

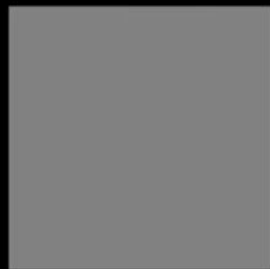
Fractals and Linear Algebra

Bryan Clark; Noah Jackson; Lindsay Finlayson; Garrett
Bullough

Thin
wire



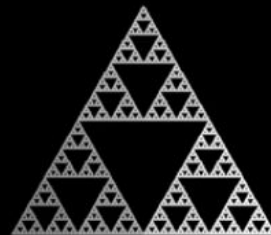
Flat
sheet



Solid
cube



Sierpinski
mesh

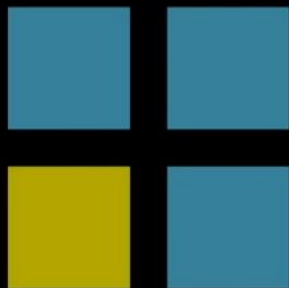


Line



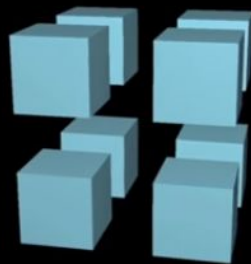
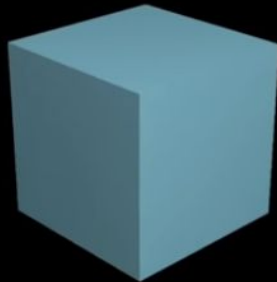
$1/2$ length

Square



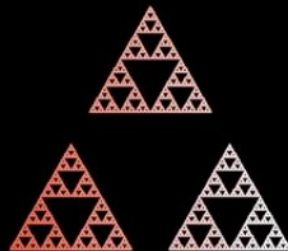
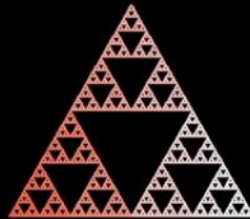
$1/4$ area

Cube



$1/8$ volume

Sierpinski



Line

Scaling factor: $\frac{1}{2}$



Mass scaling factor: $\frac{1}{2}$



Square

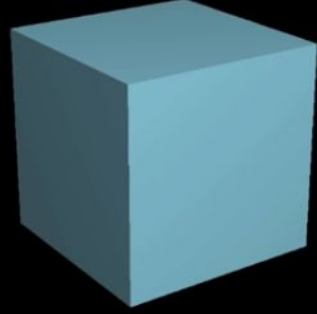
Scaling factor: $\frac{1}{2}$



Mass scaling factor: $\frac{1}{4} = \left(\frac{1}{2}\right)^2$

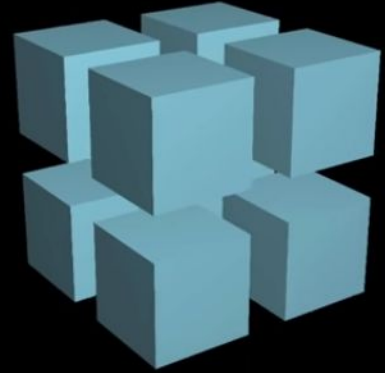


Cube



Scaling factor: $\frac{1}{2}$

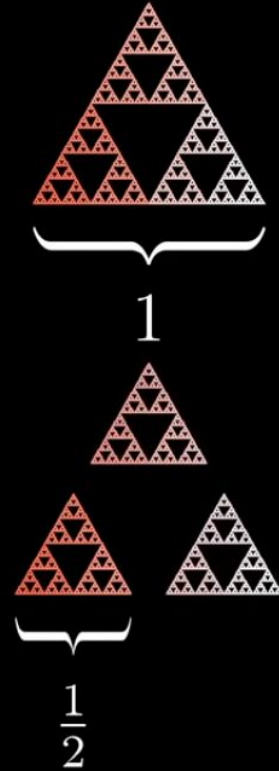
Mass scaling factor: $\frac{1}{8} = \left(\frac{1}{2}\right)^3$



Sierpinski

Scaling factor: $\frac{1}{2}$

Mass scaling factor: $\frac{1}{3}$



2-dimensional

Length: L

Mass: M



Length: sL

Mass: $s^2 M$



D-dimensional

$$\left(\frac{1}{2}\right)^D = \left(\frac{1}{3}\right)$$

Length: L



$$2^D = 3$$

Mass: M

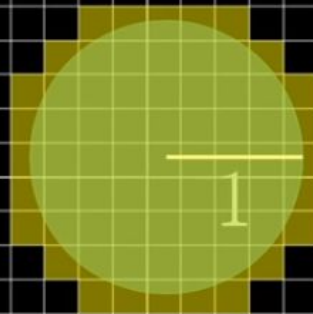
$$\log_2(3) \approx 1.585$$

Length: $\left(\frac{1}{2}\right)L$

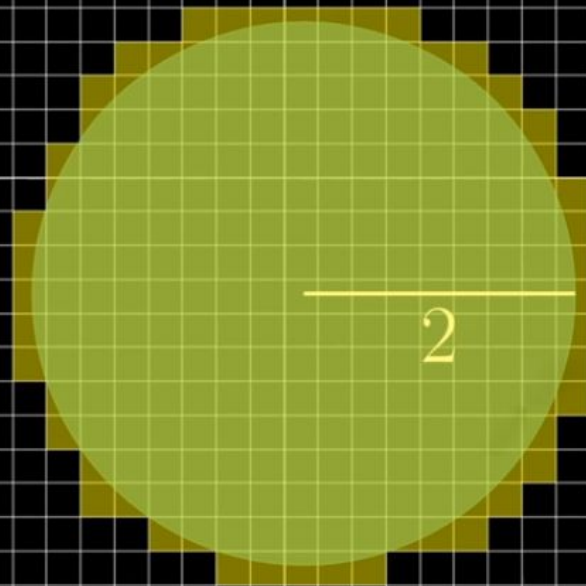


Mass: $\left(\frac{1}{2}\right)^D M$

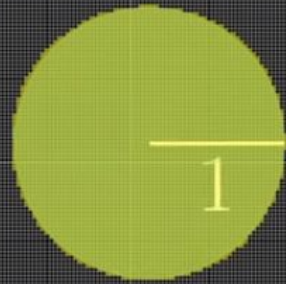
Boxes touched: 69



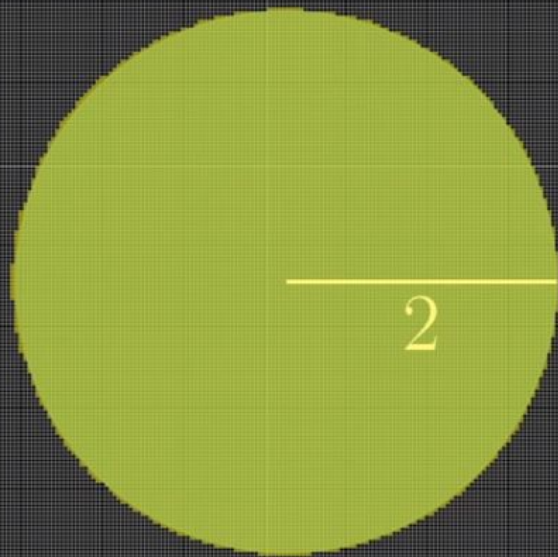
Boxes touched: $\frac{234}{69} = 3.39 \approx 2^2$



Boxes touched: 3624



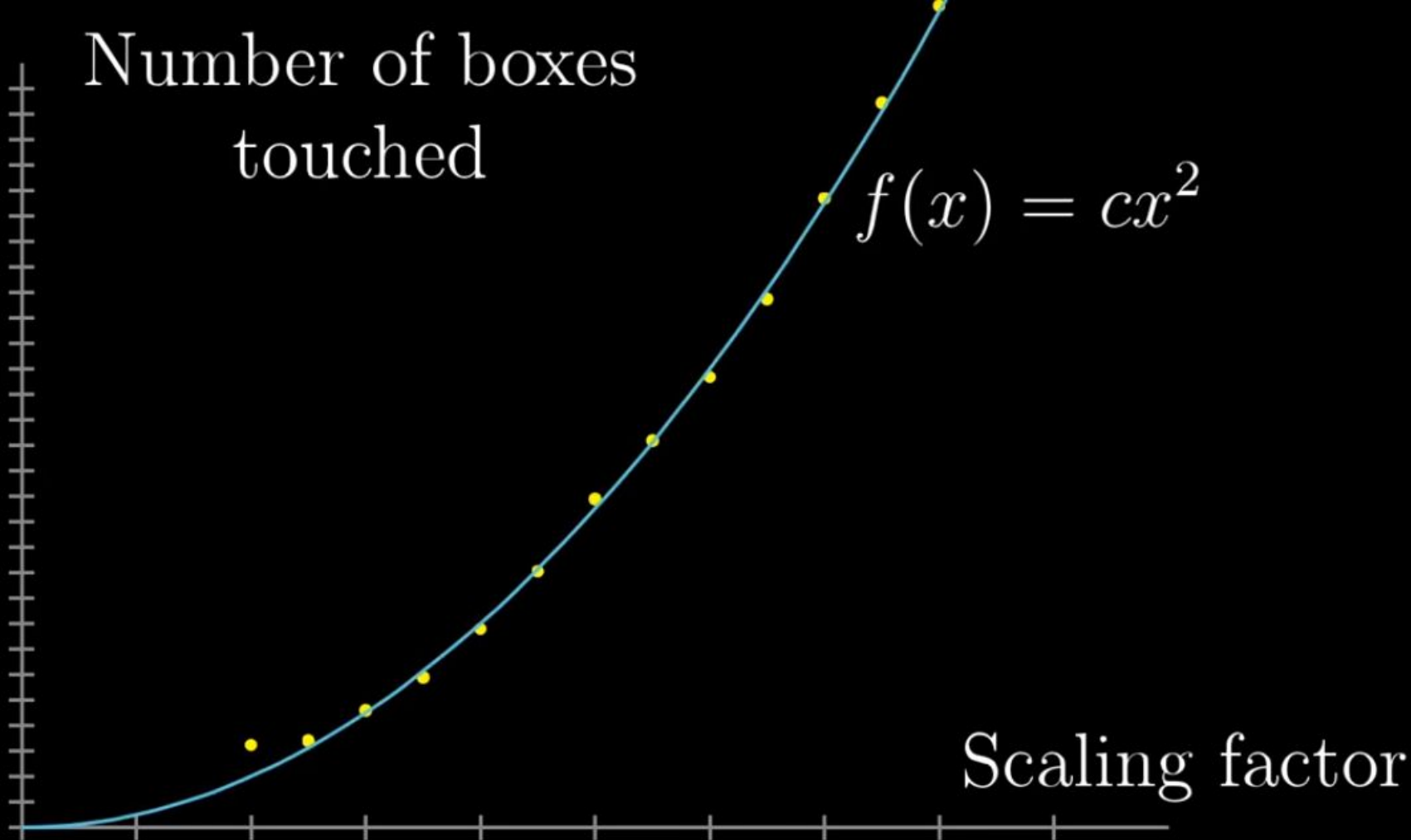
Boxes touched: $\frac{14235}{3624} = 3.93 \approx 2^2$



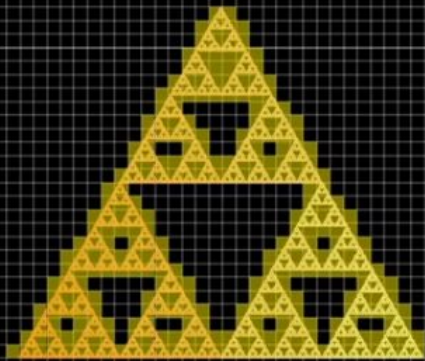
Number of boxes
touched

$$f(x) = cx^2$$

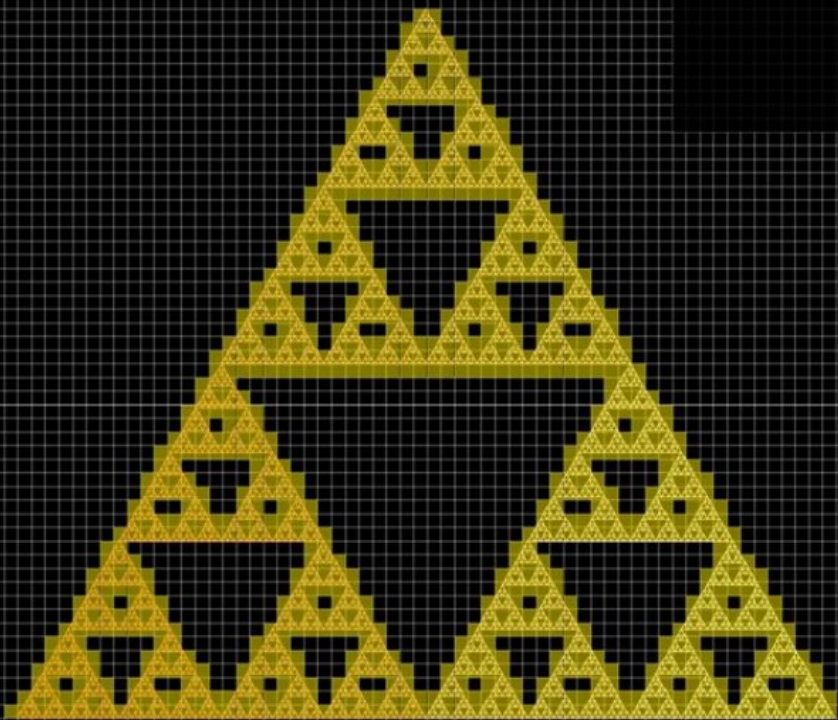
Scaling factor



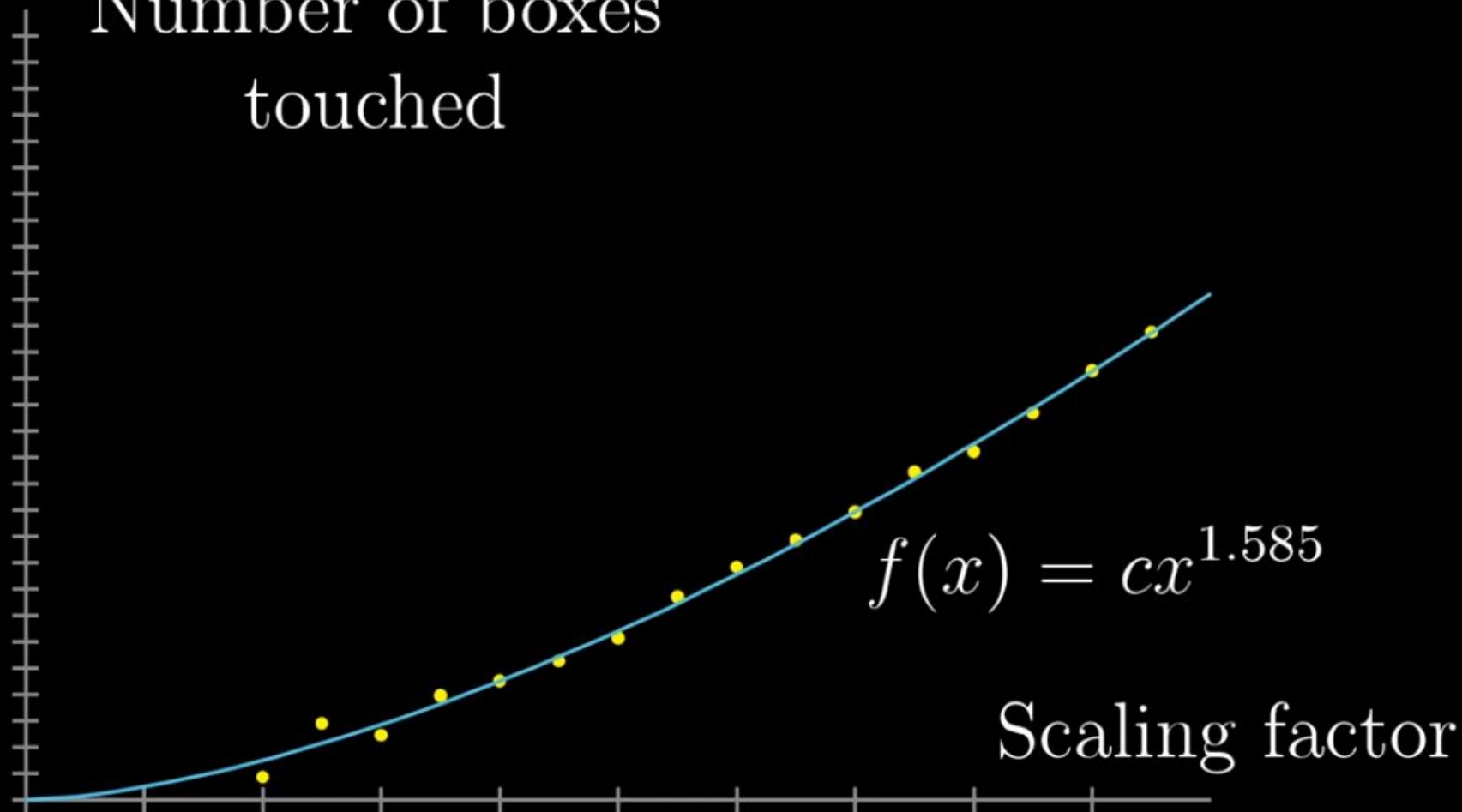
Boxes touched: 302



Boxes touched: $\frac{928}{302} \approx 3 = 2^{1.585\dots}$



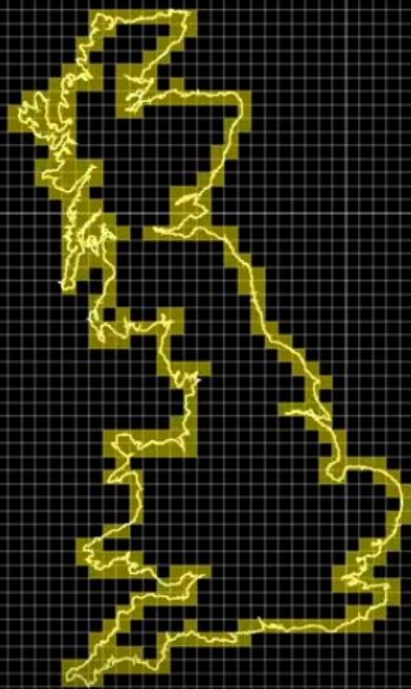
Number of boxes
touched



$$f(x) = cx^{1.585}$$

Scaling factor





Number of boxes \approx
 $c(\text{scaling factor})^{1.21}$



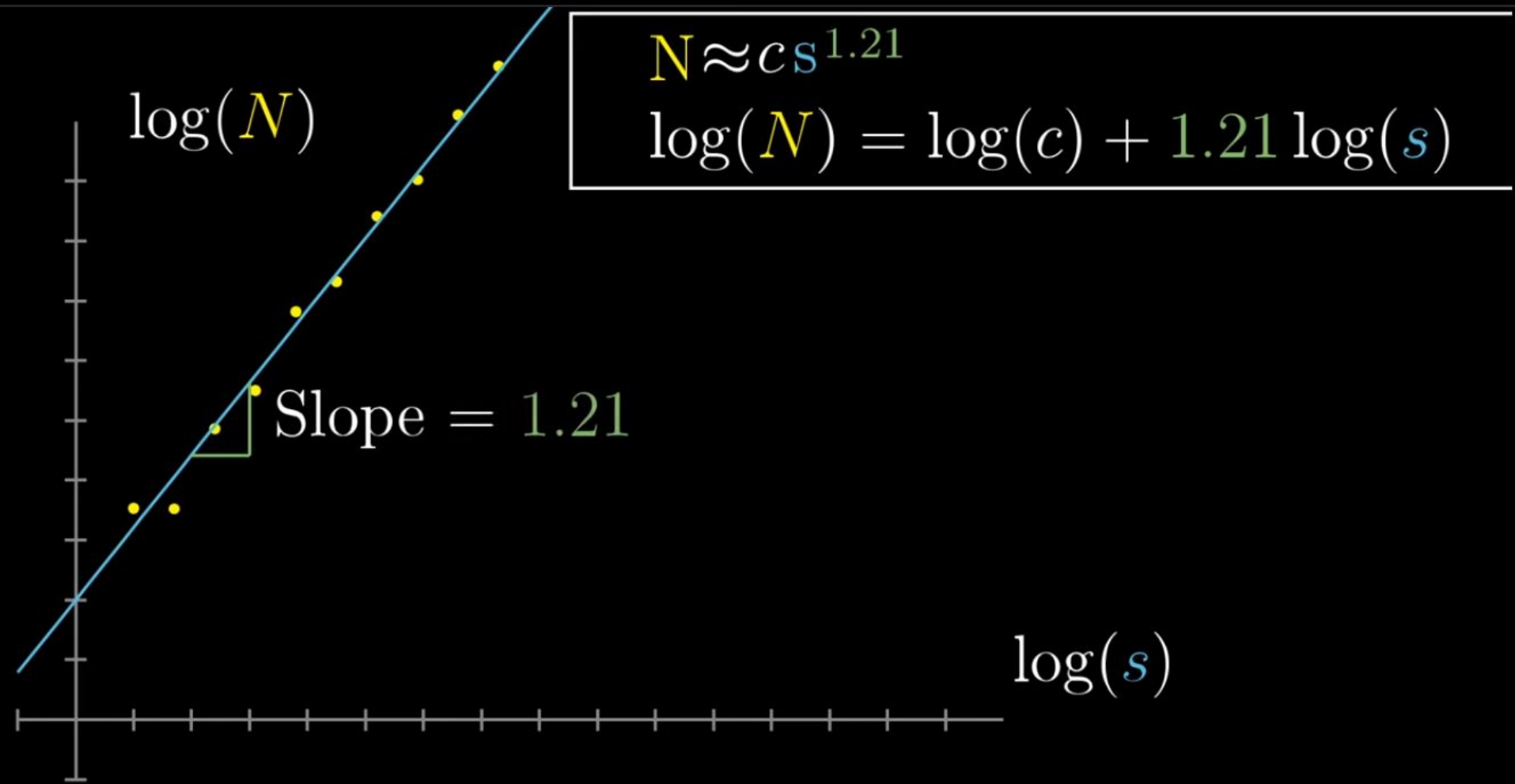
A yellow fractal curve is plotted on a dark grid. The curve is highly irregular and self-similar, characteristic of a fractal. It starts at the top left and moves generally downwards and to the right, with many small-scale oscillations and loops. The overall shape is roughly triangular, with the base at the bottom and the apex at the top left.
$$N \approx c s^{1.21}$$

$$\log(N) = \log(c s^{1.21})$$



$$N \approx c s^{1.21}$$

$$\log(N) = \log(c) + 1.21 \log(s)$$





Britain coast:
1.21-dimensional



Norway coast:
1.52-dimensional

Dimension ≈ 2.05



Dimension ≈ 2.3



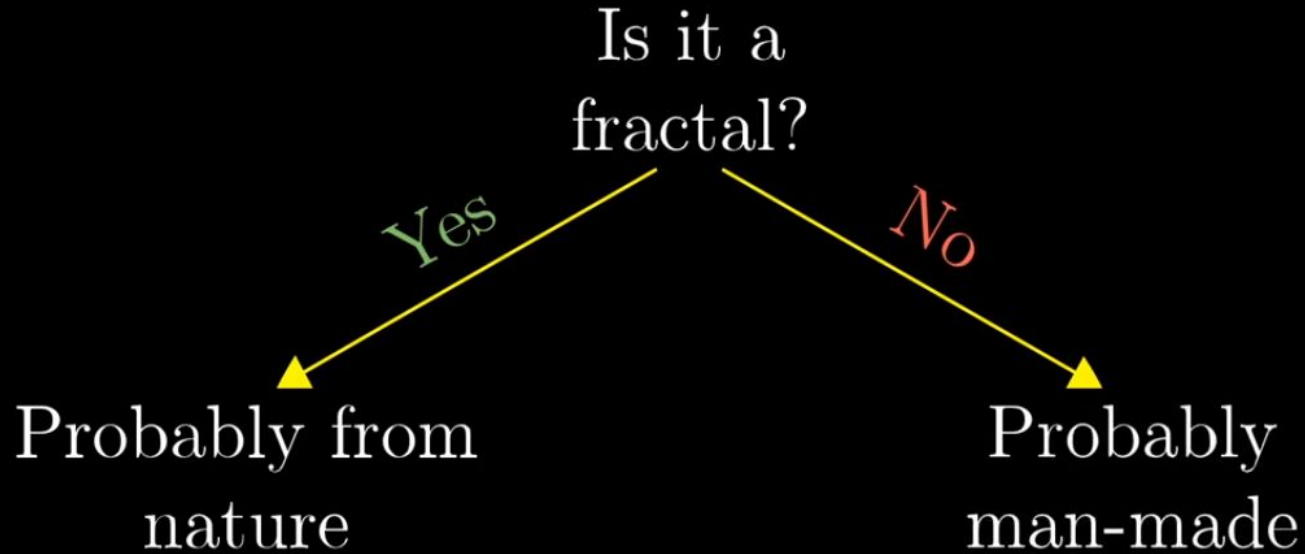
Is it a
fractal?

Yes

No

Probably from
nature

Probably
man-made



References: <https://www.youtube.com/watch?v=gB9n2gHsHN4>

