

Algorithmic & Python Programming

Imad Kissami¹

¹Mohammed VI Polytechnic University, Benguerir, Morocco



Outline of this lecture

- General knowledge
- Introduction to algorithmic
- Introduction to Python

General knowledge

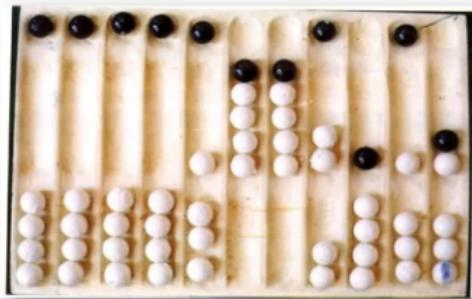
Definition of Computer

- Definition:
 - Computer is a programmable machine.
 - Computer is a machine that manipulates data according to a list of instructions.
 - Computer is any device which aids humans in performing various kinds of computations or calculations.
- Three principles characteristic of computer:
 - It responds to a specific set of instructions in a well defined manner.
 - It can execute a pre-recorded list of instructions.
 - It can quickly store and retrieve large amounts of data.

General knowledge

The Abacus

- The abacus, a simple counting aid, may have been invented in Babylonia (now Iraq) in the fourth century B.C.
- It used to perform basic arithmetic operations.



Earlier Abacus



Modern Abacus

General knowledge

Jacquard Loom

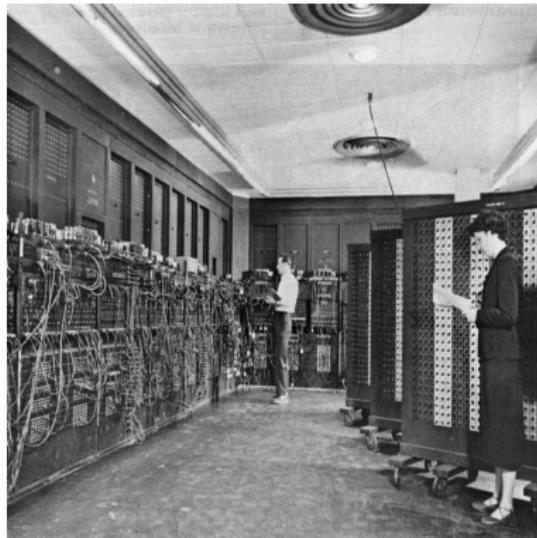
- The Jacquard loom is a mechanical loom, invented by Joseph-Marie Jacquard in 1801.
- It is an automatic loom controlled by punched cards.



General knowledge

The ENIAC

- ENIAC stands for Electronic Numerical Integrator and Computer.
- It was the first electronic general purpose computer.
- Completed in 1946.
- Developed by John Presper Eckert and John W. Mauchly.



General knowledge

The IBM 360

- Developed by Gene Amdahl in 1965.
- It was the first family of computers designed to cover both commercial and scientific applications



General knowledge

The PDP-8

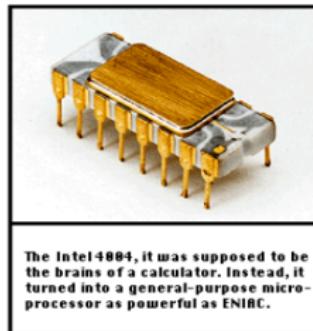
- Was introduced on 22 March 1965
- 12-bit minicomputer Produced by Digital Equipment Corporation (DEC).
- Priced at \$18,500 (equivalent to about \$150,000 in 2020)



General knowledge

The Microprocessor

- A computer chip that contains on it the entire CPU
 - Mass produced at a very low price
 - Computers become smaller and cheaper
- intel 4004 – the first computer on a chip, more powerful than the original ENIAC.
- Intel 8088 – used in IBM PC



General knowledge

Hardware

- Hardware – the physical devices that make up a computer (often referred to as the computer system)



General knowledge

Hardware core

- CPU (Central Processing Unit)
 - CPU (machine) cycle – retrieve, decode, and execute instruction, then return result to RAM if necessary
 - CPU speed measured in gigahertz (GHz)
 - + GHz – number of billions of CPU cycles per seconds
- RAM (Random Access Memory)
 - Also called Memory, Main Memory, or Primary Storage
 - Measured in gigabytes (GB, billions of bytes) today
 - + Byte – > Character
 - RAM is volatile
 - + Temporary storage for instructions and data



General knowledge

Capacity of Secondary Storage Devices

- Kilobyte (KB or K) – about 1 thousand bytes
- Megabyte (MB or M or Meg) – about 1 million bytes
- Gigabyte (GB or Gig) – about 1 billion bytes
- Terabyte (TB) – about 1 trillion bytes



General knowledge

Software

- Programs – instructions that tell the computer what to do
- Categories
 - Application software - enables you to solve specific problems or perform specific tasks.
 - System software - handles tasks specific to technology management and coordinates the interaction of all technology devices
 - Utility software - provides additional functionality to your operating system software

General knowledge

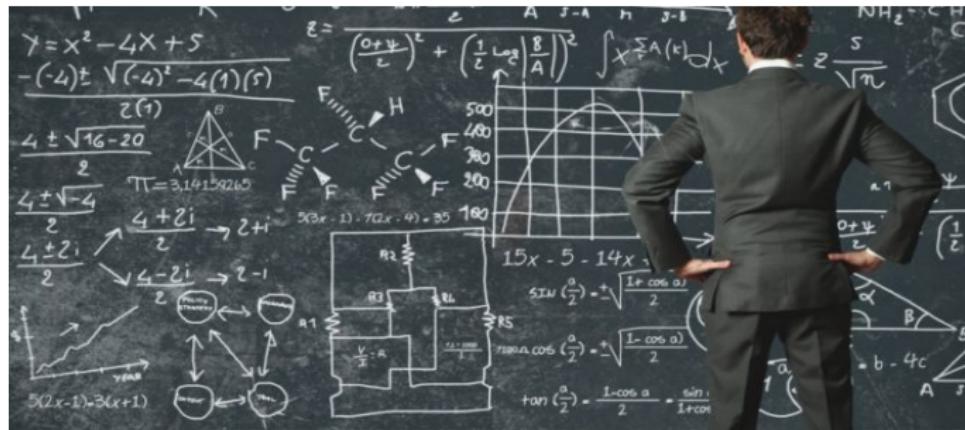
System Software

- Operating System
- UNIX / Linux
- Windows
- MAC OS
- Palm OS
- Android
- Language Translators
- C, C++, Basic, Java, ...
- Device Drivers



Introduction to algorithmic

Where can we find and use the algorithm?



- In our computers,
- In our Smartphones,
- Smart TVs
- Cars,
- ATM
- ...

Introduction to algorithmic

What's an algorithm?

Definition

Algorithm is a set of steps to complete a task.

For example,

- Task: to make a cup of tea.
- Algorithm:
 - add water and milk to the kettle,
 - boil it, add tea leaves,
 - add sugar, and then serve it in cup.

Introduction to algorithmic

What's Computer algorithm?

Definition

a set of steps to accomplish or complete a task that is described precisely enough that a computer can run it.

- Described precisely: very difficult for a machine to know how much water, milk to be added etc. in the above tea making algorithm.
- Example:

```
1 Number : integer
2 AbsoluteValue : integer
3 Begin
4     Read (number)
5     If number<0 then
6         AbsoluteValue = -number
7     Else
8         AbsoluteValue = number
9     End If
10    Write ("Absolute value is: ", AbsoluteValue)
11 End
```

Introduction to algorithmic

Characteristics of an algorithm

- Must give some output(yes/no,value etc.)
- Definiteness –each instruction is clear and unambiguous.
- Finiteness –algorithm terminates after a finite number of steps.
- Effectiveness –every instruction must be basic i.e. simple instruction.

Introduction to algorithmic

Expectation from an algorithm

■ Correctness:

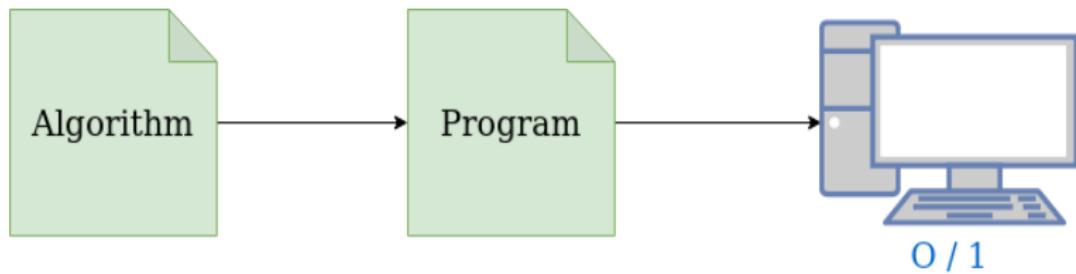
- Correct: Algorithms must produce correct result.
- Produce an incorrect answer: Even if it fails to give correct results all the time still there is a control on how often it gives wrong result. Eg. Rabin-Miller Primality Test (Used in RSA algorithm): It doesn't give correct answer all the time. 1 out of 250 times it gives incorrect result.
- Approximation algorithm: Exact solution is not found, but near optimal solution can be found out. (Applied to optimization problem.)

■ Less resource usage:

- Algorithms should use less resources (time and space).

Introduction to algorithmic

Algorithm vs programming language



Introduction to algorithmic

Why Computer Use Binary Number System?

The image is a composite of two panels. The left panel shows a hand holding a green pen, writing binary addition on yellow-lined paper. The addition is:

$$\begin{array}{r} & 1 \\ & 1 \\ 0111 & + \\ 1110 & \hline 10101 \end{array}$$

Below the addition, the text "For Simplicity:" is written, followed by the mapping of decimal values to binary digits:

0 = 0, 1 = 1, 2 = 10, 3 = 11

The right panel shows a digital display with a light gray background and a black vertical border on the right. It displays two binary numbers in large blue digits:

1010
0111

Introduction to algorithmic

Why Computer Use Binary Number System?

- information with only 2 states; black - white, open - close, right, false, on - off
- We symbolize binary information, whatever its physical medium, in the form of 1 and 0.
- In physical reality, there are no more than 1 and 0 in computers.

System	Base	Digits
Binary	2	0 1
Octal	8	0 1 2 3 4 5 6 7
Decimal	10	0 1 2 3 4 5 6 7 8 9
Hexadecimal	16	0 1 2 3 4 5 6 7 8 9 A B C D E F

Introduction to algorithmic

Decimal number system

- To represent a number, no matter how large, we have a specialized alphabet: a series of 10 signs called digits. And when we write a number by putting some of these digits behind each other, the order in which we put the digits is critical. So, for example, 2569 is not at all the same number as 9562. WHY ?
- Example: When I write 9562, what number am I talking about? Let's break the reading down digit by digit, from left to right:
 - 9000 is 9×1000 , because 9 is the fourth digit from the right
 - 500 is 5×100 , because 5 is the third digit from the right
 - 60 is 6×10 , because 6 is the second digit from the right
 - 2 is 2×1 , because the 2 is the first digit from the right

base-10 number system

$$9\ 562 = 9 \times 10^3 + 5 \times 10^2 + 6 \times 10^1 + 2 \times 10^0$$

Introduction to algorithmic

Binary number system

- Stored information is represented by **two digits**; 0 and 1.
- computers were designed to handle information in packets of 0 and 1. And the size of these packets was fixed at **8 binary** information.
- Binary information (commonly symbolized by 0 or 1) is called a **bit**.
- A group of eight bits is called a **byte**.
- With 1 byte, we can have 256 possibilities
- With 2 bytes (16 bits), we can have $256 \times 256 = 65\,536$ possibilities.
- With 3 bytes (24 bits), we can have $256 \times 256 \times 256 = 16\,777\,216$ possibilities.
- Example: 11010011
 - $1 \times 2^7 + 1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 =$
 - $1 \times 128 + 1 \times 64 + 1 \times 16 + 1 \times 2 + 1 \times 1 =$
 - $128 + 64 + 16 + 2 + 1 =$
 - 211

Introduction to algorithmic

Hexadecimal number system

- Hexadecimal is the name of the numbering system that is base 16.
- This system, therefore, has numerals 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15.
- These symbols or values are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and F.
- Example: 158 (10011110)
 - $158 = 9 \times 16 + 14 =$
 - $9 \times 16^1 + 14 \times 16^0 =$
 - 9E

Introduction to Python

Why Python ?

- Python Is a High-Level Programming Language

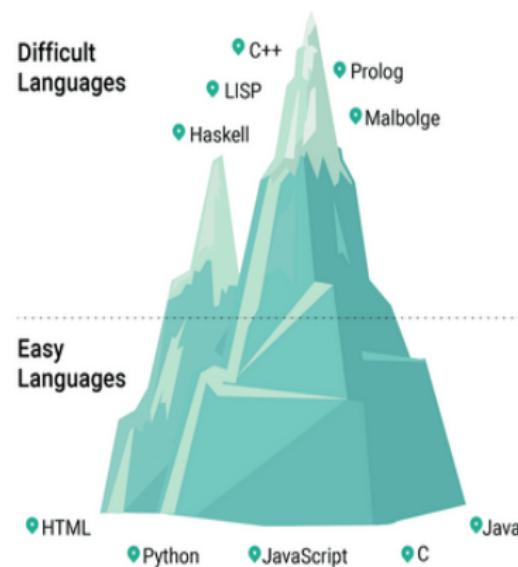
- Lower-level programming languages require a detailed understanding of the complexities of how the computer's memory is laid out, allocated and released.
- The time spent and lines of code required to handle tasks.
- Python abstracts away and handles many of these details automatically, leaving you to focus on what you want to accomplish.

Compiled (C/C++, Haskell,...)	Interpreted (Python, Ruby, ...)
Take entire program as single input and converts it into object code.	Takes single instruction as single input and executes instructions.
Run faster because compilation is done before execution.	Run slower because compilation and execution take place simultaneously.
Hard to implement.	Easy to implement.

Introduction to Python

Why Python ?

- Easy to Learn and Understand



Introduction to Python

Why Python ?

- Suitable for Rapid, Iterative Development
 - Interactive interpreter tools such as the Python shell, IPython, and Jupyter notebooks
 - Write and execute each line of code in isolation and see the results (or a helpful error message) immediately
- Can Be Used Both for Prototyping and Production Code
 - Largest software companies in the world make heavy use of Python in a variety of applications and use cases.
- Comes with “Batteries Included:” The Python Standard Library
 - Everything needed for basic operations is built right into the language
 - Python standard library has tools for working with files, media, networking, date and time information, and much more
- Great Third-party Libraries for Financial Analysis
 - Pandas with its DataFrame and Series objects
 - Numpy with its ndarray

Introduction to Python

Why Python ?

- Python Is Free!
 - Python is developed under an open source license making it free also for commercial use.
- Most used

