the POWER of 2

a zine about big numbers ♡ by igor

hi!

this is a

ZINE

about

BIG

NUMBERS

MEOW

$$O(2^n)$$

$$O(\log n)$$

MY NAME IS IGOR

@igorwhilefalse

ON The TWITTERWEB

---

i have a

strace

sticker on my phone

---

i got it from @b0rk!

FIRST, LET'S TALK ABOUT EXPONENTIATION

$$2^n$$

THAT MEANS:

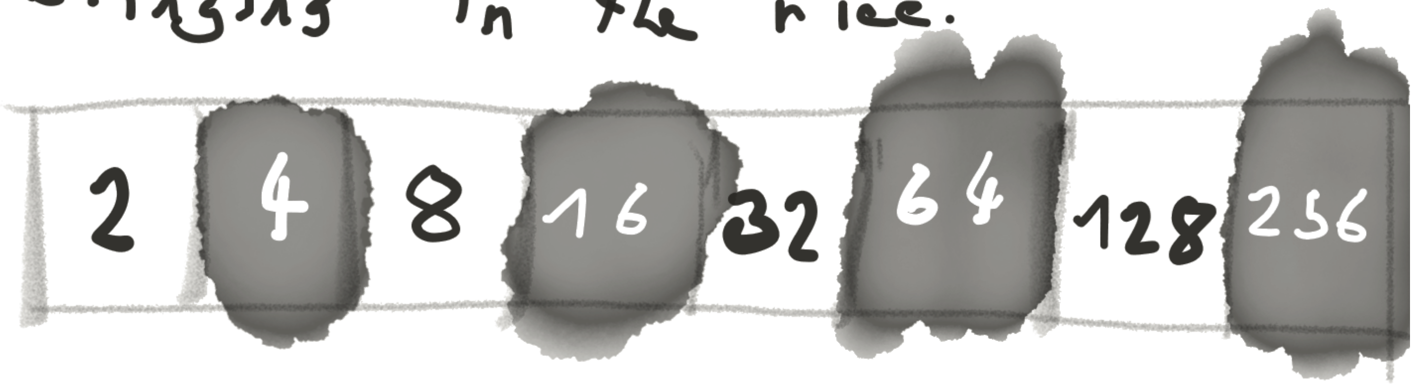
$$\underbrace{2 \times 2 \times 2 \times \ldots}_{n}$$

THE STORY OF

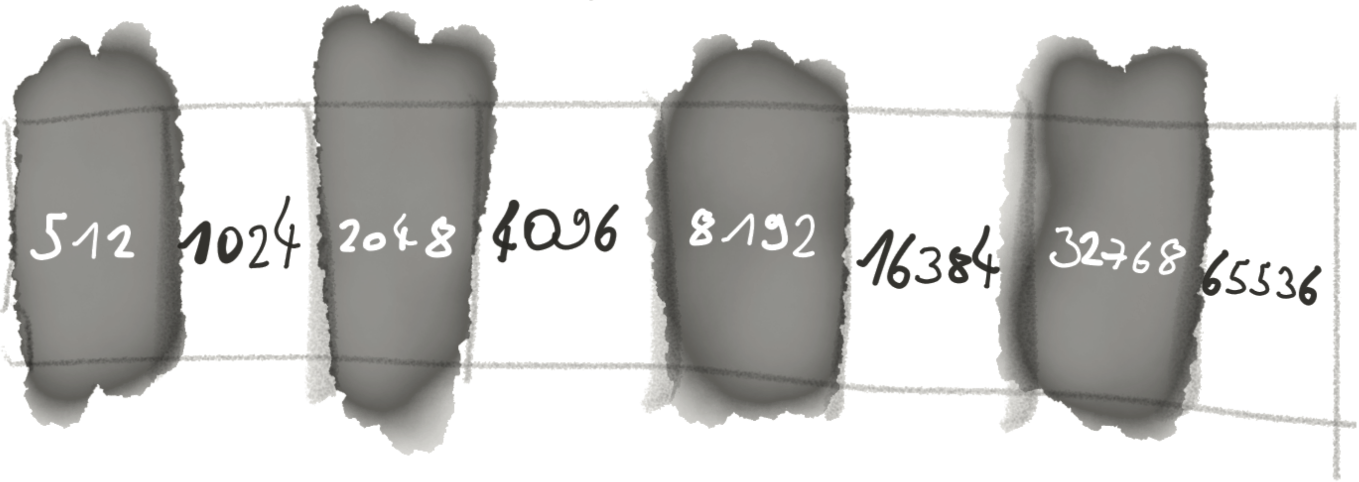
SISSA BEN DAHIR

he goes to the Queen and gives her a chess-board.

i have 1 grain of RICE. for the first sqare, give me 2 grains. for the second, give me 4. for the third give me 8. 2X she agrees, so they start bringing in the rice.



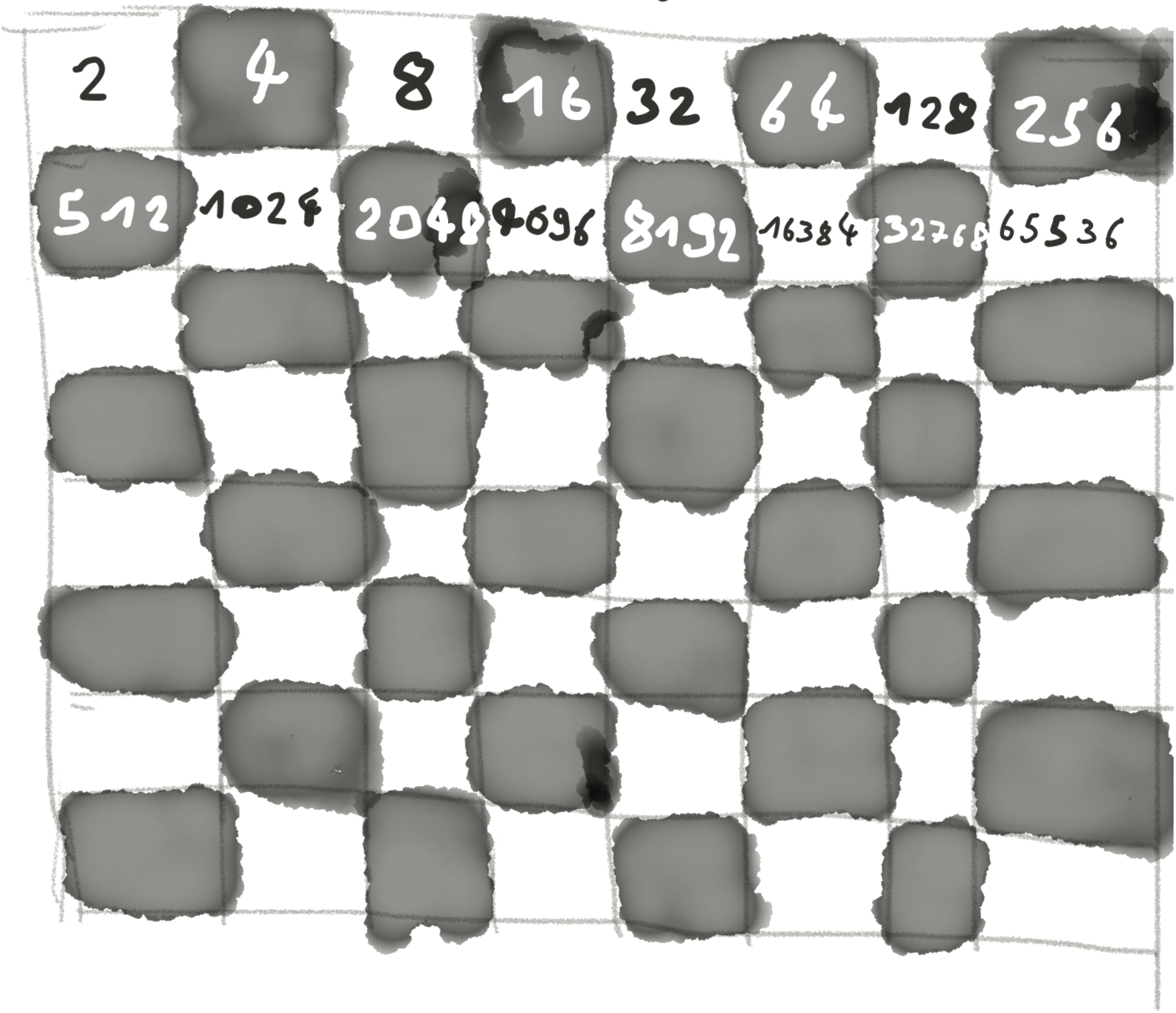
after one row we have 256 grains.



but after two rows we are already at 65k!

OH NO

WHAT HAPPENS IF WE KEEP GOING ?



How much rice?

IF WE COMPLETE THE BOARD

...

2	4	8	16	32	64	128	256
512	1024	2048	4096	8192	16384	32768	65536
131K	262K	524K	1M	2M	4M	8M	16M
33M	67M	134M	268M	536M	1B	2B	4B
8B	17B	34B	68B	137B	274B	549B	1T
2T	4T	8T	17T	35T	70T	140T	281T
562T	1Q	2Q	4Q	9Q	18Q	36Q	72Q
144Q	288Q	576Q	1 QUINT	2 QUINT	4 QUINT	9 QUINT	18 QUINT

WE END UP WITH

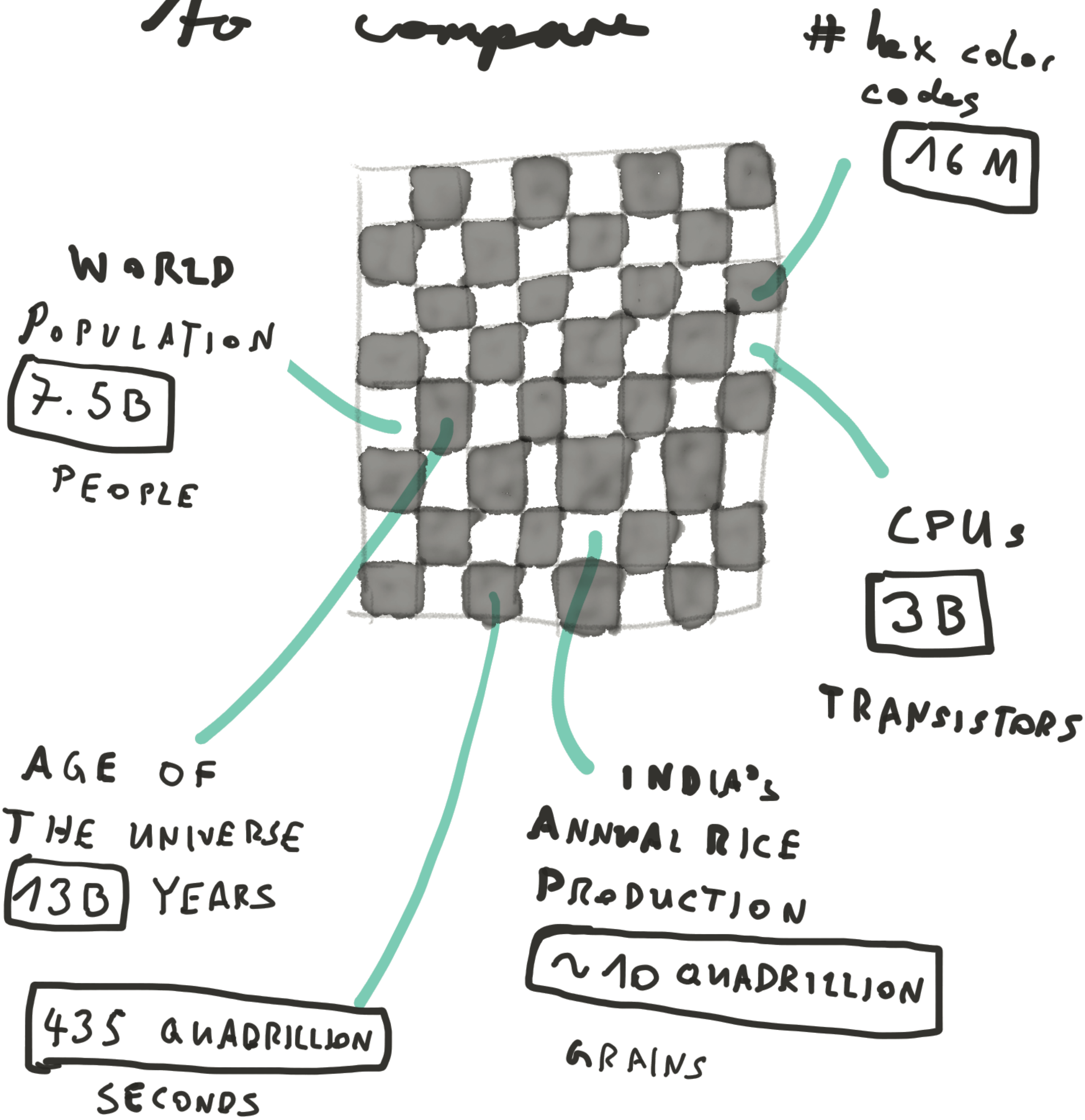
18 QUINTILLION

18'446'744'073'709'551'616

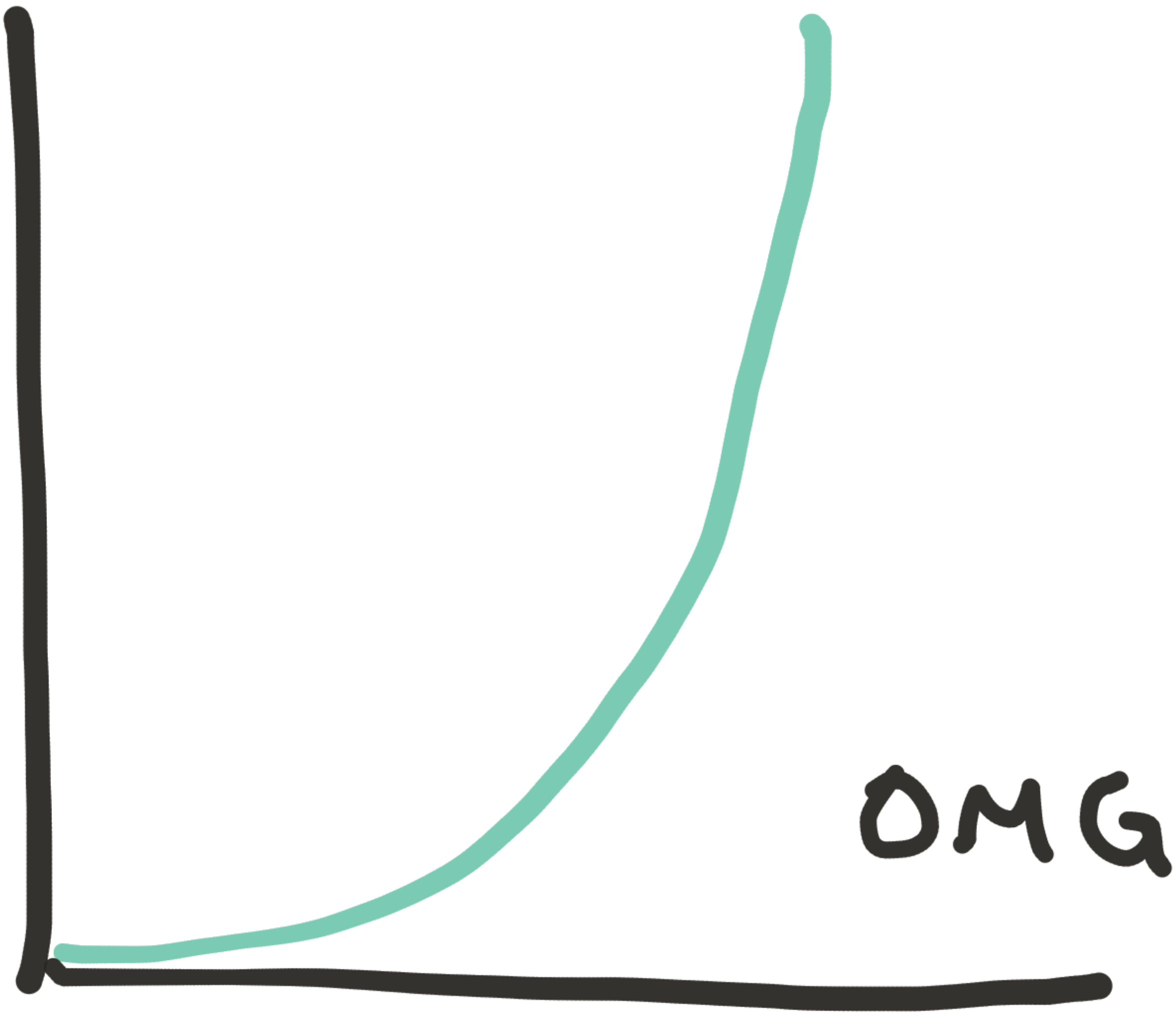
Grains of rice

of rice

BIG NUMBERS to compare



2^n grows **fast**



other examples of

EXPONENTIAL GROWTH

- POPULATION
- ZOMBIE INFECTION
- ECONOMIC MODELS (LOL)
- MOORE'S LAW

COMPUTERS KEEP GETTING
≡ FASTER
(BUT NOT FOREVEVER)

exponential growth makes your password **safe**

1 char = 16 possible values

2 chars = 256 possible values

16 chars = **18 QUINTILLION**

↑ same for a 64-bit key

$$2^{64} = 18 \text{ QUINT.}$$

☆ CRYPTO

JUST WANTED TO
LET YOU KNOW
COMPUTERS
ARE GREAT
(I love them)
but don't forget
about HUMANS

NEXT UP

The logarithm

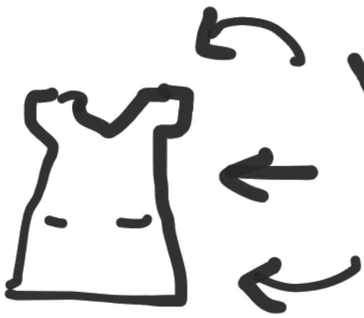
$$\log_2 n$$

$$\underbrace{n \div 2 \div 2 \ldots}_{y} = 1$$

this is going to

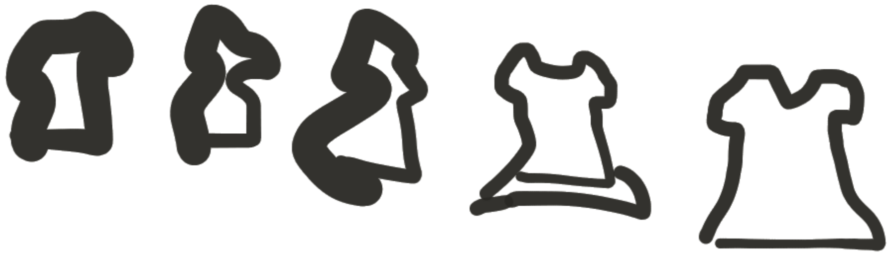
BLOW YOUR MIND!

let's say you go DRESS SHOPPING
and you see a super cute
dress WITH POCKETS !



YAY CHECK OUT
That dress !

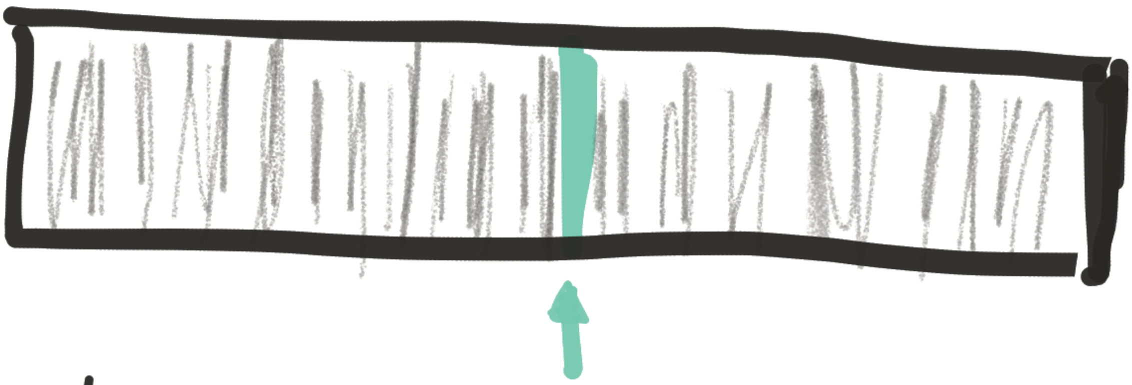
it comes in 200 sizes.



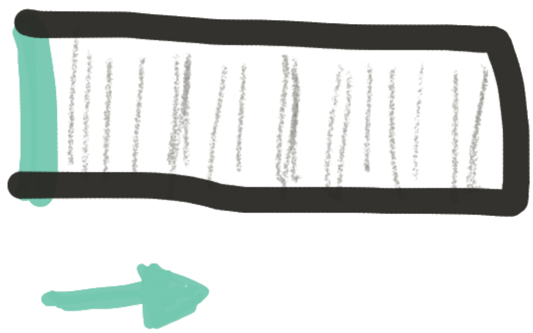
you want to find
one that fits.

they're sorted by size

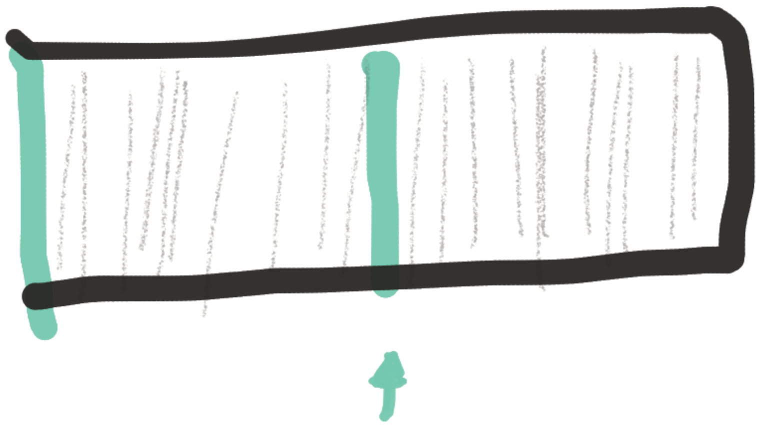
There is an algorithm that lets you do that!



start in the middle. take out a dress, try it on. if it's too small, you know your dress is in the upper half.

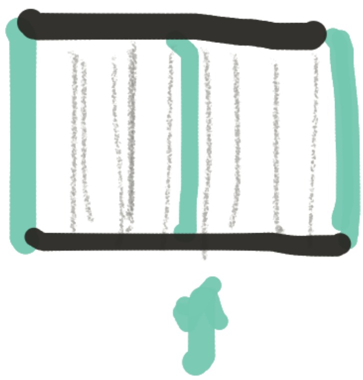


so you move to the middle of the upper *half*, take out a dress, try it on.

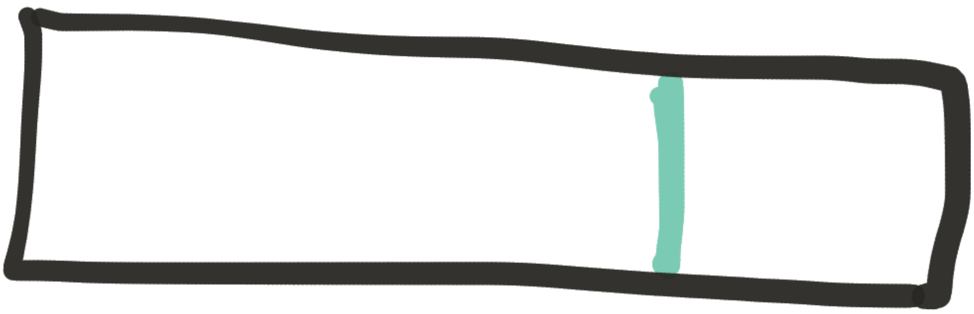


if it's too large, the dress must be somewhere in the lower half.

so you go to the middle...



you will quickly approach the size you are looking for!



this works because the dresses are sorted. the algorithm is called a

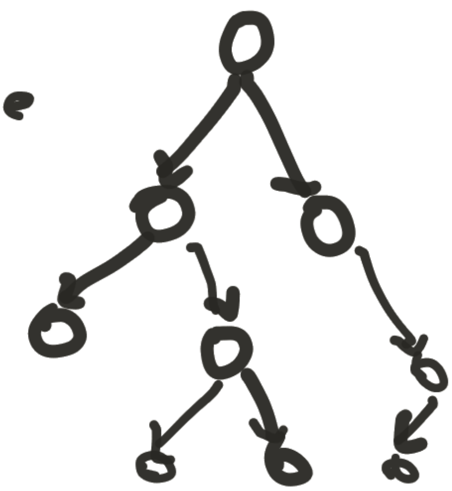
BINARY SEARCH

it will let you find a fitting dress in

LOGARITHMIC TIME

<u>databases</u> use binary search

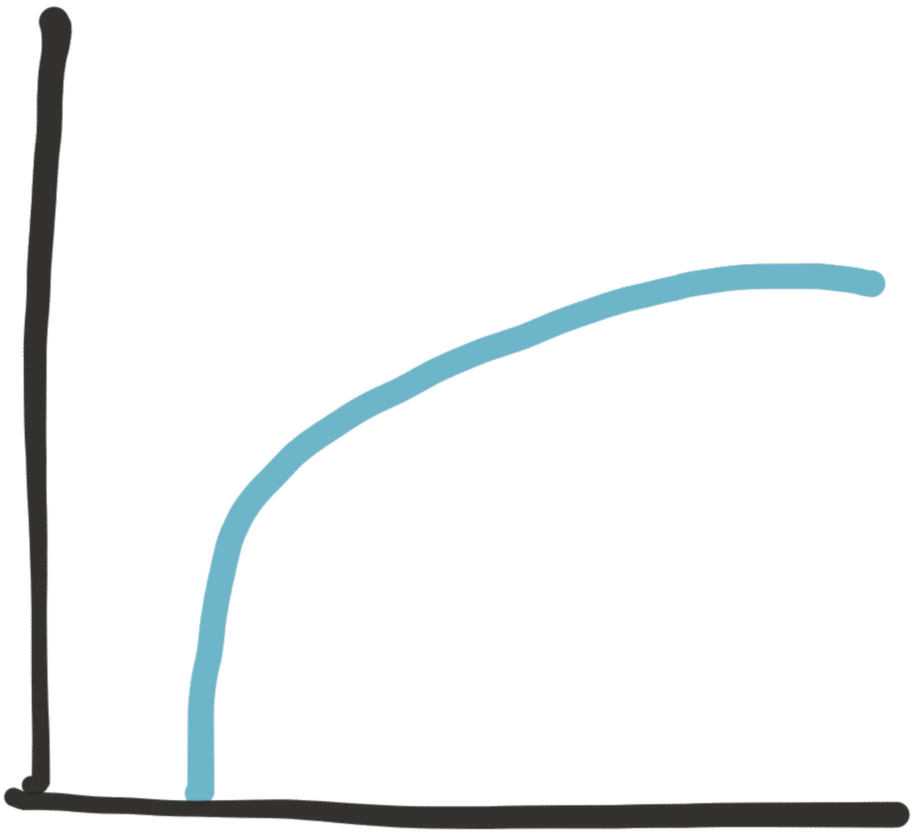
they are **literally** the same thing as finding a fitting dress !



this is why data bases work and are FAST

$\log_2 n$

shrinks fast!



OMG

even if you have

18 QUINTILLION

records, that will only require **64** comparisons to find a value.

$$\log_2(18'446'744'073'709'551'616) = 64$$

this means:

if you had 18 quintillion dresses, you would only have to try on 64 of them to find the right size!

and this scales !

atoms in a human body:

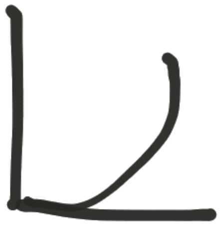
7×10^{27}

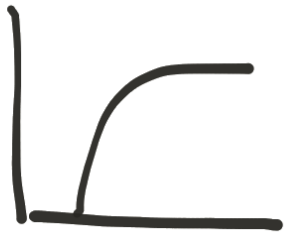
$\log_2 \Rightarrow$ 92

atoms in the observable universe:

4×10^{79}

$\log_2 \Rightarrow$ 264

2^n  grows fast

$\log_2 n$  shrinks fast

thank u