Brief history of the "classical" computer

vecchicomputer.com

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Bologna, 5 Febbraio 2019

1984....

*"Information technology includes the development and the use of **structures and procedures for information processing**. Information is presented to the computer in a certain form and is returned in a different form, generally easier to use. The first is the **input information** and can be defined as the raw material of the process. The second is the **output information** or finished product."*

*(F. Scheid, Il calcolatore e la programmazione, **1984**)*

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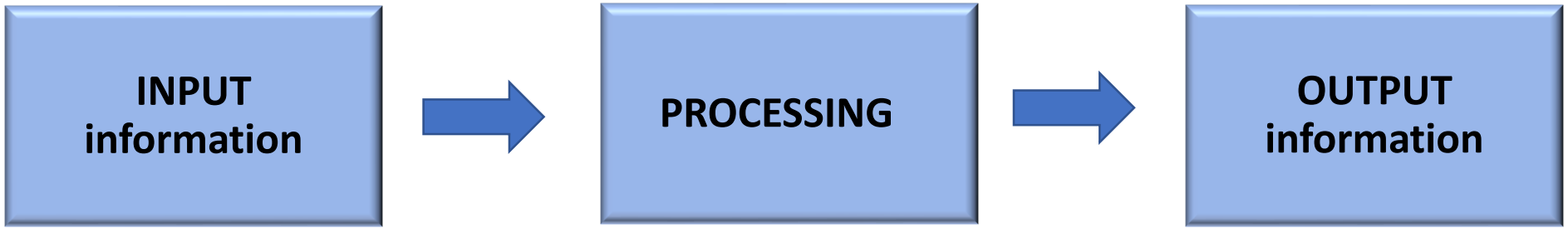

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1984....

*"To summarize, a **modern** [modern in 1984...] computer consists of a **central processing unit (CPU)** with a peripheral equipment consisting of auxiliary **memories**, and **input-output** units. The figure can be seen as a slightly more detailed version of the previous figure."*

*(F. Scheid, Il calcolatore e la programmazione, **1984**)*

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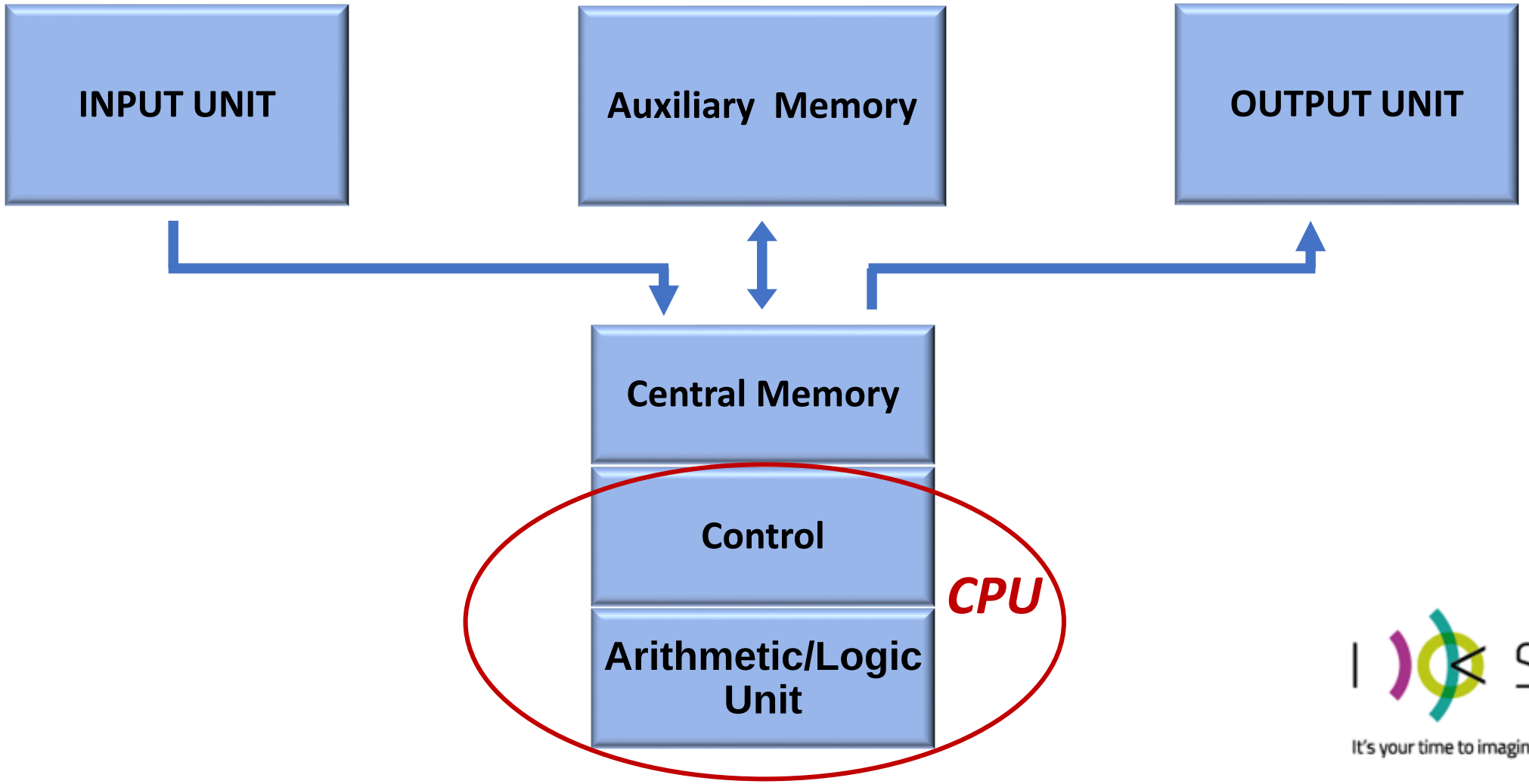
Architecture of a computer



2018….

The study and development of quantum computers has its origins in “the thought that there may be a **close correlation between the things we can compute and physics. Current computers follow the rules of classical physics.**

Once the theory of quantum mechanics was developed, physicists asked: **are there any new things that we could compute by using the principles of quantum mechanics**?”

(*La Stampa 9/11/**2018,** I computer quantistici risponderanno a domande che oggi non possiamo neppure immaginare,* interview with Andrea Rocchetto, Quantum Computing researcher, Oxford University)

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What does it mean to have…

“…a correlation between the things we can compute and physics.”?

Do current computers follow the rules of classical physics?

And also:

What does it mean that…

“…there are new things that we could compute by using the “principles” of quantum mechanics”?

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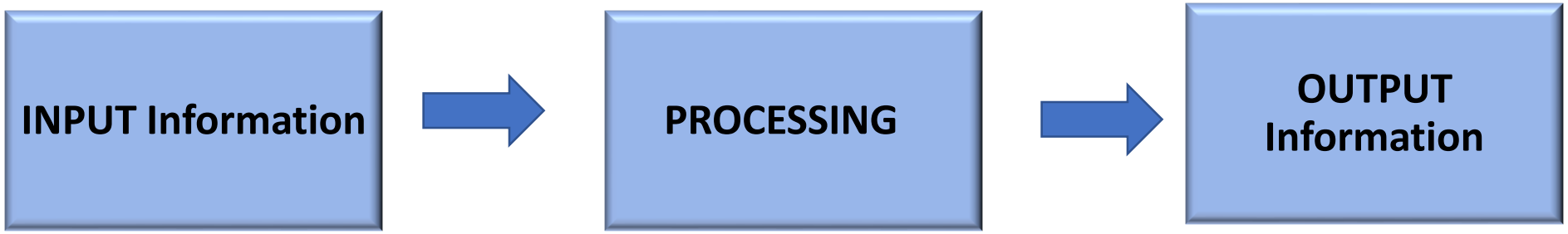
What does it mean to manage and process information?



How did information management and processing change with technological advance?

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In order to be communicated, information must first be transmitted and then understood

A communication process requires:

- ***A form of encoding*** in ***physical terms;***
- ***A form of processing*** in terms of ***algorithms.***

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Encoding for classical computers...

Basic Information Unit = ***BIT***

A bit represents the amount of information provided by a true-false, yes-no answer, on-off switch

1 state between 2 possible states

Inside a circuit, current can or cannot flow; current can go in one direction or in the opposite; a voltage can be high or low; an element can be magnetized or not;... et cetera.

The two possible states are represented by the numbers 0 and 1 (**digits**).
Their arithmetic is the binary arithmetic.

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Processing

***Processing** information means to understand:*

- *how to design the knowledge base, i.e. the **input information**;*
- *which "operations" must be carried out in order to be able to handle and "use" it;*
- *how information must be returned in order to be "understood", i.e. the **output information.***

It means to construct an **algorithm** with input and output data that are built depending on the type of information and its future use.

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Algorithm

For a classical computers…

An algorithm is a procedure that solves a given problem through a finite number of elementary steps, clear and unambiguous, in a reasonable time. (Wikipedia)

ALGORITHM:

- sequence of instructions or steps defining the operations to be performed on the data;
- the steps are executed ***in sequence;***
- It interacts with the external environment for acquiring data and communicating messages or results.

*Classic computers follow classical "**logic**"*

- *The information is processed by the algorithms with a succession of operations that are performed sequentially.*
- *The elaboration process is deterministic: if well executed, the algorithm gives a certain result.*
- *The two possible states are mutually exclusive (0 or 1 / true or false).*

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Let's go back…

"An ancient rope- and- pulley computer is unearthed in the jungle of Apraphul " by A. K. Dewdney (Scientific American, ***1988***)

"On the island of Apraphul off the North-West coast of New Guinea, archaeologists have discovered the rotting remnants of an ingenious arrangement of ropes and pulleys thought to be the first working digital computer ever built…."

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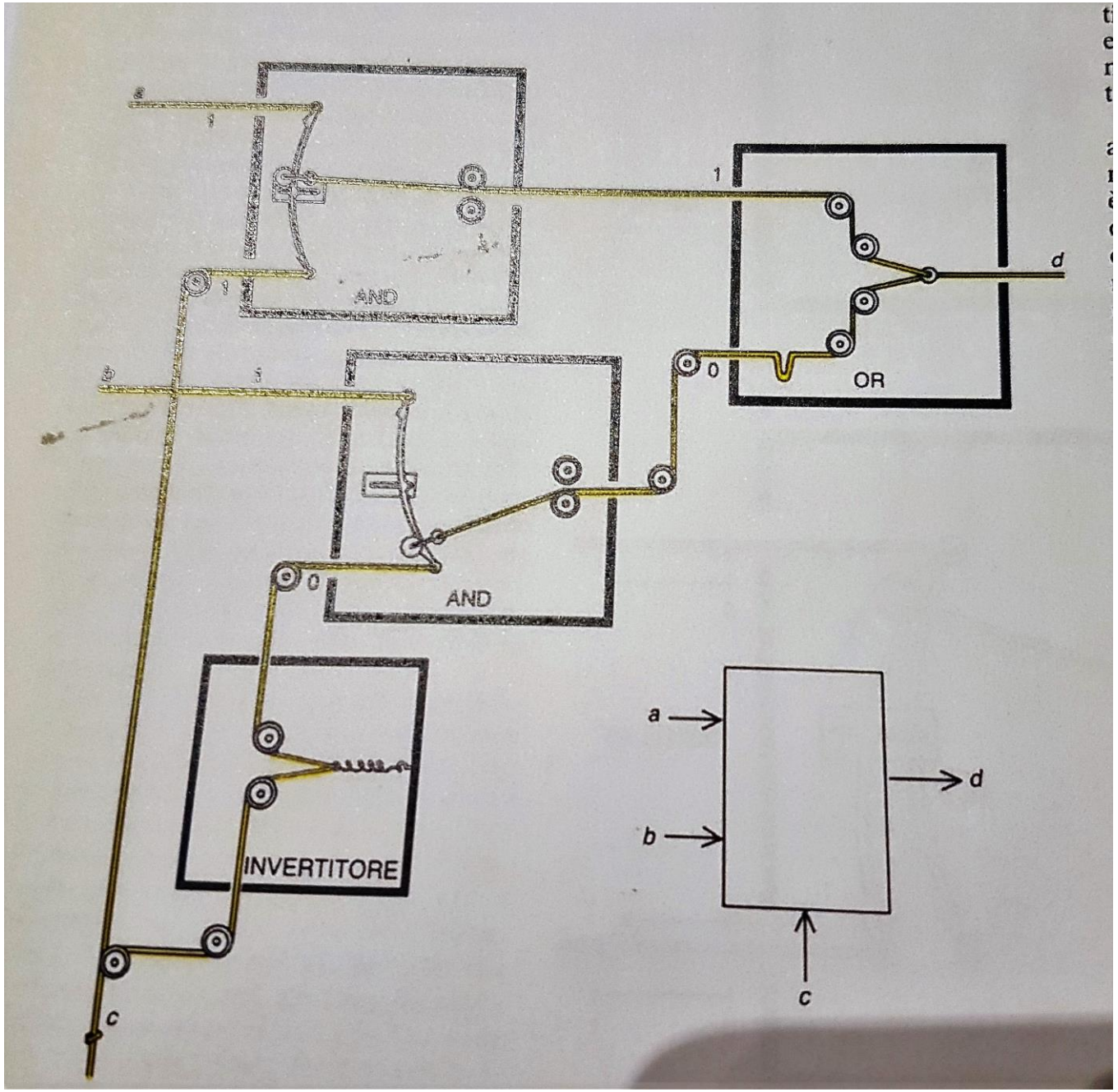
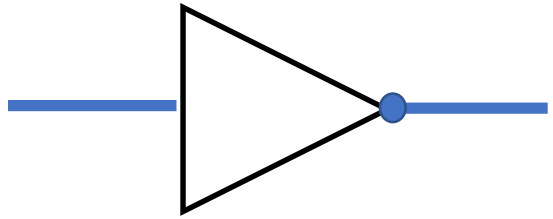


LOGIC GATES



LOGICAL OPERATORS – TRUTH TABLE

NOT

A	NOT (A)
TRUE / 1	FALSE / 0
FALSE / 0	TRUE / 1

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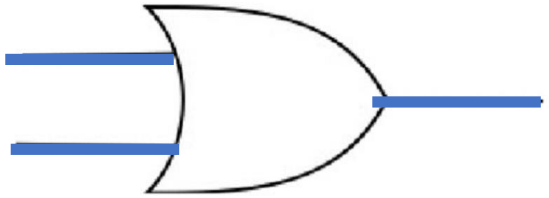
LOGIC GATES



LOGICAL OPERATORS – TRUTH TABLE

OR

A	B	A OR B
TRUE / 1	TRUE / 1	TRUE / 1
TRUE / 1	FALSE / 0	TRUE / 1
FALSE / 0	TRUE / 1	TRUE / 1
FALSE / 0	FALSE / 0	FALSE / 0

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LOGIC GATES

LOGICAL OPERATORS – TRUTH TABLE

AND

A	B	A AND B
TRUE / 1	TRUE / 1	TRUE / 1
TRUE / 1	FALSE / 0	FALSE / 0
FALSE / 0	TRUE / 1	FALSE / 0
FALSE / 0	FALSE / 0	FALSE / 0

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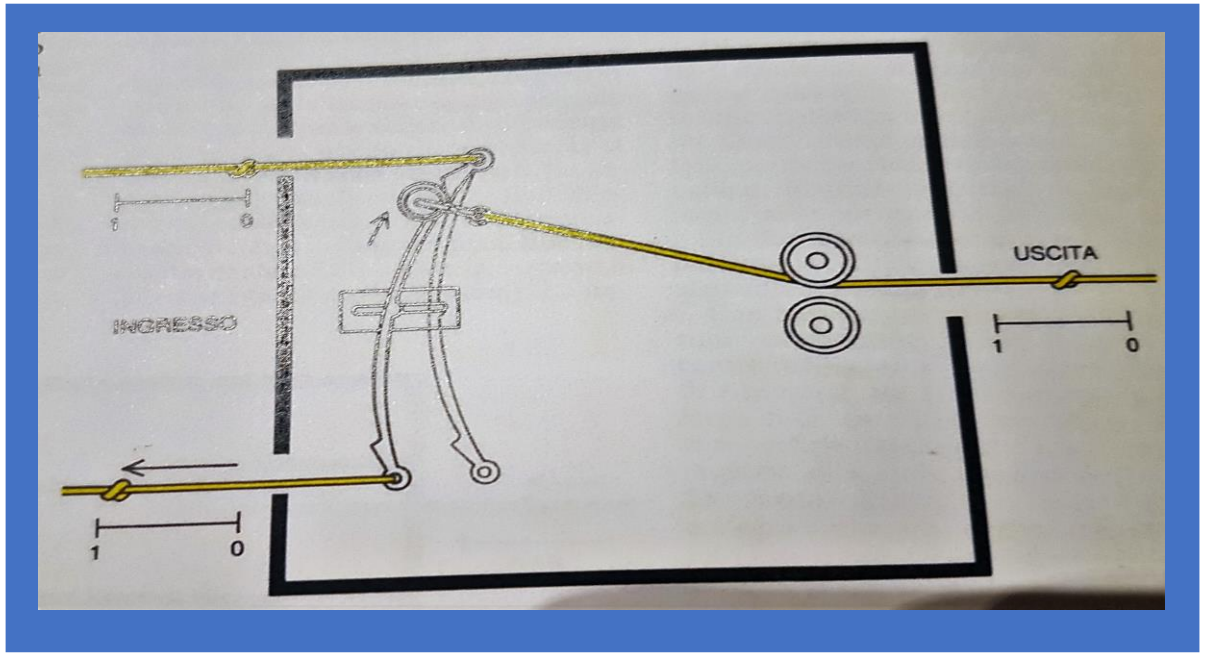
AND



A	B	A AND B
TRUE / 1	TRUE / 1	TRUE / 1
TRUE / 1	FALSE / 0	FALSE / 0
FALSE / 0	TRUE / 1	FALSE / 0
FALSE / 0	FALSE / 0	FALSE / 0

Sum of 2 binary numbers A and B, each one from a BIT

A	B	S	R
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

S

A	B	NOT A	NOT B	A AND (NOT B)	B AND (NOT A)	(A AND (NOT B)) OR(B AND (NOT A))
0	0	1	1	0	0	0
0	1	1	0	0	1	1
1	0	0	1	1	0	1
1	1	0	0	0	0	0

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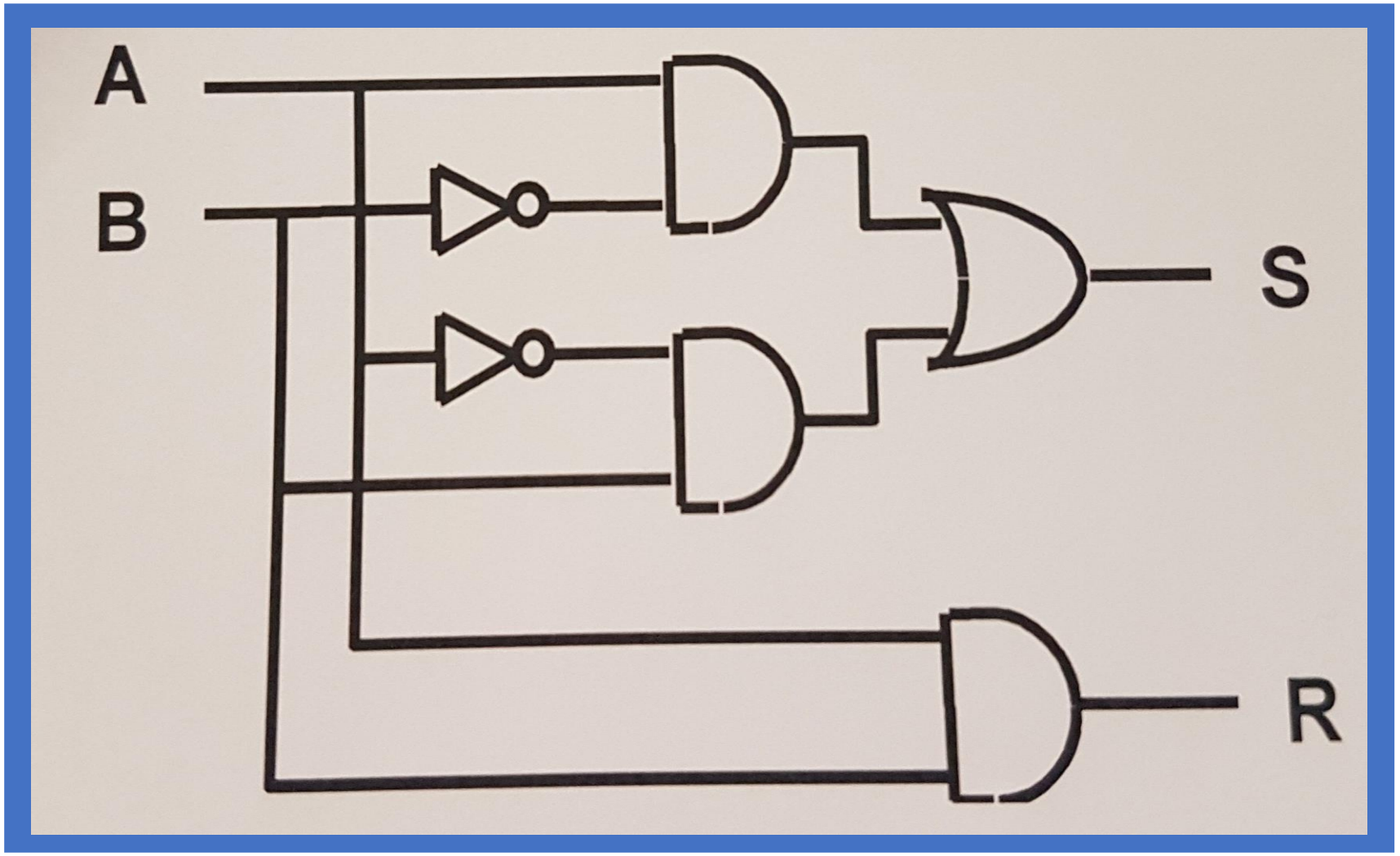
Logic Network - Semi-summer



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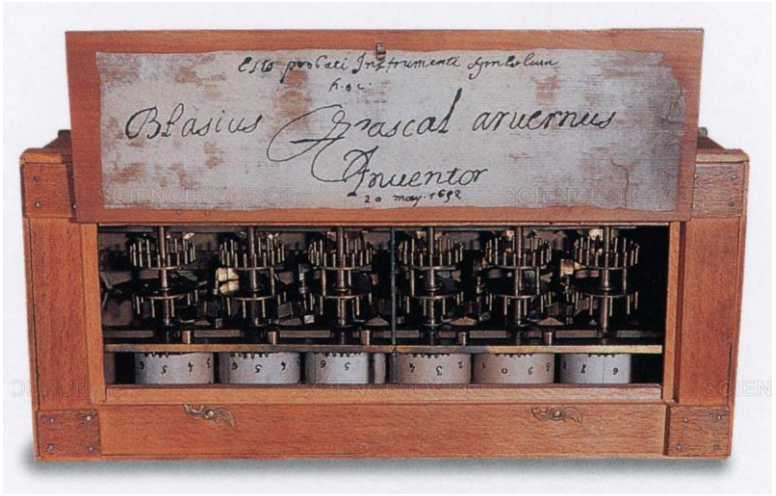
Let's go over the "history" of the computer…

Mechanical Machines … ***1640 Pascalina***

Pascal designs a mechanical calculator.



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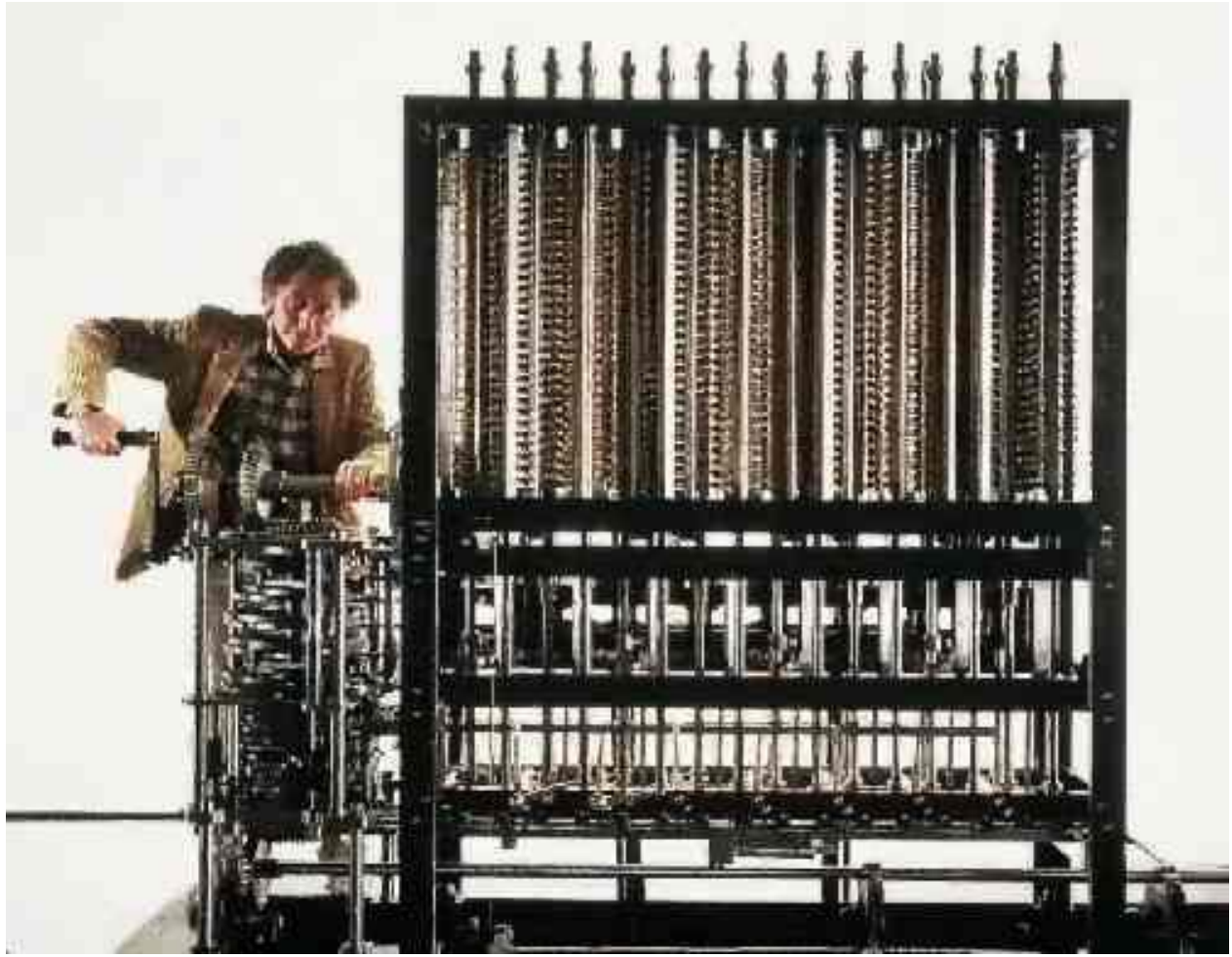
Mechanical Machines … ***1820 Babbage Machine***

They are programmed to calculate a wide range of ***arithmetic expressions***.

The problems it was supposed to solve and the information it was supposed to handle were mathematical and procedural.

It includes many "very modern" aspects as well, such as memories, punch cards, adders. But the ideas were above the technological possibilities of the time.



Mechanical Machines … ***1880 Machine made by the United States Census Office***

Machine designed to manage census data using the punch card method.

The time to analyze the data was estimated to be ¼ of the human time.

These machines are designed and built to solve mathematical applications related to the resolution of algebraic expressions (deterministic problems).

From mechanical machines to "electronic" calculators……

First generation

Vacuum tubes took on functions that had previously been carried out mechanically.

- ***1940 EIAC*** (Electronic Numerical Integrator and Computer), University of Pennsylvania
- ***1949*** EDSAC (Electronic Delay Storage Automatic Calculator), University of Cambridge
- ***1951*** UNIVAC first commercially available valve calculator

Vacuum tubes - electronic valves

A significant step…

The recording of instructions in the memory of the machine, as if it were data.

The set of instructions for performing a "certain task" was called a **programme** and machines became computers with programmes registered on them.

This was a significant step because previously instructions were sequentially given to the machine by the means of a mechanical source.

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From mechanical machines to "electronic" calculators...

First generation

Vacuum tubes took on functions that had previously been carried out mechanically.

I° computer with the architecture of von Neumann

- ***1940 EIAC*** (Electronic Numerical Integrator and Computer), University of Pennsylvania

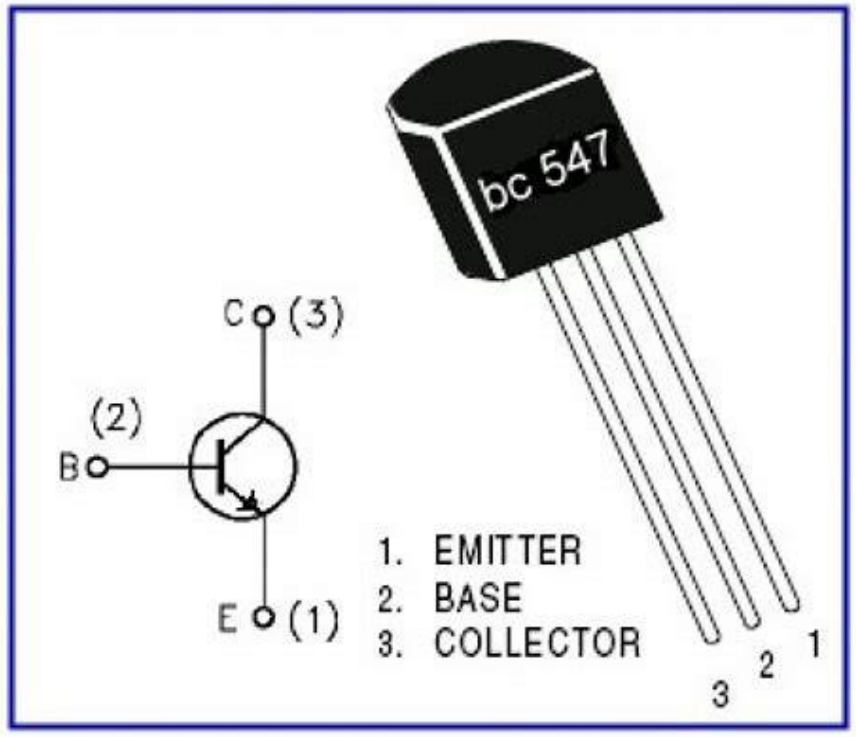
- ***1949*** EDSAC (Electronic Delay Storage Automatic Calculator), University of Cambridge
- ***1951*** UNIVAC first commercially available valve calculator

Vacuum tubes - electronic valves

From mechanical machines to "electronic" calculators…

Second generation

Vacuum tubes are replaced by transistors, which are smaller and more reliable.



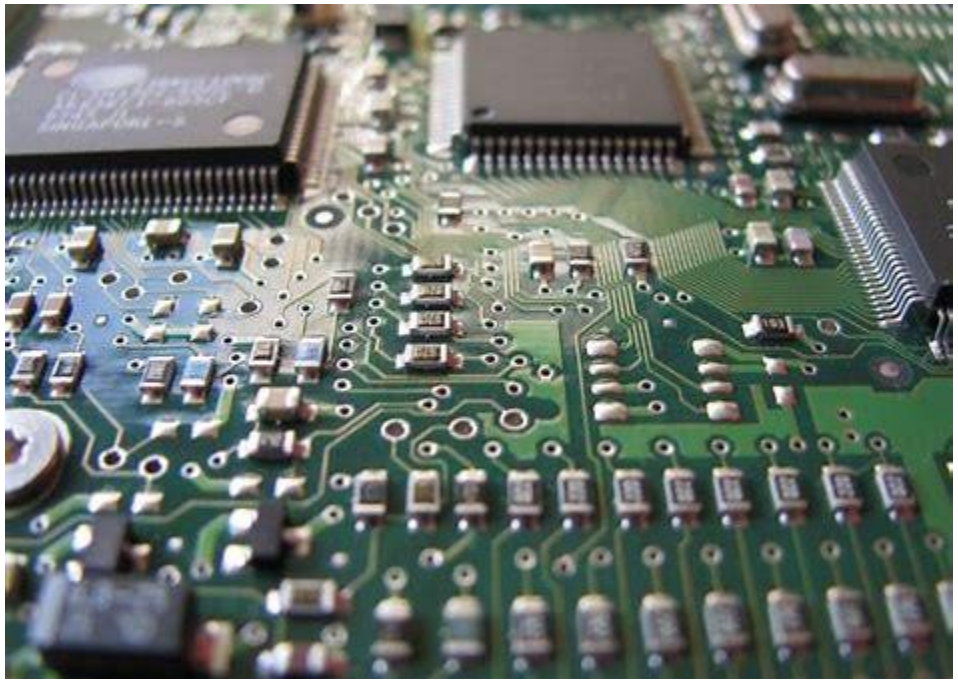
From mechanical machines to "electronic" calculators ……

60's

Third generation of computers / beginning of the history of the connection that will lead to the Internet.

Integrated circuits are introduced.

Integrated circuits: complex circuits included in a single integrated process that are capable of performing the same functions as conventional circuits with their bare components.



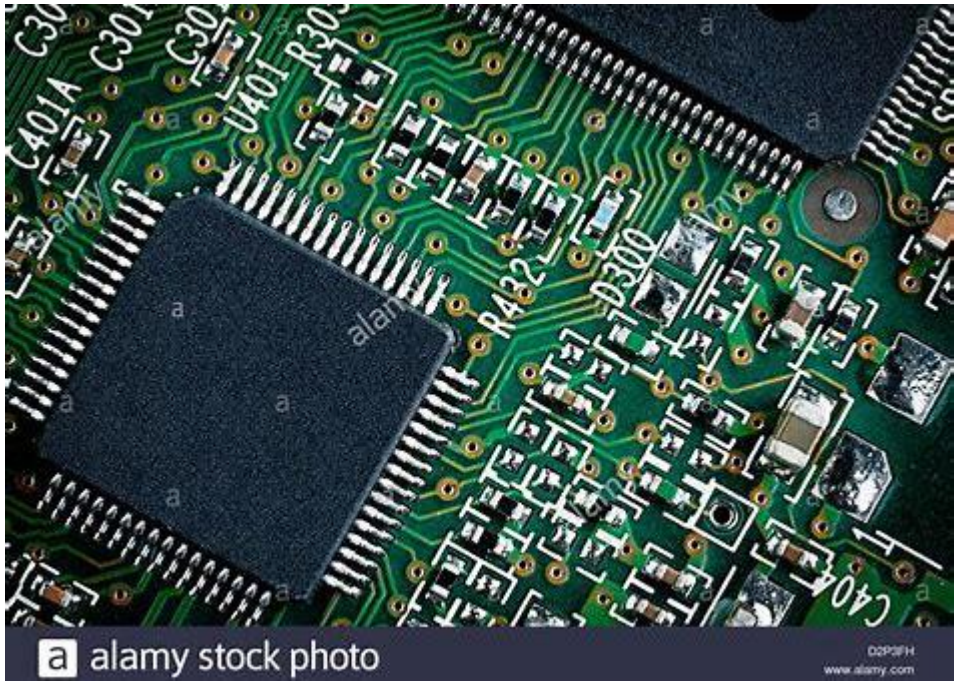
From mechanical machines to "electronic" calculators…

Fourth generation
miniaturization

Hundreds of integrated circuits in a single component with a 1/8-inch surface.

Some components (chips) were used for ***processing***, others for ***memory.***

Increased speed of calculation and cost reduction: smaller chips containing a large number of circuits substantially reduced the information travel time and therefore shorter times, greater speed.



Significant changes in devices that have made it possible to move from one generation of computers to another

- Perforated card reader (one of the first systems used);
- Magnetic tape drives (it allowed much faster input of information—hundreds of times faster);
- Remote terminals (Consoles);
- Floppy disks;
- Optical recognition of characters;
- ……

Significant changes in devices that have made it possible to move from one generation of computers to another

Memories

The information entered is stored and recorded in different ways according to the generations

- Auxiliary memories
- Magnetic tapes
- Magnetic discs
- …

Significant changes in devices that have made it possible to move from one generation of computers to another

A huge step forward: ***RAM (Random Access Memory)***

Hardware allows you to retrieve and enter data quickly. Ability to access any stored information without using a tabular search to locate the location where the information is recorded (silicon plates with integrated circuits and magnetic rings).

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Back to the '60s...

With the third generation of computers, the story of the connection up to the INTERNET begins.

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Storia di Internet

1957 - 1991

Eisenowher crea ARPA

1957

Robert LIcklider

1962

Teorizza Intergalactic Computer Network

1967

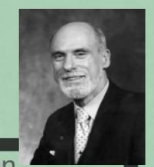
Larry Roberts

Presenta il progetto Arpanet

1965

Nasce il packet switching

Kleinrock, Baran, Davies



1969

Arpanet collega 4 università

1973

Cerf e Kahn sviluppano TCP/IP

Nasce la parola Internet

1991

Tim berners Lee

inventa il web

1985

NSFNET sostituisce Arpnanet

Arturo Di Corinto

I SEE

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The '90s: the years of the turning point…

Rapid technological advance has led to today's computers…

- Increasing power and computing capacity;
- Ever-increasing speeds;
- Ever-greater memories;
- Smaller and smaller occupied spaces;
- Increasingly connected computers…

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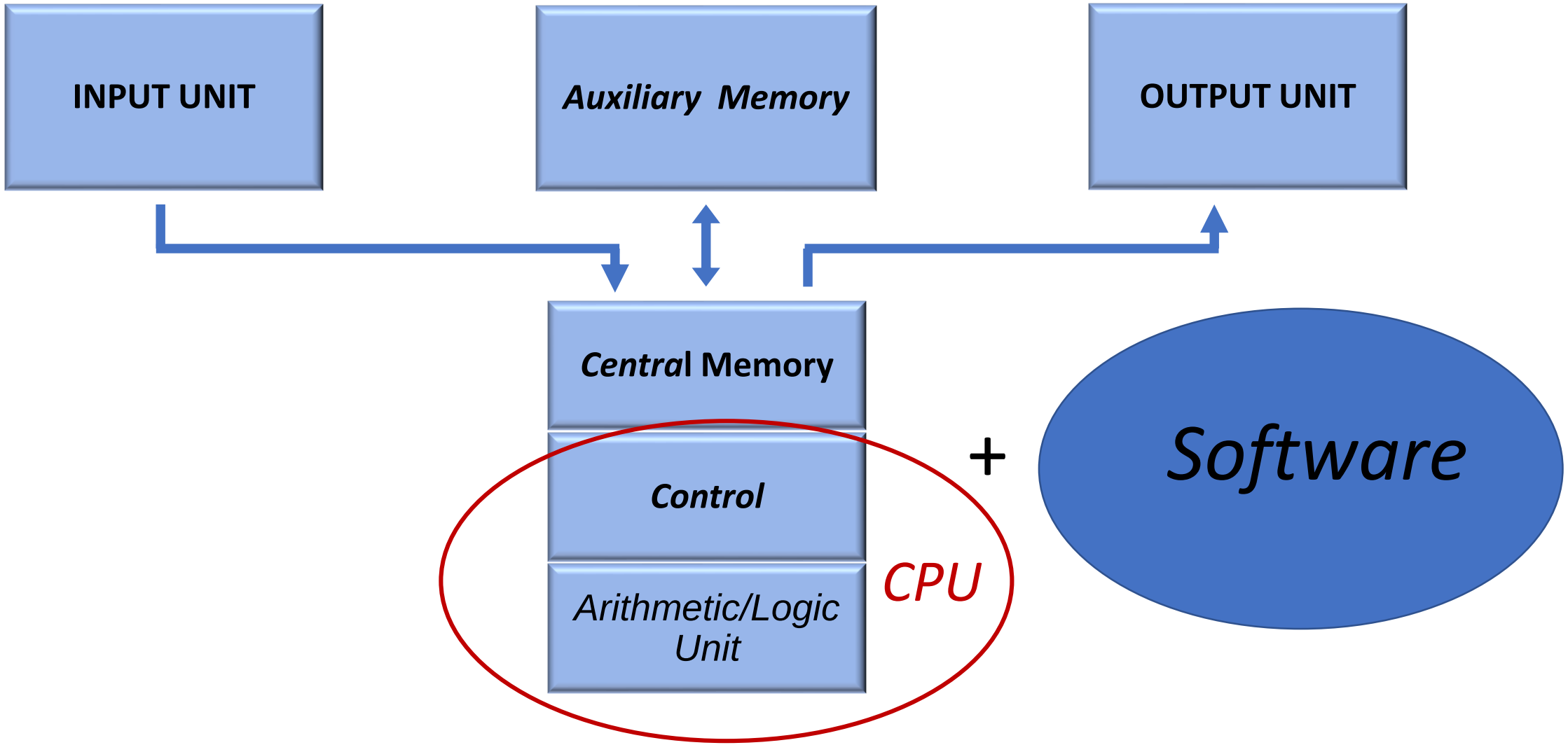
The architecture is always the same…



The development of technology allowed the development of a kind of software that is more and more distant from the classical sequential logic with which a machine processes data.

The software is developed by looking more at the type of problem to be solved and less at how the machine works.

Software development moves us away from the hardware

Developing ***software*** means developing ***algorithms***

Until the ‘90s:

- Development of concepts that refer to sequential programming, even if at a level that is increasingly closer to the problem and further from the machine;
- Great development of knowledge about data structures, design techniques and analysis that refer to the so-called

"Sequential Deterministic Algorithms"

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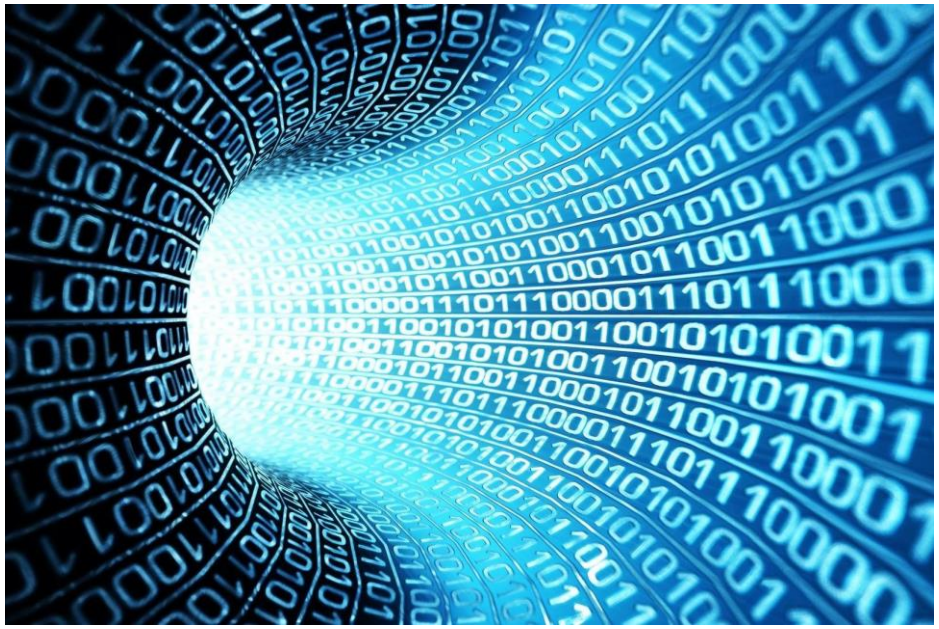
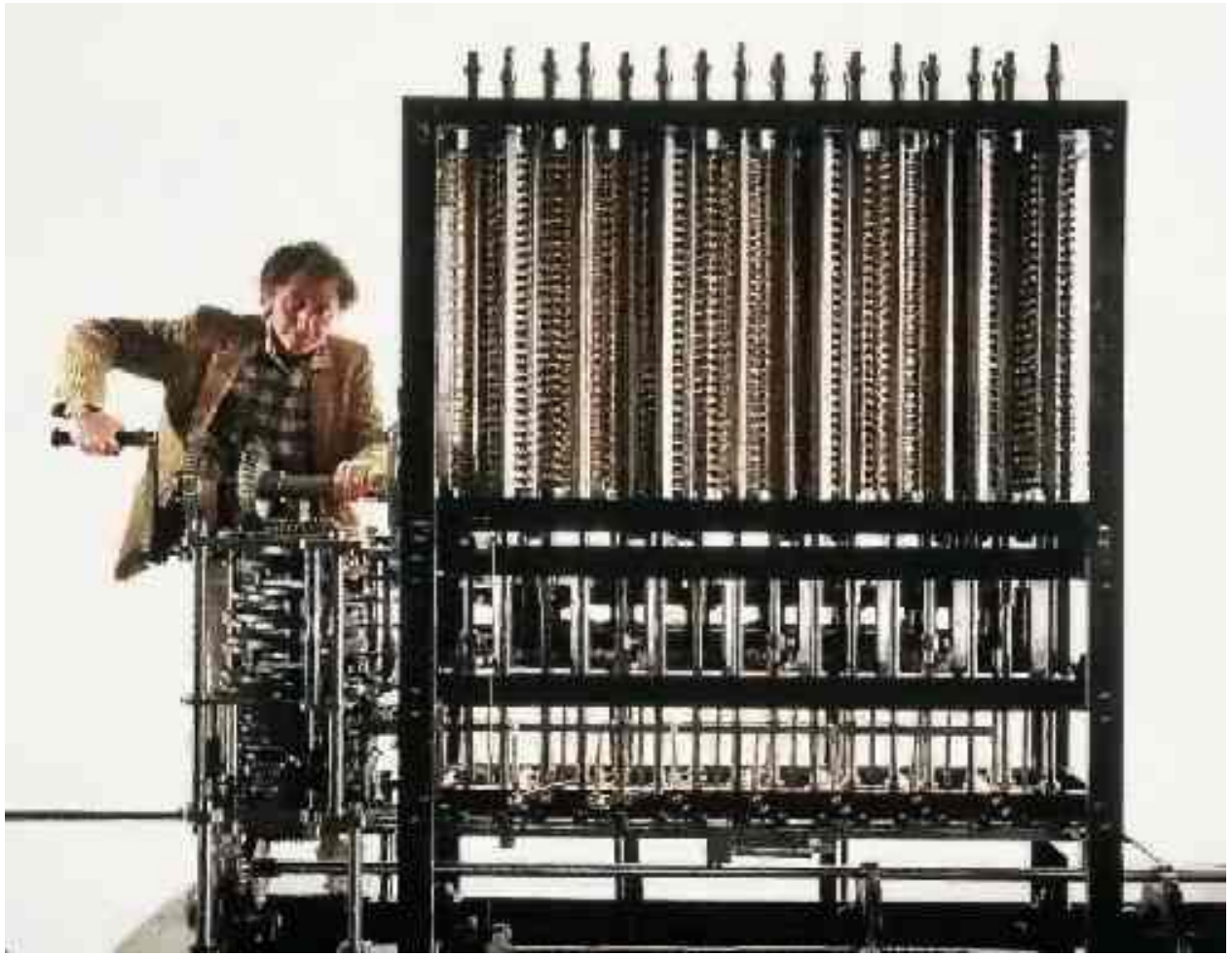
*“The evolution of electronic technologies, the push caused by the tension towards new potential applications and the need to introduce new knowledge, in a world characterized by the presence of remote and unpredictable communication systems, has required to abandon the "earthly paradise" of **sequential programming** and to venture into new areas, less systematized and more risky.*

*In the area of algorithms, the introduction of new paradigms on **the physical nature of computing** has led to attention to the development of probabilistic and quantum algorithms; further, the potential of architectures composed of many intercommunicating parts has brought to light the need to study parallel, competing and distributed algorithms.”*

(prof. Bertoni, Algoritmi II)

Will quantum computing answer questions we can't even imagine today?






D-Wave
D-Wave