

# BITS

[BACK](#)

1

2

3

1

2

3

---

$10^2$

$10^1$

$10^0$

1

2

3

---

$10^2$

$10^1$

$10^0$

100

10

1

1 2 3

---

$10^2$

$10^1$

$10^0$

$$= 1 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$$

$$= 1 \times 100 + 2 \times 10 + 3 \times 1$$

$$= 123$$

4

1

2

3

---

?

$10^2$

$10^1$

$10^0$

4 1 2 3

---

$10^3$

$10^2$

$10^1$

$10^0$

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

4 1 2 3

---

$10^3$

$10^2$

$10^1$

$10^0$

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

$$= 4 \times 1000 + 1 \times 100 + 2 \times 10 + 3 \times 1$$



4 1 2 3

---

$10^3$

$10^2$

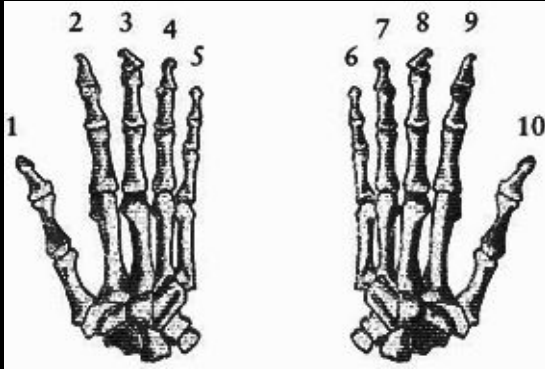
$10^1$

$10^0$

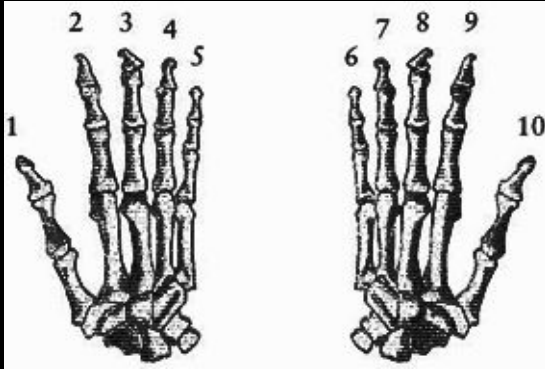
$$= 4 \times 10^3 + 1 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$$

$$= 4 \times 1000 + 1 \times 100 + 2 \times 10 + 3 \times 1$$

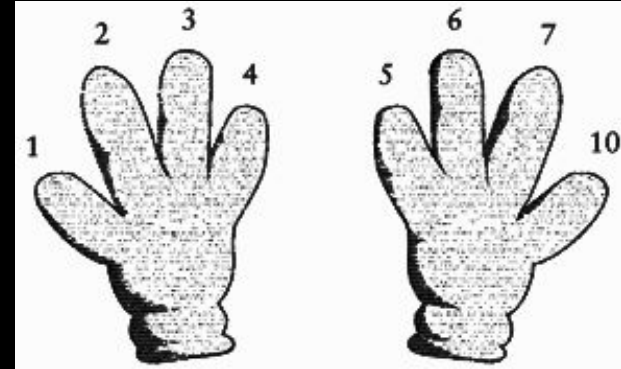
$$= 4123$$



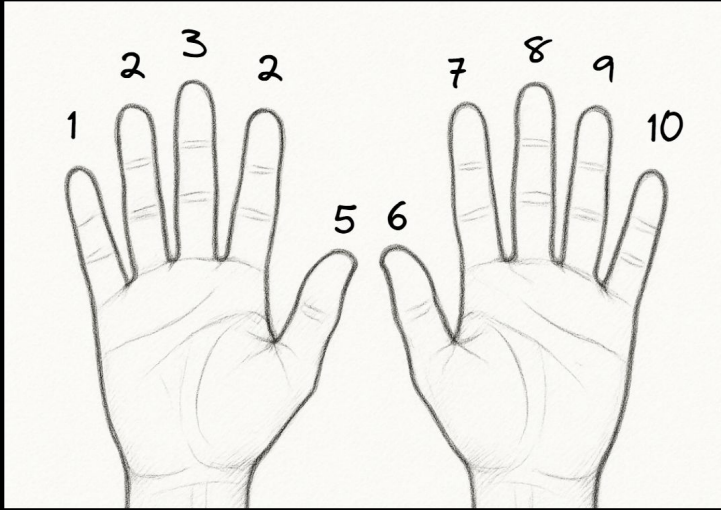
human hand



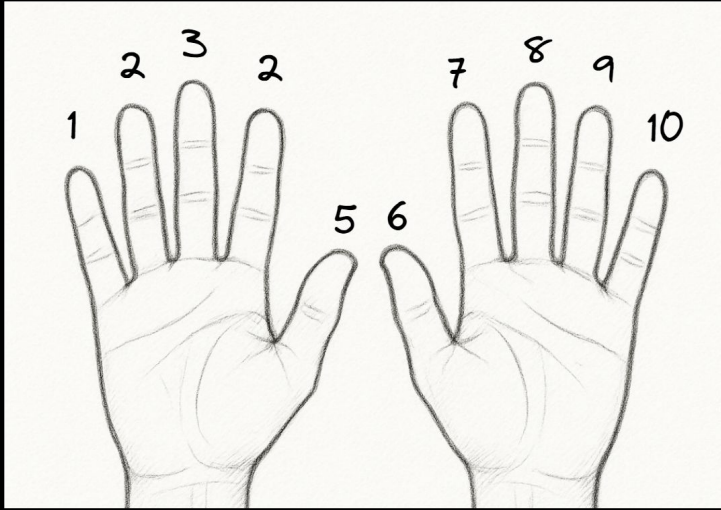
human hand



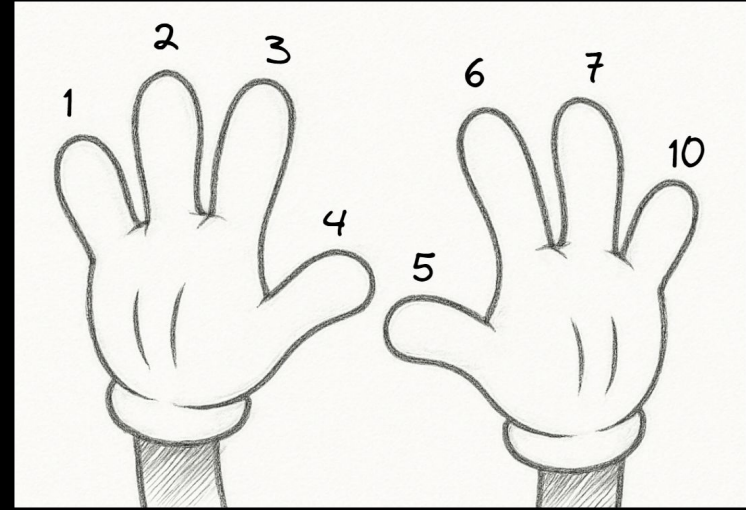
cartoon character's hand



human hand



human hand



cartoon character's hand

1

2

3

(octal)

1

2

3

(octal)

---

$8^2$

$8^1$

$8^0$

1

2

3

(octal)

---

$8^2$

$8^1$

$8^0$

$$= 1 \times 8^2 + 2 \times 8^1 + 3 \times 8^0$$



1

2

3

(octal)

---

$8^2$

$8^1$

$8^0$

$$= 1 \times 8^2 + 2 \times 8^1 + 3 \times 8^0$$

$$= 1 \times 64 + 2 \times 8 + 3 \times 1$$

1

2

3

(octal)

---

$8^2$

$8^1$

$8^0$

$$= 1 \times 8^2 + 2 \times 8^1 + 3 \times 8^0$$

$$= 1 \times 64 + 2 \times 8 + 3 \times 1$$

$$= 83 \text{ (decimal)}$$

decimal

octal

8



?

decimal

octal

?



7

decimal

octal

16



?

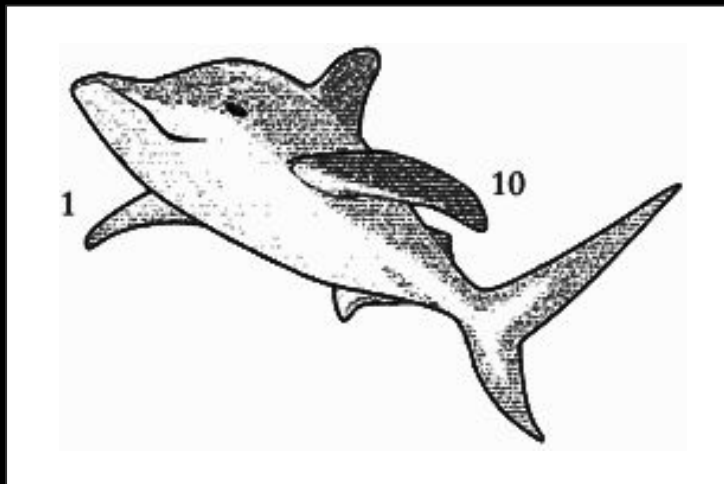
decimal

octal

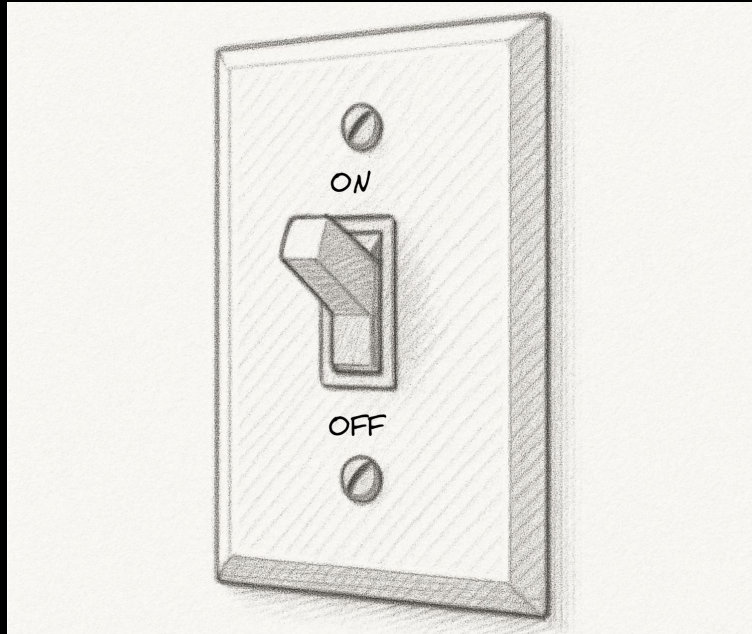
?



100

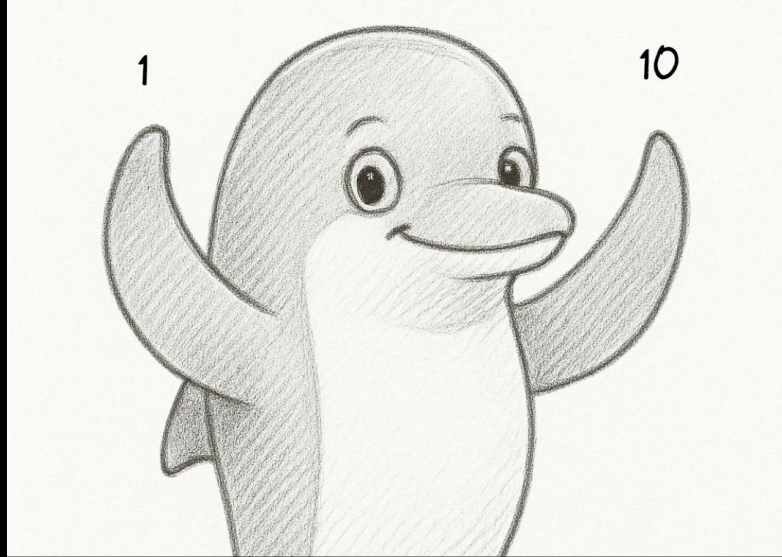


what now?



a binary number is like a switch





what now?

0, 1, ...

0, 1, 10, ...

0, 1, 10, 11, ...

0, 1, 10, 11, 100, ...

0, 1, 10, 11, 100, 101, ...

0, 1, 10, 11, 100, 101, 110

1

1

0

(binary)



1

1

0

(binary)

---

$2^2$

$2^1$

$2^0$

1 1 0

(binary)

---

$2^2$

$2^1$

$2^0$

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

1 1 0

---

(binary)

$2^2$

$2^1$

$2^0$

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

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

1 1 0

---

(binary)

$2^2$

$2^1$

$2^0$

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

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

$$= 6 \text{ (decimal)}$$

*2 3 4 5 6*

0, 1, 10, 11, 100, 101, 110

# place value systems

$$N = d_n * R^{n-1} + \dots + d_2 * R^1 + d_1 * R^0$$

$$d \in \{ 0, 1, \dots R-1 \}$$

$n$  = number of digits

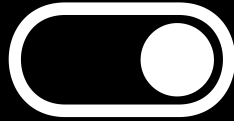
$R$  = base

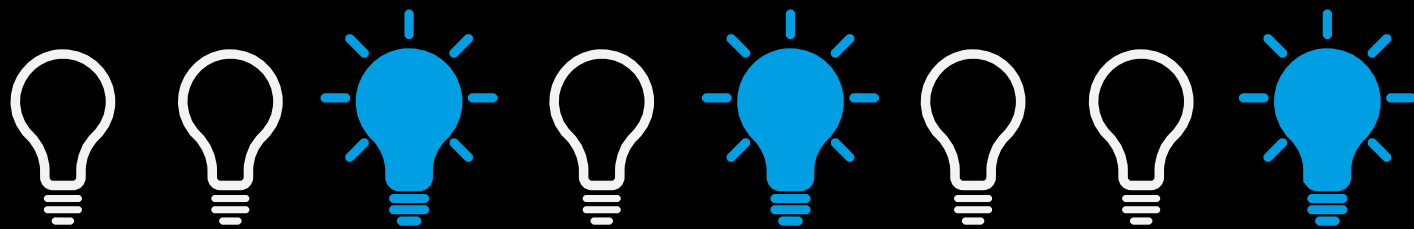
$$R \geq 2$$

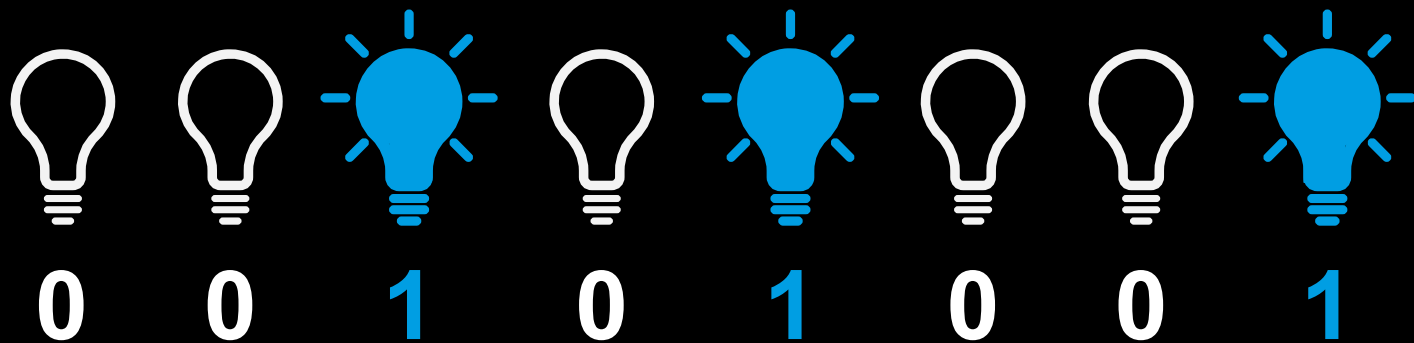
bits

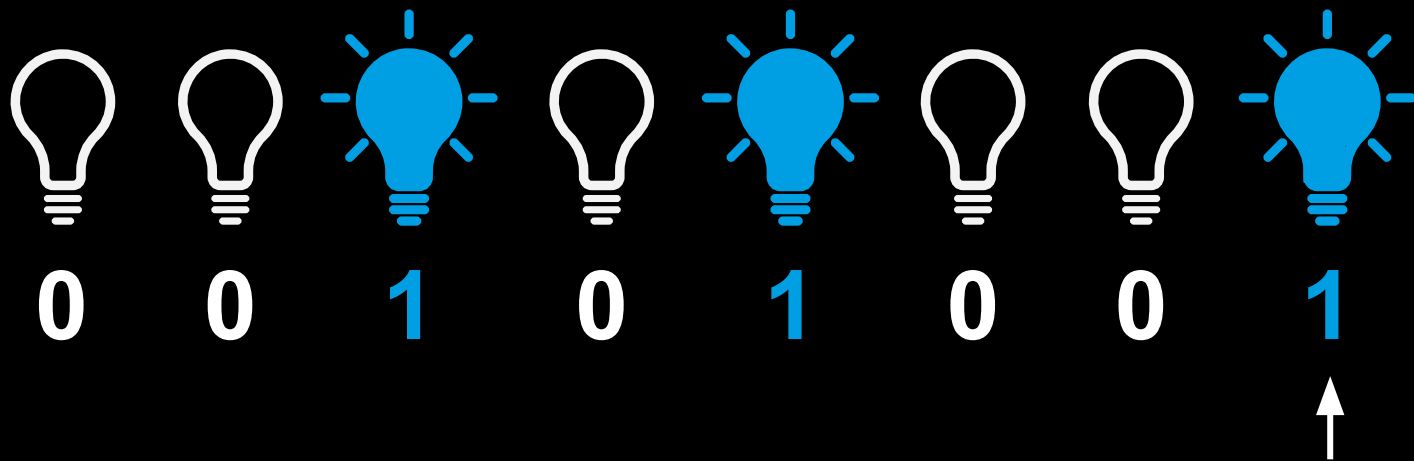


why do computers think binary?

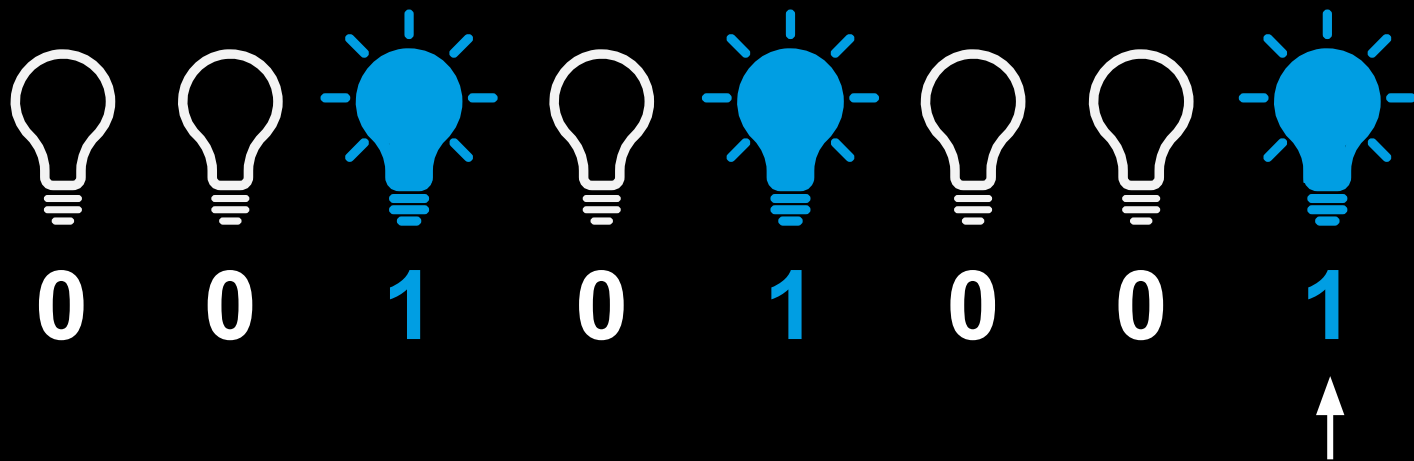






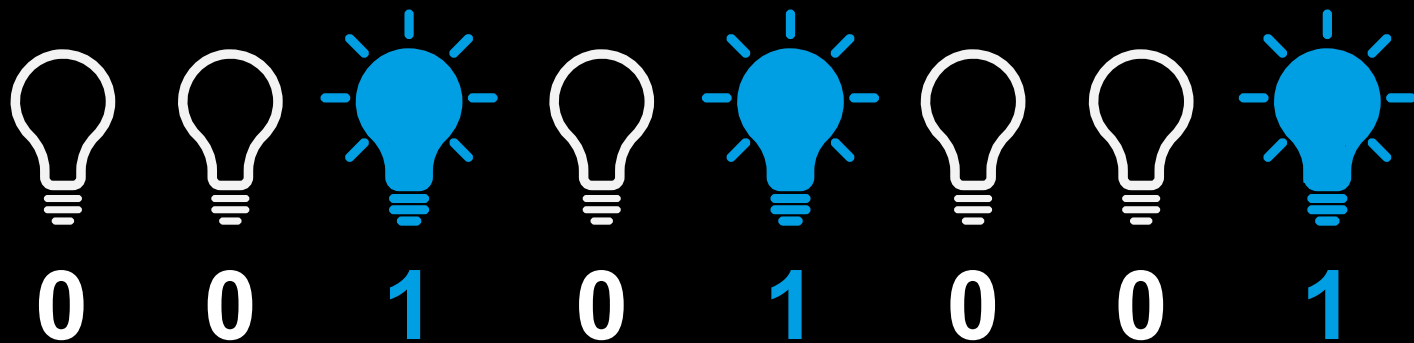


a **bit** (binary digit)



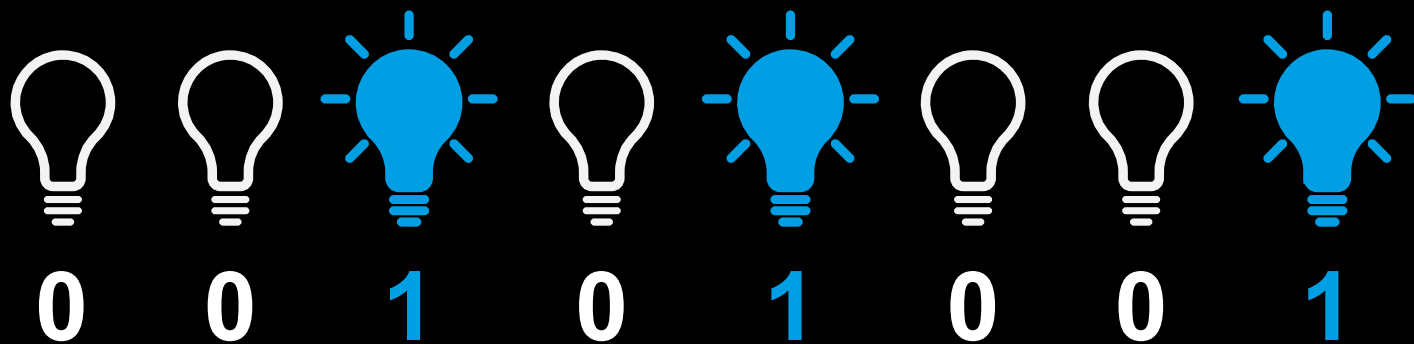
a **bit** (binary digit)

a **byte** (8 bits)



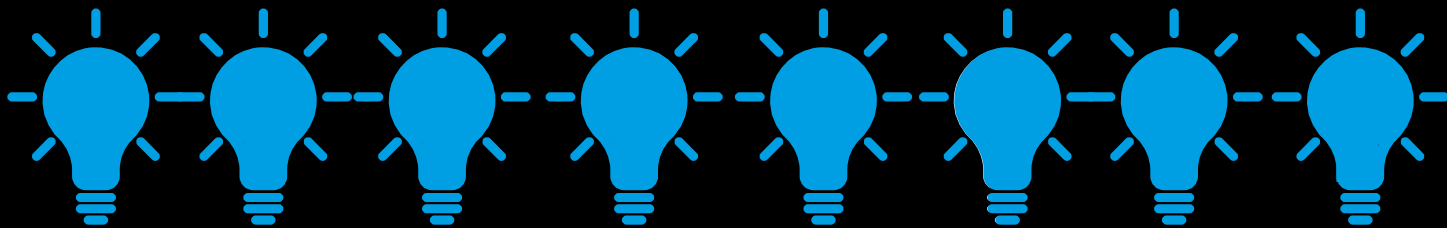
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$2^7$   $2^6$   $2^5$   $2^4$   $2^3$   $2^2$   $2^1$   $2^0$



---

$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
128	64	32	16	8	4	2	1



what can we store in one byte?



what comes after the byte?

$2^{10}$  bytes = 1.024 bytes = 1 Kibibyte (KiB)

$2^{20}$  bytes = 1.048.576 bytes = 1 Mebibyte (MiB)

$2^{30}$  bytes = 1.073.741.824 bytes = 1 Gibibyte (GiB)

$10^3$  bytes = 1.000 bytes = 1 Kilobyte (KB)

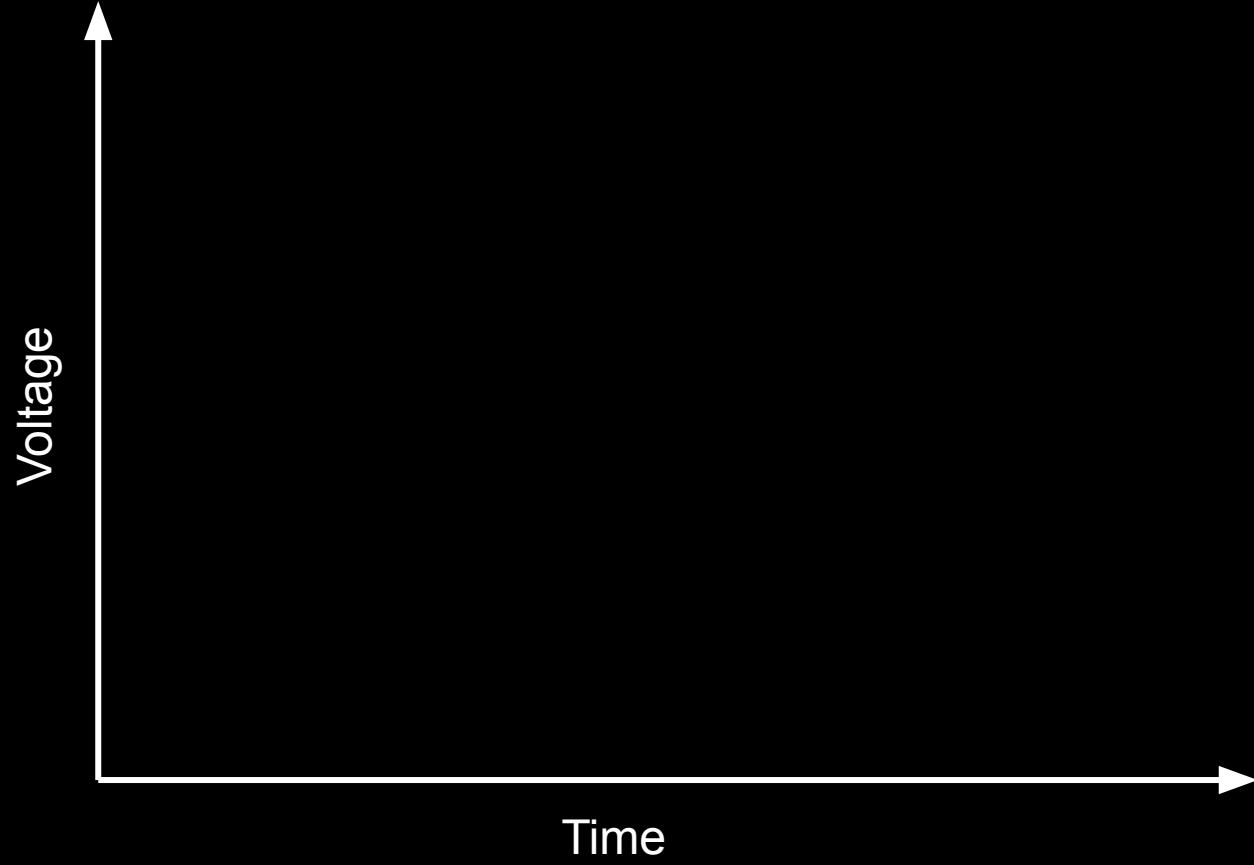
$10^6$  bytes = 1.000.000 bytes = 1 Megabyte (MB)

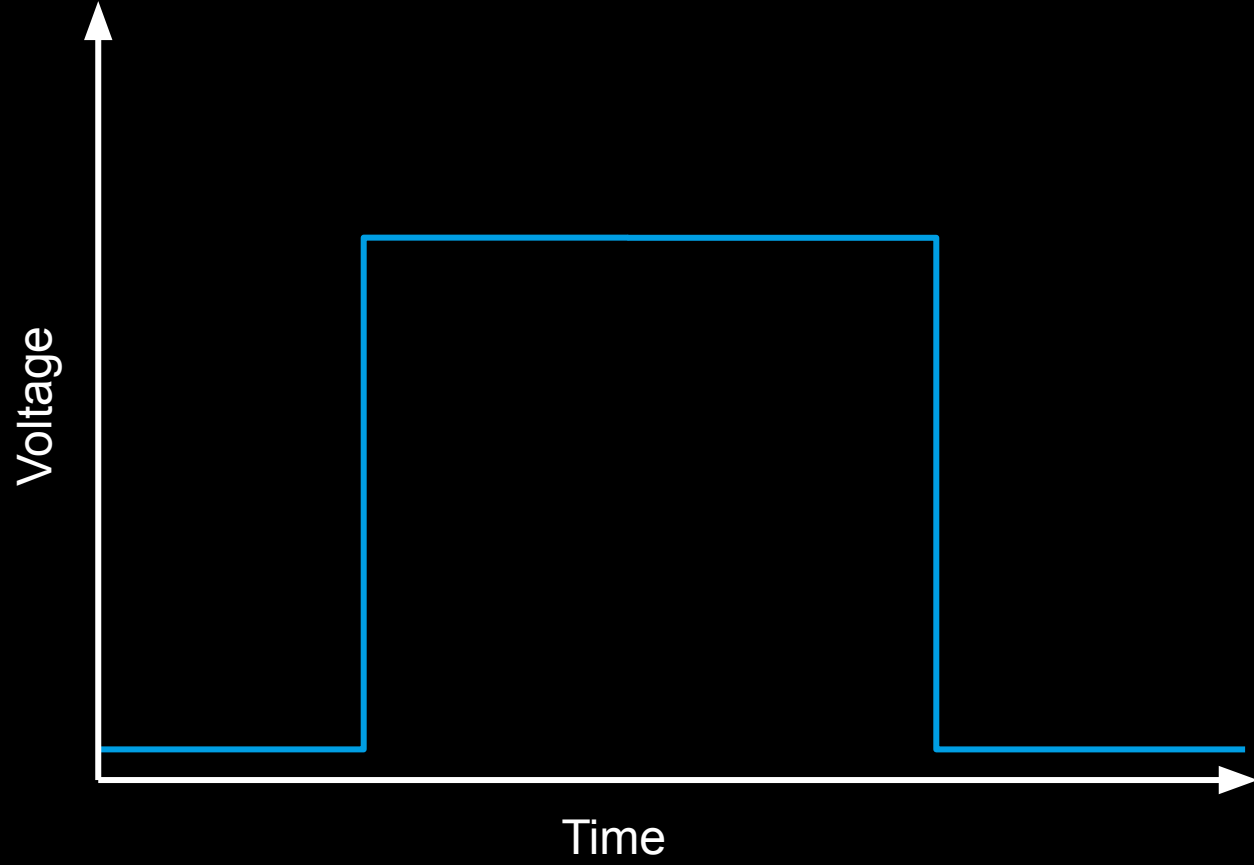
$10^9$  bytes = 1.000.000.000 bytes = 1 Gigabyte (GB)

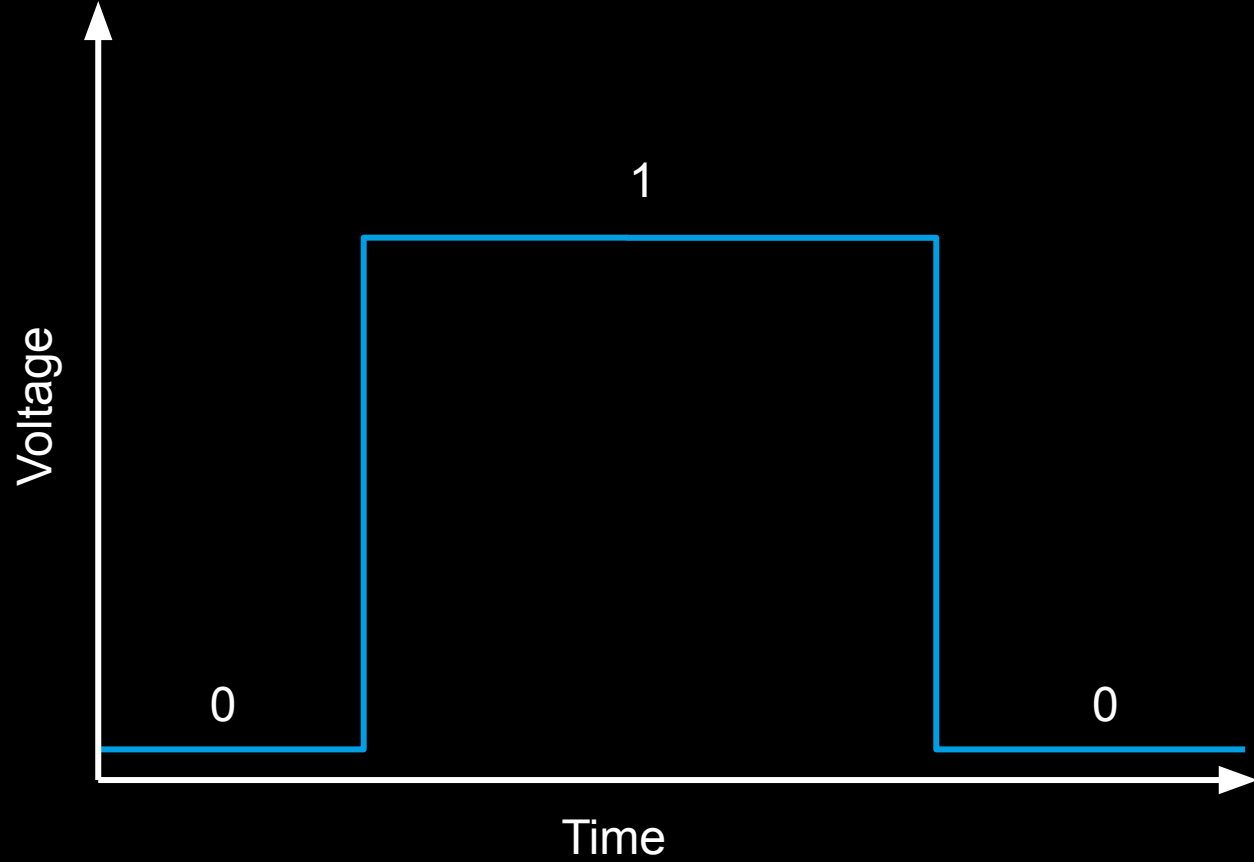
$10^{12}$  bytes = ?

how many bits are on a DVD with  
4.7 GB capacity?

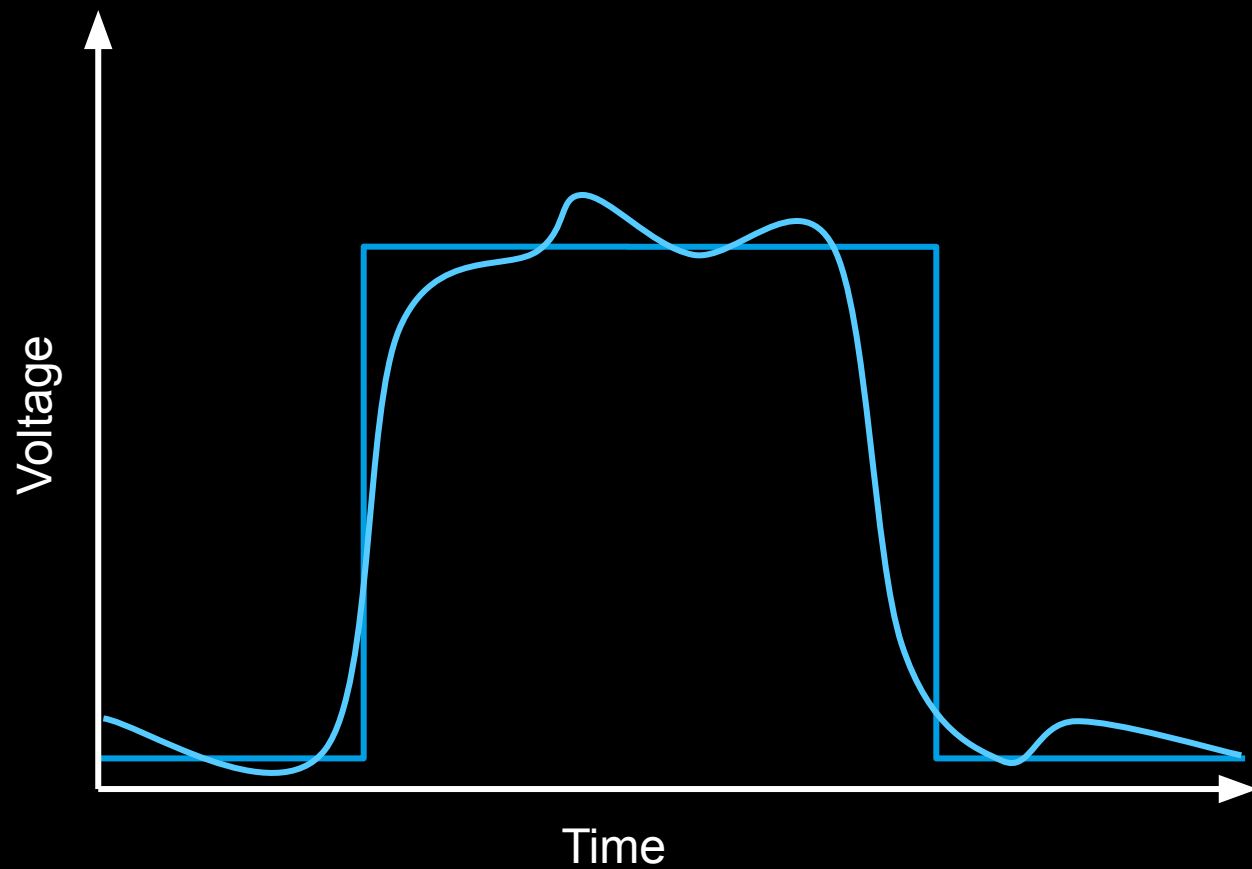
are we stuck with binary?

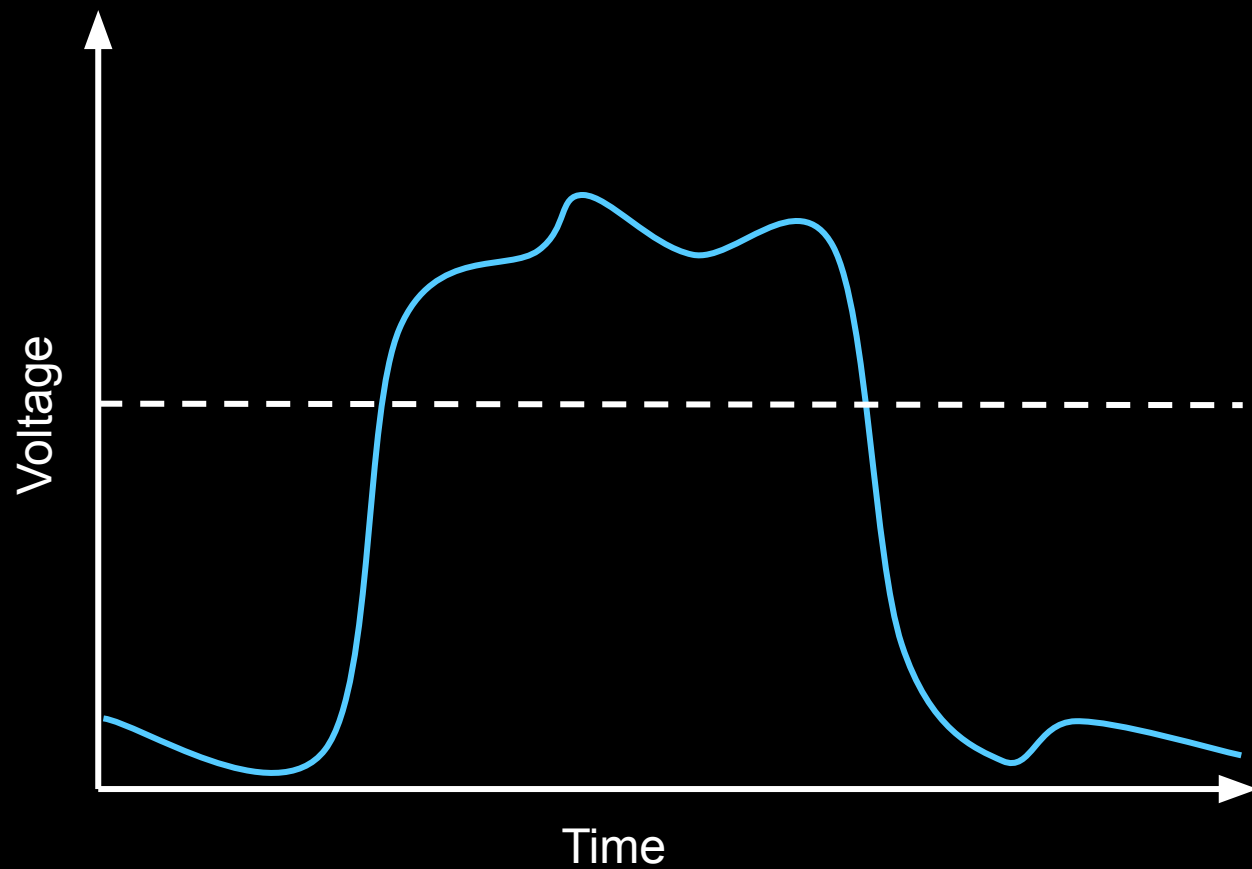


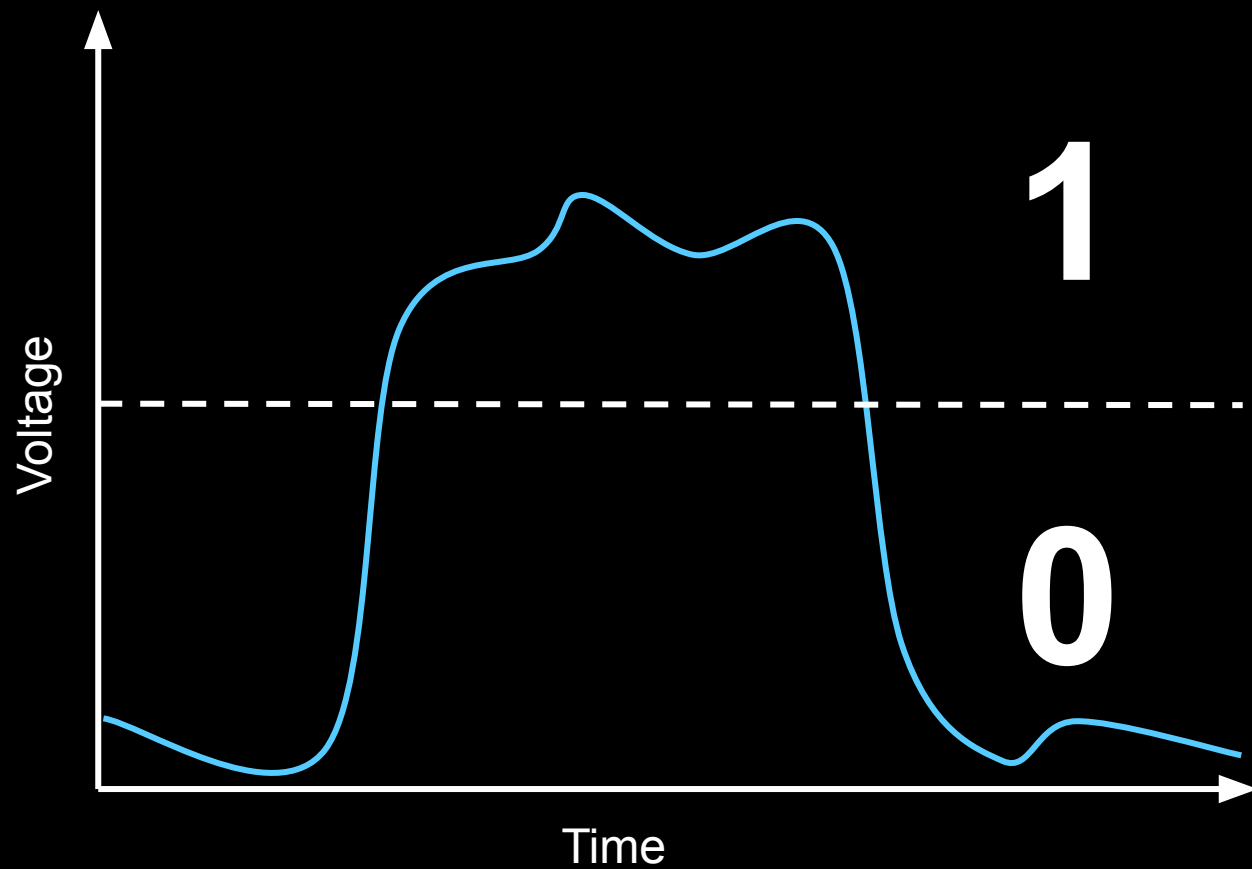


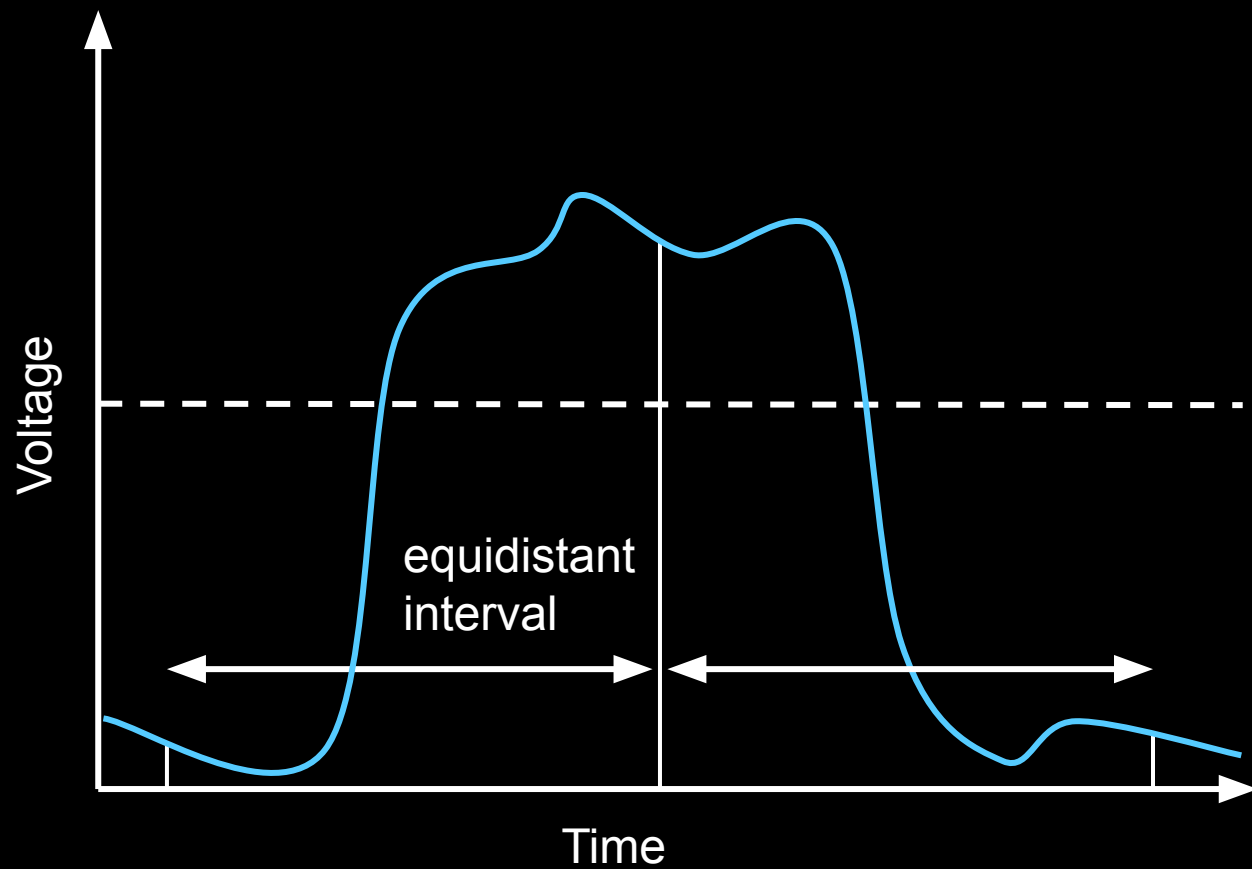


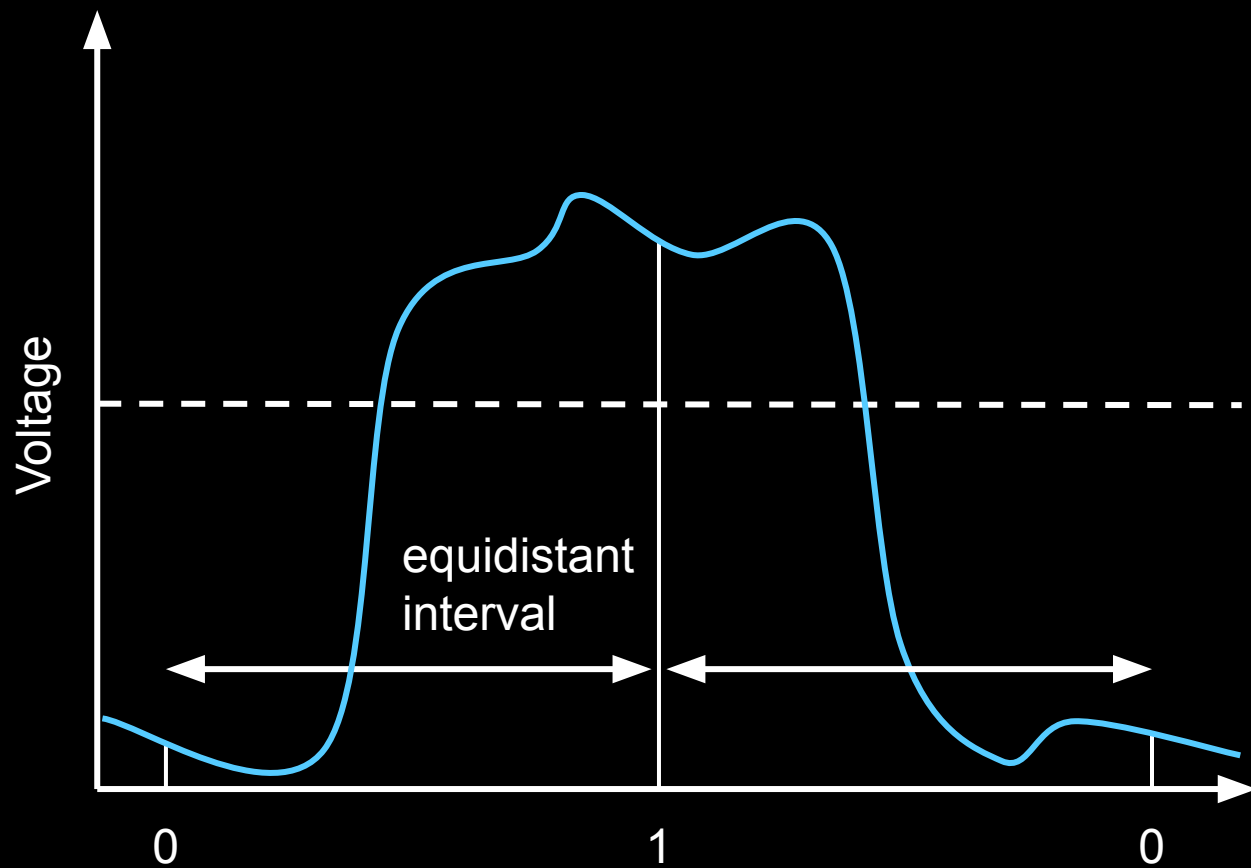


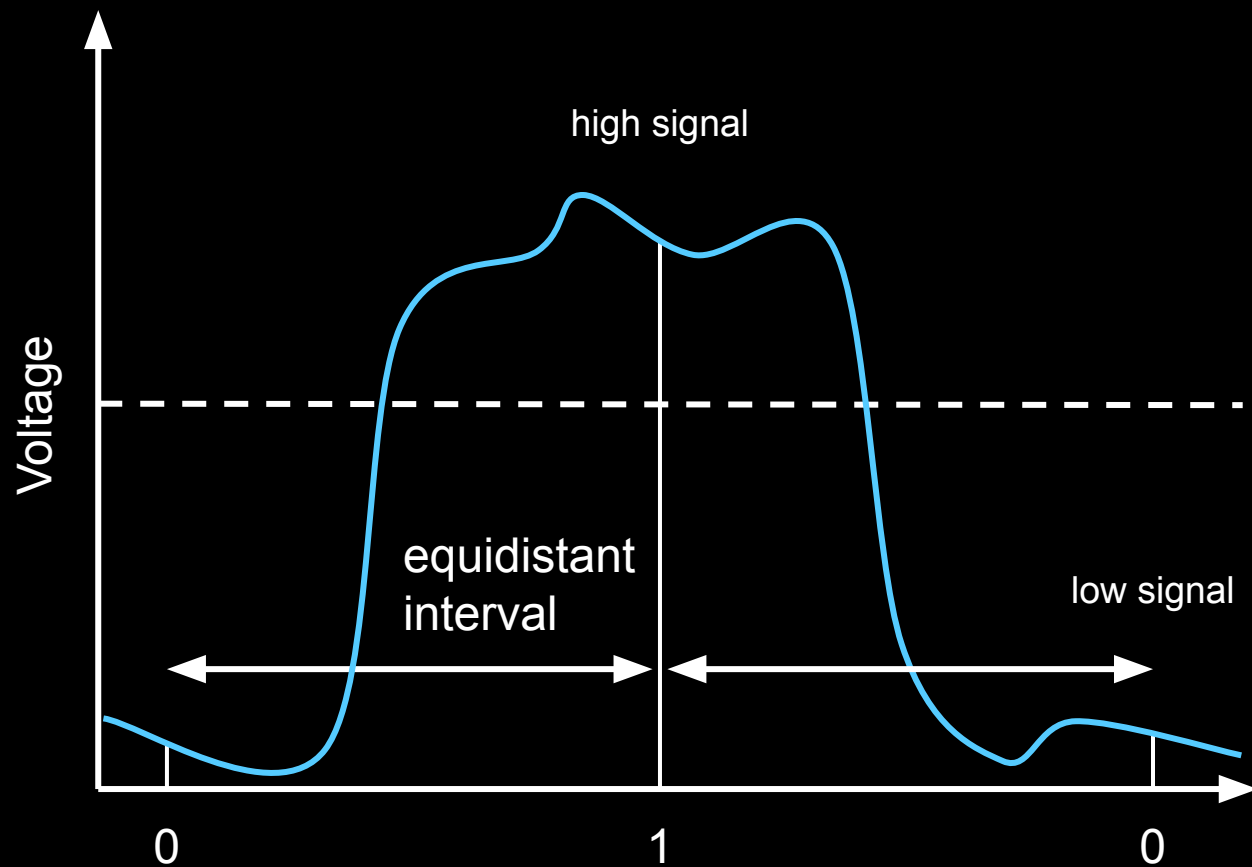




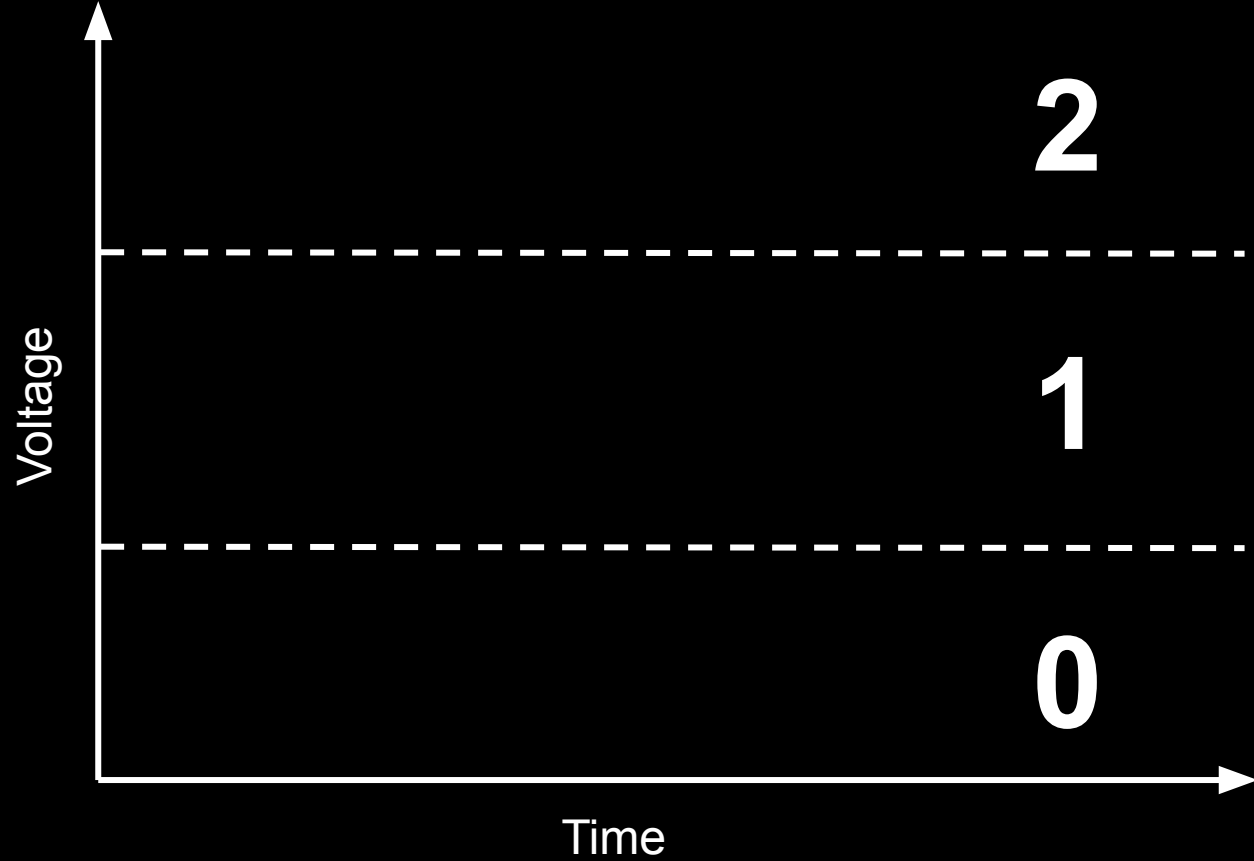




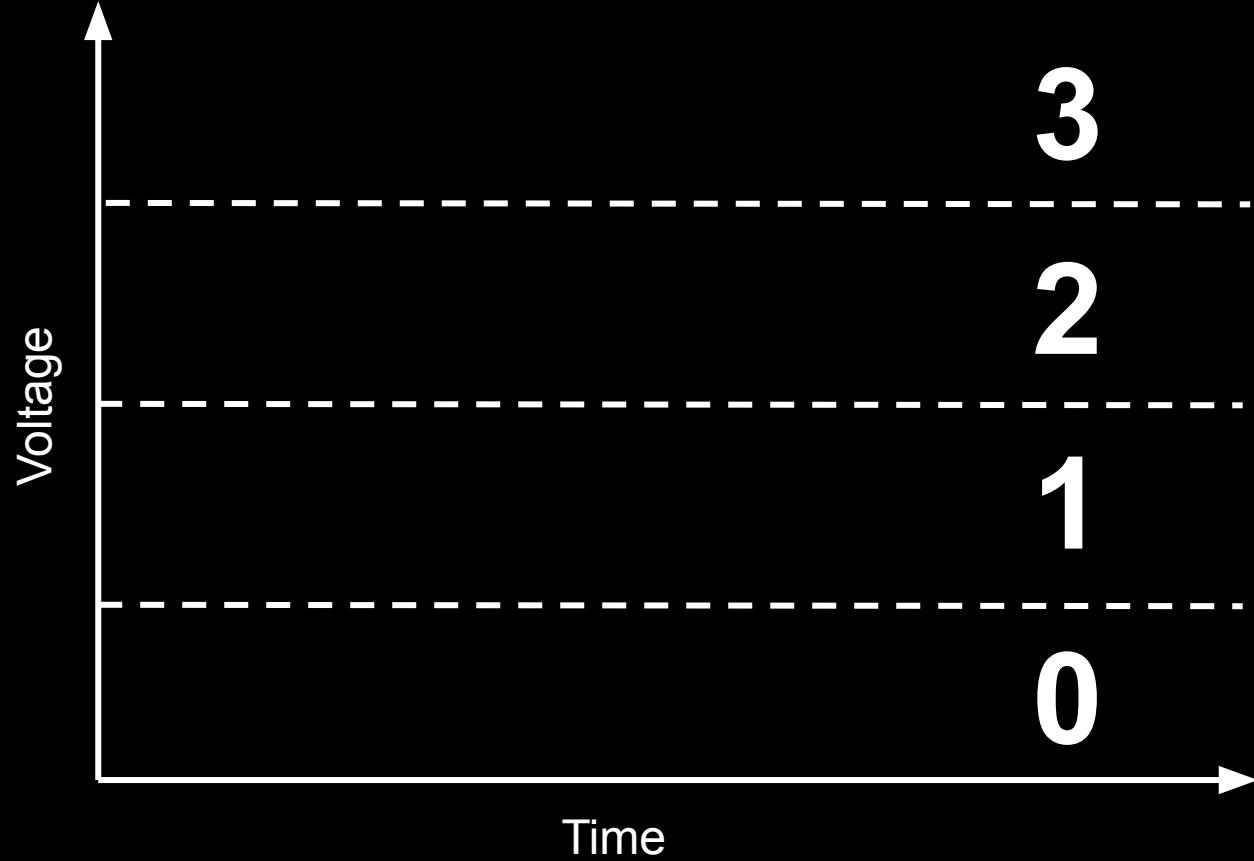


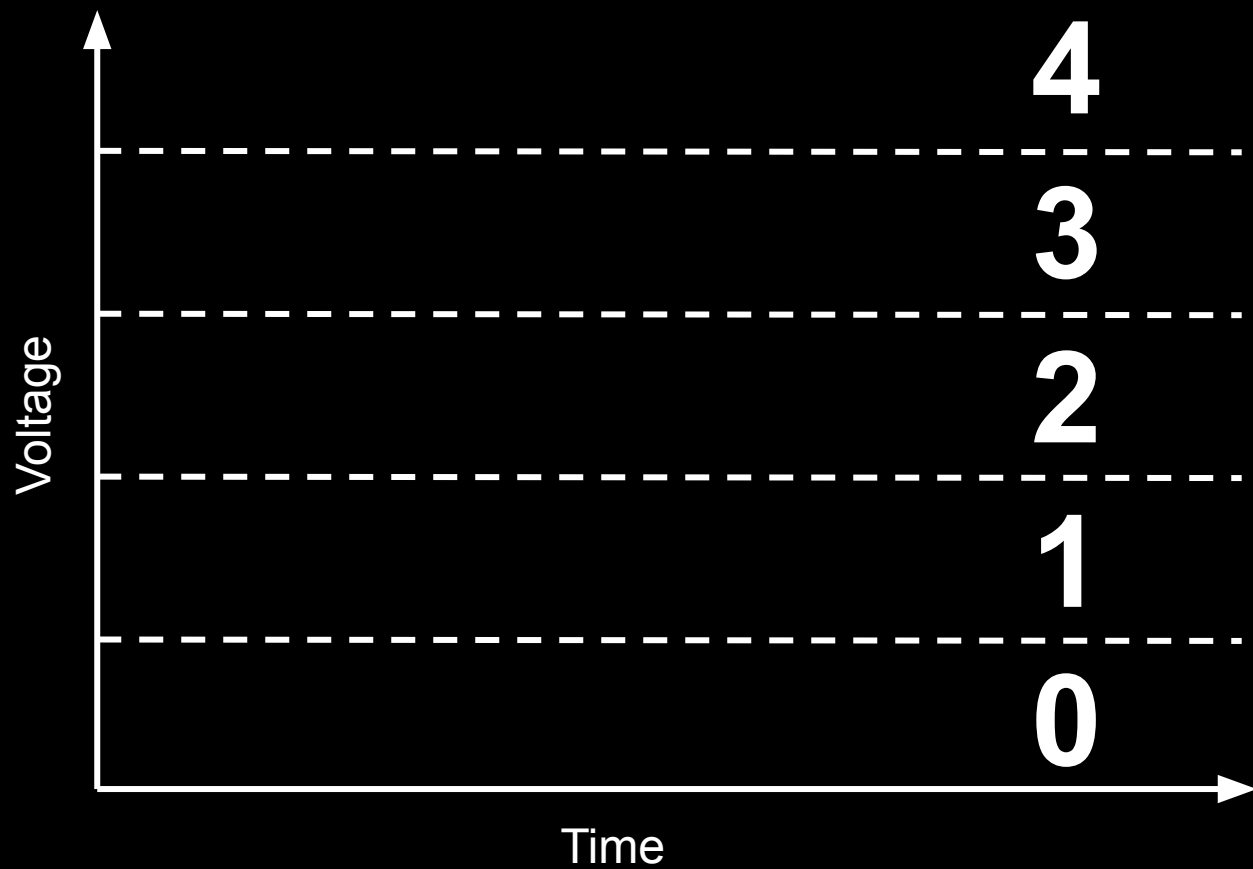


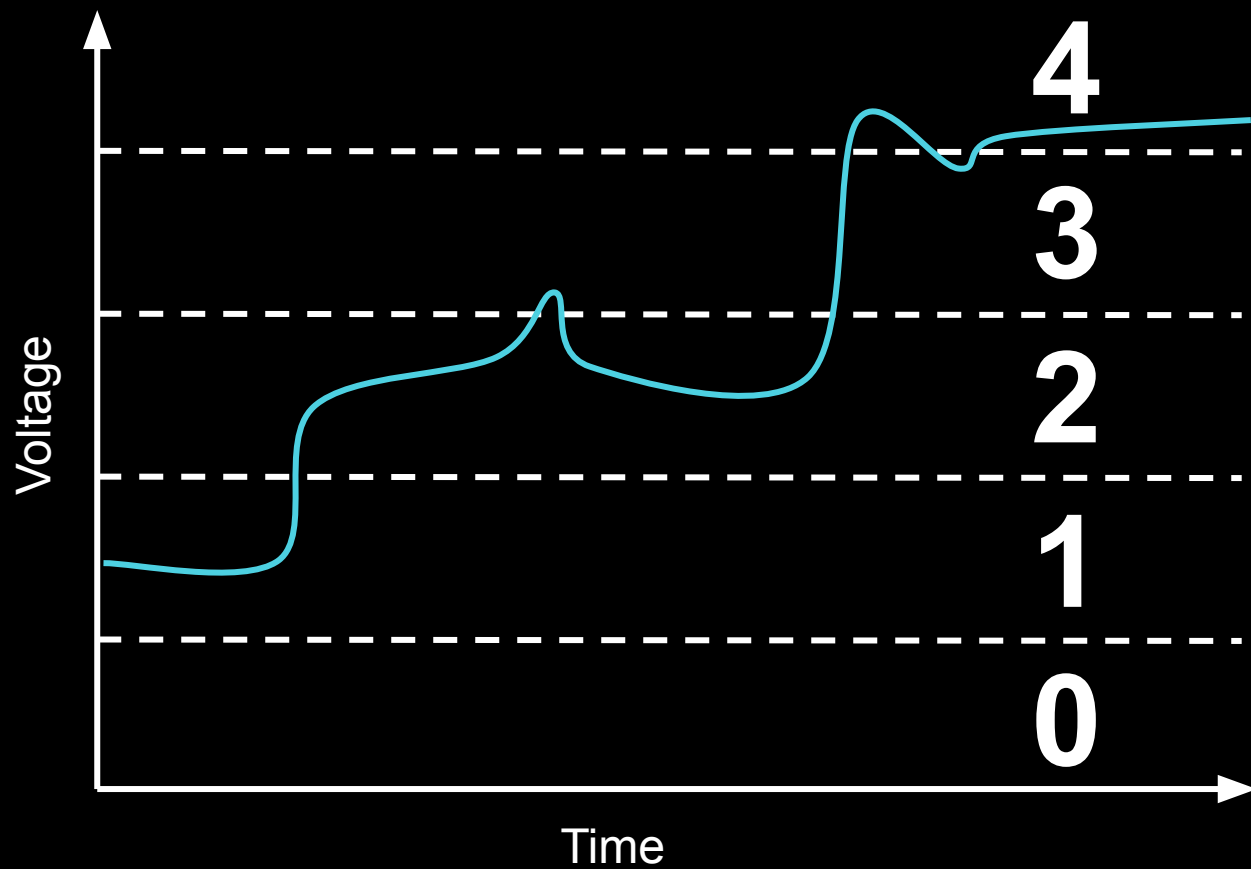
what about  $R > 2$ ?

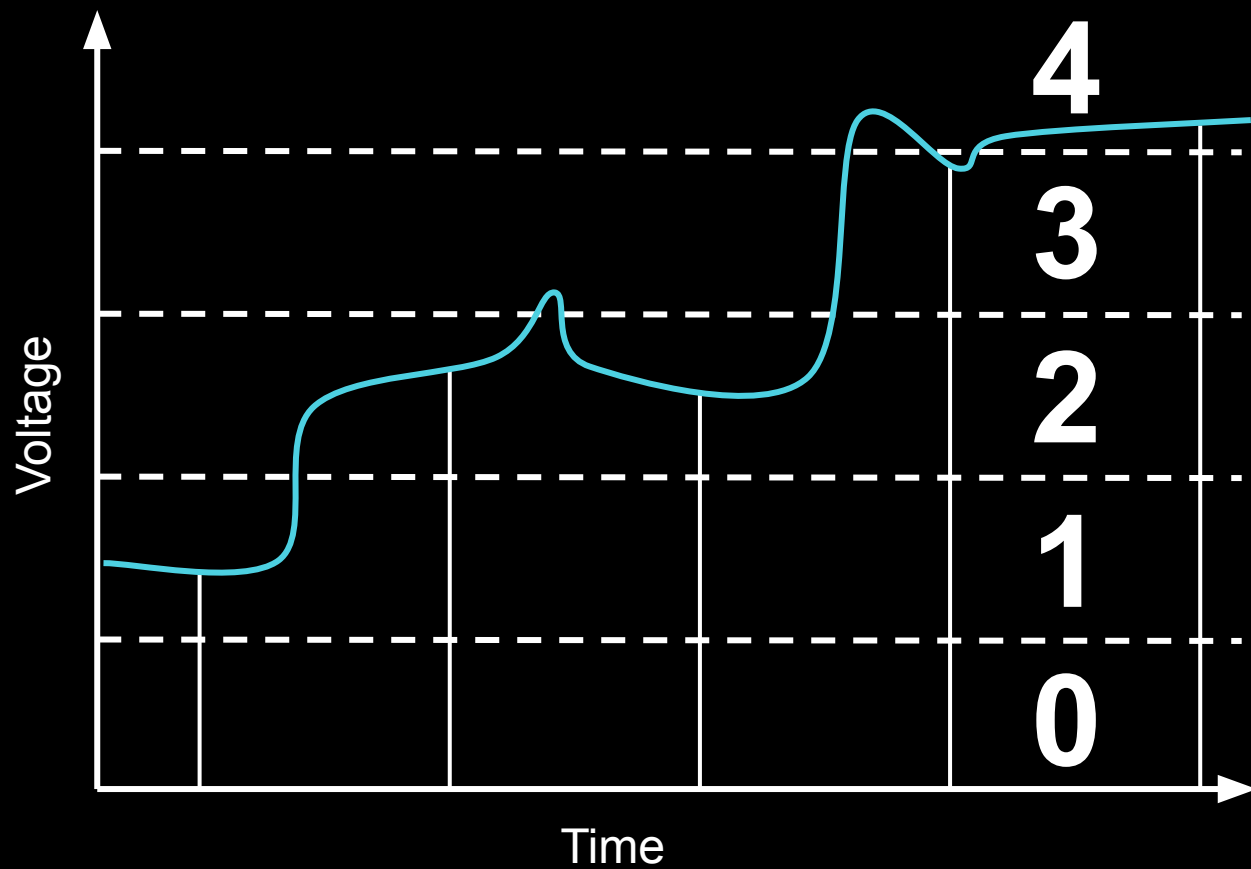


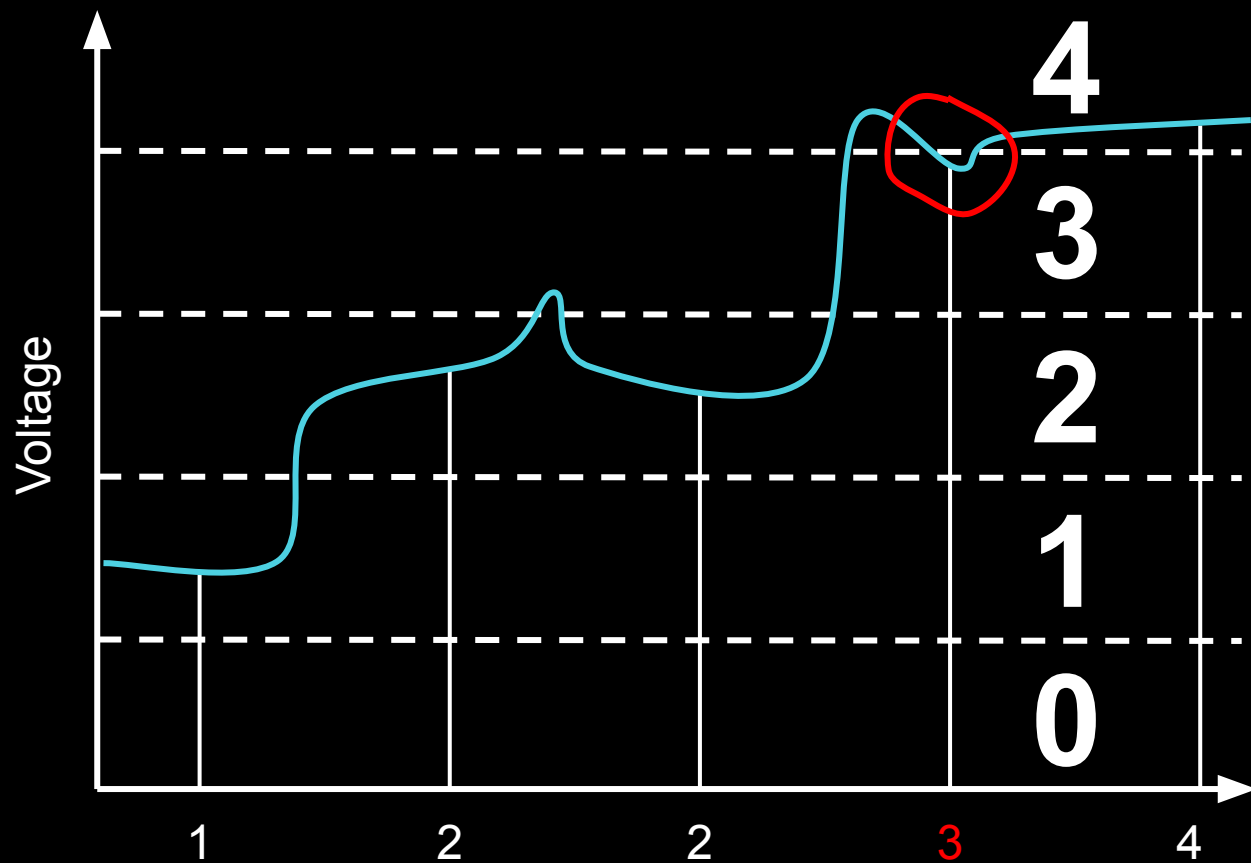












a higher base means less hardware

a higher base means less hardware  
but more complex devices

a higher base means less hardware  
but more complex devices  
and more errors