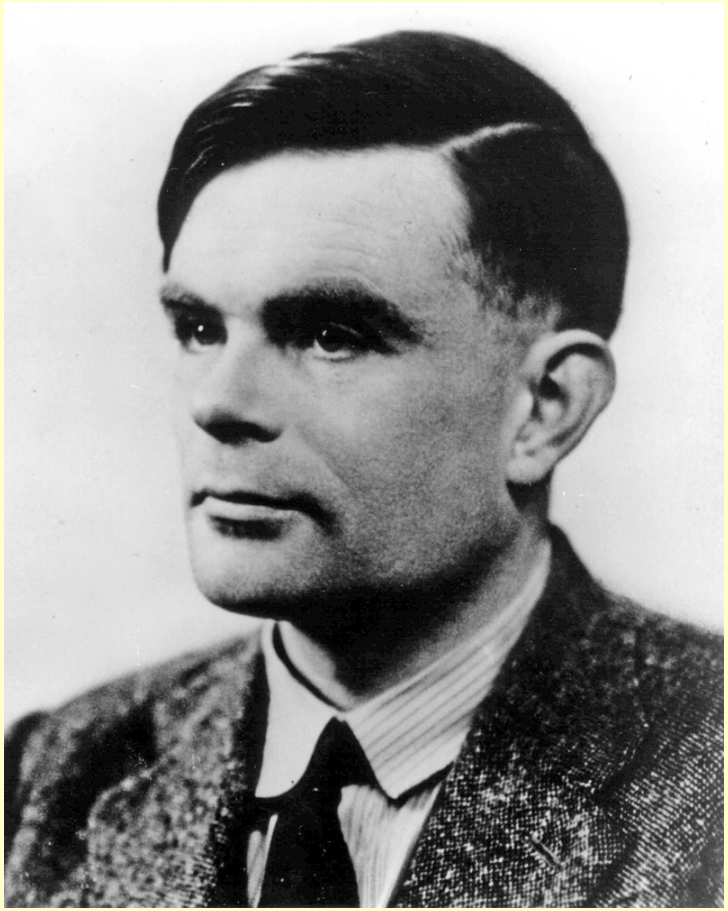
On to modern computer science…

Founders of computer science

Deschutes Hall
University of Oregon, Eugene

Alan Turing (1912-1954)



https://www.turing.org.uk/

Decision problem
Entscheidungsproblem

Is there a mechanical procedure to determine whether any given proposition is true?

If the answer were YES, then mathematicians and most scientists would lose their jobs.

Luckily, it is NO, according to Turing's work.

Mechanical procedure?

A mechanical procedure is a sequence of very simple activities that can be automated.

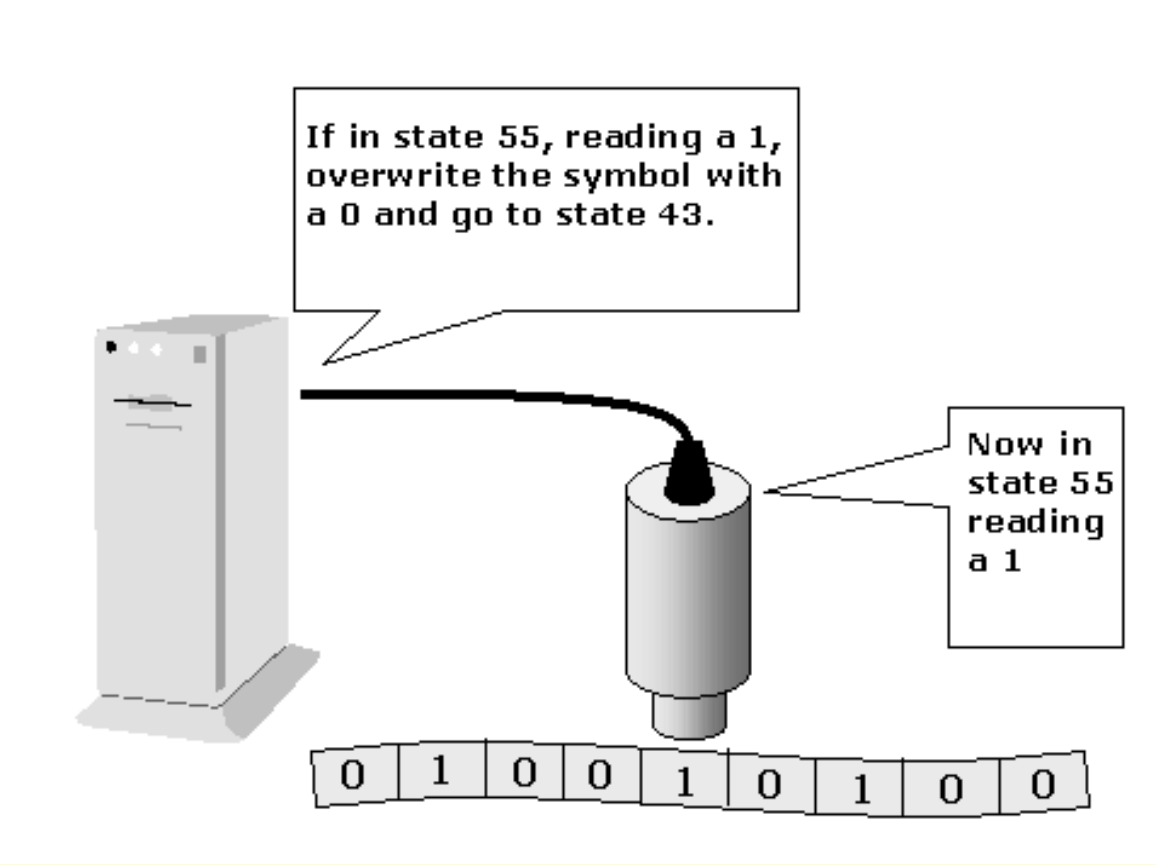
To formalize the notion of mechanical procedures, Turing considered a little machine…

Turing machine (1937)

A Turing machine is comprised from:

- A *tape* of infinite length, divided into small cells. A cell can store a single letter.
- A *tape head* to read/write one letter at a time.
- A finite number of *states*, where each state is equipped with a very simple instruction.

Turing machine (1937)

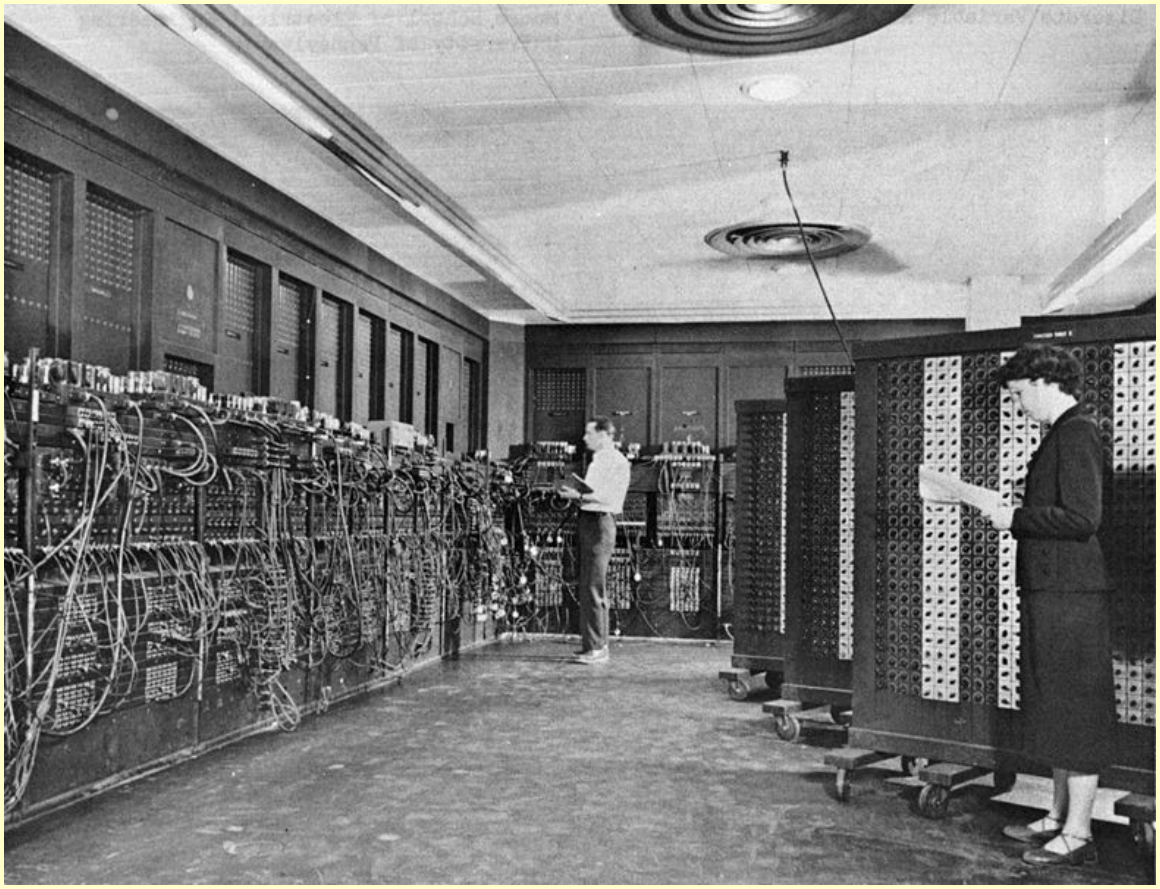


The Church-Turing thesis

A Turing machine is equivalent to an algorithm.

No Turing machine can solve the decision problem $\Leftrightarrow$ no algorithm can solve the decision problem.

ENIAC (1946)



https://www.wikipedia.org/

Hardware layers of a computer

A computer may look very complex, but its hardware is comprised of layers of simple components.

- bits
- switches
- gates
- circuits
- the processor and memory

Bits

A bit is the smallest unit of information used in computers. A bit is either 0 or 1.

Information of any format (numbers, texts, images, sounds, etc.) is represented in a collection of bits; that is, a sequence of 0's and 1's.

Binary notation

For example, numbers are represented in 0's and 1's in the following way.

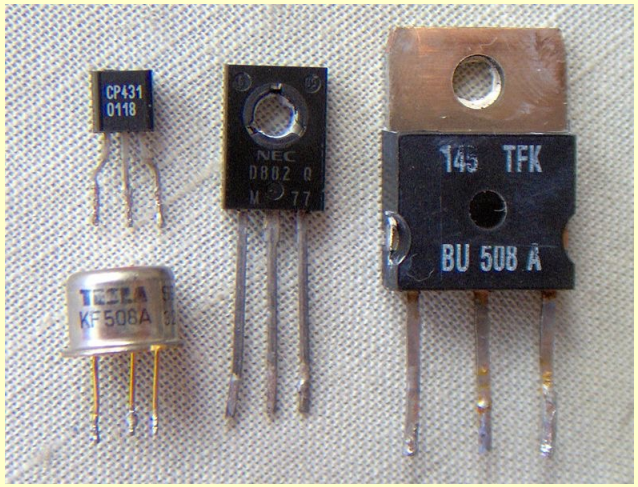
0	⇔	0
1	⇔	1
2	⇔	10
3	⇔	11
4	⇔	100
5	⇔	101
	...	

Swiches

A switch is a device that changes the status of a bit from 0 to 1 and vice versa.

In the early days (1940s and 1950s), *vacuum tubes* and *transistors* were used as switches.

https://www.tablix.org/

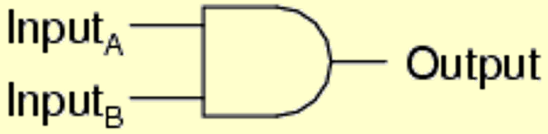


https://www.wikipedia.org/

Gates

A gate is a tiny device made out of switches designed to perform a very simple task.

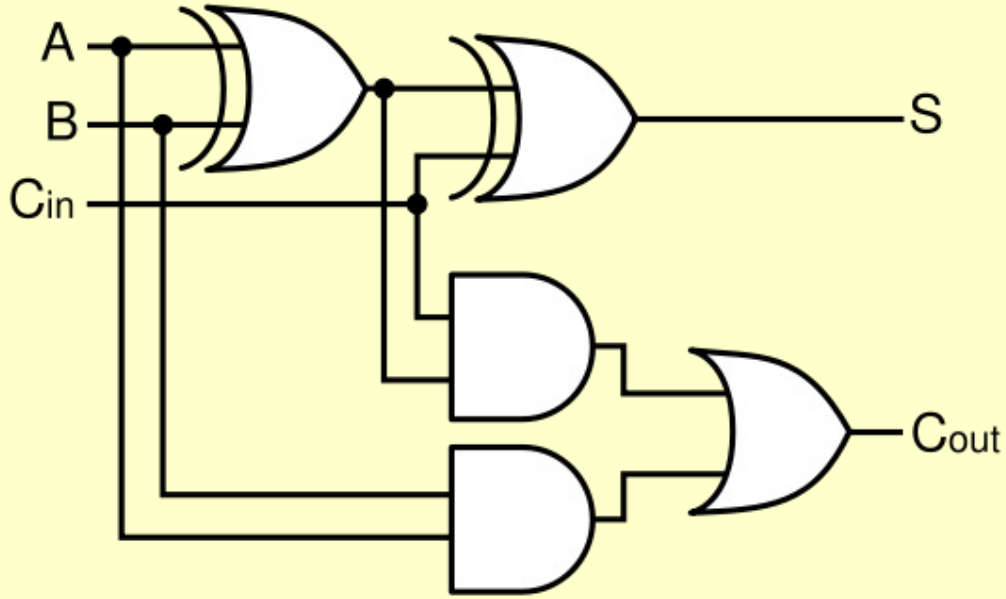
2-input AND gate



A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

Circuts

A circuit is a tiny device made out of gates designed to perform a simple task.



The processor and memory

The processor and memory are the most critical components of a computer. Both are made out of circuits.

- A *processor* executes computer programs (which are basically algorithms written in a computer language).
- *Memory* stores a large amount of information (in bits). Programs as well as data are stored in memory.