

Fractals

(Applications)

A3.6 design a simple and efficient **recursive algorithm** (e.g., **calculate a factorial**, translate numbers into words, perform a merge sort, **generate fractals**, perform XML parsing).

C2.4 identify common **pitfalls in recursive functions** (e.g., **infinite recursion**, **exponential growth in recursive algorithms such as Fibonacci numbers**).

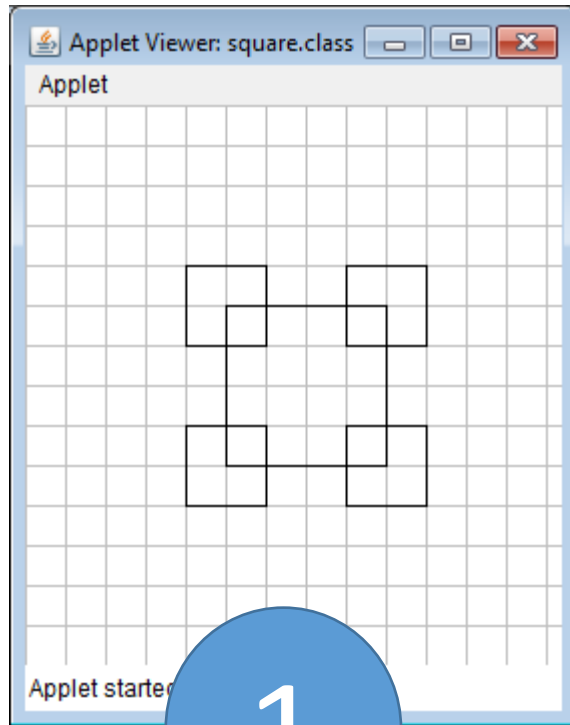
D4.1 report on some areas of **collaborative research between computer science** and other fields (e.g., bioinformatics, geology, economics, linguistics, health informatics, climatology, sociology, **art**), on the basis of information found in industry publications (e.g., from the ACM and IEEE);

Pre-reading: A strategy

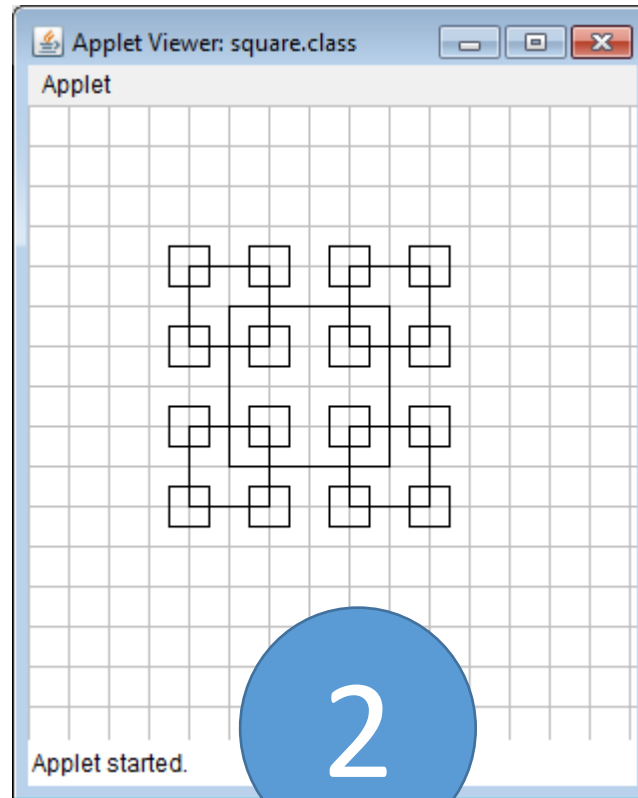
Read over the questions on your worksheet now.



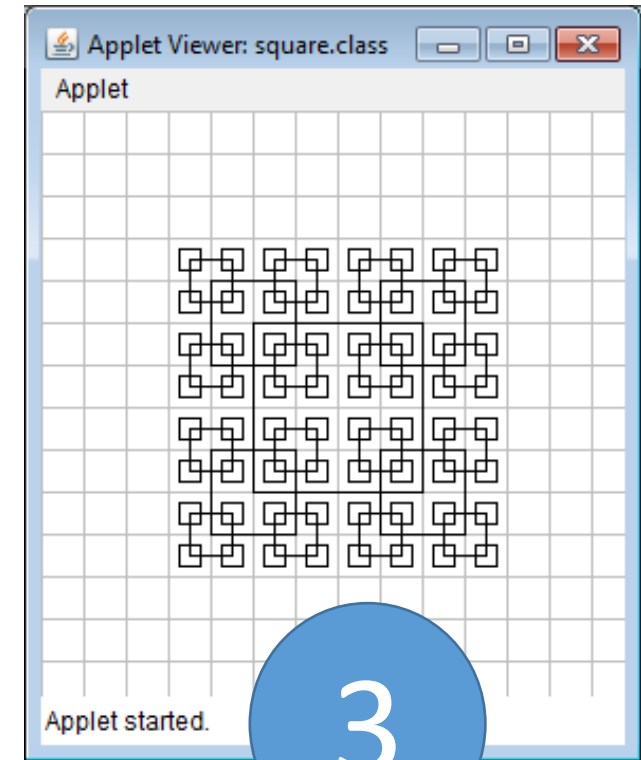
A fractal is a drawing that displays self-similarity.



1

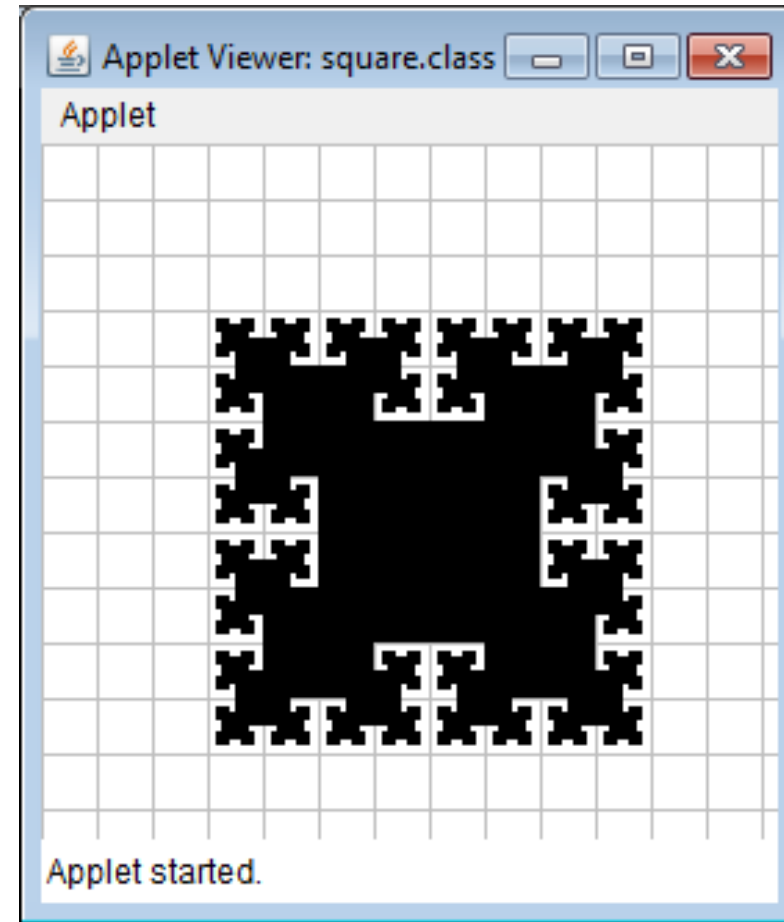
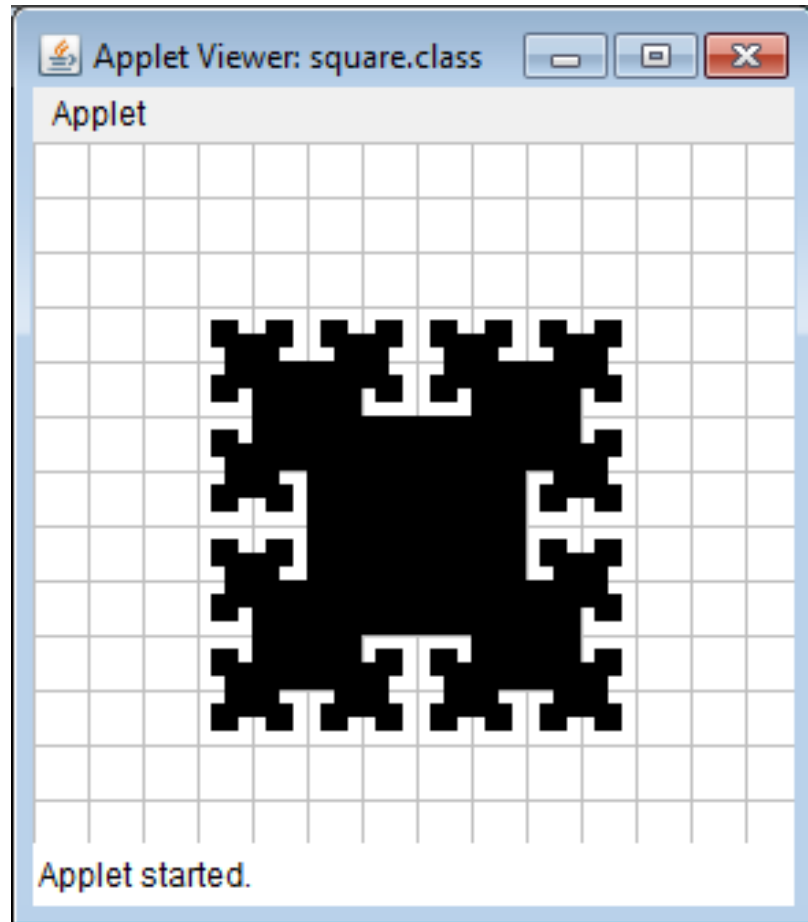


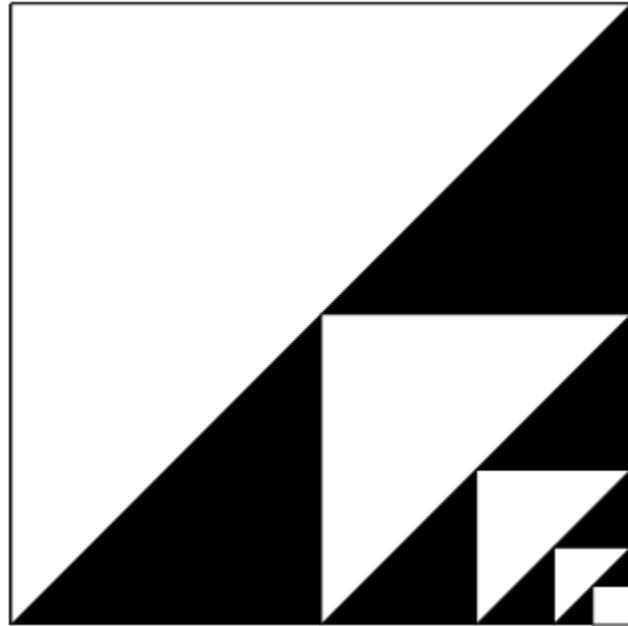
2



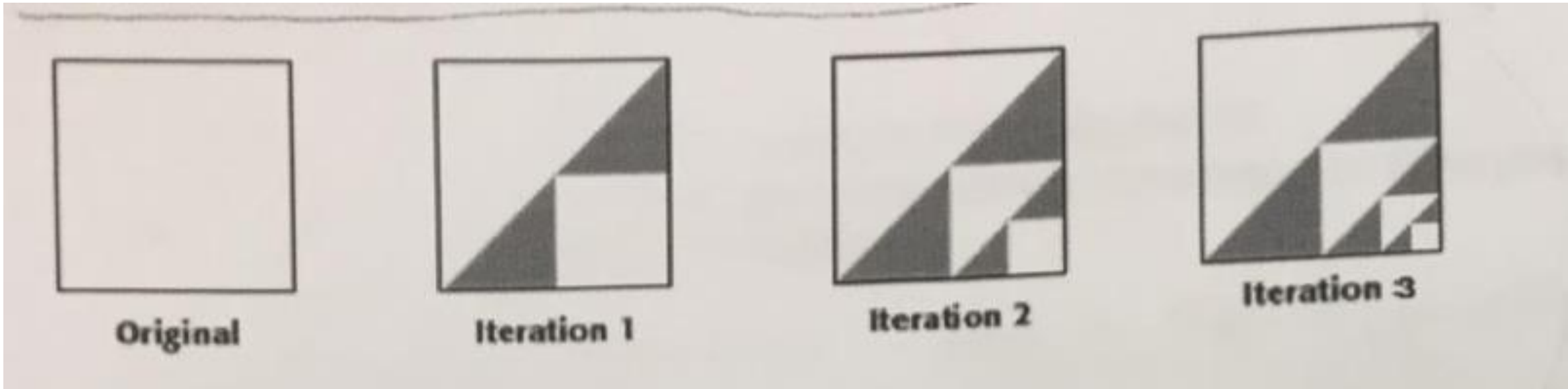
3

If you fill it, you can see where its name... T-square fractal... comes from.

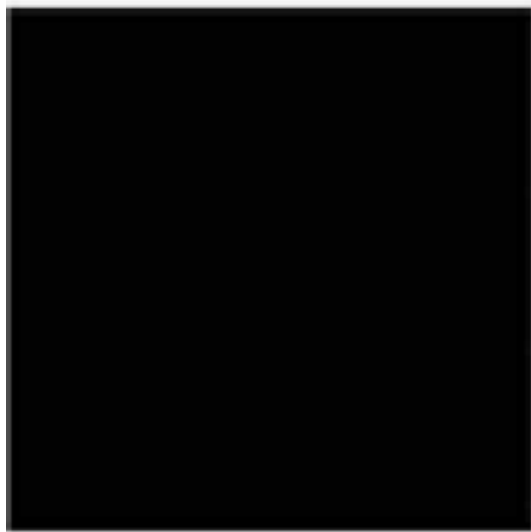




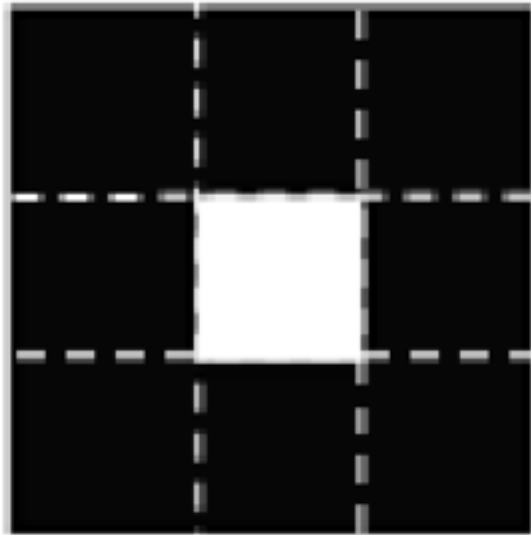
Another fractal. Draw the self similar part.



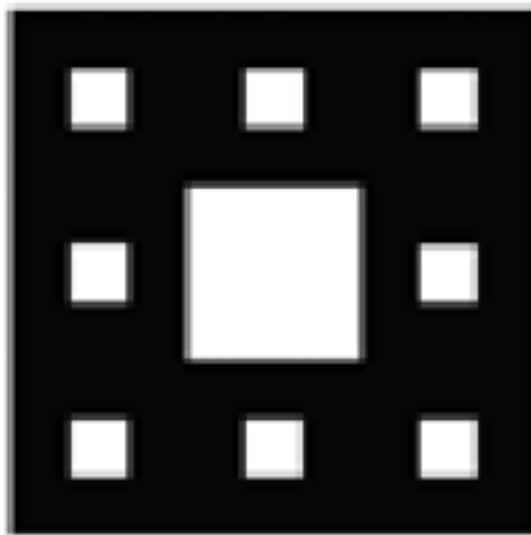
Another fractal. Draw
the self similar part.



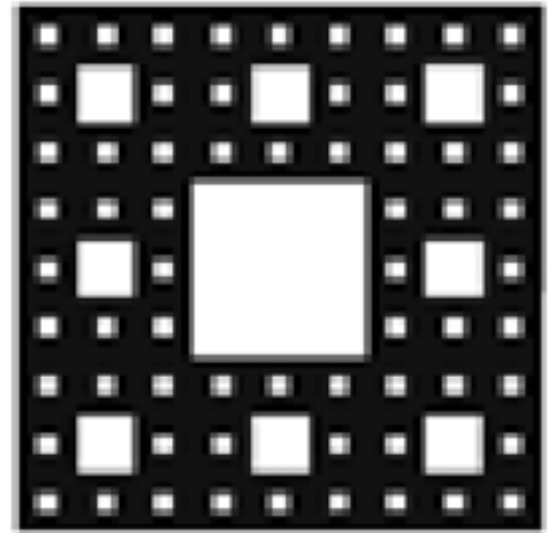
(a)



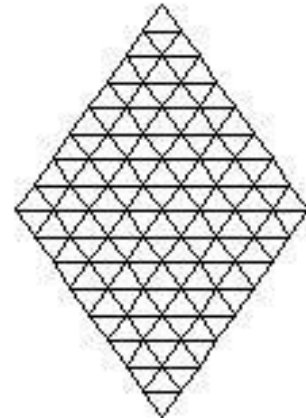
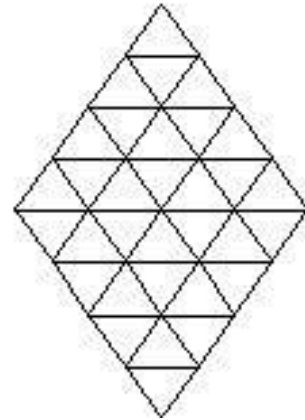
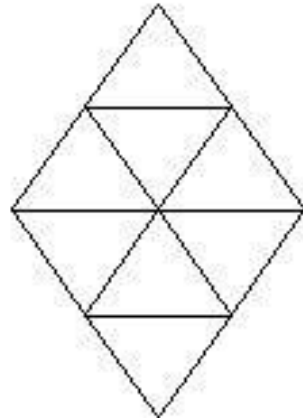
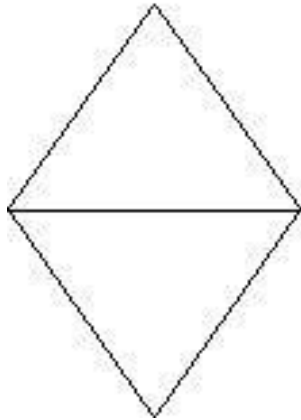
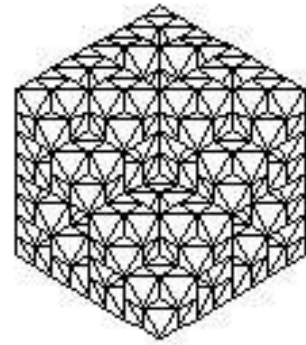
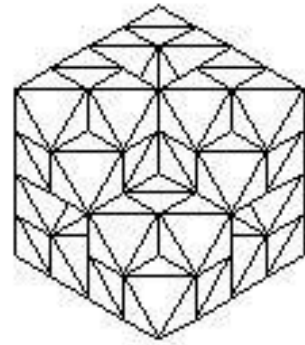
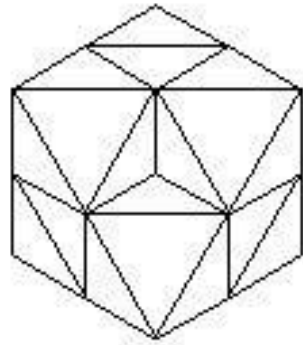
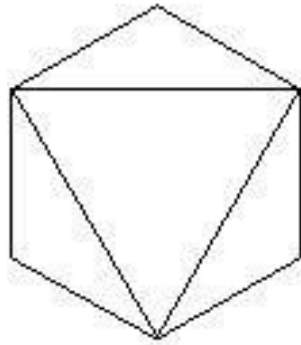
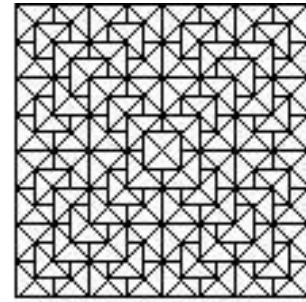
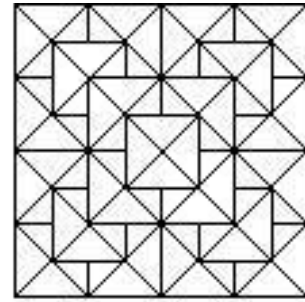
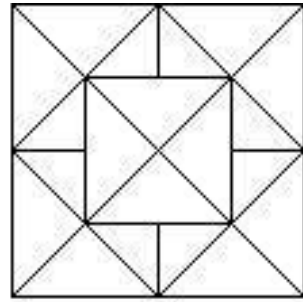
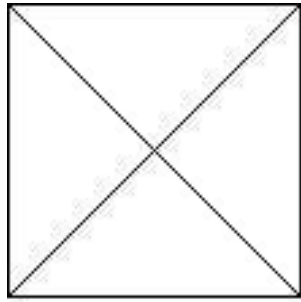
(b)



(c)



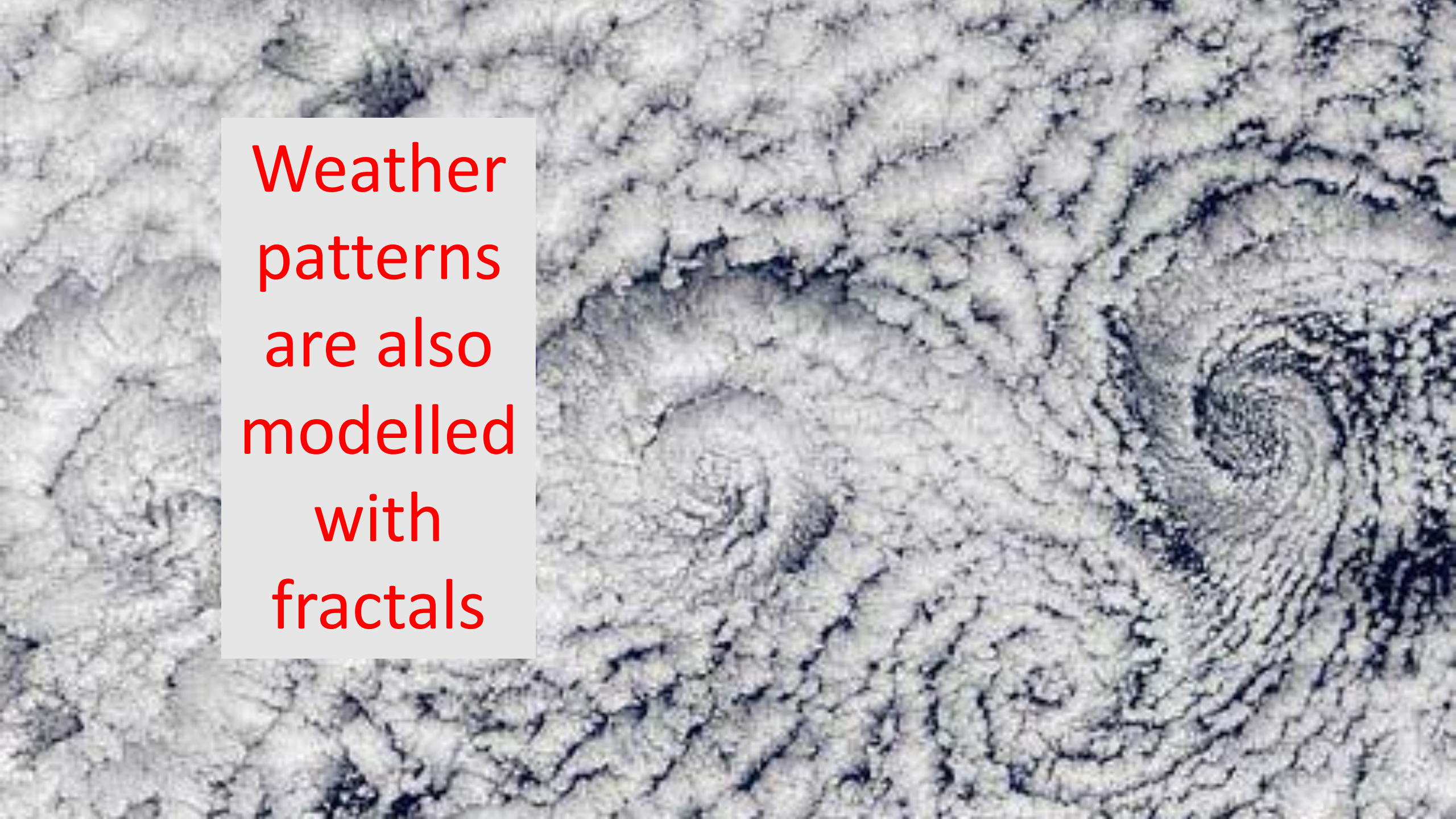
(d)





"A cloud is made of billows upon billows upon billows that look like clouds. As you come closer to a cloud you don't get something smooth, but irregularities at a smaller scale."

Benoit Mandelbrot

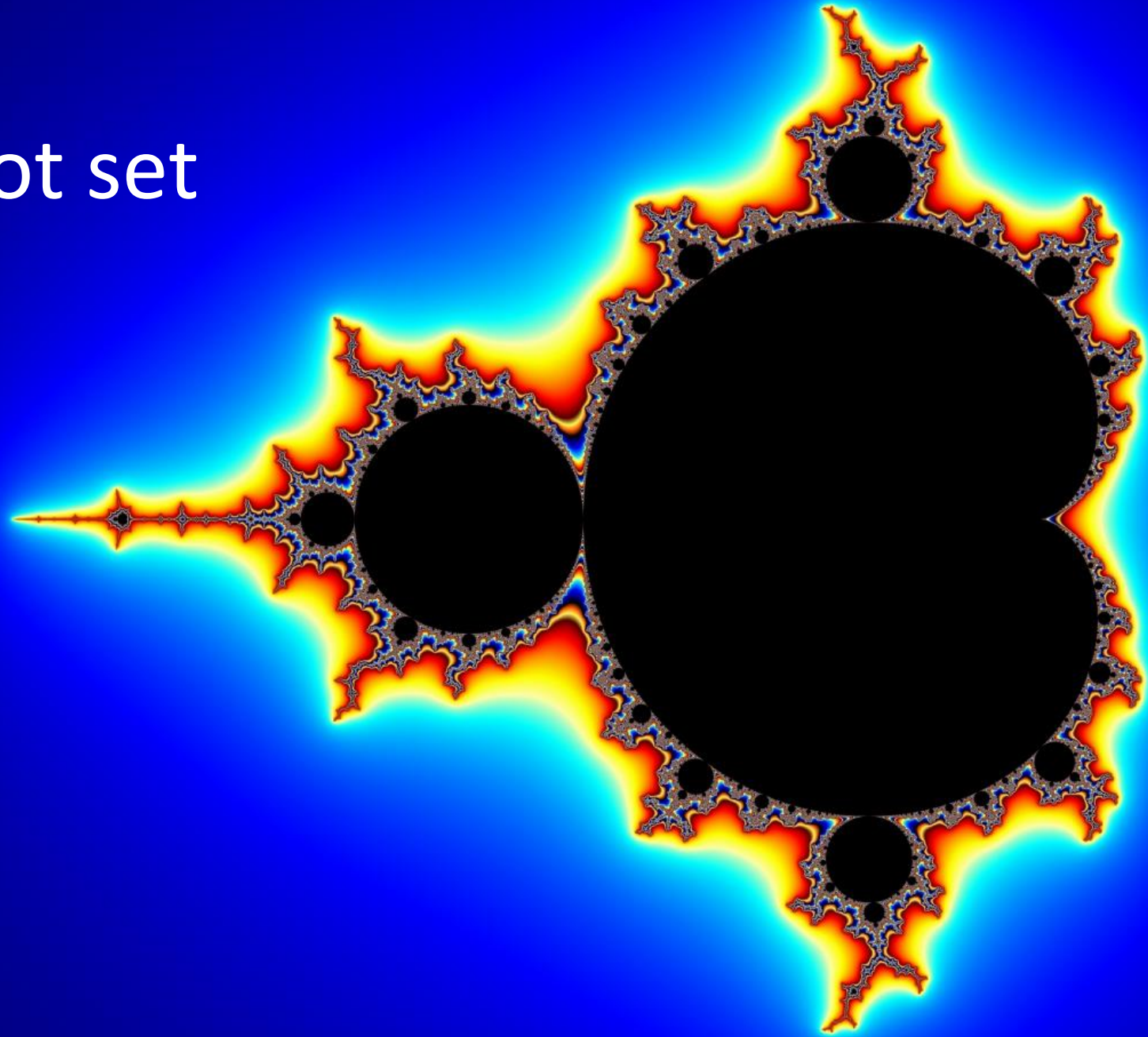


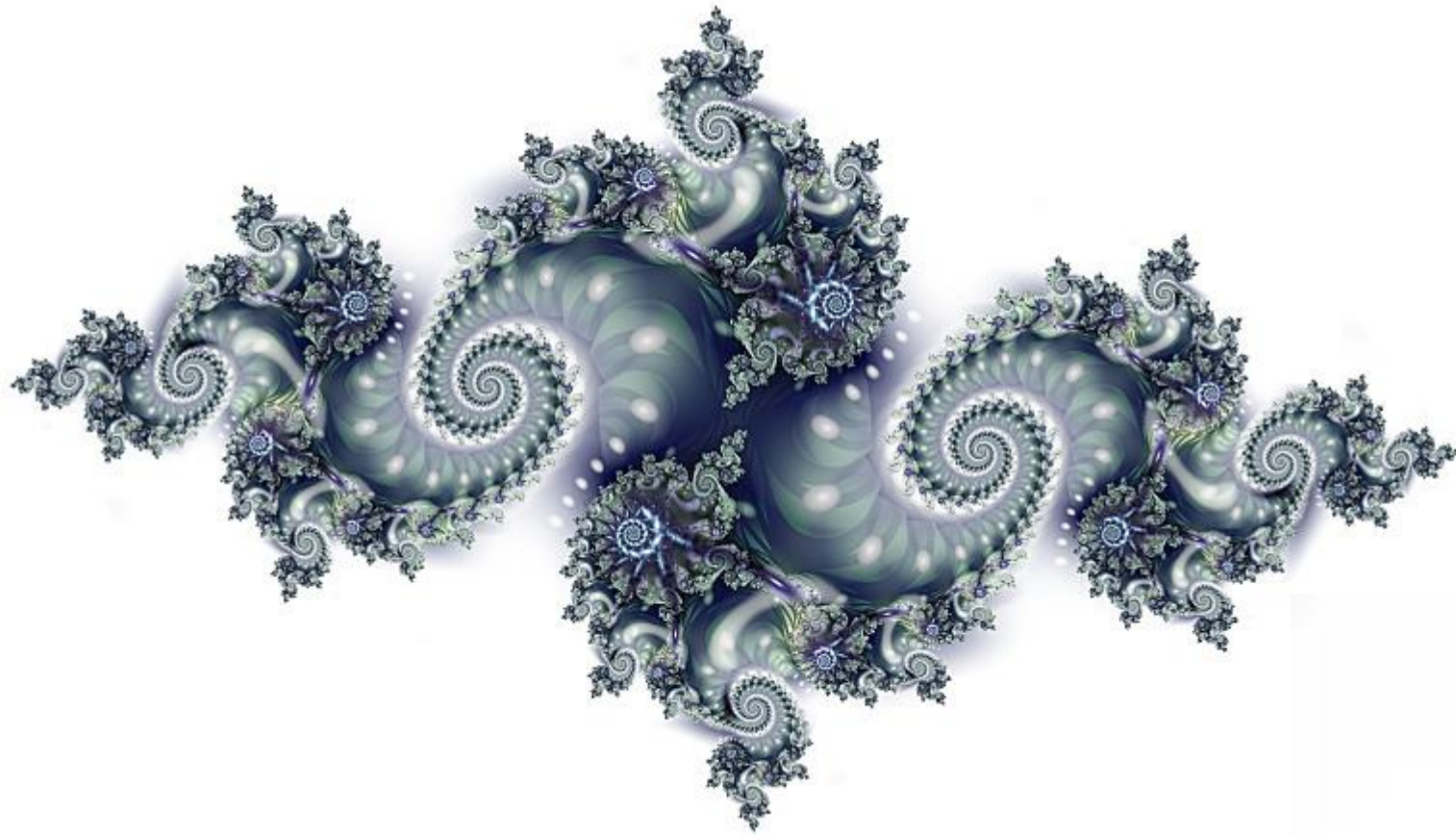
Weather
patterns
are also
modelled
with
fractals

Lightning can be easily seen to be self-similar. You can zoom in and it looks the same.



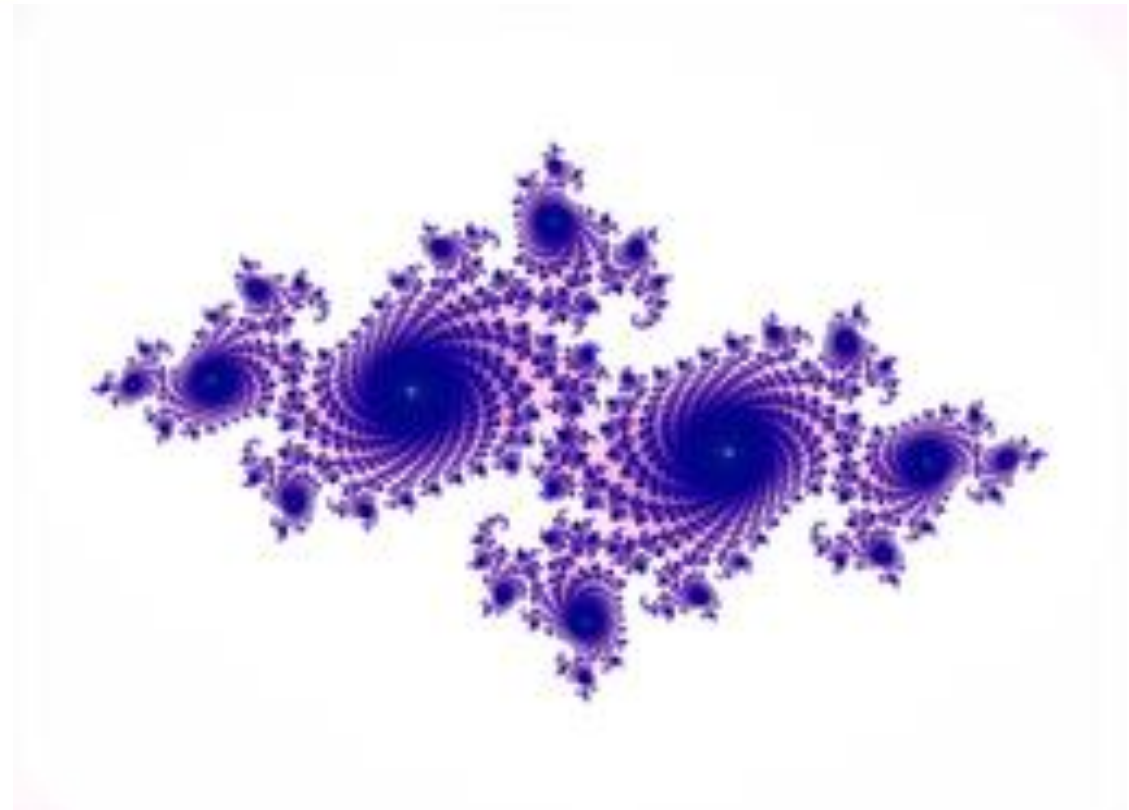
Mandlebrot set





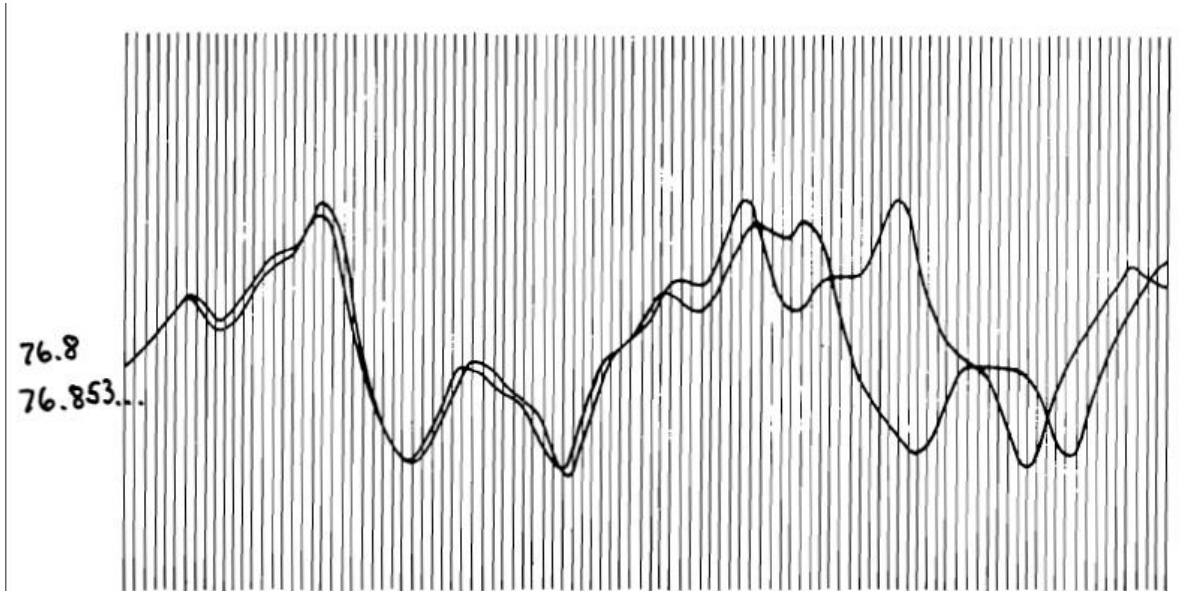
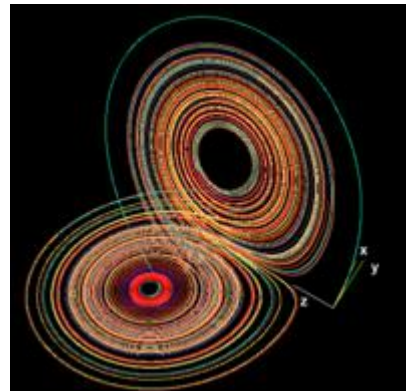
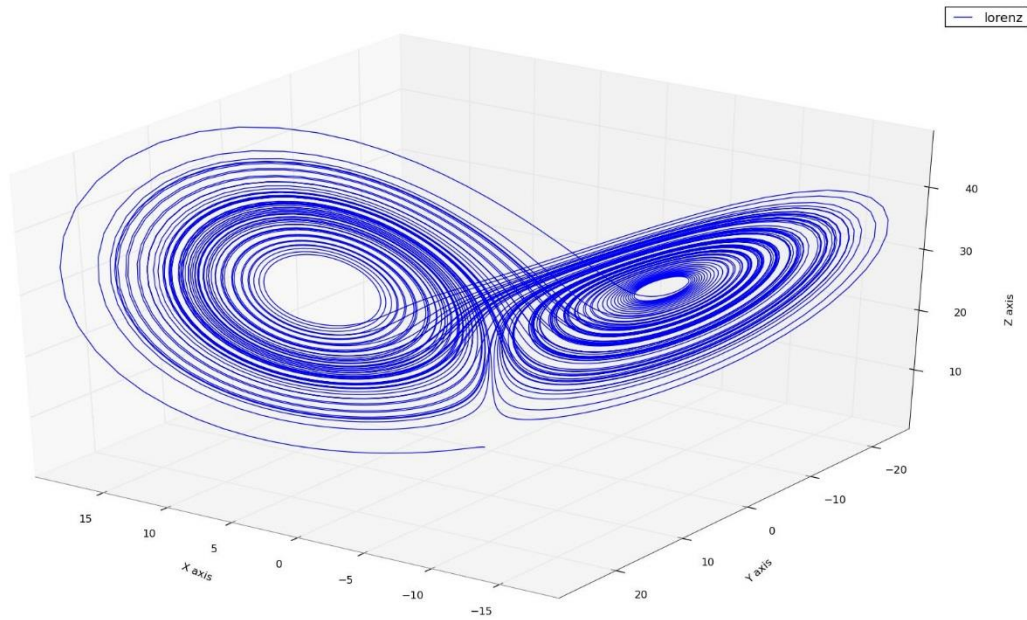
Julia Set

$$z = z^2 + c.$$




Lorenz Attractor

Weather patterns... butterfly effect... chaos theory



HOW TWO WEATHER PATTERNS DIVERGE. From nearly the same starting point, Edward Lorenz saw his computer weather produce patterns that grew farther and farther apart until all resemblance disappeared. (From Lorenz's 1961 printouts.)



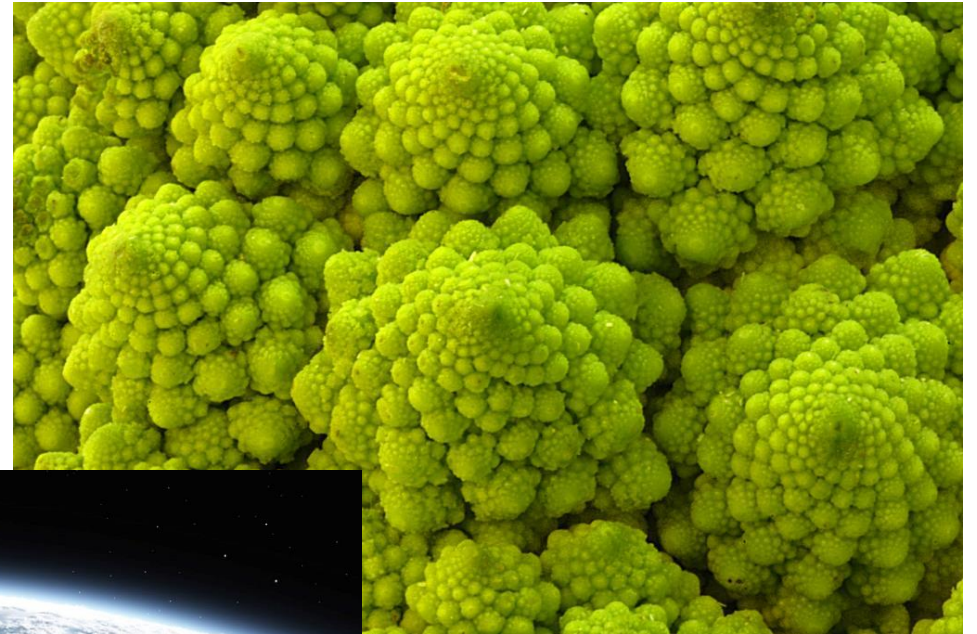
Particle
Motion
Fractal

Textures

Crumbled Paper

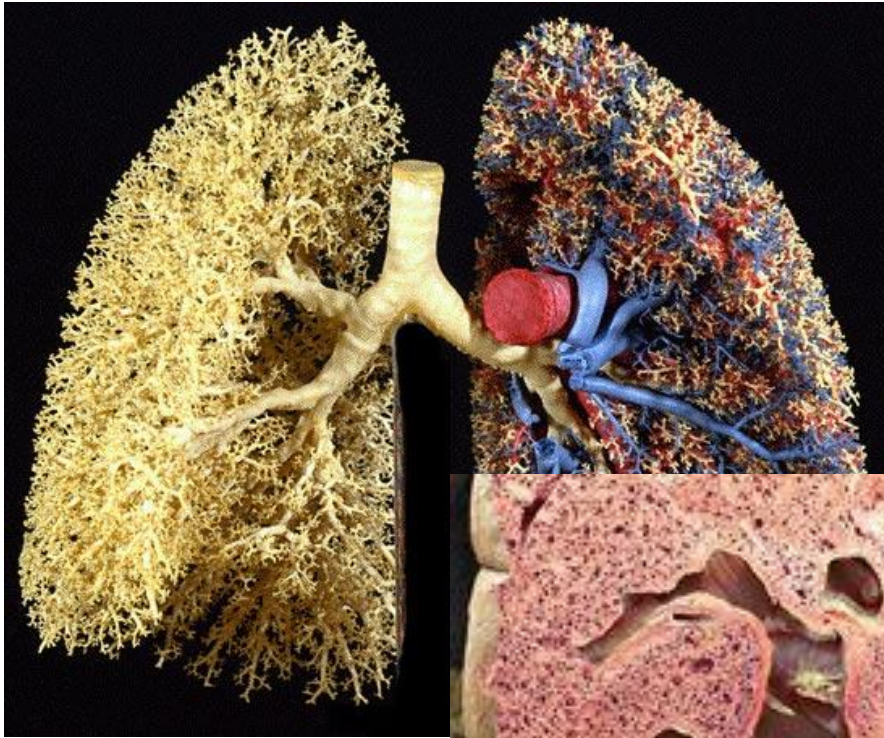


Broccoli



Planet Surface

Human Biology



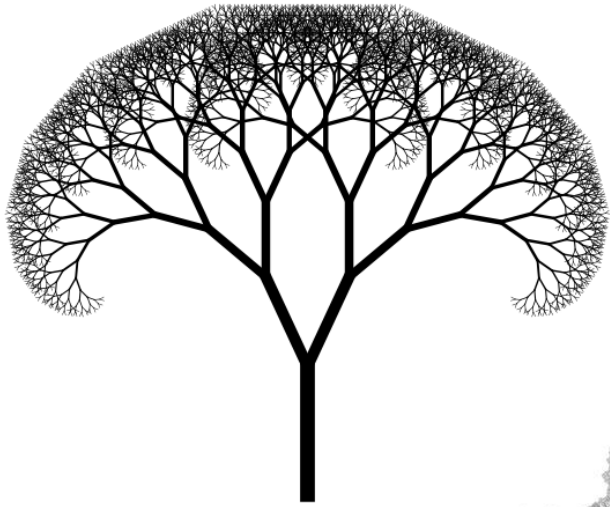
Lungs



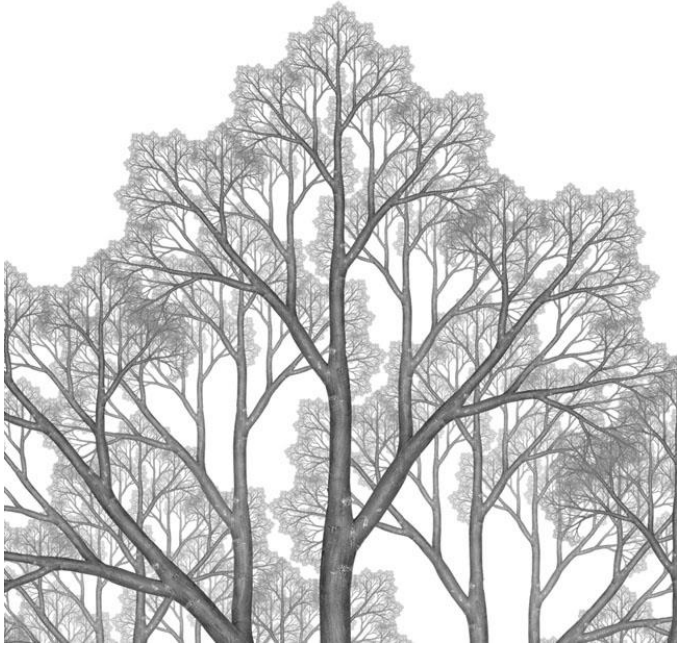
Brain Neurons



Trees



Simple



Complex



Other Items in Nature



Basically, all nature is better drawn with fractals than traditional shapes.



Nature =
Fractal



Nature =
Fractal



Nature =
Fractal



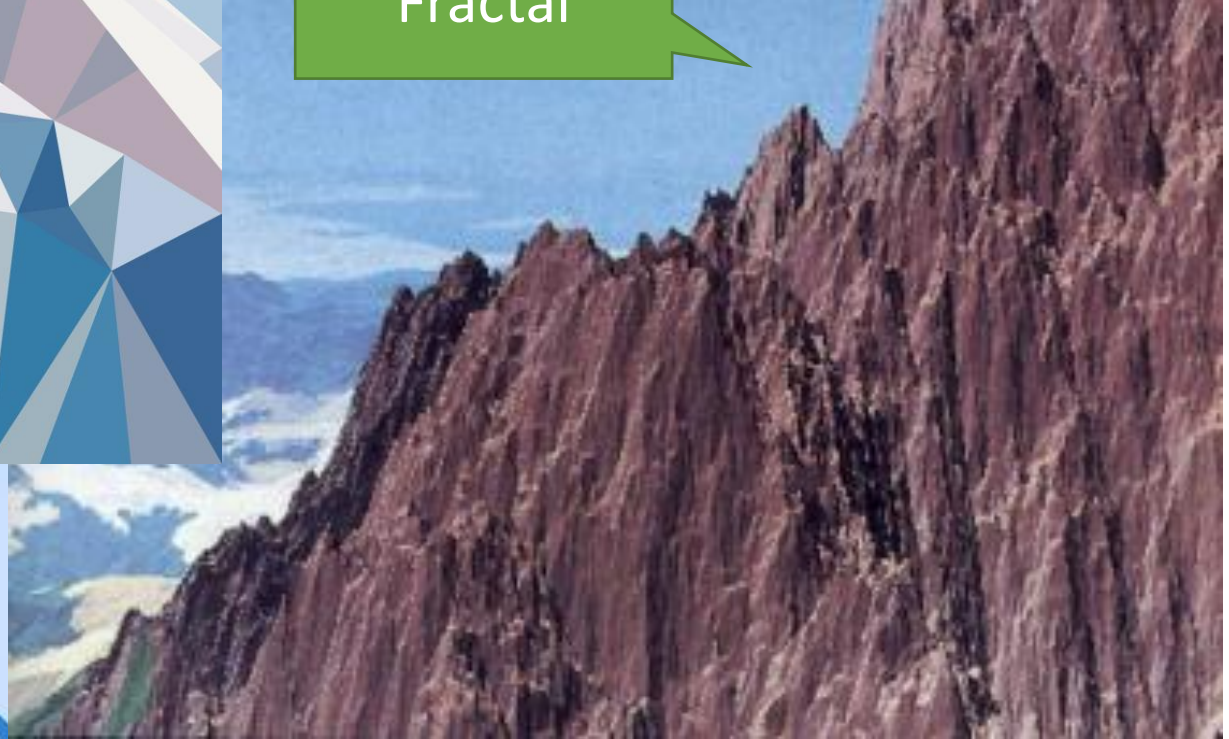
Clouds are not
spheres; Mountains
are not cones.



Geometric



Fractal



Geometric



When you draw with fractals, things look more realistic



That's why computer-generated photo-real images use fractals.



33.0mm i0.72 c253.9



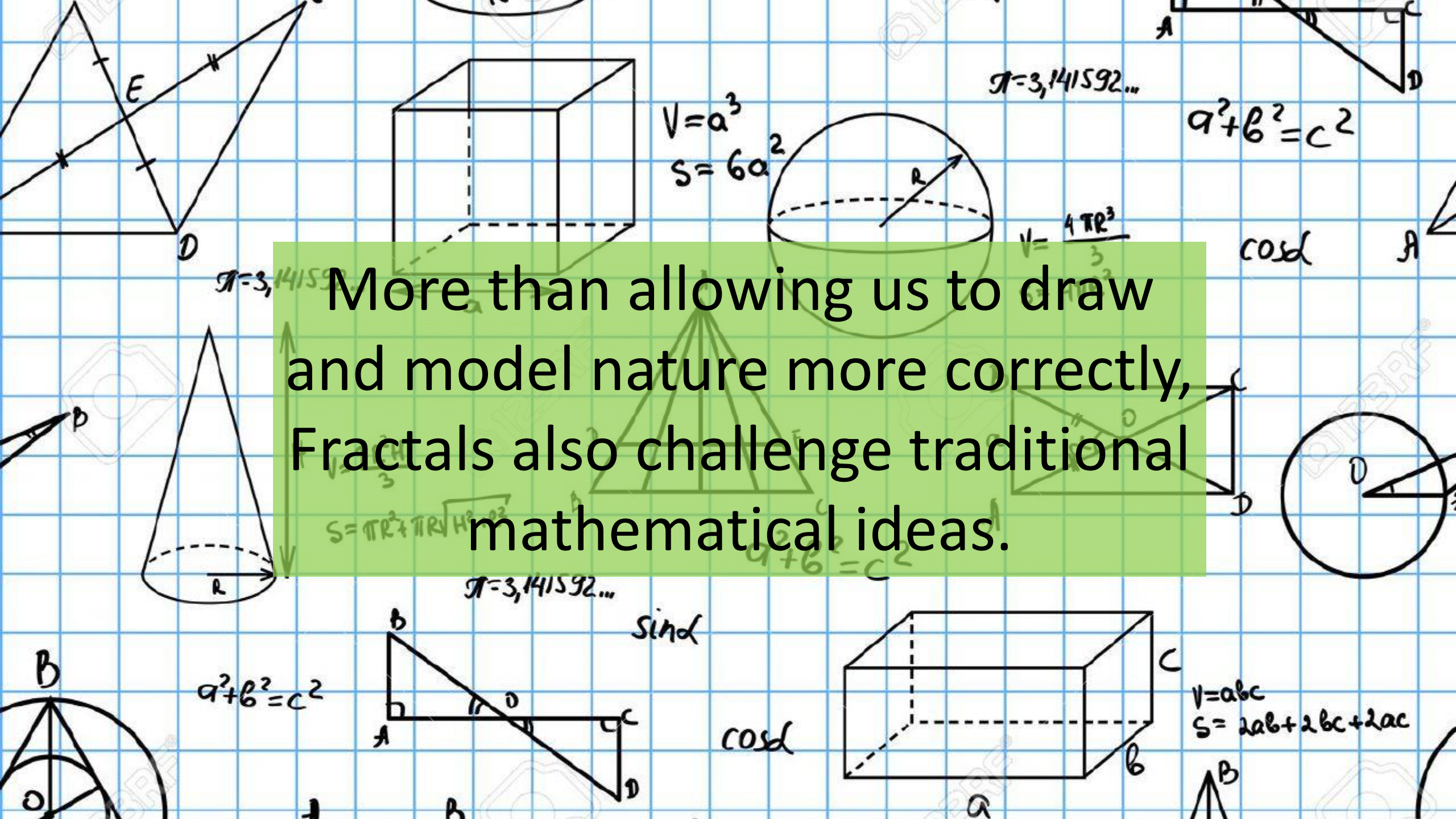
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AP 03 3108-5164+00



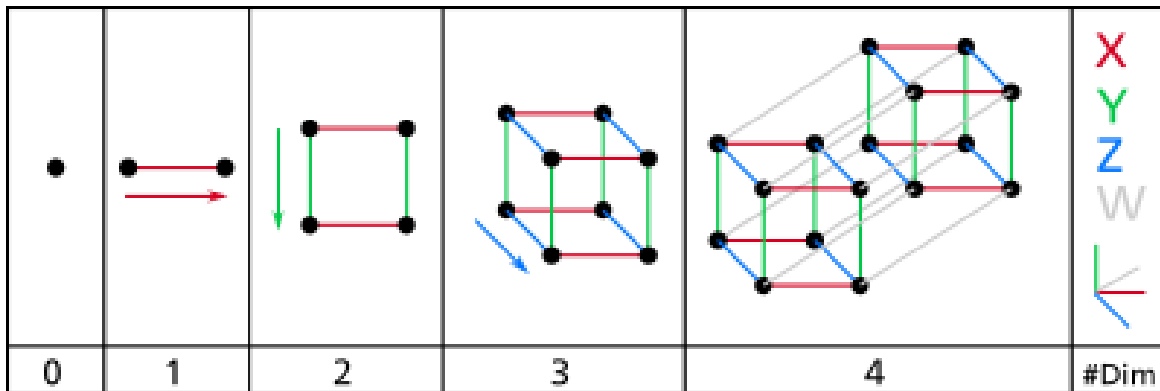
More than allowing us to draw and model nature more correctly, Fractals also challenge traditional mathematical ideas.



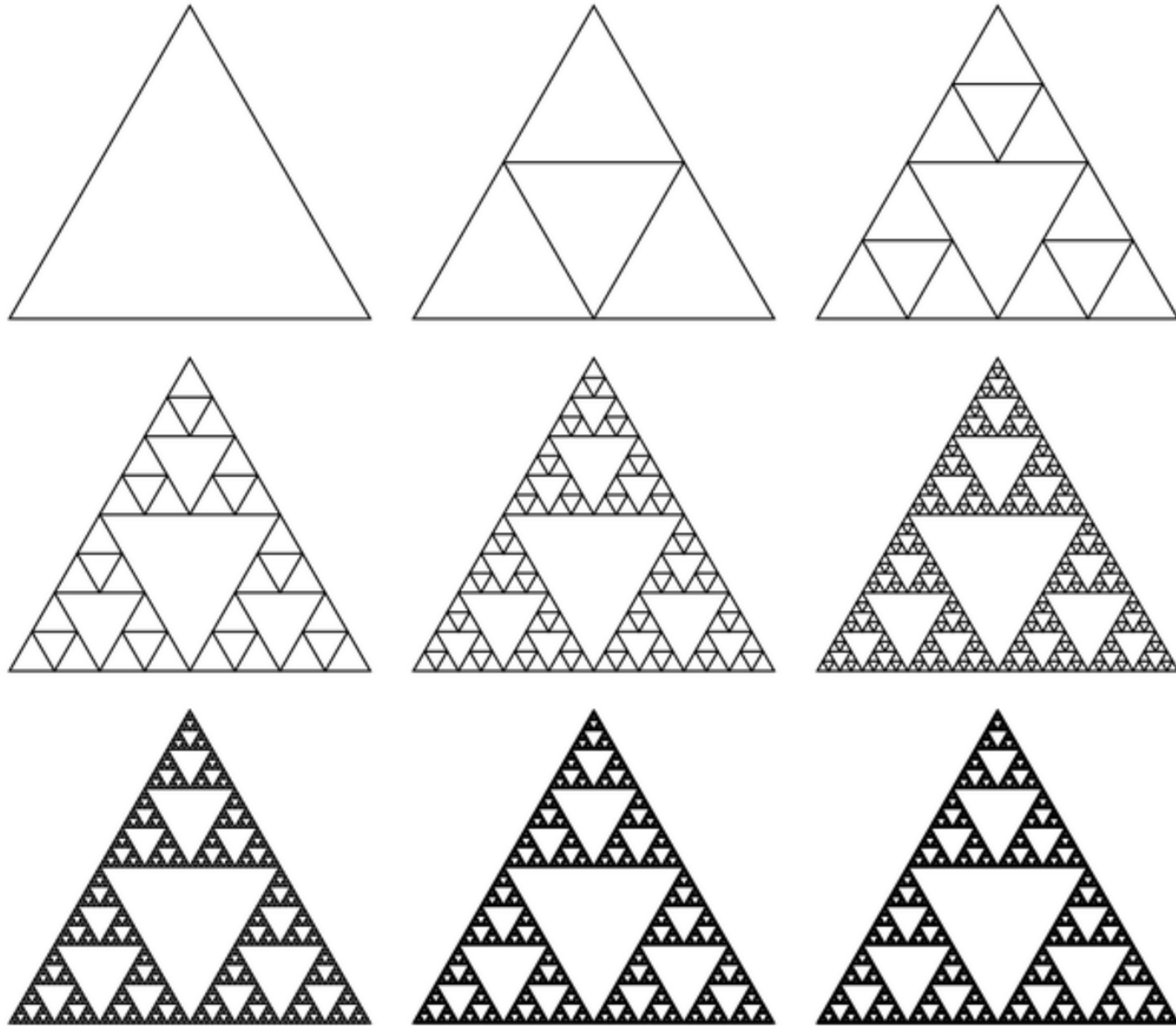
Cantor Set



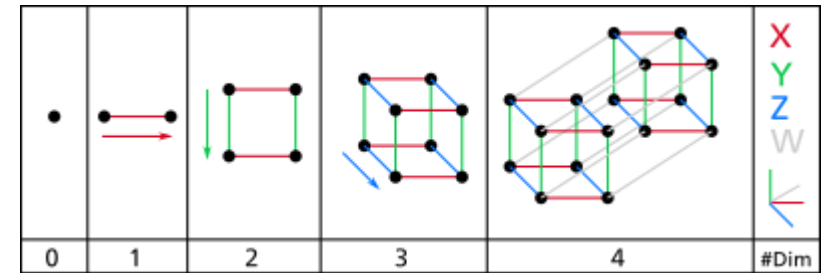
The four dimensions:



$D = 0.6309$
It's a line with
some missing

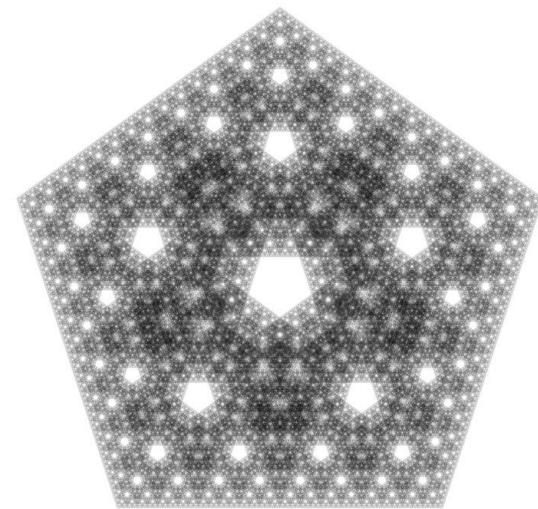
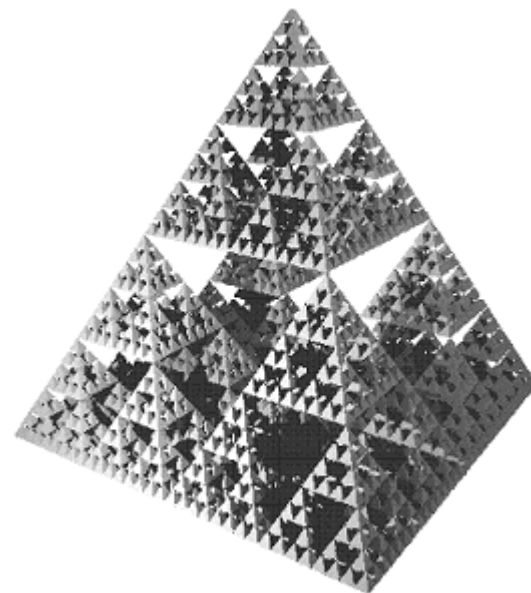
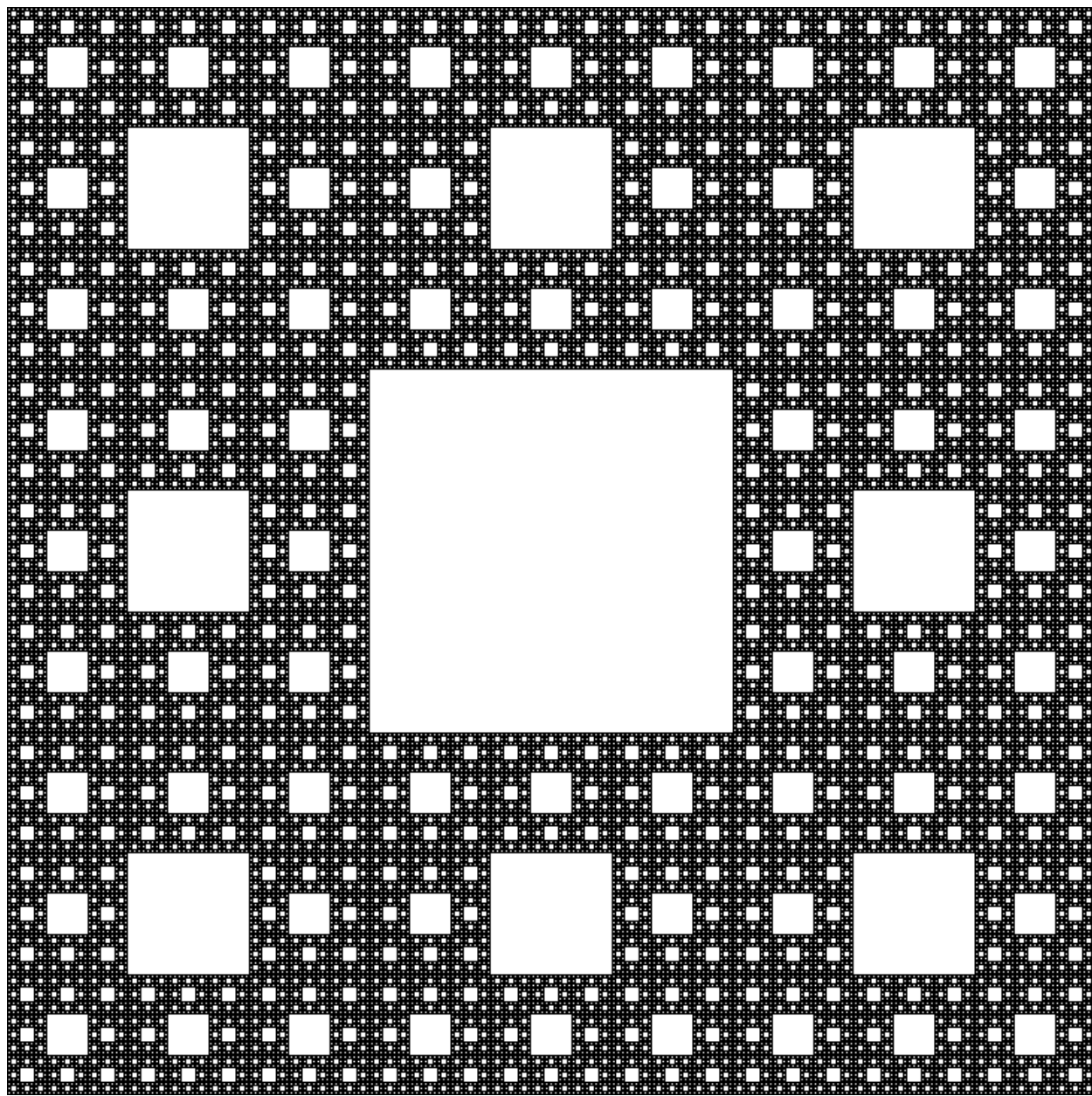


Sierpinski's Triangle



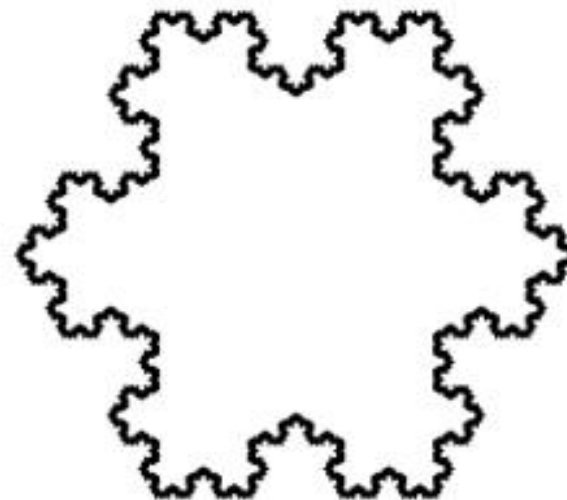
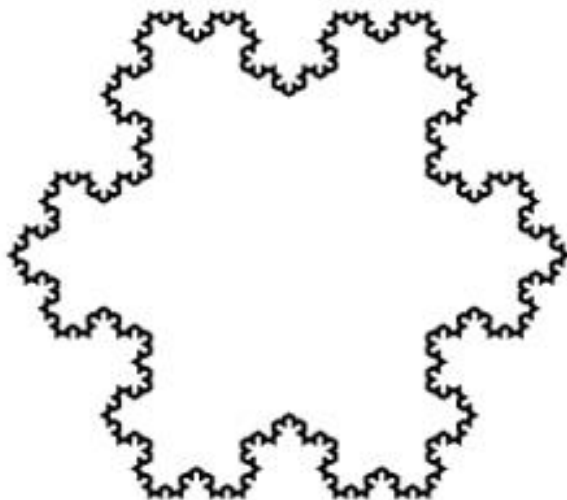
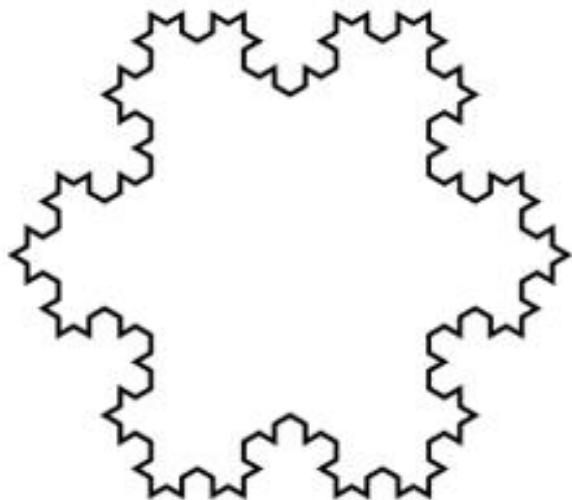
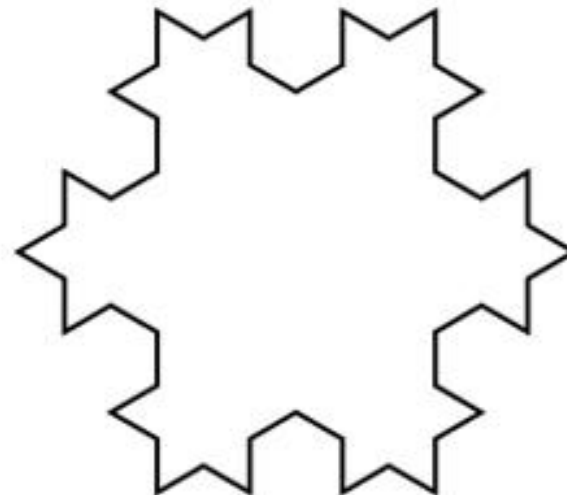
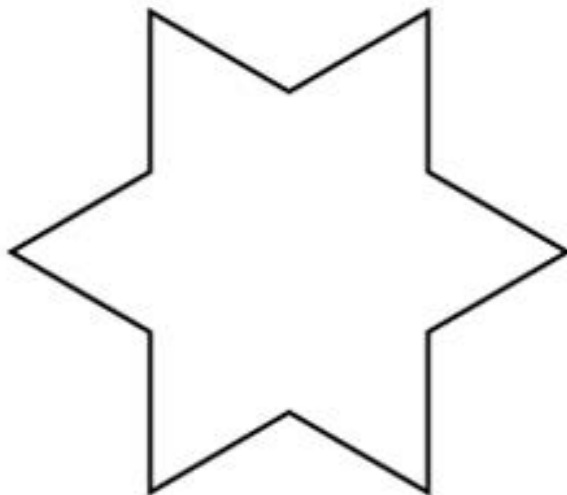
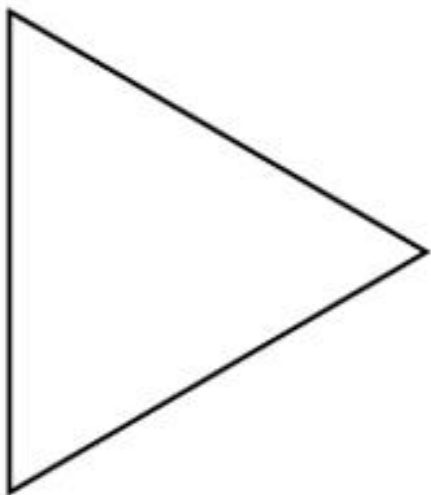
Consider the white section as REMOVED
It's a 2D shape with some missing.

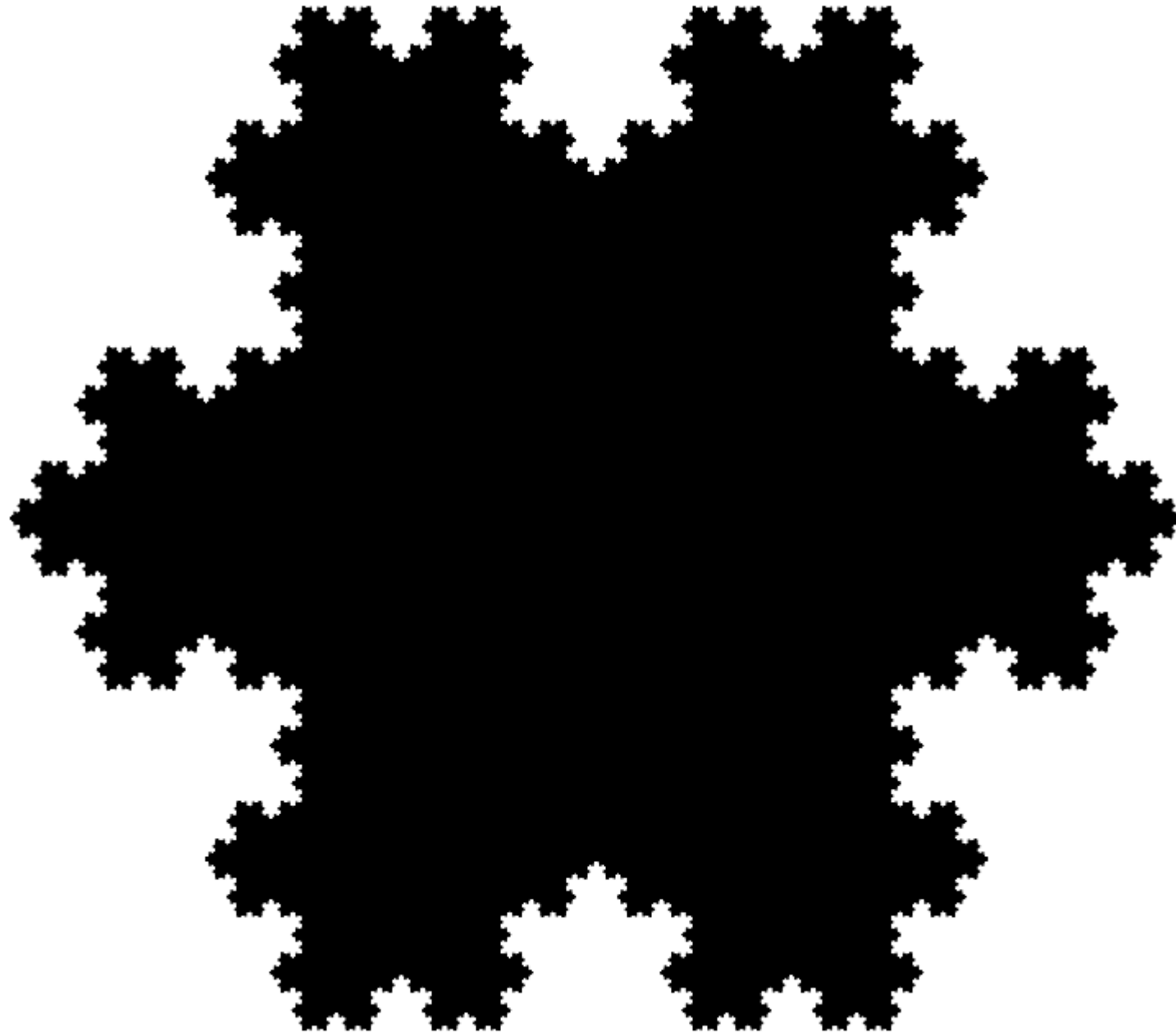
$$D = 1.584$$



Koch Snowflake

A fractal made by addition.





$$D = 1.261$$

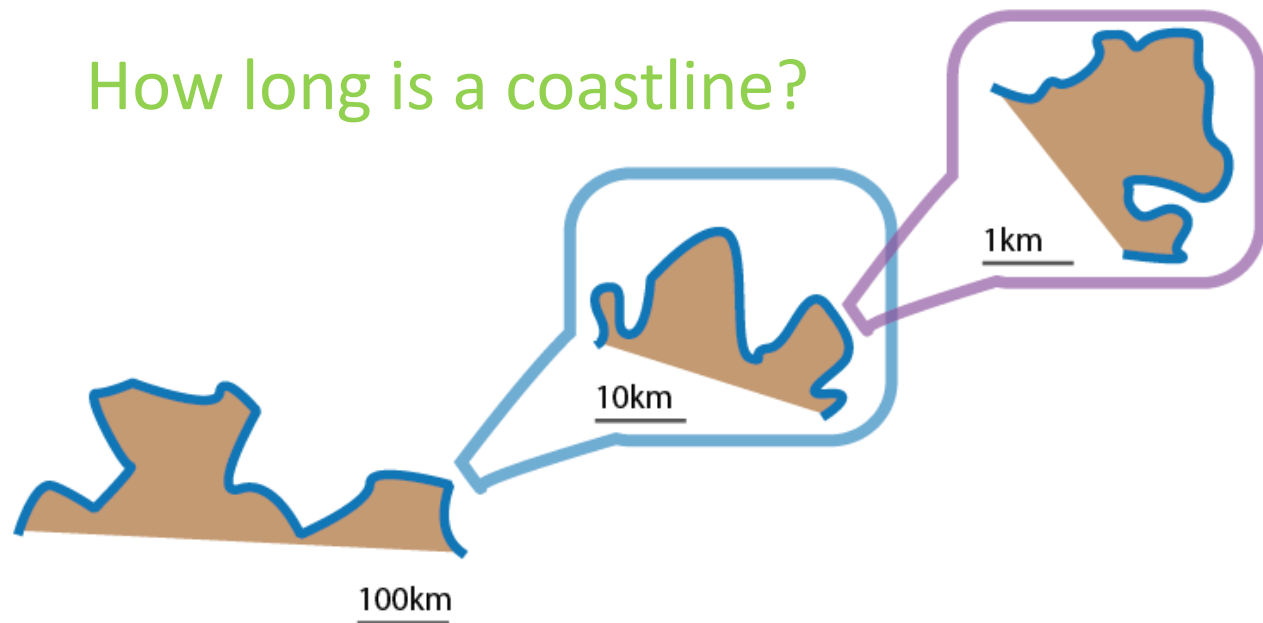
If you continue this pattern to infinity:

- It has a finite area (you can carpet it)
- It has an infinite perimeter (you can't fence it)



Fractal Paradox of measuring coastlines.

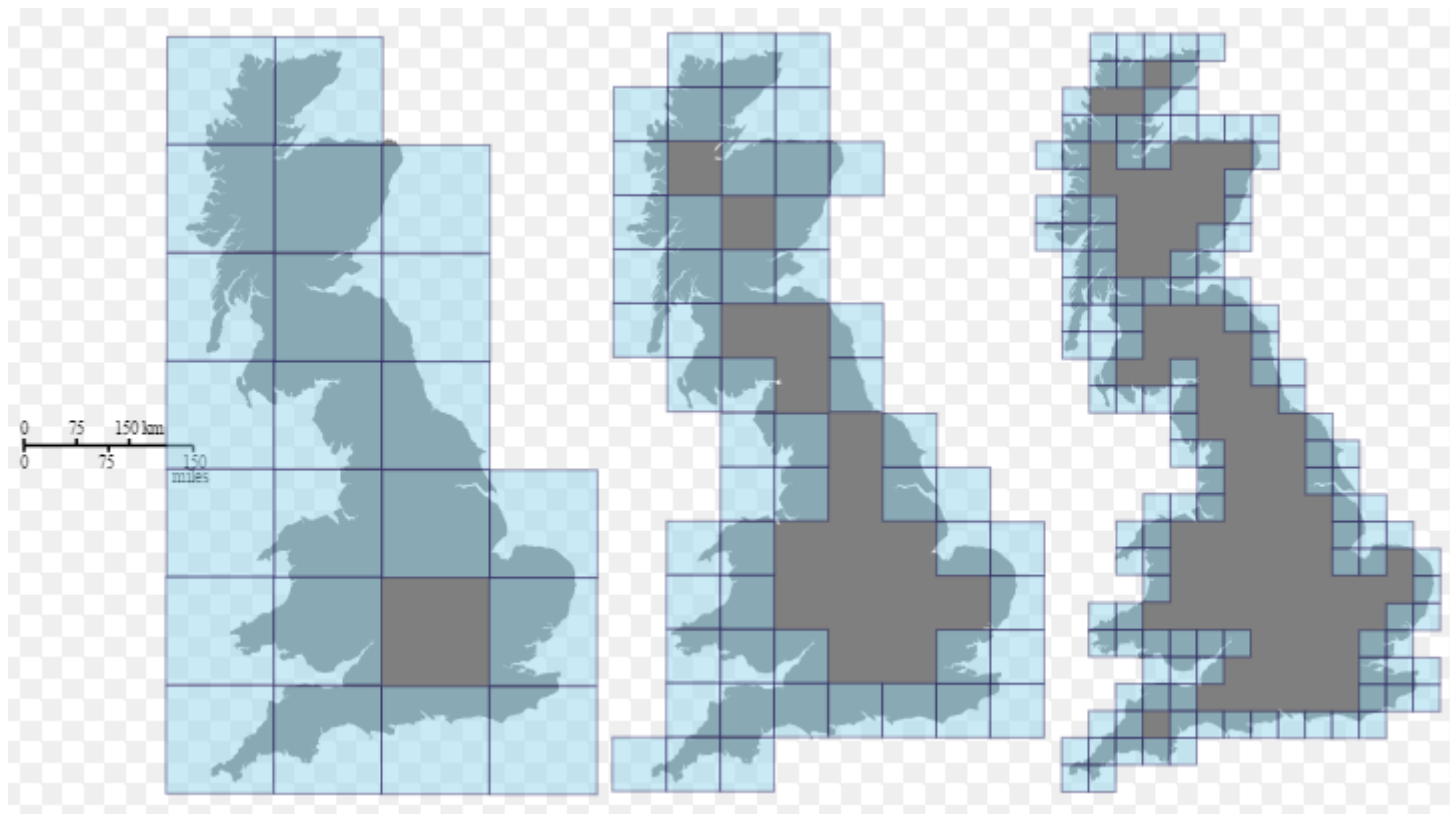
How long is a coastline?



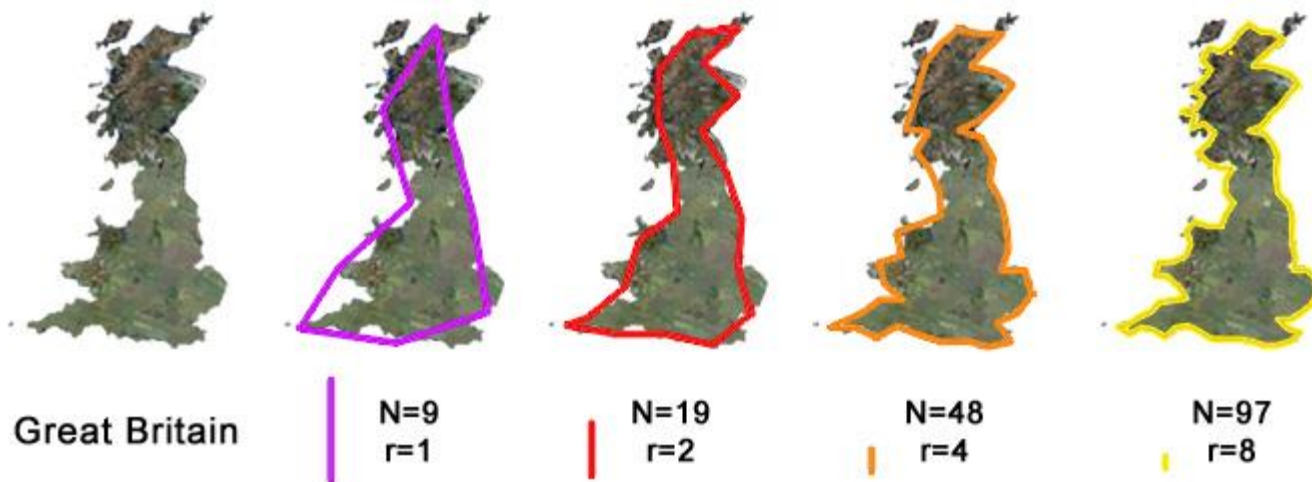
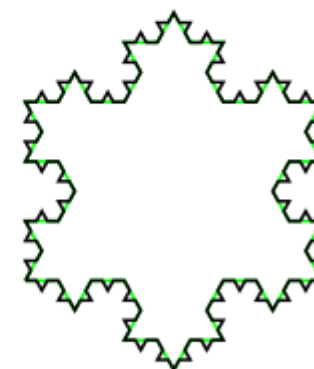
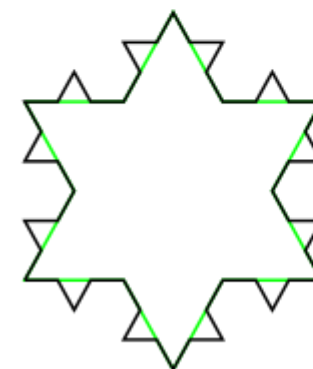
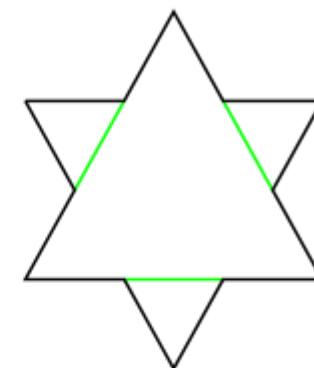
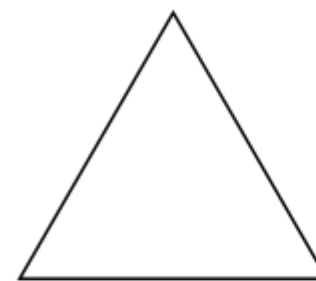
The measured length of a coastline depends of the size of the measuring stick:

If you take a satellite picture... vs. Driving it ... vs. Walking it

The lengths are different.

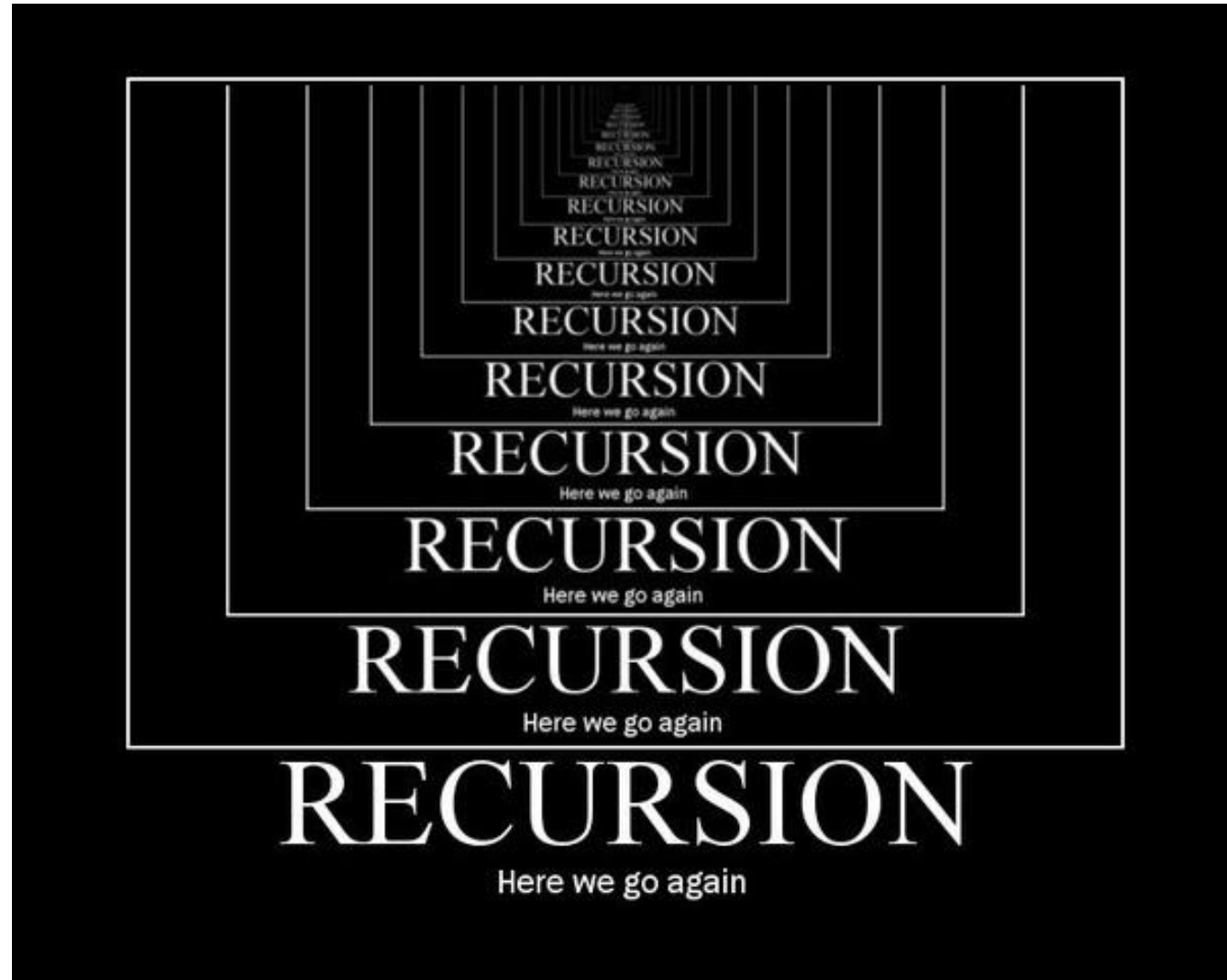


Each different measuring stick of a coastline is like a different level of fractal.



Coastlines are fractal.

That's all ... Except for this ...









dragon curve



apollonian gasket



sierpinski sieve



mandelbrot set



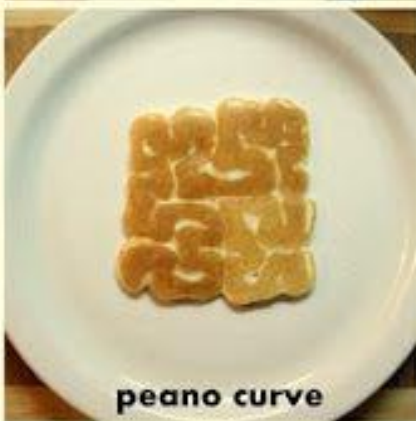
pythagorean tree



koch snowflake



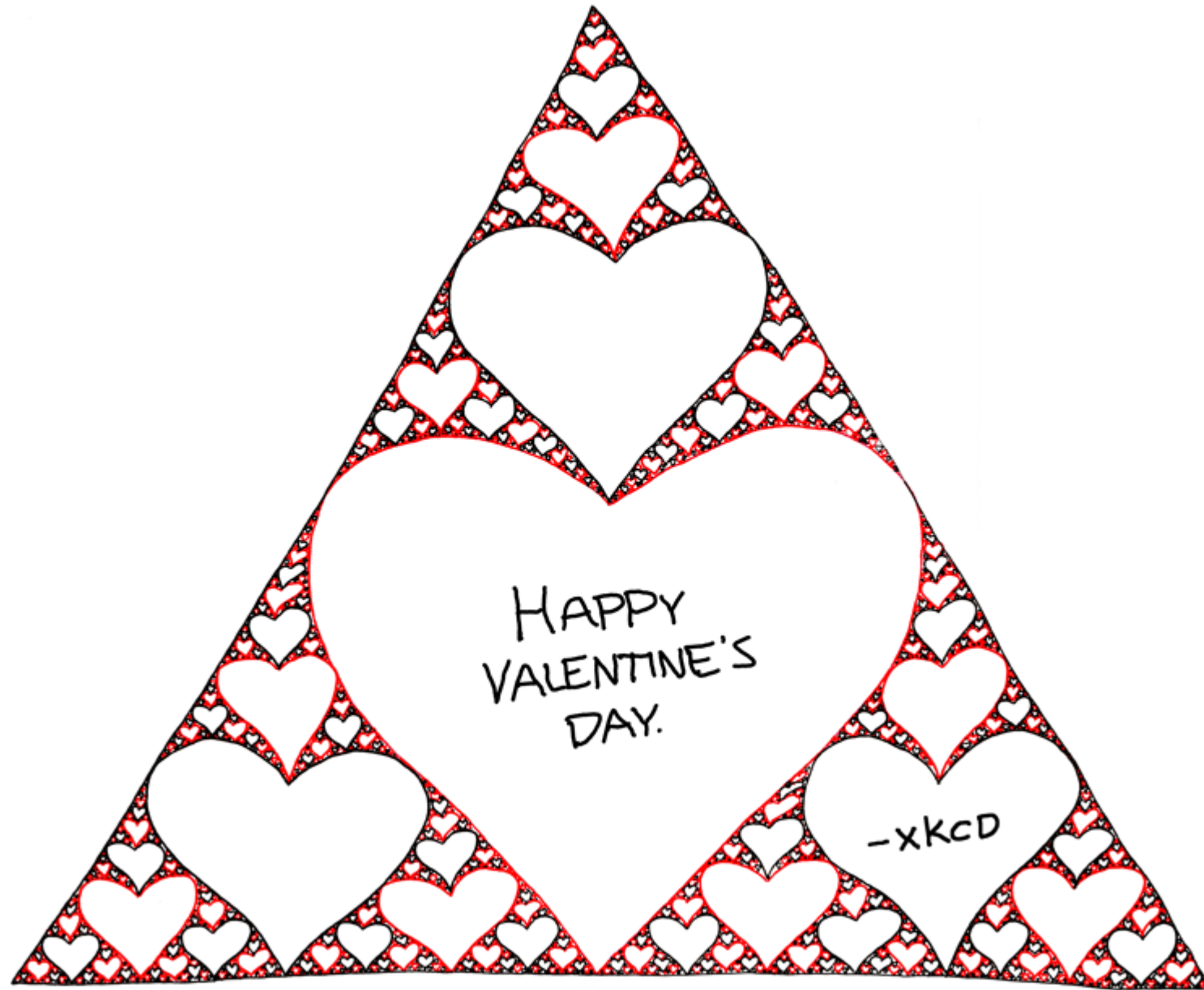
star fractal



peano curve

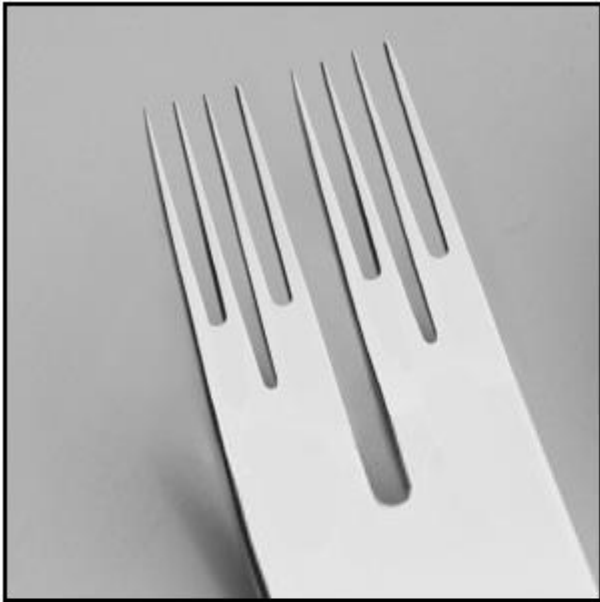


lorenz attractor



HAPPY
VALENTINE'S
DAY.

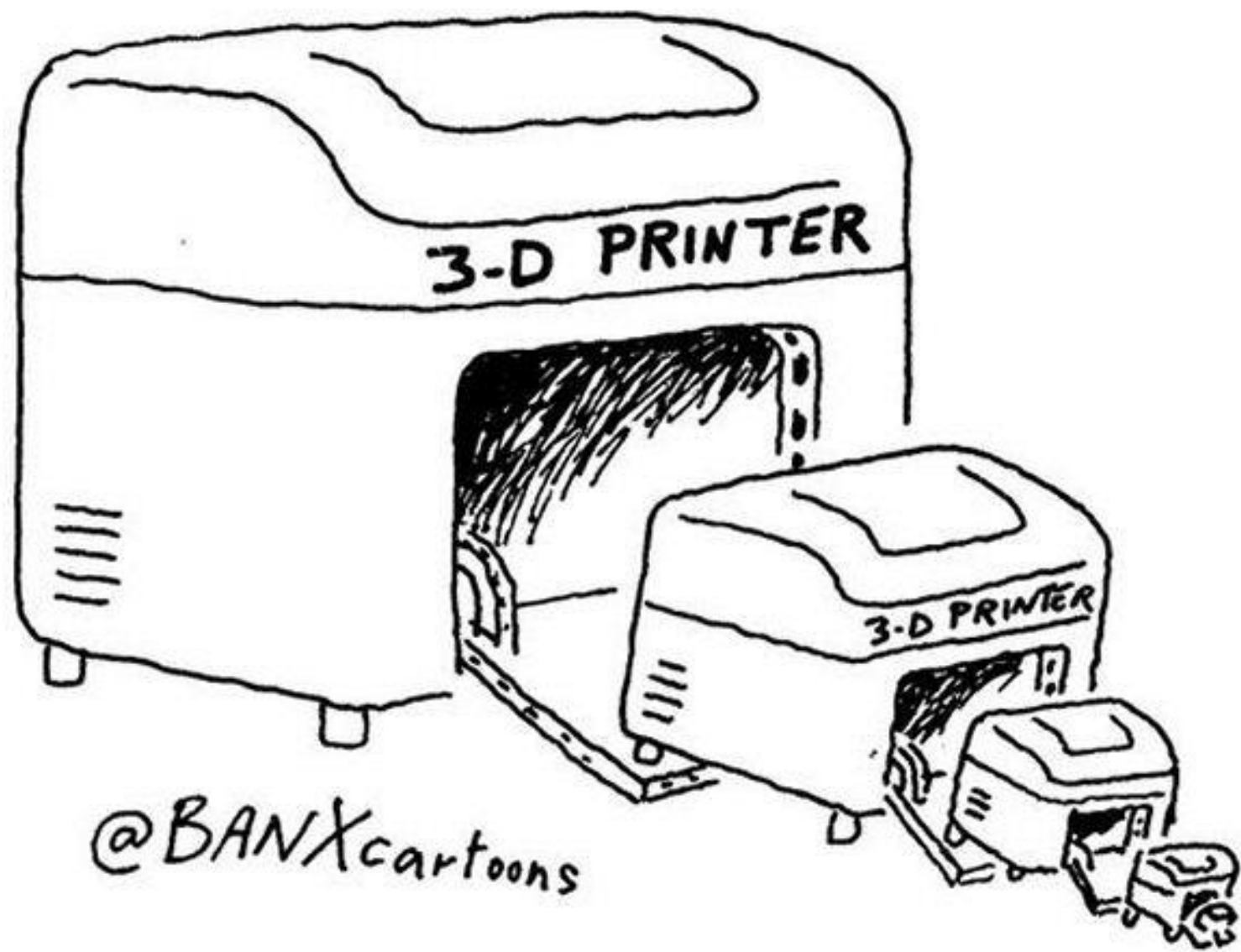
-XKCD



The Infinity Set

A luxurious blend of a vintage style, a modish sleek silhouette and a stainless antibacterial coating.





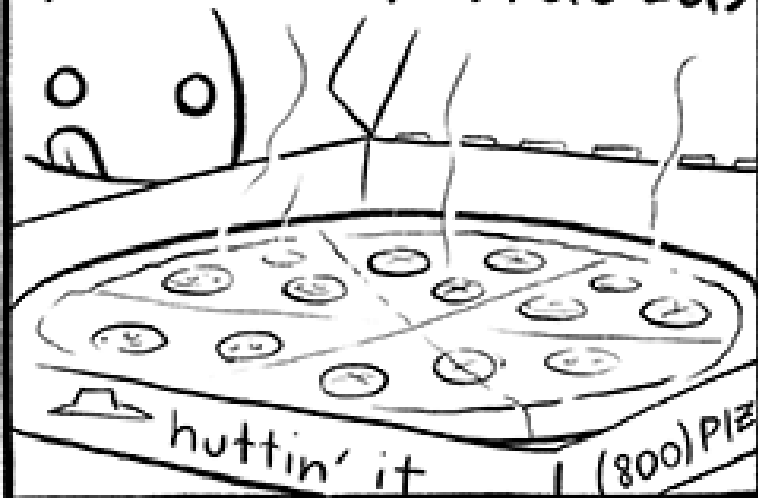
@BANXcartoons



FRACTAL WRONGNESS

You are not just wrong. You are wrong at every conceivable scale of resolution. Zooming in on any part of your worldview finds beliefs exactly as wrong as your entire worldview.

introducing new
pizza hut frac'zas



each pepperoni is
actually another
fully-rendered
pepperoni pizza



chainsawsuit.com

and each of those
pizzas also contain

