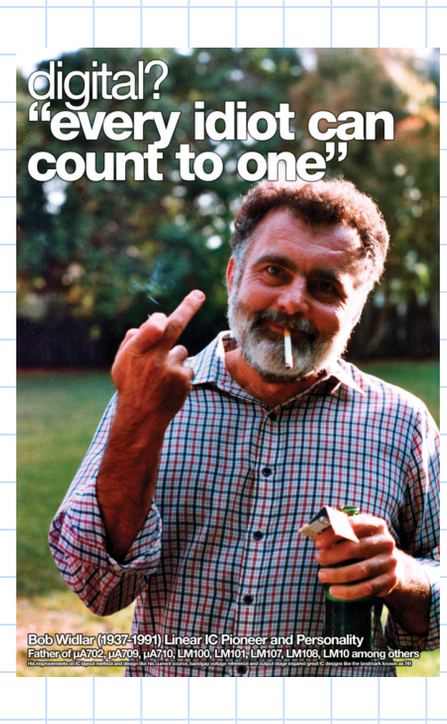
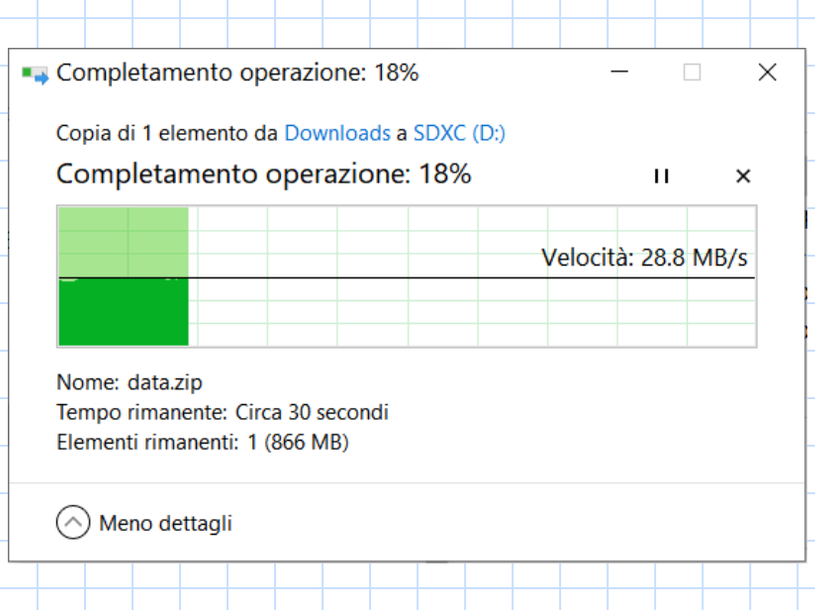
DALL' ANALOGICO AL DIGITALE



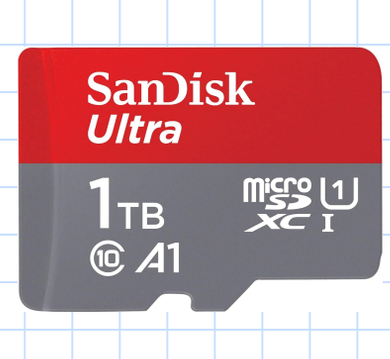
WHY DIGITAL ? → PRESERVARE INFO
→ SEMPLICITÀ DESIGN

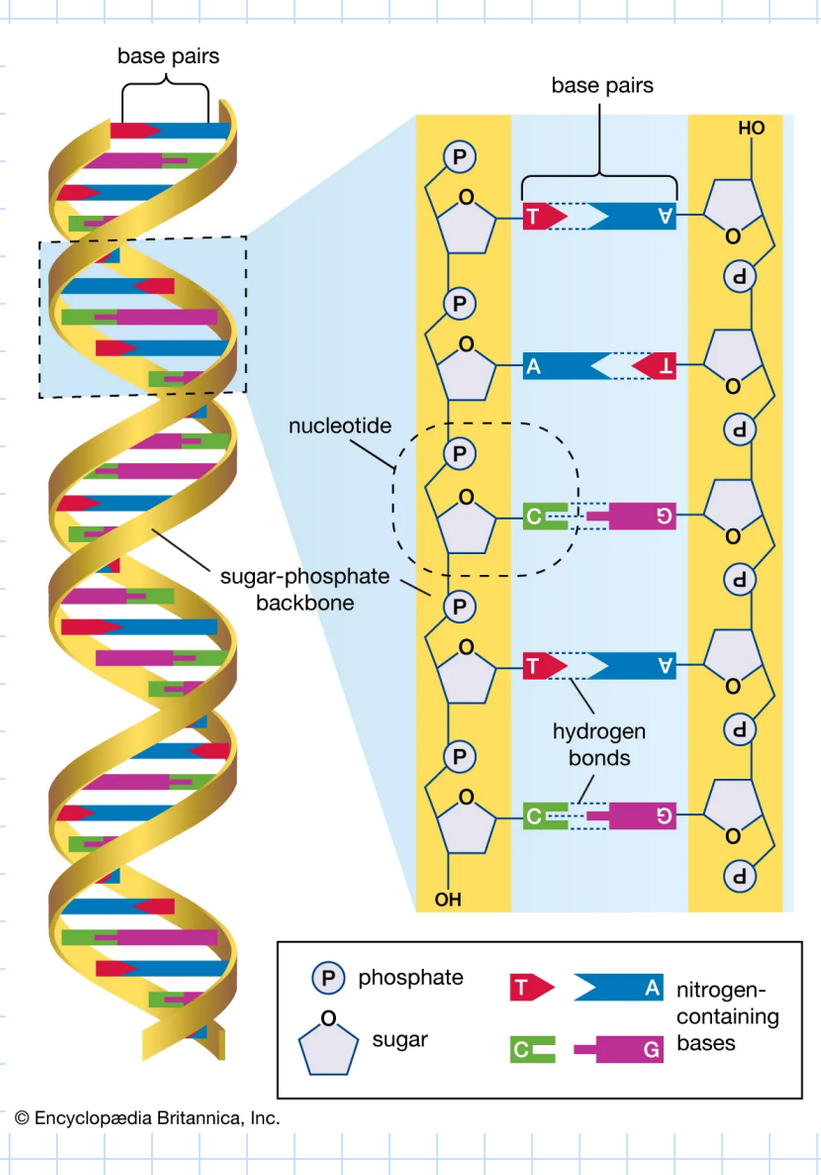


1 GB

10^{10} BIT

CON ~ ∅ ERRORI



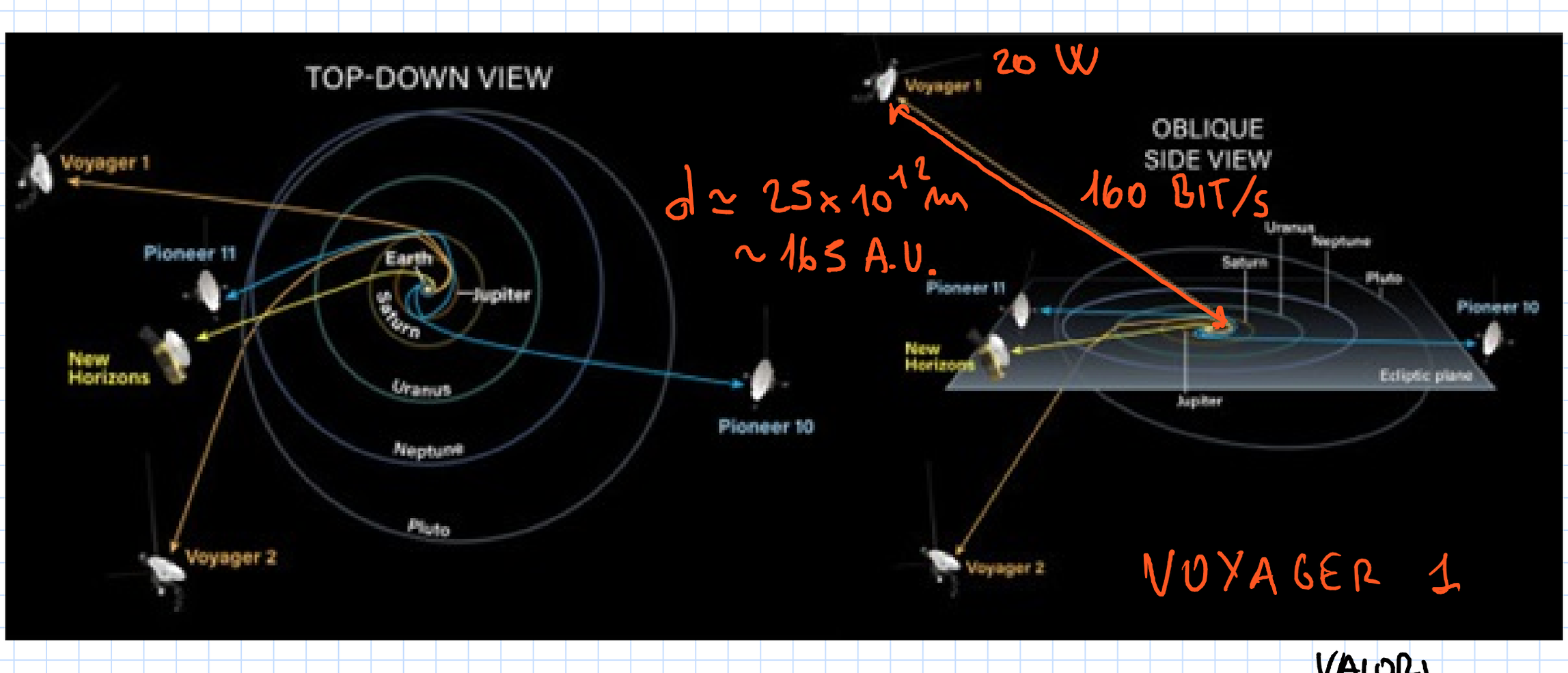


DNA → BASE DI 4 ELEMENTI

STORAGE : SINGOLO FILAMENTO DI $\ell \sim 1$ m $\sim 1{,}5$ GB

1 g DNA ~ 215 PB (10^{15})

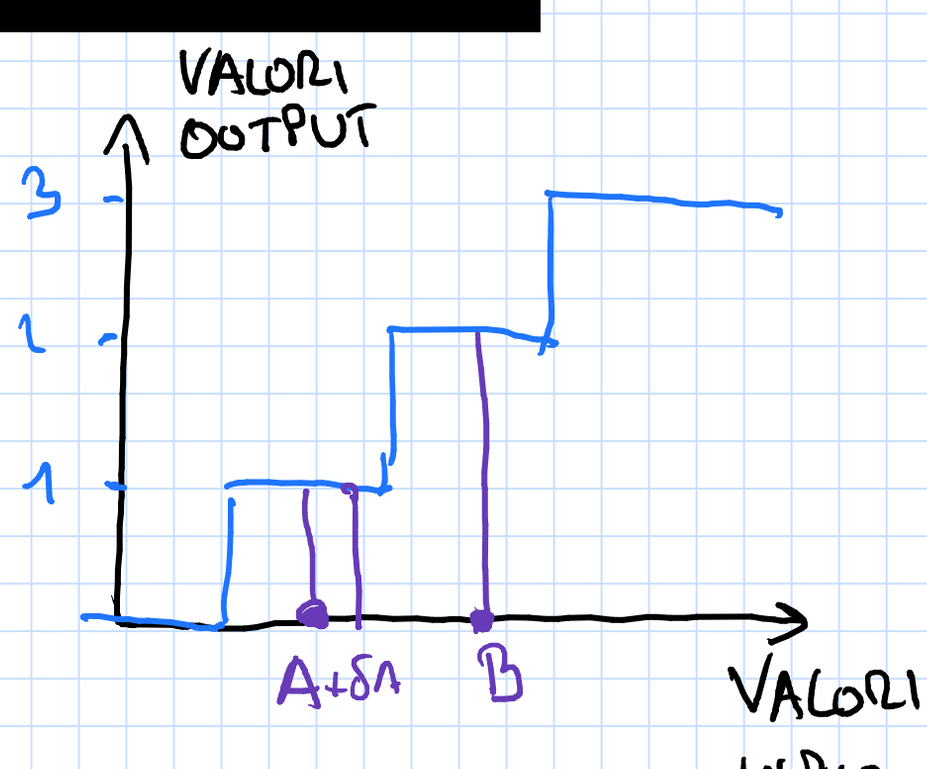
VELOCITÀ : 100 - 200 BIT/s

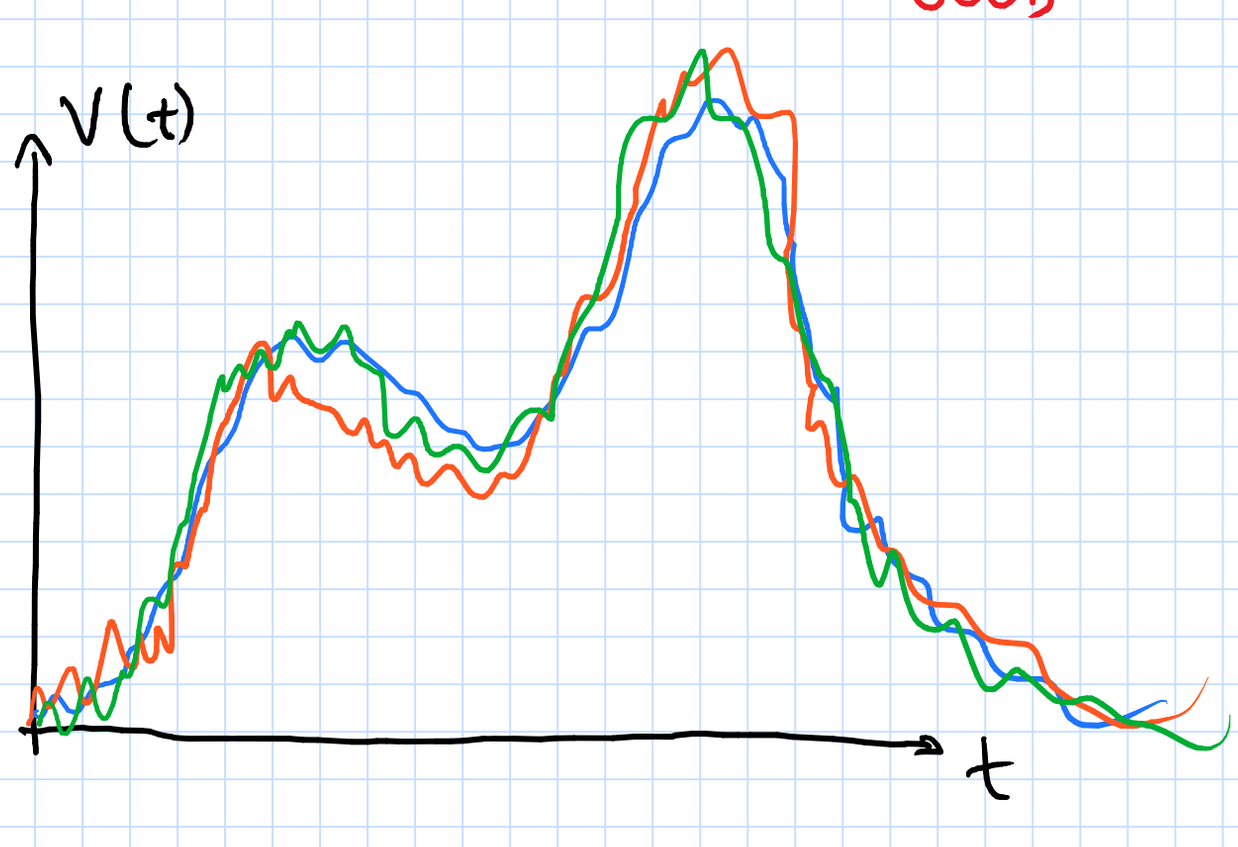


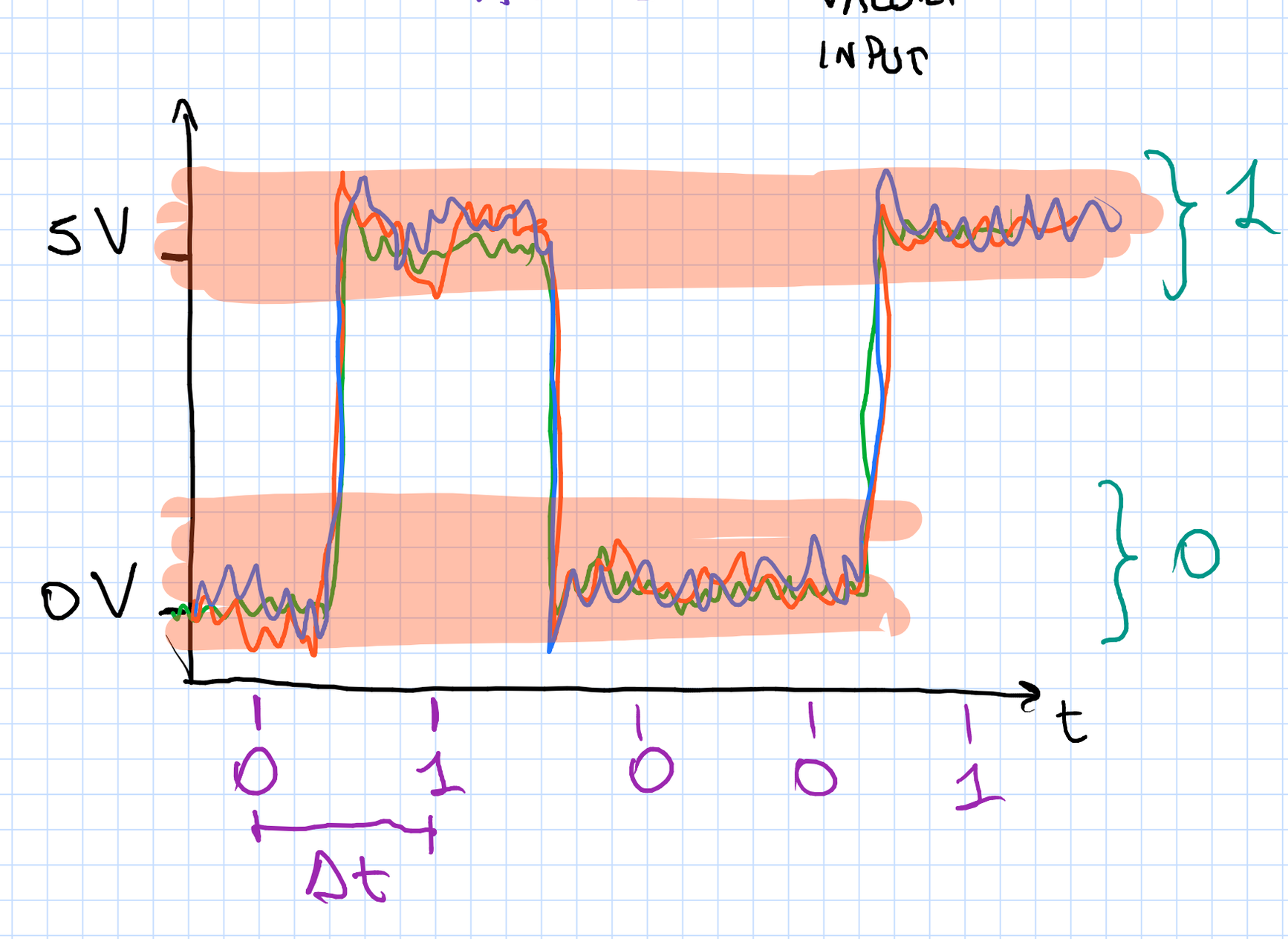
DISCRETIZZAZIONE

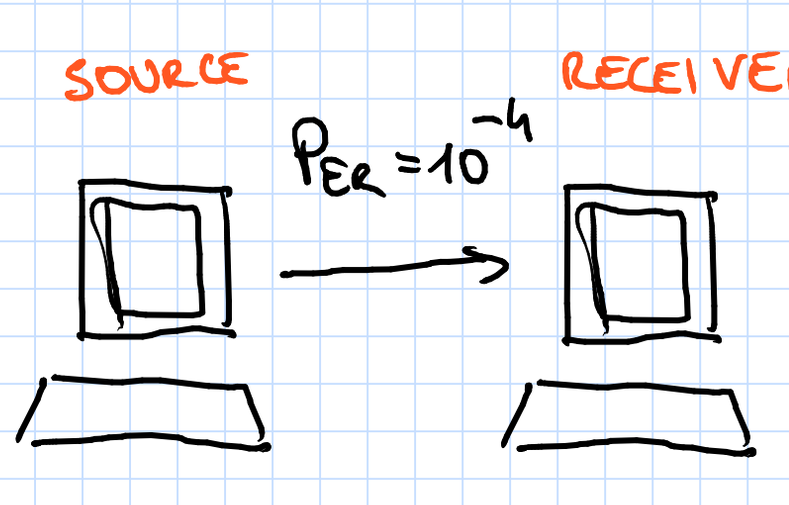
A B C D

GOOD BAD!









10 BITS

S 1 0 1 1 1 0 0 0 1 0

R 1 ~~0~~ 1 1 1 1 0 0 0 1 0 (1)

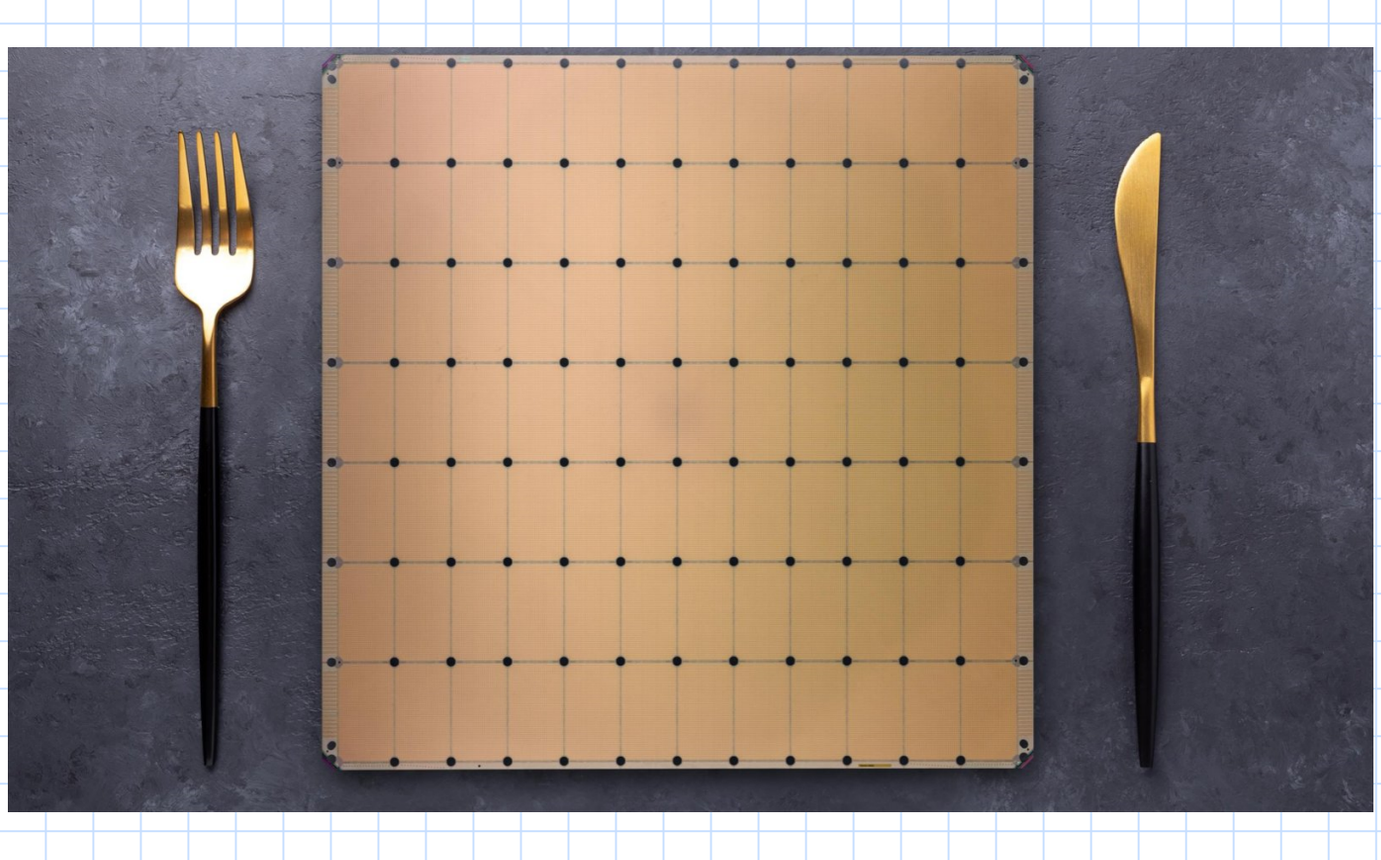
$\sim 10 \cdot P = 10^{-3} = 0{,}1\%$

CHECKSUM   PARITY CHECKSUM
+ 1 BIT CHE CONTA LA PARITÀ DEGLI "1"

1 ~~0~~ 1 1 ~~1~~ 0 0 0 1 0 1 → SCARTARLO
(1) (0)

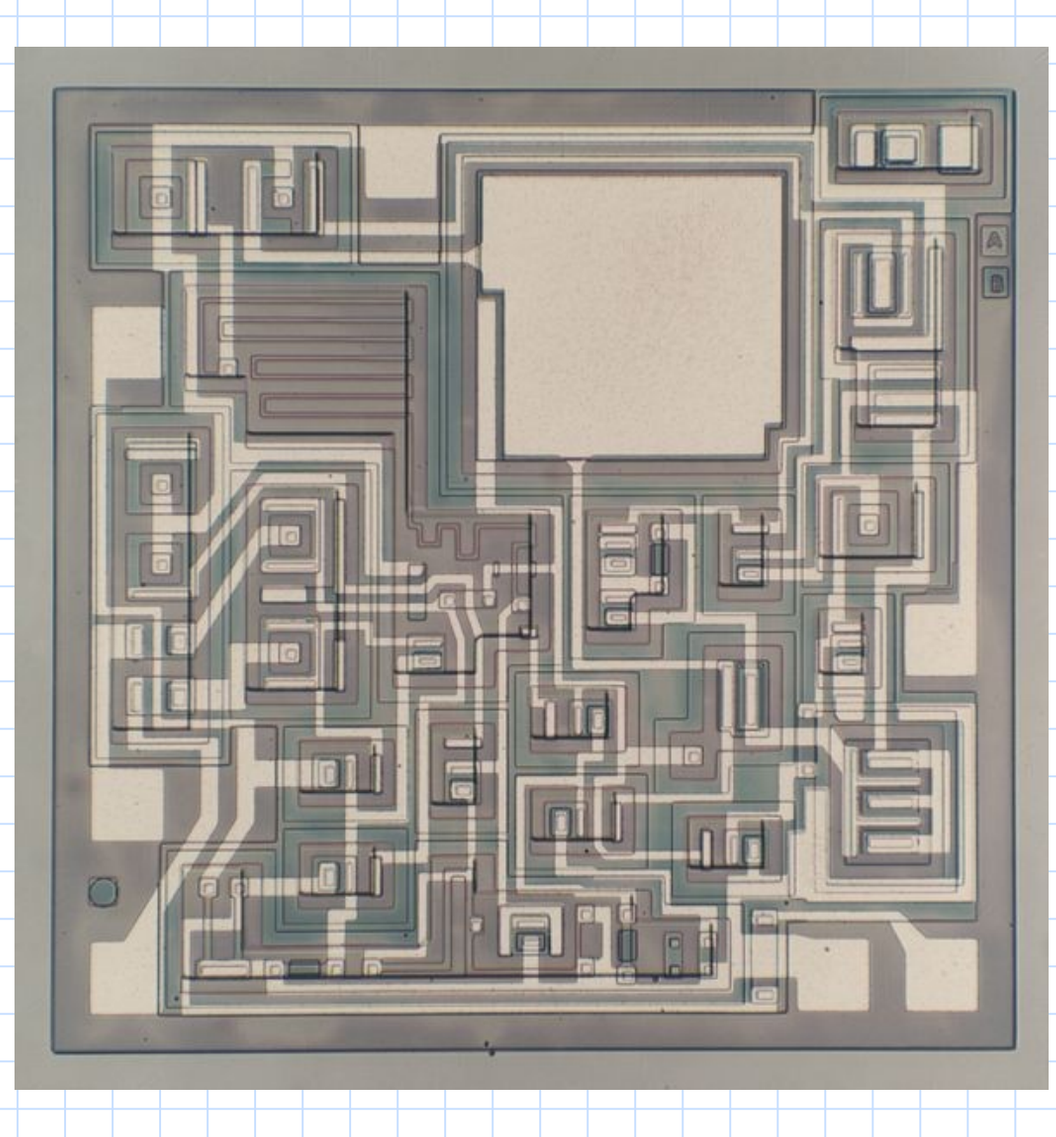
$P^{2ER} = \frac{10 \cdot 11}{2} P^2 = 5.5 \cdot 10^{-6}$

$P^{ER} \sim 10^{-12}$



CEREBRA WSE 2 (2021)

2.6×10^{12} COMPONENTI



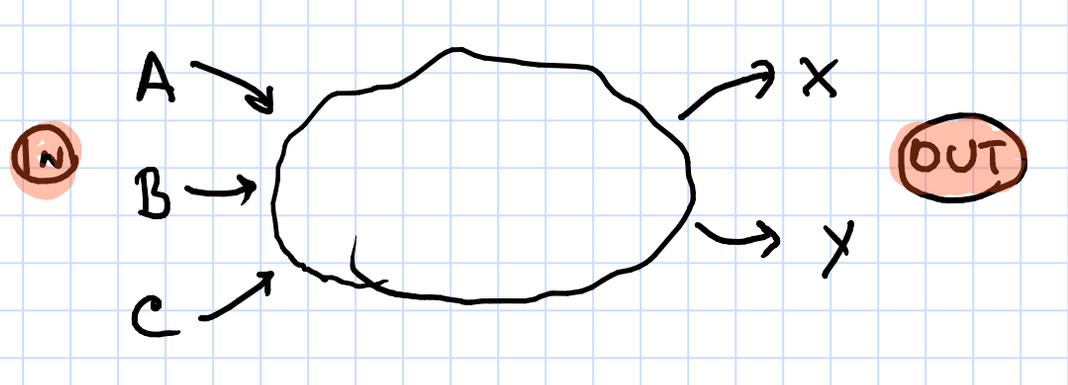
μA741 OPAMP TEXAS INSTRUMENTS

~ 20 TRANSISTOR

CHIP ANALOGICI ~ CUSTOM

CHIP DIGITAL ~ STANDARD

LOGICA E CIRCUITI



DESCRIZIONI EQUIVALENTI

1. LOGICA ASTRATTA
$X = A \vee B$
2. FUNZIONE BOOLEANA
$X = f(A, B)$, $\{0,1\}$ TRUE / FALSE
3. CIRCUITO LOGICO

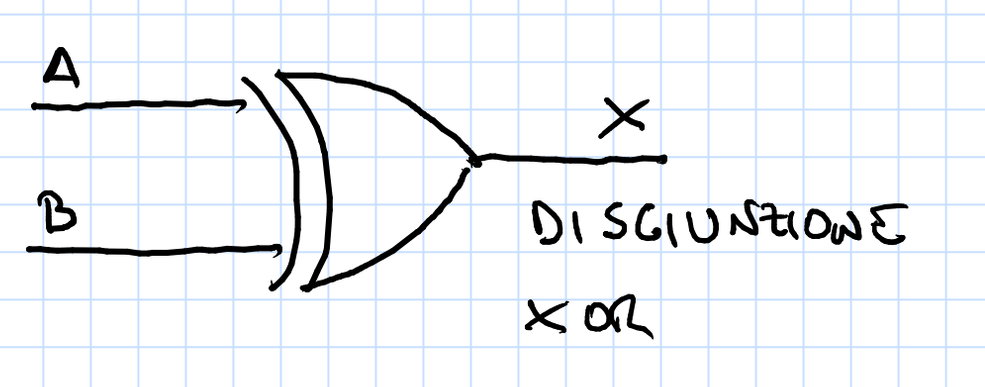
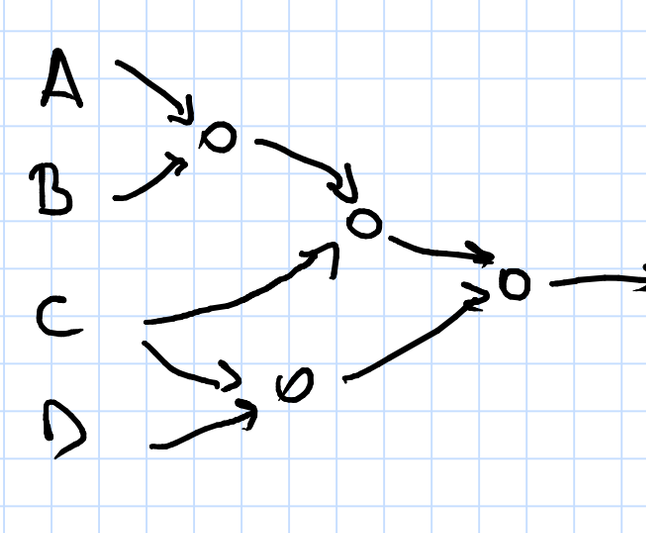
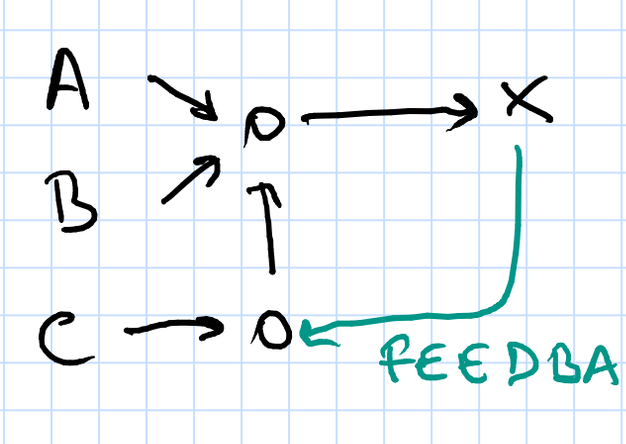


TABELLE VERITÀ ↓ CASI SE POSSIBILI

CIRC. LOGICO



COMBINATORIO



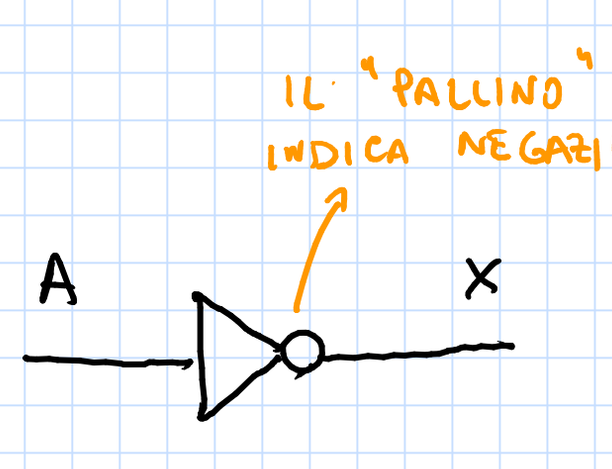
SEQUENZIALE

PORTE ELEMENTARI

Ⓐ 1 INPUT, 1 OUTPUT

A	X
0	1
1	0

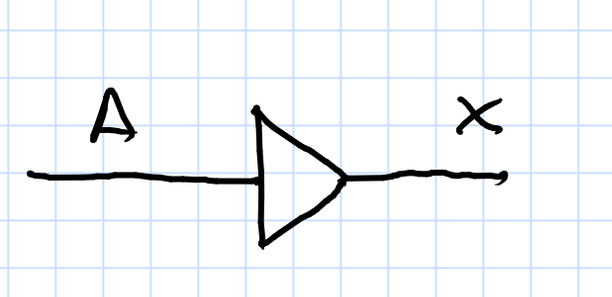
NOT



$X = !A$
$X = \neg A$
$X = \bar{A}$

A	X
0	0
1	1

BUFFER

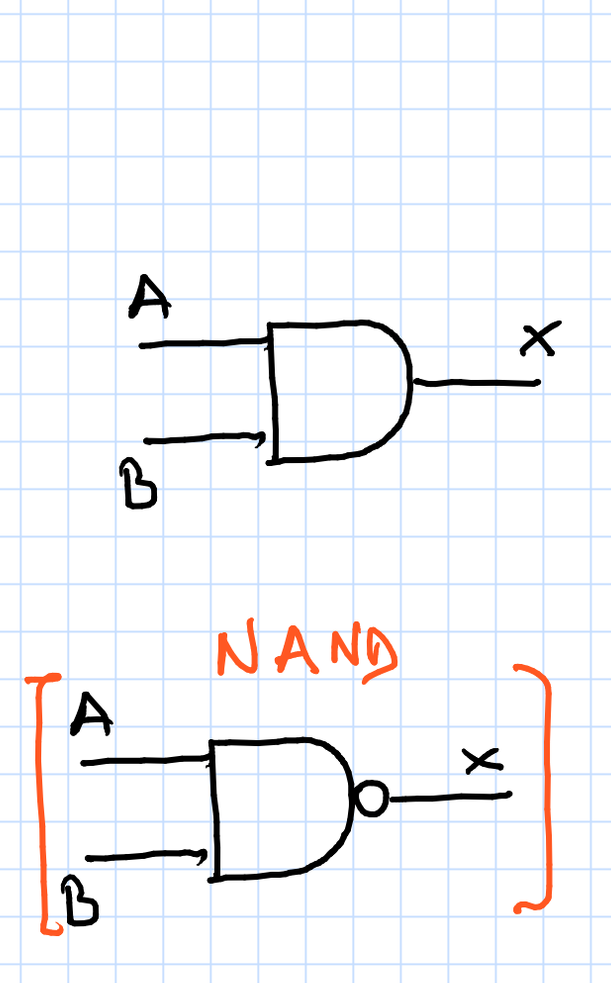


$X = A$

Ⓑ 2 INPUT, 1 OUTPUT

A	B	X	X
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

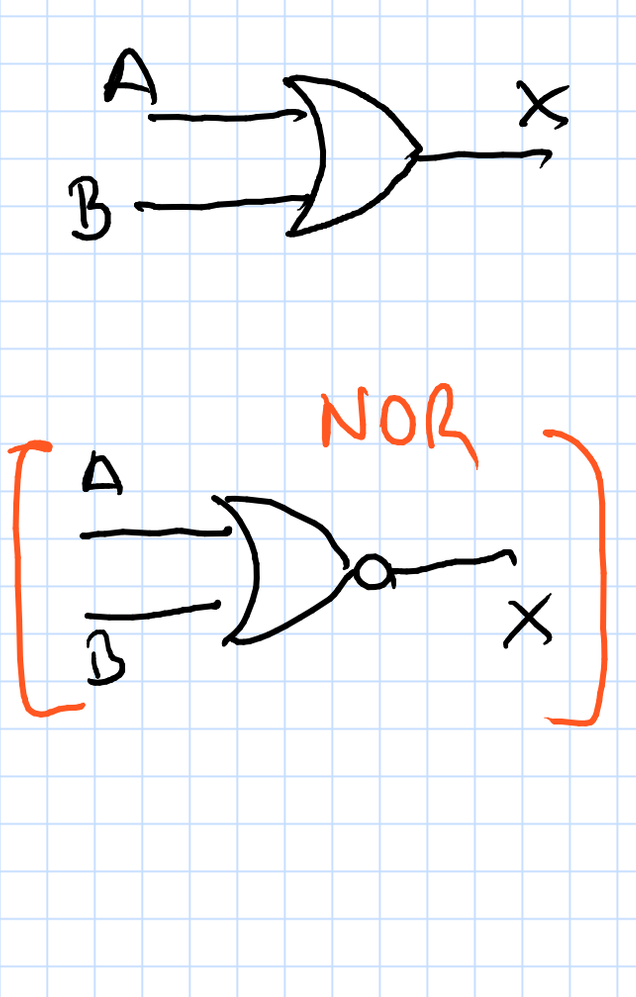
AND



$X = A \wedge B$
$X = A \& B$
$X = A \cdot B$ "PRODOTTO"

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

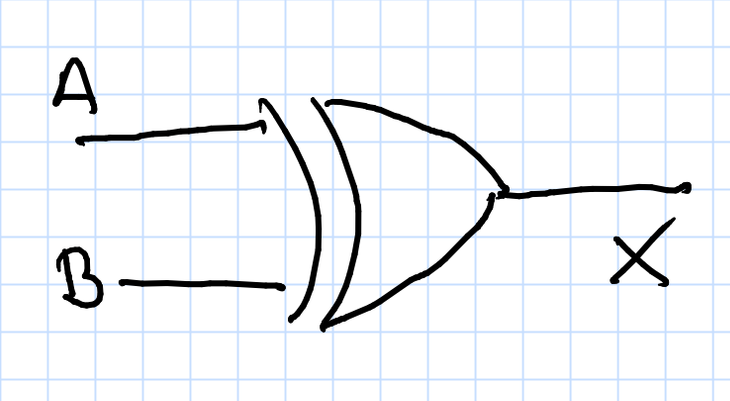
OR



$X = A \vee B$
$X = A | B$
$X = A + B$

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

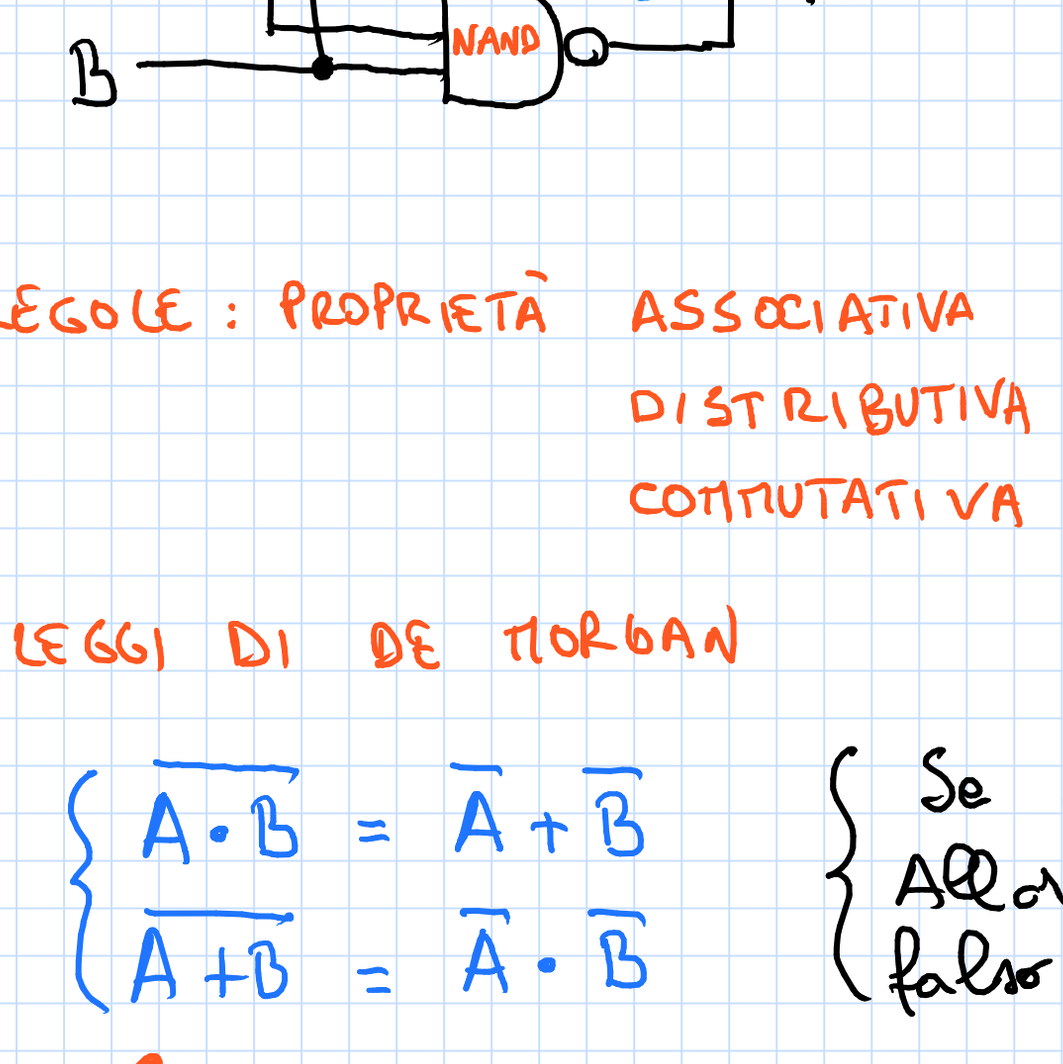
XOR o OR ESCLUSIVO



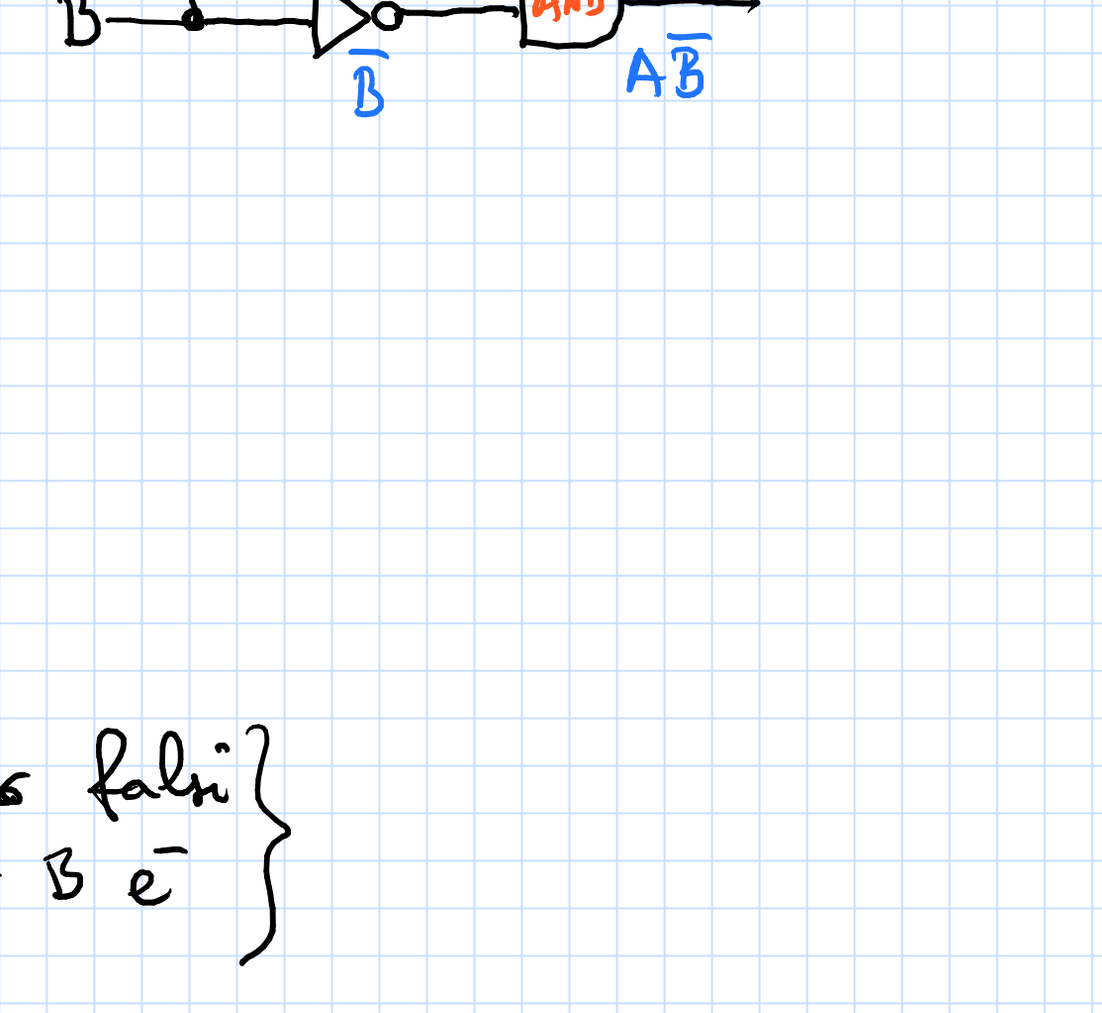
$X = A \oplus B$

COMBINAZIONE

$X = (A+B) \cdot \overline{AB}$



$X = A\bar{B} + \bar{A}B$



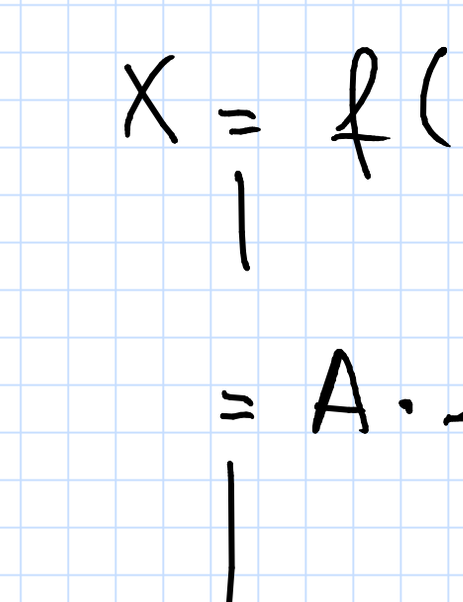
• REGOLE : PROPRIETÀ ASSOCIATIVA, DISTRIBUTIVA, COMMUTATIVA

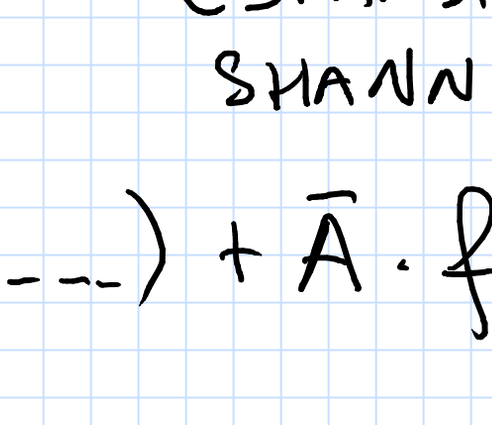
• LEGGI DI DE MORGAN

$\overline{A \cdot B} = \bar{A} + \bar{B}$
$\overline{A + B} = \bar{A} \cdot \bar{B}$

Se A e B sono falsi allora o A o B è falso

$(A \cup B)^c = A^c \cap B^c$





$X = (A+B) \cdot \overline{AB} = (A+B)(\bar{A}+\bar{B}) =$

$= \cancel{A\bar{A}} + A\bar{B} + \bar{A}B + \cancel{B\bar{B}} = A\bar{B} + \bar{A}B$

A	B	C ----	X
0	0	0	
0	0	1	
0	1	0	
|	|	|	

$X = f(A, B, C, \ldots)$

$= A \cdot f(1, B, C, \ldots) + \bar{A} \cdot f(0, B, C, \ldots)$

$AB f(1, 1, C, \ldots) + \bar{A}B f(0, 1, C, \ldots) +$
$+ A\bar{B} f(1, 0, C, \ldots) + \bar{A}\bar{B} \cdot f(0, 0, C, \ldots)$

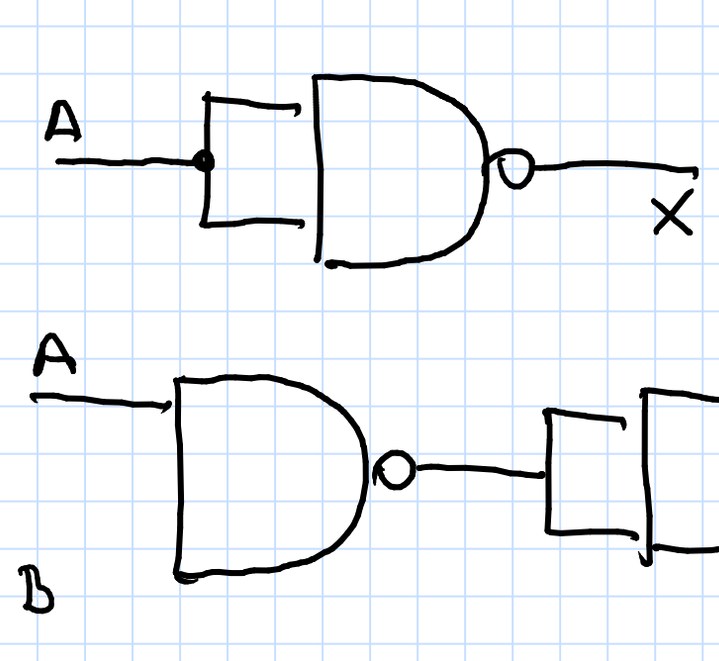
SOMMA DI PRODOTTI

1ª FORMA CANONICA DELL' ESPANSIONE DI SHANNON

2ª FORMA CANONICA → PRODOTTO DI SOMME

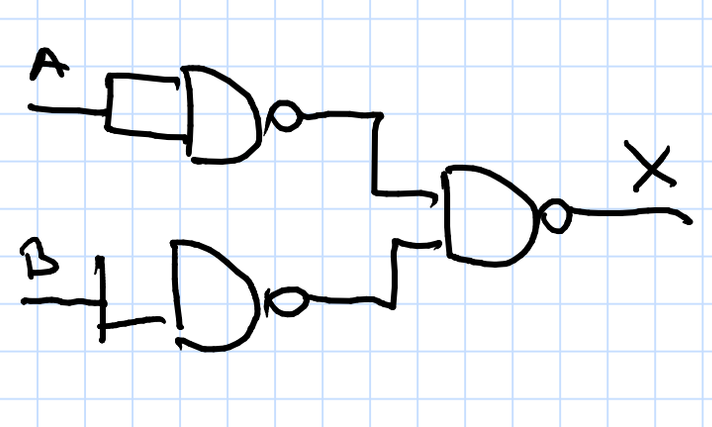
PORTE UNIVERSALI

{NOT, AND, OR} → NAND



$X = \overline{A \cdot A} = \bar{A}$ NOT

$X = \overline{\overline{A \cdot B}} = A \cdot B$ AND



$X = \overline{\bar{A} \cdot \bar{B}} = \overline{\overline{A+B}} = A+B$ OR