

Bytes and codes everyday life and Second World War

Lycée du Bois d'Amour POITIERS

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• Do you know the difference?

- Do you know the difference?
- Is there a difference ?

• **bit** the smallest unit of storage



Claude Shannon (1916-2001) 1948 A Mathematical Theory of Communication

Bytes and codes

bit the smallest unit of storage
 binary information digit : 1 or 0
 Origin John Tukey (Bell Labs) January 1947



John Tukey (1915-2000)

electric current On 1 Off 0

• byte



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• byte a group of 8 bits, an octet



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• byte a group of 8 bits, an octet Example 0 1 0 1 1 0 1 0



• byte a group of 8 bits, an octet Example 0 1 0 1 1 0 1 0



How can we write every number using only 1s and 0s?



How can we write every number using only 1s and 0s?

Labria >



Gottfried W. Leibniz(1646-1716) by Christoph Bernhard Francke

Why?

How can we write every number using only 1s and 0s?



Gottfried W. Leibniz(1646-1716) by Christoph Bernhard Francke

Why? Lobric to avoid human error

How can we write every number using only 1s and 0s?



TABLE \$6 MEMOTRES DE L'ACADEMIE ROYALE bres entiers au deflous du double du roofle NOMBRES, plus haut degré. Car icy, c'eft com- 10 me fr on difoit, par exemple, que 111 ou 7 eft la fomme de quatre, de deux 111 7 & d' Et que 1101 ou 13 eft la fomme de huit, quatre & d'un. & un. Cette proprieté fert aux Effayeurs pour 100 peler toutes fortes de maffes avec peu de poids, & pourroit fervir dans les monnoyes pour donner plufieurs valeurs avec pea de pieces. Cette exprefiion des Nombres étant établie, fert à faire tres facilement toutes fortes d'operations, Pour PAddition 111 7 101111 1000111 par exemple. 10000 16 Pour la Sea. 1011 11 10001 17 Station. Pour la Mal--11 101 5 0 tiplication. 00110 11001 14 Jun ruolu Pour la Divisse. 011123 1000 4 Et toutes ces operations sont fi aifées, qu'on n'a jamais 10014 befoin de rien effayer ni deviner , comme il faut faire فطميميا dans la division ordinaire. On n'a point befoin non-plus 1101147 de rien apprendre par cœur icy, comme il faut faire dans . 111 0 1 19 le calcul ordinaire, où il faut fcavoir, par exemple, que #1111 cito 6 & 7 pris enfemble font 13 ; & que 5 multiplié par 5 a I I I I I donne 15, fuivant la Table d'ant fois av eff av, qu'on ap rooocta pelle Pythagorique. Mais icy tout cela fe trouve & fo Se, prouve de fource, comme l'on voit dans les exemples precedens fous les fignes 3 & ⊙.

Video from Story of one

In « Explanation of Binary Arithmetic, which uses only the charac-

ters 1 and $0 \gg$

 From decimal to binary How can we write 19 using the 1s and 0s on one byte?
 19 =

From decimal to binary How can we write 19 using the 1s and 0s on one byte?
19 = 16 + 2 + 1

128	64	32	16	8	4	2	1
0	0	0	1	0	0	1	1

From decimal to binary How can we write 19 using the 1s and 0s on one byte?
19 = 16 + 2 + 1

128	64	32	16	8	4	2	1
0	0	0	1	0	0	1	1

19 is written 00010011 using one byte or $8~{\rm bits}$

• From binary to decimal What is the number written 01011001 with one byte?

128	64	32	16	8	4	2	1
0	1	0	1	1	0	0	1

• From binary to decimal What is the number written 01011001 with one byte?

128	64	32	16	8	4	2	1
0	1	0	1	1	0	0	1

 $1 \times 64 + 1 \times 16 + 1 \times 8 + 1 \times 1 = 89$

01011001 is the binary writting of the decimal number 89.

• Binary numbers and additions

• Binary numbers and additions Example from Leibniz (he forgot something...)

Dan P Allinia	110 6	101 5	1110	14
Pour l Addition	111 7	1011 11	10001	17
par exemple.	1101 13	10000 16	11111	31.

• Binary numbers and additions Example from Leibniz (he forgot something...)

Dave D Allista	110 6	101 5	1110 14
Pour I Addition	111 7	1011 11	10001 17
par exemple.	1101 13	10000 16	11111 31

How can you add 00001001 and 00001010?



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Bytes and codes

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IBM first drive RAMAC 1956

Bytes and codes

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IBM first drive RAMAC 1956



Kilo-octet	1Ko	$2^{10} = 1024 \approx 10^3$ Bytes
Mega-octet	1Mo	$2^{20} \approx 10^6$ Bytes
Giga-octet	1Go	$2^{30} \approx 10^9$ Bytes
Tera-octet	1To	$2^{40} \approx 10^{12}$ Bytes
Peta-octet	1Po	$2^{50} \approx 10^{15}$ Bytes
Exa-octet	1Eo	$2^{60} \approx 10^{18}$ Bytes
Zetta-octet	1Zo	$2^{70} \approx 10^{21}$ Bytes



Bytes and codes

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1 Mo	a 500 page book; color photo(poor quality)
1 Go	an encyclopedia; a 1 hour good quality video
32 Go	a USB key
1 To	information in the million of books published per a year;
	500 hours of video (good quality)
2 Po	archive of internet in 2006
100 Eo	all the information written on paper on Earth

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• Music One Petaoctet (or $\approx 1\,000\,000$ Go) of average MP3-encoded songs would require $\begin{array}{c} \Box 2000 \text{ hours} \\ \Box 2000 \text{ weeks} \\ \Box 2000 \text{ weeks} \end{array}$ to play. $\Box 2000 \text{ years} \end{array}$

- Music One Petaoctet (or $\approx 1\,000\,000$ Go) of average MP3-encoded songs would require $\begin{array}{c} \Box 2000 \text{ hours} \\ \Box 2000 \text{ weeks} \\ \Box 2000 \text{ years} \end{array}$ to play.
- **Photos** January 2013, Facebook over 240 billion photos uploaded, with 350 million new photos every day.

For each uploaded photo, Facebook generates and stores four images of different sizes, which translated to a total of 960 billion images and an

estimated $\begin{tabular}{c} \Box 357 & {\rm Go} \\ \Box 357 & {\rm To} \\ \Box 357 & {\rm Po} \\ \Box 357 & {\rm Eo} \end{tabular}$

Codes in everyday life?



Codes in everyday life?

• Universal Product Code (UPC-A) barcode for tracking trade items in stores.



Codes in everyday life?

• Universal Product Code (UPC-A) barcode for tracking trade items in stores.





• Credit cards...

ISBN (books), QR code

bank identification number



Bytes and codes

Universal Product Code (UPC-A) or EAN



Bytes and codes

Universal Product Code (UPC-A) or EAN



The last digit is a **check digit**

Universal Product Code (UPC-A) or EAN



How to check the code $a_1a_2a_3a_4a_5a_6a_7a_8a_9a_{10}a_{11}a_{12}$?

$$S = 3 a_1 + a_2 + 3 a_3 + a_4 + \dots + 3 a_9 + a_{10} + 3 a_{11} + a_{12}$$

The code is right if S is a multiple of 10.

QR codes (Quick Response Code)



QR codes (Quick Response Code)



- Version information
- Format information
- Data and error correction keys



- - 4.1. Position



- 4.3. Timina

5. Quiet zone





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Bytes and codes



During the Second World War, German transmissions for U-Boat were encrypted with the enigma machine.



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Alan Turing created a kind of computer named Bomba that craked the Enigma code.

He saved thousands of lives during the battle of the Atlantic.

Alan Turing





Bytes and codes

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Alan Turing





• **Turing machine** a mathematical model of a computer.

Alan Turing





- **Turing machine** a mathematical model of a computer.
- Turing patterns patterns on animals skins

What you need to remember

- bit≠byte
- Binary numbers \leftrightarrow Decimal numbers
- Units and data storage (Go, To, Po...)
- Everyday life codes (UPC...), check digit
- Enigma, Alan Turing and its Bomba during WW2