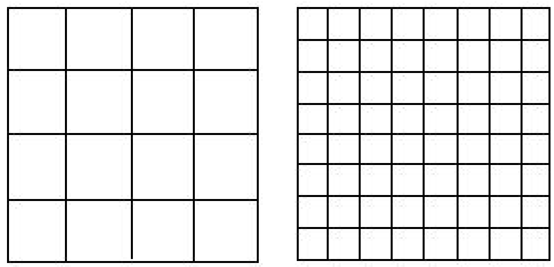
Show Notes:

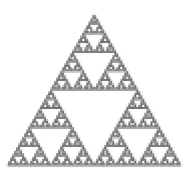
- [17:20] Fractal Dimension
  - https://en.wikipedia.org/wiki/Hausdorff_dimension
  - https://en.wikipedia.org/wiki/Fractal_dimension#Role_of_scaling
  - https://en.wikipedia.org/wiki/How_Long_Is_the_Coast_of_Britain%3F_Statistical_Self-Similarity_and_Fractional_Dimension
  - http://math.bu.edu/DYSYS/chaos-game/node6.html: Fractal dimension is a measure of how "complicated" a self-similar figure is. In a rough sense, it measures "how many points" lie in a given set.
  - A good example: a line can be broken into N different lines that each need to be scaled by a factor of N to get the original line:

    ---- (This is a line of length 4 = 4 lines of length 1)

Similarly, a square can be broken into N^2 different copies that each, when scaled by N yields the original square:



A square cut into 25 identical copies, each when scaled by a factor of 4 produces the original square. Finally, a cube can be broken to N^3 different identical cubes, each when scaled by a factor of N yields a cube of the original volume. But what about a weird curve like this?



We can approach this from a different angle: Scale the Sierpinski triangle by 2, and you get 3 different copies of it. What does this mean though? Is it 1 dimensional? It’s just a bunch of lines after all! But it’s also a triangle…?

The fractal dimension answers the question for a given curve: "What is the exponent D I need to raise an integer N by to produce N^D identical curves that each, when scaled by N give me the original curve?"

Formally, this is represented as:

D = - log(S)/log(N) where S is the total number of identical copies (this notation is not canon!), and N is our scaling factor.

Going back to our problem with the freaky triangle above,

N = 2, N^D = 3 => D = log(3)/log(2) ~=1.585

We can see it's somewhat 1-D and somewhat 2-D, but to a very precise degree. That's the power of fractal dimension, it tells us exactly what the dimension of a curve is to a degree that matches our intuition!

    - More fractals: https://en.wikipedia.org/wiki/List_of_fractals_by_Hausdorff_dimension
- [23:55] Dirac Notation and Hilbert Space

- https://en.wikipedia.org/wiki/Bra%E2%80%93ket_notation

- [26:55] 10 Martini Problem
  - The name was coined by Barry Simon in this 1982 article (page 487):
  - **The Ten Martini Problem:** *The almost Mathieu operator has a Cantor spectrum.*
  - The name comes from the fact that Mark Kac* has offered ten martinis to anyone who solves it. [...] Actually, Kac said "has all its gaps there", so perhaps one should solve instead:
  - **The Ten Martini Problem:** (Strong Form, or should it be Dry Form)...
  - [*] Marc Kac, public communication at 1981 AMS Annual Meeting.
  - https://annals.math.princeton.edu/wp-content/uploads/annals-v170-n1-p08-p.pdf
- [28:10] Mathieu Operator
  - https://en.wikipedia.org/wiki/Almost_Mathieu_operator
- [34:10] Julia Sets and Mandelbrot Set
  - http://www.alunw.freeuk.com/mandelbrotroom.html
  - https://en.wikipedia.org/wiki/Mandelbrot_set
- [51:10] Blind Spot
  - https://www.exploratorium.edu/snacks/blind-spot