Digital Data

I) Representation of numbers.

I) 1) Natural numbers (+ Ø)

$$N \nearrow a\,10^3 + b\,10^2 + c\,10 + d \quad \text{Decimal}$$

$$N \searrow a\,2^3 + b\,2^2 + c\,2 + d \quad \text{binary}$$

conversion tools are ubiquitous

II) 2) Integers.

Any integer includes 2 parts:

$\boxed{}$ $\boxed{}$

sign $\quad \underbrace{\text{absolute value}}$

↓ $\qquad$ akin to a natural number.

requires one bit $\qquad \boxed{\emptyset}$ positive

$\qquad\qquad\qquad\qquad \boxed{1}$ negative

Let us look at the number $(11)_{10}$

$$\boxed{1}\ \boxed{0}\ \boxed{1}\ \boxed{1}$$

the number $-(11)_{10}$

$$\underbrace{\boxed{1}}_{\text{"}-\text{"}}\ \underbrace{\boxed{1}\ \boxed{0}\ \boxed{1}\ \boxed{1}}_{\text{"11"}}$$

<u>Anecdotic</u>

Computers prefer the concept of "2-complement" for representing integers.

If you have a number N, positive, represented on M bits, the number $(-N)$ is represented as $2^M - N$

Recipe: a) take the representation of the positive number.

b) Reverse all bits

c) Add 1

a) $\boxed{0}\ \boxed{1}\ \boxed{0}\ \boxed{1}\ \boxed{1}$

reverse

$\boxed{1}\ \boxed{0}\ \boxed{1}\ \boxed{0}\ \boxed{0}$

b) add 1

$\boxed{1}\ \boxed{0}\ \boxed{1}\ \boxed{0}\ \boxed{1}$

I) III) Fractions or rational numbers

A rational number is the ratio of 2 integers

$$q = \frac{a}{b}$$

$a \rightarrow$ integers

$b \rightarrow$ integers

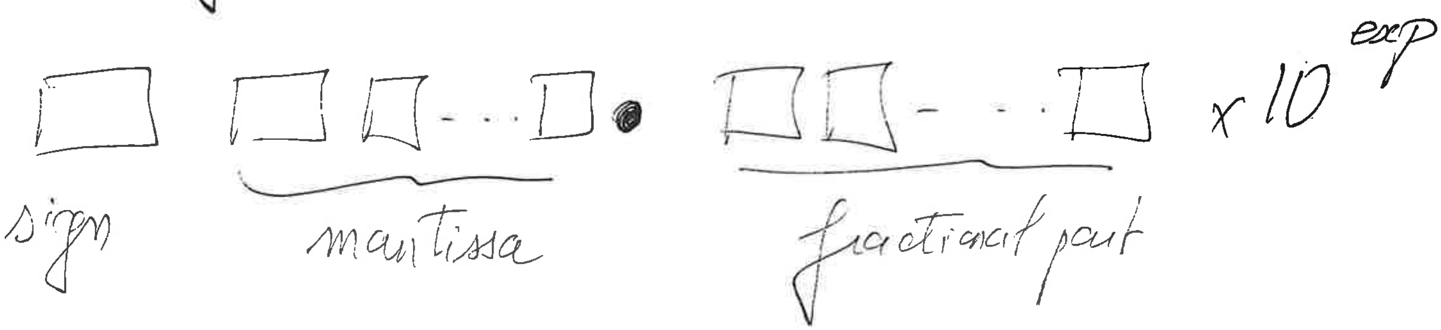
Eight-bit signed integers

Bits	Unsigned value	Two's complement value
0000 0000	0	0
0000 0001	1	1
0000 0010	2	2
0111 1110	126	126
0111 1111	127	127
1000 0000	128	−128
1000 0001	129	−127
1000 0010	130	−126
1111 1110	254	−2
1111 1111	255	−1

I) IV Real numbers.

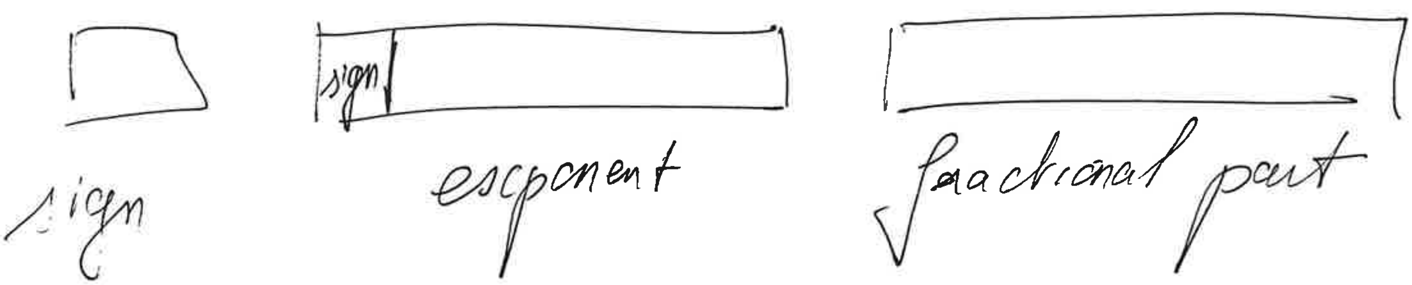
How is a real number represented?

Scientific Notation:



$$+\ 2.5\ 10^{1} \equiv +0.25\ 10^{2}$$

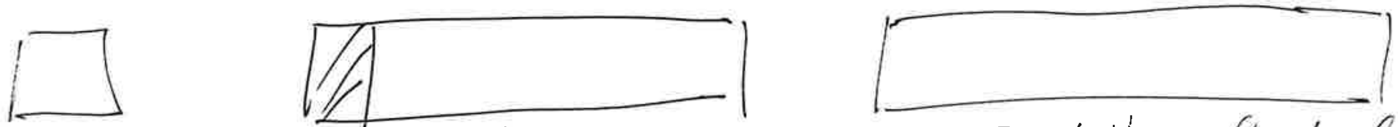
$$-\ 40.0\ 10^{-1} \equiv -0.4\ 10^{1}$$



1 bit

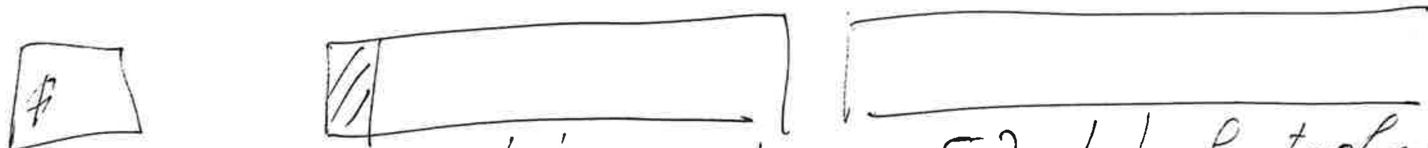
Currently, there are 2 main standards to represent real numbers:

32 bits standard



1 bit 8 bits exponent 23 bits fractional part.

64 bits:



1 bits 11 bits exponent 52 bits fractional part.

II) A different paradigm: base 16

$$N \to a\,10^3 + b\,10^2 + c\,10 + d \quad \text{decimal}$$

$$a\,2^3 + b\,2^2 + c\,2 + d \quad \text{binary}$$

$$a\,16^3 + b\,16^2 + c\,16 + d \quad \text{hexadecimal}$$

Hexadecimal
$a, b, c, d \equiv 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F$