# Let's get started!

Q: How do people and computers represent numbers?

## **Base 10**

$$238 = 2.10 + 3.10 + 8.10$$

$$m = \begin{cases} k-1 & i \\ \leq \alpha_{1} & | 0 \end{cases}$$

$$= (\alpha_{k-1}, \alpha_{k-2}, \dots, \alpha_{2}, \alpha_{n}, \alpha_{n}) + en$$

#### Base 2

$$|1000| = |1.2^{4} + |1.2^{3} + |0.2^{2}|$$

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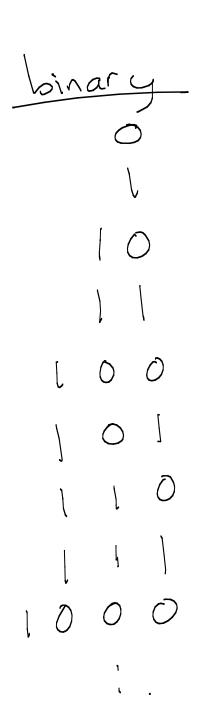
$$M = \begin{cases} \frac{1}{5} & b_1 \\ \frac{1}{5} & 0 \end{cases}$$

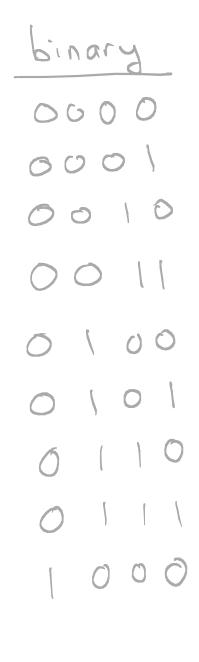
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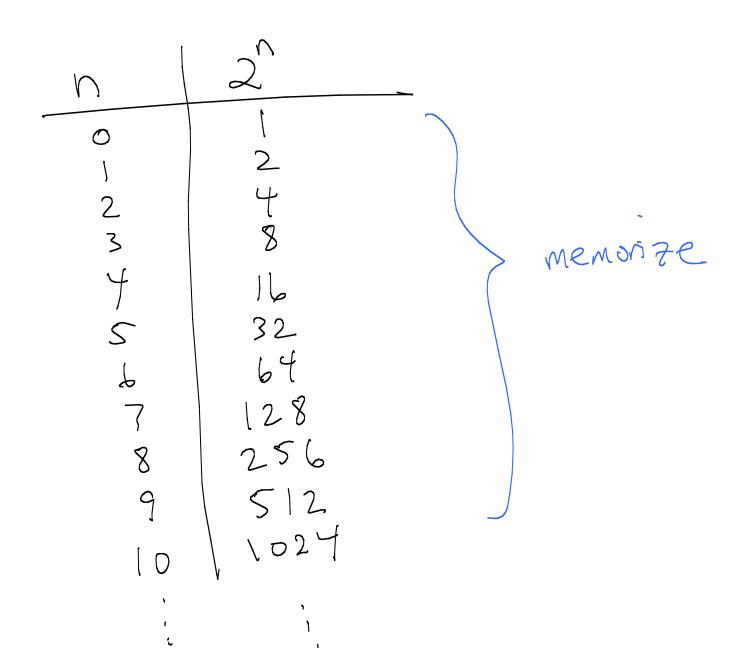
# Counting in binary

decimal
0
2
3
4
5
7
8





# To convert from binary to decimal, you need to know the powers of 2.



How can we convert **m** from decimal to binary?

Idea 1:

Find the biggest power of two less than or equal to m, and subtract it from m.

Repeat until done.

(Requires memorizing powers of 2.)

How can we convert **m** from decimal to binary?

Idea 2: Consider familiar idea from base 10:

$$238 = 230 + 8$$
 $m = (m/10) \times 10 + m\% 10$ 

integer division

#### Same idea works in base 2.

$$m = (m/2) \times 2 + m \% 2$$

Example:

$$m = (10011)$$
 $m/2 = 1001$ 
 $m = 702 = 1$ 

$$M = \begin{cases} \sum_{i=0}^{n-1} b_i \\ \sum_{i=0}^{n-1} b_{n-2} \\ \sum_{i=1}^{n-1} b_i \\ \sum_{i=1}^{n-1}$$

# Algorithm: given m in decimal, convert it to binary.

Example

$$m = 241 = (11110001)_{two}$$

(11110001) two 

### Q: How to add two numbers in binary?

You need to memorize single digit sums to do this.

Addition (Lase 2)

( base 10) Subtraction 2343 58 19

ASIDE: the grade school algorithm doesn't work when the bigger number is on the bottom. To take the difference using the grade school algorithm, you put the bigger number on top and take the negative of the result.

$$\frac{a}{b}$$

Next class we will learn how to represent *negative numbers* in binary which allows us to perform this sum.