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Chapter 1:
Introduction + Historical Background

Algorithmic and data structure

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Introduction

Computer science is one of the most important modern sciences. Its subject of study is computation, in the broadest sense of the term. This includes any type of information that can be represented by a series of numbers, such as texts, DNA, images, sounds, etc.

Definition Informatic=information + automatic

is the science that deals with the automatic processing of information using a machine..

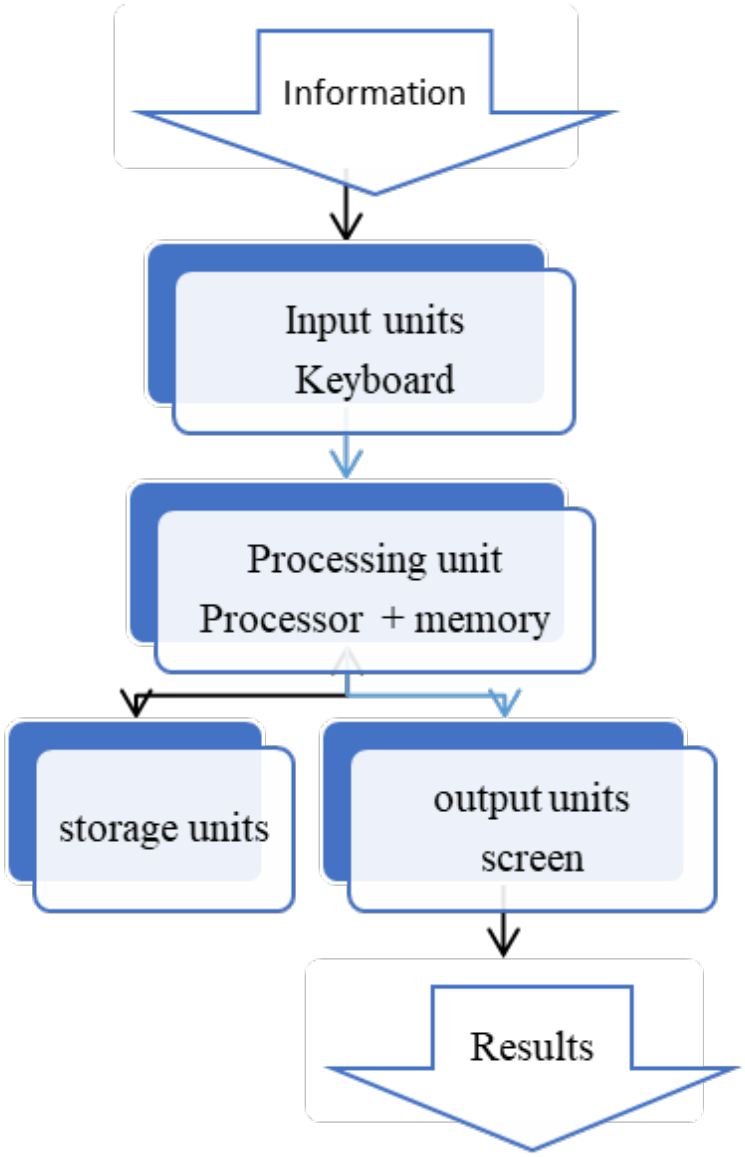
processing: is the set of operations that the machine performs or execute.

information or **data** : Anything that a machine can process. Text, numbers, images, videos..

machine: the device that executes these instructions. Such as: calculator, computer, phone, game, television, receiver,...

Computer


الشاشة
كاميرا ويب
الوحدة المركزية
مكبر الصوت
المودم
الطابعة
لوحة المفاتيح
الفأرة
العاب


Information
Input units
Keyboard
Processing unit
Processor + memory
storage units
output units
screen
Results

Computer

Any programmable device capable of inputting, processing, storing, or outputting information. It consists of:

Input units: mouse and keyboard, scanner, microphone...

Processing unit: memory and processor. The memory holds the data and instructions, and the processor executes these instructions and produces results that are stored in the memory.

Storage units: used for storing and retrieving information. Hard disk, CD or DVD, flash drive, memory card...

Output units: screen, printer, speaker...

Information representation 1/3

To represent information, we need:

28 characters in Arabic,

26 characters in French,

over 5000 characters in Chinese.

In **computer science**, we only need **2** characters.

Information representation 2/3

- The information inside a computer, such as memory and the processor, is processed in the form of electrical signals, which can only have two states: **presence** or **absence** of electric current.
- On a CD, information is represented by holes, which also have two states: **presence** of a hole or **absence** of a hole.
- On a hard disk, information is represented by magnetic charges, which can be either **magnetized** or **non-magnetized**, thus having two states.
- To represent information, we always need two states. We can denote them as 0 and 1 (just an **abstraction**). Therefore, the machine language is referred to as **binary language**.

Information representation 3/3

The smallest unit of storage for information is called a bit, which is short for "binary digit." A bit can hold either a 0 or a 1, representing two distinct states.

In computer systems, information is often manipulated in larger chunks called bytes. A byte consists of a group of 8 bits. Each bit within the byte can independently hold a value of 0 or 1.

1 Byte =8 bit.

history of computing

Computing has gone through many stages, including the beginnings of a computer that ran on vacuum tubes. Then came the era of transistors and integrated circuits. And then the era of the Internet and the Web. Finally, the current era, which represents the age of mobility and data sharing.

Introduction to algorithms

A computer can be compared to a human being. If we find a human being with senses, a brain, a memory and a language, and we ask him, for example, to calculate 25×13, or to solve a first-degree equation, without teaching him, he won't be able to do it, unless we teach him. The same applies to the computer. alone can't do anything, unless we provide him with the solving method, or the so-called algorithm or software.

Algorithm

The **word Algorithm** comes from the name of Abu Jaafar Muhammad ibn Musa **al-Khwarizmi**.

Definition 1: An algorithm is a method or approach used to solve a problem.

Definition 2: An algorithm is a set of data and a set of instructions on this data.

Definition 3: An algorithm is a set of sequential, detailed and completed steps required to solve a problem and achieve results.

Definitions

Data Structure: It is a way of storing and organizing data to facilitate its use and modification.

Program: It is an algorithm written in a programming language. The computer cannot execute it directly until it is translated.

Application: A program that has been translated into machine language (0 and 1) and is ready to be executed by the processor. It is sometimes also referred to as a program.

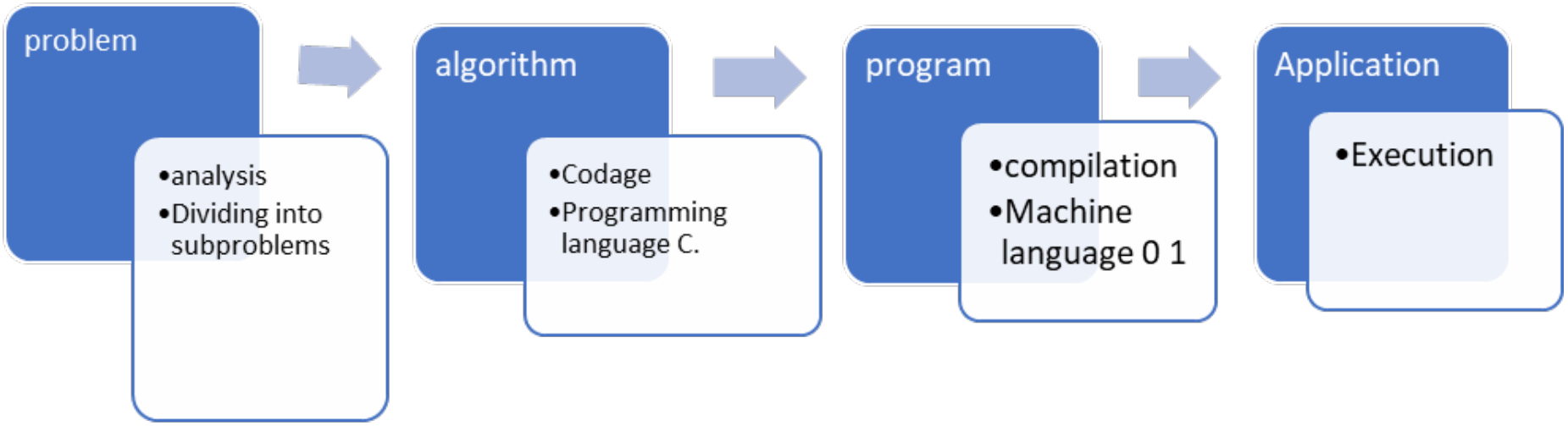
Examples of algorithms

- Cuisine recipe, changing a car tire, recitation method, chess game...
- Calculation of the greatest common divisor, quadratic equation solving method, derivative calculation...
- Calculation of student averages, employee salaries, electricity bill...

Algorithm features

- **Readability**: The algorithm should be understood, even by non-computer scientists.
- **Precision**: Each step should be clear and free from ambiguity. The inputs (data) and outputs (results) should be precisely defined.
- **Termination**: It should stop after a limited number of steps.
- **Generality**: The solution should be applicable to a specific type of problem. Therefore, for each problem case or dataset, the algorithm should terminate and return the correct result.
- **Independence**: It should be written in a manner independent of any specific device, programming language, or operating system.
- **Abbreviation**: It should not exceed one page, otherwise the problem should be divided into multiple sub-problems.
- **Efficiency**: Measured by the execution time (processor) and the amount of memory required.

Steps to solving a computer problem



I. Analysis 1/2
(to obtain the algorithm)

The process of analysis goes through three stages:

1. By breaking down the problem into simpler sub-problems, and if the partial problem remains complex, further dividing it into less complex problems. Solving these problems leads to the solution of the initial problem.

I. Analysis 2/2
(to obtain the algorithm)

2. For each sub-problem, the elements required to formulate a solution must be identified.
   - Inputs: Specify the data required for processing.
   - Outputs: Determine the expected results.
   - Intermediates:
3. Determine the relationships that exist between these elements (between data and results), in terms of rules, formulas, mathematical equations, and processing methods.

Example 1/3

The problem: Calculate the sum of the squares of two numbers.

Analysis:

The problem can be divided into three sub-problems:

1. Calculate the square of the first number.
2. Calculate the square of the second number.
3. Calculate the sum of the two squares.

For the first sub-problem, calculate the square of "a":

- Inputs: a of type integer.
- Output: x of type integer.
- Relation: x = a * a.

Example 2/3

The second sub-problem: Calculate the square of "b":

- Input: b of type integer.
- Output: y of type integer.
- Relation: y = b * b.

The third sub-problem: Calculate the sum:

- Identify the inputs: x and y of type integer.
- Identify the output: z of type integer.
- Relation: z = x + y.

Example 3/3

Algorithm

Data

Determine inputs : a and b of integer type.

Specify output : z integer type.

Determining intermediaries : x and y of integer type.

Instructions

x=a*a

y=b*b

z=x + y

II. Programming / Coding (to obtain the program)

After obtaining the algorithm, which is usually written in human-readable language, the programmer selects a programming language such as C and then translates the data and instructions into that language. The resulting program is called the source code. It is a text file (readable by a person) with a file extension specific to the language used. For example, .c for C or .cpp for C++.

III. Compilation (to obtain the application)

The program is translated and converted into codes that can be understood and executed by the computer, namely binary language (0 and 1). This binary language varies depending on the device (processor and operating system). This translation process is automated. It results in a binary file (unreadable by humans) that typically carries the .exe extension in the Windows environment. This process is accompanied by a spell-checking process (syntax errors and writing errors).

IV. Execution (running)

The processor loads the program into memory and begins executing one instruction after another. In a Windows environment, this is typically done by double-clicking on the application (.exe). This process also involves testing and correcting semantic errors (errors in the result).

Note: In the case of interpreted languages, the translation and execution process take place simultaneously.

End of Chapter 01