

Information Technology - advanced

Lecture 1
Computer hardware and
numbering systems

Course introduction

Course info

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- ❖ course web page: <https://sas.utmn.ru/en/sas-it-course/>
- ❖ shared google folder: <https://goo.gl/SsXpSr>

Course web page

university
of
tyumen

school
of advanced
studies

Ru / Eng



About

BA Program:
general description
structure
curriculum
electives
booklet (in Russian)
FAQ

MA Programs

Digital Cultures and
Media Production

Education

① First year

Module No

1st module

2nd module

Research

Events

Course title → in-class
academic hours

Writing and Thinking ➡ 90

Analysis and Interpretation ➡ 90

“The City as Text”

Physical Education ➡ 32

History ➡ 16

Great Books: Philosophy and Social

Course web page

4th module

Global Issues ➔ 48

Quantitative Methods ➔ 32

1 out of 7 **electives ➔ 64**

Physical Education ➔ 32

Open Courses

History ➔ 16

Great Books: Philosophy and Social

Thought ➔ 32

Information Technologies ➔ 64

1 elective ➔ 64

Physical Education ➔ 32

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university
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school
of advanced
studies

Rus /Eng



Education

Research

Events

SAS IT course

On this page I will collect some useful information for the students of the IT course for the SAS (see links at the bottom).

This is a core course, we have divided the SAS students in 4 groups of students:

IT basic 1, IT basic 2, IT intermediate, IT advanced,

for the three syllabi reported in the links below.

This year I will teach all the courses, and we will start in room 203.

Please don't hesitate to write me for any question concerning the course:

f.grazioso@utmn.ru

Fabio Grazioso, 13 April 2018.

[Textbooks and other material](#)

[IT basic - list of classes](#)

[IT intermediate - list of classes](#)

[IT advanced - list of classes](#)

[Classes Slides](#)

Shared folder

	summaries on this subject.
Norman – The Design of Everyday Things (2002)	This is an interesting side reading on the subject of User Interfaces and ergonomics.
Mackay – Information Theory, Inference, and Learning Algorithms (2004)	This book will be used mostly just for the lecture on Information Theory.
Sipser – Introduction to the Theory of Computation [3rd Ed] (2012)	This book will be used mostly just for the lecture on Complexity Theory.

These and few other books can be found at this [shared folder](#).



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introduction

- ❖ bird's-eye view
- ❖ several concepts
- ❖ have a general idea of many different things
- ❖ have the tools to do an in-depth study in the future
- ❖ refer to the books
- ❖ you don't need to read all the books!

Todays' lecture

Computers



summary of the lecture

- ❖ Historical introduction
- ❖ Turing Machine
- ❖ Computer architecture
- ❖ Data representation

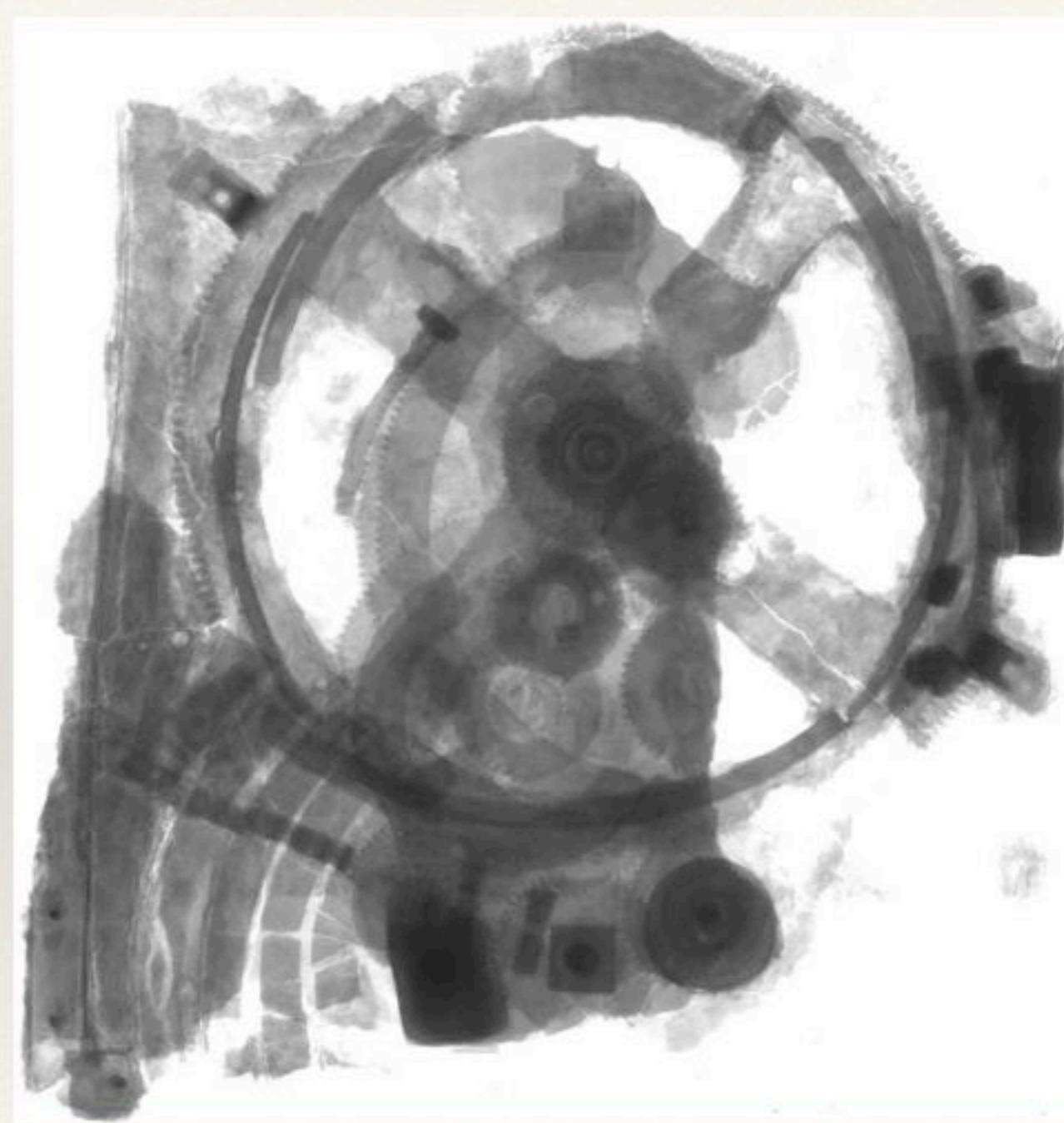
Historical introduction

Old mechanical computing devices



Antikythera mechanism

Old mechanical computing devices



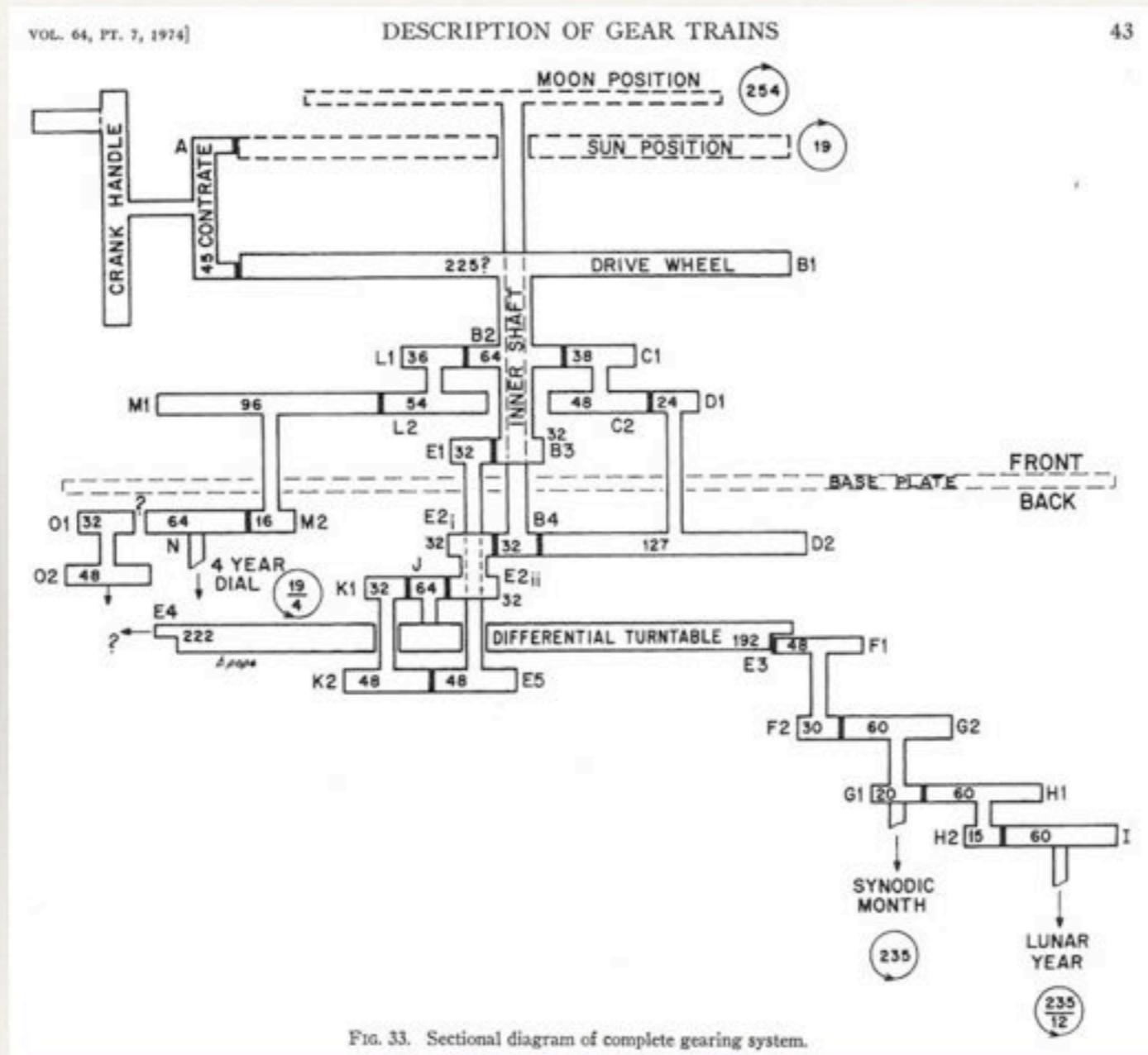
Antikythera mechanism

Old mechanical computing devices



Antikythera mechanism

Old mechanical computing devices



Antikythera mechanism

Old mechanical computing devices

ANTIKYTHERA MECHANISM – THE BOOK



Computer model of the Antikythera Mechanism made by Rhidian

MODELS



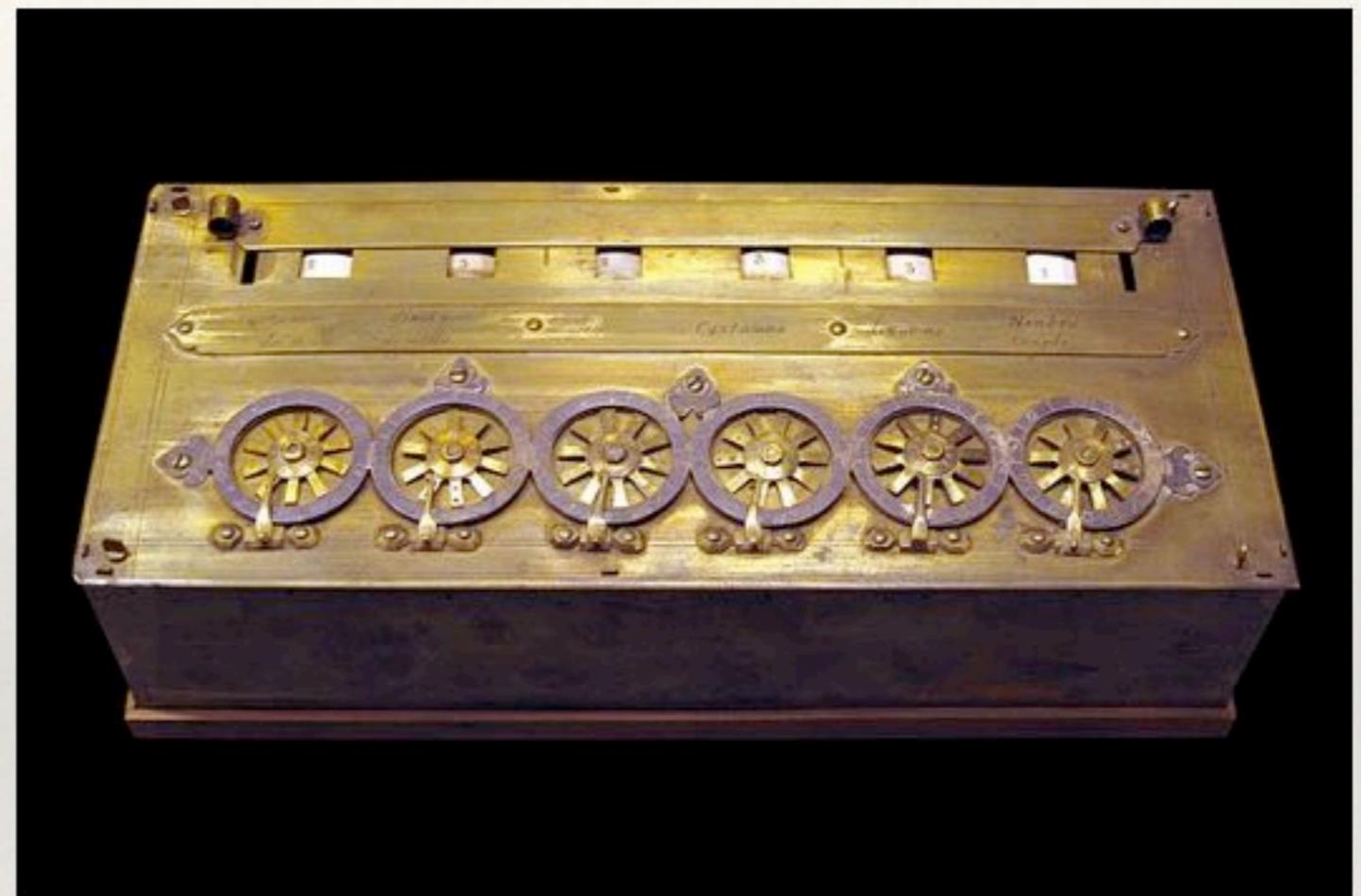
The Neuma calendar and the Olympiad dial of the Mechanism
Computer model by Rhidian, with jets designed by the Aristotle
University of Thessaloniki

Antikythera mechanism

Old mechanical computing devices

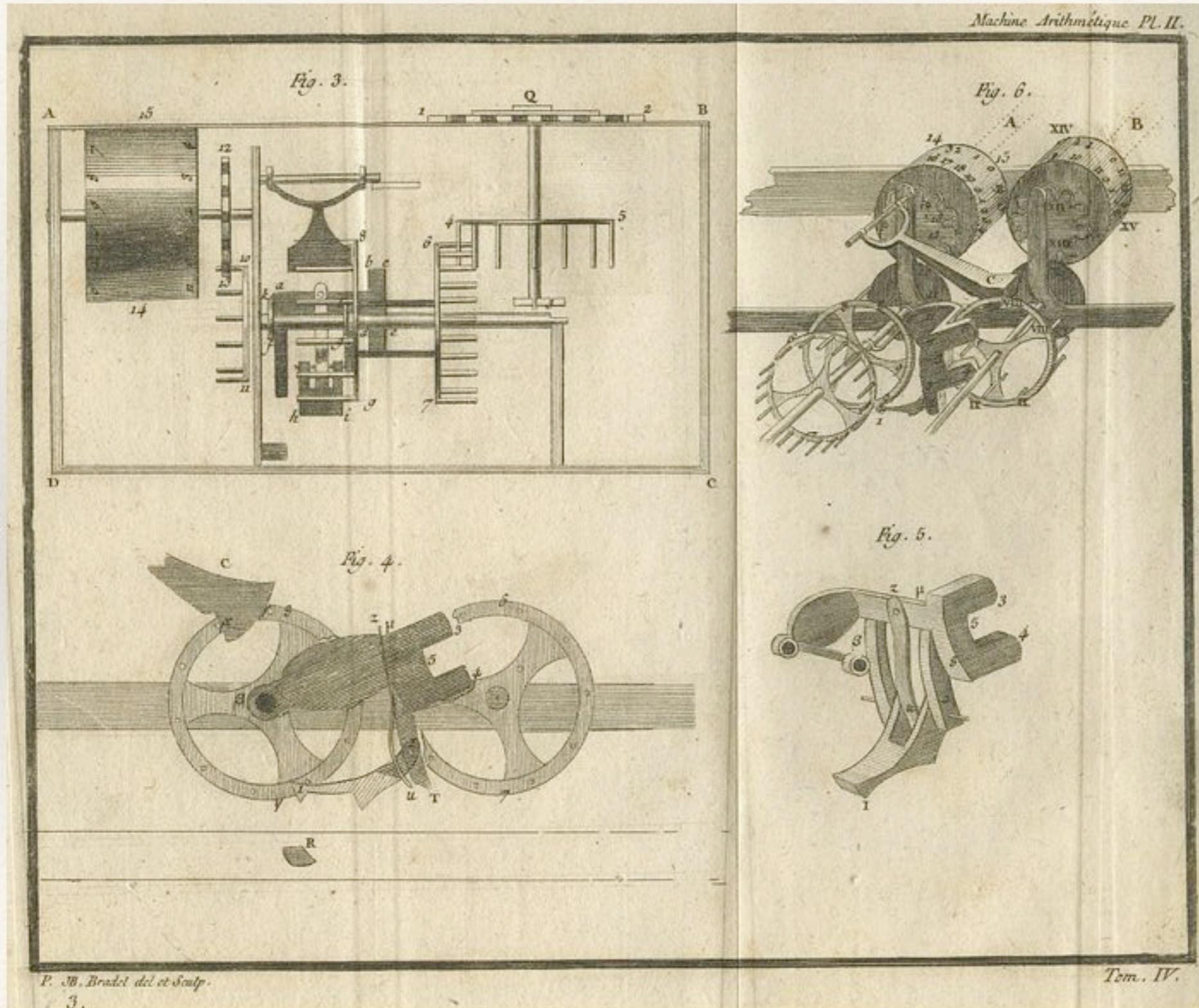


Blaise Pascal



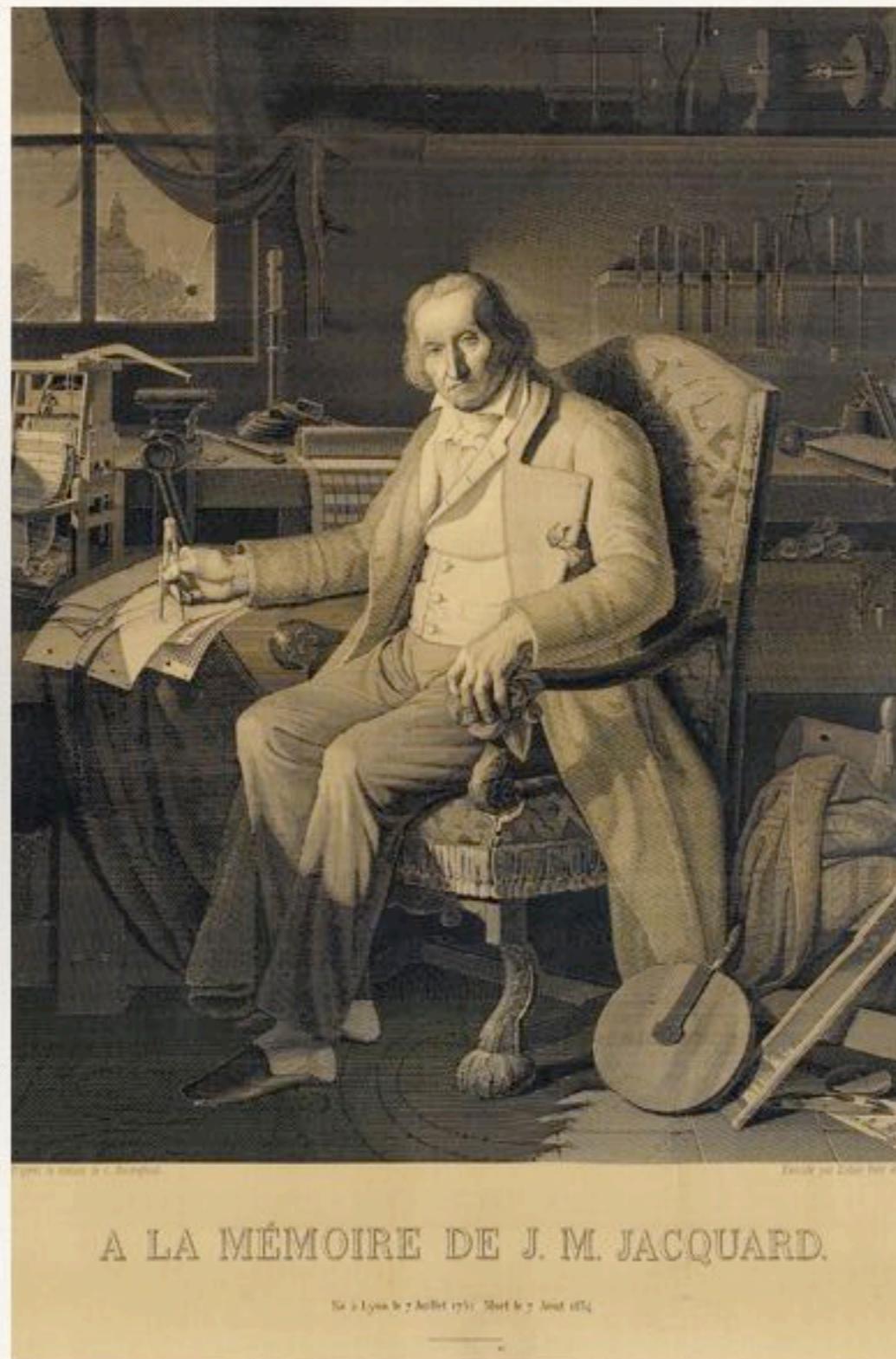
Pascal's calculator

Old mechanical computing devices



Old mechanical computing devices

Joseph Marie Jacquard



Old mechanical computing devices



Jacquard loom

Old mechanical computing devices



Jacquard loom

Old mech

g devices

ARTI E MESTIERI
TELATO ALLA JACQUART

PIG. XXXV (26)

Fig. 2.

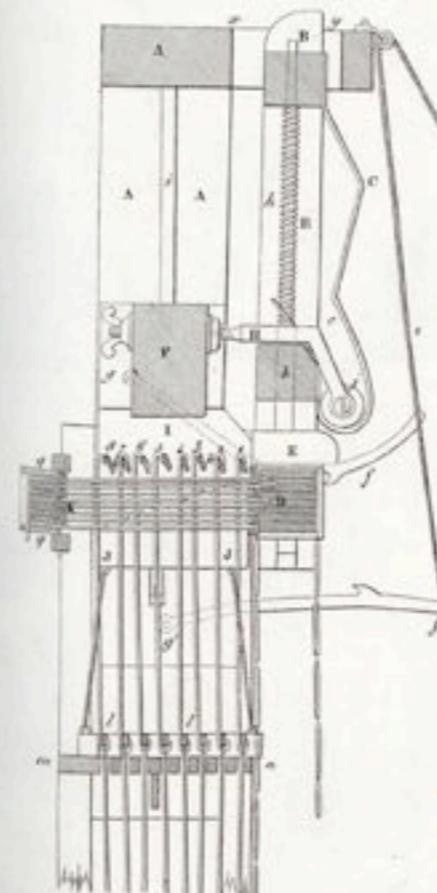


Fig. 1.

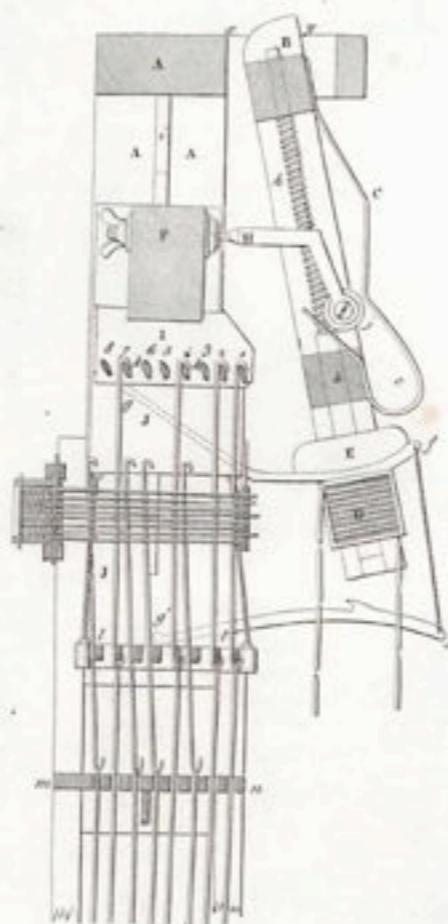


Fig. 4.

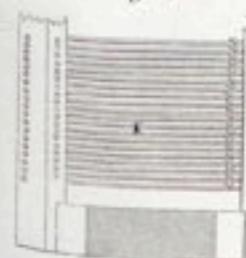
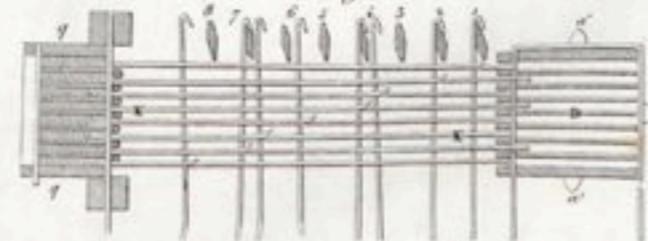
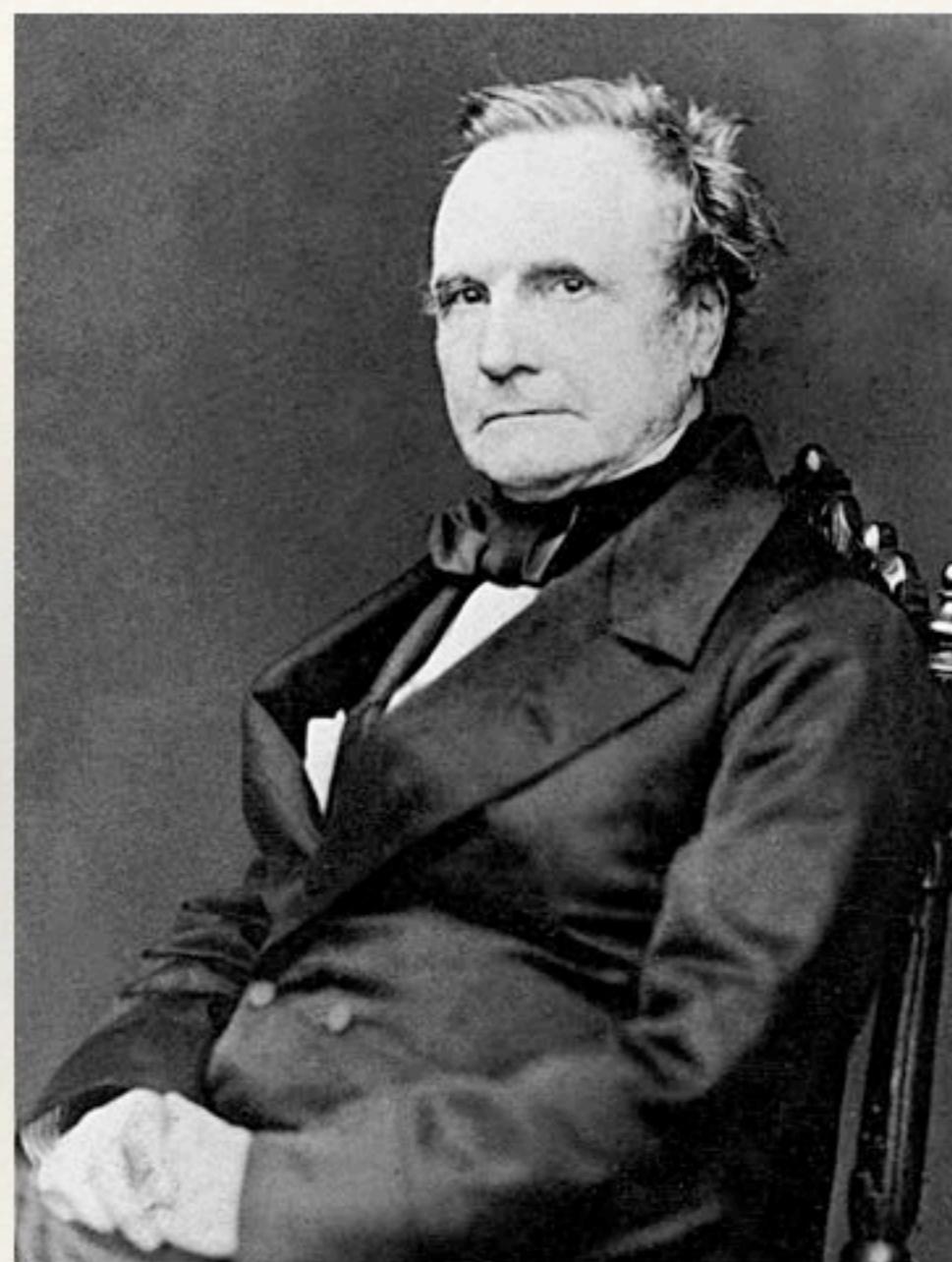


Fig. 3.



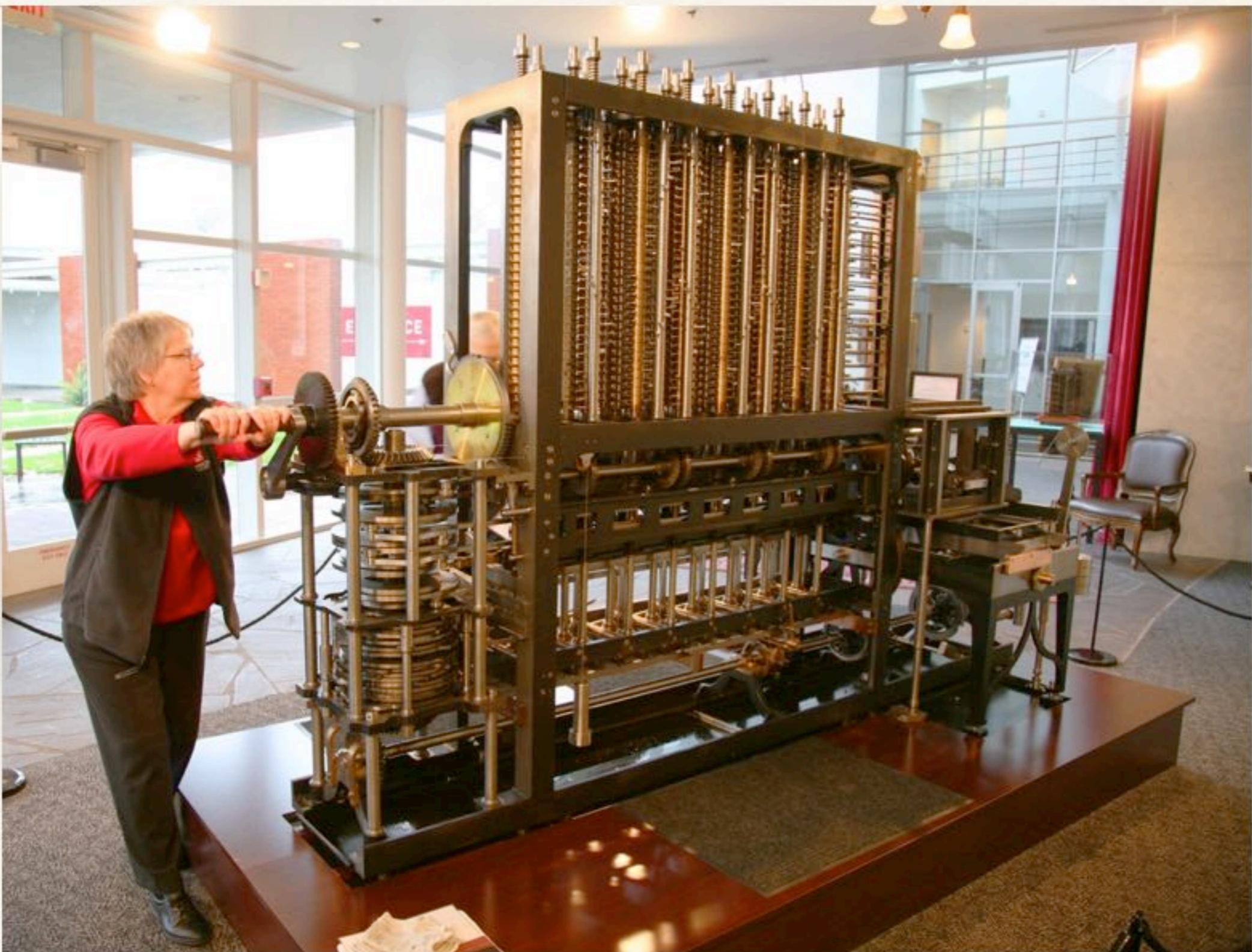
Jacquard loom

Old mechanical computing devices



Charles Babbage

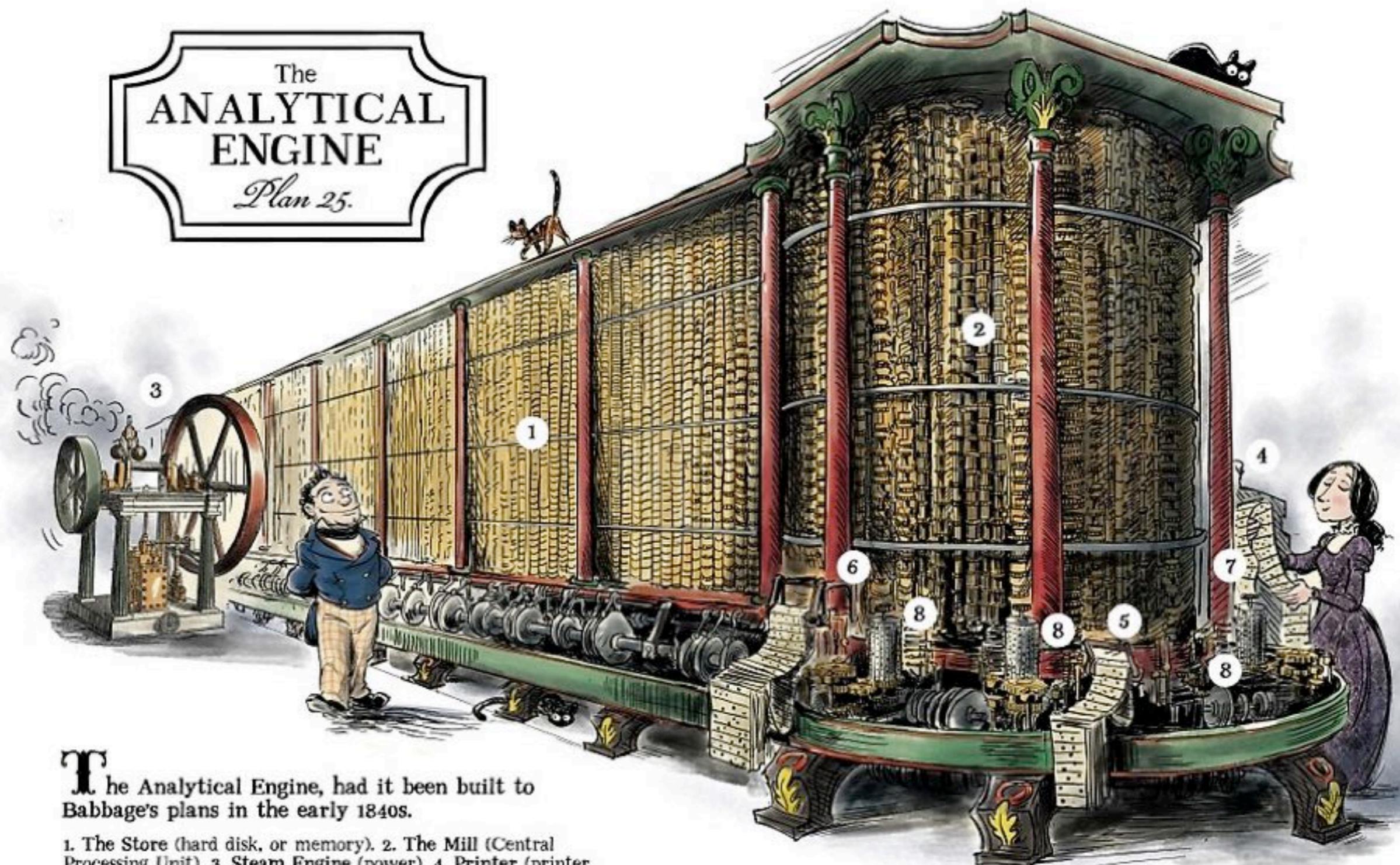
Old mechanical computing devices



Old mechanical computing devices



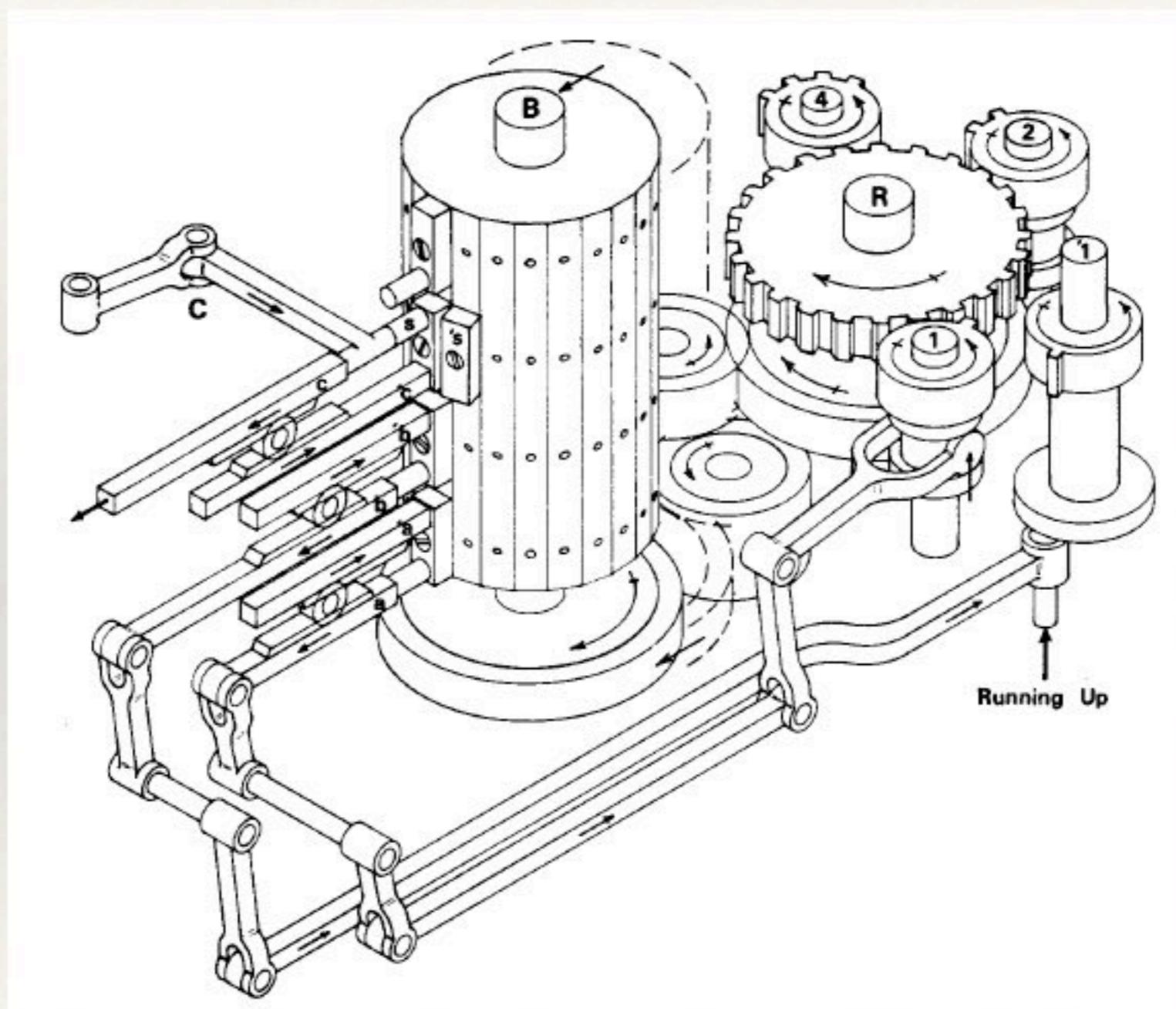
The
**ANALYTICAL
ENGINE**
Plan 25.



1. The Store (hard disk, or memory).
2. The Mill (Central Processing Unit).
3. Steam Engine (power).
4. Printer (printer, round the other side).
5. Operation Cards (the program).
6. Variable Cards (Addressing system)
7. Number Cards (for entering numbers).
8. The Barrel Controllers (microprograms).

Sydney Padua

Old mechanical computing devices



difference engine - detail

programming is for women!



Ada Lovelace



Augusta Ada King-Noel, Countess of Lovelace

programming is for women!

Grace Brewster Murray Hopper



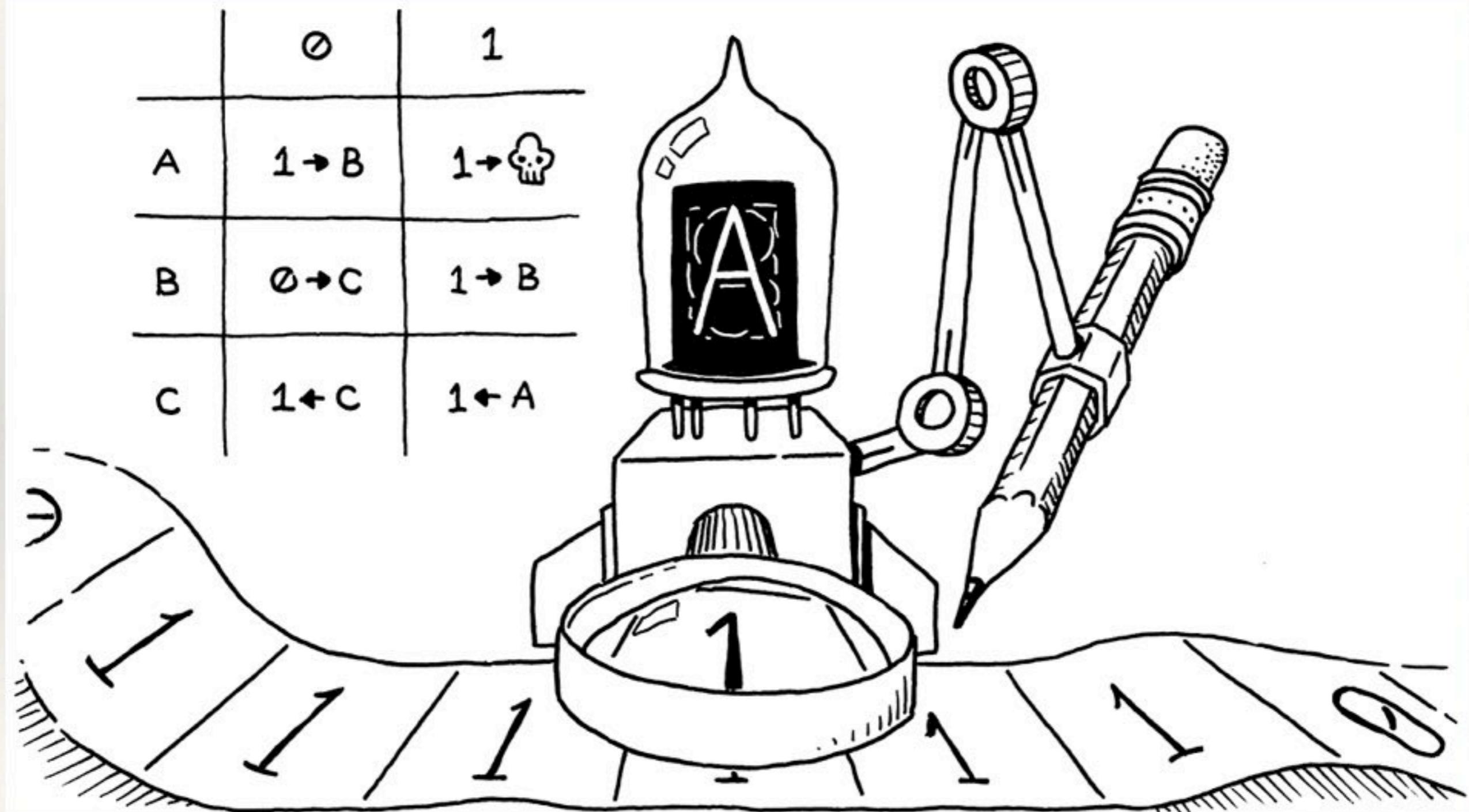
programming is for women!



Grace Brewster Murray Hopper

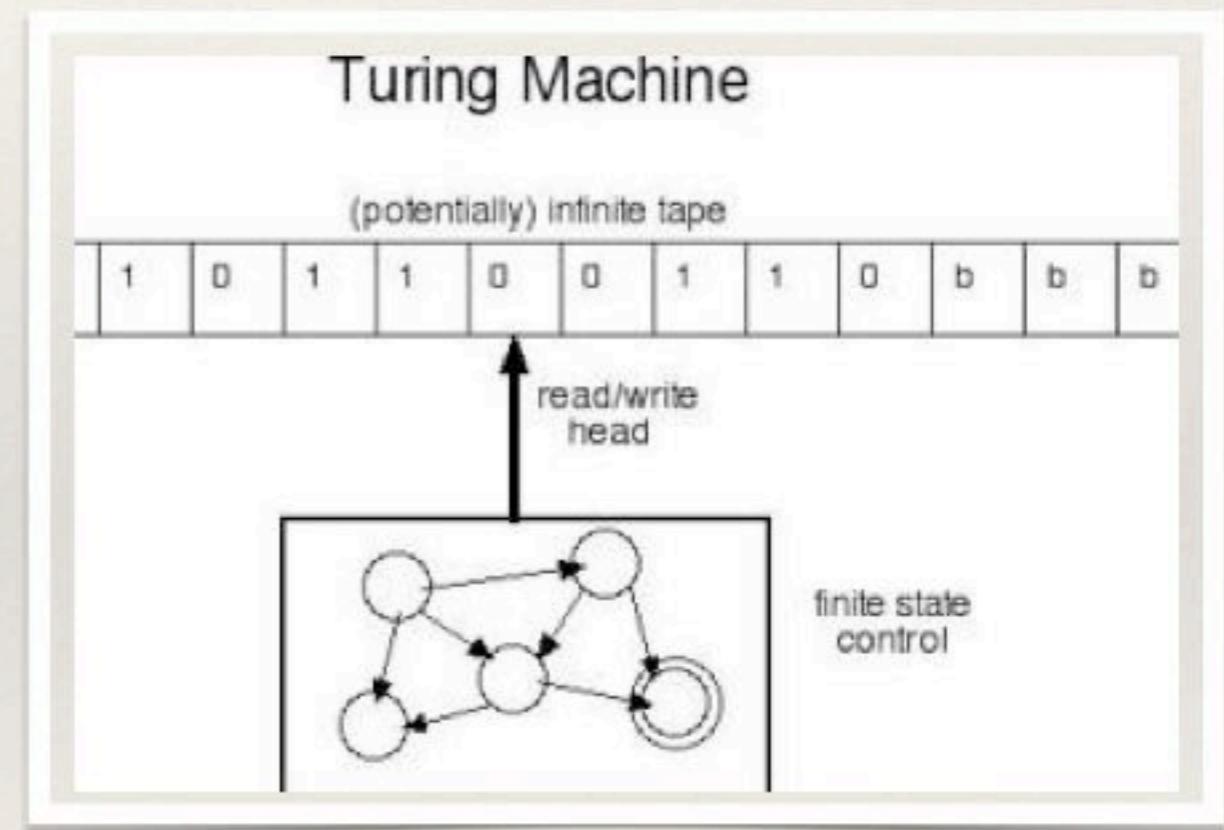
Foundational concepts

The Turing machine



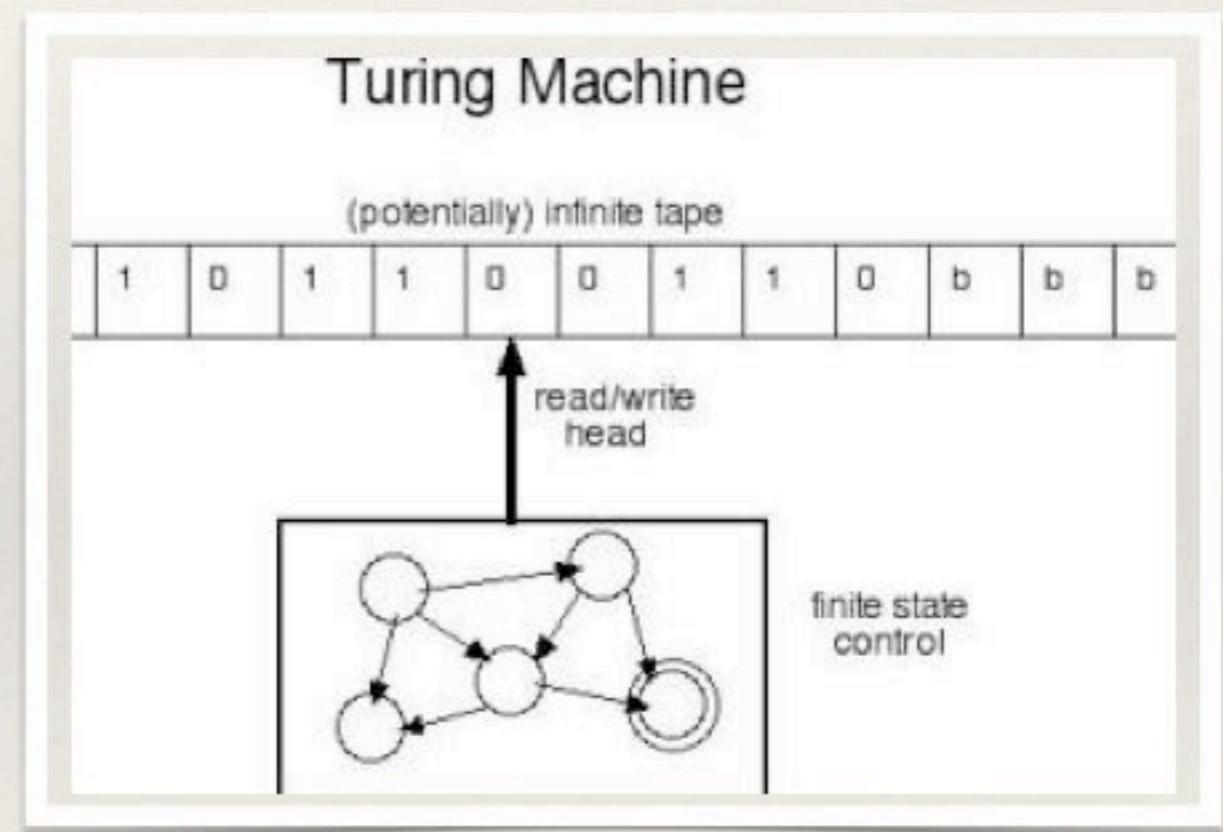
The Turing machine

- ❖ an infinite tape
 - ❖ divided in discrete cells
- ❖ a read / write head
- ❖ a finite-state control unit



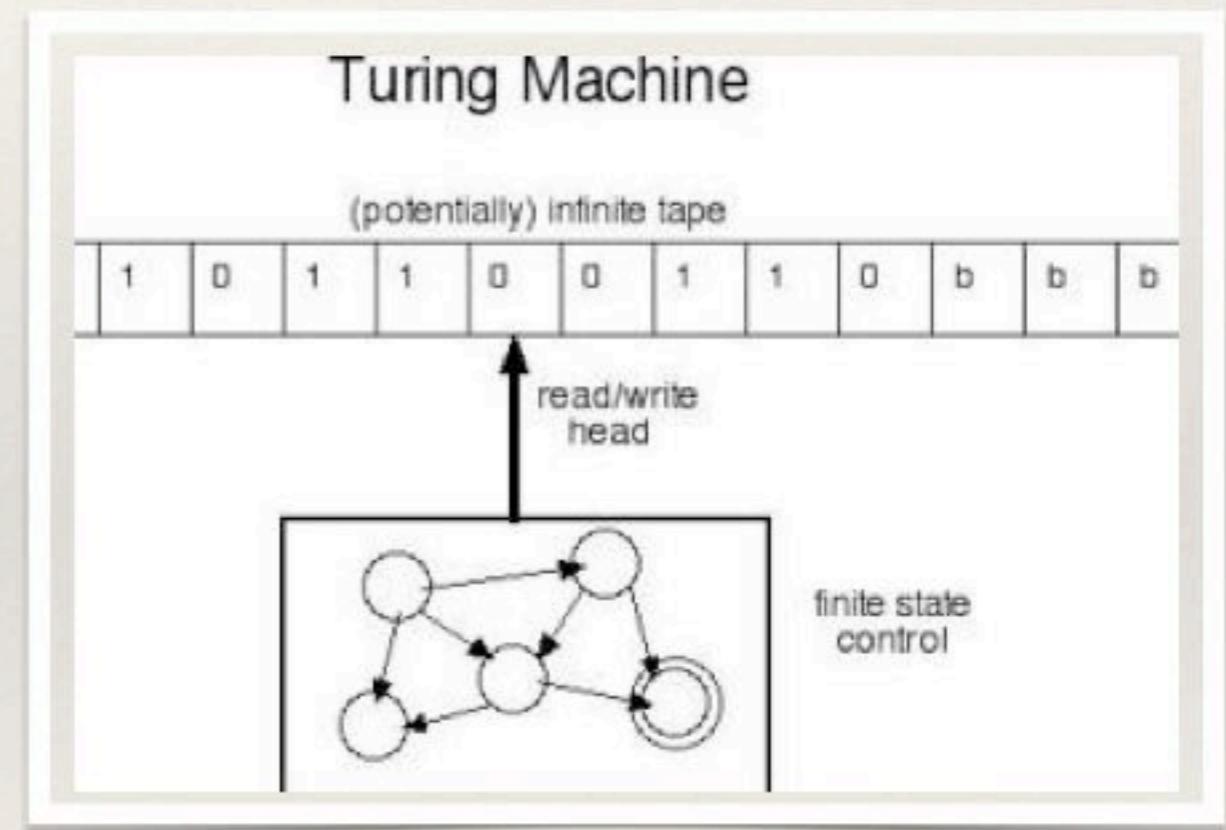
The Turing machine

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The Turing machine

- ❖ an infinite tape
 - ❖ divided in discrete cells
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The Turing machine

- ❖ a finite-state control unit

DEFINITION 1.5

A **finite automaton** is a 5-tuple $(Q, \Sigma, \delta, q_0, F)$, where

1. Q is a finite set called the **states**,
2. Σ is a finite set called the **alphabet**,
3. $\delta: Q \times \Sigma \rightarrow Q$ is the **transition function**,¹
4. $q_0 \in Q$ is the **start state**, and
5. $F \subseteq Q$ is the **set of accept states**.²



Church-Turing conjecture

«Anything that can be computed at all can be computed by a Turing machine.»

«A function on the natural numbers is computable by a human being following an algorithm, ignoring resource limitations, if and only if it is computable by a Turing machine.»

«The intuitive concept of *algorithm* and the rigorous definition of Turing machine are equivalent»

human computers



Harvard_computers 1890

human computers



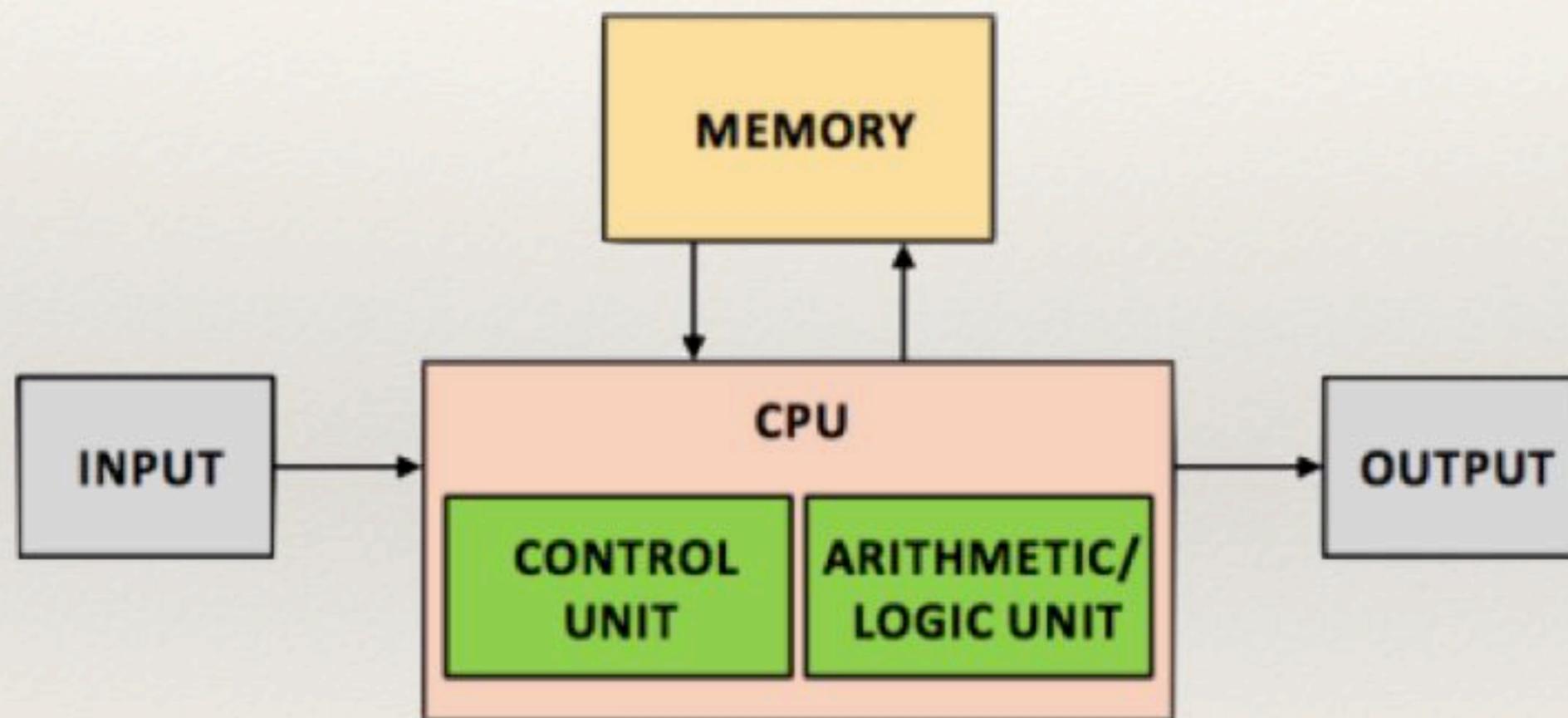
Harvard College Observatory 1913

human computers



NACA High Speed Flight Station "Computer Room" (1949)

The von Neumann architecture

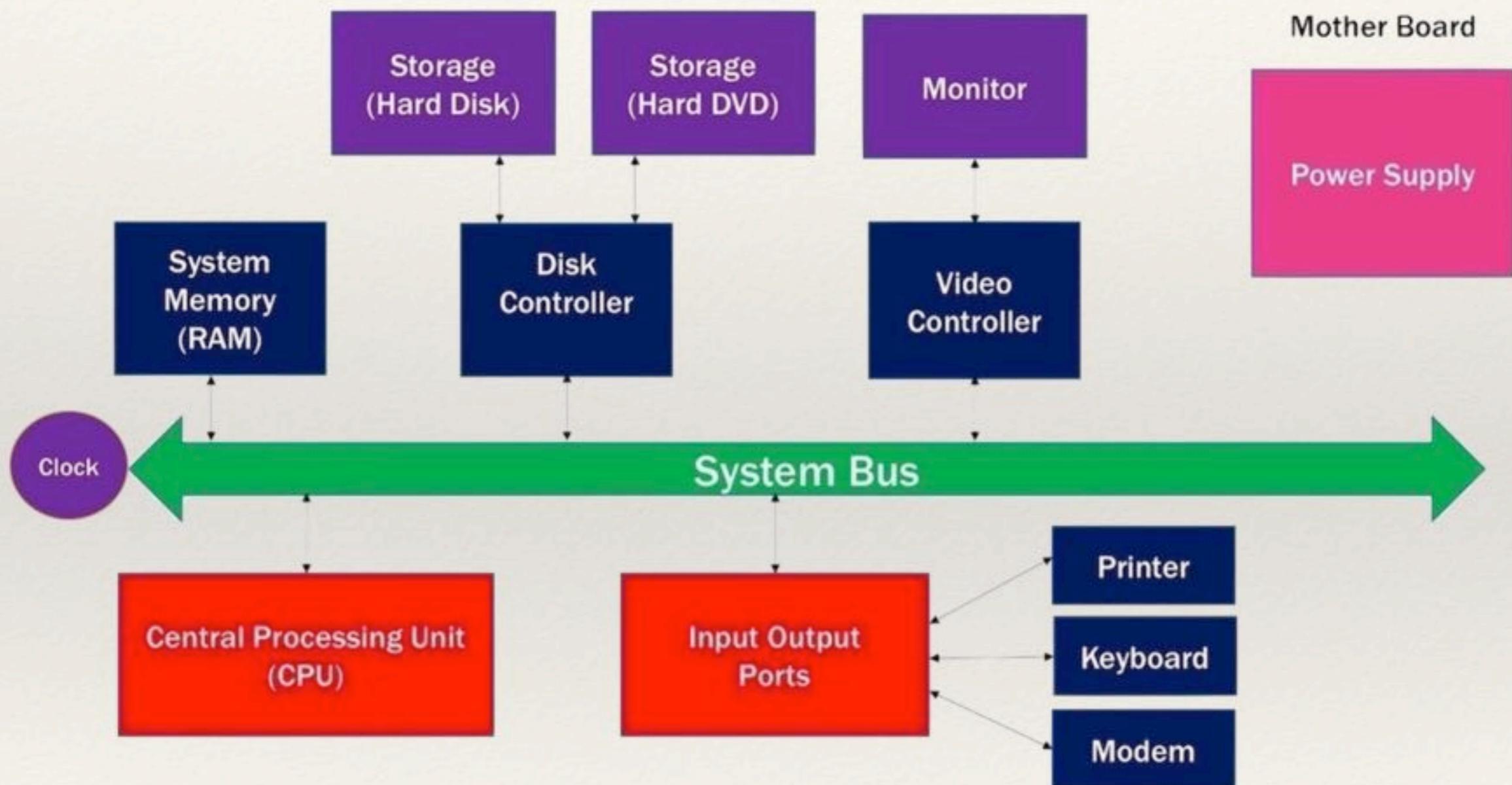


Computer hardware

- ❖ System unit
 - ❖ motherboard
 - ❖ CPU
 - ❖ cooling unit for the CPU
 - ❖ Possibly extra processors (for instance, for graphics)
 - ❖ Memory chips for RAM, ROM
 - ❖ Connectors for peripherals (sometimes known as ports)
 - ❖ Expansion slots for other peripheral device cards
 - ❖ ROM BIOS for booting and basic input and output instructions
 - ❖ Power supply connector
 - ❖ Disk drives
 - ❖ Fan units
 - ❖ Power supply
- ❖ A monitor
- ❖ A keyboard and a pointing device (mouse, track point, track ball)
- ❖ Speakers (optional)



Computer hardware



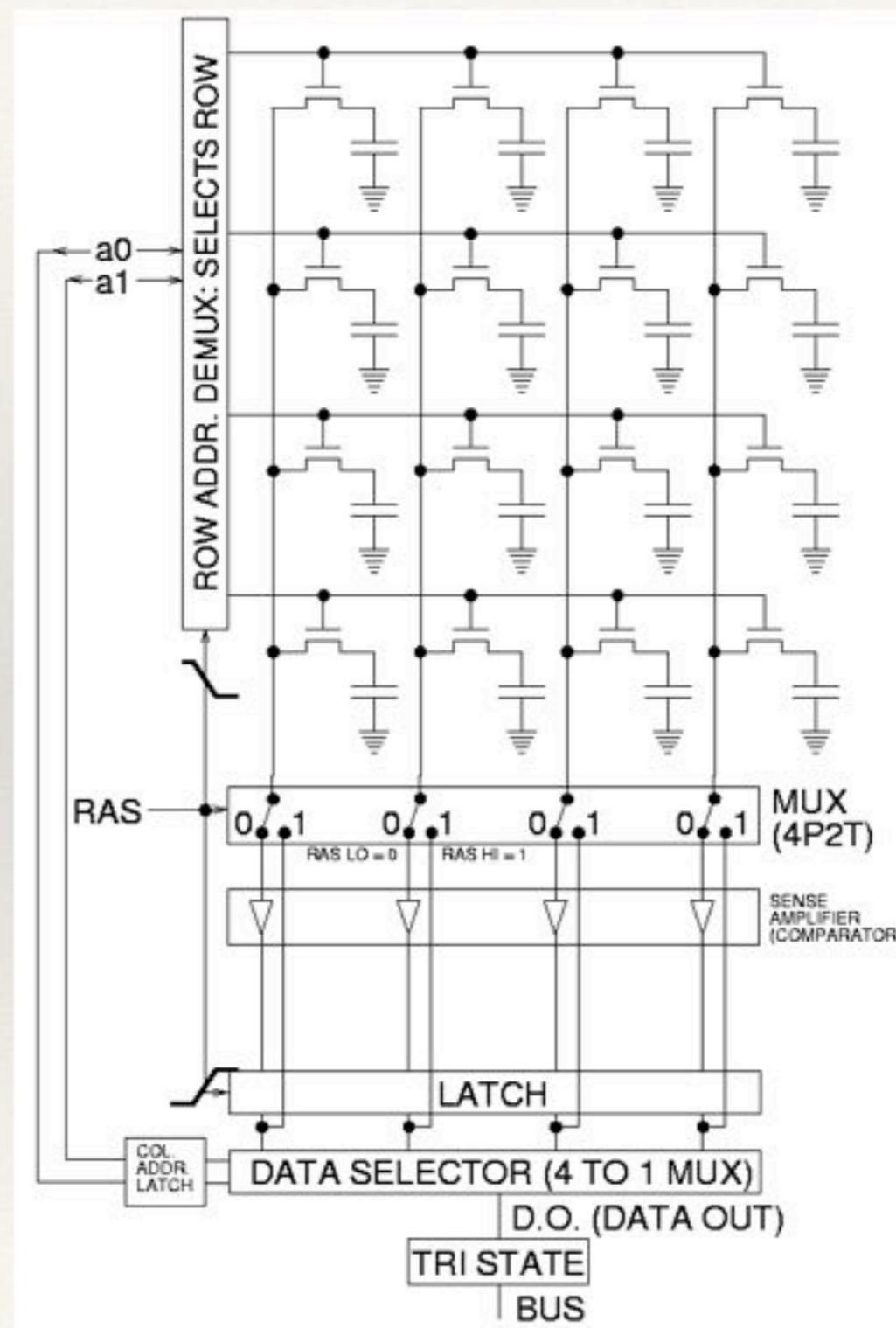
Computer representation of data

binary numbers

0 0 1 1 1 0 1 0



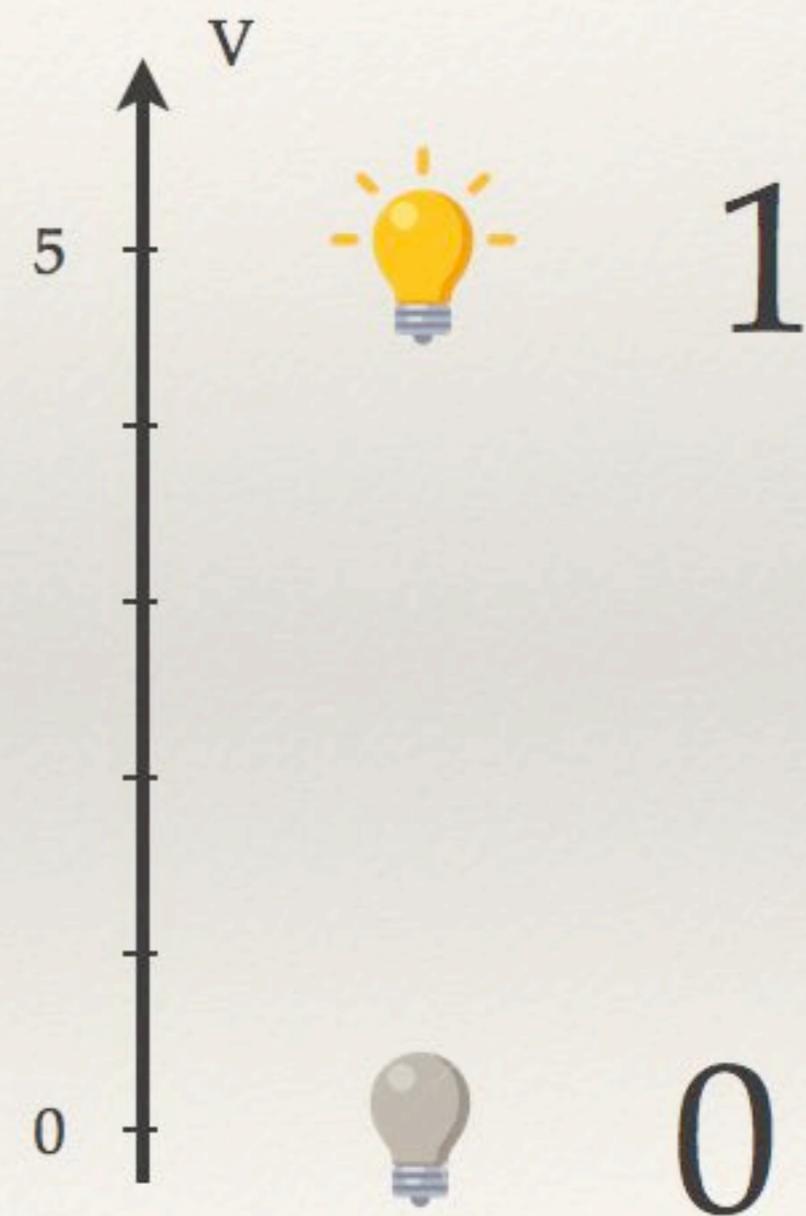
binary numbers storage



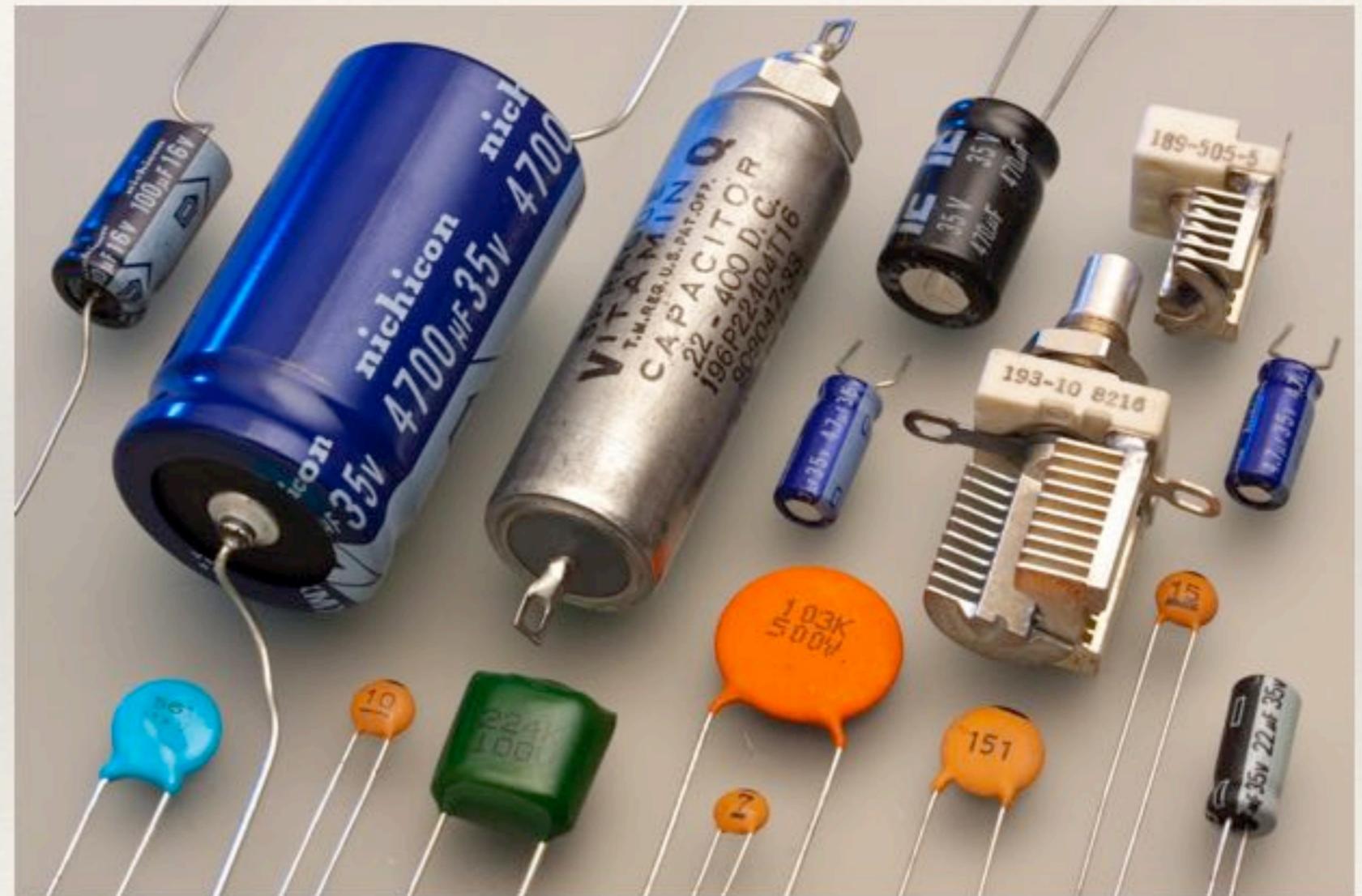
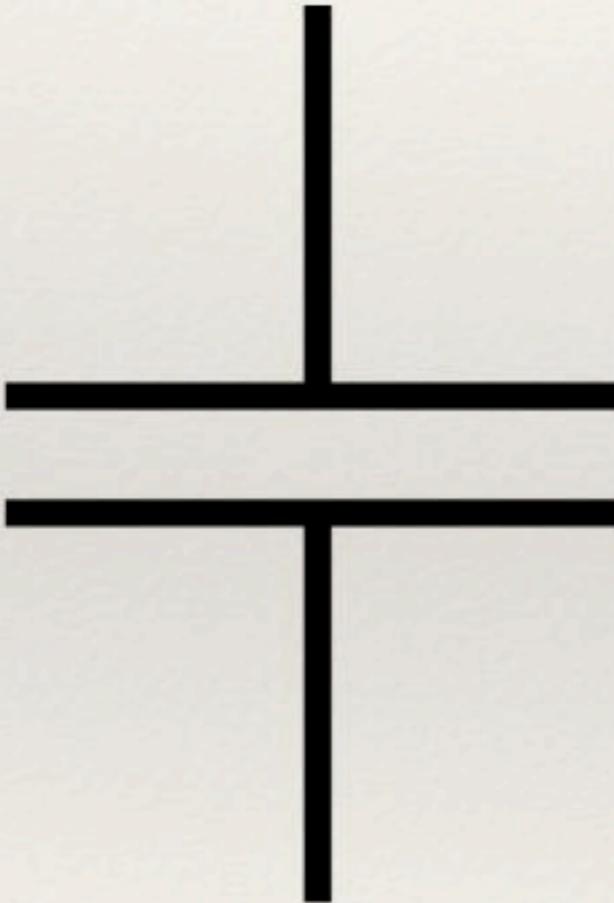
binary numbers storage



binary numbers storage

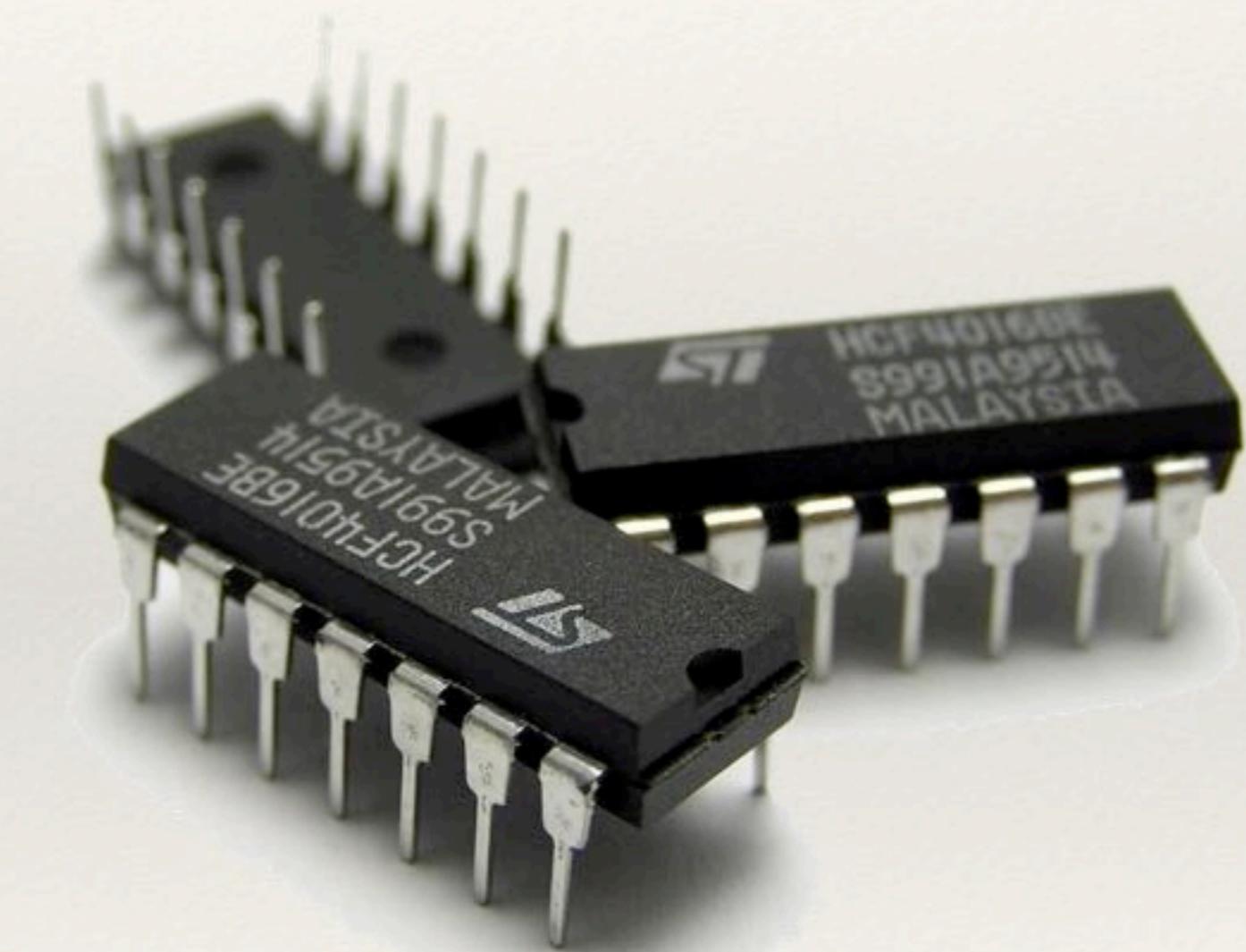
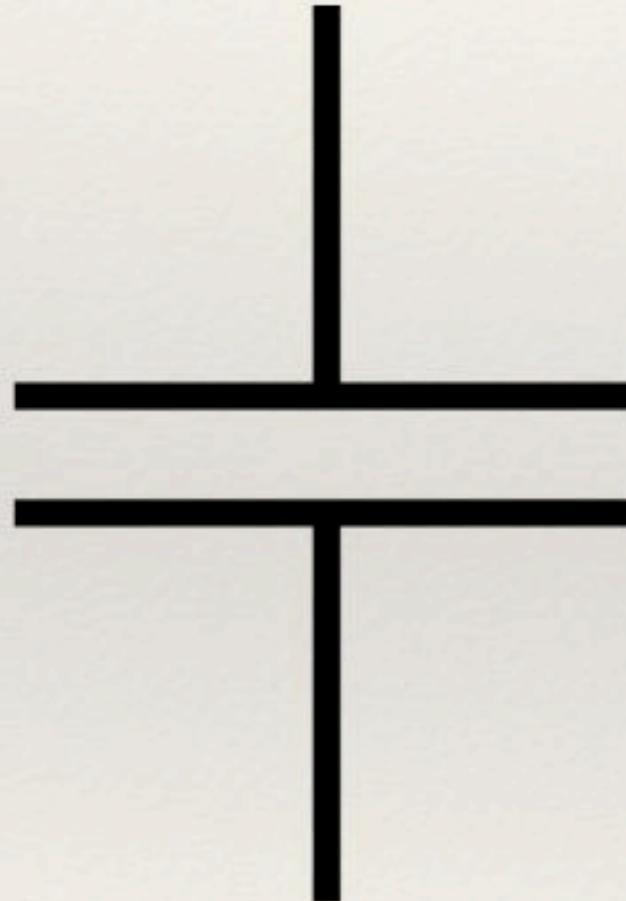


binary numbers storage

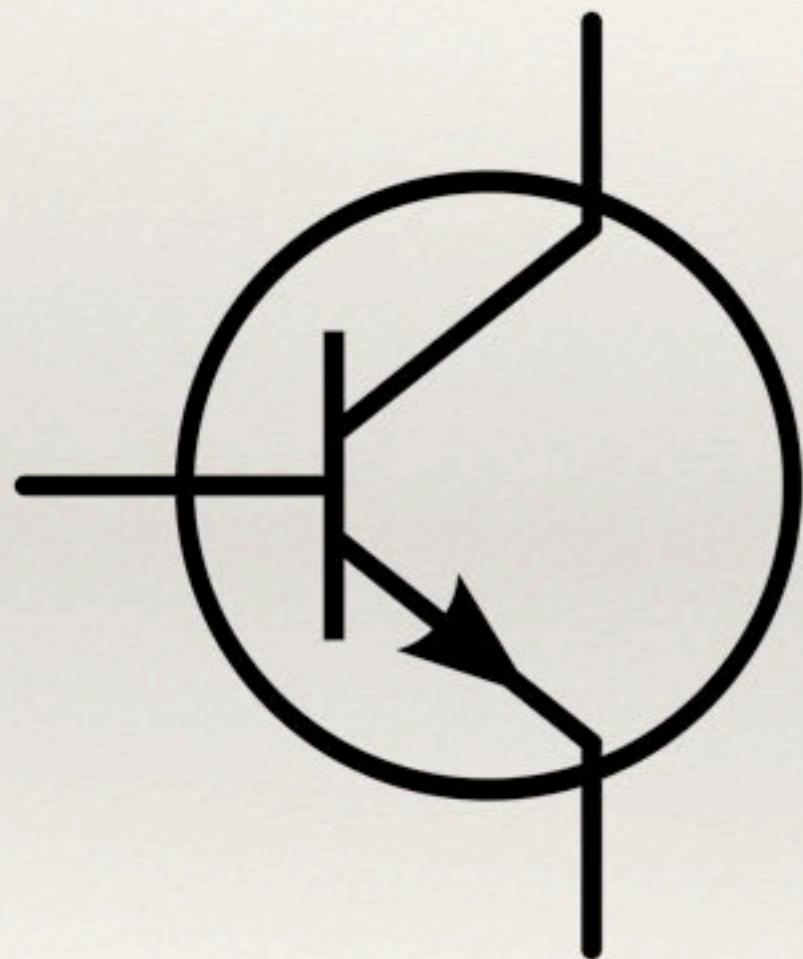


capacitor

binary numbers storage

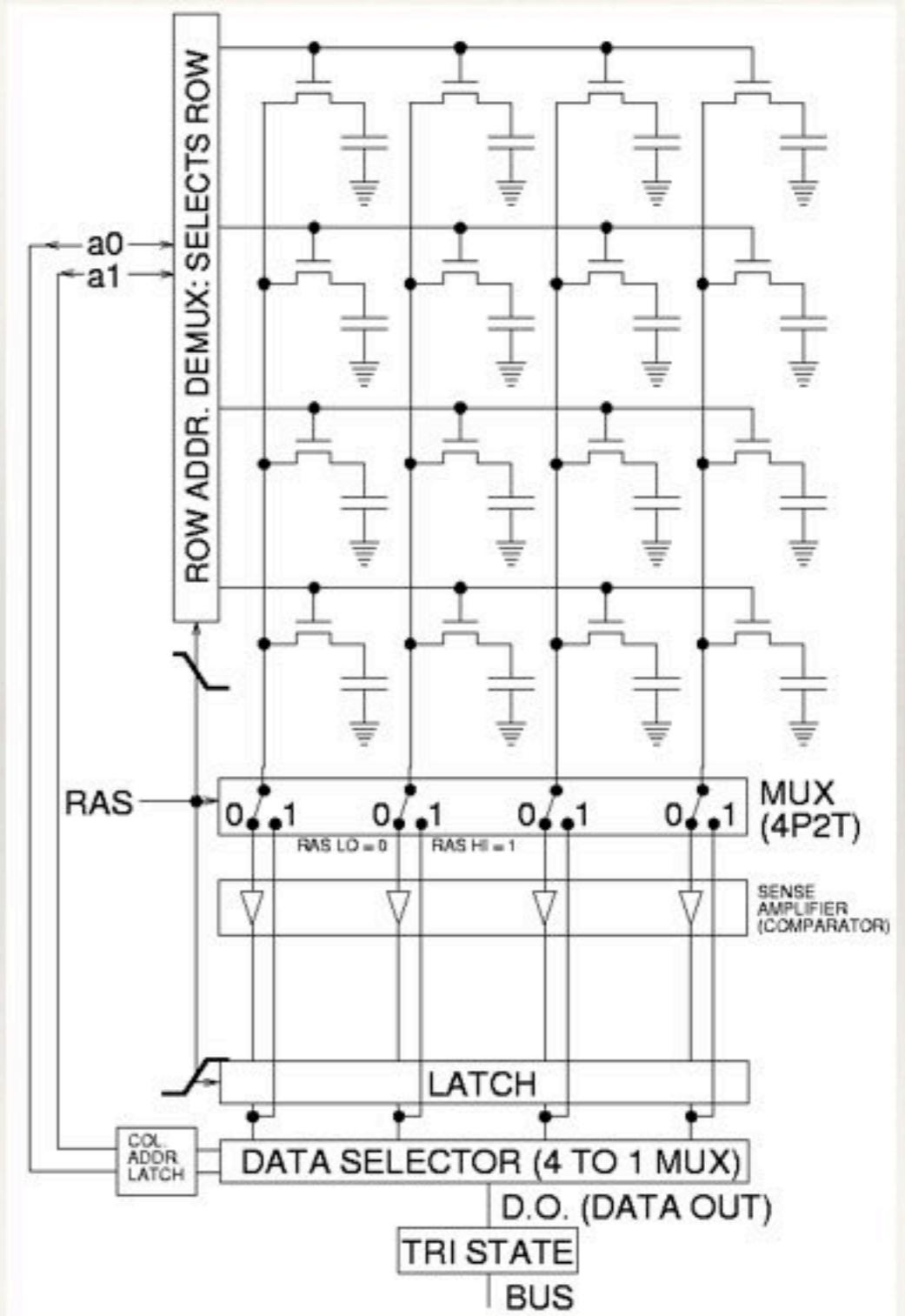
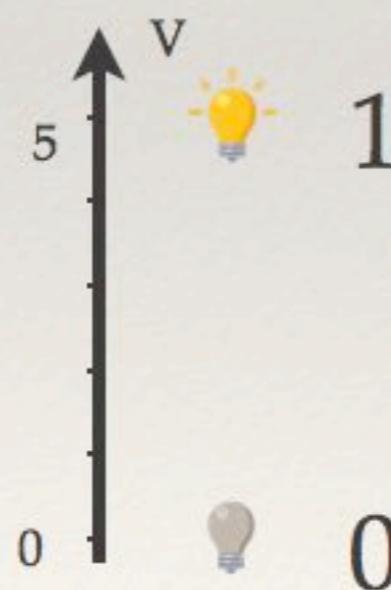
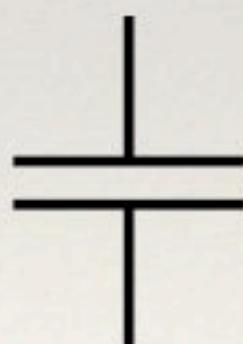
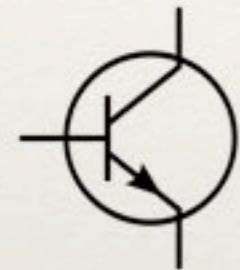


binary numbers storage

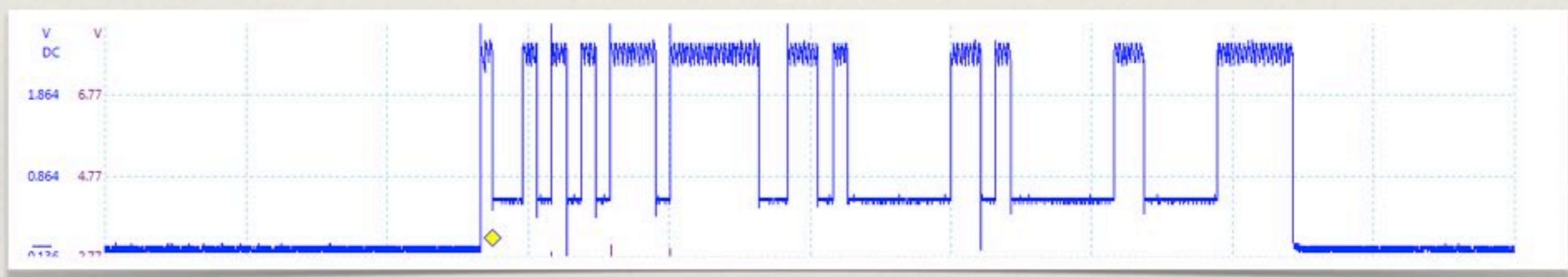


transistor

binary numbers storage



binary numbers transmission



numbering systems



“normal” numbers

234

3980

637821

3491

12

100

444

decimal numbers

54729

5

4

7

2

9

decimal numbers

54729

$$10000 = 10^4$$



$$1000 = 10^3$$



$$100 = 10^2$$



$$10 = 10^1$$



$$1 = 10^0$$



5

4

7

2

9

power notation

54729

$$10000 = 10^4$$



5

$$1000 = 10^3$$



4

$$100 = 10^2$$



7

$$10 = 10^1$$



2

$$1 = 10^0$$



9

$$= 5 \times 10^4 + 4 \times 10^3 + 7 \times 10^2 + 2 \times 10^1 + 9 \times 10^0$$

decimal numbers

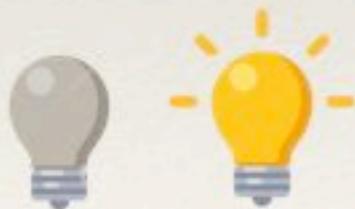
0 1 2 3 4 5 6 7 8 9

ten symbols

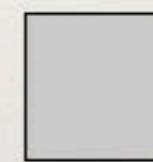
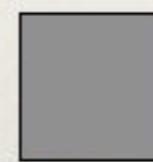
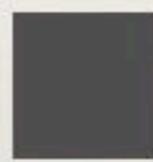
alternative?

0 1 2 3 4 5 6 7 8 9

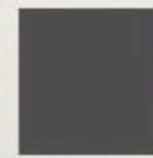
0 1



binary numbers



binary numbers



1

0

1

1

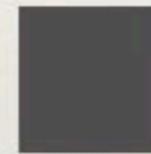
0

binary numbers

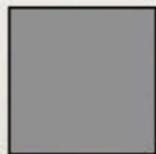
$$2^4 = 16$$



$$2^3 = 8$$



$$2^2 = 4$$



$$2^1 = 2$$



$$2^0 = 1$$



1

0

1

1

0

$$= 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$$

$$= 16 + 0 + 4 + 2 + 0$$

$$= 22$$

binary numbers

$$2^3 = 8$$

#

$$2^2 = 4$$

#

$$2^1 = 2$$

#

$$2^0 = 1$$

#

what is the highest value with 4 digits?

binary numbers

$$2^3 = 8$$

1

$$2^2 = 4$$

1

$$2^1 = 2$$

1

$$2^0 = 1$$

1

what is the highest value with 4 digits?

binary numbers

$$2^4 = 16$$

0

$$2^3 = 8$$

1

$$2^2 = 4$$

1

$$2^1 = 2$$

1

$$2^0 = 1$$

1

$$= 0 \times 2^4 +$$

$$1 \times 2^3 +$$

$$1 \times 2^2 +$$

$$1 \times 2^1 +$$

$$1 \times 2^0$$

$$= 0 +$$

$$8 +$$

$$4 +$$

$$2 +$$

$$1$$

$$= 15$$

binary numbers

$$2^4 = 16$$

0

$$2^3 = 8$$

1

$$2^2 = 4$$

1

$$2^1 = 2$$

1

$$2^0 = 1$$

$$= 0 \times 2^4$$

+

$$1 \times 2^3$$

+

$$1 \times 2^2$$

+

$$1 \times 2^1$$

+

$$1 \times 2^0$$

$$= 0$$

+

$$8$$

+

$$4$$

+

$$2$$

+

$$1$$

$$= 15$$

$$2^4 = 16$$

$$2^3 = 8$$

$$2^2 = 4$$

$$2^1 = 2$$

$$2^0 = 1$$

1

0

0

0

0

bits and bytes

bit = binary digit

1

$2^7 \ 2^6 \ 2^5 \ 2^4 \ 2^3 \ 2^2 \ 2^1 \ 2^0$

byte = 8 bits

10100110

bits and bytes

little endian

$2^7 \ 2^6 \ 2^5 \ 2^4 \ 2^3 \ 2^2 \ 2^1 \ 2^0$
10100110

big endian

$2^0 \ 2^1 \ 2^2 \ 2^3 \ 2^4 \ 2^5 \ 2^6 \ 2^7$
10100110

floating point - precision

scientific notation

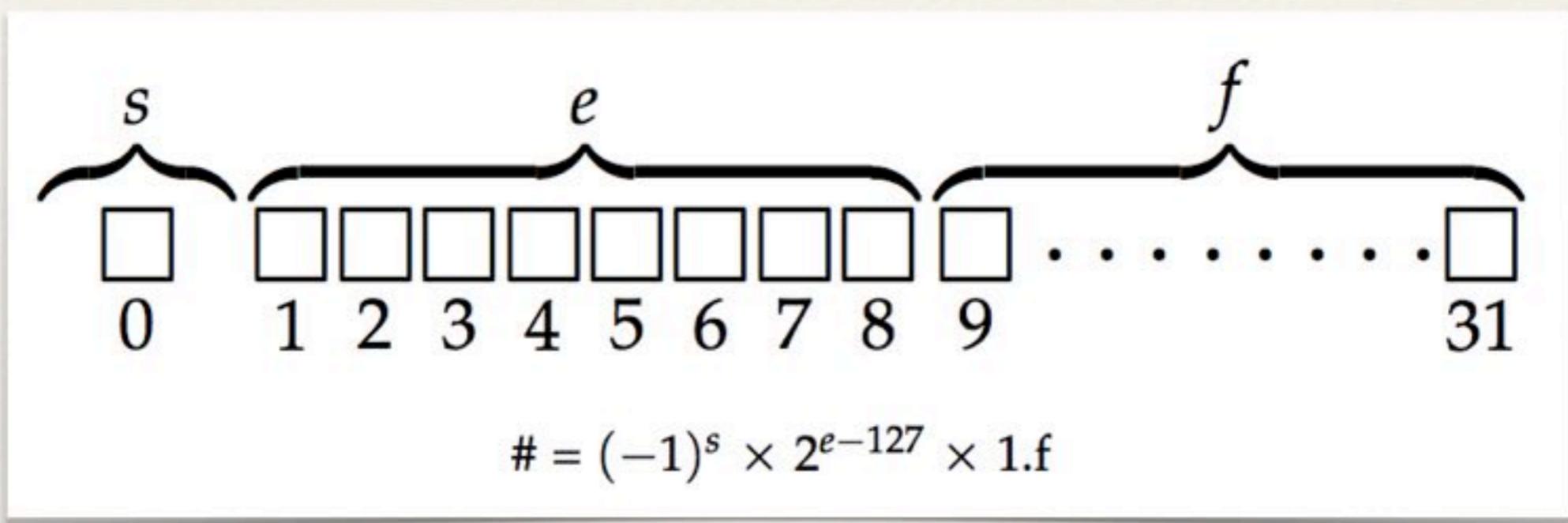
$$100 = 10 \times 10$$

$$100 = 10^2$$

$$500 = 5 \times 100$$

$$500 = 5 \times 10^2$$

floating point

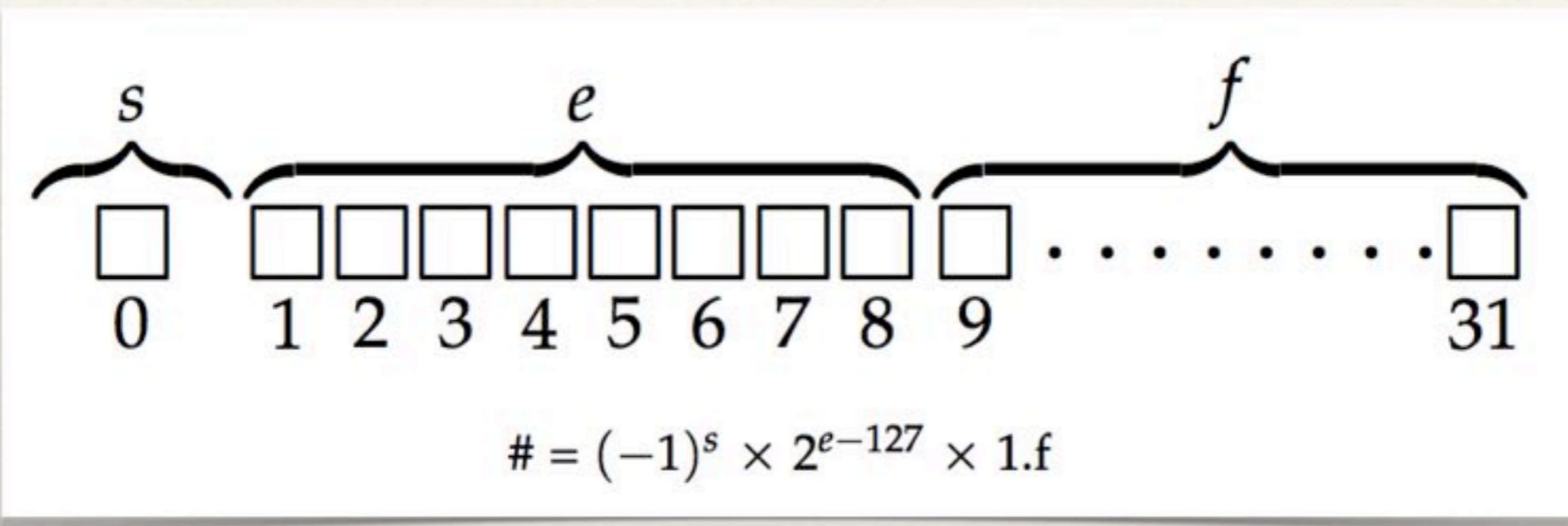


floating point

- ❖ Using the scientific notation, 55.25 is actually represented as $0.5525 * 10^2$
- ❖ This leads to some important questions:
 - ❖ which is the **biggest** number we can represent?
 - ❖ which is the **smallest** number we can represent?
 - ❖ what is the **smallest distance** between two consecutive numbers, that we can represent?



floating point



A floating point number consists of three parts: the **sign** (+ or -), a **mantissa**, which contains the string of significant bits, and an **exponent**. The three parts are stored together in a single computer word.



floating point

There are three commonly used levels of precision for floating point numbers: single precision, double precision, and extended precision, also known as long-double precision. The number of bits allocated for each floating point number in the three formats is 32, 64, and 80, respectively. The bits are divided among the parts as follows:

precision	sign	exponent	mantissa
single	1	8	23
double	1	11	52
long double	1	15	64



Numerical Analysis

We will study more in details the floating point binaries in a future lecture, when we will study **Numerical Analysis**.

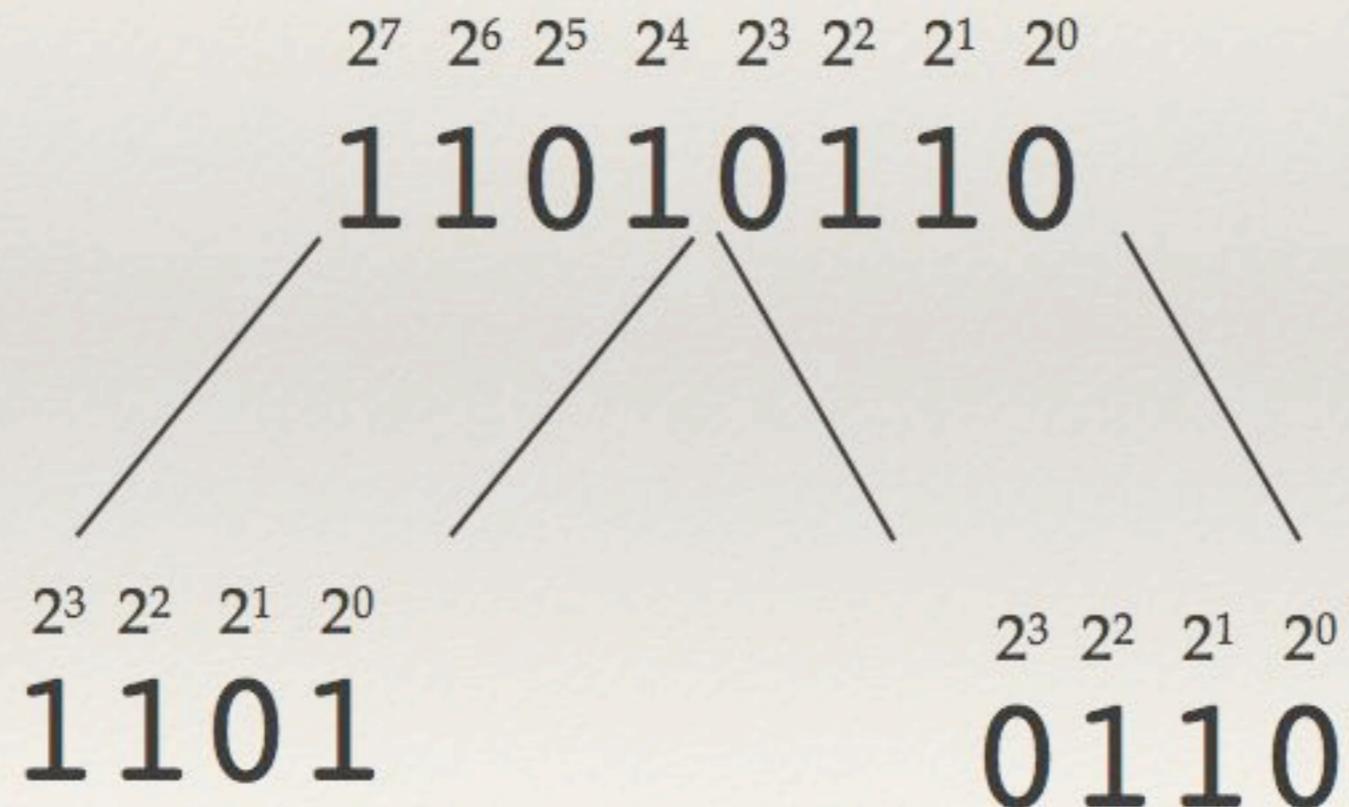
Hexadecimal

bits and bytes

bit = binary digit

1

byte = 8 bits



hexadecimals

half a byte = 4 bites

$$\begin{array}{cccc} 2^3 & 2^2 & 2^1 & 2^0 \\ \# & \# & \# & \# \end{array}$$

highest value

$$\begin{array}{cccc} 2^3 & 2^2 & 2^1 & 2^0 \\ 1 & 1 & 1 & 1_2 \end{array} = 15_{10}$$

hexadecimals

half a byte = 4 bites

$\begin{matrix} 2^3 & 2^2 & 2^1 & 2^0 \end{matrix}$
#####

highest value

$\begin{matrix} 2^3 & 2^2 & 2^1 & 2^0 \end{matrix}$
 $1111_2 = 15_{10}$

highest value

0123456789ABCDEF => 16^n

hexadecimals

half a byte = 4 bites

$$\begin{array}{cccc} 2^3 & 2^2 & 2^1 & 2^0 \\ \# & \# & \# & \# \end{array}$$

highest value

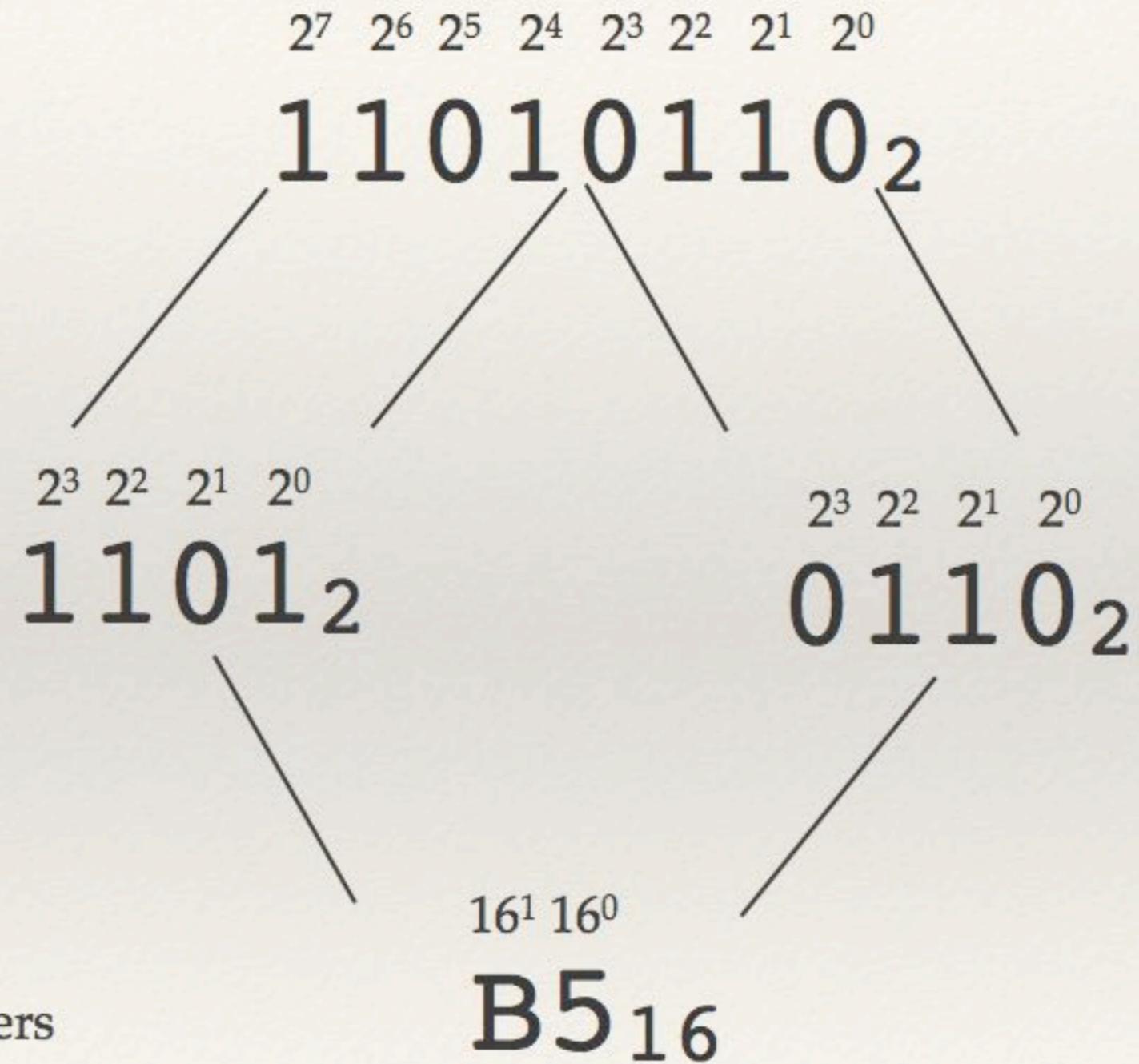
$$\begin{array}{cccc} 2^3 & 2^2 & 2^1 & 2^0 \\ 1 & 1 & 1 & 1_2 \end{array} = 15_{10}$$

hexadecimal

$$\begin{array}{cccc} 16^3 & 16^2 & 16^1 & 16^0 \\ \# & \# & \# & \#_{16} \end{array}$$

bits and bytes

byte = 8 bits



one byte = two hex numbers

hexadecimals

byte = 8 bites

11010110_2

byte = two hex numbers

$B5_{16}$

hexadecimals - examples

byte = 8 bites

11111111_2

byte = two hex numbers

FF_{16}

hexadecimals - examples

byte = 8 bites

10001000_2

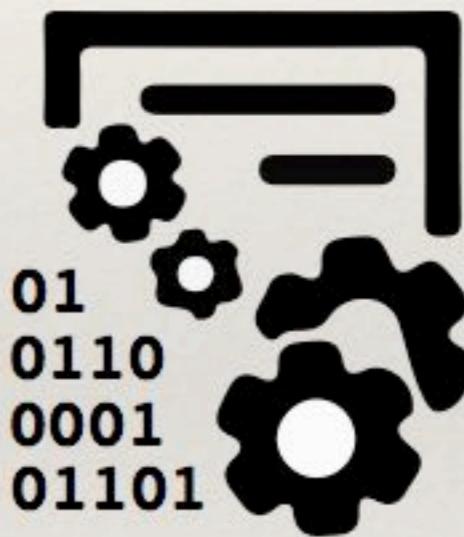
byte = two hex numbers

88_{16}

Files



Binary files



Edit (visualize) Binary files

	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	
Start	0x00000000	50	51	54	54	54	52	00	00	31	2E	30	2E	30	30	00	00
End	0x00000100	46	69	6C	65	5F	47	55	49	44	00	00	00	00	00	00	
Length	0x00000200	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
Content	0x00000300	FF	FF	FF	FF	FF	01	40	28	00	00	00	00	00	00	00	
0x00000400	7B	46	32	41	32	44	30	31	45	2D	33	41	33	39	2D	34	
0x00000500	34	41	46	2D	42	30	42	45	2D	32	38	31	39	30	39	33	
0x00000600	33	36	35	42	33	7D	00	00	46	69	6C	65	5F	41	73	73	
0x00000700	75	72	65	64	43	6F	6E	74	65	6E	74	00	00	00	00	00	
0x00000800	00	00	00	00	00	00	00	00	FF	FF	FF	FF	FF	FF	01	40	
0x00000900	20	00	00	00	00	00	00	00	48	79	64	72	61	48	61	72	
0x00000A00	70	3A	20	48	57	53	45	54	47	20	53	57	53	45	54	47	
0x00000B00	00	00	00	00	00	00	00	00	43	72	65	61	74	6F	72	53	
0x00000C00	57	5F	43	6F	6E	74	65	6E	74	56	65	72	73	69	6F	6E	
0x00000D00	00	00	00	00	00	00	00	00	FF	FF	FF	FF	FF	FF	01	40	
0x00000E00	08	00	00	00	00	00	00	00	33	2E	30	00	00	00	00	00	
0x00000F00	43	72	65	61	74	6F	72	53	57	5F	4E	61	6D	65	00	00	
0x00001000	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0x00001100	FF	FF	FF	FF	FF	01	40	10	00	00	00	00	00	00	00	00	
0x00001200	48	79	64	72	61	48	61	72	70	20	41	63	71	55	49	00	
0x00001300	43	72	65	61	74	6F	72	53	57	5F	56	65	72	73	69	6F	
0x00001400	6E	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0x00001500	FF	FF	FF	FF	FF	01	40	08	00	00	00	00	00	00	00	00	
0x00001600	33	2E	30	2E	30	2E	31	00	46	69	6C	65	5F	43	72	65	
0x00001700	61	74	69	6E	67	54	69	6D	65	00	00	00	00	00	00	00	
0x00001800	00	00	00	00	00	00	00	00	FF	FF	FF	FF	08	00	00	21	
0x00001900	9C	A9	D5	45	EC	FE	E4	40	46	69	6C	65	5F	43	6F	6D	
0x00001A00	6D	65	6E	74	00	00	00	00	00	00	00	00	00	00	00	00	
0x00001B00	00	00	00	00	00	00	00	FF	FF	FF	FF	FF	FF	01	40	00	

Edit (visualize) Binary files

	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
Start	End	Length	Content													
0x00000000	0x00000005	0x06	50	51	54	54	54	52	00	00	31	2E	30	2E	30	30
0x00000010	0x00000015	0x06	46	69	6C	65	5F	47	55	49	44	00	00	00	00	00
0x00000020	0x00000025	0x06	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0x00000030	0x00000035	0x06	FF	FF	FF	FF	FF	FF	01	40	28	00	00	00	00	00
0x00000040	0x00000045	0x06	7B	46	32	41	32	44	30	31	45	2D	33	41	33	39
0x00000050	0x00000055	0x06	34	41	46	2D	42	30	42	45	2D	32	38	31	39	30
0x00000060	0x00000065	0x06	33	36	35	42	33	7D	00	00	46	69	6C	65	5F	41
0x00000070	0x00000075	0x06	75	72	65	64	43	6F	6E	74	65	6E	74	00	00	00
0x00000080	0x00000085	0x06	00	00	00	00	00	00	00	FF	FF	FF	FF	FF	FF	01
0x00000090	0x00000095	0x06	20	00	00	00	00	00	00	48	79	64	72	61	48	61
0x000000A0	0x000000A5	0x06	70	3A	20	48	57	53	45	54	47	20	53	57	53	45
0x000000B0	0x000000B5	0x06	00	00	00	00	00	00	00	43	72	65	61	74	6F	72
0x000000C0	0x000000C5	0x06	57	5F	43	6F	6E	74	65	6E	74	56	65	72	73	69
0x000000D0	0x000000D5	0x06	00	00	00	00	00	00	00	FF	FF	FF	FF	FF	FF	01
0x000000E0	0x000000E5	0x06	08	00	00	00	00	00	00	33	2E	30	00	00	00	00
0x000000F0	0x000000F5	0x06	43	72	65	61	74	6F	72	53	57	5F	4E	61	6D	65
0x00000100	0x00000105	0x06	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0x00000110	0x00000115	0x06	FF	FF	FF	FF	FF	FF	01	40	10	00	00	00	00	00
0x00000120	0x00000125	0x06	48	79	64	72	61	48	61	72	70	20	41	63	71	55
0x00000130	0x00000135	0x06	43	72	65	61	74	6F	72	53	57	5F	56	65	72	73
0x00000140	0x00000145	0x06	6E	00	00	00	00	00	00	00	00	00	00	00	00	00
0x00000150	0x00000155	0x06	FF	FF	FF	FF	FF	FF	01	40	08	00	00	00	00	00
0x00000160	0x00000165	0x06	33	2E	30	2E	30	2E	31	00	46	69	6C	65	5F	43
0x00000170	0x00000175	0x06	61	74	69	6E	67	54	69	6D	65	00	00	00	00	00
0x00000180	0x00000185	0x06	00	00	00	00	00	00	00	FF	FF	FF	FF	FF	FF	08
0x00000190	0x00000195	0x06	9C	A9	D5	45	EC	FE	E4	40	46	69	6C	65	5F	43
0x000001A0	0x000001A5	0x06	6D	65	6E	74	00	00	00	00	00	00	00	00	00	00
0x000001B0	0x000001B5	0x06	00	00	00	00	00	00	00	FF	FF	FF	FF	FF	FF	01

Edit (visualize) Binary files

	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
Start	End	Length	Content													
0x00000000	50 51 54 54 54 52 00 00 31 2E 30 2E 30 30 00 00	PQTTTR..1.0.00..														
0x00000010	46 69 6C 65 5F 47 55 49 44 00 00 00 00 00 00 00	File_GUID.....														
0x00000020	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00														
0x00000030	FF FF FF FF FF 01 40 28 00 00 00 00 00 00 00 00 00@(...														
0x00000040	7B 46 32 41 32 44 30 31 45 2D 33 41 33 39 2D 34	{F2A2D01E-3A39-4														
0x00000050	34 41 46 2D 42 30 42 45 2D 32 38 31 39 30 39 33	4AF-B0BE-2819093														
0x00000060	33 36 35 42 33 7D 00 00 46 69 6C 65 5F 41 73 73	365B3}..File_Ass														
0x00000070	75 72 65 64 43 6F 6E 74 65 6E 74 00 00 00 00 00	uredContent.....														
0x00000080	00 00 00 00 00 00 00 00 FF FF FF FF FF FF 01 40@.....														
0x00000090	20 00 00 00 00 00 00 00 48 79 64 72 61 48 61 72HydraHar														
0x000000A0	70 3A 20 48 57 53 45 54 47 20 53 57 53 45 54 47	p: HWSETG SWSETG														
0x000000B0	00 00 00 00 00 00 00 00 43 72 65 61 74 6F 72 53CreatorS														
0x000000C0	57 5F 43 6F 6E 74 65 6E 74 56 65 72 73 69 6F 6E	W_ContentVersion														
0x000000D0	00 00 00 00 00 00 00 00 FF FF FF FF FF FF 01 40@.....														
0x000000E0	08 00 00 00 00 00 00 00 33 2E 30 00 00 00 00 003.0.....														
0x000000F0	43 72 65 61 74 6F 72 53 57 5F 4E 61 6D 65 00 00	CreatorSW_Name..														
0x0000100	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00														
0x0000110	FF FF FF FF FF 01 40 10 00 00 00 00 00 00 00 00@.....														
0x0000120	48 79 64 72 61 48 61 72 70 20 41 63 71 55 49 00	HydraHarp AcqUI.														
0x0000130	43 72 65 61 74 6F 72 53 57 5F 56 65 72 73 69 6F	CreatorSW_Versio														
0x0000140	6E 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	n.....														
0x0000150	FF FF FF FF FF 01 40 08 00 00 00 00 00 00 00 00@.....														
0x0000160	33 2E 30 2E 30 2E 31 00 46 69 6C 65 5F 43 72 65	3.0.0.1.File_Cre														
0x0000170	61 74 69 6E 67 54 69 6D 65 00 00 00 00 00 00 00	atingTime.....														
0x0000180	00 00 00 00 00 00 00 00 FF FF FF FF 08 00 00 21!.....														
0x0000190	9C A9 D5 45 EC FE E4 40 46 69 6C 65 5F 43 6F 6D	.E...@File_Com														
0x00001A0	6D 65 6E 74 00 00 00 00 00 00 00 00 00 00 00 00	ment.....														
0x00001B0	00 00 00 00 00 00 00 FF FF FF FF FF FF 01 40	@.....														

Text encodings

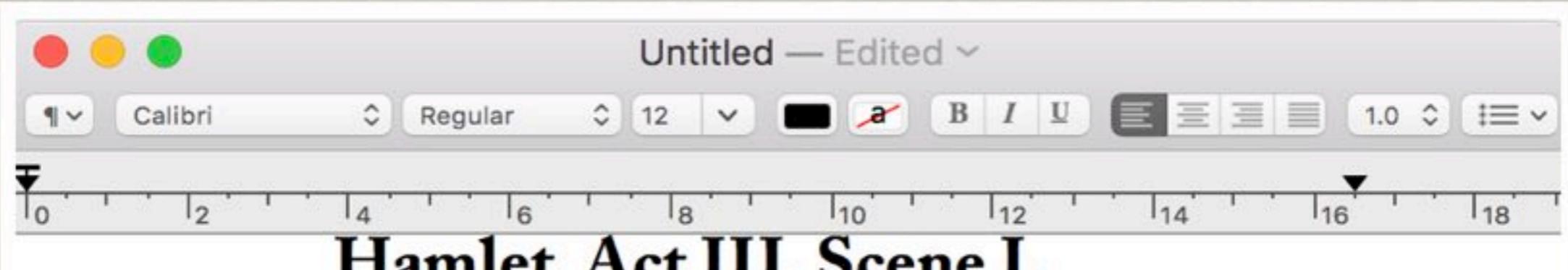
text files

A screenshot of a Microsoft Word document titled "Document1". The ribbon menu is visible at the top, showing tabs for Home, Insert, Design, Layout, References, Mailings, Review, and View. The Home tab is selected. The ribbon includes various icons for file operations, search, and document settings. Below the ribbon is the toolbar, which includes buttons for Paste, Bold (B), Italic (I), Underline (U), superscript (X₂), subscript (X²), font style (Calibri (Body)), font size (16), font color (A), font underline (Aa), font strikethrough (A), font shadow (A), font orientation (A), and font effects (A). The ruler shows horizontal and vertical measurements from 1 to 18 inches. The main content area contains the text "Hamlet. Act III, Scene I." in a large serif font, followed by "William Shakespeare" in a cursive script, and a blank line. Below this, the famous opening lines of Hamlet's soliloquy are displayed in a black serif font:

To be, or not to be, that is the question:
Whether 'tis nobler in the mind to suffer
The slings and arrows of outrageous fortune,
Or to take Arms against a Sea of troubles,
And by opposing end them: to die, to sleep

The status bar at the bottom shows "Page 1 of 2", "290 Words", "English (CAN)", and a zoom level of "100%".

text files



William Shakespeare

To be, or not to be, that is the question:
Whether 'tis nobler in the mind to suffer
The slings and arrows of outrageous fortune,
Or to take Arms against a Sea of troubles,
And by opposing end them: to die, to sleep
No more; and by a sleep, to say we end
the heart-ache, and the thousand natural shocks
that Flesh is heir to? 'Tis a consummation
devoutly to be wished. To die, to sleep,
To sleep perchance to Dream: ay, there's the rub

text files

The screenshot shows a window titled "Hamlet.txt" with three colored window controls (red, yellow, green) at the top left. The main content area displays the first few lines of Hamlet's famous soliloquy:

Hamlet. Act III, Scene I.

William Shakespeare

To be, or not to be, that is the question:
Whether 'tis nobler in the mind to suffer
The slings and arrows of outrageous fortune,
Or to take Arms against a Sea of troubles,
And by opposing end them: to die, to sleep
No more; and by a sleep, to say we end
the heart-ache, and the thousand natural shocks
that Flesh is heir to? 'Tis a consummation
devoutly to be wished. To die, to sleep,
To sleep, perchance to Dream; aye, there's the rub,
for in that sleep of death, what dreams may come,
when we have shuffled off this mortal coil,
must give us pause. There's the respect
that makes Calamity of so long life:
For who would bear the Whips and Scorns of time,
the Oppressor's wrong, the proud man's Contumely,
the pangs of despised Love, the Law's delay,
the insolence of Office, and the spurns
that patient merit of the unworthy takes,
when he himself might his Quietus make

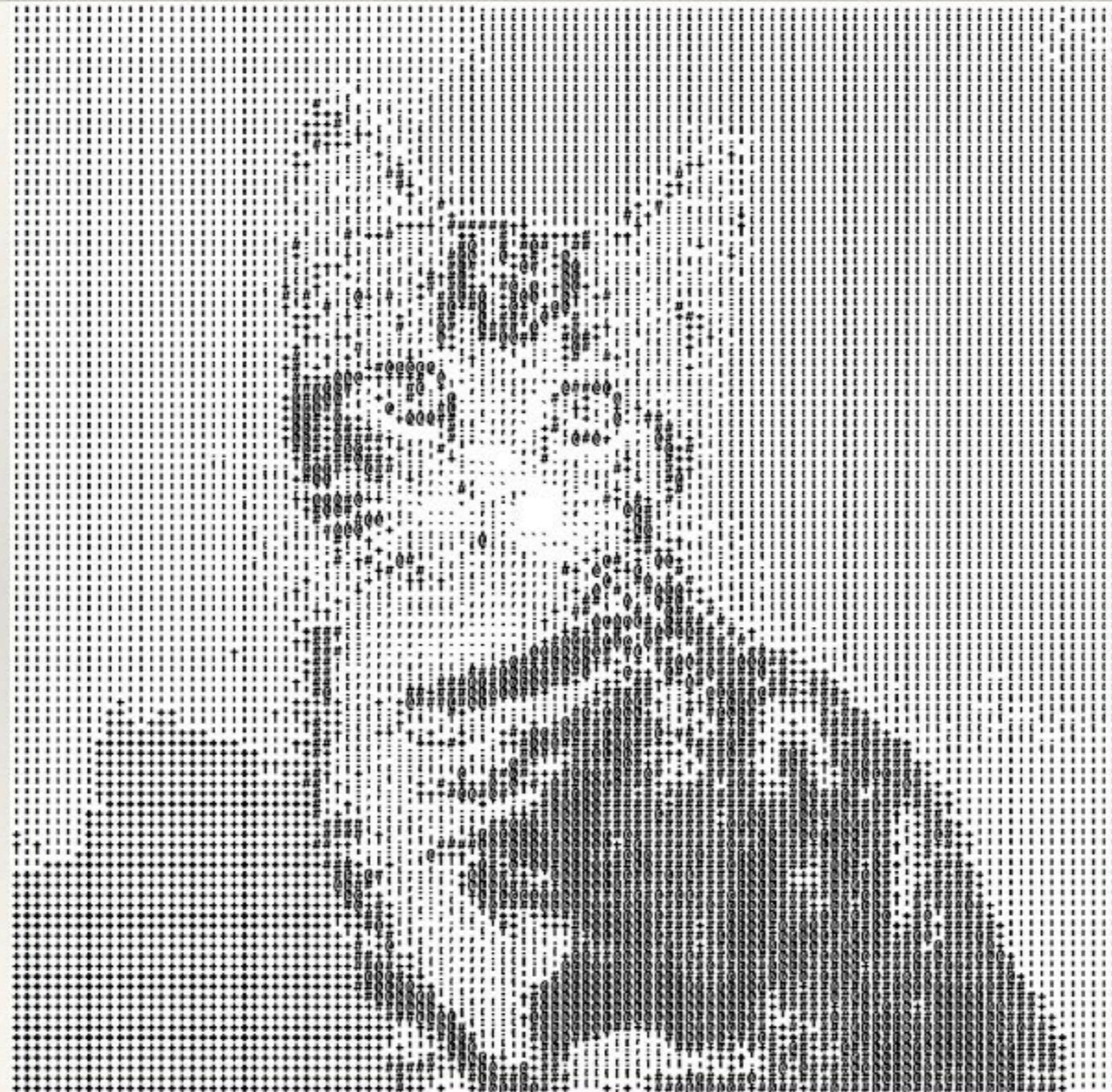
ascii characters

American Standard Code for Information Interchange (ASCII)

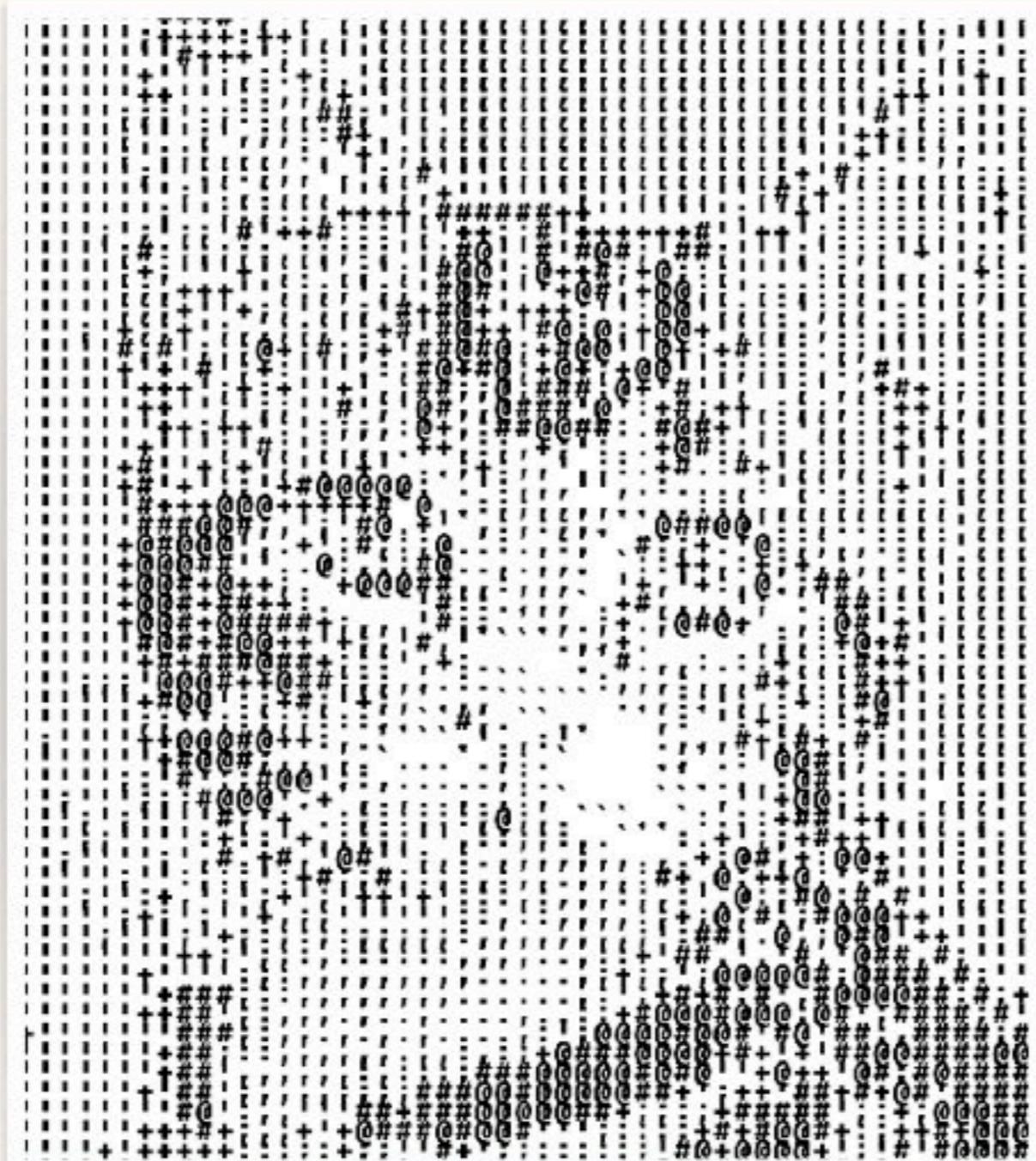
010 0000	32	<u>space</u>	100 0001	65	<u>A</u>	110 0001	97	<u>a</u>
010 0001	33	<u>!</u>	100 0010	66	<u>B</u>	110 0010	98	<u>b</u>
010 0010	34	<u>"</u>	100 0011	67	<u>C</u>	110 0011	99	<u>c</u>
010 0011	35	<u>#</u>	100 0100	68	<u>D</u>	110 0100	100	<u>d</u>
010 0100	36	<u>\$</u>	100 0101	69	<u>E</u>	110 0101	101	<u>e</u>
010 0101	37	<u>%</u>	100 0110	70	<u>F</u>	110 0110	102	<u>f</u>
010 0110	38	<u>&</u>	100 0111	71	<u>G</u>	110 0111	103	<u>g</u>
010 0111	39	<u>,</u>	100 1000	72	<u>H</u>	110 1000	104	<u>h</u>
010 1000	40	<u>(</u>	100 1001	73	<u>I</u>	110 1001	105	<u>i</u>
010 1001	41	<u>)</u>	100 1010	74	<u>J</u>	110 1010	106	<u>j</u>
010 1010	42	<u>*</u>	100 1011	75	<u>K</u>	110 1011	107	<u>k</u>
010 1011	43	<u>+</u>	100 1100	76	<u>L</u>	110 1100	108	<u>l</u>
010 1100	44	<u>.</u>	100 1101	77	<u>M</u>	110 1101	109	<u>m</u>
010 1101	45	<u>:</u>	100 1110	78	<u>N</u>	110 1110	110	<u>n</u>
010 1110	46	<u>,</u>	100 1111	79	<u>O</u>	110 1111	111	<u>o</u>
010 1111	47	<u>/</u>	101 0000	80	<u>P</u>	111 0000	112	<u>p</u>
011 0000	48	<u>0</u>	101 0001	81	<u>Q</u>	111 0001	113	<u>q</u>
011 0001	49	<u>1</u>	101 0010	82	<u>R</u>	111 0010	114	<u>r</u>
011 0010	50	<u>2</u>	101 0011	83	<u>S</u>	111 0011	115	<u>s</u>
011 0011	51	<u>3</u>	101 0100	84	<u>T</u>	111 0100	116	<u>t</u>
011 0100	52	<u>4</u>	101 0101	85	<u>U</u>	111 0101	117	<u>u</u>
011 0101	53	<u>5</u>	101 0110	86	<u>V</u>	111 0110	118	<u>v</u>
011 0110	54	<u>6</u>	101 0111	87	<u>W</u>	111 0111	119	<u>w</u>
011 0111	55	<u>7</u>	101 1000	88	<u>X</u>	111 1000	120	<u>x</u>
011 1000	56	<u>8</u>	101 1001	89	<u>Y</u>	111 1001	121	<u>y</u>
011 1001	57	<u>9</u>	101 1010	90	<u>Z</u>	111 1010	122	<u>z</u>

ascii characters

ascii characters

A large grid of ASCII characters, including letters, numbers, symbols, and punctuation marks, is arranged to form a portrait of Steve Jobs. He is depicted from the chest up, wearing his signature black turtleneck sweater over a white collared shirt. His hands are clasped together in front of him. The portrait is set against a light beige background.

ascii characters

A large grid of ASCII characters, primarily consisting of plus signs (+) and hash symbols (#), arranged to form a portrait of Steve Jobs. The portrait is centered within a white rectangular frame. Steve Jobs is depicted from the chest up, wearing his signature dark turtleneck sweater over a collared shirt. He has his characteristic wild hair and is looking slightly to the right with a thoughtful expression. The background behind him is a light gray color.

ascii encoding

- ❖ The best known and most widely used character encoding standard is the **American Standard Code for Information Interchange** (ASCII).
- ❖ The first version of ASCII was published in **1964** as a standard way of representing textual data in computer memory and sending it over communication links between computers.
- ❖ ASCII is based on a **seven-bit byte**. Each byte represented a character, and characters were represented by assigning them to individual binary numbers.



ascii encoding

what is the highest value that we can write with 7 binary digits?

2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	1	1	1	1	1	1

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	0	0	0	0	0	0	0

$$2^7 = 128$$



ascii encoding

- ❖ Perhaps the main deficiency in ASCII comes from the “A” in its name: **American**. ASCII is an American standard, and was designed for the storage and transmission of English text. 95 characters are sufficient for representing English text, barely, but that’s it. On early teletype machines, ASCII could also be used to represent the accented letters found in many European languages, but this capability disappeared in the transition from teletypes to CRT terminals.

CRT = Cathode Ray Tube

