memory) or hard drive, but also a complex distributed database, like DNS or the web. In these cases, main memory can be changed without going through the cache. This leads to consistency problems between the "original" data and the data in the cache, or a possible misalignment.

In some cases it is possible to validate the data contained in the cache by querying the main memory to see if it is still synchronized and correct. This is the task that on the web, for example, proxy servers do: they ask the HTTP server if the page they own has been modified after it was stored, and if it is not, they avoid transferring it and propose it directly to the client.

In other cases, a timed expiration mechanism for stored data is used, and as long as a data in the cache has not expired it is used, even if it does not correspond to what is present in main memory. This is the mechanism adopted by the DNS.

A cache reduces the request load that has to be cleared from main memory, and from the link between it and the data user. This can also help improve system performance. For example, think of a proxy server used by many users: when a user requests a page that had already been requested by another, the proxy will be able to respond without having to connect to the original site, and thus avoid loading both the original site and the network, thus improving system performance even for requests that need to be forwarded to the original sites.

A cache uses an algorithm to decide which data to keep and which to discard, which takes into account the most recently used pages, the contiguity of the pages, or several other factors.

A cache can index stored data based on its address (a block of memory or hard disk data) or its "name" (associative cache, such as a web page or DNS name).

9.3. ROM

ROM, an acronym for **Read Only Memory**, is as the name implies a memory of read only.
ROM has a simpler structure than RAM, because it records information that only needs to be read and not changed.
Unlike RAM, ROM is **non-volatile memory,** which means that once the computer is turned off, the data remains stored there.

9.4. Memory unit of measure

The bit

The **bit**, which is the **smallest unit** of storage, is a **binary digit**, a unit of elementary information in a digital computer that can assume only two states: **ONE or ZERO**.

The **1** represents the **ON state** (lit) and the **0** represents the **OFF state** (off, inactive) hence the binary name. The bits are mapped in to groups of eight to represent characters, numbers or symbols.

A group of **eight bits** makes up **one byte**.

The byte

1 BYTE = 8 BIT

The **Byte** is a term that indicates a set of **8 bits**, a byte is necessary to represent a **character**. The groups of 8 bits that assume the value of 0 or 1 from time to time allow to obtain **256 different variants**, thanks to which the group of 8 bits (1 byte) is able to represent all the letters of the Latin alphabet, capital letters and lowercase letters, numbers, punctuation marks, and various other symbols.

For example: the sequence 01000001 in binary code is used to indicate the letter A.

The Megabyte

1 Megabyte = 1.048.576 bytes = 1024 Kilobytes

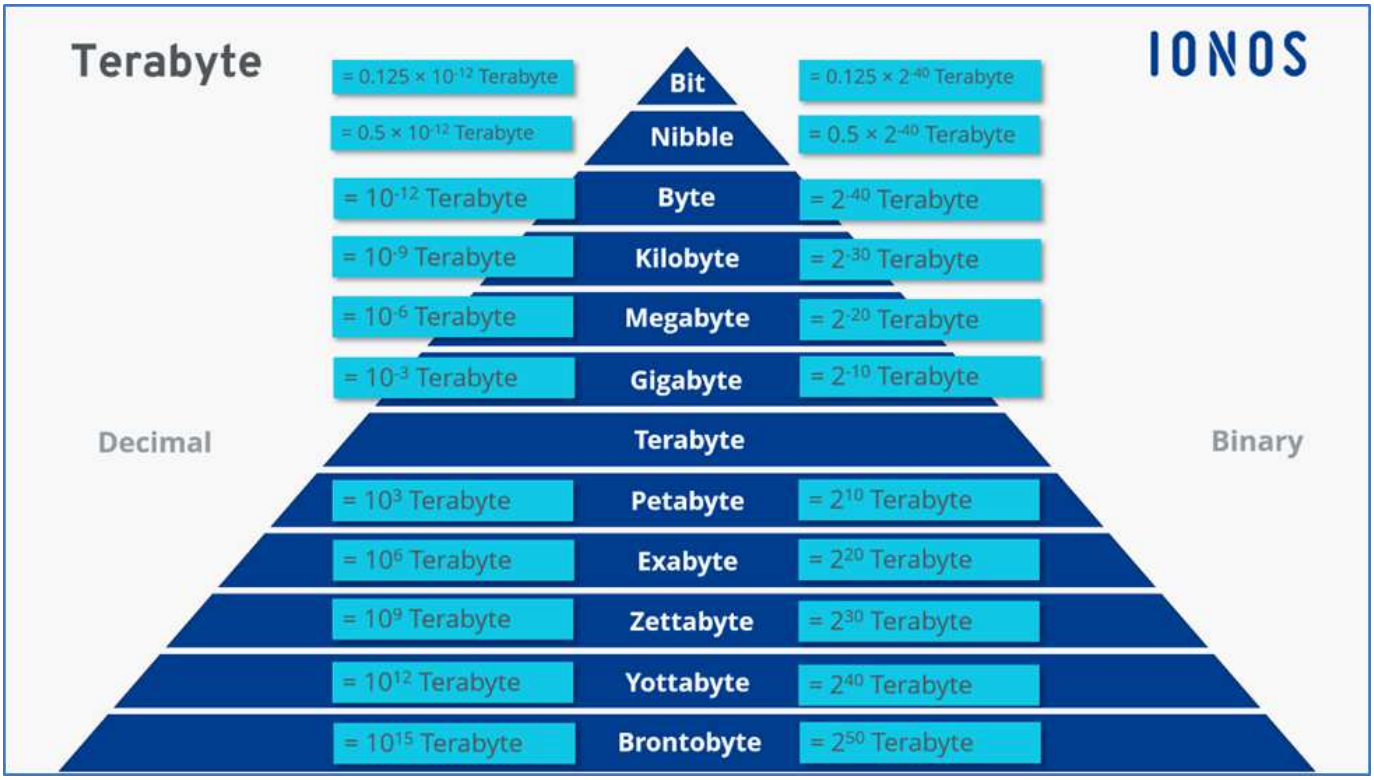
The **megabyte** consists of **1024 Kilobytes**, that is **1,048,576 bytes**. To give a concrete example, 1 MB corresponds to 1000 pages of text.

The Gigabyte

The next multiple is the **gigabyte** (GB) that is made up **1024 megabytes**, i.e. 1,073,741,824 bytes.
The memory capacity of many storage drives today like hard drives, it measured in gigabytes.

The Terabyte

The **Terabyte** is the next multiple of gigabyte. The Terabyte is 1,099,511,627,776 bytes.
1 terabyte of data can be stored on approximately 1400 CD-Roms, 212 4.7GB DVDs, 66.6 HD DVDs, or 40 single-layer (20 dual-layer) Blu-ray Discs.



10. Software

Types of software

The term **software** is used to indicate the **immaterial part** of the computer as opposed to the physical one defined as hardware.
The different programs used to operate the computer and the devices connected to it are software.
The software is divided into two categories:

- **System software**,
- **Application software**.

System software

It can be said that the **software system** is necessary for the **machine to function**, while the application software is for the user to work.
Part of the system software is the **operating system**, a which is group of programs that manage the basic operation of the computer.

Application software

The **application software** consists of programs that do the **real work** for end users. Some examples of application software are: Microsoft Office, OpenOffice; These applications cannot work autonomously and independently from the system software.

The Operating System

The **operating system** is the most important software or **"set of programs"** on your computer. Any computer, in order to work, needs an operating system.
Its role is to **manage the main computer components** (computer, hard disk, keyboard, monitor, printer, etc.), thus making it possible to use any other software. The operating system is the interface through all the data necessary to perform the operations is entered and then becomes elaborated giving coherent results.

The operating system coordinates the general functions of the computer, such as the graphic aspect of the visualizations on video, writing and reading from disks, the creation and closing of various programs as well as, the processing and transmission of data through all the Input / Output tools.

The operating system resides on the hard drive like any other programs and is loaded into the RAM memory when the machine is turned on.

Main operating systems

The best known and most popular operating systems are:
Windows which is undoubtedly the most widely used operating system;
MacOS from Apple, for MacIntosh and PowerPC;
LINUX, designed by Linus Torvalds, is an implementation of UNIX and can be used on any type of platform, including Personal Computers. This system has become extremely popular both for its versatility and for the fact that it is free.

10.1. GUI (Graphical User Interfaces)

The **user interface** allows the user to **interact** with a computer.

The first computers were based on MS-DOS (now obsolete), which uses a text interface consisting of a command line to establish a dialogue between the computer and the recipient. To communicate with the computer the user therefore had to give special orders through digital commands, very often quite lengthy and difficult to memorize. Today, however, the graphical interface is unanimously adopted.

A **graphical interface**, as the name suggests, uses **graphical representations**, such as windows and icons, to represent commands, files and applications, thus making the use of programs easier and more immediate.
All operations take place not only through icons and windows, but above all by using the mouse to launch commands, choose options, etc.

10.2. Application Software

Texts Processors

Text processors are **word processors** and represent the most widespread application software.
In the beginning these programs guaranteed slightly higher functionality than a simple typewriter, but over the years they have become more and more sophisticated.
Features such as saving a text on file, keeping it, correcting it, modifying it, copying it, printing it, are all offered by most recent word processors such as Microsoft Word.
There are various word processing programs: the most popular is Microsoft Word, an easy-to-use word processor with multiple functions.

With Word, you can improve the style, and the look and feel of a document. Graphic elements, letters, faxes, or notes are easily embellished. The final result can be checked at any time using the Print Preview function and, in the event that the document does not correspond to our expectations, we can make all the desired changes.

The spreadsheet

The **spreadsheet** is used in the management and processing of **numerical data** and for the creation of **tables** and **graphs.**
It allows us to perform various operations such as organize accounting, create statistics, etc.

A spreadsheet is nothing more than a table containing rows, columns and cells. By entering numeric values in the cells, you can perform various calculations.
In fact, among the most advantageous functions offered by the spreadsheet, we find the calculation of arithmetic formulas and functions. This allows you to do automatic operations that usually require a calculator or a sheet of paper.

Another important function of these programs is to be able to create graphs, always in relation to the numerical data introduced in the tables.
As cell values change, the graphs are redrawn based on the new data.
Charts can also be "exported" to others applications and enrich, for example, a report written in Word or a presentation created with PowerPoint.

Presentation tools

Programs such as Microsoft Power Point allow you to create various kinds of **presentations**, often accompanied by **images** and **sounds.**
When creating presentations with Microsoft PowerPoint, you can rely on the content wizard or your own creativity.
Presentations are often enriched with texts, captions, images or drawings, but graphics or tables can also be used, elaborated with spreadsheets.
It is possible to make the presentation more attractive by adding multimedia interactions such as sounds, movies and animated images.

Database

Databases are applications that allow to **manage various types of archives** by **organizing** the various **information** in an intelligent way.
Databases work the same way as any another archive such as that of a company, in which it is possible to classify one's employees on the basis of personal data, the date of hiring, the position held, etc.
The main feature of a database is that of being able to retrieve information very quickly among thousands of records.
The results are displayed on the screen and can be printed.
Microsoft Access it is the most widely distributed program for creating databases.

Utility programs

Other general utility programs are:
Antivirus, which act as an "antidote" to electronic viruses, focusing and eliminating them;

File compression programs, the function of which is to compress a file, reducing the space occupied.

Single Board Computer

Sito: DTAM Online Training Platform
Corso: Introduction
Libro: Single Board Computer

Stampato da: Mirco Ferrera
Data: lunedì, 23 ottobre 2023, 09:51

Sommario

1. Single Board Computer

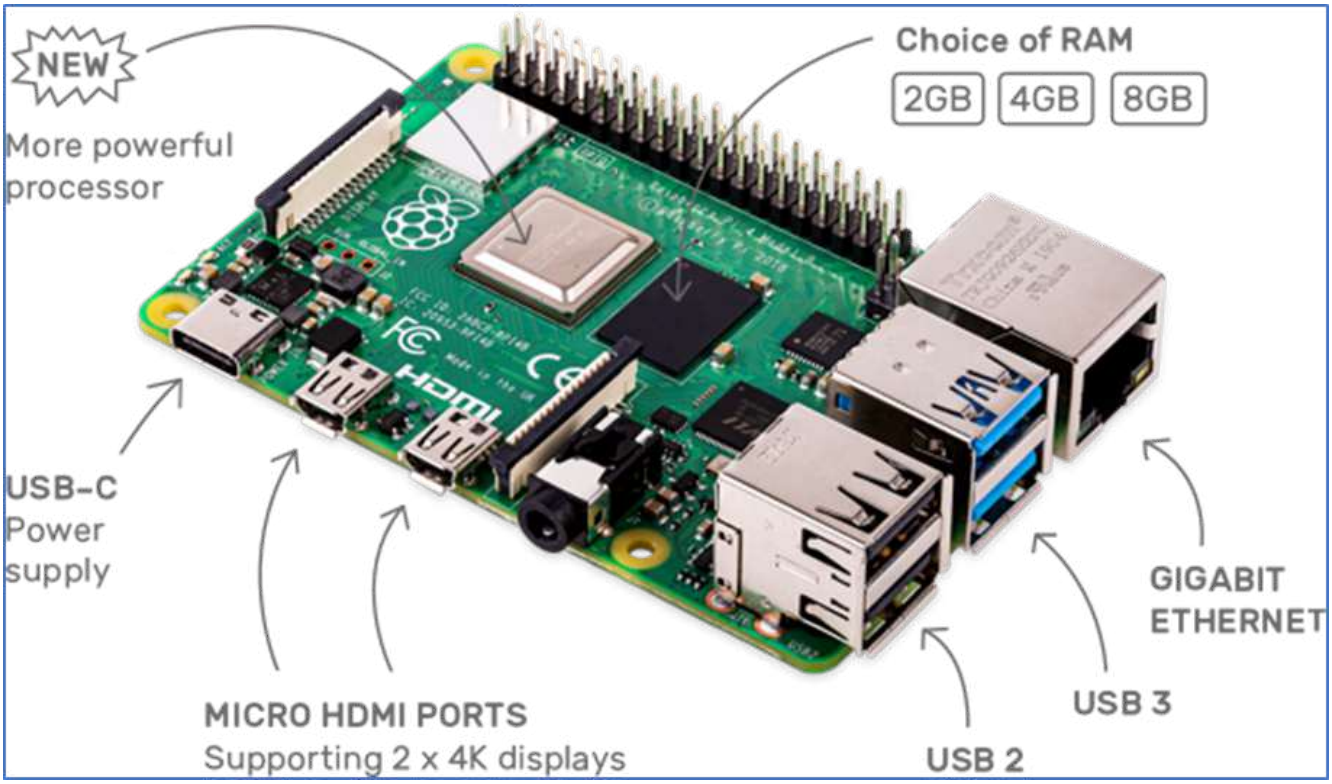
2. Raspberry PI

1. Single Board Computer

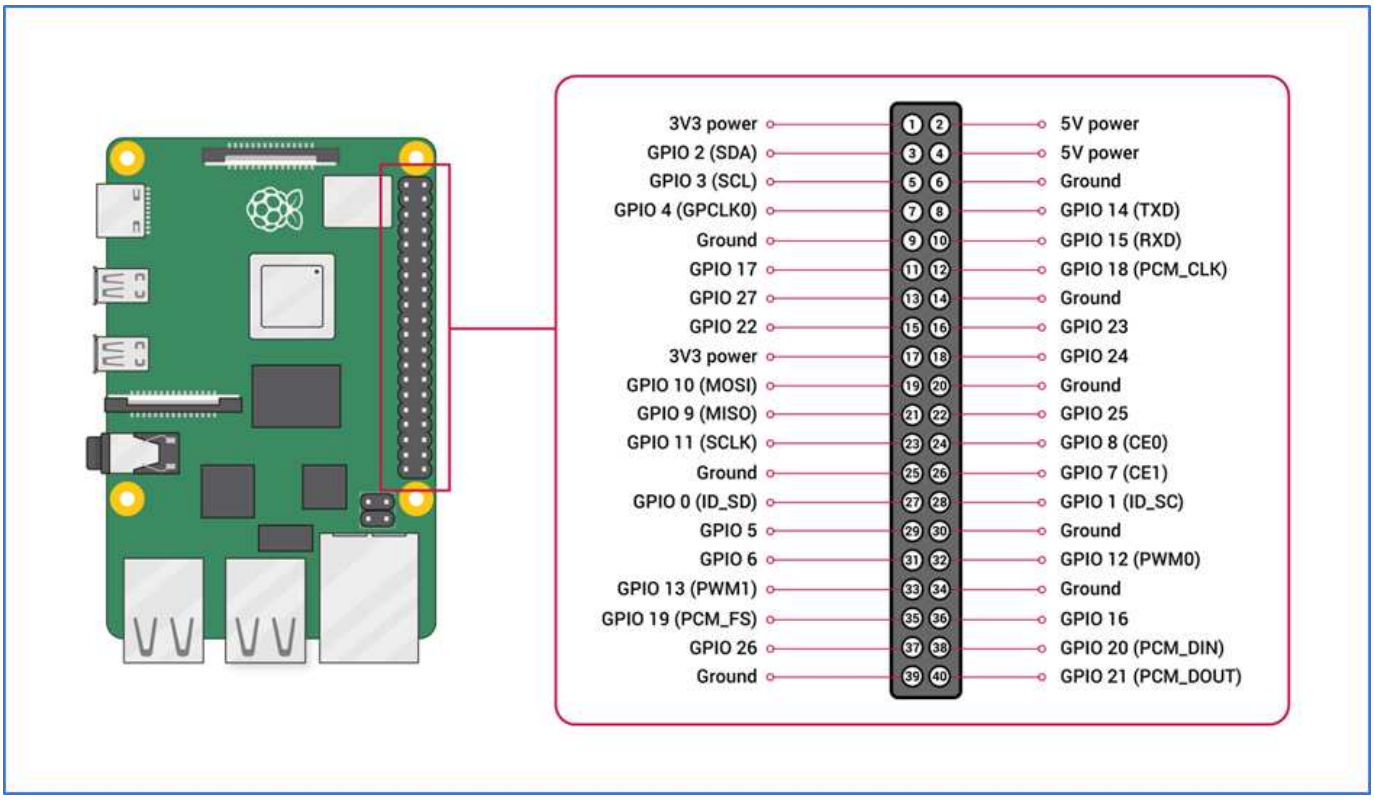
A **single board computer** (SBC) is a **complete computer** built on a **single printed circuit board** (PCB). It does not rely on expansion slots for expansion or peripheral functions. Everything is integrated in one PCB. Single board computers have been with us for many years, but it is only recently that they have become affordable and accessible. Also the formfactor has changed radically. Where they used to be bulky, also due to the components being quite large, a typical single board computer these days is the size of a credit card or slightly larger. Additionally what makes them an interesting platform is the integration of general purpose input / output (GPIO) pins. These allow for each interfacing with a wide variety of input (sensors) and output devices (actuators).

2. Raspberry PI

A specifically popular and accessible SBC is the **Raspberry Pi**. At the time of writing the most recent version is called the Raspberry Pi 4 and comes in 3 flavors: 2GB, 4GB or 8GB of RAM. It has a ARM 64 bit processor at 1.5Ghz, dual HDMI mini, a Gigabit Ethernet port, 2 USB 3.0 ports and 2 USB 2.0 ports (more specifications).



Moreover it has a 40 pin **GPIO connector** with digital I/O ports, I2C bus, SPI, serial connection and more.



What makes the Raspberry Pi such a powerful platform is not just its hardware combined with the affordable price. Maybe even more important is the extensive documentation and community associated with the Raspberry Pi. This makes it an ideal choice for a wide variety of applications.

Typically a Raspberry Pi will be booted from a microSD card using the microSD card slot on the bottom side of the device. Before booting the Raspberry Pi, the microSD card needs to be loaded with the appropriate operating system (OS). The most used OS for the Raspberry Pi is called Raspberry OS, which is a debian derivative optimized for the Raspberry Pi.

The Raspberry Pi foundation has developed their own application for easy selecting and writing the desired OS, called Raspberry Pi Imager.

Alternative options are booting the Raspberry Pi from an external SSD (or HDD) connected through USB or booting from a server using network boot (PXE).

The basic elements for creating a network

Sommario

1. To Start – Definition

2. Basic components of a network

3. Ethernet topology

4. Summary table

5. Client and server

6. Wiring

7. Network cards

8. Hub
8.1. Example

9. Switch
9.1. Example

10. Router
10.1. Example

1. To Start – Definition

Al though the term **"network"** has many meanings, we can define it as a **group of two or more connected computers.**

If the computers are networked, it is possible to **exchange files** and **share peripherals** such as modems, printers, backup tape drives, CD-ROM drives.

Networks can be **local** or **geographic**: when we talk about the network located in a single company site we have a local network **(LAN, Local Area Network)**, if two networks located in two different locations are connected through services offered by an Internet Service Provider (ISP) or via a dedicated line provided by a telephone company, we also have in addition to two local networks a **WAN (Wide Area Network, also called geographic network)**.

Each network includes:

- at least two **computers**;
- a **network card** (a device that allows the computer to communicate with the network) on each computer (also called NIC, Network Interface Card);
- a means of **connection**, namely the cable. Today there is also the possibility of making computers and peripherals connected to the network communicate wirelessly (in English, "wireless");
- a **network software**, normally already present in the most common operating systems such as Windows 9x, Windows NT / 2000, Apple MacOS, Novell NetWare.
- a **'point of aggregation'**, that is a 'box' to connect all the cables. In the past there were also networks in which the network cable of each PC connected directly to another PC: today, however, networks almost always provide a more efficient structure, which brings together the cables connected to the PCs in a single point. This' smart box that cables from PCs attach to can be a hub or switch.

2. Basic components of a network

Most networks consist of at least two **computers**, **network cards**, **cabling**, **network software**, and a **hub**.

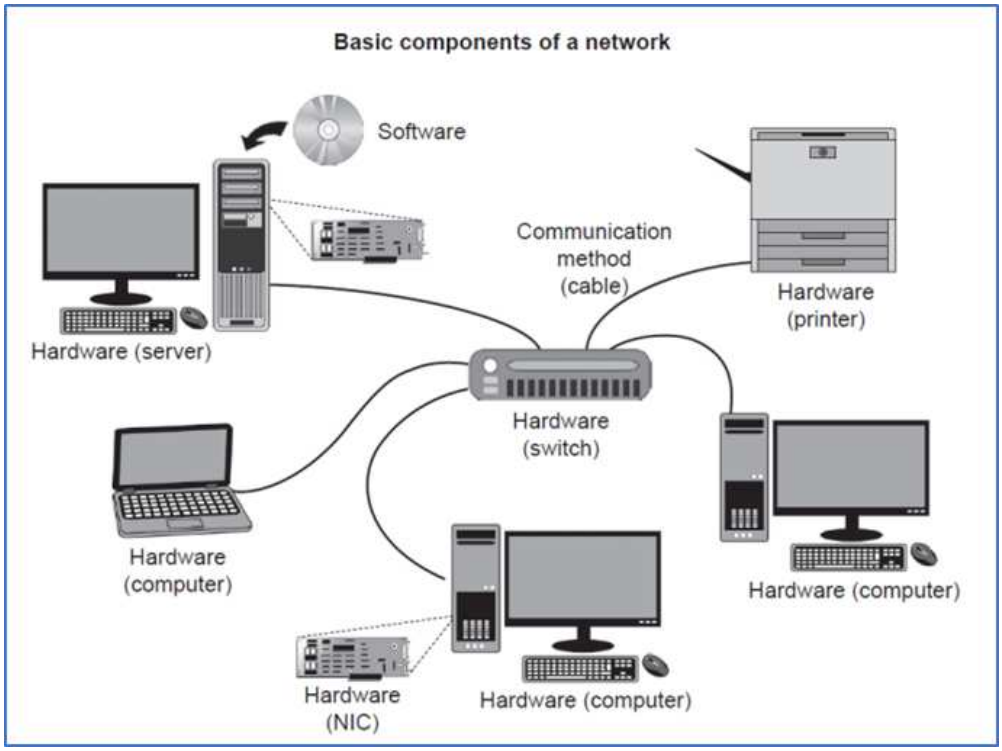


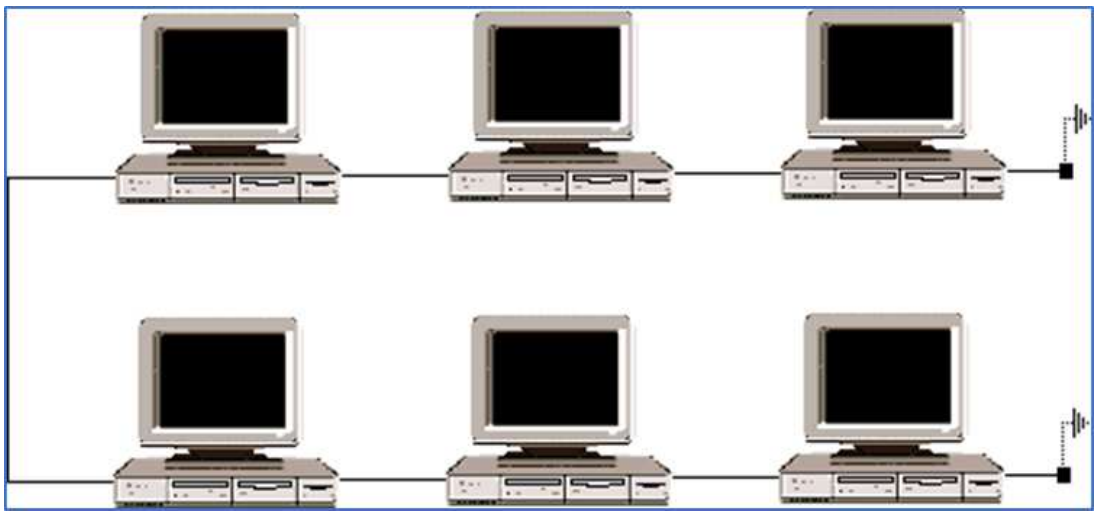
Figure 1: Basic components of a network

3. Ethernet topology

The physical connection between the nodes of an **Ethernet network** can be **bus** or **star**, depending on the version.

The topology we are talking about is the **physical topology**, which should not be confused with the electrical topology of the network, which in both cases remains on the bus. This means that in any Ethernet network, the signal touches the nodes passing through **only one path**, regardless of how they are placed. A popular example of a non-bus-based network is Token Ring, which has an electrical ring topology.

The 10Base-2 and 10Base-5 networks have a physical bus topology, so the cable runs from one computer to another by "touching" each computer, without creating rings or secondary branches.



Networks such as 10Base-T and 100Base-TX continue to have an electrical bus topology, but the physical topology becomes star. This means that all the machines are connected to **one point**, the **hub** (concentrator in English) which, in addition to bringing together all the connections, also acts as a **repeater**.

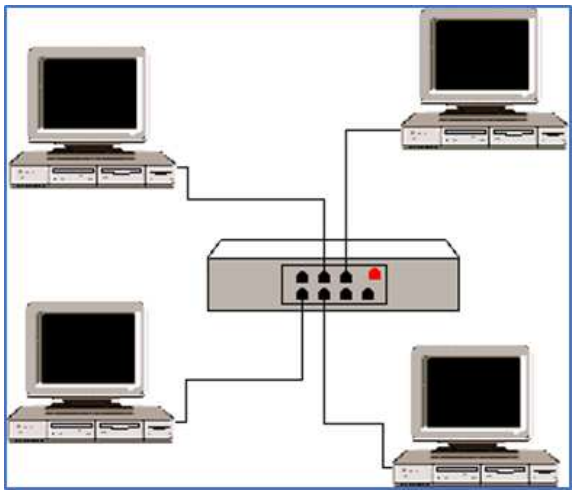


Figure 3: Star topology

4. Summary table

Version	Max speed	Max length of a segment	N ° max. of nodes on a segment	Total reachable length	N ° max. of repeaters	N ° max. of segments	Type of cable used
10Base-5	10Mbps	500m.	100	2500m.	4	5, of which 2 are not populated	Coaxial coaxial
10Base-2	10Mbps	200m.	30	1000m.	4	5, of which 2 are not populated	Thin coaxial
10Base-T	10Mbps	100m.UTP 500m.STP	2	500m.	4	5, of which 2 are not populated	UTP / STP twisted pair
100Base-T	100Mbps	100m.	2	205	2	3, including 1 for the uplink	UTP pair (cat.5)

5. Client and server

Often, when the network grows and the number of connected users increases, a computer is introduced on which no one will work: it will in fact be a computer dedicated to offering services to the other PCs on the network.

This computer is called a **server**, a centralized place to **store** (and **share**) **information** (files) or **programs.**

The servers also **manage and make some peripherals** such as printers available to everyone. If a server exists on the network, the other computers take the name of the client.

In small networks where you decide not to install a server, some sharing functions can be performed by the single connected computers.

Users can still exchange files and emails, copy files to someone else's hard drives, and even use printers connected to another computer. However, if more users are added to the network, a dedicated server is certainly more efficient and secure.

6. Wiring

Network cabling can be done using three types of devices:

1. The **coaxial cable**, which looks like television cables, but whose diffusion is decreasing.

2. The **twisted pair**, (also called 10BaseT), which is typically used in new installations and complies with various standards such as Category 3 Unshielded Twisted Pair (UTP) used in traditional telephone lines, and Category 5, increasingly used in current data networks (and mixed data / voice networks).

3. **Optical fibers**, which are generally reserved for the most important links of large networks. This is a cabling, which you will not normally see connecting office PCs: it is used to carry large amounts of data and is particularly expensive.

It is therefore important to choose the right cabling for offices and buildings and it must not be forgotten that what is passed under the floor or along the walls must not only meet current needs but must be able to cope with future transformations. For example, for a normal Ethernet local network (speed: 10 Mbps) it is sufficient to use Category 3 UTP twisted pair cabling.

But if you later decide to switch to a faster Fast Ethernet network (speed 100 Mbps), you will need Category 5 UTP twisted-pair cabling: otherwise you risk having to re-install all the cables.

7. Network cards

Network cards are usually installed inside the computer. The terminal part of the card appears on the back of the computer, where the network cable is inserted.

Laptops and notebooks have different network cards (PCMCIA format), and occupy a slot that is usually found on one side.

It is also necessary to choose the network card with an eye towards the future: for example those who a year or two ago adopted the Fast Ethernet card (10/100 Mbps speed, now a standard), instead of the slower card. Ethernet, it is now easier to take advantage of the performance of an enhanced network.

Fast Ethernet is spreading rapidly, but it is already foreseeable that local networks with higher speeds will be common in the future.

8. Hub

Hubs, or repeaters, are the devices that **connect users to each other**, the 'aggregation point of all cables connected to PCs.

Each data packet from a computer is received by the hub on one port and transmitted to all the others.

All users connected to a hub or a series of "cascaded" hubs are in the same network "segment" and share the same bandwidth (speed, so to speak).

For example, in the case of the common Ethernet network, the 10 Mbps bandwidth is shared in such a way that if one user is using 10% of it, the other users are left with 9 Mbps. It is easy to imagine that this type of bandwidth connection "shared" rapidly depletes the network's ability to rapidly send information traffic.

8.1. Example

Let's use a metaphora to understand why a hub, while being an inexpensive device, is less efficient than other network devices: hotel with a single internal telephone line for all guests.

If one guest calls another, the phones in all the other guests' bedrooms start ringing.

To understand who the call is addressed to, each guest will have to answer.

Furthermore, the telephone line cannot be used by others for the duration of the call.

With few guests this system might be acceptable, however, at peak times, say when everyone returns to their room at 6pm, it becomes difficult to communicate.

The telephone line is always busy and the phones ring continuously.

9. Switch

Switches perform the same function as hubs, but are more **powerful and intelligent**. First of all, they offer greater bandwidth to users, because the bandwidth is not shared, but dedicated: if it is 10 Mbps, each user has their own 10 Mbps, not to be shared with anyone.

Furthermore, a **switch sends data packets only to the specific port** of the recipient (this happens because it "reads" the information with the address of each packet.

To isolate the broadcast from other ports, the switch establishes a temporary connection between the source and the destination, closing it when the conversation ends.

9.1. Example

Compared to the previous example, the switch is like an intelligent and multiline telephone switchboard, where it is possible to call only the desired person (without making all the other telephones ring) and where there are no “traffic jams” in case of excessive traffic: the line is always free.

10. Router

Routers are also **"traffic shippers"** that receive data and send it somewhere else.

In networks, they usually deal with traffic outside the local network, for example to an **Internet connection.**

Routers are particularly intelligent: they read a more complete "address" to determine the next point to send the data "packet" to.

Based on a network map called a routing table, routers can make sure that packets reach their destinations through the most effective routes.

If the connection between two routers drops, in order not to block traffic, the source router can define an alternative route.

Routers also create **links** between networks using different languages or, in technical terms, **different "protocols**".

Protocols used include **Internet Protocol (IP)**, **Internet Packet Exchange (IPX)**, and **AppleTalk.**

Routers can also connect networks located in the same place or in a group of buildings but are mainly used for the WAN connection between physically distant networks.

WAN services, which are offered by telecommunication companies to connect geographically distributed networks, will be explained in detail below.

10.1. Example

To understand the function of routers, one can imagine that the Ambasciatori Hotel and all the other associated hotels in the chain have more efficient operators.

When Fabiola Sassaroli, a guest of the Hotel Ambasciatori, calls Rita Mascetti at the Hotel Firenze, the Ambasciatori operator knows the best way to forward the call. She then sends the call to the Michelangelo Hotel which then passes it to the Hotel Firenze.

If there was a problem with the switchboard of the Hotel Michelangelo, the Ambassador operator could use an alternative route, passing the call to another switchboard in the hotel which, in turn, would send the call to the Michelangelo.

Networking Technologies Overview

Sito: DTAM Online Training Platform
Corso: Introduction
Libro: Networking Technologies Overview

Stampato da: Mirco Ferrera
Data: lunedì, 23 ottobre 2023, 09:52

Sommario

1. LAN Ethernet and Fast Ethernet

2. LAN Ethernet access and WAN

3. Virtual Private Network (VPN)
3.1. Security in VPNs
3.2. The elements needed to create a VPN

4. Analog lines (Obsolete)

5. ISDN (Obsolete)

6. ADSL Lines

1. LAN Ethernet and Fast Ethernet

Ethernet appeared in the 1970s and is the **most popular networking** technology for local area networks (LANs). Ethernet is based on the CSMA / CD (Carrier Sense Multiple Access with Collision Detection) standard, (See the Token Ring entry in the glossary for information on another type of basic network communication).

A computer with an Ethernet network card can only send data packets when **no other packets are traveling** on the network, that is, when the network is **"quiet".**

It is like when, during a conversation, one person has to wait for the other to stop before speaking back.

If several computers perceive a "quiet" moment at the same time and start sending data at the same time, there is a **"collision"** of the data on the network, which does not imply errors but the need for further attempts.

Each computer, in fact, waits for a certain period and tries to send the data packet again.

As the number of people trying to use the network increases, the number of collisions, errors and retransmissions rapidly increases, with a snowball effect detrimental to network performance.

When more than 50 percent of the total bandwidth is used, the collision rate then causes **congestion**: the time to print files gets longer, applications open slowly, and users have to wait.

When this value reaches and exceeds 60 percent, the network drastically slows down or even stops.

As pointed out in the previous chapter, the **bandwidth** or data transmission capacity of Ethernet is **10 Mbps**.

Fast Ethernet operates the same way but at ten times the speed (**100 Mbps or more**).

Given the way Ethernet networks operate, it is easy to understand how efficient a switch can be in solving traffic problems by providing more 'lanes' to traveling data than networks where bandwidth is shared by all computers.

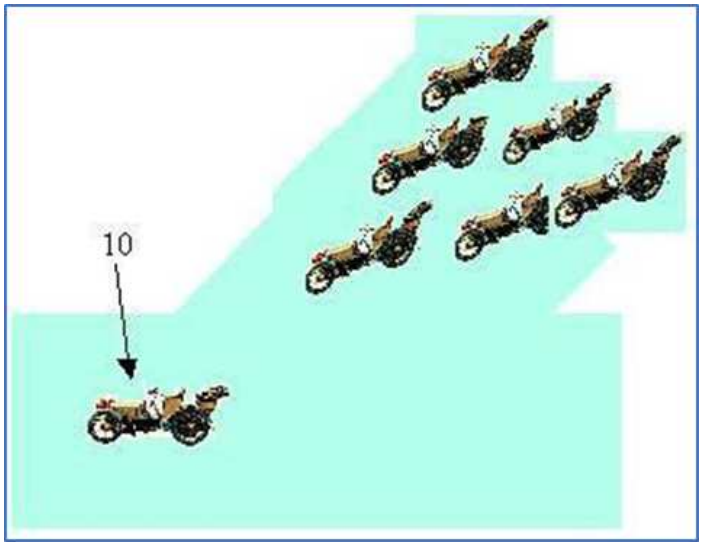


Figure 4: Ethernet

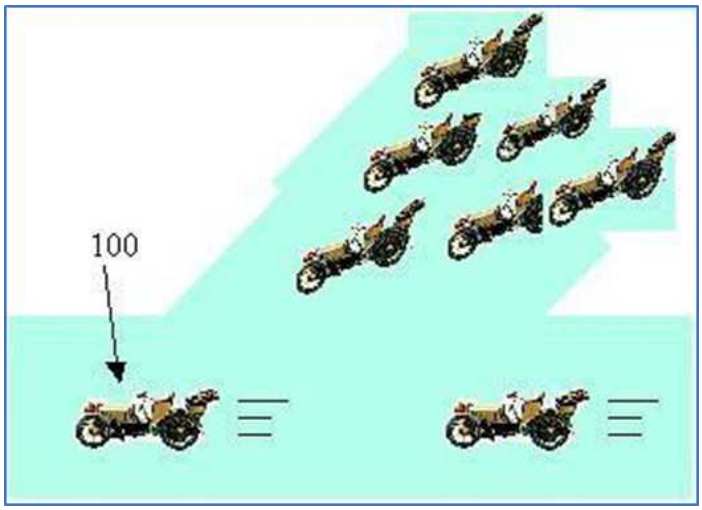


Figure 5: Fast Ethernet

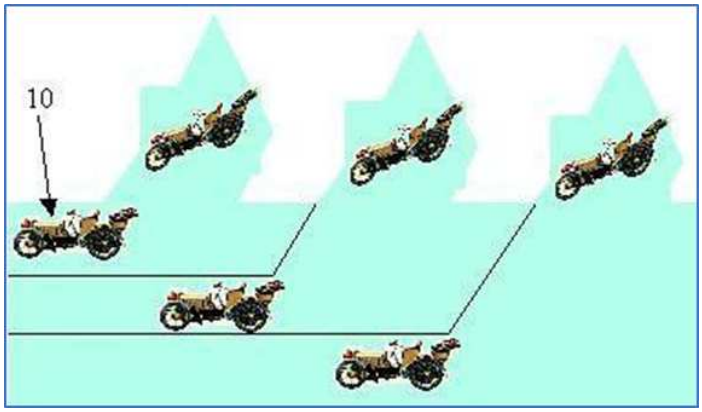


Figure 6: Switched Ethernet

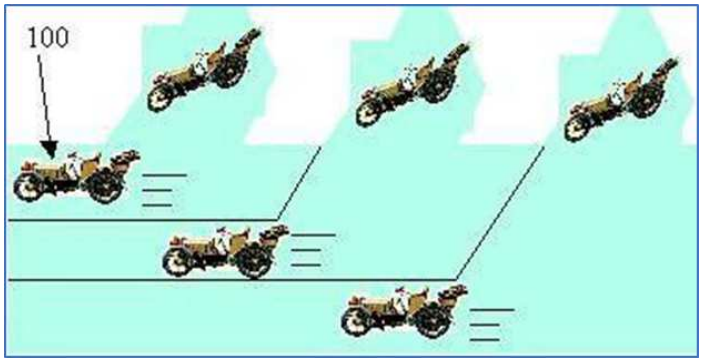


Figure 7: Switched fast Ethernet

2. LAN Ethernet access and WAN

LANs serve **local users** within a building (or at most adjacent buildings, the so-called "campuses"). **WANs**, on the other hand, connect **LANs located in different places** in the same city, country or anywhere else in the world.

It is therefore a remote connection and in this case we speak of geographical connectivity. The **Internet** is obviously a **WAN network**, as are the networks that connect the branches of a company scattered throughout the territory.

In general, the speeds of local area networks (LANs) are significantly higher than those of WANs.

If an Ethernet goes at 10 Mbps, which is millions of bits per second, a common modem operates at 56 Kbps (thousands of bits per second), which is less than 10 percent of the speed of an Ethernet.

Even the most powerful and expensive dedicated WAN connections can't hold a candle.

Geographic connections are also those between a single user and a distant network, for example, an employee connecting to the office network from home (to access a document or send a message).

Or a user who connects to an Internet Service Provider to use the latter as a "bridge" to the Internet or to the corporate network.

In these cases we speak of "remote access" and usually telephone lines are used.

3. Virtual Private Network (VPN)

As we have seen, local networks can be connected to each other even if they are distant and thus a geographic network is created.

For the geographic connection (from city to city, for example) companies have traditionally used dedicated lines, provided by a telephone company.

The "conjunction" between headquarters and branch, or between the headquarters and the home of an employee, in the past therefore required an expensive "private" line, specifically chartered by the company for the service.

For a small or medium-sized business, a WAN was therefore a challenging asset.

But now an alternative is available: the virtual private network (**VPN**).

A **VPN** is a connection that **uses a public network** (such as the Internet) to offer the same advantages as dedicated lines: **security and efficiency** in data transfer.

Practically:

- **Greater convenience**. Remote users and branches can connect to central network resources by calling a local Internet Service Provider, at the cost of a local call. A much cheaper method than city-to-city dedicated lines.

- **More flexibility**. Moving or opening new branches in other locations does not require the installation of new dedicated lines for data transmission. Furthermore, VPNs also simplify the creation of an extranet, that is a 'protected' and confidential network accessed by customers or suppliers, for example, to order products, check the status of supplies, send invoices.

3.1. Security in VPNs

Leveraging the Internet for your WAN can seem dangerous - someone could see your company's private data without permission.

In reality, **VPNs protect data from unauthorized access** in a variety of ways.

First of all, they create a kind of reserved "tunnel" within the public network: the data does not mix with that of all other companies and users, furthermore particular encryption technologies make the data readable only by the sender and the recipient: therefore, no danger.

3.2. The elements needed to create a VPN

A medium or small business can create and manage their own VPN, but it is certainly easier to rely on an Internet Service Provider.

In this case, the company connects to the **Provider's network**, which will act as a **"bridge"** to the branch or the remote user you want to connect.

It is obviously necessary that the chosen Provider is able to guarantee an effective level of service (including uninterrupted operation for at least 99% of the time!) And performance.

It is also useful to choose a Provider that has many connection points spread over the territory (POP) to facilitate the creation of new VPNs in other cities while keeping telephone calls on the urban rate.

With a VPN network it is also advisable to have a **firewall**, a device that acts as a "sentinel" and further **protects the network** from **unauthorized users**.

Firewall functions can also be performed by existing network devices by adding appropriate software.

4. Analog lines (Obsolete)

The **standard solution** for connecting to other networks or the Internet, or for allowing remote users to connect to their own centralized network, is the **normal analog telephone line**. It is therefore sufficient to connect a modem to the computer and to the telephone socket to connect to an Internet Service Provider or a branch.

Currently, the fastest analog modems for data transfer operate at **56 Kbps**. Increasing file sizes and increasing use of the network make this speed often insufficient.

Furthermore, a modem can only support one remote "conversation" at a time and each computer that wants to connect with the outside must have its own modem.

10 computers therefore require 10 modems, but in this case there is a more efficient solution for a WAN connection: the router.

The router uses ISDN (digital) lines and connects all the computers on the local network: a router is enough and 10 (or more) computers can surf the web or connect to a branch.

In addition, the router offers greater protection from unwanted access, is faster in making the connection and disconnecting the telephone line when network activity ceases.

5. ISDN (Obsolete)

The **ISDN** lines are spreading considerably around the world. From the telephone point of view they are convenient because they offer additional services based on digital technologies at reduced costs.

From the point of view of network data they are efficient because they are **digital** and not analog. What does this mean?

Remember the noises emitted by a fax or modem? That is the analogue language, less efficient and with greater risk of error.

The digital technology, used by the ISDN line and routers, transmits pure data (and not "noisy" signals to be decoded), is not affected by the "noise" of the line, operates at **64 or 128 Kbps** (it is therefore faster than modems) and allows many more features. The costs for ISDN connections are comparable to those for analog lines, but the convenience comes from the increased speed.

Technically, an ISDN line comprises two 64 Kbps channels that operate separately or together. You can use one for telephoning and the other for data, or use both channels for data transmission, or even use them for one or the other activity depending on the need of the moment.

It should also be emphasized that ISDN lines are able to make you use your old analog devices as well (an old fax, a non-digital telephone, an analog modem): obviously you will not take advantage of all the benefits of digital, but you will save your investments.

You can connect a router to the ISDN line (of the type predisposed for ISDN), able to "convey" the entire local network to the external line digitally.

You could also use, instead of a router, a “digital modem” also known as a terminal adapter, which represents a cross between an analog modem and a router, but in this case you will only connect a computer and not the whole local network.

6. ADSL Lines

ADSL (Digital Subscriber Line Asynchronous) technology is a **high-speed** service which, like ISDN, operates through normal telephone cables (the copper twisted pair we are used to seeing in homes) and provides telephone services to homes and businesses. It is an asymmetric technology, meaning the ability to transmit data is greater from the Internet to the user (and less when the user sends data to the Internet). To use it you will need an ADSL modem or router (it will probably be provided by the ISP you will rely on for the service).

This technology ensures faster data transmission than both analog modems and ISDN service.

The ADSL offers on the market include an **uninterrupted connection** for 24 hours a day without clicks, in exchange for a **fixed fee** and also give the possibility of using the line to make calls at the same time.

In short, ADSL is proving to be very beneficial, particularly for smaller companies.

Ethernet protocol

Sommario

1. Gigabit Ethernet 1000BASE

2. IP Address

2.1. IPv6

1. Gigabit Ethernet 1000BASE

The new **Gigabit Ethernet** standards allowing Ethernet users to fully leverage their investments in both product and technology knowledge. Gigabit Ethernet will retain support for the first Ethernet standard's access method, Carrier Sense Multiple Access / Collision Detection (CSMA / CD) and will include both full-duplex and half-duplex operational support.

Early Gigabit Ethernet standards will **support** both multimode or single-mode f**iber optic cable and local copper cabling** (UTP / STP / FTP). The standards for long distance copper cabling, 100BASE-T (UTP), have been defined by Category 5E.

1000BASE-SX	850nm multimode optical fiber
1000BASE-LX	multimode and single-mode1300nm optical fiber
1000BASE-CX	Local copper wiring (STP)
1000BASE-T	Long distance copper wiring through UTP

To ensure component and product availability, the standard leverages Fiber Channel physical layer signaling technology adapted to support a data rate of 1000 Mbit / s over the optical fiber.

Further developments in silicon technology and digital signal processing have facilitated cost-effective support for Gigabit Ethernet operation over Category 5E UTP cabling.

Regarding the maximum lengths of Gigabit Ethernet links, the standard objectives set by the committee are the following:

Gigabit Ethernet compared to Ethernet and Fast Ethernet

	10BASE-T Ethernet	Fast Ethernet 100BASE-T	Gigabit Ethernet
Data rate	10 Mbit / s	100 Mbit / s	1 Gbit / s
Category 5 of UTP	100 m (min)	100 m	25-100 m (cat5 / 5E)
STP	500 m	100 m	25 m
Multimode fiber	2 km	412 m (hd) * 2 km (fd) **	50/125: 500 m 62.5 / 125: 275 m
Single-Mode Fiber	25 km	20 km	From 2 km to 70 km

* IEEE half duplex specification

** IEEE full duplex specification

2. IP Address

An **IP address**, 32 bits, is indicated as **4 decimal numbers**, each expressing 8 bits (8bit x 4n = 32bit), eg. 192.168.150.10. Since there are only 8 bits for each number, the values will go from **0 to 255**.

A 32-bit IP address can be seen as a pair of two numbers: the network number and the host or node number.

The number of bits used for the network number depends on the address class. There are five classes of IP addresses:

Class A: starts with a 0 bit (first octet from 1 to 126 in decimal), 7 bits for the network, 24 for the host. It allows to have 126 networks with 16777213 hosts each.

Class B: starts with two bits at 10 (first octet 128 to 191 in decimal), 14 bits for the network, 16 for the host. 16382 networks, of 65534 hosts each.

Class C: starts with three bits at 110 (first octet 192 to 223 in decimal), 21 bits for the network, 8 for the host. 2097150 networks, of 254 hosts each.

Class D: Starts with four bits at 1110 (first octet 224 to 239 in decimal), reserved for multicasting.

Class E: Starts with four bits at 1111 (first octet 240 to 254 in decimal), reserved for future use.

The **network number** is assigned by a central body, the **InterNIC**, the host number is instead decided by the owner of that network number. When the host number is only '0', the address expresses the network address. When made up of only '1', it indicates a broadcast to all nodes on the network.

Since the division by classes is rather crude, the concept of **subnet** was created, which allows you to subtract a few bits from the host number in favor of greater configuration flexibility (for example to separate network traffic via a router), invisible outside the network.

In this way the address is made up of: a **network number**, a **subnet number**, a **host number**.

If we do a bit by bit AND between an IP address and a subnet mask, what we get is the network number including the subnet number.

The default valuesfor the first three classes are:

Class A: 255.0.0.0, equal to 11111111.00000000.00000000.00000000

Class B: 255.255.0.0, equal to 11111111.11111111.00000000.00000000

Class C: 255.255.255.0, equal to 11111111.11111111.11111111.00000000

Using these standard masks with an IP address, we simply get the network number back. However, if we wanted to make three subnets, given a Class C network number, we can "steal" three bits from the fourth octet (the beginning of the host number), 3 bits are enough because with 111 we have the number 7 (> 5). When we do this we get a Subnet Mask of 11111111.11111111.11111111.11100000 (255.255.255.224)

If the network is 193.1.1.0, the hosts of the various subnets	they will have addresses	starting with:
11000001.00000001.00000001.00000001.00000000	(193.1.1.0)	1st subnet
11000001.00000001.00000001.00000001.00100000	(193.1.1.32)	2nd subnet
11000001.00000001.00000001.00000001.01000000	(193.1.1.64)	3rd subnet
11000001.00000001.00000001.00000001.01100000	(193.1.1.96)	4th subnet
11000001.00000001.00000001.00000001.10000000	(193.1.1.128)	5th subnet
11000001.00000001.00000001.00000001.10100000	(193.1.1.160)	6th subnet
11000001.00000001.00000001.00000001.11000000	(193.1.1.192)	7th subnet
11000001.00000001.00000001.00000001.11100000	(193.1.1.224)	8th subnet

An Ethernet address, 48 bits, is instead indicated with a different notation: 6 hexadecimal numbers, but each of them still expresses 8 bits (8bit x 6n = 48bit), eg. 20-53- 52-b8-1f-00.

The values range from 00 to ff (which are then equivalent in decimal to 0 and 255, only the way of writing them changes). Here, too, the numbers 0 and ff are not to be used, but you don't have to worry about this.

In fact, Ethernet addresses are already written to network cards when they are manufactured. They must follow the provisions of the IEEE on the subject, according to which there must not be two network cards with the same address.

2.1. IPv6

IPv6 is the name of the Internet protocol that is used for the IP **addresses** of the **domains** and which replaces the IPv4 protocol, which is still valid today. IP addresses are automatically assigned to a domain during its registration.
IPv6 uses 128-bit IP addresses and contains up to 32 characters (eight blocks of 4 characters each), e.g. 2001: 0629: 0000: 0000: 0211: 24FF: FE80: C12C.

By combining all the existing digits in different ways, it is possible to form approximately 340 trillion IP addresses. IPv6 addresses do not replace existing IPv4 addresses. IPv4 and IPv6 will continue to exist side by side for several more years.

IPv6 is the version of the Internet Protocol designated as the successor of IPv4. This protocol introduces some new services and greatly simplifies the configuration and management of IP networks.
Its most important feature is the larger address space:
IPv6 reserves 128 bits for IP addresses and manages 2128 (approximately 3.4 × 1038) addresses;
IPv4 reserves 32 bits for addressing and manages 232 (approximately 4.3 × 109) addresses.

By quantifying with an example, for every square meter of the earth's surface, there are 655,570,793,348,866,943,898,599 unique IPv6 addresses (i.e. 655,571 billion or 655 trillion), but only 0.000007 IPv4 (i.e. only 7 IPv4 per million square meters).
The widespread adoption of IPv6 and therefore of the IP address format would solve the problem of IPv4 address exhaustion indefinitely.

IPv6 addresses consist of 128 bits and are represented as 8 groups, separated by colons, of 4 hexadecimal digits (i.e. 8 words of 16 bits each) in which letters are written in lowercase form. For example 2001: 0db8: 85a3: 0000: 1319: 8a2e: 0370: 7344 represents a valid IPv6 address.

If one of the groups - as in the example - is composed of a sequence of four zeros it can be contracted to a single zero: 2001: 0db8: 85a3: 0: 1319: 8a2e: 0370: 7344

Furthermore, a sequence of contiguous zeros (and only one) [8] made up of 2 or more groups can be contracted with the simple sequence :: that is 2001: 0db8: 0000: 0000: 0000: 8a2e: 0370: 7344 corresponds to 2001: 0db8: 0: 0: 0: 8a2e: 0370: 7344 or even more briefly 2001: 0db8 :: 8a2e: 0370: 7344

By following the rules mentioned above, if several similar sequences follow one another, it is possible to omit them all; various representations of the same address are shown below:

2001:0db8:0000:0000:0000:0000:1428:57ab

2001:0db8:0000:0000::1428:57ab

2001:0db8:0:0:0:0:1428:57ab

2001:0db8:0::0:1428:57ab

2001:0db8::1428:57ab

The correct network connections

Sommario

1. How to connect to the Internet

2. How to choose the Internet Service Provider

3. Elements of evaluation of an Internet Service Provider (ISP)

1. How to connect to the Internet

The **Internet** is a **global network** of thousands of computers that grows by leaps and bounds every year. It allows a **community** of billions of people to communicate from any distance, access information around the world and share text and images instantly. The Internet allows you to connect to the information resources of companies, universities and public bodies, simplifying the collection of information, and increasing the possibilities of electronic commerce of goods and services.

If in the past the connections required special and expensive services, now there are many options available.

Nowadays, numerous **Internet Service Providers (ISP)** offer from free Internet connection via modem to fast connections for every price range with high line speed for environments with complex needs or numerous users.

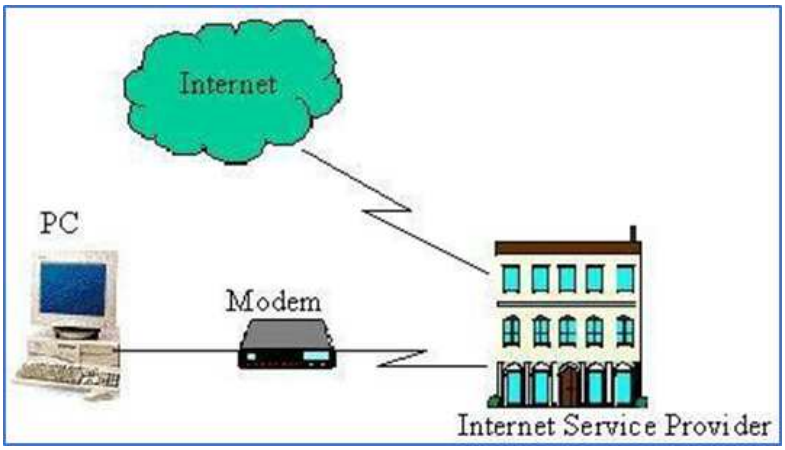


Figure 11: Dialup access

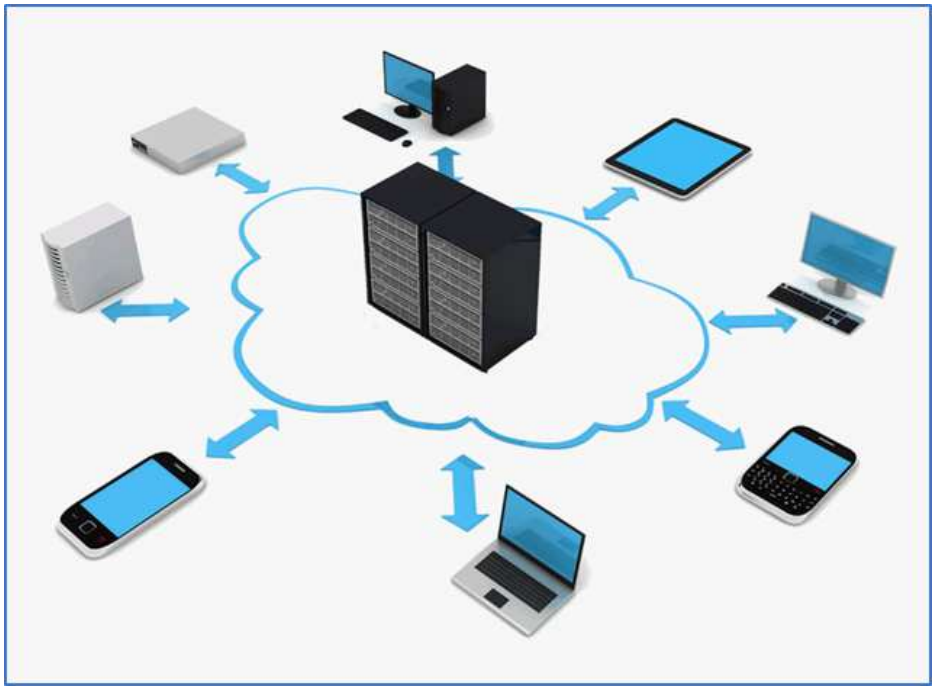


Figure 12: Shared access

A **router** can represent the **shared access solution** which, with the direct connection to the ISP router, allows to manage multiple users and multiple simultaneous connections to the Internet.

2. How to choose the Internet Service Provider

There are more and more Internet Service Providers to choose from which offer very different services and prices.

To get information on the local provider you can rely on the Internet (sites or guides and books on the net), or trade magazines.

3. Elements of evaluation of an Internet Service Provider (ISP)

Some ISPs offer access to a fixed monthly or annual fee. Others offer the service at rates per hour or per megabyte of data transferred or stored.

If you don't know your level of use, it's helpful to start with a flat-rate plan and then check your usage.

Technical support

If the company does not have its own networking experts, the ISP must also provide technical support.

It is therefore better to inquire at the ISP about on-site configuration services, training, the software included in the service and the existence of a telephone or e-mail help desk.

Access

It is advisable to ask the ISP a few questions, including (in the case of a dialup connection, i.e. occasional):

- Are there maximum connection times and password protected access?
- Are you using a single access number or a series of numbers?
- What are the available link speeds? (For example, 33.6 and 56 Kbps high speed analog modems or, if interested, 128 Kbps ISDN digital modems must be available. Check the compatibility of the technology used with that of the Provider).

Performance

It is important to know how the Provider "connects himself" to the Internet.

For example, there is no point in having a T3 leased line connection between your office and the ISP if the ISP is connected to the Internet with a slower T1 line, especially if the ISP has numerous other customers to serve.

Generally speaking, higher connection speeds allow the ISP to satisfy more users and operate more efficiently.

Additional services

Internet connectivity involves ongoing configuration and maintenance; services that can all be offered by ISPs.

For smaller users who connect occasionally, it is necessary to inquire with the Provider if a good support service is offered for connection problems and if e-mail address management is foreseen; in particular, it is important that

the ISP does not limit the size of e-mail messages that can be received and sent (some do) so that both e-mails and any attached documents can be received.

It is also advisable to ask if web space will be provided and, for the more technical, if a static IP address is to be assigned, which is useful in the case of permanent connections such as ADSL or dedicated lines; you can then associate one or more of this "numerical address" web domain names, or the famous addresses www.companyname.com and have an Internet site “at home” and the complete management of e-mail on a server of your property and total control.

Network Design Questions and Answers

Sito: DTAM Online Training Platform
Corso: Introduction
Libro: Network Design Questions and Answers

Stampato da: Mirco Ferrera
Data: lunedì, 23 ottobre 2023, 09:52

Sommario

1. Guide to congestion problems

2. How to spot congestion on the network

3. The 8020 rule

4. How to increase network performance

5. Short list of key networking components

1. Guide to congestion problems

In the network context, congestion refers to an excess of traffic that blocks the paths of data along the network.

The main causes of congestion are:

- too many users on a single network segment (called a collision domain);
- heavy traffic due to the use of 'demanding' applications such as multimedia or electronic publishing;
- heavy traffic due to too many emails with too heavy attachments;
- an excessive number of users connecting to the Internet.

2. How to spot congestion on the network

Among the most common signs of network congestion, the following can be highlighted:

Greater delay on the network

All networks are characterized by limited data transport capacity.

When the load is light, the average time between a computer attempting to send a data packet and actually sending it over the LAN is quite short. If many users try to connect and communicate, the average delay increases and makes the network seem "slower" because, compared to light load conditions, it takes longer to send the same amount of data.

In extreme cases, under a heavy network load, applications can even crash.

The computer may go offline, applications or the operating system crash, and the system may require a restart.

However, it should not be forgotten that the performance level of applications also depends on other factors (for example the speed of the computer and the performance of the disk).

High usage of the network

When trying to determine an acceptable level of usage, many variables must be considered, including the number of stations on the LAN, the behavior of the software or application, and traffic patterns on the network.

In other words, the question is whether the main traffic is between users and the local server, or whether users are exiting their own network segments causing congestion.

For most business environments, the following usage levels can become an empirical method of determining whether an Ethernet LAN is reaching its maximum load:

- 20 percent of total capacity, measured as the average of an eight-hour working day;
- 30 percent, as an average of the worst hour of the day;
- 50 percent, as an average of the worst 15 minutes of the day.

Dissatisfied users

Network speeds are partly subjective: to measure the level of LAN congestion, you can ultimately simply check whether users are doing their jobs efficiently.

If users are not satisfied with the performance of the network, the problem exists, even if the statistics indicate that the network is functioning well.

Of course, user dissatisfaction is less indicative if the computer they use is outdated and thus affects people's feelings of poor performance.

3. The 8020 rule

Good network design depends on the right balance between client and server. Ideally, clients should be on the same network as the servers they access most frequently.

This can simply be the result of a connection of client and server to the same device (hub), but it can also be achieved in a "virtual" way, through the network software, so that users of the building area can be in the same logical segments of the network as a server located at the opposite end of the same building.

This expedient allows to minimize the load of the network backbone that carries the traffic between the segments.

Here's a good rule of thumb: In a properly designed medium / small network environment, 80 percent of the traffic on a given segment must be local (for example, to a server in the same workgroup) and no more. 20 percent can, if necessary, move on the backbone, to other segments or "subnets".

Backbone congestion indicates traffic patterns do not meet the 80/20 rule.

In that case, instead of adding switches or upgrading hubs, it may be easier to improve network performance in one of the following ways:

- Move resources (e.g. applications, programs, files from one server to another) to maintain local traffic within a workgroup.
- Move users ("virtually", via specific software, if not physically possible) so that workgroups better reflect actual traffic patterns.
- Add servers to allow users to access it locally without crossing the backbone.

After ensuring the best network design and resource location, the next step is to choose the technology that best suits your needs.

4. How to increase network performance

Most LANs start out as Ethernet that is shared with all users on a single segment. Obviously, if the number of users connected to the network increases and if they send ever larger files, the traffic load increases.

Compared to traditional 10 Mbps hubs, Fast Ethernet hubs and switches (speed: 100 Mbps) immediately and dramatically improve performance.

Adding these devices to the network is like raising the speed limit (in the case of a Fast Ethernet hub) and, with a switch, adding lanes to a highway as well.

Many small files

For heavy traffic of small files (frequent e-mails or word document printouts), the congestion is between the client and the server.

For existing installations segmenting the network with an Ethernet switch (10 Mbps on all ports except one or two faster ports) is the most cost effective solution. This means having 10 Mbps per port connections with computers and a fast 100 Mbps connection for accessing the server.

Few Large files

Traffic congested with the transfer of large files and the use of bandwidth-intensive applications by some users requires a different approach.

A group of technicians using CAD programs can be an example of sporadic traffic with large file transfers.

In that case, a speed of 10 Mbps takes a long time to send and it is therefore better to opt for switches that offer all ports at high speed (100 Mbps).

Obviously, the network cards of the computers connected to these ports will also have to be at 100 Mbps to take advantage of this wider and faster "highway" for data transfer.

Many Large files

Even for sustained traffic of large files, such as in the case of network backups, Fast Ethernet switches are the best solution.

They can in fact increase the speed of transactions, reducing the impact on the backbone and minimizing traffic congestion.

In addition, Fast Ethernet switches allow you to segment the LAN (divide it into smaller segments, "subnets") and to assign a specific network connection to each segment. This is an undoubted advantage because it allows flexibility and adaptability of the network, allowing to create subgroups of users and to connect them with speed suited to their needs.

Some switches may also have one or more ports at 1000 Mbps (in this case we are talking about Gigabit Ethernet, and it is easy to imagine that in the future it will be talked about more and more). By combining switches and hubs, it is now possible to assume a LAN with an ultra-fast connection to the server or to the corporate backbone (at 1000 Mbps), fast connections at 100 Mbps for some very demanding users in terms of network use and slower connections at

10 Mbps to hubs connected to small workgroups with few networking needs.

5. Short list of key networking components

The fundamental components necessary for the implementation of a network are summarized below with the aim of providing general guidelines, which in practice must be adapted to the specific needs of the user.

Creating a small LAN

- Computer with network cards
- One server
- A hub or small switch
- The wiring
- The network operating system (e.g. Windows / Linux)
- A router for connecting to the Internet

Linking offices and departments

- Computer with network cards
- Server
- Hub
- Switch
- The wiring
- The operating system (e.g. Windows / Linux)
- A router for Internet access

Connection of offices located in different places

- Computer with network cards
- Server
- Hub
- Switch
- Router at each location for WAN links and shared Internet access
- A specific router (dialup access server) for users connecting remotely
- The wiring
- The WAN service (ISDN, Frame Relay or dedicated line)
- The operating system (e.g. Windows / Linux)

IT introduction

Sito: DTAM Online Training Platform
Corso: Introduction
Libro: IT introduction

Stampato da: Mirco Ferrera
Data: lunedì, 23 ottobre 2023, 09:53

Sommario

1. What a program is

2. A “bit” of history

1. What a program is

A computer program is a list of instructions that a computer executes to accomplish a task.
A computer program is usually written in a programming language, because we could also create a program using switches or punched cards, so, if you are able to make a Boolean device, you are able to build a computer.

We can compare a computer program as a cooking recipe, step by step. In the instructions there must not be any ambiguity and every decision must be predetermined by the programmer; nowadays the computer seems intelligent but it is only a fast device, the real intelligence belongs to the human being.

2. A "bit" of history

At the beginning of the IT era, programmers used to work directly in **machine language**, namely the only language that the machine is able to understand and execute.
Below an example of **machine language**:

```
00010010 0000 000 0111100 00101100
00010010 0000 110 0111100 00100000
01010010 0000 000 0100100 10001100
```

This way of programming is very time consuming and cannot permit the creation of complex programs, so computer scientists invented languages at a higher level.
Below an example of **Assembly** language:

```
0806280c      mov1   &0x0,0xffffffc
0806060a      cmp1    %ebp
0606080c      push1   %eax
08022804      jmp     0806839
```

With same length of a code, I can make more instructions.

As the language level goes up, the programming is more useful but it needs a more powerful computer resources and higher economic cost. Thanks to the technological advances and cost reduction ("bit cost"), it is possible to use languages at a higher level.

See below an example of **C** language:

```
#include <stdio.h>
int main() {
    printf("Hello, buddies!");
    return 0;
}
```

See below an example of **Python** language:

```
print("Hello Dordrecht")
```

Remember! Whatever program wrote in any language, will be always "translated" in **machine language**.
To sum it up: there are low level and high level languages. Low level languages are less useful but faster, high level languages are more useful but slower (C language is considered middle level language). Nowadays the bit is cheap, so now, we can work usefully with high level languages at a lower cost.

Python introduction

Sommario

1. Python introduction

2. How to start: basic working tools

1. Python introduction

The Python programming language was invented by the Dutch computer scientist Guido van Rossum in the nineties. He was not satisfied with the available languages of its time; his intent was to create an easy language, designed for small projects and suitable for prototyping.

Python is a **high-level pseudo compiled language** with a software free of cost. The programmer needs to install the free interpreter and every program can run without modifications on any machine with any operating system. The interpreter analyzes the code and, if correct, executes it. There is no separate compilation that generates an executable file.

The main motto is "*There should be one, and preferably only one, obvious way to do it*" (https://www.python.org) and so the syntax is minimal.

Python main feature is the **lack of brackets**, so to run a program the code **must be correctly indented**. If the code is not placed correctly, the interpreter fails and therefore the program will not work. It is impossible to create obfuscated code.

In the figure below you can see a fully functional **obfuscated C program**. In **Python** would be impossible to run it.

```
                                                                    char
                                                                  _3141592654[3141
        ],__3141[3141];_314159[31415],_3141[31415];main(){register char*
     _3_141,*_3_1415, *_3__1415; register int _314,_31415,__31415,*_31,
   _3_14159,__3_1415;*_3141592654=__31415=2,_3141592654[0][_3141592654
  -1]=1[__3141]=5;__3_1415=1;do{_3_14159=_314=0,__31415++;for( _31415
 =0;_31415<(3,14-4)*__31415;_31415++)_31415[_3141]=_314159[_31415]= -
1;_3141[*_314159=_3_14159]=_314;_3_141=_3141592654+__3_1415;_3_1415=
__3_1415    +__3141;for                (_31415 = 3141-
          __3_1415  ;                  _31415;_31415--
          ,_3_141 ++,                  _3_1415++){_314
          +=_314<<2 ;                  _314<<=1;_314+=
         *_3_1415;_31                   =_314159+_314;
         if(!(*_31+1)                   )* _31 =_314 /
         __31415,_314                   [_3141]=_314 %
         __31415 ;* (                  _3__1415=_3_141
        )+= *_3_1415                    = *_31;while(*
        _3__1415 >=                     31415/3141 ) *
        _3__1415+= -                    10,(*--_3__1415
       )++;_314=_314                    [_3141]; if ( !
       _3_14159 && *                    _3_1415)_3_14159
       =1,__3_1415 =                    3141-_31415;}if(
       _314+(__31415                     >>1)>=__31415 )
       while ( ++ *                      _3_141==3141/314
       )*_3_141--=0                      ;}while(_3_14159
       ) ; { char *                      __3_14= "3.1415";
       write((3,1),                      (--*__3_14,__3_14
       ),(_3_14159                        ++,++_3_14159))+
      3.1415926; }                        for ( _31415 = 1;
     _31415<3141-                         1;_31415++)write(
    31415% 314-(                          3,14),_3141592654[
  _31415    ] +                           "0123456789","314"
  [ 3]+1)-_314;                           puts((*_3141592654=0
,_3141592654))                             ;_314= *"3.141592";}
```

Figure 1.1 Obfuscated code in C language

Python *software is used to:*

- *Web development*
- *Access to databases*
- *Desktop applications*
- *3D graphics*
- *Numerical and scientific computing*

2. How to start: basic working tools

The interpreter is free and it is available at https://www.python.org
The software is equipped with the **IDLE Shell** that allows to quickly experiment the code.

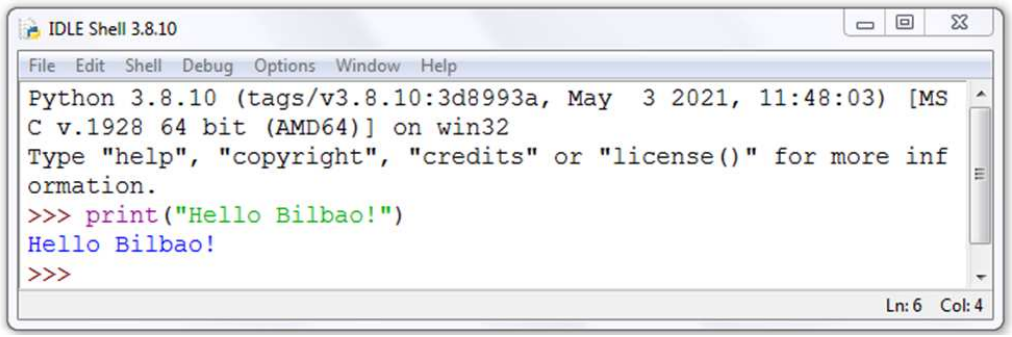


Figure 1.2 The IDLE Shell

If you want to write a code in several lines, press SHIFT+ENTER

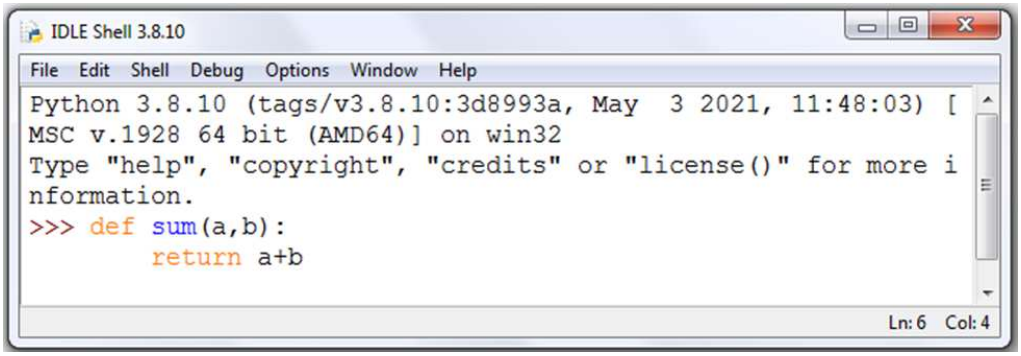


Figure 1.3 Start a new line and write a simple function

To create and save a program click on *File→new file* to open the editing window, then write the code and save it. The new file will be saved with ***.py extension**

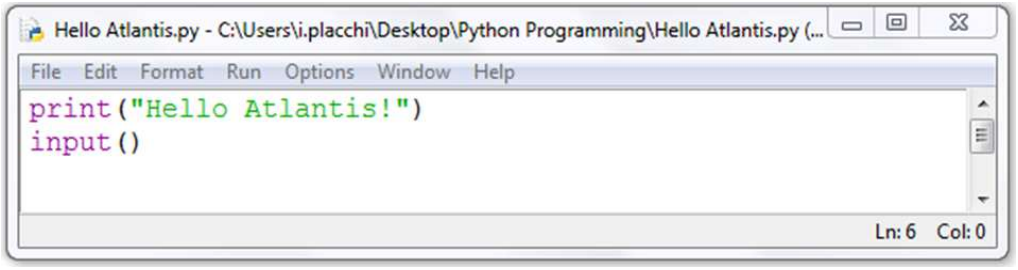


Figure 1.4 Editing file

To run the program, click on "run". The program will be executed in the Shell

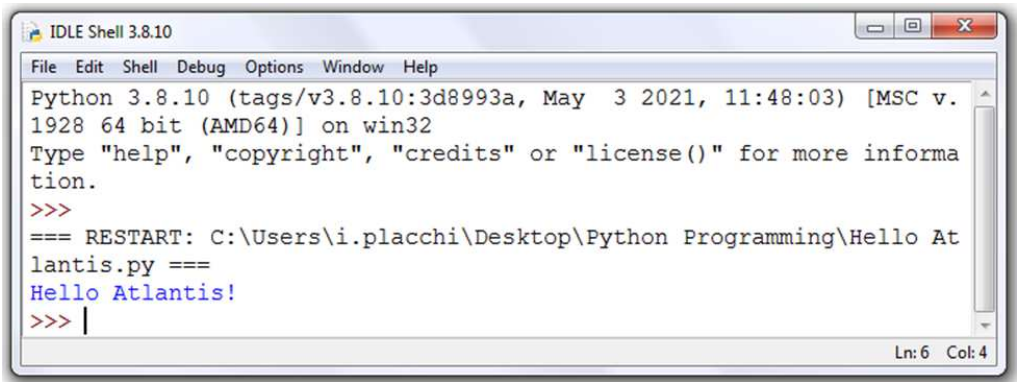


Figure 1.5 Execute the code

You can also run the program clicking on his executable file (as example MyFirstPythonFile.py)

Figure 1.6 Executable file

Fast & Useful commands:

ALT+P for history codes

CTRL+F6 to restart shell

CTRL+C to stop the code execution.

Python - Programming fundamentals

Sommario

1. Data types

2. Math Operators

3. Variables

4. Boolean Variables and logic operators

5. Relation operators

6. Arrays

1. Data types

numbers	int (32 bit) long (no limit precision) float (fractional numbers) complex numbers
strings	str
arrays	list (to store multiple items in a single variable) tuple (to store multiple immutable items in a single variable) dictionary(to store unordered collection of data values in key:value pairs)

Table 1.1 Data types

2. Math Operators

+	addition
-	subtraction
*	multiplication
/	division

Table 1.2 Base math operators

//	division with approximation
**	exponentiation
sqrt()	square root
log()	logarithm
%	remainder of the division

Table 1.3 Other math operators

3. Variables

A **variable** is a location in the computer memory where we can **store informations** such as numbers or strings; it is called variable because we can modify its value.

The value written to the right of the expression is assigned in the variable to the left.

It is **forbidden** to declare variables with a **reserved word** like: *if, else, class, for*, etc…

The variable name cannot contain **punctuation elements** like brackets, symbols or spaces.

How to improve readability of a variable name:

Use *snake_case* notation (words separated with underscore), for example "triangles_count"

Use *camelCase* notation (words separated with a single capitalized letter), for example "FineAmount".

You have not to declare the data type, python detects it automatically

Python	Other languages
a=4	int a=4
b=4.3	float b=4.3
c= "Txorierri"	string c="Txorierri"

Table 1.4 Variables declaration

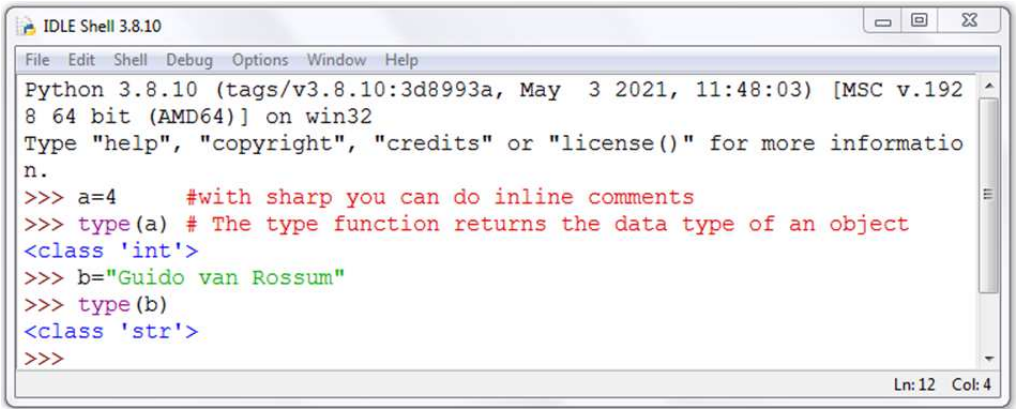


Figure 1.7 Variables declaration and "type" command

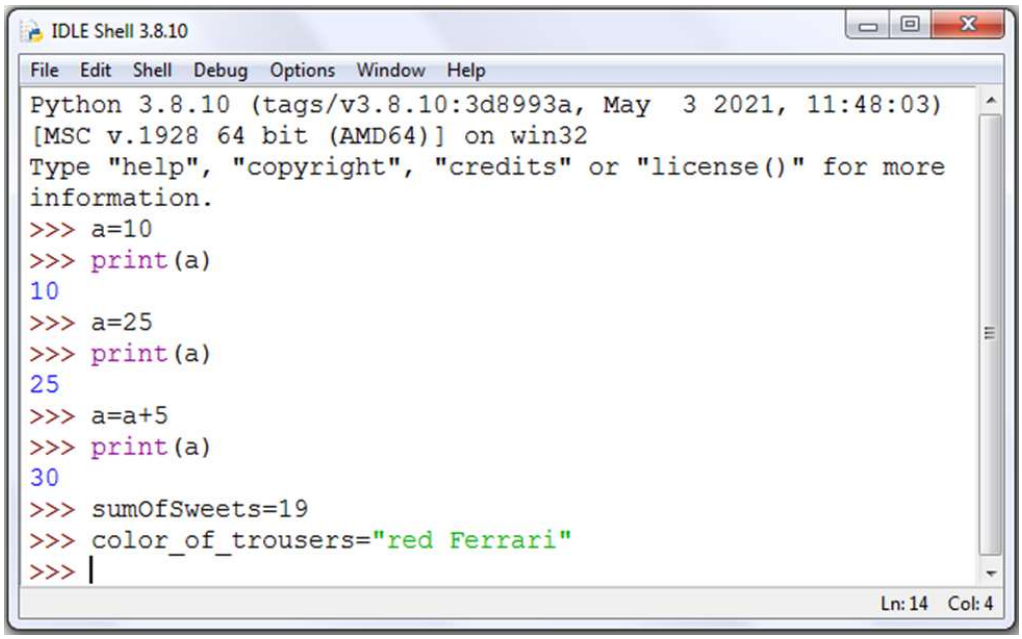


Figure 1.8 Variable declaration sample

4. Boolean Variables and logic operators

True or 0: logic variable true
False or 1: logic variable false

Logic operators:

And	Or	Not
true output when all the entities are true	true output when at least one of the entities are true	negates the truth value

Table 1.5 Logic operators

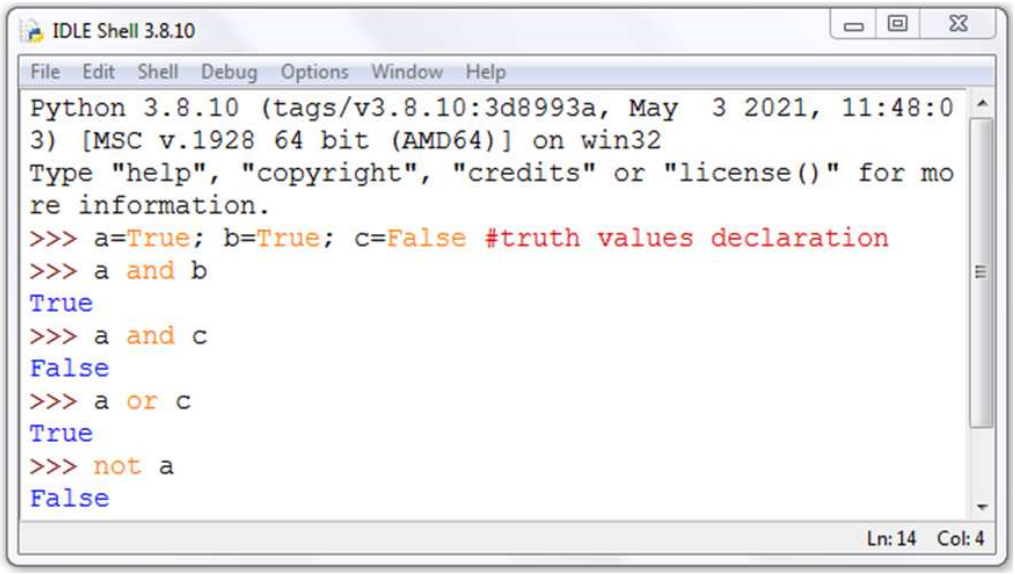


Figure 1.9 Boolean expressions

5. Relation operators

>	greater than
<	smaller than
==	equal to
>=	greater or equal than
<=	smaller or equal than
!=	different from
<>	different from (equivalent to previous)

Table 1.6 Relation operators

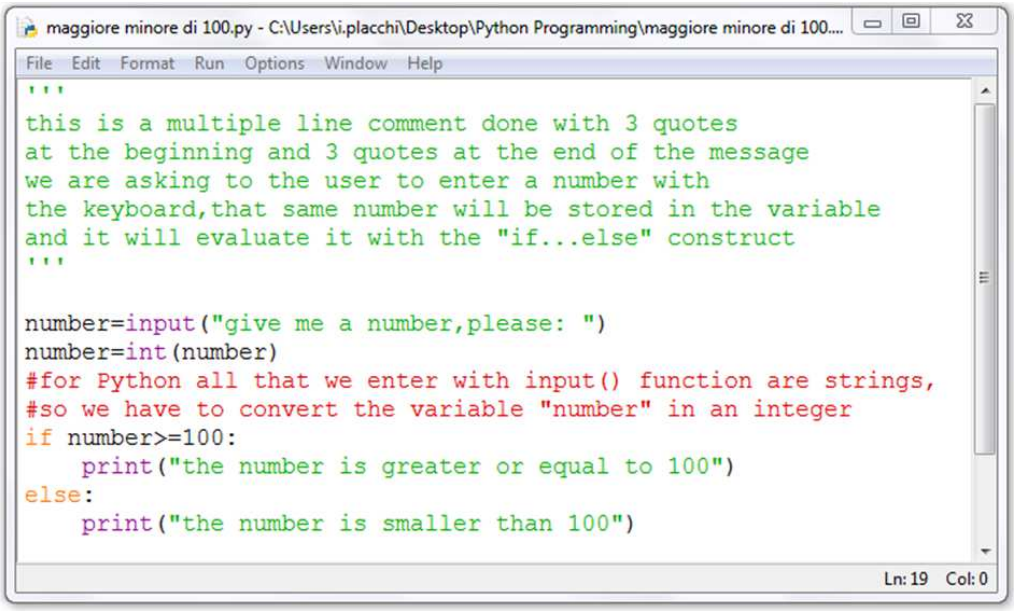


Figure 1.10 Relation example

6. Arrays

The **array** is used to represent a mutable **sequence of elements**, even heterogeneous ones.
To create an array, use the notation

NameOfArray = [*first element, second element,……,n-element***]**

Each element is associated with a position, or rather, **index,** which is an integer. In computer technology the indexing always begins from 0. To access to the array elements we can use the notation.

NameOfArray[*index***]**

Figure 1.11 Example of an array declaration

Figure 1.12 Array structure in the memory

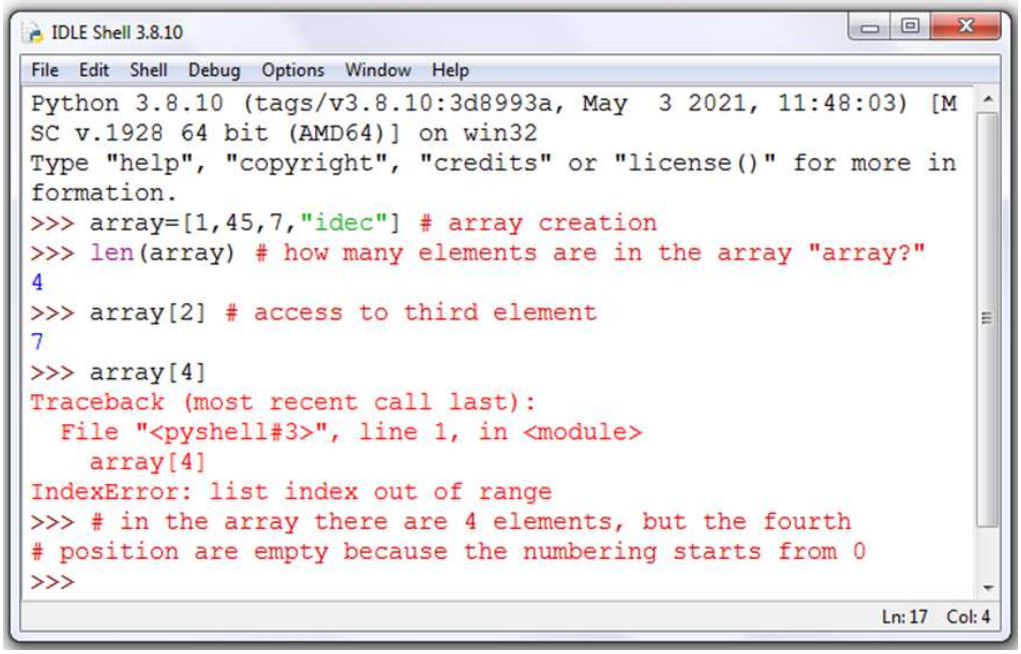


Figure 1.13 Most common error with arrays

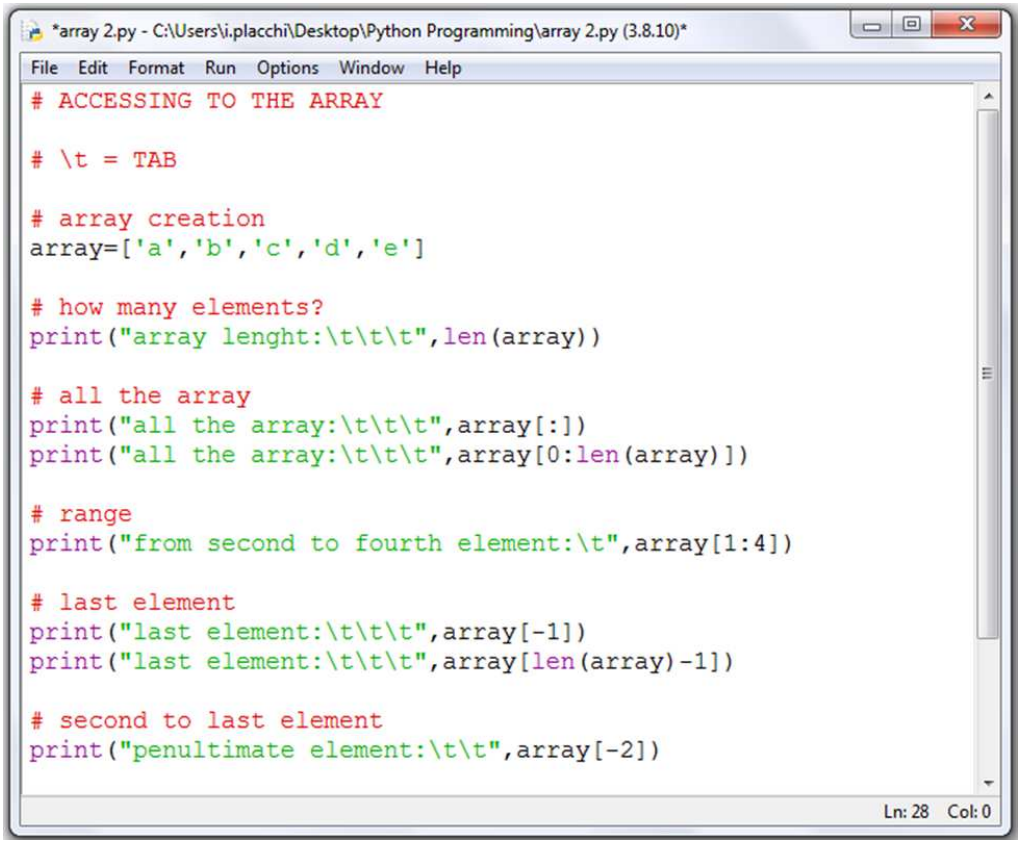


Figure 1.14 Exercise: Array access. Try to write and to execute a similar code

Python - Program flow

Sommario

1. If…else statement

2. Loops
2.1. While loop
2.2. For loop

1. If…else statement

The ***if….else*** statement is used to **make a decision** within a program; when a condition is met (*if*), one part of the code will be executed, otherwise (*else*) another code will be executed. The programmer has to evaluate all possible ramification (path) of every decision taken.

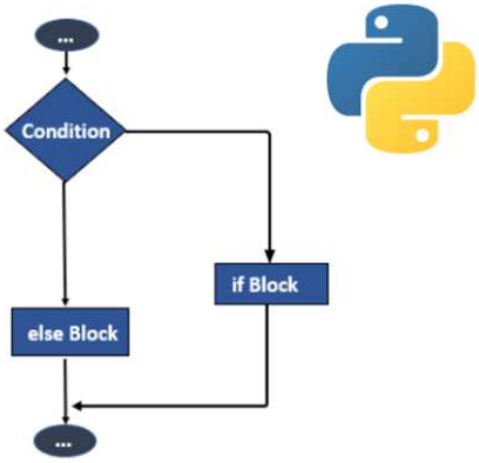


Figure 1.15 If statement

If syntax

If *condition:* # do not forget colon
body of if
else: # do not forget colon
body of else

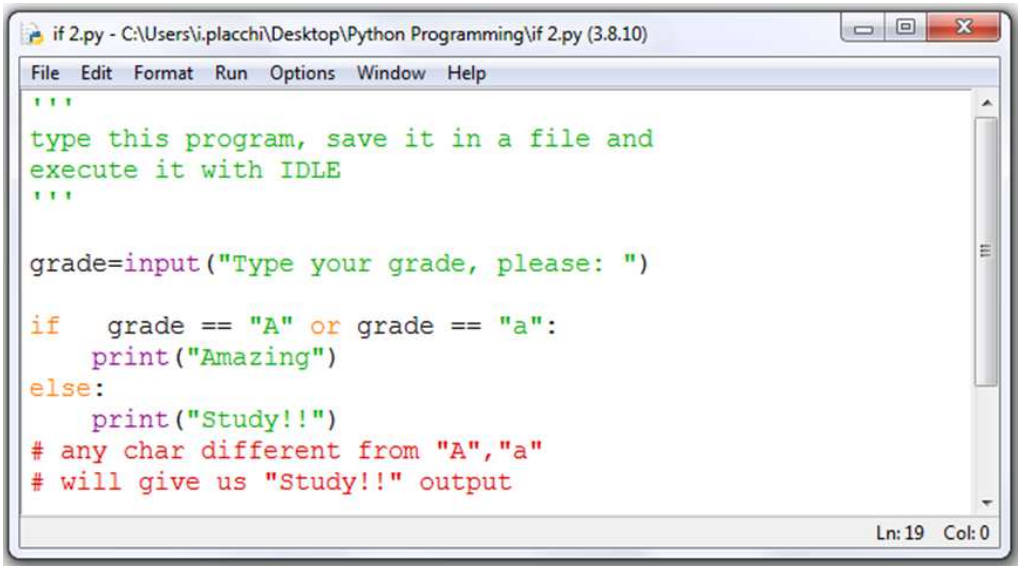


Figure 1.16 If….else statement

If there are multiple alternatives, we can use the ***elif*** statement

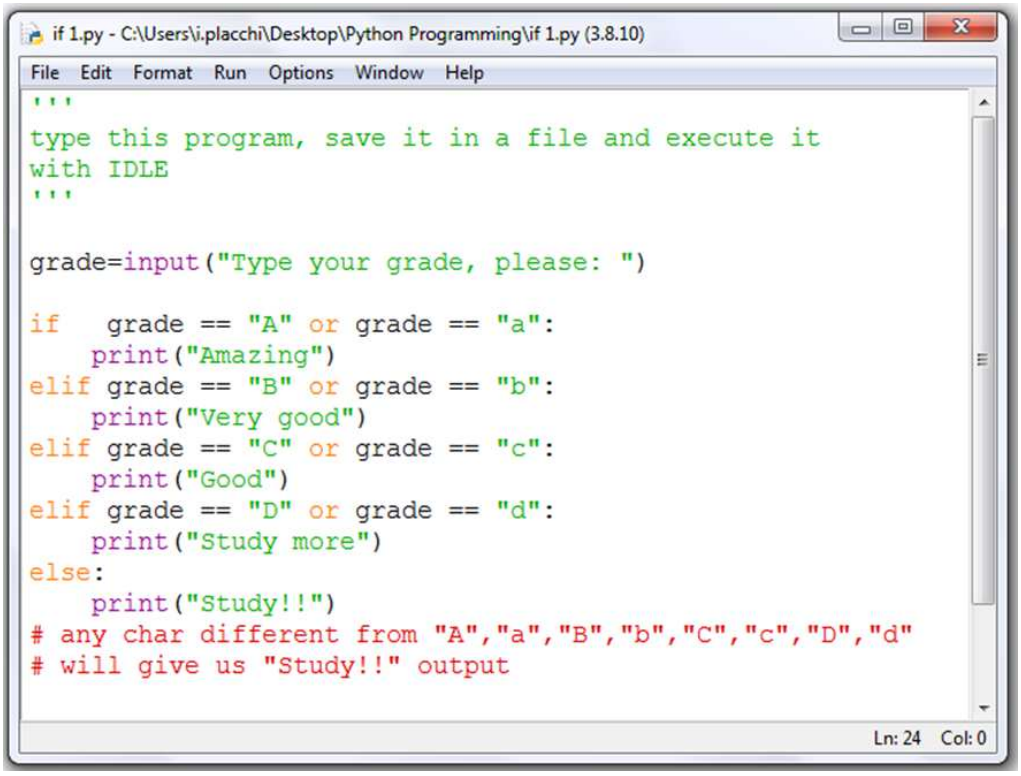


Figure 1.17 Multiple alternatives

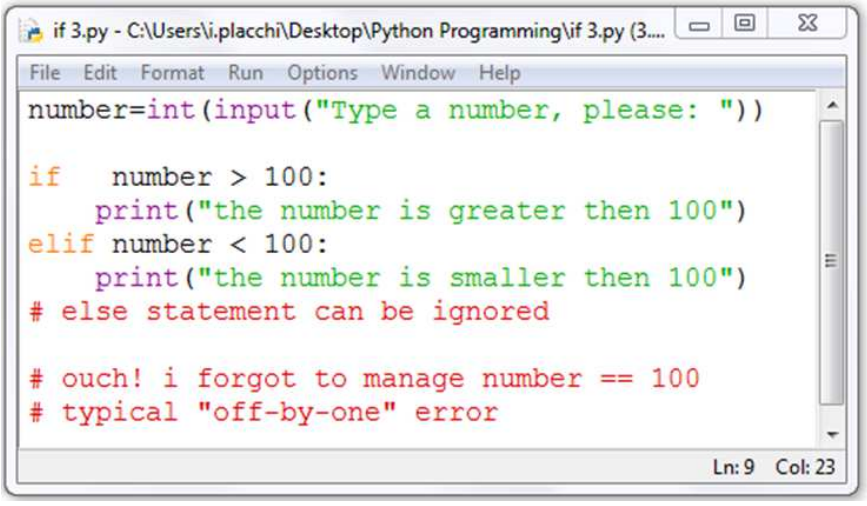


Figure 1.18 Ouch! An error

It is possible to code nested statements

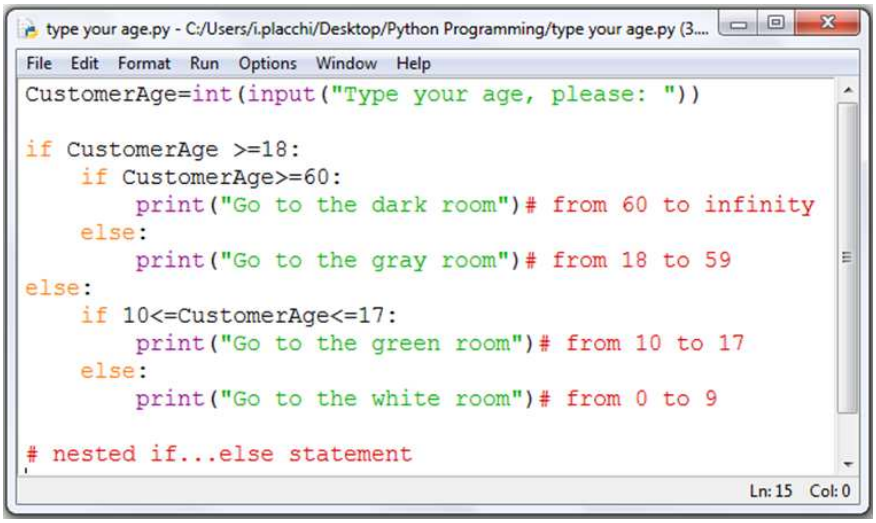


Figure 1.19 Nested if....else statement

2. Loops

A **loop** is a construct that is **repeatedly executed** until a purpose is achieved.

There are two loop constructs: **while** and **for**…**while** is used when the programmer does not know how many times the loop will be executed; vice versa he will implement a **for** construct.

Why a If statement is not the right solution for a Loop? Look below:

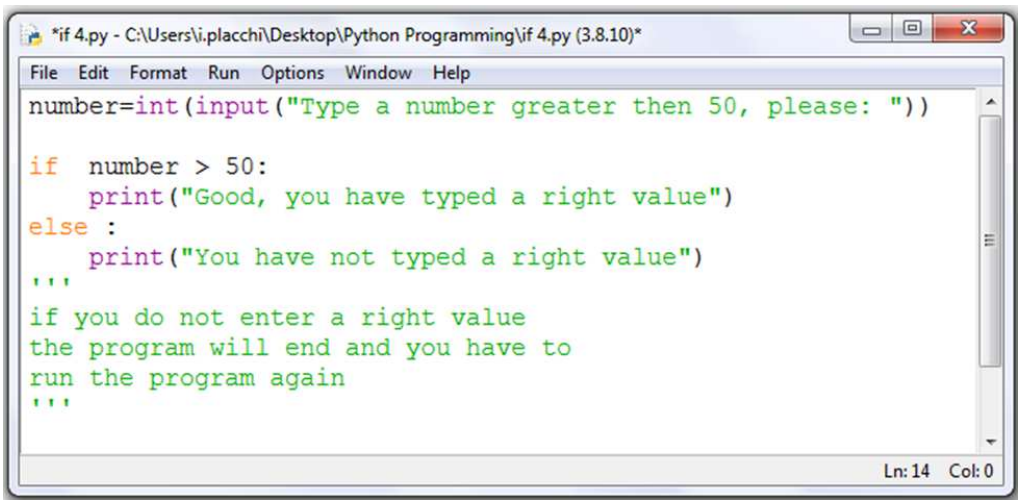


Figure 1.20 Uncomfortable code

2.1. While loop

While syntax

While *condition:* # do not forget colon
body of while

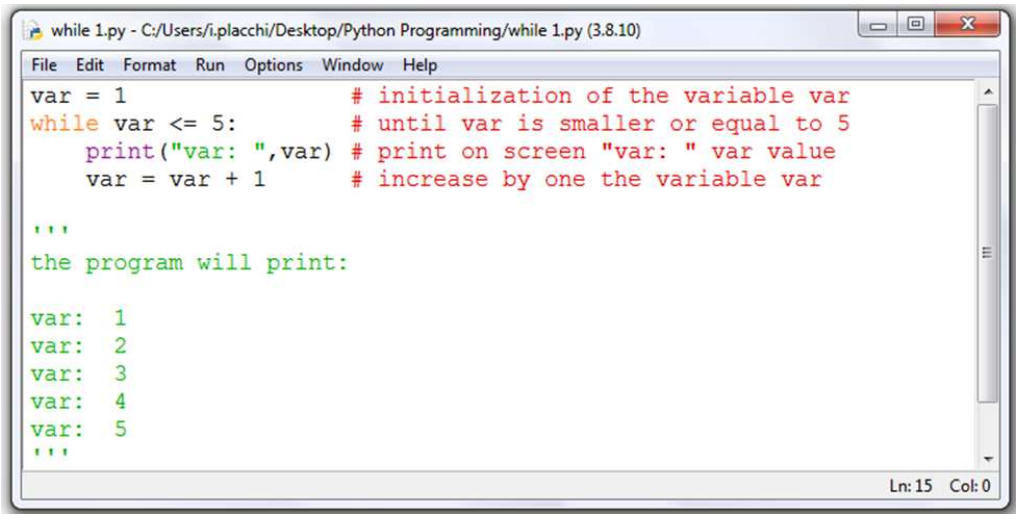


Figure 1.21 Example of a while loop

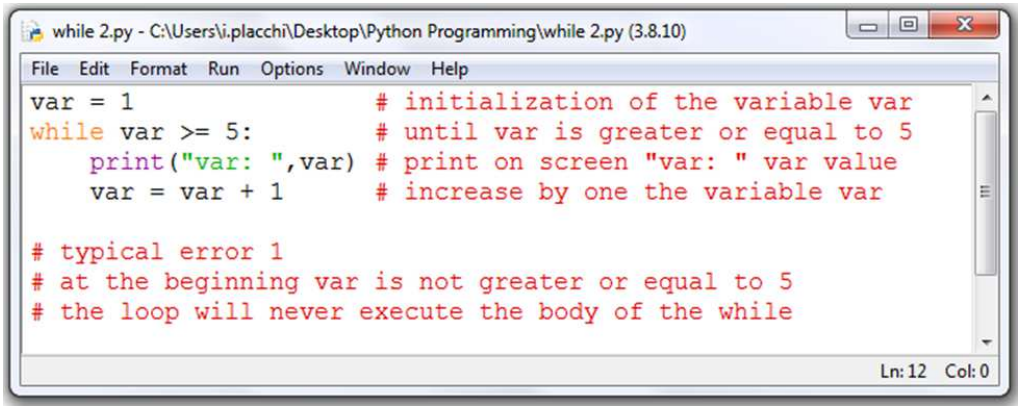


Figure 1.22 First typical error for the "while loop"

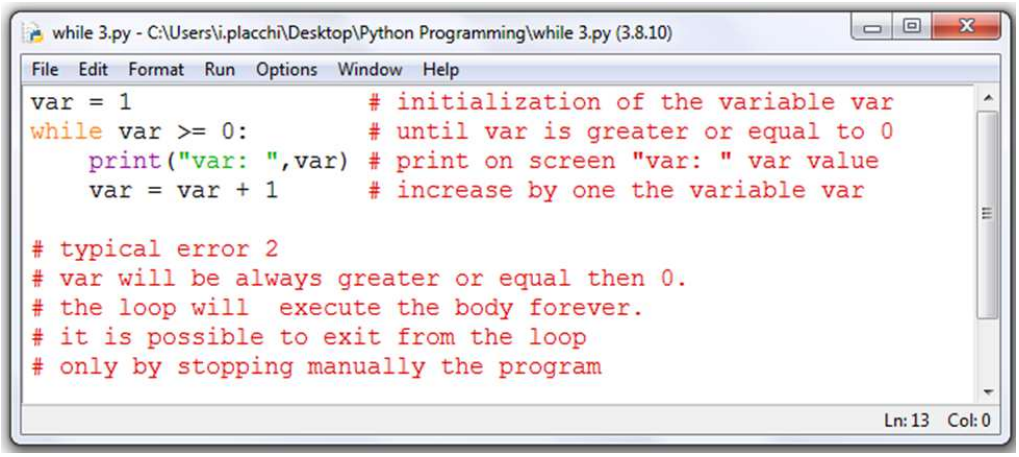


Figure 1.23 Second typical error for the "while loop"

A **break** statement causes the loop exit regardless of the **while** control condition

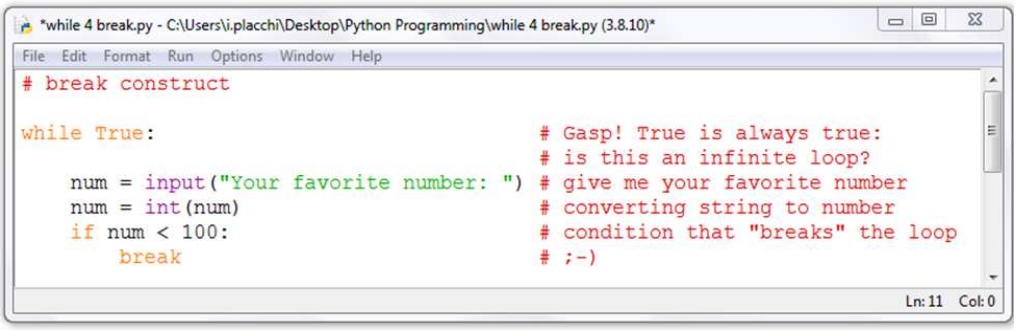


Figure 1.24 Break construct

While statement could be used also to wait a "**sentinel value**" input

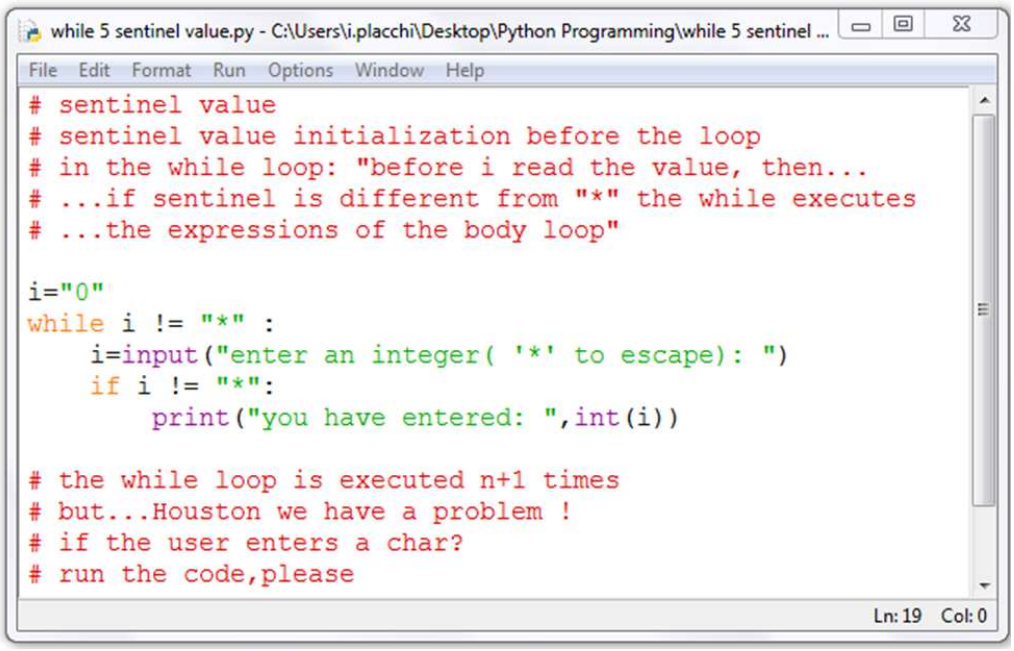


Figure 1.25 Sentinel value

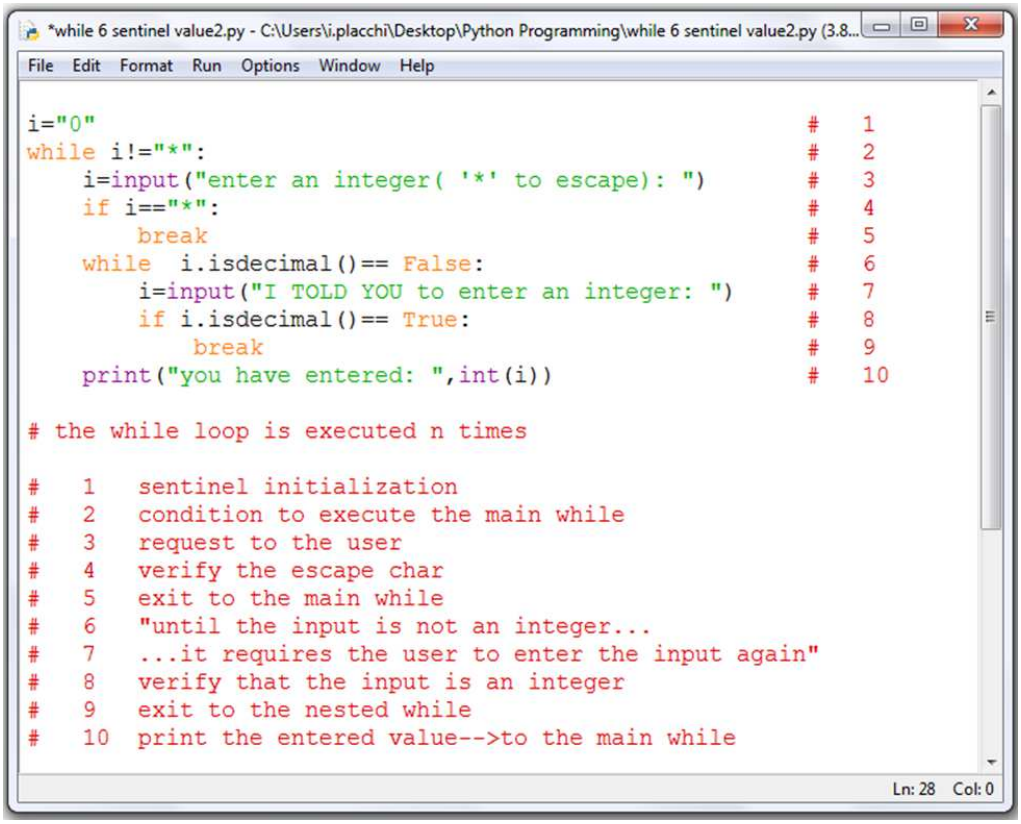


Figure 1.26 Sentinel value enhanced

2.2. For loop

For syntax:

for *value in a sequence:* # do not forget colon

body of for

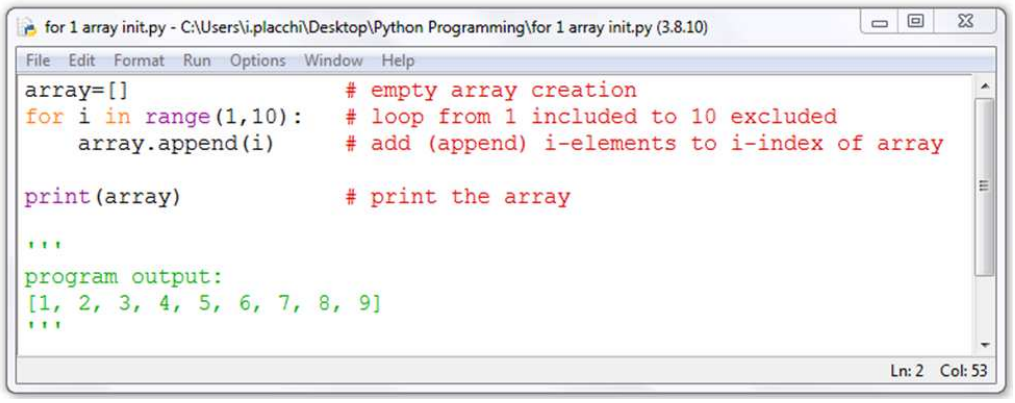


Figure 1.27 Array initialization with for loop

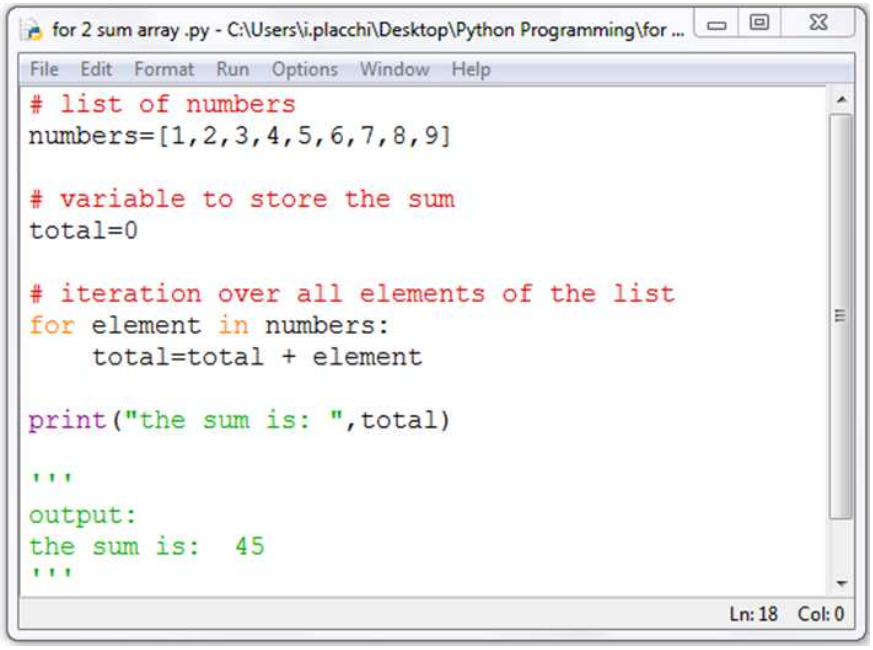


Figure 1.28 Access to the array elements

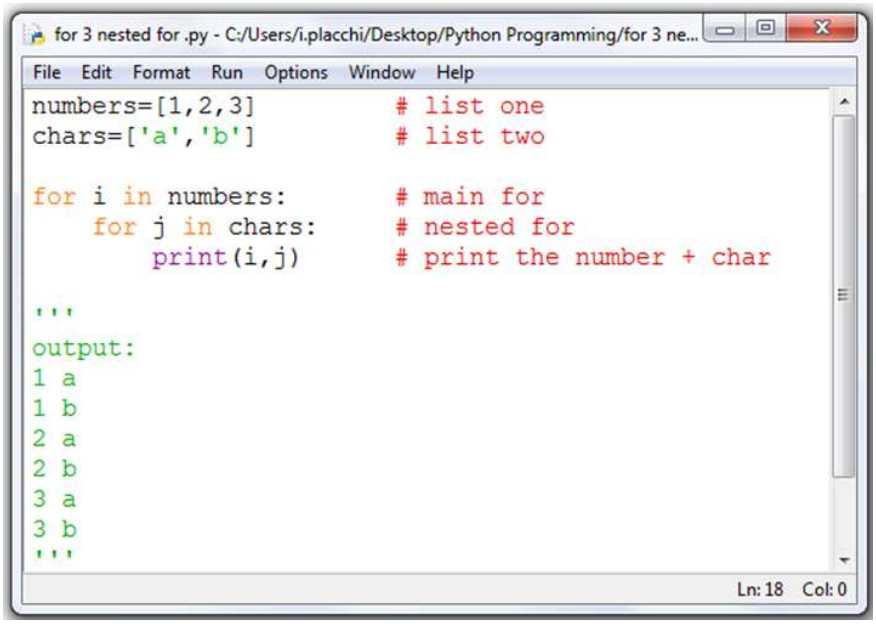


Figure 1.29 Nested for

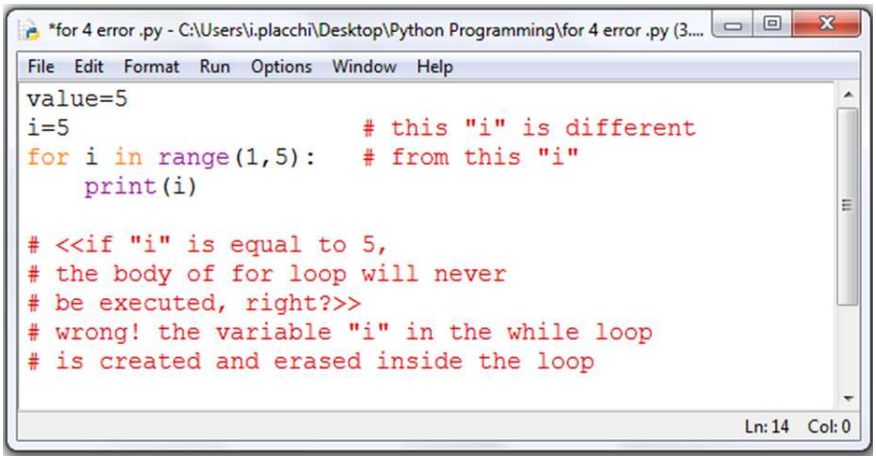


Figure 1.30 Misunderstanding

Python - Functions

Sito: DTAM Online Training Platform
Corso: Introduction
Libro: Python - Functions

Stampato da: Mirco Ferrera
Data: lunedì, 23 ottobre 2023, 09:54

Sommario

1. Functions

2. Some built-in functions

3. Print function parameters

4. Custom functions

5. Recursive function

6. A curiosity of Python

1. Functions

A **function** is a **sequence of instructions** with a unique name: there are **predefined functions** (built-in) and **custom functions**, that is, created by the programmer.

Built-in functions are always loaded into the memory, custom functions are only loaded if declared.

When I need a function, I call it using its name.

Function syntax:

```
def NameOf Function (parameter 1, parameter 2,.....n-parameter):
        body of function
```

2. Some built-in functions

capitalize()	Converts the first character to upper case
casefold()	Converts string into lower case
count()	Returns the number of times a specified value occurs in a string
endswith()	Returns true if the string ends with the specified value
find()	Searches the string for a specified value and returns the position of where it was found
isalnum()	Returns True if all characters in the string are alphanumeric
isdecimal()	Returns True if all characters in the string are decimals
isdigit()	Returns True if all characters in the string are digits
islower()	Returns True if all characters in the string are lower case
isnumeric()	Returns True if all characters in the string are numeric
isupper()	Returns True if all characters in the string are upper case
lower()	Converts a string into lower case
swapcase()	Swaps cases, lower case becomes upper case and vice versa

Table 1.7 Python built-in string functions

abs()	Returns the absolute value of a number
bin()	Returns the binary version of a number
bool()	Returns the boolean value of the specified object
chr()	Returns a character from the specified Unicode code
complex()	Returns a complex number
divmod()	Returns the quotient and the remainder when argument1 is divided by argument 2
int()	Returns an integer number
float()	Returns a floating point number
input()	Allowing user input
len()	Returns the length of an object
max()	Returns the largest item in an iterable
min()	Returns the smallest item in an iterable
pow()	Returns the value of x to the power of y
print()	Prints to the standard output device

Table 1.8 Some others built-in functions

3. Print function parameters

print() syntax:

print (value,.....sep= ' ',end=' \n', file=sys.stdout, flush= False)

value,.....	I can enter an arbitrary number of values
sep= ' '	one empty space that separates each value (default setting)
end='\n'	carriage return line feed (default setting)
file=sys.stdout	output over screen (default setting)
flush=False	cleaning buffer output (default setting)

Table 1.9 Print function parameters

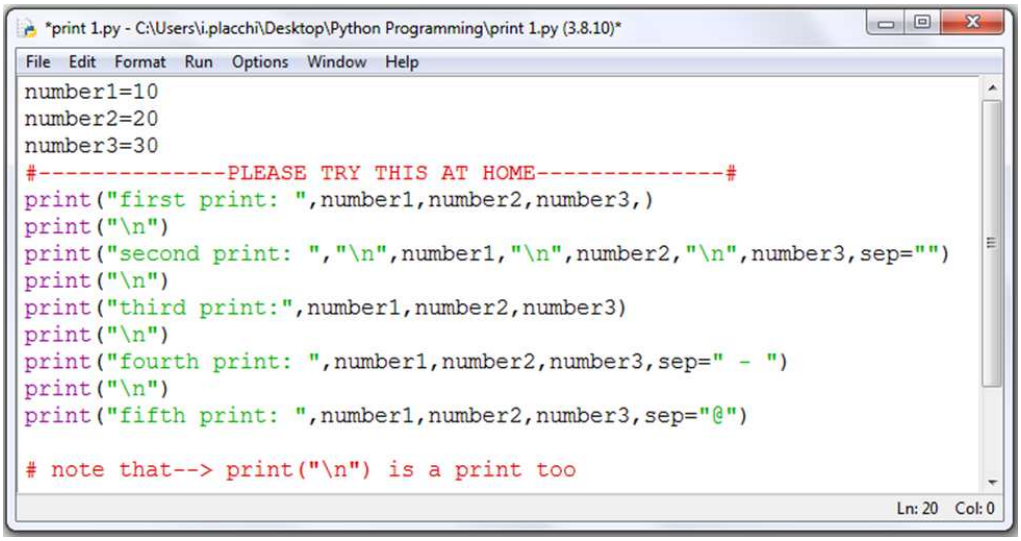


Figure 1.31 Print examples

4. Custom functions

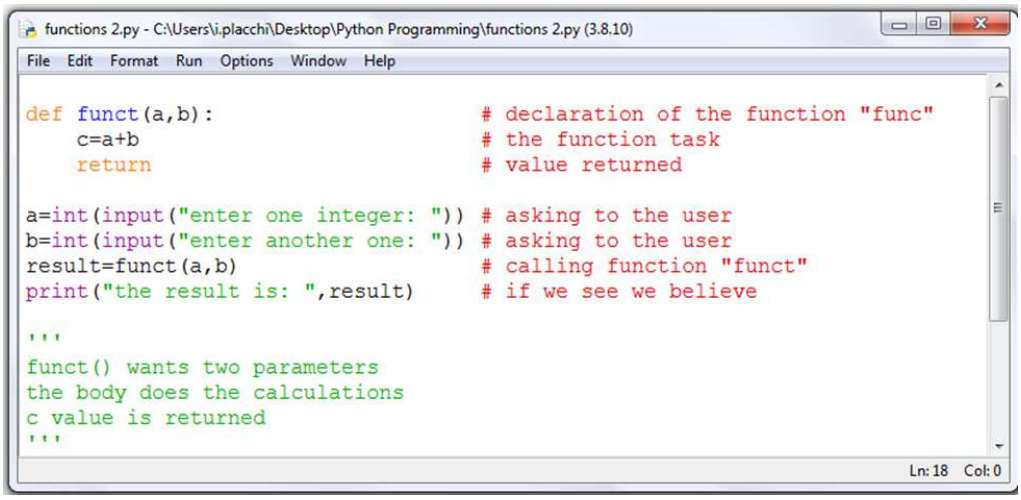


Figure 1.32 Function example 1

In the example below we created a function that counts the vowel occurrences of a string.

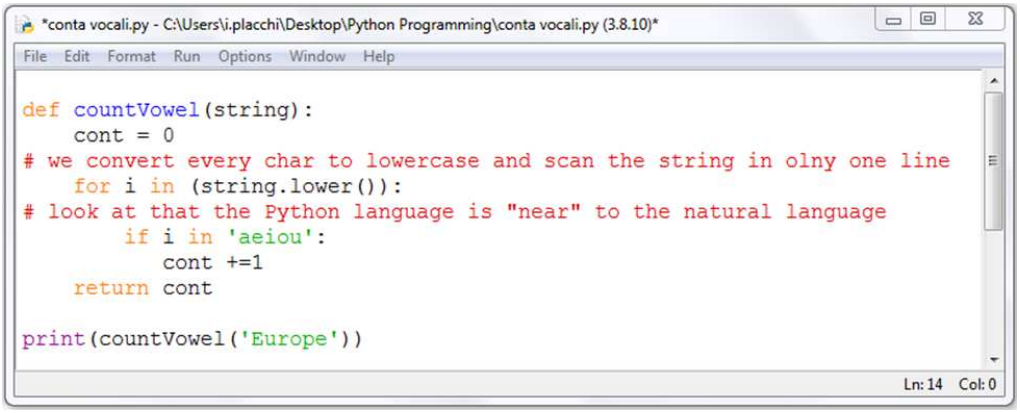


Figure 1.33 Function example 2

Shall we calculate PI Greek with the Leibnitz algorithm? Yes, of course!

$$\frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \ldots = \frac{\pi}{4}$$

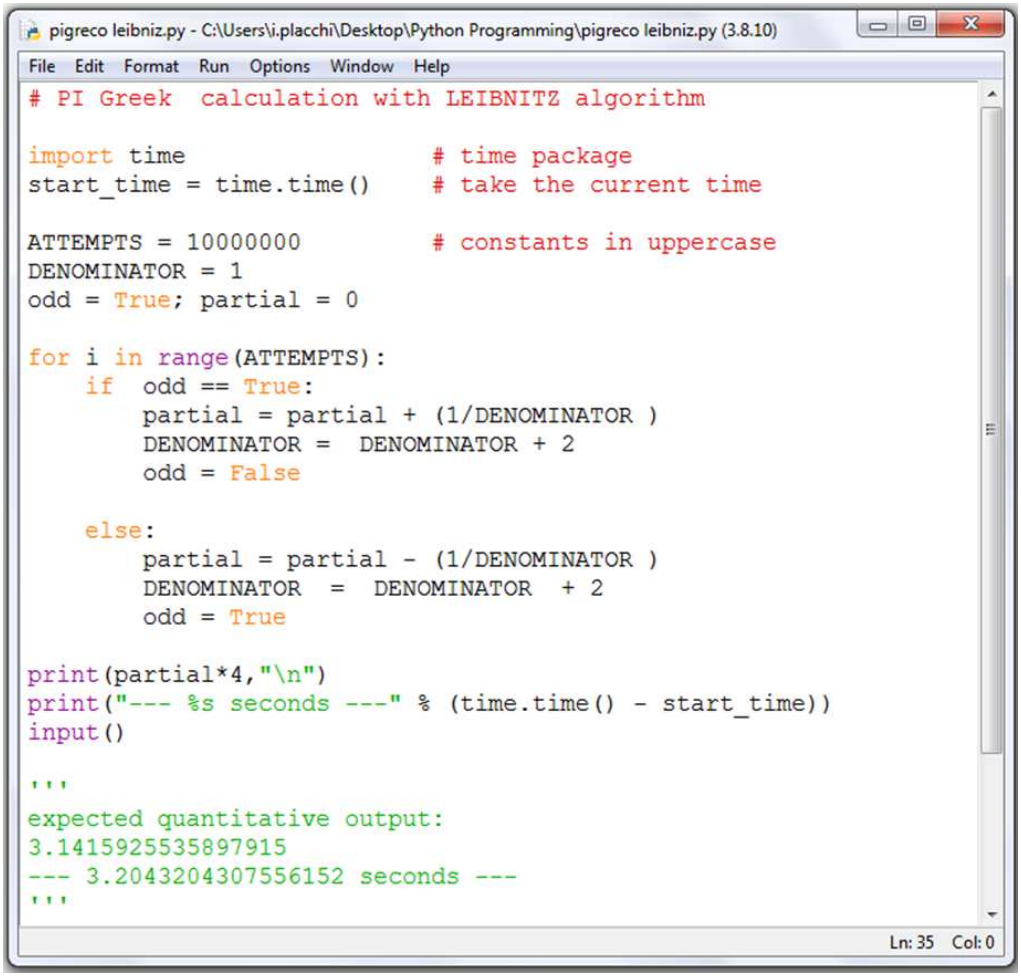


Figure 1.34 Function example 3

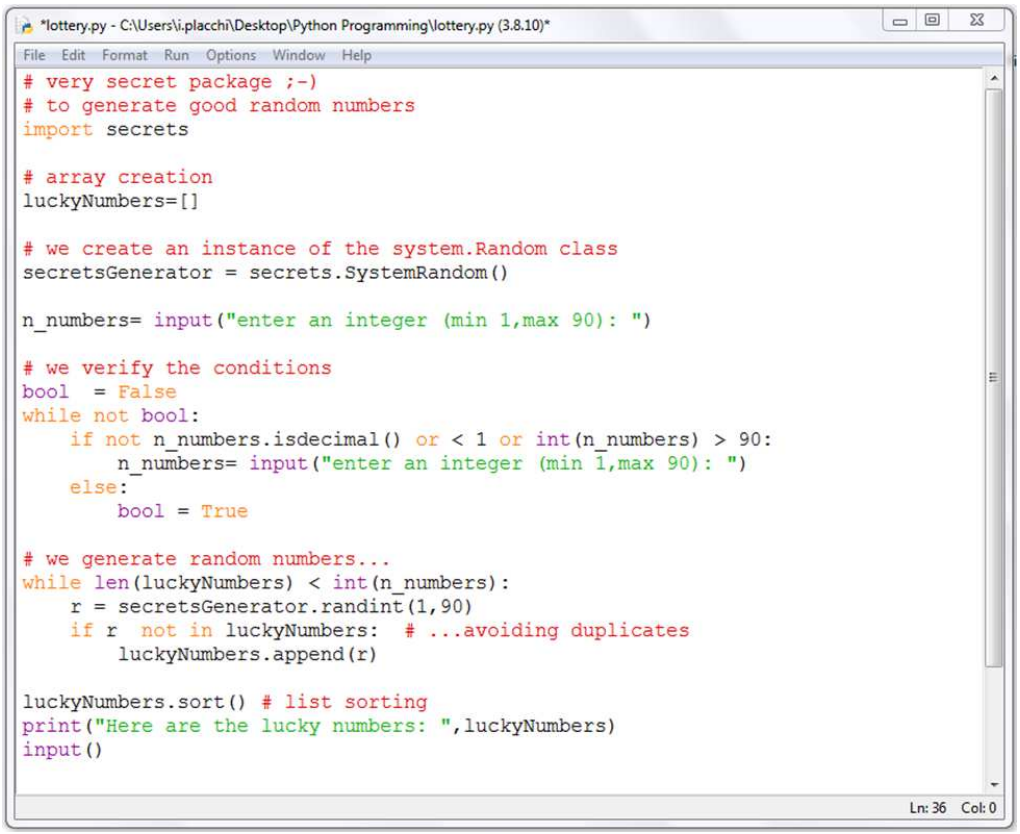


Figure 1.35 Lottery code

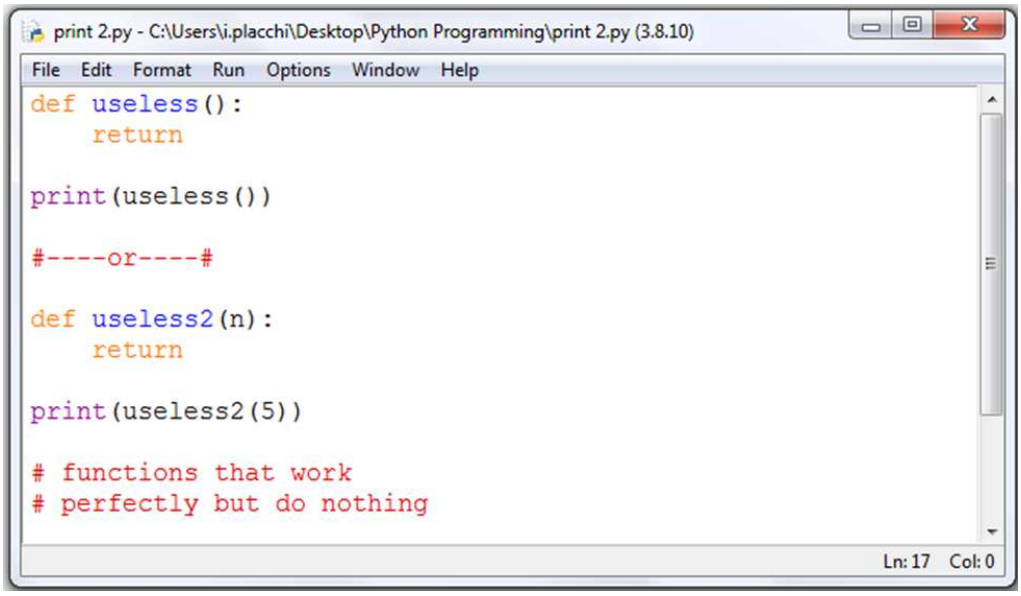


Figure 1.36 Useless function

5. Recursive function

The **recursive function** contains a **call to itself**. An initial condition is defined, called trivial case, which, if not satisfied, will activate the recursive function.
The **recursive function** will **call itself** until it reaches the trivial case and then it ends.
The number of iterations is not predictable.
We can see its use in satellite navigators, where, once the departure destination and various conditions have been set, it scans all possible roads until it finds the shortest one; at this point it "returns" the value and exits from the cycle.

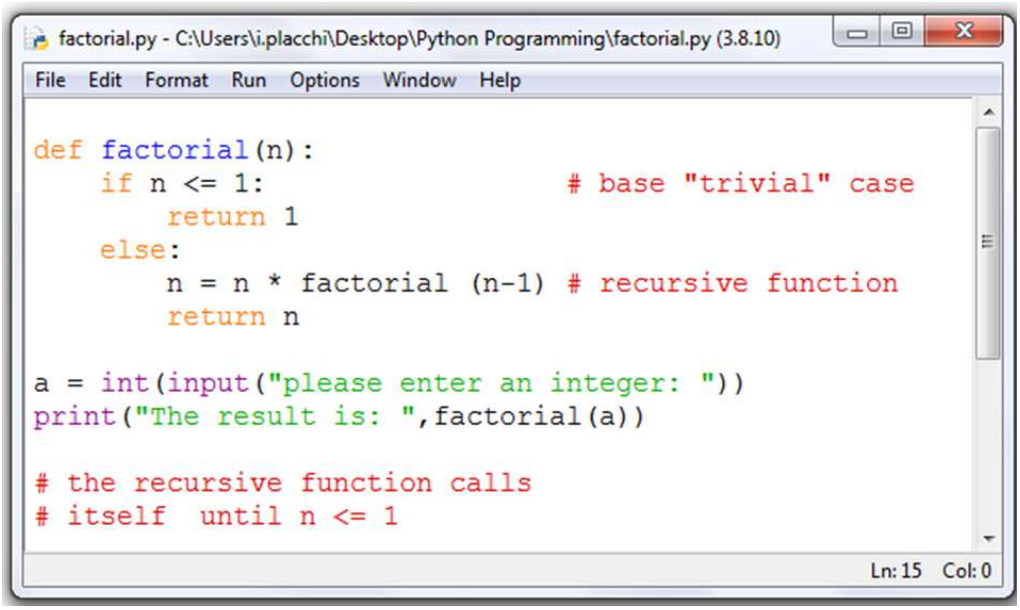


Figure 1.37 Factorial calculation with a recursive function

6. A curiosity of Python

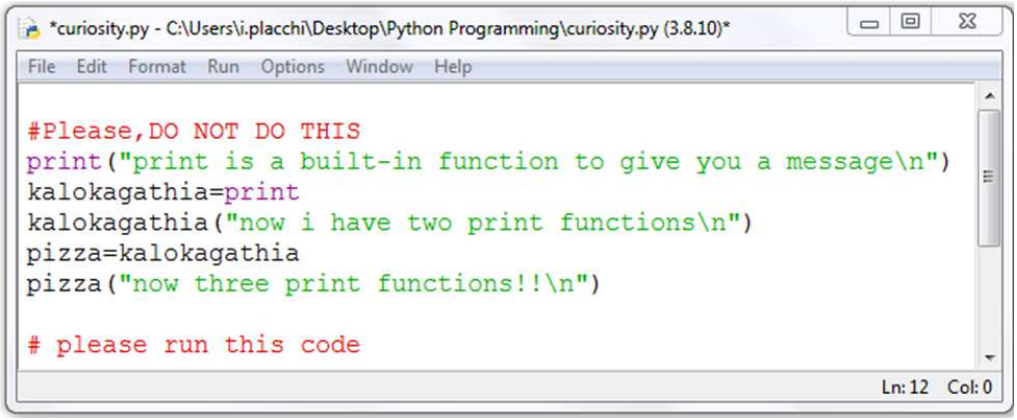


Figure 1.38 Odd Python

Exercises - Python

Sito: DTAM Online Training Platform
Corso: Introduction
Libro: Exercises - Python

Stampato da: Mirco Ferrera
Data: lunedì, 23 ottobre 2023, 09:55

Sommario

1. Print characters
1.1. ASCII codes table
1.2. Expected Result
1.3. Solution

2. The lenght of the longer word
2.1. Expected result
2.2. Solution

3. Find a prime number
3.1. Expected results
3.2. Solution #1
3.3. Solution #2

1. Print characters

Write a "for" loop that prints only the printable characters of the first 7 bits of ASCII code and separate each one by a white space without starting a new line.

- Take a look about chr() function, revise "for" function.
- The printable characters of the first 7 bits of ASCII code begins from 32 (white space is a printable character!) to 127. (see the ASCII tab in the subchapter)
- The chr() function returns the associated ASCII character of the numeric argument function.

1.1. ASCII codes table

Complete List of ASCii codes			Format: Excel spreadsheet
		symbol	
ascii code	0	NULL	(Null character)
ascii code	1	SOH	(Start of Header)
ascii code	2	STX	(Start of Text)
ascii code	3	ETX	(End of Text)
ascii code	4	EOT	(End of Transmission)
ascii code	5	ENQ	(Enquiry)
ascii code	6	ACK	(Acknowledgement)
ascii code	7	BEL	(Bell)
ascii code	8	BS	(Backspace)
ascii code	9	HT	(Horizontal Tab)
ascii code	10	LF	(Line feed)
ascii code	11	VT	(Vertical Tab)
ascii code	12	FF	(Form feed)
ascii code	13	CR	(Carriage return)
ascii code	14	SO	(Shift Out)
ascii code	15	SI	(Shift In)
ascii code	16	DLE	(Data link escape)
ascii code	17	DC1	(Device control 1)
ascii code	18	DC2	(Device control 2)
ascii code	19	DC3	(Device control 3)
ascii code	20	DC4	(Device control 4)
ascii code	21	NAK	(Negative acknowledgement)

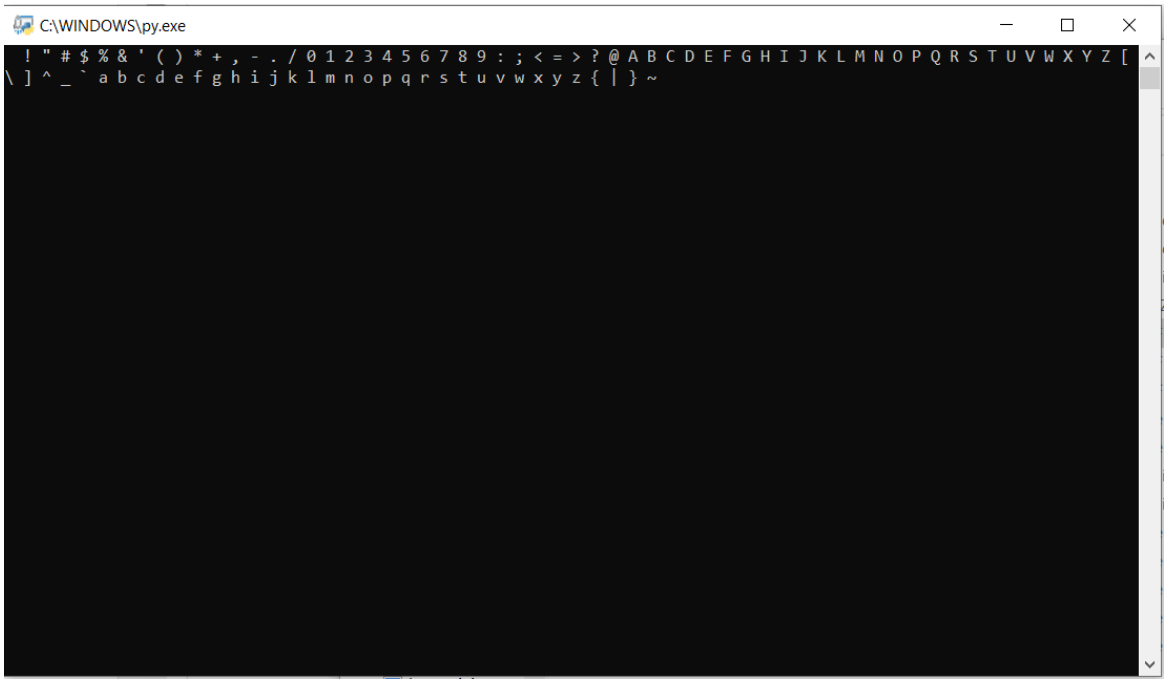
ascii code	22	SYN	(Synchronous idle)
ascii code	23	ETB	(End of transmission block)
ascii code	24	CAN	(Cancel)
ascii code	25	EM	(End of medium)
ascii code	26	SUB	(Substitute)
ascii code	27	ESC	(Escape)
ascii code	28	FS	(File separator)
ascii code	29	GS	(Group separator)
ascii code	30	RS	(Record separator)
ascii code	31	US	(Unit separator)
ascii code	32		(Space)
ascii code	33	!	(Exclamation mark)
ascii code	34	"	(Quotation mark ; quotes)
ascii code	35	#	(Number sign)
ascii code	36	$	(Dollar sign)
ascii code	37	%	(Percent sign)
ascii code	38	&	(Ampersand)
ascii code	39	'	(Apostrophe)
ascii code	40	(	(round brackets or parentheses)
ascii code	41	)	(round brackets or parentheses)
ascii code	42	*	(Asterisk)
ascii code	43	+	(Plus sign)
ascii code	44	,	(Comma)
ascii code	45	-	(Hyphen)
ascii code	46	.	(Dot , full stop)
ascii code	47	/	(Slash)
ascii code	48	0	(number zero)
ascii code	49	1	(number one)
ascii code	50	2	(number two)
ascii code	51	3	(number three)
ascii code	52	4	(number four)
ascii code	53	5	(number five)
ascii code	54	6	(number six)
ascii code	55	7	(number seven)
ascii code	56	8	(number eight)
ascii code	57	9	(number nine)
ascii code	58	:	(Colon)
ascii code	59	;	(Semicolon)
ascii code	60	<	(Less-than sign)
ascii code	61	=	(Equals sign)
ascii code	62	>	(Greater-than sign ; Inequality)
ascii code	63	?	(Question mark)
ascii code	64	@	(At sign)
ascii code	65	A	(Capital A)
ascii code	66	B	(Capital B)
ascii code	67	C	(Capital C)
ascii code	68	D	(Capital D)
ascii code	69	E	(Capital E)
ascii code	70	F	(Capital F)
ascii code	71	G	(Capital G)
ascii code	72	H	(Capital H)
ascii code	73	I	(Capital I)
ascii code	74	J	(Capital J)
ascii code	75	K	(Capital K)
ascii code	76	L	(Capital L)
ascii code	77	M	(Capital M)
ascii code	78	N	(Capital N)
ascii code	79	O	(Capital O)
ascii code	80	P	(Capital P)
ascii code	81	Q	(Capital Q)
ascii code	82	R	(Capital R)

ascii code	83	S	(Capital S)
ascii code	84	T	(Capital T)
ascii code	85	U	(Capital U)
ascii code	86	V	(Capital V)
ascii code	87	W	(Capital W)
ascii code	88	X	(Capital X)
ascii code	89	Y	(Capital Y)
ascii code	90	Z	(Capital Z)
ascii code	91	[	(square brackets or box brackets)
ascii code	92	\	(Backslash)
ascii code	93	]	(square brackets or box brackets)
ascii code	94	^	(Caret or circumflex accent)
ascii code	95	_	(underscore , understrike , underbar or low line)
ascii code	96	`	(Grave accent)
ascii code	97	a	(Lowercase a)
ascii code	98	b	(Lowercase b)
ascii code	99	c	(Lowercase c)
ascii code	100	d	(Lowercase d)
ascii code	101	e	(Lowercase e)
ascii code	102	f	(Lowercase f)
ascii code	103	g	(Lowercase g)
ascii code	104	h	(Lowercase h)
ascii code	105	i	(Lowercase i)
ascii code	106	j	(Lowercase j)
ascii code	107	k	(Lowercase k)
ascii code	108	l	(Lowercase l)
ascii code	109	m	(Lowercase m)
ascii code	110	n	(Lowercase n)
ascii code	111	o	(Lowercase o)
ascii code	112	p	(Lowercase p)
ascii code	113	q	(Lowercase q)
ascii code	114	r	(Lowercase r)
ascii code	115	s	(Lowercase s)
ascii code	116	t	(Lowercase t)
ascii code	117	u	(Lowercase u)
ascii code	118	v	(Lowercase v)
ascii code	119	w	(Lowercase w)
ascii code	120	x	(Lowercase x)
ascii code	121	y	(Lowercase y)
ascii code	122	z	(Lowercase z)
ascii code	123	{	(curly brackets or braces)
ascii code	124	|	(vertical-bar, vbar, vertical line or vertical slash)
ascii code	125	}	(curly brackets or braces)
ascii code	126	~	(Tilde ; swung dash)
ascii code	127	DEL	(Delete)
ascii code	128	Ç	(Majuscule C-cedilla)
ascii code	129	ü	(letter "u" with umlaut or diaeresis ; "u-umlaut")
ascii code	130	é	(letter "e" with acute accent or "e-acute")
ascii code	131	â	(letter "a" with circumflex accent or "a-circumflex")
ascii code	132	ä	(letter "a" with umlaut or diaeresis ; "a-umlaut")
ascii code	133	à	(letter "a" with grave accent)
ascii code	134	å	(letter "a" with a ring)
ascii code	135	ç	(Minuscule c-cedilla)
ascii code	136	ê	(letter "e" with circumflex accent or "e-circumflex")
ascii code	137	ë	(letter "e" with umlaut or diaeresis ; "e-umlaut")
ascii code	138	è	(letter "e" with grave accent)
ascii code	139	ï	(letter "i" with umlaut or diaeresis ; "i-umlaut")
ascii code	140	î	(letter "i" with circumflex accent or "i-circumflex")
ascii code	141	ì	(letter "i" with grave accent)
ascii code	142	Ä	(letter "A" with umlaut or diaeresis ; "A-umlaut")
ascii code	143	Å	(Capital letter "A" with a ring)

ascii code	144	É	(Capital letter "E" with acute accent or "E-acute")
ascii code	145	æ	(Latin diphthong "ae" in lowercase)
ascii code	146	Æ	(Latin diphthong "AE" in uppercase)
ascii code	147	ô	(letter "o" with circumflex accent or "o-circumflex")
ascii code	148	ö	(letter "o" with umlaut or diaeresis ; "o-umlaut")
ascii code	149	ò	(letter "o" with grave accent)
ascii code	150	û	(letter "u" with circumflex accent or "u-circumflex")
ascii code	151	ù	(letter "u" with grave accent)
ascii code	152	ÿ	(Lowercase letter "y" with diaeresis)
ascii code	153	Ö	(letter "O" with umlaut or diaeresis ; "O-umlaut")
ascii code	154	Ü	(letter "U" with umlaut or diaeresis ; "U-umlaut")
ascii code	155	ø	(slashed zero or empty set)
ascii code	156	£	(Pound sign ; symbol for the pound sterling)
ascii code	157	Ø	(slashed zero or empty set)
ascii code	158	×	(multiplication sign)
ascii code	159	ƒ	(function sign ; f with hook sign ; florin sign)
ascii code	160	á	(letter "a" with acute accent or "a-acute")
ascii code	161	í	(letter "i" with acute accent or "i-acute")
ascii code	162	ó	(letter "o" with acute accent or "o-acute")
ascii code	163	ú	(letter "u" with acute accent or "u-acute")
ascii code	164	ñ	(letter "n" with tilde ; enye)
ascii code	165	Ñ	(letter "N" with tilde ; enye)
ascii code	166	ª	(feminine ordinal indicator)
ascii code	167	º	(masculine ordinal indicator)
ascii code	168	¿	(Inverted question marks)
ascii code	169	®	(Registered trademark symbol)
ascii code	170	¬	(Logical negation symbol)
ascii code	171	½	(One half)
ascii code	172	¼	(Quarter or one fourth)
ascii code	173	¡	(Inverted exclamation marks)
ascii code	174	«	(Angle quotes or guillemets)
ascii code	175	»	(Guillemets or angle quotes)
ascii code	176	░	
ascii code	177	▒	
ascii code	178	▓	
ascii code	179	│	(Box drawing character)
ascii code	180	┤	(Box drawing character)
ascii code	181	Á	(Capital letter "A" with acute accent or "A-acute")
ascii code	182	Â	(letter "A" with circumflex accent or "A-circumflex")
ascii code	183	À	(letter "A" with grave accent)
ascii code	184	©	(Copyright symbol)
ascii code	185	╣	(Box drawing character)
ascii code	186	║	(Box drawing character)
ascii code	187	╗	(Box drawing character)
ascii code	188	╝	(Box drawing character)
ascii code	189	¢	(Cent symbol)
ascii code	190	¥	(YEN and YUAN sign)
ascii code	191	┐	(Box drawing character)
ascii code	192	└	(Box drawing character)
ascii code	193	┴	(Box drawing character)
ascii code	194	┬	(Box drawing character)
ascii code	195	├	(Box drawing character)
ascii code	196	─	(Box drawing character)
ascii code	197	┼	(Box drawing character)
ascii code	198	ã	(Lowercase letter "a" with tilde or "a-tilde")
ascii code	199	Ã	(Capital letter "A" with tilde or "A-tilde")
ascii code	200	╚	(Box drawing character)
ascii code	201	╔	(Box drawing character)
ascii code	202	╩	(Box drawing character)
ascii code	203	╦	(Box drawing character)
ascii code	204	╠	(Box drawing character)

ascii code	205	═	(Box drawing character)
ascii code	206	╬	(Box drawing character)
ascii code	207	¤	(generic currency sign)
ascii code	208	ð	(Lowercase letter "eth")
ascii code	209	Ð	(Capital letter "Eth")
ascii code	210	Ê	(letter "E" with circumflex accent or "E-circumflex")
ascii code	211	Ë	(letter "E" with umlaut or diaeresis ; "E-umlaut")
ascii code	212	È	(letter "E" with grave accent)
ascii code	213	ı	(lowercase dot less i)
ascii code	214	Í	(Capital letter "I" with acute accent or "I-acute")
ascii code	215	Î	(letter "I" with circumflex accent or "I-circumflex")
ascii code	216	Ï	(letter "I" with umlaut or diaeresis ; "I-umlaut")
ascii code	217	┘	(Box drawing character)
ascii code	218	┌	(Box drawing character)
ascii code	219	█	(Block)
ascii code	220	▄	(Bottom half block)
ascii code	221	¦	(vertical broken bar)
ascii code	222	Ì	(letter "I" with grave accent)
ascii code	223	▀	(Top half block)
ascii code	224	Ó	(Capital letter "O" with acute accent or "O-acute")
ascii code	225	ß	(letter "Eszett" ; "scharfes S" or "sharp S")
ascii code	226	Ô	(letter "O" with circumflex accent or "O-circumflex")
ascii code	227	Ò	(letter "O" with grave accent)
ascii code	228	õ	(letter "o" with tilde or "o-tilde")
ascii code	229	Õ	(letter "O" with tilde or "O-tilde")
ascii code	230	µ	(Lowercase letter "Mu" ; micro sign or micron)
ascii code	231	þ	(Lowercase letter "Thorn")
ascii code	232	Þ	(Capital letter "thorn")
ascii code	233	Ú	(Capital letter "U" with acute accent or "U-acute")
ascii code	234	Û	(letter "U" with circumflex accent or "U-circumflex")
ascii code	235	Ù	(letter "U" with grave accent)
ascii code	236	ý	(Lowercase letter "y" with acute accent)
ascii code	237	Ý	(Capital letter "Y" with acute accent)
ascii code	238	¯	(macron symbol)
ascii code	239	´	(Acute accent)
ascii code	240		(Hyphen)
ascii code	241	±	(Plus-minus sign)
ascii code	242	‗	(underline or underscore)
ascii code	243	¾	(three quarters)
ascii code	244	¶	(paragraph sign or pilcrow)
ascii code	245	§	(Section sign)
ascii code	246	÷	(The division sign ; Obelus)
ascii code	247	¸	(cedilla)
ascii code	248	°	(degree symbol)
ascii code	249	¨	(Diaeresis)
ascii code	250	·	(Interpunct or space dot)
ascii code	251	¹	(superscript one)
ascii code	252	³	(cube or superscript three)
ascii code	253	²	(Square or superscript two)
ascii code	254	■	(black square)
ascii code	255	nbsp	(non-breaking space or no-break space)

1.2. Expected Result



1.3. Solution

One possible solution of this exercise:

```
for i in range(32,127):
    print(chr(i),end =" ")
input()
```

2. The lenght of the longer word

Write a function namend "Lenght(words)" that takes a list as input and returns the lenght of the longer word.

Some suggestions:

- "List" is similar to "array" but could store different types of data (ref. Programming fundamentals\data types)
- Using "list.append" you could add variables in a list
- The function "len" could give you the lenght of a text (ref. functions\some built-in functions)
- Use the max() function. (ref. functions\some built-in functions)
- Write a custom function (ref.functions\custom functions)

2.1. Expected result

Consider to input these three strings in the function:

- "learn" [5 characters]
- "python" [6 characters]
- "my friend" [9 characters]

The result is:

2.2. Solution

One possible solution of this exercise:

```
def Lenght(words):                                  #1
    list=[]                                         #2
    for element in words:                           #3
        list.append(len(element))                   #4
    return max(list)                                #5


output = Lenght(["learn","python","my friend"])#6
print(output)                                       #7
input()


'''
#1 i declare the Lenght(words) function
#2 i create the list named "list"
#3 i scan every word of the list "list" with "for" function
#4 i add to the list the lenght of every word
#5 the function returns the maximum value
#6 i call the function and i assign its value to the "output" variable
#7 i print the "output" variable
```

3. Find a prime number

Write a function "Is_It_Prime(mumber) that, giving a integer number as input, returns TRUE if the number is a prime number.

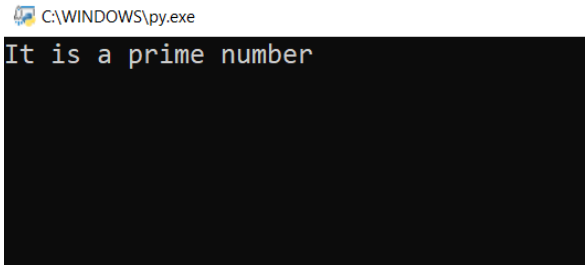
If the functions returns TRUE, print the string "It is a prime number", else print the string "It is not a prime number"

Some suggestions:

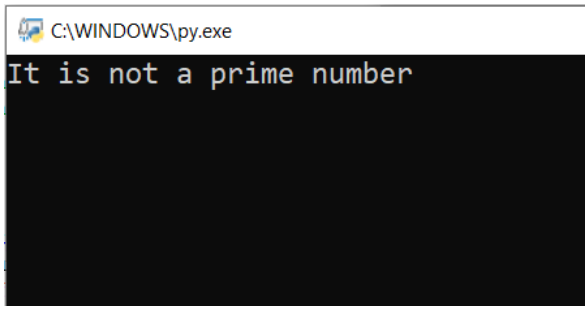
- Prime numbers are divisible only by 1 and themselves
- The math operator "%" gives the remainder of a division (ref. Programming fundamentals\Math operators
- A prime number has always a reminder if it is divided by any number except obviously 1

3.1. Expected results

If you give a prime number to the function, for example 23:



If the number is not a prime number, for example 24:



3.2. Solution #1

One possible solution of this exercise:

```
def Is_It_Prime(number):                    #1
    if number > 1:                          #2
        for i in range(2, int(number-1)):   #3

            if (number % i) == 0:           #4
                return False                #5

        return True                         #6

    else:
        return True                         #7

if Is_It_Prime(24) == True:                 #8
    print("It is a prime number")           #9
else:
    print("It is not a prime number")       #10

input()
```

Note: A prime number is never divisible without return by a number that is its half +1. Considering this, it's possible to reduce the algorithm, increasing its efficiency

3.3. Solution #2

Another possible solution.

In this case we manage some more:

- The number is input trough the keyboard
- The number is verified: if it is not an integer an error message will be printed
- The number of interations will be printed, in the same field as the result string.

```
def Is_It_Prime(number):
    n = 0
    l = [0, 0]
    # l[0]= prime or not prime; l[1]= number of iterations
    if number > 1:
        limit = int(number / 2) + 1
        for i in range(2, limit ):
            n += 1
            if (number % i) == 0:
                l[1] = n
                return l          # no prime number
        else:
            l[0] = 1;l[1] = n + 1
            return l              # prime number
    else:
        l[0] = 0;l[1] = 0
        return l                  # no prime number

while input("Press enter to continue, space to exit \n") != " ":
    number = input("Please give me an integer: ")
    if number == " ":
        break
    while number.isdecimal() == False:
        number = input("Please give me an INTEGER: ")

    else:
        m = Is_It_Prime(int(number))

        if m[0] == 0 and m[1] == 0:
            print("The prime number must be > 1")

        elif m[0] == 0 and m[1] != 0:
            print("It is not a prime number,number of iterations: %d " % m[1])

        elif m[0] == 1:
            print("It is a prime number,number of iterations: %d " % m[1])
```

And the expected resul is:

DataBase Fundamentals

Sito: DTAM Online Training Platform
Corso: Introduction
Libro: DataBase Fundamentals

Stampato da: Mirco Ferrera
Data: lunedì, 23 ottobre 2023, 09:55

Sommario

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1.2. Types of databases
1.3. Hierarchical databases
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1.5. Object databases
1.6. Relational databases
1.7. The elements of a databases
1.8. The tables
1.9. The masks
1.10. The queries
1.11. The reports

1. Introductions to Databases

Databases are one of major fields of application of information technology.
Any organization, Company or school, has its own system informative, not necessarily computerized, consisting of:

Files and paper archives: they contain the information, organized according to a certain structure (cards, fields, codes, ...).
Connections: the archives are logically connected to each other, according to the information and operational needs (references, links to other files).

What's a database?
A database is a **set of computerized archives** connected to each other appropriately, which makes it possible to consult and update information in real-time.

1.1. Fundamental characteristics and functions of a database

A database has the following characteristics:

Integrity (robustness): protection and recovery of data in the event of hardware failures, system crashes, etc.
Security (privacy): controlled access to information from authorized operators, for example system administrators, basic users, etc.
Concurrency: simultaneous access to data by multiple operators or programs.
Consistency: internal consistency of the database, among the various information represented in it.
Efficiency: means the ability to perform operations using a set of resources (time and space) that is acceptable to users.

To fully understand what a Database is and what the advantages are related to its use, It is necessary to understand the differences between:

- **Database,**
- **DBMS (Data Base Management System).**

A **Database** can be defined as a **set of data**, stored on a mass storage medium, forming a whole, which can be manipulated by multiple programs applications.

A **Data Base Management System** (DBMS) is a **set of data linked together** with management of the software system. it takes care of updating, maintenance and consultation of a set of records contained in a mass storage medium. The DBMS, therefore, consists of the database plus a set of programs, which are used for the management of data stored in archives.

The Database is not a static entity. It is possible to **modify** and **delete** the data, **carry out research** through user-defined criteria and **classify** data individually or according to various criteria and print reports.

1.2. Types of databases

The main types of databases are:

- **Hierarchical databases**
- **Reticular databases**
- **Object database**
- **Relational databases**

1.3. Hierarchical databases

Developed in the 1960s, but still used today.
A **hierarchical database** model is a data model in which data is organized in a **tree structure.** The data is stored as linked records. A record is a collection of fields, with each field containing only one value. The type of a record defines which fields the record contains.

The hierarchical database model dictates that each child record has only one parent, while each parent record can have one or more child records. To retrieve data from a hierarchical database, the entire tree must be traversed starting from the root node.

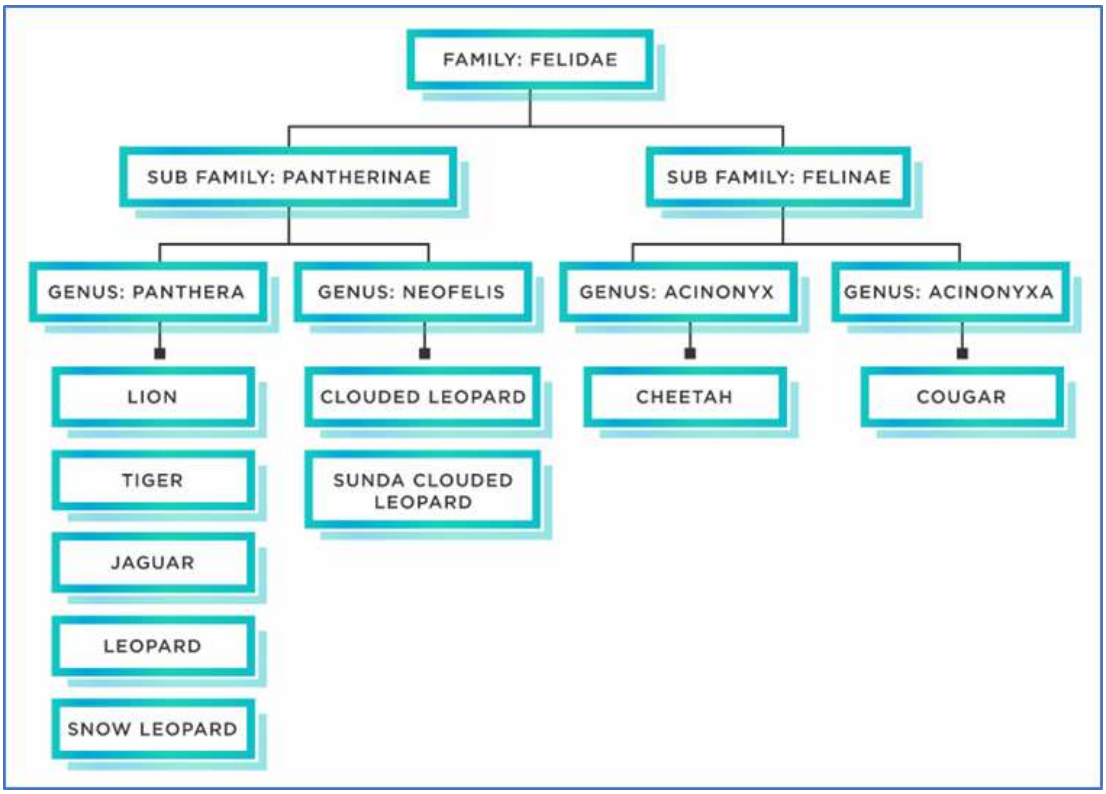


Figure 1: Hierarchical database

1.4. Reticular databases

In the **reticular model** of the database, the records are **interlinked** with ring structures (pointers) that allow the user to **access the data more easily**, without the rigid ligaments of the hierarchical structure.
A record may have one or more parent records and this allows you to avoid redundancy problems.
The problem of the dependency of the programs on the structures remains as well as the problem of the complexity of the structures, which grows proportionally to the growth of the data.
To modify the structures, even partially, it is necessary to clone the database and to recreate it.

It is similar to the hierarchical database, but each child can have multiple parents.
It is more flexible than the hierarchical database.

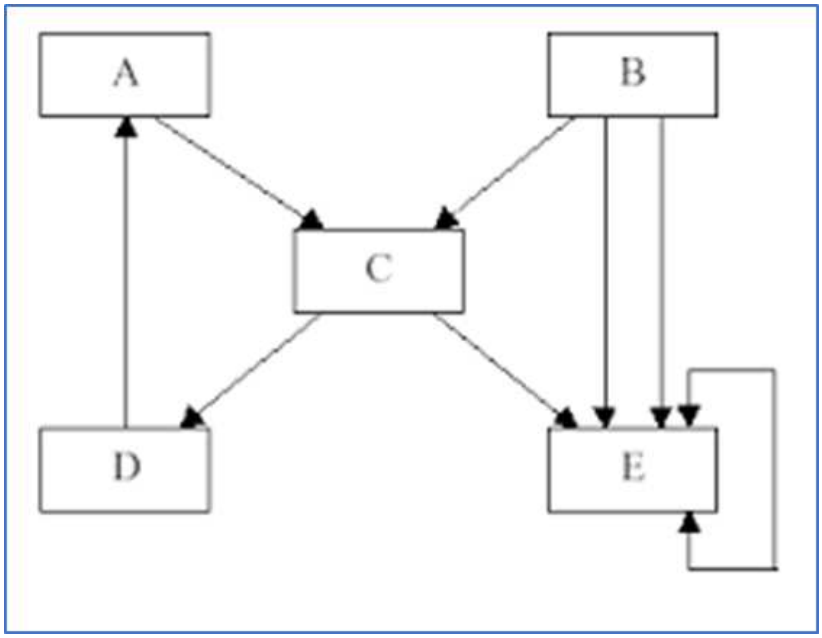


Figure 2: Reticular database

1.5. Object databases

An **object-oriented** database model is a database model in which information is represented in the **form of objects** as in object-oriented programming languages, located in a market of niche with respect to the relational model. Objects can be considered as entities capable of exchanging information with each other through messages.

Considered since the 1980s and 1990s, but with little commercial impact, they were used only in certain fields of application such as engineering, space databases, telecommunications, and scientific areas such as high-energy physics and molecular biology.

1.6. Relational databases

They are not only the most used, but they are also the simplest because they rely on a way of represent the data we are familiar with: the **tables**. Today the main databases in circulation are relational type. All datasets used to describe complex and organized systems such as businesses, schools, associations, ... imply links between the various data: the goods are linked to the suppliers, to the students take courses, teachers take courses, and so on.

Using a database has the following benefits:
It allows a "**friendly use**" of the procedures;
management takes place with commands and easily intelligible menus to the user, while remaining hidden all the physical details of the program;
avoid programming for common tasks: the program incorporates a number of functions that allow you to perform operations without the need for a programming language;
Reduces repetitiveness: just think of the archives (paper) of libraries, where the volumes are sorted by authors and titles;
A database allows you to **relate data between them**, which greatly reduces duplication;
Reduces costs: databases are standard products for this reason they are cheaper than tailored applications;
Guarantees a certain level of security, especially in multi-user environments.

1.7. The elements of a databases

The fundamental elements in a database are:

- Tables
- Masks
- Queries
- Report

1.8. The tables

The information of a database must be grouped into tables that are represented in rows and columns:
Columns are made up of **fields**
The **rows** are called **records**
The first row of a table is called header and contains the name of the fields.

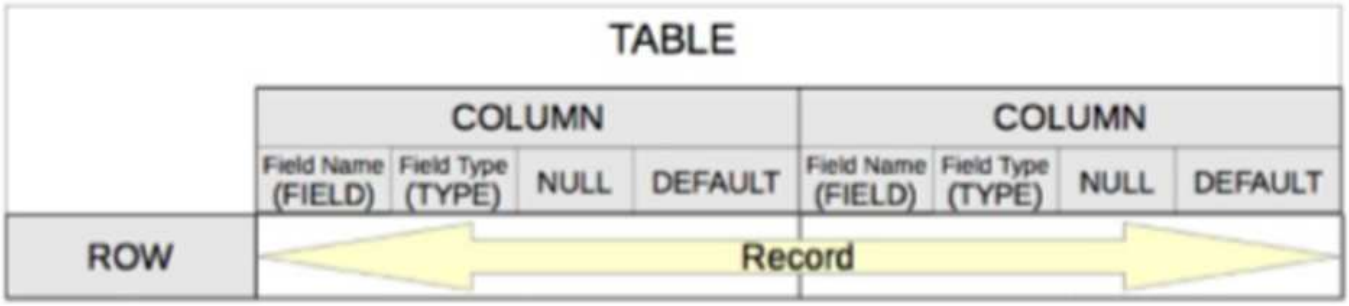


Figure 3: Table

It can therefore be said that a table is formed from: RECORD which are made up of FIELDS

Primary key

The **primary key** is a field that uniquely **identifies the records** (rows) of the table.
Examples:
A tax code allows you to uniquely identify the person: there are no two identical tax codes.
The phone number is unique in the phone book.

The primary key is important because the fundamental rule for establishing **relationships** between **tables** is that the linking field must not have repetitions, i.e. each record must be able to be uniquely identified. The field that allows the identification of each record is called "**primary key**" and must be common to the tables to be related.
The one field which acts as the primary key must be indicated for each table..

Relations

In addition to storing information, a database is also capable of storing any **relationships** that may exist **between the data**.

Example:
We think of a company that needs to stock up on various kinds of materials for its work. A list of the various necessary materials could be prepared, within which information relating to the supplier, for example Name and Telephone.

It is easy to imagine that if more products are found at the same supplier, the name and telephone number of the latter will appear many times with an obvious waste of space.

To solve this problem, the possibilities that database management programs have, of organizing the database on multiple tables by putting them in RELATIONSHIP (logical connection) between them.

We could then divide our information into two tables: the first would report the names of the products and a code that identifies the supplier (even if the codes are repeated "waste" much less space than before), while the second would become a sort of supplier registry (with all the necessary information for each supplier), each with its own identification code.

In this way the data on suppliers are no longer repeated and if it should be necessary to change some information on a supplier it will be enough to make a single change in the table of suppliers and not for all the times appears.

A database of this type is called **relational**.

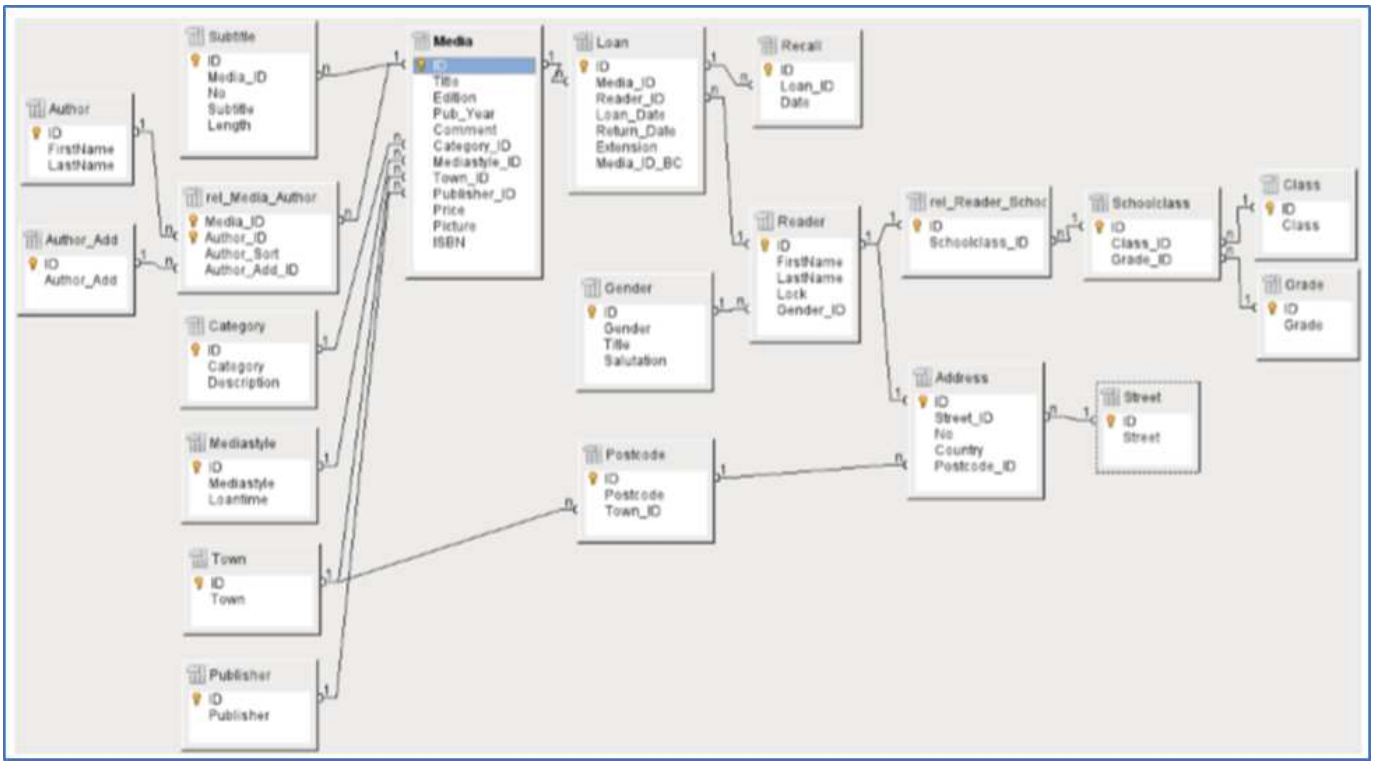
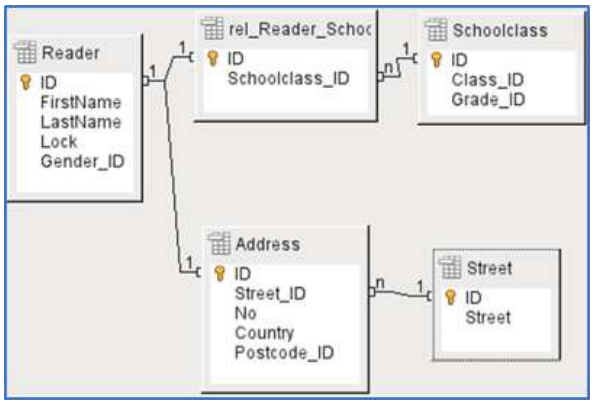


Figure 4: Relational database

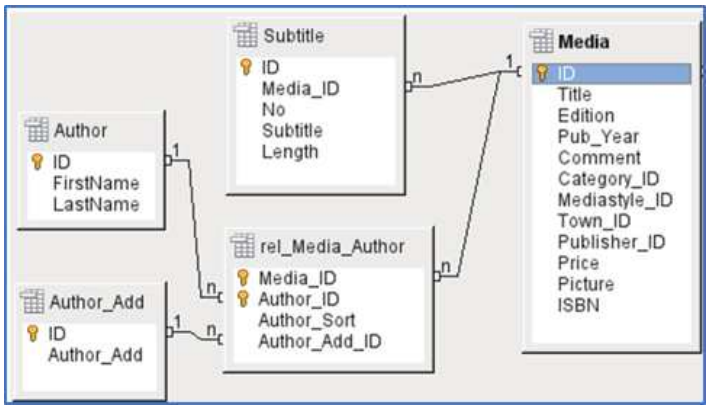
Three types of relationship can be established:

one to one: these are relationships between elements that have a **unique match**: to an element of a table only one corresponds to another and vice versa;



one to many: they are relationships that are established **between a record** from one table **and multiple records** from another table, but not the other, for example the many track titles for a music CD. The primary key for the Media table is stored as a foreign key in the Subtitle table. Most relationships between tables in a database are one-to many relationships.

many to many: a record can be **related to more than a record from another table** and vice versa; this kind of relationship is usually defined through a third table which constitutes a "bridge" between the two to be related.


Subtitle
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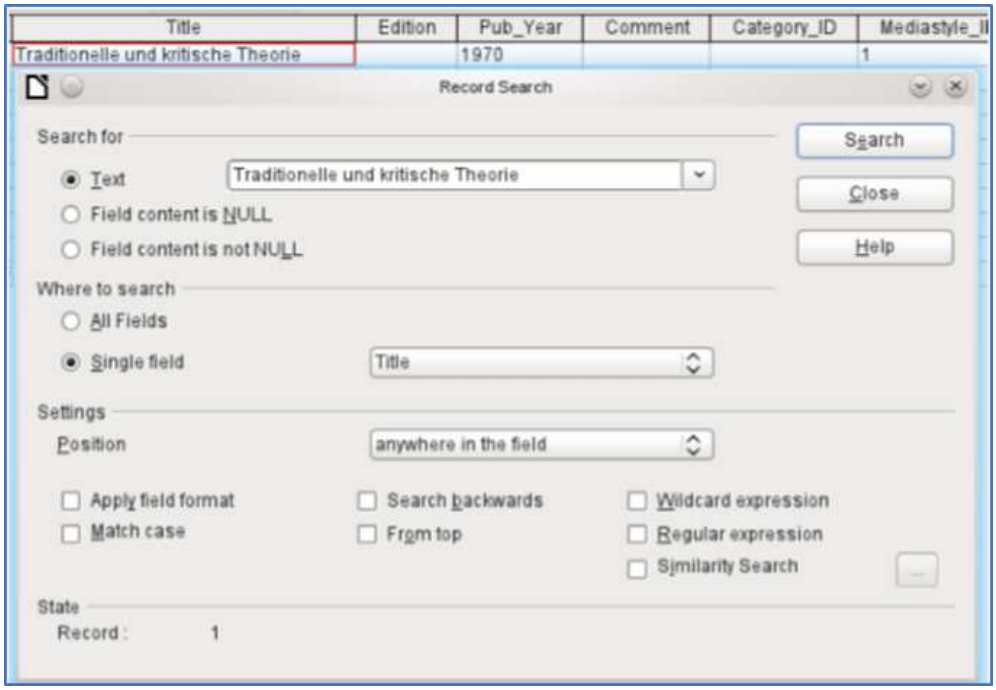
1.9. The masks

In a table the data can be inserted considering the table as if it were an Excel sheet or by using the (insertion) masks. They are forms with specific fields that guide the user in entering data.
Data entry can be facilitated by creating **masks** that help display the contents of the tables in an orderly manner. Graphic elements can also be inserted.



1.10. The queries

A **query** is a **tool** that allows you to make **queries on the contents** of the tables and also to perform specific actions on the data.

1.11. The reports

Reports allow you to **preview or print** data in a specific format.

Examples:
Lists
Invoices
Book cards

A report allows you to view data stored in DB tables or queries.
This display is not intended to allow entries or changes, but to PRESENT the data in an effective format on paper or video.

Libre Office Library

Mr.
Henrich Müller
Nowhereroad 14 b
GB 3P67Q Downtown

11/24/12

Recall

Dear Mr. Müller,

the following media weren't returned at the right time:

Recalldate	Recallfix	Medium	Loandate	Overrun	Charge
24.11.12	1	5 - I hear you knocking - by Edmunds, Dave	29.04.12	202Days	$7.00
24.11.12	1	8 - Im Augenblick - by van Veen, Herman	22.04.12	209Days	$7.25
24.11.12	1	2 - Eine kurze Geschichte der Zeit - by Hawking, Steven W.	04.04.12	213Days	$7.50

Recall Charge: **$21.75**

Sincere regards,

(Administration of Library)

Electrical quantities

Sommario

1. Voltage
1.1. Direct Current (DC) and Alternate Current (AC) Voltage
1.2. Voltage measurement

2. Electric Current
2.1. Current measurement
2.2. The Clamp Meter

3. Electric Resistance
3.1. Resistivity
3.2. Resistance measurement
3.3. Commercial resistors

4. Electric Power
4.1. AC circuit: active, reactive, and apparent power

5. Frequency

1. Voltage

Voltage is the difference in electric potential between two points, which is defined as the work needed per unit of charge to move a test charge between the two points. **Electric potential difference, electromotive force (emf), electric pressure or electric tension** are other names used instead of Voltage.

In the International System of Units, the derived unit for voltage (potential difference) is named **Volt [V]**. Voltage is denoted symbolically by Δ**V**, simplified **V** or **U** for instance in the context of Ohm's or Kirchhoff's circuit laws.

Electric potential differences between points can be caused physically by:

- Electric charge build up (e.g. electrochemical processes in cells and batteries)
- Electric current imbalance through a magnetic field
- Time-varying magnetic fields (e.g. dynamo or generator)
- Some combination of these three.

Voltage is the pressure from an electrical circuit's power source that pushes charged electrons (current) through a conducting loop, enabling them to do work such as illuminating a light.

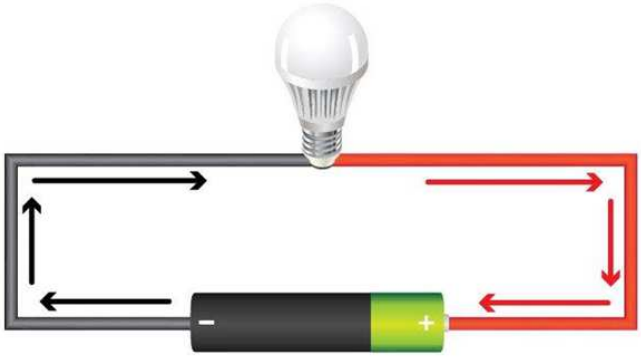


Figure 1.1 Simple direct current circuit

Example of voltage in a simple circuit:

- In this circuit, there is not any switch, so the circuit is "closed".
- Voltage in the power source creates pressure that forces electrons to flow as current out the battery's negative terminal.
- Current reaches the lamp, causing it to glow.
- Current returns to the power source.

1.1. Direct Current (DC) and Alternate Current (AC) Voltage

Voltage can be **direct current (DC)** voltage or **alternating current (AC)** voltage. Ways they differences:

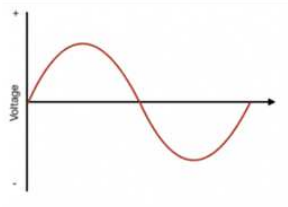
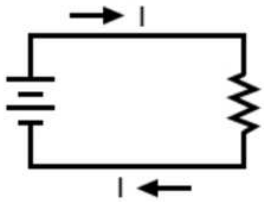
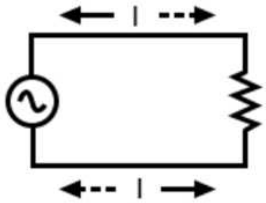
	DC	AC
Characteristics	Travels in a straight line, and in one direction only. DC voltage has polarity	Flows are evenly undulating since waves. Reverses direction at regular intervals. AC Voltage has not polarity
Graphical representation	 Figure 1.2 DC graphic	 Figure 1.3 AC graphic
Basic Circuit	 Figure 1.4 DC basic circuit	 Figure 1.5 AC basic circuit
Origin	Commonly produced by sources of stored energy such as batteries or by devices like photovoltaic panels	Commonly produced by utilities via generators, where mechanical rotating motion powered by flowing water, steam, wind or heat is converted to electrical energy Utilities deliver ac voltage to homes, businesses and industries
Use examples	Electronic devices	Electric motors, Transformers A lot of devices use rectifiers to convert AC voltage and current to DC
Voltage Value examples	Industrial electronics (e.g controllers, sensors, auxiliary actuators) work usually at 24V DC Microcontroller systems (e.g. Arduino, Raspberry pi) work usually at 5V DC A household AA alkaline battery, offers 1,5 V DC	House Voltage Supply in Europe is 230V AC – 1 phase Industrial Voltage Supply in Europe is 400V AC – 3 phases

Table 1.1 DC/AC Differences

1.2. Voltage measurement

As its name implies, a **"Voltmeter"** is an instrument used for measuring voltage (V), that is the potential difference present between any two points within a circuit. To measure a voltage (potential difference), a voltmeter **must be connected in parallel** with the component whose voltage you wish to measure. Voltmeters can be used to measure the voltage drop across a single component or supply, or they can be used to measure the sum of voltage drops across two or more points or components within a circuit.

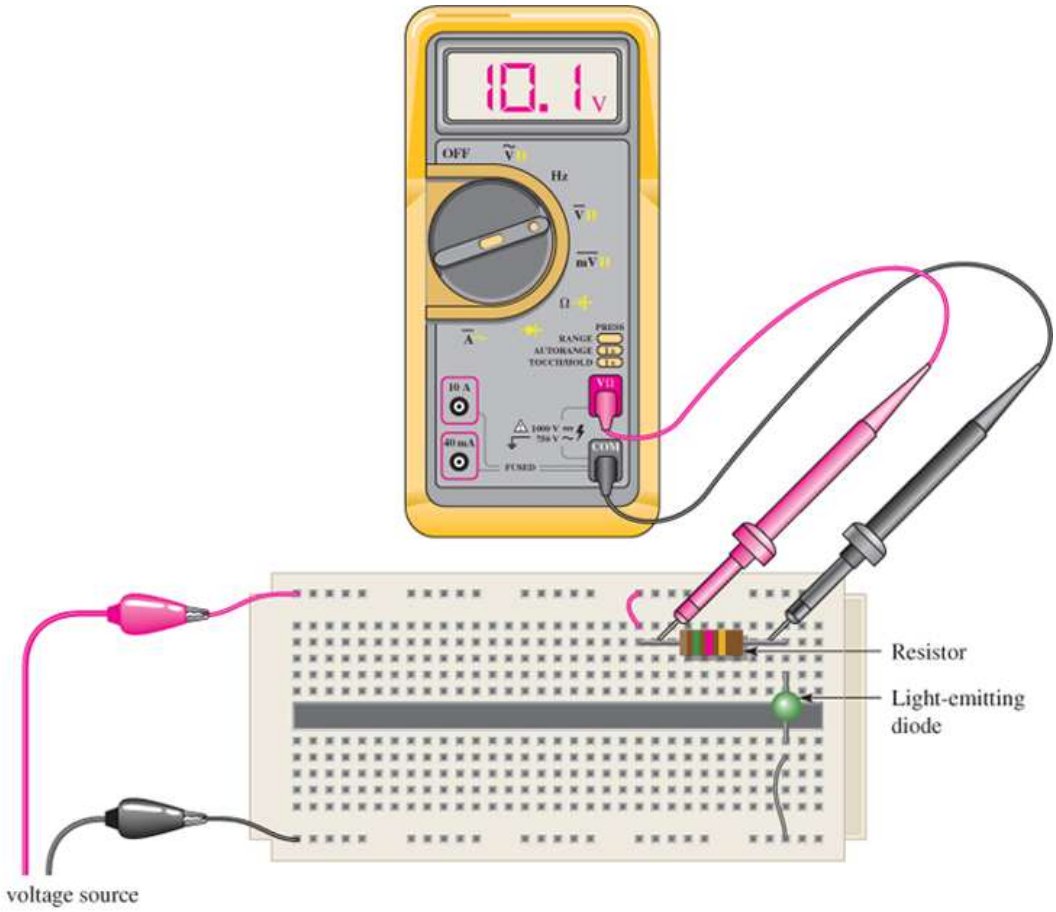


Figure 1.6 Voltage measurement with multimeter

Step by step procedure of a voltage measurement using a Multimeter

1) Using the rotative switch select the Voltage position. Pay attention to select AC voltage or DC voltage position, according to the circuit source.

2) Most multimeters power up in Autorange mode. This automatically selects a measurement range based on voltage present. Other way you have to select the correct range according to the circuit source

3) Insert the black lead into the COM jack and the red lead into the V jack

4) Connect the test leads to the circuit, between the two points where you want to measure the voltage.

5) Read the measurement in the display and remove the leads.

2. Electric Current

An **electric current** is a stream of charged particles, such as electrons or ions, moving through an electrical conductor or space. The moving particles are called **charge carriers**, which may be one of several types of particles, depending on the conductor. In electric circuits the charge carriers are often electrons moving through a wire

The SI unit of electric current is the **ampere**, or **amp**, which is the flow of electric charge across a surface at the rate of one coulomb per second. The ampere (**symbol: A**) is an SI base unit. The conventional symbol for current is **I**, which originates from the French phrase *intensité du courant*, (current intensity).

Electric currents create magnetic fields, which are used in motors, generators, inductors, and transformers. In ordinary conductors, they cause Joule heating, which creates light in incandescent light bulbs. Time-varying currents emit electromagnetic waves, which are used in telecommunications to broadcast information.

Electrons flow through a conductor (typically a metal wire, usually copper) when two prerequisites of an electric circuit are met:

- The circuit includes an energy source (a battery, for instance) that produces voltage. Without voltage, electrons move randomly and evenly within a wire, and current cannot flow. Voltage creates pressure that drives electrons in a single direction.

- The circuit forms a closed, conducting loop through which electrons can flow, providing energy to any device (a load) connected to the circuit. A circuit is closed (complete) when a switch is turned to the ON, or closed, position.

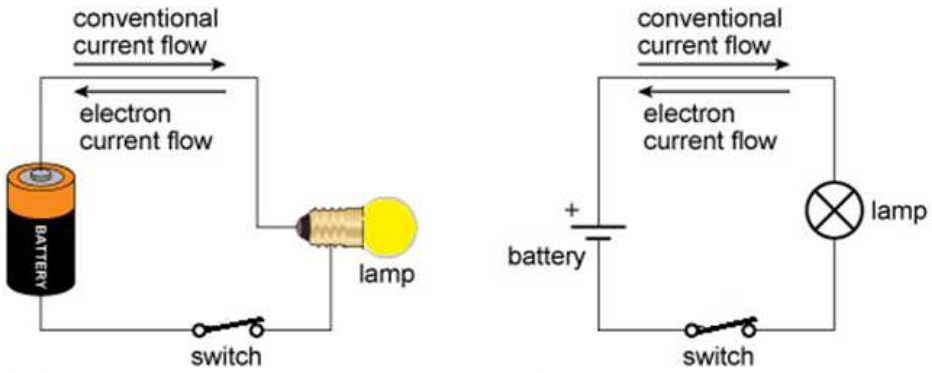


Figure 1.7 DC Current flow sample

2.1. Current measurement

As its name implies, an **Ammeter** is an instrument used for measuring electrical current (I) and gets its name from the fact that the unit of measurement is "amps", or more precisely, Amperes. But in order to measure an electric current, an ammeter must be connected so that the total current of interest can pass through it. In other words, the ammeter should always be **connected in series** to the circuit or component being measured.

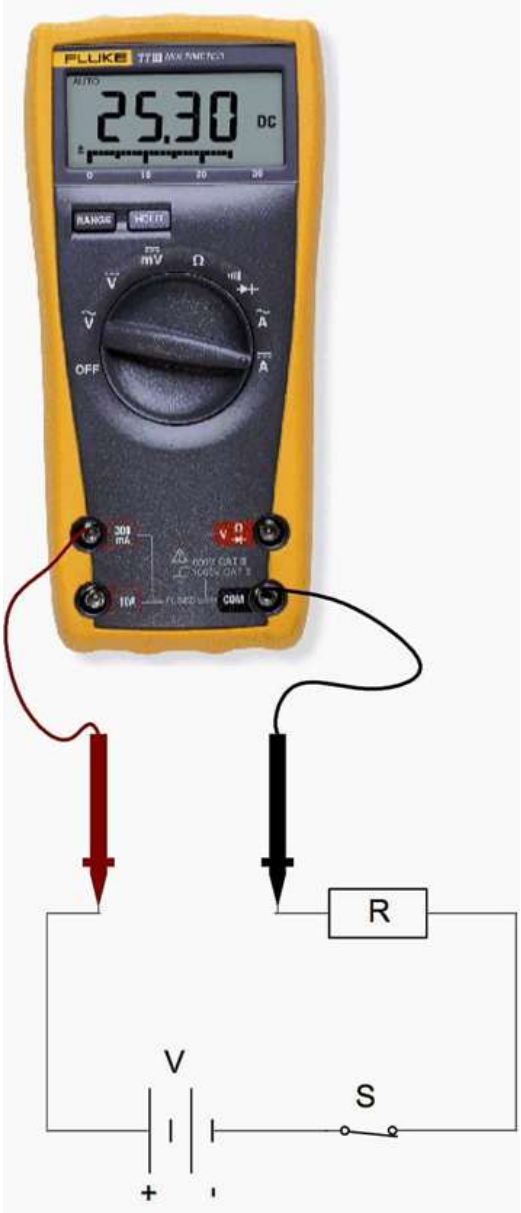


Figure 1.8 Current measurement with multimeter

Step by step procedure of a current measurement using a Multimeter

1) Using the rotative switch select the Amperage position. Pay attention to select AC amperage or DC amperage position, according to the circuit source

2) Most multimeters power up in Autorange mode. This automatically selects a measurement range based on present current. Other way you have to select the correct range according to the estimated current absorption

3) Connect the black lead to the COM jack and the red probe lead to either very low (mA or µA) or very high current range (A) jack (depending on the higher range of the current being measured).

4) Turn OFF the circuit and interrupt it at the point where the reading has to be taken.

5) Connect the red probe to the more positive side and black test lead to the more negative side of the circuit.

6) Turn ON the power supply and adjust the range of current to closer digital form.

7) If the meter shows ‘OL’, it is indicating an over range situation and hence the selector switch, i.e., range has to be adjusted accordingly.

8) Note: if the circuit current overrate the maximum instrument current, the meter could be damaged

2.2. The Clamp Meter

It may be difficult to open a circuit to connect an in-line ammeter to measure the current. A type of test tool that overcomes such problems is the **clamp meter**, which consists of clamp probes or inbuilt clamp on the meter (standalone tool). This method of measuring the current is safest and easiest than breaking the circuit.

Every wire has a magnetic field around it when the current passes through it. When the current flow increases, the magnetic field will also increase. The clamp-on probe measures this magnetic field strength and converts it into corresponding current value.

A clamp-on probe meter can measure low currents as well as very high current ranging from less than 1A to 2000A (depending on the manufacturer).

Figure 1.9 Multimeter with clamp

3. Electric Resistance

In electronics and electromagnetism, the **electrical resistance** of an object is a measure of its opposition to the flow of electric current. Electrical resistance shares some conceptual parallels with the notion of mechanical friction.

The SI unit of electrical resistance is the **ohm (Ω)**. Resistance is denoted symbolically by **R**.

The resistance of an object depends in large part on the material it is made of. Objects made of electrical insulators like rubber tend to have very high resistance, while objects made of electrical conductors like metals tend to have very low resistance. The nature of a material is not the only factor in resistance and conductance, however; it also depends on the size and shape of an object and on the temperature.

3.1. Resistivity

Table 1.3 Electrical Resistivity for common materials

The **resistivity** of a substance is the resistance of a cube of that substance having edges of unit length, with the understanding that the current flows normal to opposite faces and is distributed uniformly over them

Resistivity is normally measured in **Ohm meters**. This means that the resistivity is measured for cube of the material measuring a meter in each direction.

0

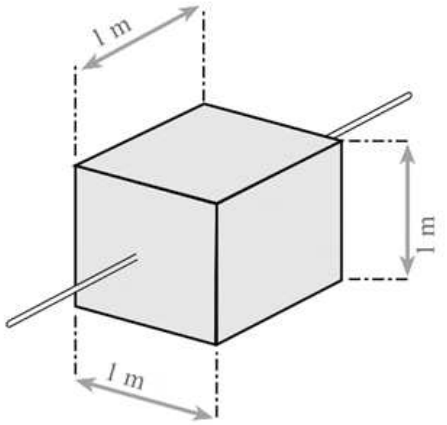


Figure 1.10 Resistivity specimen

The SI unit of electrical resistivity is the **ohm·metre (Ω·m)**. It is commonly represented by the Greek letter **ρ, rho**.

Although the SI resistivity unit, the ohms metre is generally used, sometimes figures will be seen described in terms of ohms centimetres, Ω·cm.

There are three broad classifications of materials in terms of their resistivity: conductors, semiconductors and insulators.

MATERIAL	TYPICAL RESISTIVITY RANGE (ΩM)
Conductors	10^{-2} - 10^{-8}
Semiconductors	10^{-6} - 10^{6}
Insulators	10^{11} - 10^{19}

Table 1.2 Comparison of resistivity of conductors, semiconductor and insulators

Many resistors and conductors have a uniform cross section with a uniform flow of electric current. In this case, the equation used to calculate the resistance is:

$$R = \rho \frac{l}{A}$$

R is the electrical resistance of a uniform specimen of the material measured in ohms
l is the length of the piece of material measured in metres, m
A is the cross-sectional area of the specimen measured in square metres, m^2

MATERIAL	ELECTRICAL RESISTIVITY AT 20°C OHM METRES
Aluminium	2.8 x 10^{-8}
Brass	~0.6 - 0.9 x 10^{-7}

Cadmium	6×10^{-8}
Cobalt	5.6×10^{-8}
Copper	1.7×10^{-8}
Gold	2.4×10^{-8}
Carbon (Graphite)	1×10^{-5}
Germanium	4.6×10^{-1}
Iron	1.0×10^{-7}
Nichrome	1.1×10^{-6}
Nickel	7×10^{-8}
Platinum	0.98×10^{-7}
Quartz	7×10^{17}
Silicon	6.4×10^{2}
Silver	1.6×10^{-8}
Tantalum	1.3×10^{-7}
Tungsten	4.9×10^{-8}
Zinc	5.5×10^{-8}

Table 1.3 Electrical Resistivity for common materials

3.2. Resistance measurement

Ohmmeter is the electrical instrument that measures electrical resistance. The ohmmeter usually calculates the resistance applying the ohm's law, so it needs to know the voltage and the current circulating in the measurement point.

Some Ohmmeter uses the circuit voltage, but in most cases multimeter works by applying a little voltage (supplied by the internal accumulator) and the value of the measured current generated is used to calculate the value of the resistance. In this case **it's fundamental to disconnect the main supply before the measure.**

Figure 1.11 Resistance measurement with multimeter

Step by step procedure of a resistance measurement using a Multimeter

1) Turn power to circuit OFF. If a circuit includes a capacitor, discharge the capacitor before taking any resistance reading.

2) Turn digital multimeter dial to resistance, or ohms. The display should show OLΩ because, in Resistance mode, even before test leads are connected to a component, a digital multimeter automatically begins taking a resistance measurement.

3) Most multimeters power up in Autorange mode. This automatically selects a measurement range based on resistance present. Otherwise, you have to select the range manually.

4) Best results will be achieved if the component to be tested is removed from the circuit. If the component is left in the circuit, the readings could be affected by other components in parallel with the component to be tested.

5) Insert the leads into the COM and the VΩ jack.

6) Connect test leads across the component being tested

7) Read the measurement on the display.

3.3. Commercial resistors

How to recognize the value of the commercial resistors?

There are some painted band on them. Follow the video to know how to decode the resistor value

4. Electric Power

An important aspect of any electrical or electronic circuit is the **power** associated with it. Whether power is used in a mechanical environment or an electrical environment, the definition of power is still the same.

Electric power is the rate, per unit time, at which electrical energy is transferred by an electric circuit. It is the rate of doing work.

The unit of power is the **Watt** which is denoted by the symbol **W**. It is named after the Scottish engineer James Watt.

The Watt can be defined according to the application:

- Electrical definition of the Watt: one Watt is the rate at which work is done when a current of one Ampere, if current flows through a network which has an electrical potential difference of one volt

- Mechanical definition of the Watt: one Watt is the rate at which work is done when the velocity of an object is held constant at one meter per second against constant opposing -force of one Newton.

From the definition it can be seen that:

$$P = U \bullet I$$

4.1. AC circuit: active, reactive, and apparent power

In alternating current circuits, energy storage elements such as **inductors and capacitors** may result in periodic reversals of the direction of energy flow

If the load is **purely resistive**, current and voltage reverse their polarity at the same time. At every instant the product of voltage and current is positive or zero, the result being that the direction of energy flow does not reverse.

In the next graphic, the power is all in the positive side. The positive side identify the Active Power, or rather the energy flowing to the load

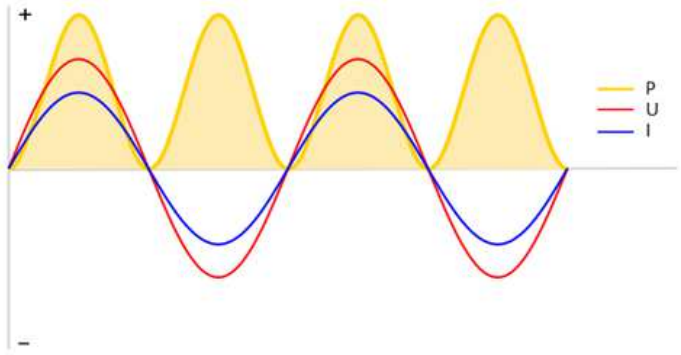


Figure 1.12 AC Power with resistive load

If the load is **reactive** (composed by capacitors or inductors) then the voltage and current are 90 degrees out of phase. For two quarters of each cycle, the product of voltage and current is positive, but for the other two quarters, the product is negative, indicating that on average, exactly as much energy flows into the load as flows back out.

Practical loads have resistance as well as inductance, or capacitance, so both active and reactive powers will flow to normal loads. We can define practical loads as **"partially reactive loads"**

In the next graphic, a part of the power is on the negative side. The negative side identifies the Reactive Power, or rather the energy flowing back from the load. Reactive power does no useful work.

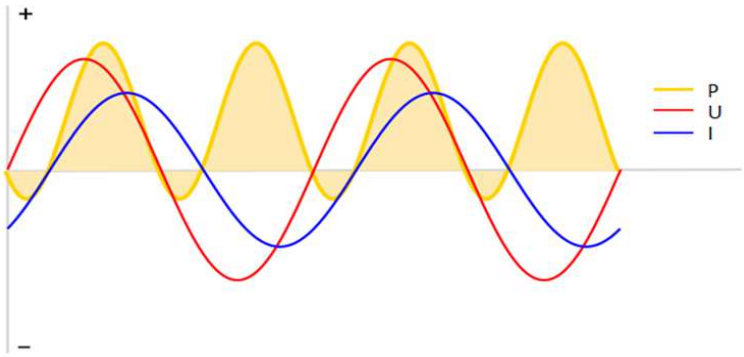


Figure 1.13 AC Power with partially reactive load

The **amount of the power**, that considers the active power and the reactive power, is called **Apparent Power**. In the previous graphics the Apparent Power is the pink part. It's easy to understand that in case of purely resistive load Apparent Power corresponds to the Active Power.

The three elements which make up power in an AC circuit can be represented graphically by the three sides of a right-angled triangle.

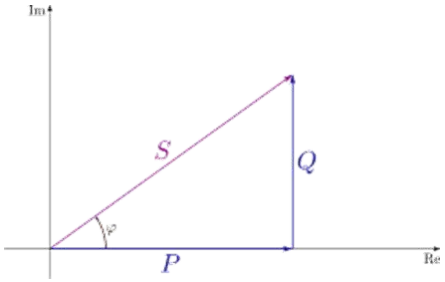


Figure 1.14 Power Triangle

P is Active power or real power

Q is Reactive power

S is Apparent power

φ is the Phase of voltage relative to current: the angle of difference (in degrees) between current and voltage

	P	Q	S
Name	Active Power	Reactive Power	Apparent Power
Units	Watt (W)	var (volt-ampere reactive)	VA (volt-ampere)
Equations related to I and U	$P = U \bullet I \bullet cos\varphi$	$Q = U \bullet I \bullet sin\varphi$	$S = U \bullet I$
Equations related to other powers	$P = \sqrt{S^2 - Q^2}$	$Q = \sqrt{S^2 - P^2}$	$S = \sqrt{Q^2 + P^2}$

Table 1.4 AC Power Summary

5. Frequency

Frequency is the number of occurrences of a repeating event per unit of time.

For cyclical phenomena such as oscillations or waves the term frequency is defined as the number of cycles or vibrations per unit of time.

The conventional symbol for frequency is **F**. The SI unit of frequency is the **Hertz (Hz).**

The **period T** is the **time** taken to complete one cycle of an oscillation. The relation between the frequency and the period is given by the equation:

$$F = \frac{1}{T}$$

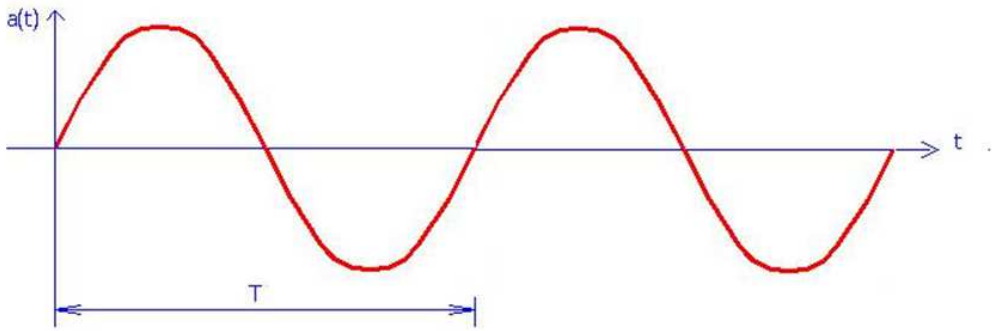


Figure 1.15 Definition of period

In Europe, Africa, Australia, Southern South America, most of Asia, and Russia, the frequency of the alternating current in electrical distribution systems is 50 Hz. In North America and northern South America, the frequency of the alternating current in the electrical distribution system is 60 Hz.

Fundamental laws

Sommario

1. Ohm's law

2. Kirchhoff's current law

3. Kirchhoff's voltage law

4. Equivalent resistance in series

5. Equivalent resistance in parallel

1. Ohm's law

Ohm's Law is a formula used to calculate the **relationship between voltage, current and resistance** in an electrical circuit.

Ohm's Law can be used to validate the static values of circuit components, current levels, voltage supplies, and voltage drops. If, for example, a test instrument detects a higher than normal current measurement, it could mean that resistance has decreased or that voltage has increased.

Ohm's principal discovery was that **the amount of electric current through a metal conductor in a circuit is directly proportional to the voltage applied** . Ohm expressed his discovery in the form of a simple equation, describing how voltage, current, and resistance interrelate:

$$U = R \cdot I$$

$$I = \frac{U}{R}$$

$$R = \frac{U}{I}$$

Example: What is the amount of the current (I) in the circuit?

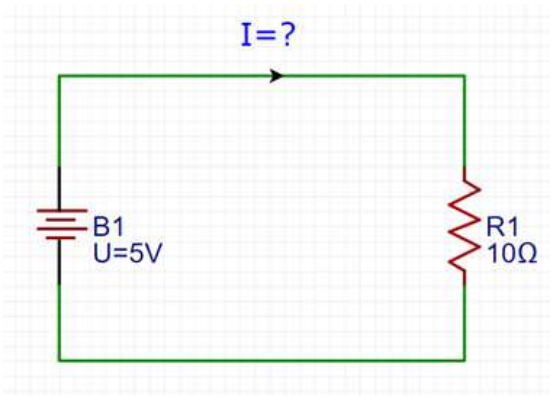


Figure 1.16 Ohm's law example

$$I = \frac{U}{R} = \frac{5V}{10\Omega} = 0.5A \Rightarrow 500mA$$

2. Kirchhoff's current law

To determine the amount of the electrical current flowing around an electrical or electronic circuit, we need to use certain laws or rules that allow us to write down these currents in the form of an equation. The network equations used are those according to **Kirchhoff's laws,** and as we are dealing with circuit currents, we will be looking at Kirchhoff's current law, (KCL).

Kirchhoff's Current Law is one of the fundamental laws used for circuit analysis. His current law states that for a parallel path the total current entering a circuit's junction is exactly equal to the total current leaving the same junction. This is because it has no other place to go as no charge is lost.

In other words **the algebraic sum of ALL the currents entering and leaving a junction must be equal to zero** as:

$$\sum I_{in} = \sum I_{out}$$

Example: What is the amount of the current (I_{tot}) in the circuit?

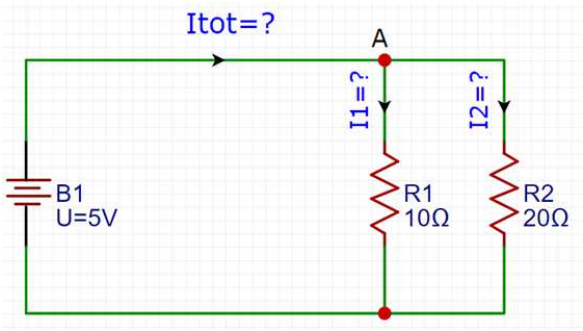


Figure 1.17 KCL Example (theme)

The value of I_1 and I_2 is easily calculated applying the ohm's law:

$$I_1 = \frac{U}{R_1} = \frac{5V}{10\Omega} = 0.5A$$

$$I_2 = \frac{U}{R_2} = \frac{5V}{20\Omega} = 0.25A$$

Considering the circuit node "A", we can consider I_{tot} as entering current and I_1 and I_2 as leaving current.

Applying KCL:

$$I_{tot} = I_1 + I_2 = 0.5A + 0.25A = 0.75A$$

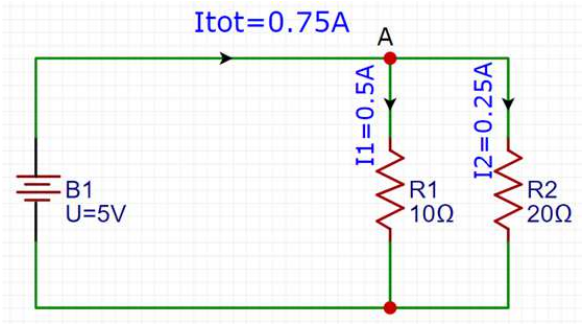


Figure 1.18 KCL Example (solution)

3. Kirchhoff's voltage law

Kirchhoff's Voltage Law (KVL) is the second of his fundamental laws we can use for circuit analysis. His voltage law states that for a closed loop series path the algebraic sum of all the voltages around any closed loop in a circuit is equal to zero. This is because a circuit loop is a closed conducting path so no energy is lost.

In other words, **the algebraic sum of ALL the potential differences around the loop must be equal to zero** as:

$$\sum U = 0$$

Note: here that the term "algebraic sum" means to take into account the polarities and signs of the sources and voltage drops around the loop.

Example: What is the amount of the voltage (U_s) needed to supply the circuit?

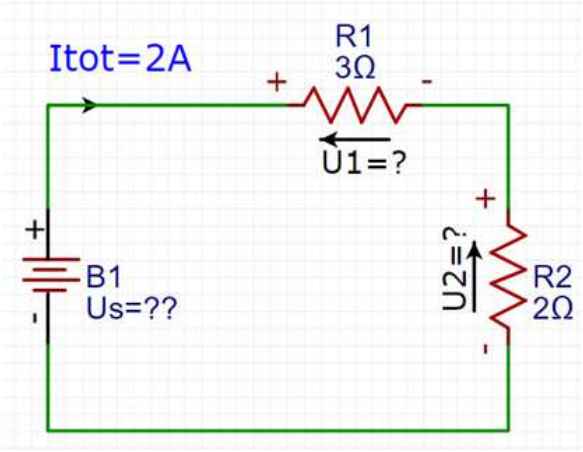


Figure 1.19 KVL Example (theme)

The value of U_1 and U_2 is easily calculated applying the ohm's law:

$$U_1 = R_1 \bullet I_{tot} = 3\Omega \bullet 2A = 6V$$

$$U_2 = R_2 \bullet I_{tot} = 2\Omega \bullet 2A = 4V$$

Considering polarities and applying KVL:

$$U_s + (-U_1) + (-U_2) = 0$$

$$U_s = U_1 + U_2$$

$$U_s = 6V + 4V = 10V$$

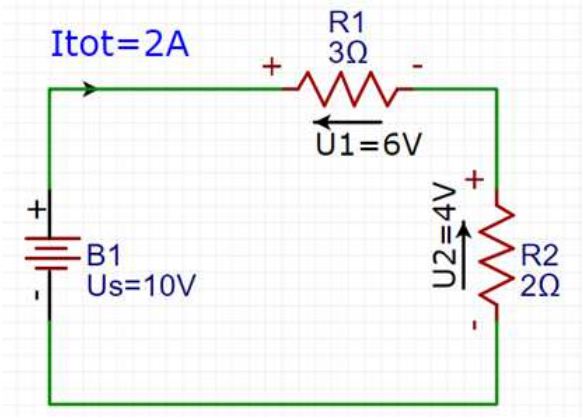


Figure 1.20 KVL Example (solution)

4. Equivalent resistance in series

Most circuits have more than one resistor that limits the flow of charge in the circuit. The simplest combinations of resistors are the **series** and **parallel** connections. The total resistance of a combination of resistors depends on both their individual values and how they are connected.

Resistors are connected in series whenever the current flows through the resistors sequentially. Since there is only one path for the charges to flow through, the current is the same through each resistor. **The equivalent resistance of a set of resistors in a series connection is equal to the algebraic sum of the individual resistances.**

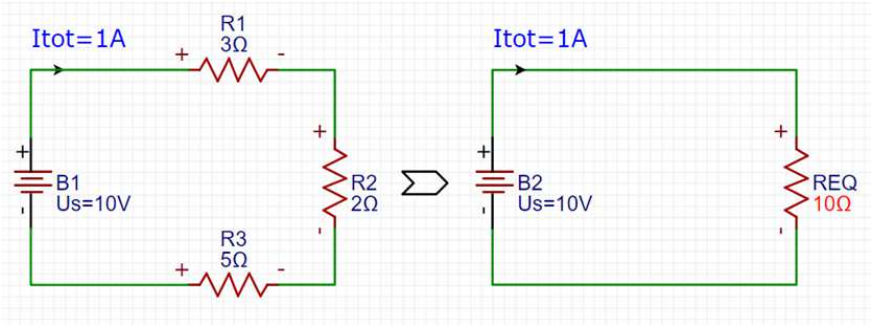


Figure 1.21 Equivalent resistance in series

$$R_{eq} = R_1 + R_2 + R_3 = 3\Omega + 2\Omega + 5\Omega = 10\Omega$$

5. Equivalent resistance in parallel

Resistors are in parallel when each resistor is connected directly to the voltage source by connecting wires having negligible resistance. Each resistor thus has the full voltage of the source applied to it.

The total resistance in a parallel circuit is equal to the sum of the inverse of each individual resistances

This relationship results in a total resistance that is less than the smallest of the individual resistances. When resistors are connected in parallel, more current flows from the source than would flow for any of them individually, so the total resistance is lower.

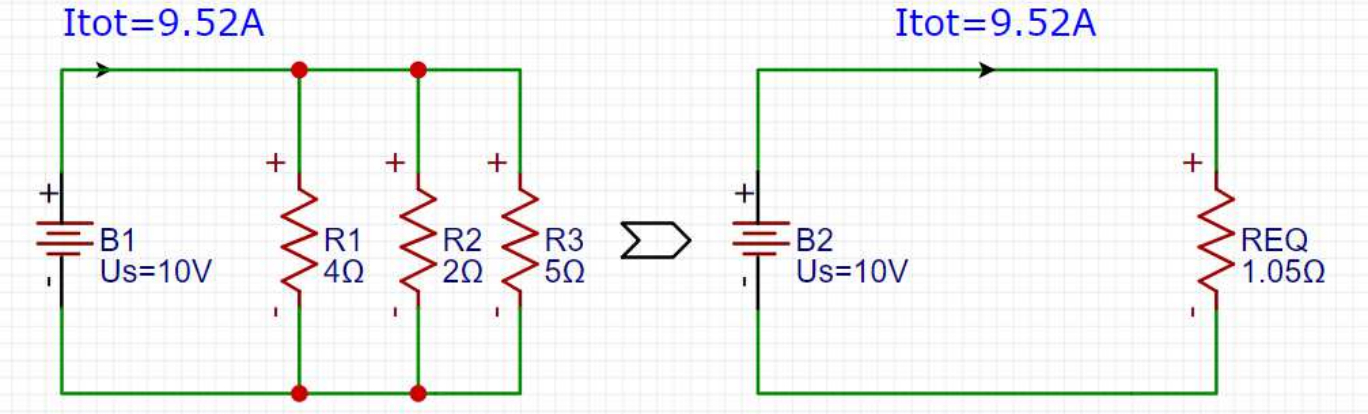


Figure 1.22 Equivalent resistance in parallel

$$R_{eq} = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}} = \frac{1}{\frac{1}{4}\Omega+\frac{1}{2}\Omega+\frac{1}{5}\Omega} = 1.05\Omega$$

Electronic signals

Sommario

1. Electronic signal definition

2. Analog Signal

3. Digital Signal

4. Analog-to-Digital (ADC) and Digital-to-Analog (DAC) Signal Conversion

1. Electronic signal definition

A **signal** is an electromagnetic or electrical current that **carries data from one system or network to another**. In electronics, a signal is often a time-varying voltage that is also an electromagnetic wave carrying information, though it can take on other forms, such as current. There are **two main types of signals** used in electronics: **analog** and **digital signals**.

2. Analog Signal

An **analog signal** is **time varying** and generally **bound to a range** (e.g. +12V to -12V), but there is an infinite number of values within that continuous range. An analog signal uses a given property of the medium to convey the signal's information, such as electricity moving through a wire. In an electrical signal, the voltage, current, or frequency of the signal may be varied to represent the information. Analog signals are often calculated responses to changes in light, sound, temperature, position, pressure, or other physical phenomena.

When plotted on a voltage vs. time graph, an **analog signal** should produce a **smooth** and **continuous** curve.

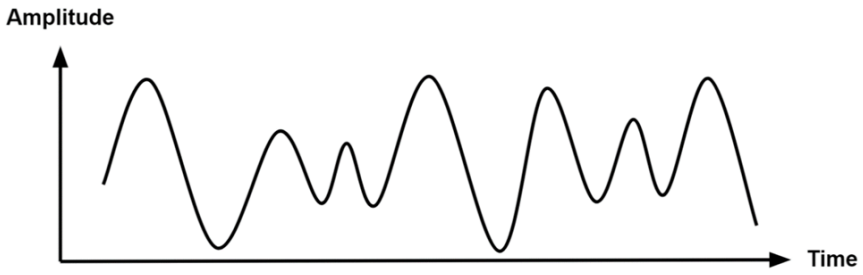


Figure 1.23 Analog Signal

Advantages to using analog signals, including analog signal processing (ASP) and communication systems, include the following:

- Analog signals are easier to process.
- Analog signals best suited for audio and video transmission.
- Analog signals are much higher density, and can present more refined information.
- Analog signals use less bandwidth than digital signals.
- Analog signals provide a more accurate representation of changes in physical phenomena, such as sound, light, temperature, position, or pressure.
- Analog communication systems are less sensitive in terms of electrical tolerance.

3. Digital Signal

A **digital signal** is a signal that represents data as a **sequence of discrete values**. A digital signal can only take on one value from a finite set of possible values at a given time.

Digital signals are used in all digital electronics, including computing equipment and data transmission devices. When plotted on a voltage vs. time graph, **digital signals** are **one of two values**, and are usually between 0V and VCC (usually 3.3V, 5V or 24V)

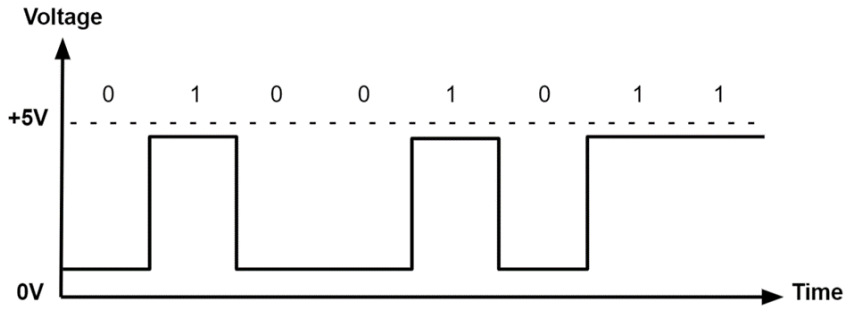


Figure 1.24 Digital Signal

Advantages to using digital signals, including digital signal processing (DSP) and communication systems, include the following:

- Digital signals can convey information with less noise, distortion, and interference.
- Digital circuits can be reproduced easily in mass quantities at comparatively low costs.
- Digital signal processing is more flexible because DSP operations can be altered using digitally programmable systems.
- Digital signal processing is more secure because digital information can be easily encrypted and compressed.
- Digital systems are more accurate, and the probability of error occurrence can be reduced by employing error detection and correction codes.
- Digital signals can be easily stored on any magnetic media or optical media using semiconductor chips.

Digital signals can be transmitted over long distances

4. Analog-to-Digital (ADC) and Digital-to-Analog (DAC) Signal Conversion

Many systems used today are "mixed signal," meaning they rely on both analog and digital subsystems. These solutions require ADCs and DACs to convert information between the two domains.

ADC Operation

The **input** is the **analog signal**, which is processed through a sample-hold (S/H) circuit to create an **approximated digital representation of the signal**. The amplitude no longer has infinite values, and has been "quantized" to discrete values, depending on the resolution of the ADC. An ADC with a higher resolution will have finer step sizes, and will more accurately represent the input analog signal. The last stage of the ADC **encodes** the digitized signal into a **binary stream of bits** that represents the amplitude of the analog signal. The digital output can now be processed in the digital domain.

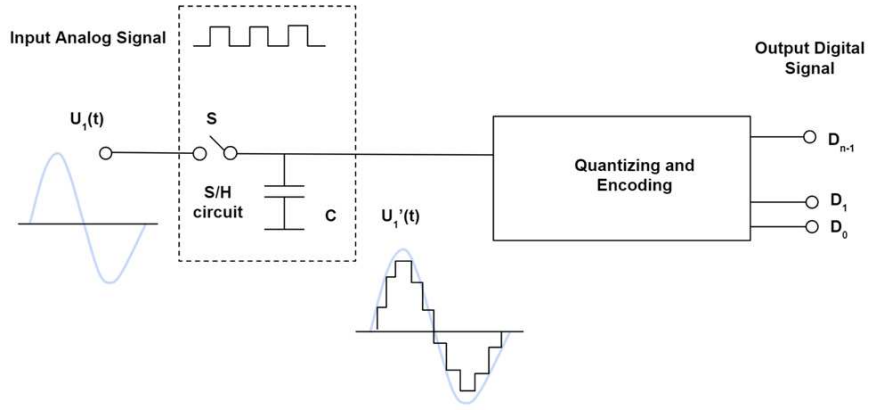


Figure 1.25 ADC sample

DAC Operation

A DAC provides the reverse operation. The DAC **input** is a **binary stream of data** from the digital subsystem, and it **outputs** a **discrete value**, which is **approximated** as an **analog signal.** As the resolution of the DAC increases, the output signal more closely approximates a true smooth and continuous analog signal. There is usually a post filter in the analog signal chain to further smooth out the waveform.

Time	D5	D4	D3	D2	D1	D0
1/Fs	0	1	1	1	1	1
2/Fs	1	0	1	0	1	0
3/Fs	1	1	1	0	0	0
.	.	.	.	.	.	.
.	.	.	.	.	.	.
N-2/Fs	0	1	0	1	0	1
N-1/Fs	0	0	0	1	1	1
N/Fs	1	1	0	1	0	1

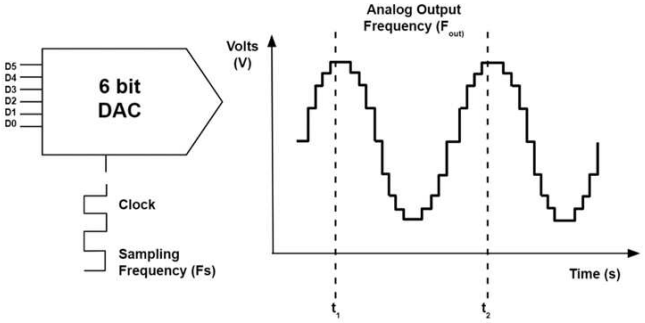


Figure 1.26 DAC sample

Sensors & Actuators

Sito: DTAM Online Training Platform
Corso: Introduction
Libro: Sensors & Actuators

Stampato da: Mirco Ferrera
Data: lunedì, 23 ottobre 2023, 09:56

Sommario

1. The difference between Sensors and Actuators

2. Common sensors and actuators

1. The difference between Sensors and Actuators

Whereas **sensors monitor conditions** of equipment, **actuators drive events** within the equipment. Sensors and actuators are often found in the same areas of equipment and systems within an industrial setting. Although they often interact, they are two different components. They **frequently complement each other** and **work together** to ensure that various assets and systems are functioning effectively. They both play important roles in condition-based maintenance.

A **sensor** monitors **environmental conditions** such as fluid levels, temperatures, vibrations, or voltage. When these environmental conditions change, the sensor send a **signal** to a **control system** or adjust the functioning of a particular piece of equipment. For example, if a motor reaches the temperature point of overheating, it can automatically shut off.

An **actuator**, on the other hand, **causes a work**. It takes an **electrical signal** and combines it with an **energy source** to create **physical work**. An actuator may be pneumatic, hydraulic, electric, thermal, or magnetic. For example, an electrical pulse may drive the functioning of a motor within an asset.

Sensors look at the **inputs** from the environment, which trigger a particular action. On the other hand, **actuators** track **outputs** of systems and machines.

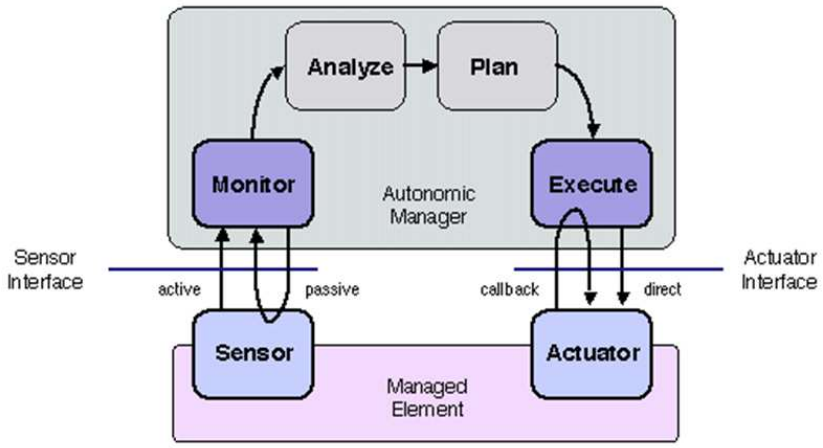


Figure 1.27 Structure of an automatic control

2. Common sensors and actuators

Physical quantity	Sensor	Actuator
Light	Light Dependent Resistor (LDR) Photodiode Photo-transistor Solar Cell	Lights & Lamps LED's & Displays
Temperature	Thermocouple Thermistor Thermostat Resistive Temperature Detectors	Heater Cooler Fan
Force/Pressure	Strain Gauge Pressure Switch Load Cells	Lifts & Jacks Electromagnet Vibration
Position	Potentiometer Encoders Opto-switch Limit switch Proximity switch	Motor Solenoid Pneumatic actuators
Speed	Tacho-generator Encoders	AC and DC Motors Stepper Motor Brake

Table 1.5 Common sensors and actuators

Sensor and actuator could be analogic or digital. **Analogic** types works with a **continuous signal** which is generally proportional to the physical quantity, **digital** types works with a **discrete signal**.

What is a sensor?

Different types of sensors

What is an actuator?

Exercises - Electronic fundamentals

Sommario

1. Resistors connection
1.1. Series connection
1.2. Parallel connection

2. Ohm's law

3. Kirchhoff's current law

4. Kirchhoff's voltage law

1. Resistors connection

What you need:

- A breadboard
- Different value resistors
- A multimeter

1.1. Series connection

Draw a diagram with several resistors connected in series and calculate the value of the total equivalent resistance.

Take the resistors and connect them in series on the breadboard, following your diagram.

Now, with the multimeter measure the amount of the total circuit resistance.

Is it the same as your calculation?

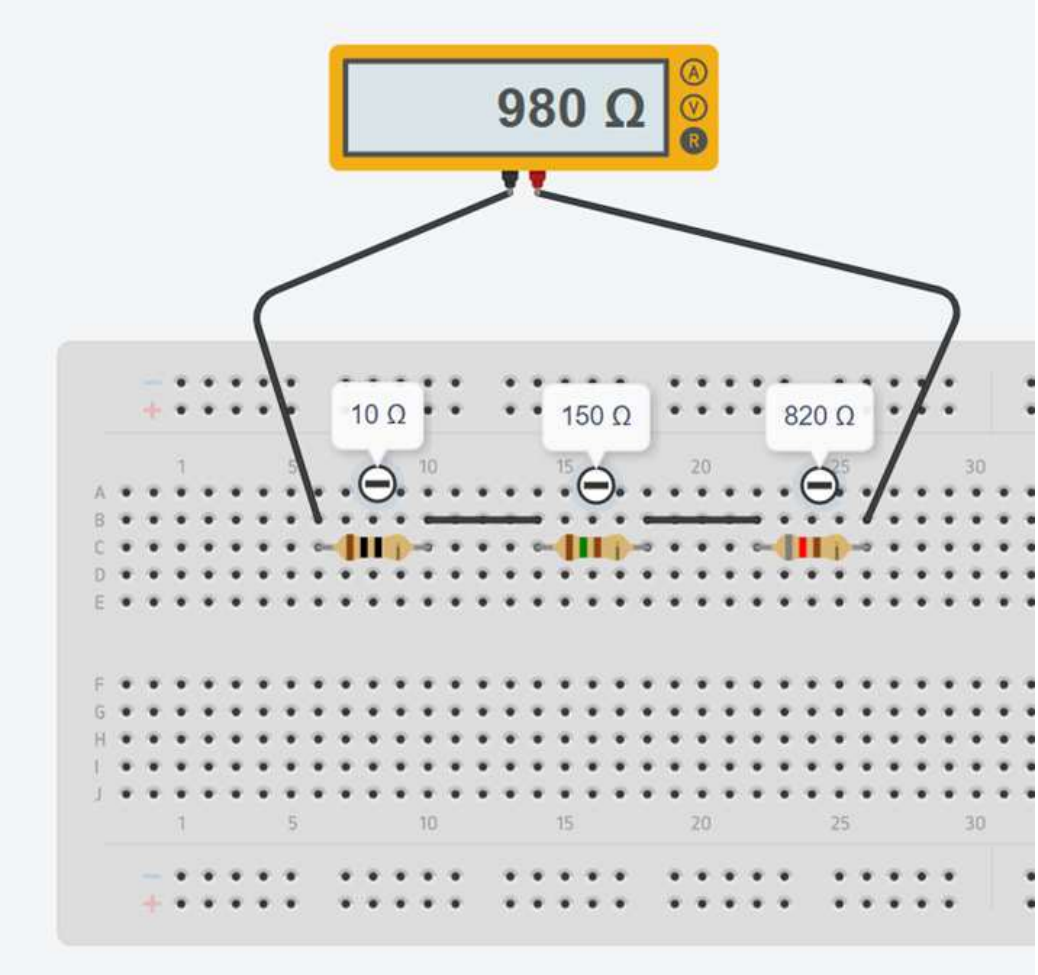


Figure 1.1 Series connection exercise sample

1.2. Parallel connection

Draw a diagram with several resistors connected in parallel and calculate the value of the total equivalent resistance.

Take the resistors and connect them in parallel on the breadboard, following your diagram.

Now, with the multimeter measure the amount of the total circuit resistance.

Is it the same as your calculation?

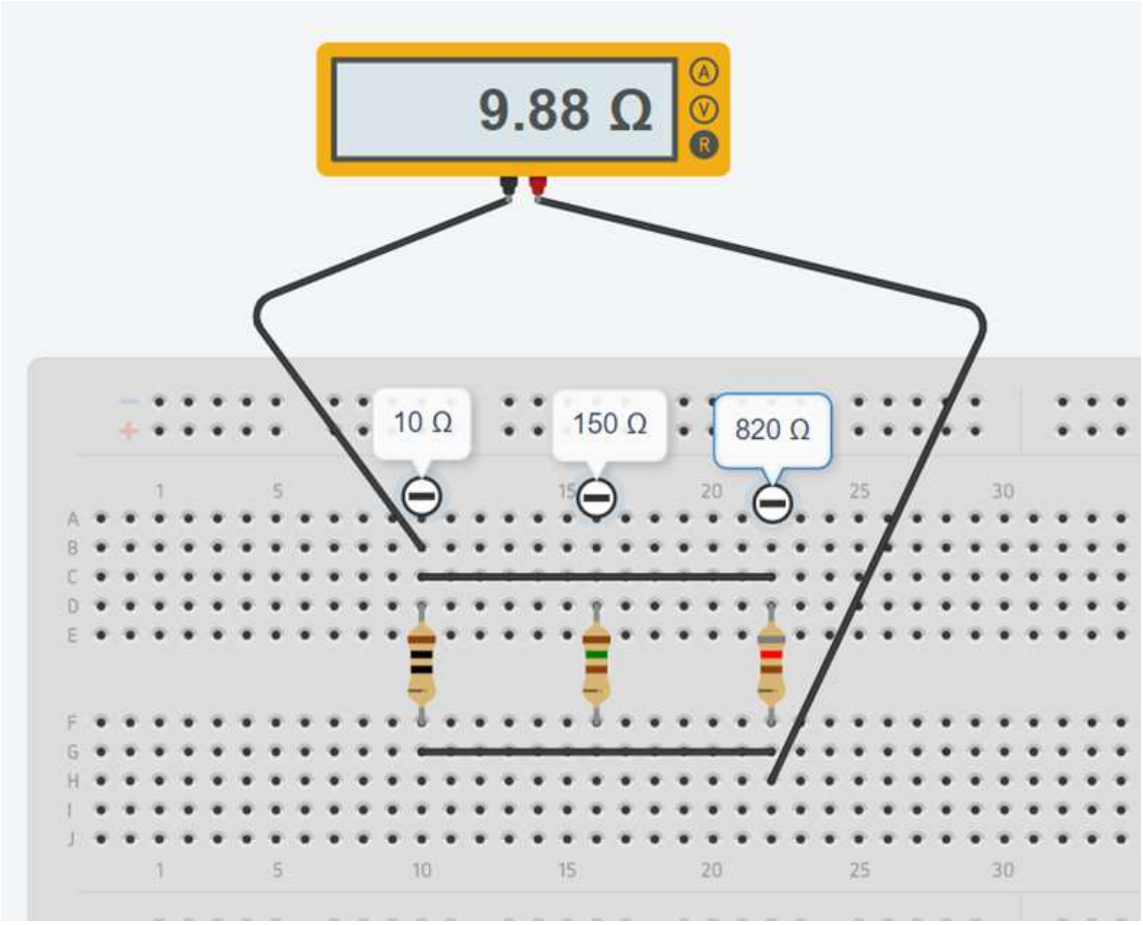


Figure 1.2 Parallel connection exercise sample

2. Ohm's law

What you need:

- A breadboard
- A resistor
- A multimeter
- A DC power supplier

Draw a diagram where a resistor is connected to a power supplier and calculate the circuit current.

Take the resistor and connect it to the power supplier on the breadboard, following your diagram.

Now, with the multimeter measure the amount of the circuit current.

Is it the same as your calculation?

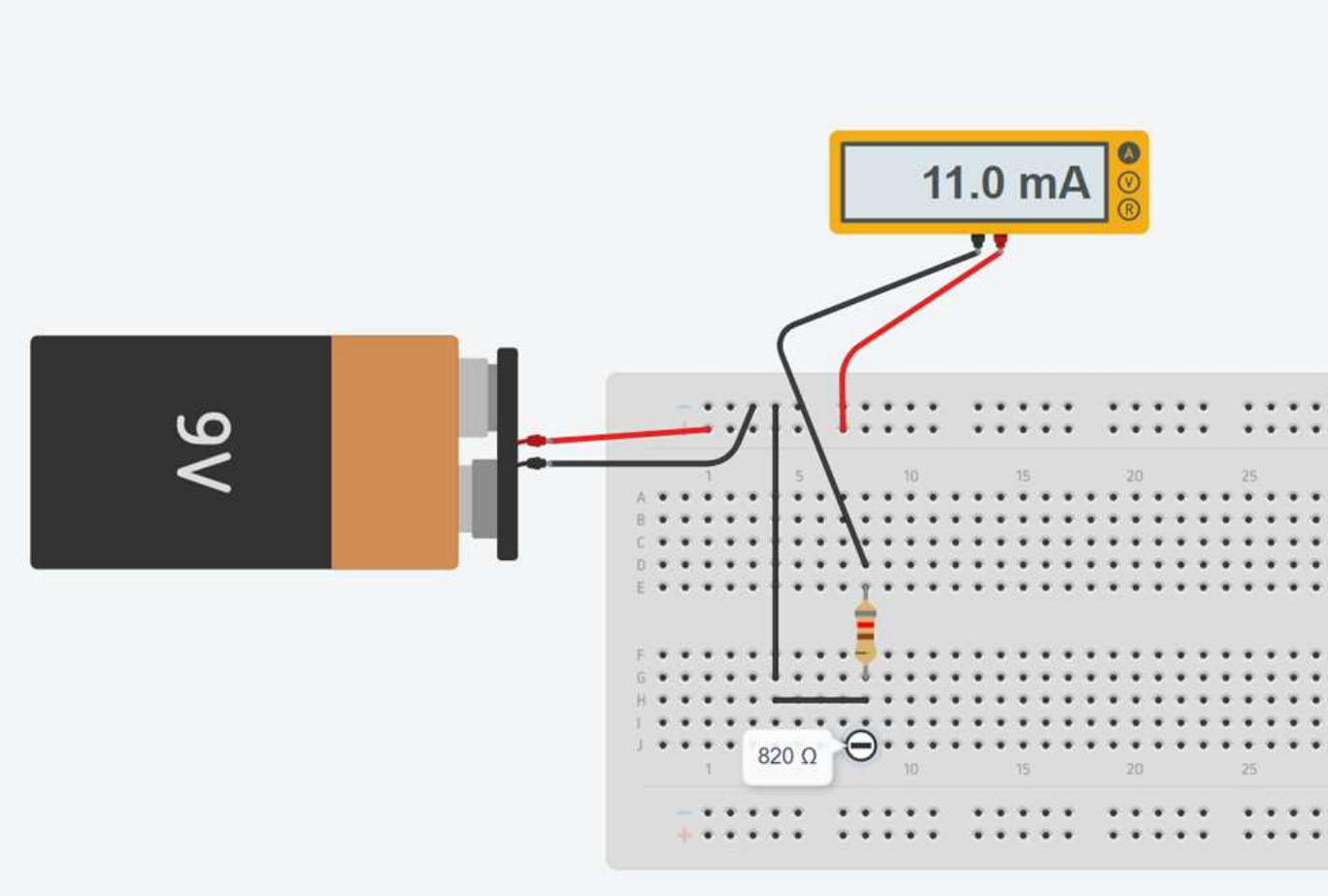


Figure 1.3 Ohm's law exercise sample

3. Kirchhoff's current law

What you need:

- A breadboard
- Different value resistors
- A multimeter
- A DC power supplier

Draw a diagram where several resistors in parallel are connected to a power supplier and calculate the current of each resistor and the total amount of current.

Take the resistors and connect them to the power supplier on the breadboard, following your diagram.

Now, with the multimeter measure the amount of the circuit current and the current of each resistor. Are they the same as your calculation?

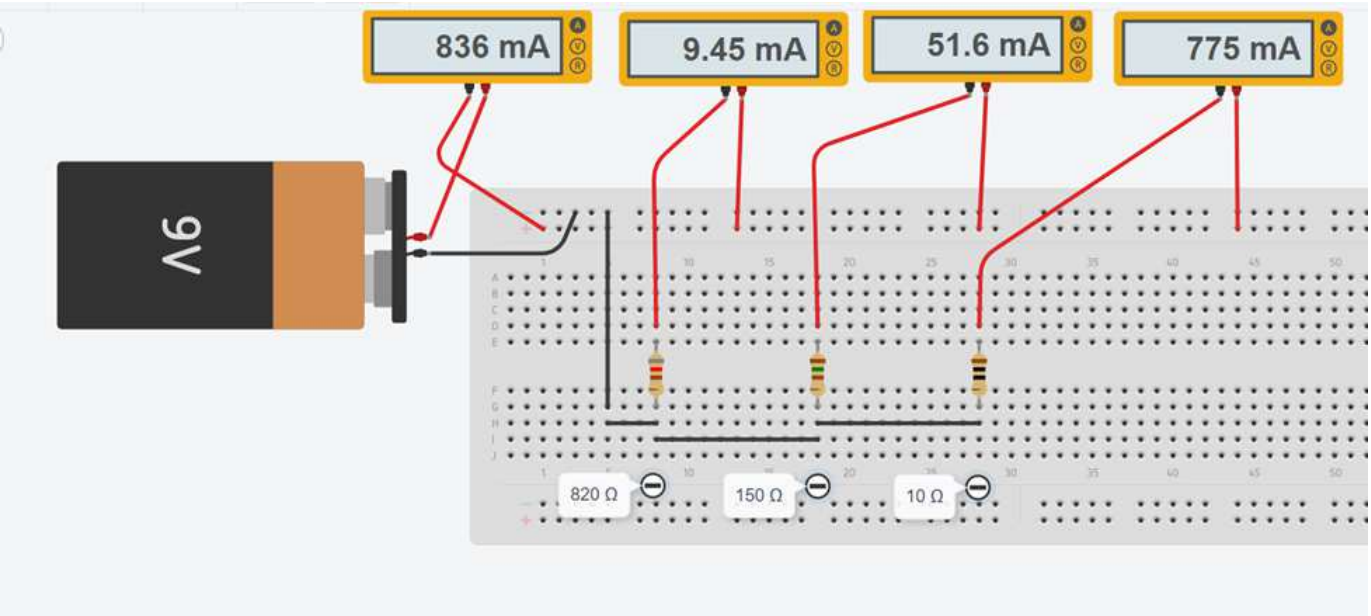


Figure 1.4 KCL exercise sample

4. Kirchhoff's voltage law

What you need:

- A breadboard
- Different value resistors
- A multimeter
- A DC power supplier

Draw a diagram where several resistors in series are connected to a power supplier and calculate the voltage of each resistor and the total amount of current.

Take the resistors and connect them to the power supply on the breadboard, following your diagram.

Now, with the multimeter measure the amount of the circuit current and the voltage of each resistor. Are they the same as your calculation?

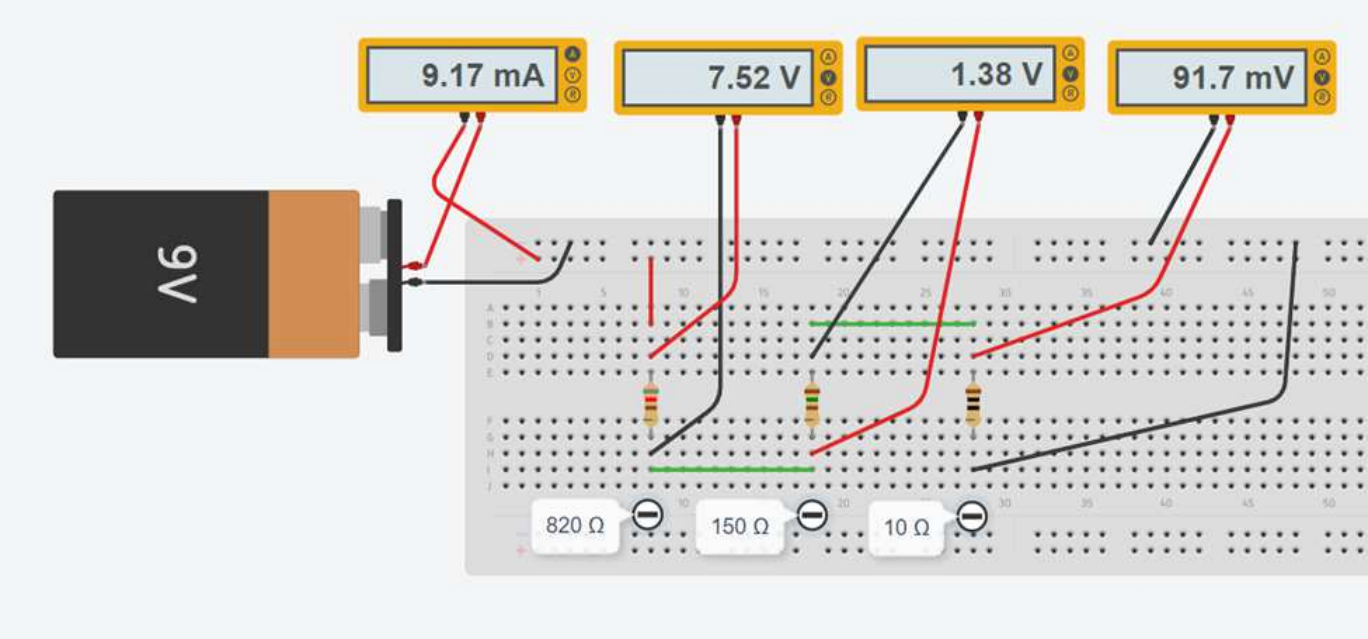


Figure 1.5 KVL exercise sample

Sustainability of development: terminology, circular economy and green economy

Sommario

1. Introduction to the concept of Sustainable Development

2. The economics of things and a sustainable approach to production

3. Circular Economy and Green Economy

4. The 2030 Agenda for Sustainable Development and the Green Deal

1. Introduction to the concept of Sustainable Development

The concept of **Sustainable Development** is the result of a progressive awareness of the importance of the environment for the survival of human beings on our planet.

The origins of this important path can be placed in the first half of the 1970's when, following the increase in the cost of oil, a series of chain reactions were triggered in many economically important countries and led to the rise in price of everything. The resulting financial crisis led everyone to reflect on the close relationship between the economic system and the limited resources of our planet. Other worrying data came to light such as the exponential growth of the world population over time and with it also of the industrialization, pollution, food production and resources consumption. As a direct result, a complex international research for an economic model, capable of guaranteeing the planet's resources in the future, started in the 1980's.

The term "**Sustainability**" was created in the scientific and economic world community. Many people tried to give a precise definition and confine the thematic areas of influence for this new way of conceiving development. The definition, still valid today, contained in the **Brundtland Report**, drawn up in 1987 by the World Commission on the Environment, which takes its name from the former Norwegian Prime Minister **Gro Harlem Brundtland**, who chaired the session:

"Sustainable Development means development that meets the needs of the present without compromising the ability of future generations to meet their own."

Figure 1.1 Gro Harlem Brundtland

From this definition it is clear that the concept of Sustainable Development involves three different areas:

*1) **Economy**: to be sustainable must guarantee a job and an income for the entire world population.*

*2) **Society**: development is sustainable if it guarantees democracy, health, education, justice and security, without any discrimination.*

*3) **Environment**: Environmental resources must be protected and should be understood as an asset of all present and future form of life. The quality and sustainability of resources, for future generations, must therefore protected.*

Human development is defined as sustainable if meets economic, social and environmental requirements.

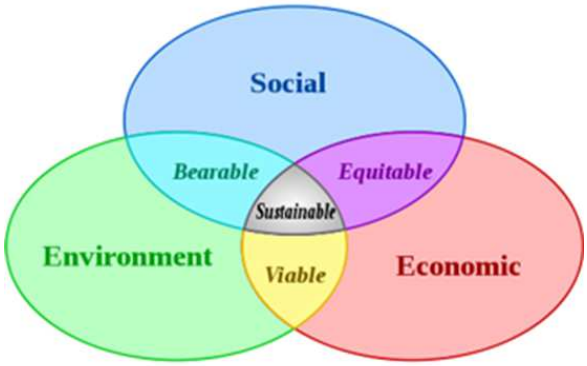


Figure 1.2 The three sectors in which sustainable development is defined

2. The economics of things and a sustainable approach to production

We live in a world where everything is connected, subjected to an economic system based on consumerism. To buy things is the basis of the economy and producing everyday objects is fundamental to maintain our "lifestyle". To keep the system sustainable, first of all, we must know how the object-related economy works.

To produce everything, we must always operate through five fundamental phases: **EXTRACTION OF RAW MATERIALS, PRODUCTION, DISTRIBUTION, USE, WASTE DISPOSAL.**

Figure 1.3 The five phases of the economy of things

The economic system that governs our life provides for a direct linear passage, with a beginning and an end. The five above-mentioned phases lead to the production of an increasing quantity of waste at the expense of a continuous decrease in raw materials. These actions trigger an infinite series of chain mechanisms that prompt to a progressive **increase in prices, pollution, social and economic discriminations**. This system can only work if the resources are infinite, but, even if the amount of them are very large, our Earth is limited in the mass and, consequently, only limited resources are available.

To be sustainable, it is necessary to change the economic system from linear to cyclical. In this new perspective, for example, **waste**, which has always been considered a problem to solve, can be re-evaluated and transformed into new resources as raw materials.

In every single phase of the "economy of things", we can also introduce ways of optimize processes that make it possible to reduce the impact on the environment and production waste. **Technology,** and above all technological innovation represents a key element to make all human activities increasingly sustainable.

Figure 1.4 Sustainability as a goal

Transportation and energy production systems are other important aspects of the economy of things. Transportation is a vital process with a great environmental impact and it is the link of the transition from one phase to another of the production processes. Just think of the fact that the raw materials, in most cases, are extracted in places usually very distant from the areas of production. For each phase we also need large amounts of energy which is unfortunately still produced by exploiting resources with a high impact on the environment. The production of energy is a strong source of environmental impact. Over 90% of the world's energy is still produced by fossil fuels. Promote and encourage the use of **renewable sources** represents a fundamental path for sustainability.

Figure 1.5 Renewable sources for energy production

3. Circular Economy and Green Economy

A central aspect of sustainable development is its **cross curricular**. In the day-to-day life, in every production process and, in general, in any context we operate, we increasingly find references to sustainability. Sustainability has become a way of thinking that has slowly introduced itself into our life by changing our ways of seeing and, above all, of doing things: a new life style.

There are three important aspects that have made possible introduce sustainability especially in the economy process:

1) Consumers have become much more sensitive to environmental issues and have begun to choose more and more sustainable products and ways of life.

2) The production processes and the products have become increasingly sustainable to cope with the market requests from the new costumers. Corporate sustainability communication becomes important to attract new consumers.

3) By promoting sustainable methods, we realize that production is optimized, the cost production decreases and the profit grows.

In this context, technology represents an important and innovative development sector for sustainability, therefore new terms are born that express specific contexts. First of all, the **Circular Economy** and **Green Economy**. Let's see what these two concepts specify.

The **Circular Economy** is a production and consumption model that involves sharing, lending, reusing, repairing, reconditioning and recycling existing materials and products for as long as possible. This extends the life cycle of products, helping to reduce waste to a minimum. Once the product has finished its function, the materials that it is made of are reintroduced into the economic cycle. The materials can be continuously reused within the production cycle, generating additional value. The principles of the circular economy contrast with the traditional linear economic model, based instead on the typical "extract, produce, use and throw" scheme. The traditional economic model depends on the availability of large quantities of materials and energy that are readily available and at low prices.

Figure 1.6 The fundamental points of the Circular Economy

Thanks to measures such as waste prevention, eco-design and reuse of materials, the circular economy within companies brings savings and reduces the total annual greenhouse gases emission amount. The transition to a more circular economy can also lead to numerous other advantages: reduction of burden on the environment, greater security regarding the availability of raw materials, increase competitiveness, impulse to innovation and economic growth and furthermore the increase of employment. With the circular economy, consumers will also be able to have more durable and innovative products capable of saving money and improving the quality of life.

The concept of the circular economy should not be confused with the more recent concept of the Green Economy.

The **Green Economy** is a much wider and more complex economic model that introduces sustainability on all the fundamental stages of production. It takes into consideration energy, the optimization of transportation and above all people lives. Green economy provides the reduction of the impact on the environment such as essential factor of development. It is therefore a type of economy that takes into account the environmental aspect with earnings and profits.

The European Commission specify that Green Economy can be understood as "*An economy that generates growth, creates jobs and eradicates poverty by investing and safeguarding the resources of natural capital on which the survival of our planet depends*".

Figure 1.7 Green Economy and sustainable economic growth

The Green Economy aims to create jobs in the context of so-called **green jobs**. The fundamental tools of the green economy are: increased energy efficiency and production, use of resources and renewable energy, abatement of greenhouse gas emissions, reduction of local and global pollution, recycling of domestic and industrial waste.

4. The 2030 Agenda for Sustainable Development and the Green Deal

Sustainable development is a current topic also in both international and European agreements. We can mention among these the 2030 Agenda for Sustainable Development and the European Green Deal.

The **2030 Agenda for Sustainable Development** is a set of guidelines and actions signed in September 2015 by the governments of 193 member countries of the UN (United Nations). It is a reference framework for reorienting humanity towards sustainable development through 17 goals, the Sustainable Development Goals (SDGs). The goals are divided into 169 targets or milestones in a large program of action. The official introduction of the objectives took place at the beginning of 2016 and the UN member countries, have committed to reach them by 2030. The 2030 Agenda is based on five key concepts defined as the 5 P's of the 2030 Agenda:

Figure 1.8 The 5 P's of Agenda 2030

1) **People**: eliminate hunger and poverty in all forms, guarantee dignity and equality.

2) **Prosperity**: ensuring prosperous and full lives in harmony with nature.

3) **Peace**: promote peaceful, just and inclusive societies.

4) **Partnership**: implement the Agenda through solid partnerships.

5) **Planet**: protect the planet's natural resources and climate for future generations.

In the Figure 1.9 you can find the 17 goals of Agenda 2030.

Figure 1.9 The 17 Goals of the Agenda 2030

The 2030 Agenda brings with it a great novelty: for the first time a clear judgment is expressed on the unsustainability of the current development model, not only on the environmental level, but also on the economic and social one. It is therefore definitively overcoming the idea that sustainability is not only an environmental issue, affirming an integrated vision of the three different dimensions of development.

The **European Green Deal** is a "strategic plan" that provides for the adoption of various measures of different nature, to be implemented through laws, decrees and investments, in order to contrast the current **global warming** and **climate change**.

Climate change is closely related to the production of carbon dioxide (CO_2) released into the atmosphere made up human activity such as industry, trade and agriculture. As you can see from the Figure. 1.10, the rise in the average temperatures of the planet it is closely linked to the increase in the concentration of CO_2 in the atmosphere connected to anthropogenic activities.

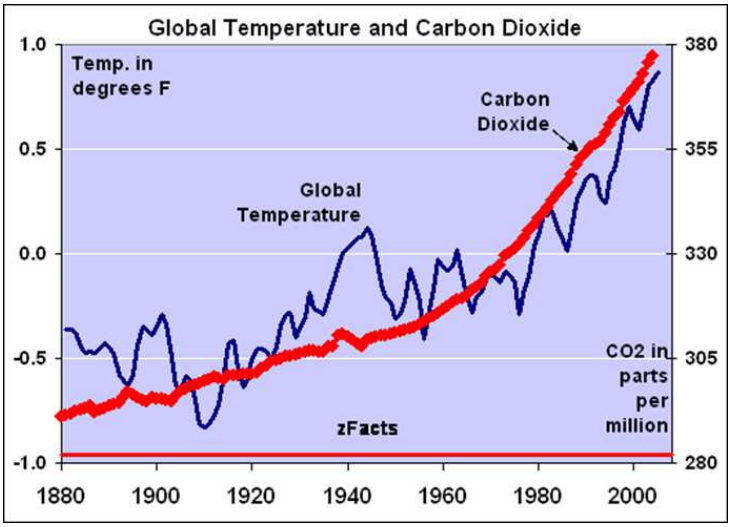


Figure 1.10 Correlation between average Temperatures of the Earth and CO_2 concentration in the atmosphere

European Green Deal is a very ambitious project, promoted and carried out with commitment by the **European Commission** led by **Ursula Von Der Leyen**, which aims to transform the European Union into a "*just and prosperous society, with a modern market economy and where gas emissions they will be eliminated, and growth will be decoupled from the use of natural resources*".

All the funding, that will be allocated by the European Community, will be aimed to achieve the following objective by 2050: **climate neutrality by 2050**. For that year it means that Europe will have to gain energy independence from fossil fuels; promote and invest in green mobility - introducing forms of private and public transportation cleaner, cheaper and healthier- and in the renovation of buildings; helping people to reduce their bills energy and use of it; support industrial innovation and become world leaders in the green economy.

Figure 1.11 Ursula Von Der Leyen explain European Green Deal at European Commission

In relation to the Green Deal, the whole of Europe is in a **period of transition** in which weaknesses are being analyzed and new strategies are being developed to achieve the objectives.

The technological sector and research will be strongly encouraged by these two agreements.

Conscious use of resources in technology sector: raw materials, waste and energy

Sommario

1. Technology and Sustainability

2. Raw materials

3. Sustainable waste management

4. Energy

1. Technology and Sustainability

Technology certainly represents an important sector closely linked to sustainability. Technological choices have played a central role in giving rise to a series of problems that we are facing every day. At the same time, however, the same technology can help to solve many problems and direct our economy and our society towards sustainable development. Technological innovation brings year after year a progressive reduction in energy consumption, the optimization of raw materials, their transformation into resources and the possibility of real-time monitoring of consumption. Technological innovation therefore represents a fundamental tool for taking concrete actions. A clear example of this is the importance given to renewable energy sources, robotics and energy efficiency.

2. Raw materials

The **raw materials** to produce tools, equipment and goods related to the technology sector certainly represent the first issue to act upon. To find raw materials we must know how to choose, those that satisfy our needs, in the most sustainable way. In that case we have to move differently and distinguish between primary and secondary raw materials. **Primary raw materials** are those directly connected to the planet's resources such as wood, oil and derivatives, coal, metals and minerals. We need to extract and make them usable. **Secondary raw materials** are those that can be obtained from waste in a circular economy perspective.

For primary raw materials there are many points that must be taken into consideration if we want to be sustainable:

1) **The impact on the planet of the methods of extraction**: many of the materials related to the technology sector, for example conductors and semiconductors, such as copper and rare earths, lithium for batteries, and plastic connected to all the insulating elements, have a very high environmental impact. Natural ecosystems are devastated to create increasing large quarries in the ground, trees and forests are destroyed. The machinery used for drilling and transport pollutes and disturbs the delicate natural balance. Furthermore, many of the raw materials extracted are highly toxic. Think about oil! In many cases, moreover, to get to the raw material in purity, high polluting substances are used both ground and water tables.

Figure 1.12 An example of mine in rocks

2) **The social impact**: behind many extractive activities, especially in developing countries, very often there is human and especially child exploitation. An example that fits with the technology sector is that of Coltan mines, a fundamental mineral needed for our smartphones. In Africa, on the border between Congo and Rwanda the occupation of the mining areas is also a source of political instability and guerrilla warfare.

Figure 1.13 Child exploitation in coltan mines in Congo

3) **Impact linked to the transformation of natural resources into raw materials:** In order to obtain the raw materials very often we have to carry out processes that allow them to be extracted. These processes take place with the consumption of energy, the use and release of polluting chemicals. It is therefore important to know how to choose the production processes underlying the raw materials and evaluate process certifications that confirm their sustainability.

4) **Distances and transportation:** Another important factor to consider for the sustainability of raw materials is the distance from mining to transformation. It is necessary to choose raw materials extracted in one's own national territory or to choose minimum distances. The vehicle type chosen for transport obviously have a different environmental impact and this must also be taken into consideration when choosing the suppliers of our raw materials.

Figure 1.14 An example of highly impactful transport: cargo ships

Choosing **secondary raw materials** for our production processes, we have already begun to walk a path towards sustainability. It is important to remember that very often, as in this case, sustainable choices are the most economically advantageous one. All secondary raw materials are produced by selecting waste collection in the recycling chain. In every production sector it is essential to make choices that lead to the reduction or total elimination of unsorted waste. A typical example of a raw material now obtained exclusively through sustainable waste management is Aluminum

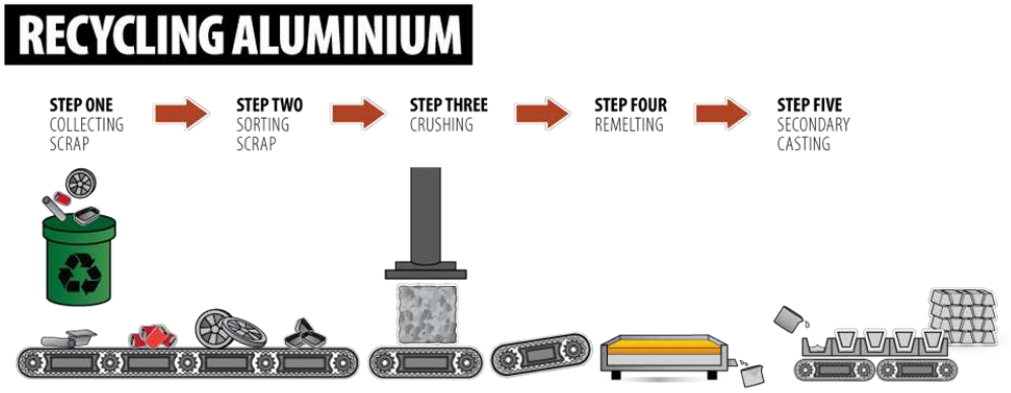


Figure 1.15: The process of obtaining aluminum as a secondary raw material

3. Sustainable waste management

Waste is another key element on which we have to act to be sustainable, both in our daily life and in all production sectors including the technological one. The accumulation of waste, or its wrong management, modifies our entire planet by promoting cause-and-effect reactions that are beyond our ability to control. **Water and atmosphere pollution create loss of biodiversity** and **climate change**. They are some of the consequences of waste accumulation. Directly or indirectly, everything we disperse in the environment return to us as a threat.

A very current example is plastic pollution in marine and coastal ecosystems. **Landfills**, considered as a last resort in waste management, can contaminate soil and water and release methane, a very powerful greenhouse gas linked to climate change. Illegal activities, such as illegal dumping, burning or leakage of oil piping, also play a role, but it is difficult to estimate the true extent of these activities or their impacts. Finally, waste also represents an economic loss. In some areas of the World many people are living next to mountains made of garbage accumulated year after year.

The management of this problem can be summarized by the famous rule introduced in the eighties with the name of "Rule of the 4 R's", so defined as the four keywords that summarize the mode of action. They begin with the letter R. Furthermore, the four practices follow each other in order from that more important to the less one:

REDUCE - REUSE - RECYCLING - RECOVERY (of energy)

1) **REDUCE**: If the problem is waste, the first thing to do is to **act in order to prevent the problem**, **reducing its production**. In the manufacturing sector, using technology, we can:

- Minimize the waste of raw materials in the production cycle.

- Design production cycles that avoid or reduce the generic waste to a minimum

- In packaging, reducing the amount of materials used as much as possible, preferring mono-material or a packaging design that helps to differentiate raw materials. Currently waste is made up of more than 60% of packaging.

Figure 1.16 Packaging design is important for managing waste in a sustainable way

- Promote the use of increasingly innovative equipment, reducing processing times and energy consumption. Technological innovation is therefore important.

- Consider repairing equipment, devices and tools before replacing them with new ones, avoiding the creation of bulky and unnecessary waste.

- Introduce equipment capable of reducing the space created by waste: hydraulic presses, shredders or specific equipment can be very useful.

2) **REUSE**: before considering some objects as a waste, evaluate the possibility **of using them again for the same or for different purposes**, extending their life as much as possible. According to the principle
of reuse, it is necessary to give space to: repair, design tools and technological equipment in a modular way.

Another way to extend the life cycle of technological equipment is **refurbishing**. With this term we indicate the use of obsolete equipment, that it has been updated or converted to carry out different purposes. An example is given by company computers that have become slow for the task assigned, yet still useable for school purposes. In this way, the social sustainability of companies in the area is also enhanced.

Figure 1.17 Example of bins for the separate collection of waste

3) **RECYCLING**: If we can no longer reuse an object, we can **reuse the raw material that it is made of to produce new things**. Recycling means giving new life to raw materials. In order to be able to recycle, it is, first, necessary to carry out a **separate collection of waste**. That is a division of the waste according to the raw materials of which they are composed. Each city and in every manufacturing area has specific modalities and bin containers of different colors for each material. In general paper, metals, plastic and glass are everywhere collect separated. As we have already said, aluminum that we use now comes from 100% recycled process. Today it is cheaper to procure this raw material from waste than to extract it from the minerals in which it is contained. In this way the impact on natural resources is reduced.

Recycled plastic is often used to produce synthetic textile fibers from which technical winter sports clothing is made. Paper is another classic example where recycling adds a value to waste by producing new paper without cutting down trees. (Another way to produce paper in a sustainable manner it is also linked to the **Forest Stewardship Council** (**FSC brand)** to produce paper. Cellulose is obtained from trees from sustainably managed forests, by planting trees instead of those harvested

Figure 1.18 The FSC brand

Technological products are a huge source of raw materials that are difficult to find on our planet and with increasingly higher prices. Over 60 elements of the periodic table are identifiable in materials and components used in electronics. Despite the fact, that most of their weight is made out of metal and plastic, the materials used in electronics can be grouped into four large categories:

- **Metals**: steel and iron are the main metals and account for about 50% of total weight. Other common materials are aluminum and copper, used for their high conductivity and malleability. Others metals that can be extracted in small doses are nickel, chromium, lead, silver, gold or tin.

- Rare earths: rare earths (REEs) are a group of 17 elements of the periodic table that are used in small or very small amount; nevertheless, they result vital for numerous high-tech applications.

- Plastics and petroleum derivatives: plastic materials represent the second major group of materials used for the realization of electronic products and make up about 20% of the waste. They find their use for the characteristics insulation and resistance to high temperatures.

- Minerals and non-metallic materials: Some semi-metals find also used in the manufacturing of electronic products. Silicon and its derivate represent main materials used for the creation of microchips and semiconductors. Other materials non-metallic or semi-metallic are antimony, bismuth, cobalt, fluorite, garnet, magnesium and talc are used for other components.

The growing interest in technological waste has led to the birth of the term **e-waste.** It indicates that all type of technological waste it is considered more and more important for obtaining raw materials that are increasingly difficult to find in nature.

To act in a sustainable way, we have to promote separate collection of technological products and network with company partners who deal with the recovery of raw materials from electronic waste.

Figure 1.19 E-waste, the new resource for raw materials with high commercial value

4) **RECOVERY** (of Energy): if we cannot reuse or recycle waste, as an alternative to landfill it is to **use it to produce electricity.** Waste, especially undifferentiated ones, is an excellent fuel and it is suitable in waste-to-energy plants. In this case energy recovery leads to the formation of toxic and highly polluting solid and gaseous substances that must be disposed of properly before being released into the environment. However, technological innovation is also optimizing these processes by reducing, year after year, the polluting waste produced by this process.

In many manufacturing sectors, where thermal energy is produced, technological innovation allows the introduction of small plants for the production of electricity or cogeneration of electricity-heat for heating systems.

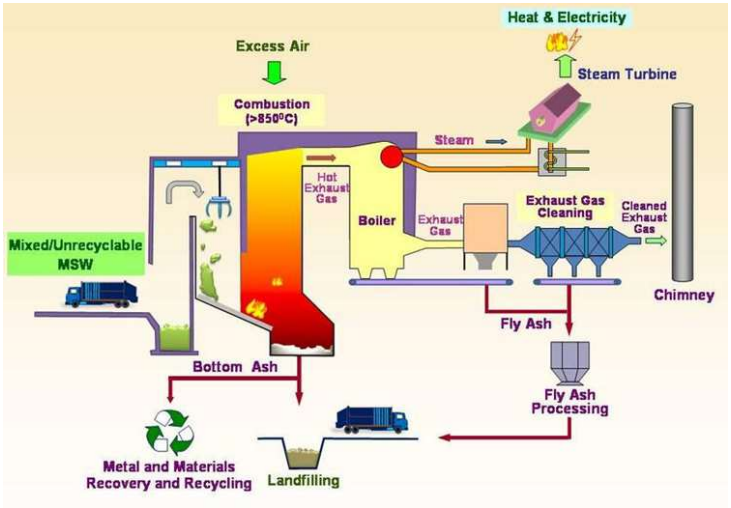


Figure 1.20 Operation diagram of a waste power plant

4. Energy

Another great challenge for sustainability is to reduce our dependence on fossil fuels. In particular, we need to make significant changes on **energy production** and **optimization of energy consumption**.

World energy production is directly linked to fossil fuels. Although we know that these types of resources will run out shortly, more than 75% of the world's energy is still obtained through the combustion of coal, oil derivatives and natural gas. The technology sector will be increasingly important in finding and developing new ways of producing energy from a sustainable perspective.

Promoting the production of energy from renewable sources represent an important starting point on which mankind has to be working on. **Renewable sources of energy are any natural resource that can replace itself quickly and dependably**. They are abundant, sustainable, and environmentally friendly. These sources are:

-Sunlight: the solar photon flux can be converted to heat, electricity or chemical energy;

-Wind: the motion of air molecules can be harvested in wind turbines that create electric power through generators installed in windmills;

-Biomass: organic materials can be used for cooking and heating, as well as to produce electricity and liquid transportable fuels;

-Earth's internal heat: can be used for heating and electricity production;

-Water: the potential and kinetic energy of flowing water can be tapped to produce electricity or mechanical tasks.

Figure 1.21 Renewable energy sources

We define **renewable or green** the energy produced using these kind of resources. For the production of large quantities of energy, we can mention mirror solar power, wind power, geothermal power, tidal power plants. All these types of control units are undergoing a progressive transformation that makes them more efficient thanks to the application of industry 4.0 and Internet Of Things (IOT), through remote sensors and home automation.

Next to large plants, **small-scale electricity systems** are becoming more and more widespread in homes, public buildings and workplaces. Micro-wind and photovoltaic panels are a classic example.

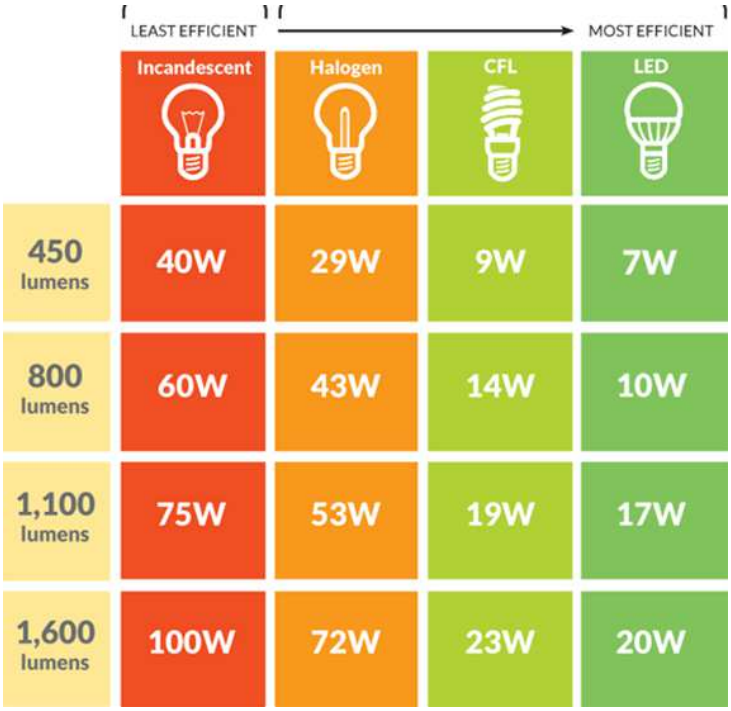


Figure 1.22 Savings in electricity consumption linked to the technological innovation of light bulbs

The discovery and development of **energy accumulators** it has also made possible unimaginable things compared to twenty years ago.

Renewable energy is important for many different reasons: it reduces global warming, air and water pollution; there is an increase of jobs involved in harnessing renewable energy; the industry creates more employment opportunities and other economic benefits.

Another possibility to reduce the energy-related impact is to act by **decreasing energy consumption**. To do this, all of us must be willing to change our habits at home and at work. In this case, we have an excellent ally in technology. Thanks to technology we invent machines that are increasingly complex but above all more efficient. For example, think about the energy savings linked to the introduction of Light Emitting Diode (LED) light bulbs instead of incandescent bulbs, or how much more thermally insulated are our homes than in the past thanks to new generation windows or insulating panels.

Life Cycle Assessment (LCA)

Sommario

1. What is Life Cycle Assessment (LCA)

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1. What is Life Cycle Assessment (LCA)

Every human action determines on one hand an extraction/acquisition of resources from the environment and, on the other, the release of emissions (chemical and/or physical agents, such as substances, noise pollution, etc.). Both extractions and emissions are forms of environmental impact. **Life Cycle Assessment - LCA (translated as "Life Cycle Analysis")** is a methodology that allows us to evaluate, quantify and interpret the relationships between human actions and the environment, and the consequent forms of impact on it. It can be used in all sectors of production, including technology.

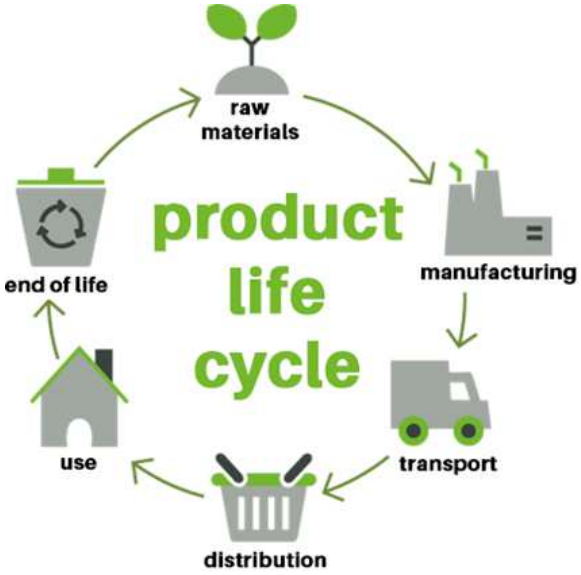

Figure 1.23 Production cycle of things

The LCA is used to measure the environmental performance of a product or service throughout its life cycle, considering in a model all the activities of the supply chain: starting from pre-production (including extraction of raw materials from the earth and manufacturing of materials), passing through production, distribution, use (including maintenance), eventual reuse or recycling, up to disposal or final disposal.

Based on a multi-criteria approach (i.e. different categories of environmental impact: CO_2, energy, water, etc.) LCA is a method to support the calculations of environmental footprints, such as the **Carbon Footprint** (assessment of potential environmental impacts on climate change) and the **Water Footprint** (assessment of potential environmental impacts related to water, in quantitative and qualitative terms).

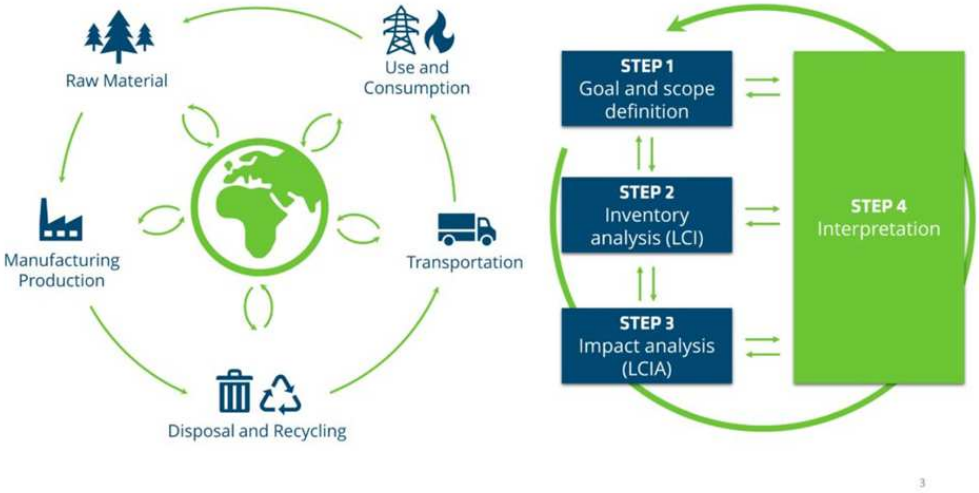

Figure 1.24 The main steps of LCA

The LCA has four main phases:

1) **Definition of objectives and field of application**: in this preliminary moment for the objectives and the purposes of the study are defined: the functional unit (kg, litres; or in the case of transport, passenger / km, etc.), the boundaries of the system, the data requirements, the assumptions and limits of the system.

2) **Inventory analysis**: consists of data collection and calculation procedures aimed at quantifying all inputs and outputs (mass and energy) - connected to the different phases of the life cycle of a product or service and referred to the functional unit.

3) **Impact assessment**: following the consumption of resources and releases into the environment calculated in the inventory, the extent of the potential environmental impacts caused by the processes or activities necessary for the manufacturing of the product or service is assessed.

4) **Interpretation of results**: procedure that relates the results of the inventory analysis and impact assessment; the results of the previous phases take the form of conclusions and recommendations aimed at reducing the environmental impacts of the processes or activities considered.

LCA is currently a widely used method. Many companies have understood that it can be of help for a wide range of applications: design, identification of areas for improving environmental performance, support in the definition of purchasing procedures, environmental education, marketing communication.

LCA constitutes the basic methodology for a wide range of actions aimed at increasing the sustainability of products and supply chains, since it helps to understand the impact generated on the environment by products, services, economic systems and production chains. LCA also allows us to measure the environmental impact generated by the individual production processes including the analyzed system, identifying those with the greatest impact and thus understanding the environmental performance of each individual part of the process.

Figure 1.25 Life Cycle Thinking

The ultimate purpose of the LCA is to be able to operate changes that gradually lead to a reduction of the impact and optimizing the process or service under analysis. Linked to the LCA there is an important way of thinking often used in decision making, the **Life Cycle Thinking (LCT**). Starting from the data and observations related to the LCA of the project of a product but not yet in production, Life Cycle Thinking allow us to make choices aimed at optimizing production and reducing the impact, evaluating every possible alternative in every single phase of production.

In practice, the environment is particularly complex and difficult to define in a model, which is why the LCA, due to the purposes of the analysis, must be a compromise between practicality and complexity. However, LCA represents the method that, at this moment, best addresses and evaluates the relationship between man and the environment in a holistic way.

In Figure 1.26 you can find a scheme to start the LCA analysis for a smartphone you can find countless LCA case studies on this technology and related products. If you want to learn more in References, the last chapter, you can find valid examples.

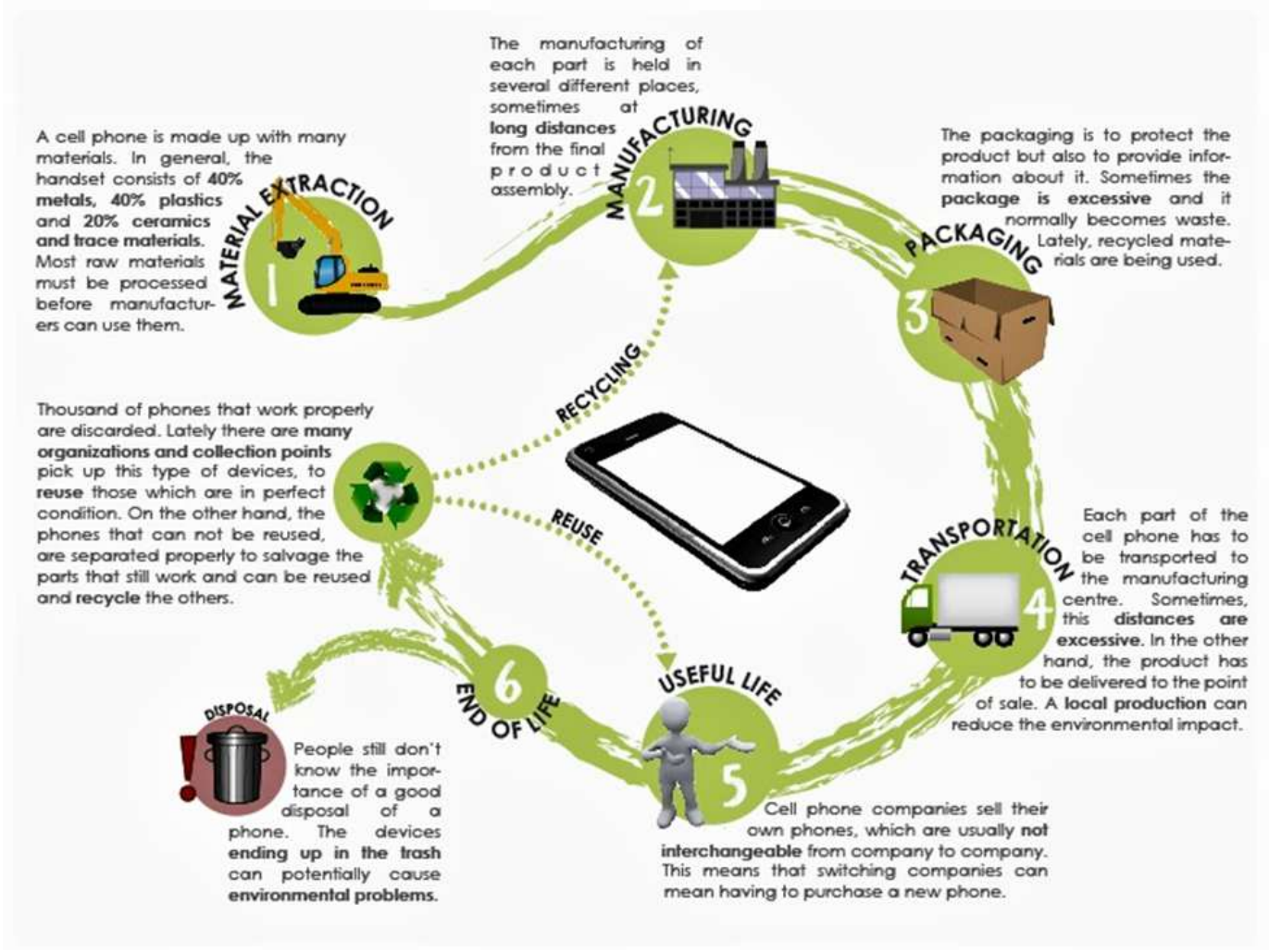

Figure 1.26 LCA analysis for a smartphone

2. Conclusion

Sustainability is a very broad and complex concept that does not end with the things dealt within this short work and that, in addition to technology, must be introduced and developed as much as possible in all human activities. Sustainability is the key to ensuring a future for humanity and it is everyone's duty to promote it in the workplace and in the aspect of everyday life.