Ministry of Higher Education and Scientific Research
Djilali BOUNAAMA University - Khemis Miliana(UDBKM)
Faculty of Matter Science and Computer Science
Department of Mathematics

Chapter : 1

Introduction

MI-L1-UEF121 : Algorithms and Data Structures I

Ali Khalfi

Khalfiali.udbkm@gmail.com

Course Topics

1, Computer science

2, Hardware and Equipment

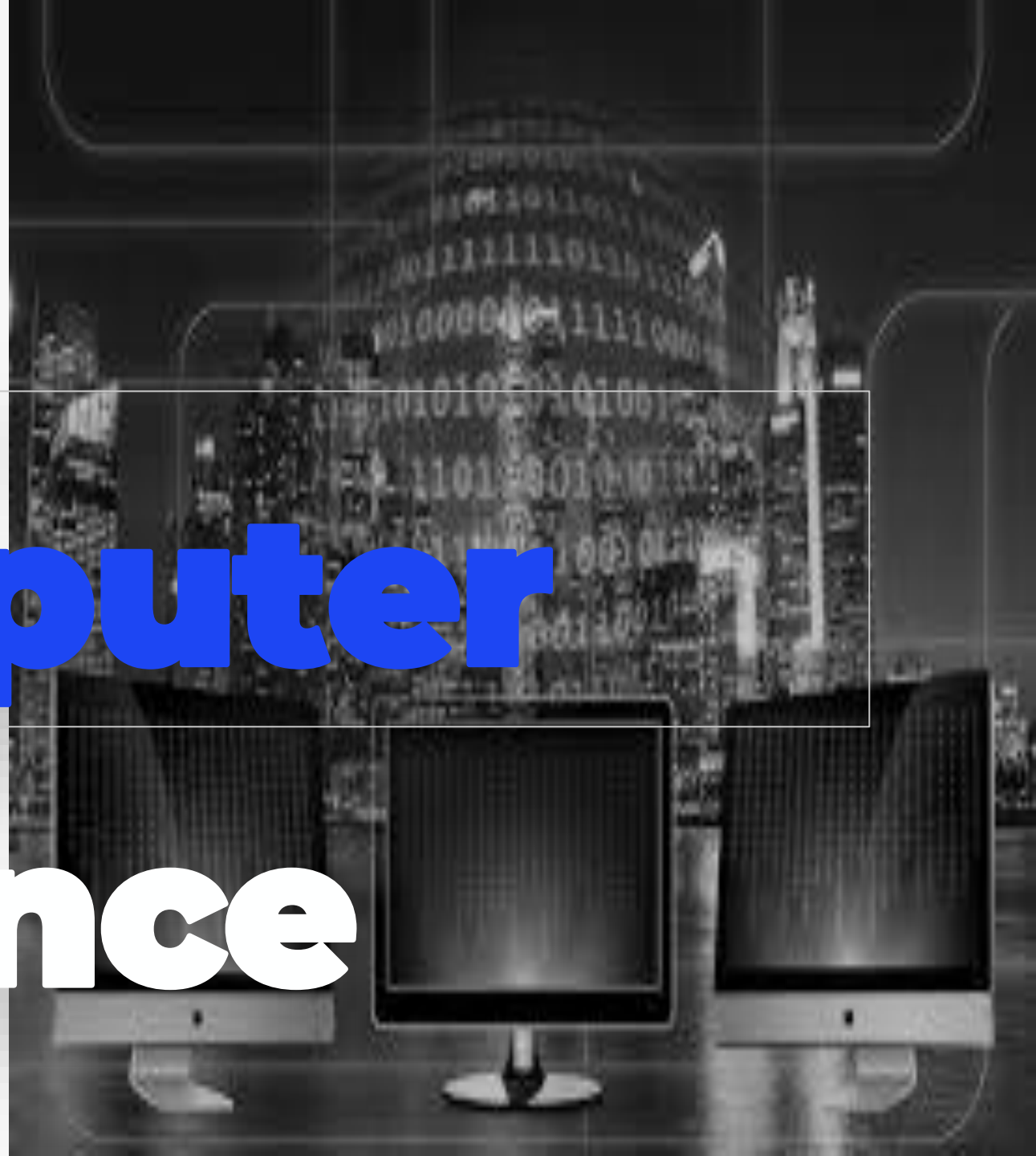
3, Softwares

4, Brief History of Computer Science

5, Introduction to algorithms

6, Studies

1.Computer Science



Definition

- ✓ ***Computer Science*** designates the ***automation*** of information processing by a concrete (machine) or an abstract system.
  - Example: “John”, “Smith”, 30000
- ✓ ***Computer Science*** refers to all of the ***sciences*** and ***techniques*** related to information processing.
- ✓ ***Computer Science*** can also refer to what relates to computer hardware (electronics), and office automation (bureautique).
- ✓ The French translation is « ***L’informatique*** »

Computer Science

Approch

*« Computer Science is the **automated processing** of **data** (or **information**) by an electronic device: the computer »*

- ✓ ***Data or Information*** : computer manipulates numbers
  - ➢ can represent various types of information: numbers (calculations or accounting), text, letters (characters), images or videos
  - ➢ converting this information into a series of numbers raises the problem of data format, coding and standardized formats
- ✓ ***Automated*** :
  - ➢ the processing is defined in a program which runs on its own,
  - ➢ the user simply provides processing parameters
  - ➢ establishing this program is the domain of programming

Approch

« *Computer Science is the **automated processing** of **data** (or **information**) by an electronic device: the computer* »

✓ ***Processing*** : these data are :

- ***creates*** : automatic acquisition, type text, draw an image, record sound or video
- ***analyse*** : number analysis, finding word occurrences, identifying an object, speech recognition
- ***modify*** : calculations, typing text, modifying existing text, modifying contrast, brightness, colors, applying effects
- ***archive*** and ***restore***

Definitions

Computer Science

- ***Informatics*** (science de l'information) : the study of systems, biological or artificial, that record, process and communicate information.
- ***Computer science*** (l'Informatique théorique) : procedural epistemology, the study of algorithms, software, and computers.
- ***Computer engineering*** (Génie informatique) : the manufacture and use of computer hardware.
- ***Software engineering*** (Génie logiciel ou ingénierie de logiciel) : software modeling and development
- ***Information technology*** (Technologies de l'information) : Represents the evolution of techniques and technologies related to Computer Science.
- ***Information and communication technology*** : (Technologies de l'information et de la communication TIC)

Application areas of Computer Science

- ***Computer Science for management*** :
  - guide management and management processes in companies,
  - areas of activity: human resources management, sales administration, purchasing management, marketing, finance
- ***Computer Science scientifique:***
  - assist design engineers in industrial engineering fields
  - design and size equipment using calculation programs
  - used in design offices to simulate scenarios quickly and reliably.

Computer Science

Application areas of Computer Science

- ✓ ***Real time Computer Science*** :
  - ➢ define software for controlling systems in direct contact with the world
  - ➢ aeronautics, space, weaponry, miniaturization of circuits
- ✓ ***Knowledge management :*** (*L'ingénierie des connaissances*)
  - ➢ consists of managing innovation processes
  - ➢ bring coherence between the three areas of management, real time, and scientific
- ✓ ***Intelligence*** (*Intelligence ou Veille*) ***Economic and strategic :***
  - ➢ use information technologies to search for information (search engines)

2.Hardware & Equipment

Definitions

- ***Computer materiel*** is all the components that can be found in a computer, peripherals and embedded devices.
- To designate Computer ***materiel*** & equipment, we also use the English term "***hardware***".
- A ***computer*** is a set of electronic circuits for manipulating data in binary form, represented by variations of an electrical signal.

Types of computers

- ***Computers*** or ***PC***: desktop or laptop
  - composed of a central unit: a case containing the motherboard, processor, RAM, power supply, and storage units.
  - A console: a screen (output), a keyboard and a mouse (input).
  - Various peripherals: a printer, a scanner, etc..
- ***Workstations***:
  - Particularly powerful and expensive PCs,
  - used only for professional purposes

Types of computers

- ✓ ***Mainframes***
  - ➢ A cabinet houses the CPU and power supply, one or more storage devices (hard drive, backup) while Hardware & Network Equipment (router, hubs, modem) are in the same room (separate racks).
  - ➢ An administration console (screen, keyboard, etc.) is located in this same room.
- ✓ ***Servers:***
  - ➢ universal storage location for users connected to servers
  - ➢ perform tasks: serve as a firewall, host a web server, etc.

Components of a computer

- ***UCT*** or ***CPU*** (Central Processing Unit) or ***Processor :*** includes command and control unit (***UCC***) + arithmetic and logical unit (***UAL***).
- ***Read-Only Memory:*** (***ROM***)
  - contains programs essential to the operation of the hardware.
- ***Random Access Memory:*** (***RAM***)
  - Required for the execution of any program (Volatile).
- ***Peripheral devices***
- all units intended for reading or writing information (keyboard, screen, printer
- These devices are physically connected by electrical tracks (lines) called ***buses***

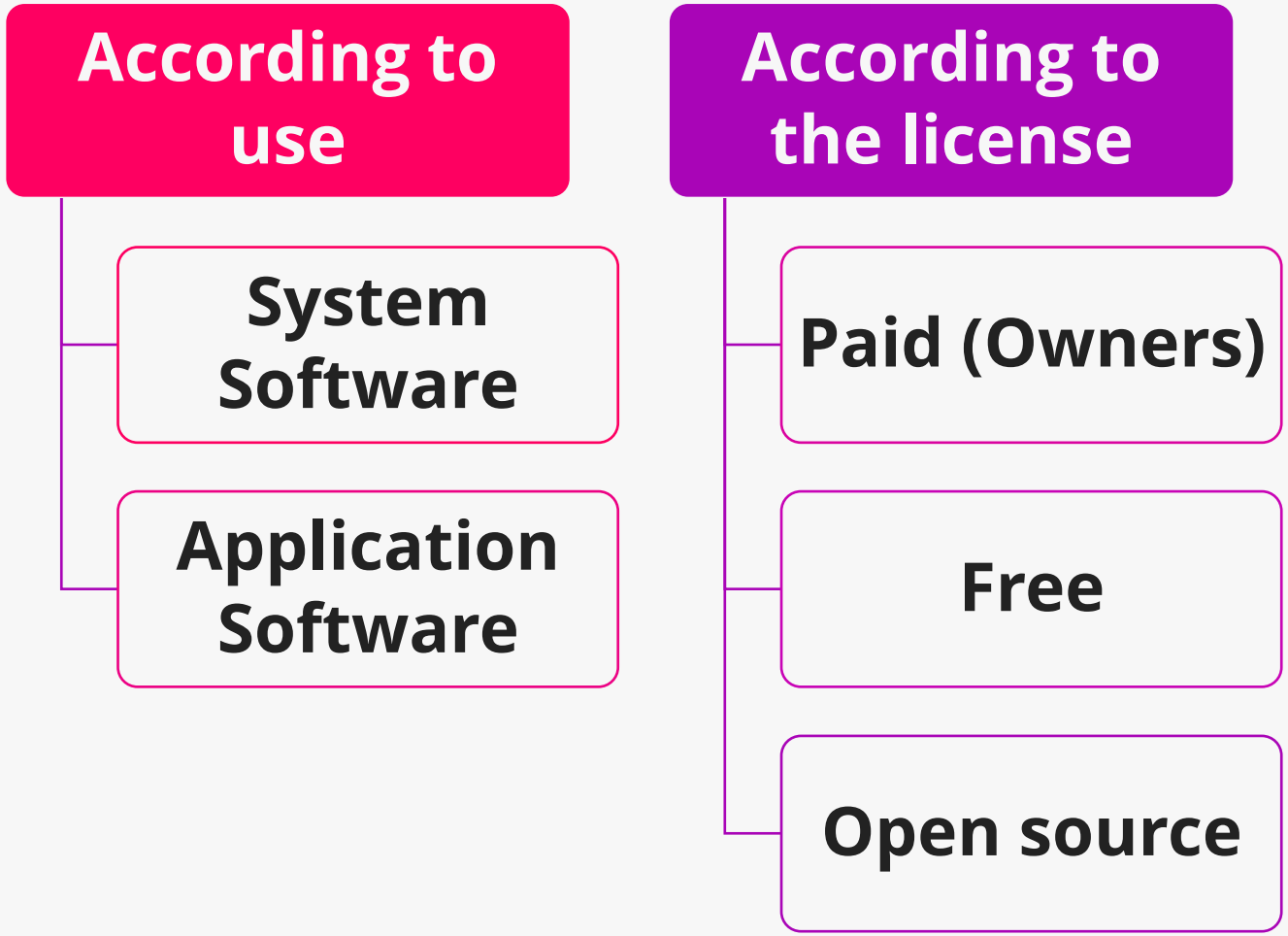
3.SoftWare

Definition

- ✓ A **Software** refers to the intangible part of Computer Science, the organization and processing of information: **programs**.
- ✓ A **Software** is a set of programs that allows a computer or computer system to perform a particular task or function

Softwares

Software Categories



Softwares according to use

- ✓ **System Software**:
  - ✓ ***Operating systems:*** MS Windows, Linux Ubuntu, Androis, iOS, Mac OS..
  - ✓ ***Device drivers:*** Motherboard drivers, graphics card drivers, etc.
  - ✓ ***Firmware:*** BIOS, UEFI, Embedded systems...
  - ✓ ***Programming language tools:*** Interpreter, compiler and assemblers,
  - ✓ ***Utilities:*** Anti-virus (Avast, McAfee), CCleaner, WinRAR, ...
- ✓ **Application Software:**
  - ✓ ***Content Management:*** MS Word, Google Docs...
  - ✓ ***Database Management:*** MS Access, MySQL, Oracle ...
  - ✓ ***Multimedia:*** Adobe Photoshop, VLC Media Player, Inkscape ...
  - ✓ ***Web browser:*** Google Chrome, Mozilla Firefox, ...
  - ✓ ***Accounting and Management:*** SAP, Ciel, ...

Softwares according to the license

- ✓ **Paid software:**
  - ✓ MS Office, SAP, Sky
- ✓ **Freeware:**
  - ✓ Adobe Reader, Skype, TeamViewer, ...
- ✓ **Shareware:**
  - ✓ Adobe Acrobat, Winzip, etc.
- ✓ **Free Software (Open Source):**
  - ✓ Moodle, Mozilla Firefox, Apache Web Server..

4. Brief History of Computer Science

3.1Ancient and Pre-Digital Era

Abacus (2000 BCE):

- ✓ **Wooden frame with beads used to perform basic arithmetic.**

An abacus with labeled parts (rods and beads).

3.1Ancient and Pre-Digital Era

Mechanical Calculators (17th century):

Pascaline (1642): Addition and subtraction machine created by Blaise Pascal. The pascaline (also known as the arithmetic machine or Pascal's calculator) is a mechanical calculator invented by Blaise Pascal in 1642. He designed the machine to add and subtract two numbers and to perform multiplication and division through repeated addition or subtraction.

3.1Ancient and Pre-Digital Era

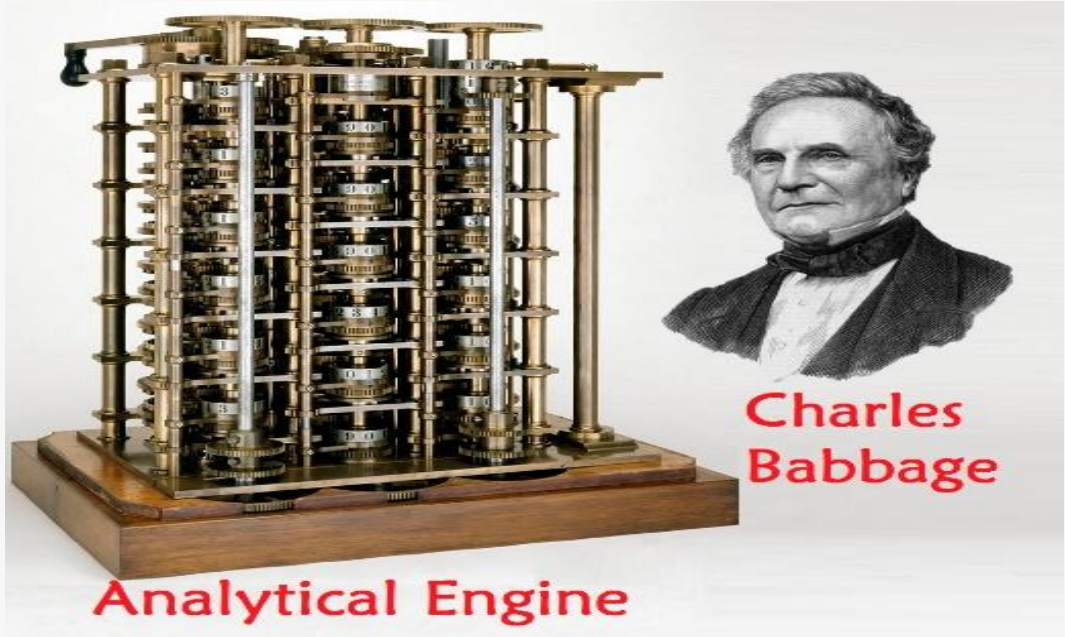
Abacus (2000 BCE):

- ✓ **Leibniz's Stepped Reckoner (1673): Improved calculator capable of multiplication/division.**

3.1Ancient and Pre-Digital Era

Analytical Engine

Charles Babbage: in 1883 Designed the Analytical Engine (never built), with ideas of memory, processor, and input/output → first "computer architecture."



3.2 Evolution of Modern Computers

First generation (1940–1956): Vacuum tubes, very large (ENIAC);

- ✓ These were the **first generation computers** 1940–1956. They employed **vacuum tubes** for circuitry and **magnetic drums** to hold the memory. They were huge, costly, and had enough power wastage and heat emission. The programs were written in machine or assembly language; hence they required lots of technical knowledge

3.2 Evolution of Modern Computers

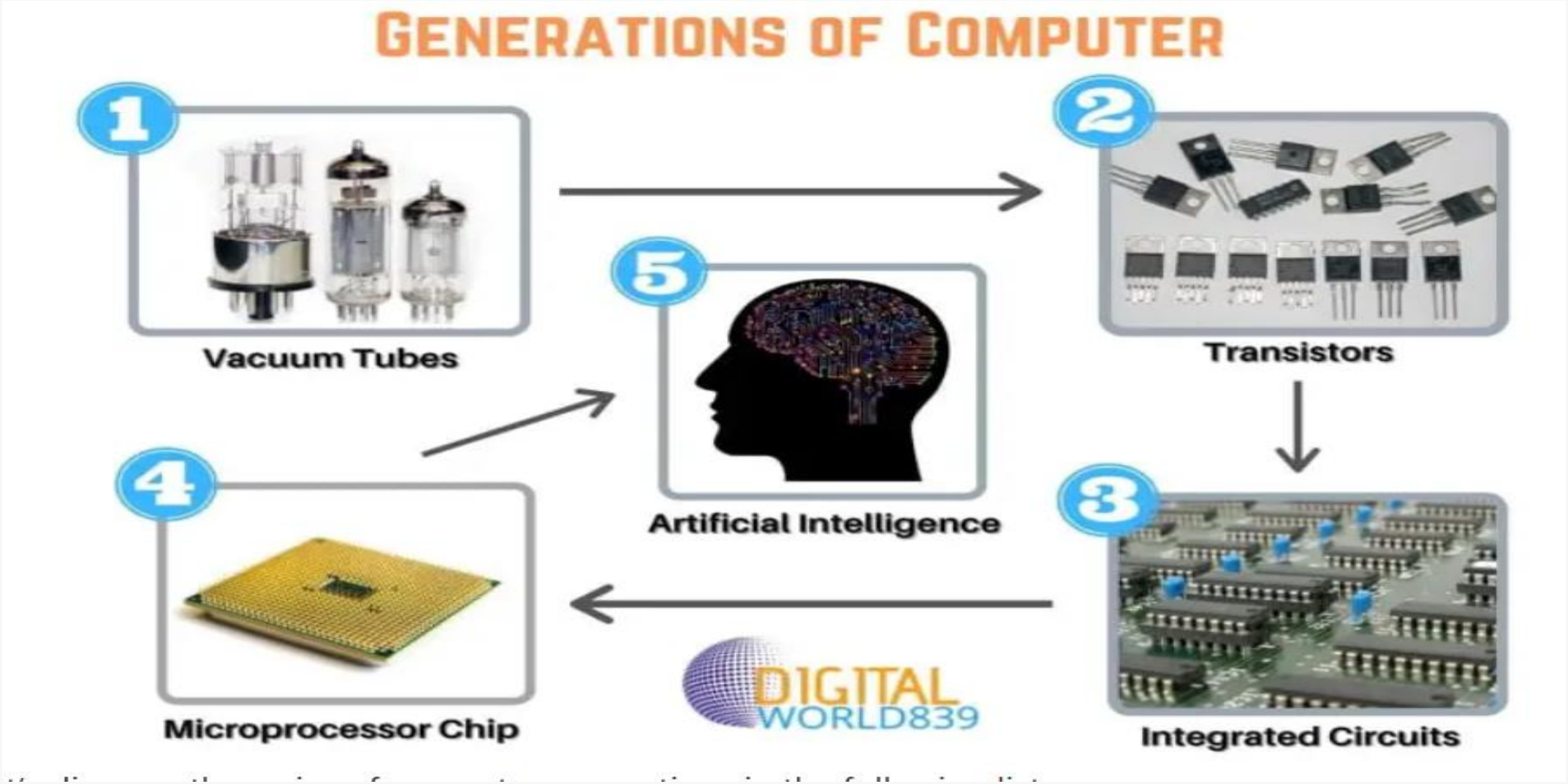
Second generation (1956–1963): Transistors → faster, smaller, more reliable.

Third generation (1964–1971): Integrated Circuits (ICs) → miniaturization.

Fourth generation (1971–today): Microprocessors → personal computers.

Fifth generation (today and beyond): AI, Cloud Computing, Quantum Computing.

3.2 Evolution of Modern Computers



5.Introduction to algorithms

Goal

- ✓ Getting the “**machine**” to do work for us.

Problem

- ✓ explain to the "**machine**" how it should do it.
  - ➢ *how to tell it?*
  - ➢ *How to teach it?*
  - ➢ *How do we make sure it does this job as well as we do?*
  - ➢ *Even, Better than us?*

Objectives

- ✓ ***solve*** problems “like” a **machine**
- ✓ know how to ***explain*** your reasoning
- ✓ know how to ***formalize*** your reasoning
- ✓ ***design*** (and write) **algorithms**

Concepts covered

- ✓ **Basic Concepts**
  - ➢ "***basic***" algorithms for elementary problems
- ✓ **Learning a language**
  - ➢ Algorithmic ***formalism***,
  - ➢ ***programming*** languages: C, Pascal
- ✓ **Data Structures**
  - ➢ from the ***simplest*** to the most ***complex***
- ✓ **Complex problem solving**
  - ➢ ***clever*** and ***efficient*** algorithms

Algorithms

Definition

- ✓ An **ALGORITHM** is a ***sequence of instructions*** which, once ***executed correctly***, leads to a ***given result*** (desired).

- ✓ **Examples : Algorithms**

  - ➢ show a way to a lost tourist;
  - ➢ write a cooking recipe;
  - ➢ Dispense drinks automatically;
  - ➢ Play a video on YouTube

Example : Pancakes recipe

Preparing the pancakes

Algorithm

1. Put the flour in a bowl
2. Form a well
3. Add the whole eggs, sugar, oil and butter
4. Mix gently with a whisk, adding the milk.
5. Heat a pan and add a few drops of oil.
6. Cook the pancakes over low heat

The actions

The processor

The person making the recipe

Definition : Processor

- ✓ An **algorithm** is always executed by a ***PROCESSOR***.
- ✓ An **algorithm** must therefore only contain instructions understandable by a ***PROCESSOR.***
- ✓ **Examples : Algorithms (Processor)**
  - ➢ show a way to a lost tourist (***a person***);
  - ➢ write a cooking recipe (***a person***);
  - ➢ Dispense drinks automatically (***a machine - dispenser***);
  - ➢ Play a video on YouTube (***a program***)

Definition : Environment

✓ ***Environment*** :

- It is the set of **objects** or **elements** required to carry out a work described by an algorithm,
- We distinguish:
  - ***input objects***: provided to Algorithm.
  - ***output objects***: produced by Algorithm.
  - ***internal objects***: internal manipulation of Algorithm
- The environment of an algorithm can also be called: the **settings** (parameterization)

Definition : Action

✓ ***Actions :***

- These are the "**sequence of instructions**" or **steps** of Algorithm
- It is an ***event*** of finite duration which ***modifies*** the environment
- Please note that:
  - Changing the order of actions can transform the result.
  - The same action can appear several times in the same algorithm
- A **primitive action** is an action executed (by a processor) without any ***additional information***.

Definition : Algorithm

An algorithm is a sequence (sequel) of primitive actions, which once executed by a well-defined processor, will carry out a very specific job (requested)

Properties

1. ***General:*** an algorithm must always be designed in such a way as to consider *all eventualities* of a treatment (take into account *all possible cases*).
2. ***Finitude:*** An algorithm *must stop* after a finite time (*finite number* of primitive actions).
3. ***Definition:*** all actions of an algorithm must be *unambiguously defined*
4. ***Repetitiveness:*** generally, an algorithm contains *several iterations*, that is to say actions that are *repeated* several times.
5. ***Efficiency:*** Ideally, an algorithm should be designed in such a way that it runs in *minimal time* and consumes *minimal resources*.
6. ***Independence:*** an algorithm must be *independent* of programming languages and computers

Learn Algorithms

To master Algorithms, three (3) qualities are required :

1. ***be methodical:***

   ✓ Before writing the instructions for an algorithm, you must *analyze the problem* to be solved. You must then *define the inputs* and *outputs* of Algorithm.

2. ***have intuition:***

   ✓ No recipe allows you to know a priori which instructions will achieve the desired result. The *reflexes* of algorithmic reasoning become spontaneous with experience.

3. ***Be rigorous :***

   ✓ Each time you write a series of instructions, you must systematically *put yourself* mentally in the *place of the machine* that will execute them.

History of Algorithms

1. ***18th century BC AD.*** :
   - ✓ the **Babylonians** defined exhaustive descriptions of algorithms for calculations concerning trade and taxes;

2. ***3rd century BC AD*** :
   - ✓ **Euclide** introduced (in his work The Elements) the famous algorithm which makes it possible to find the greatest common divisor (PGCD) of two numbers;

History of Algorithms

1. *9th century*:
   - ✓ **Al Khuwarizmi** was the first to formalize the notion of algorithm in his work Algebra and Balancing ;

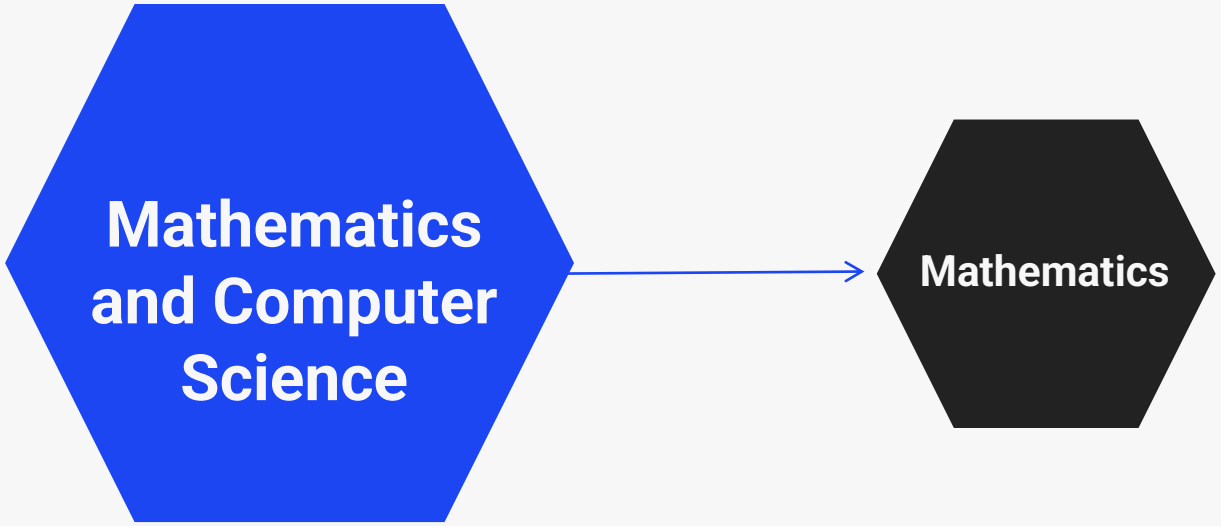
2. *12th century*:
   - ✓ **Adelard de Bath** introduced the Latin term algorismus (with reference to the name of Al Khuwarizmi);

6.Studies

« Mathematics and Computer Science » domain

- ✓ The **mathematics** path is intended for students who wish to have a solid foundation in **mathematics**.
- ✓ The first year (L1) is designed to allow you to choose and opt for a more specialized path in mathematics.

« Mathematics and Computer Science » domain



Bachelor of Mathematics

Objectives

Studies

01
- **basic general training in the fundamental areas of Computer Science and Mathematics:** Analysis , algebra, Algorithmics, ...

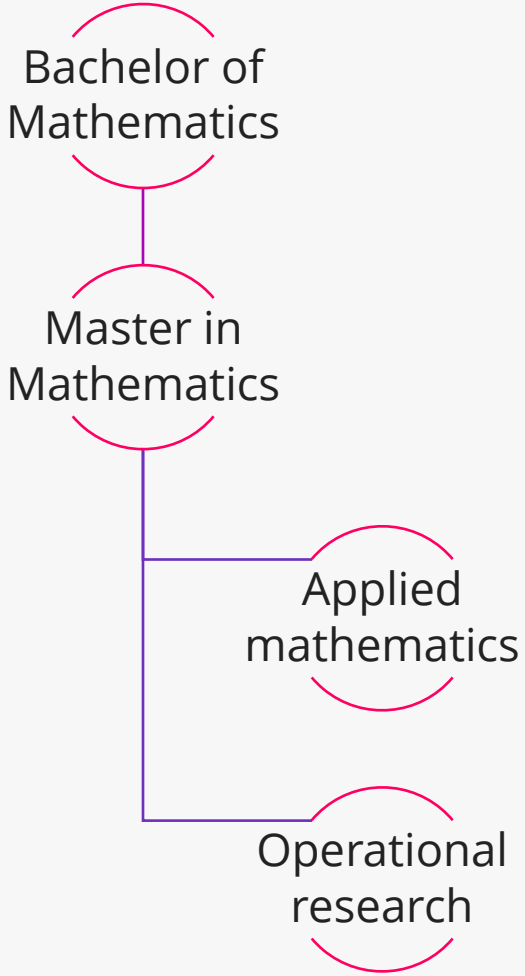
02
- **specialized training in Mathematics:** advanced studies in mathematics

03
- **Prepare a Master's degree in Mathematics**

04
- **mastery of applied mathematics**

Continuation to Master's Studies

Bridges are possible between the Bachelor of Mathematics degree and other fields:



Ministry of Higher Education and Scientific Research
Djilali BOUNAAMA University - Khemis Miliana(UDBKM)
Faculty of Matter Science and Computer Science
Department of Mathematics

Chapter : 1

Introduction

MI-L1-UEF121 : Algorithms and Data Structures I

Ali Khalfi

Khalfiali.udbkm@gmail.com