

Algorithmic & Python Programming

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Outline of this lecture

- General knowledge
- Introduction to algorithmic
- Introduction to Python

General knowledge

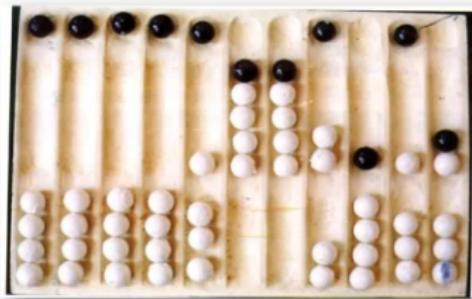
Definition of Computer

- 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

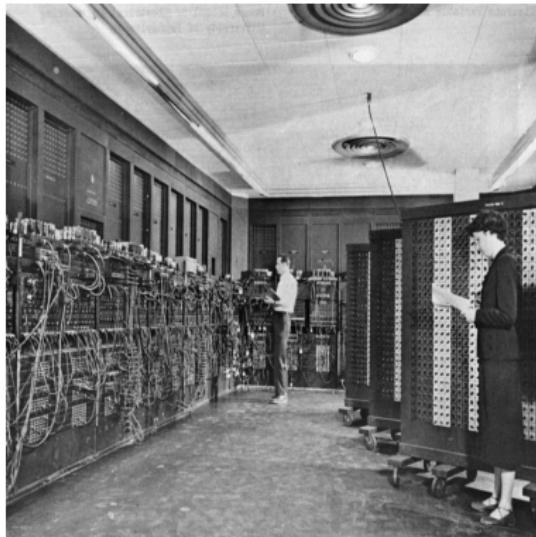
- The Jacquard loom is a mechanical loom, invented by Joseph-Marie Jacquard in 1881.
- It is an automatic loom controlled by punched cards.



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

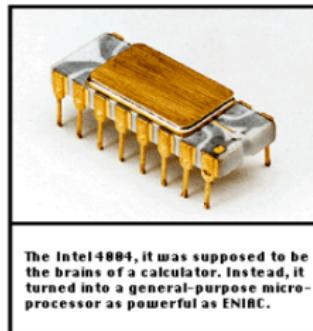
- Was introduced on 22 March 1965
- 12-bit minicomputer Produced by Digital Equipment Corporation (DEC).
- Priced at \$18,500 (equivalent to about \$150,000 in 2020)



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

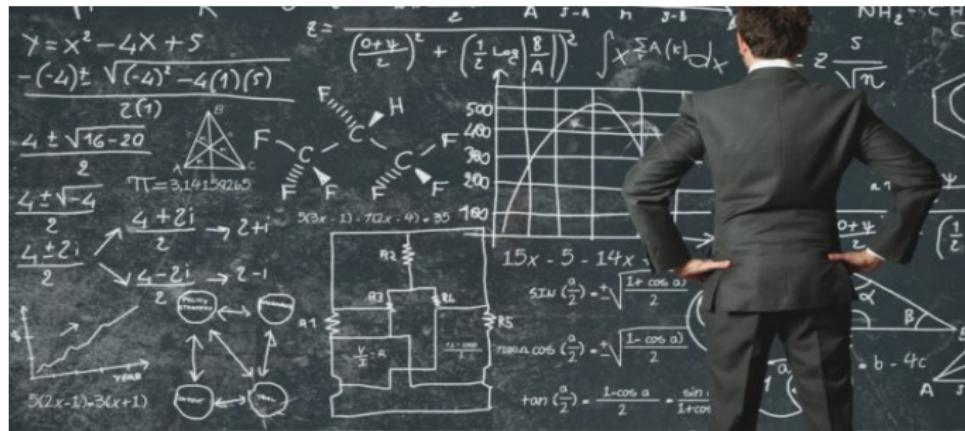
System Software

- 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:

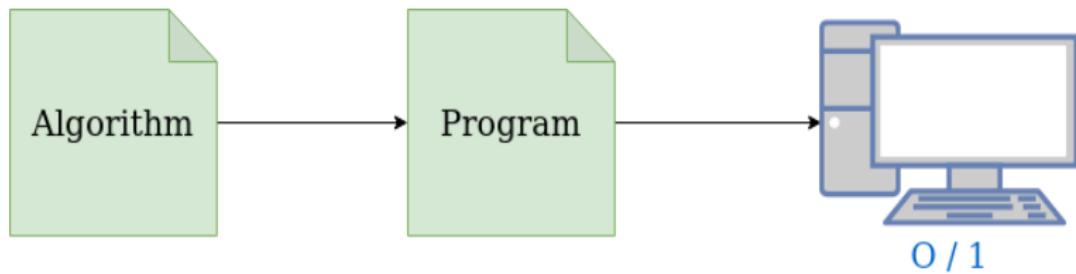
- Correct: Algorithms must produce correct result.
- Produce an incorrect answer: Even if it fails to give correct results all the time still there is a control on how often it gives wrong result. Eg. Rabin-Miller Primality Test (Used in RSA algorithm): It doesn't give correct answer all the time. 1 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 split into two vertical sections. The left section shows a handwritten-style binary addition problem on a grid of light green horizontal lines:

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

A hand holding a green pen is shown writing the sum "10101". Below this, the text "For Simplicity:" is followed by the mapping: $0 = 0, 1 = 1, 2 = 10, 3 = 11$. The right section shows two large blue binary numbers displayed side-by-side against a white background with a fine grey diagonal hatching pattern:

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