Recursive Graphics

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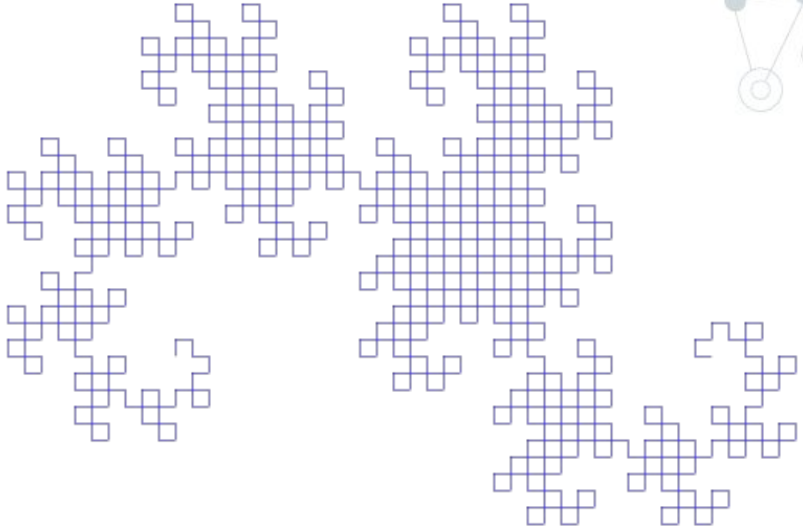
What are Recursive Graphics?

What they are

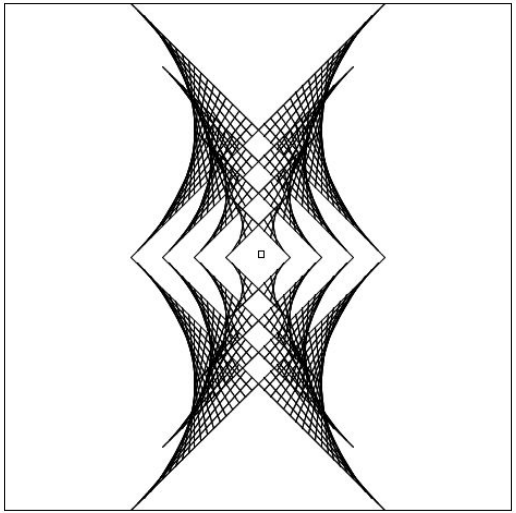
- Recursive graphics are sect of computer graphics using recursion to generate images

- Famous examples include Koch Snowflake and Sierpinski Triangle



How they work

- Apply a set of rules to a shape ie. square, triangle, circle, L-shape
- Repeat them, upscale or downscale the shapes
- Through repeated transformations create complex patterns like fractals



Applications

- Comp graphics and animation
  - Complex shapes and patterns
- Data visualization
  - Appealing and intuitive visual of data
- Video games
  - Generate terrain/landscapes
- Art
  - Fractal patterns/L-systems

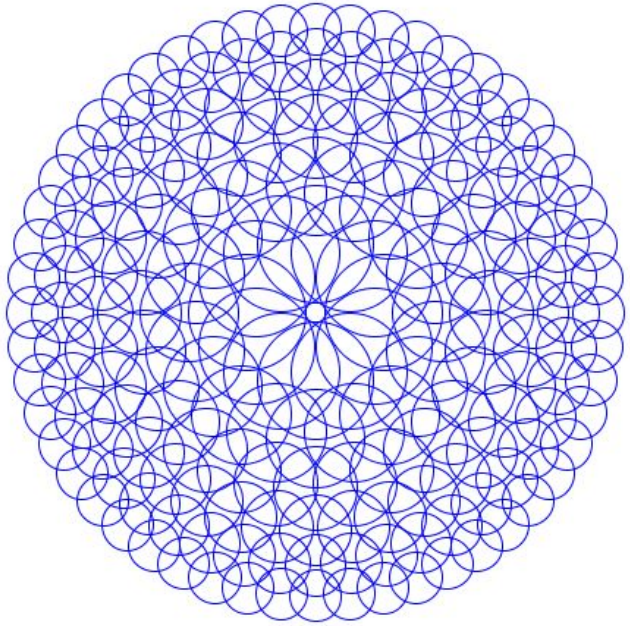
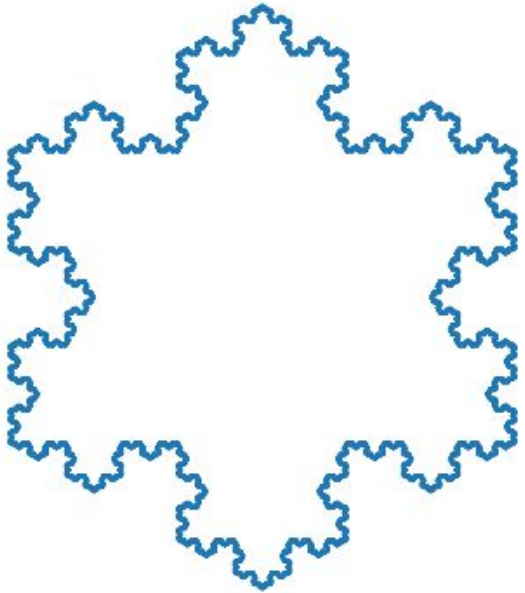


Image from Recursive Graphics Gallery

Our Graphics

Koch Snowflake

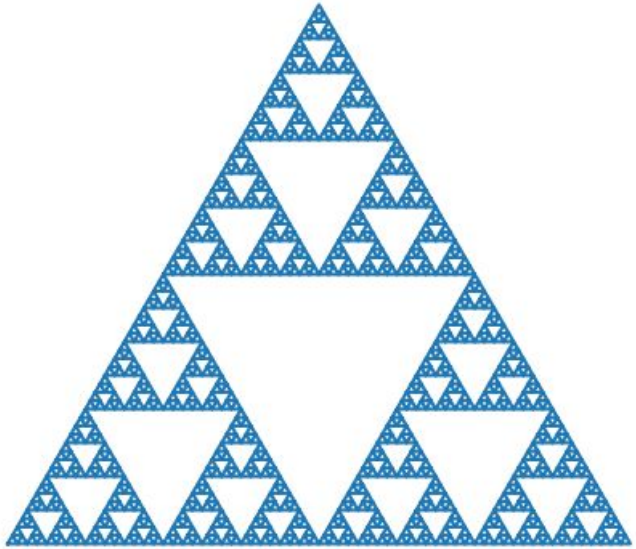
- The Koch Snowflake is named after Swedish Mathematician Helge von Koch
- Fractal involving nested triangles
- Start with a straight line, break it into three parts, and replace the center line with an arch



Sierpinski Triangle

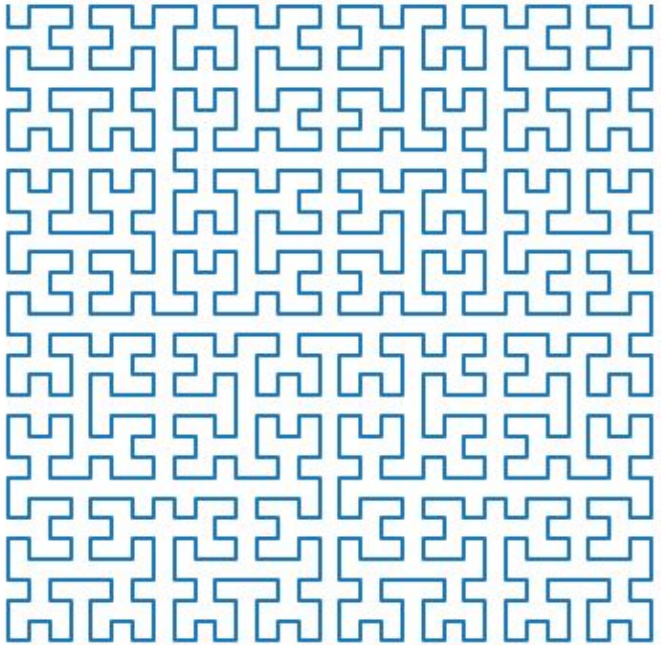
- Named after Polish mathematician Wacław Sierpiński

- Start with an equilateral then divide it into 4 smaller triangles by connecting the midpoints of each side



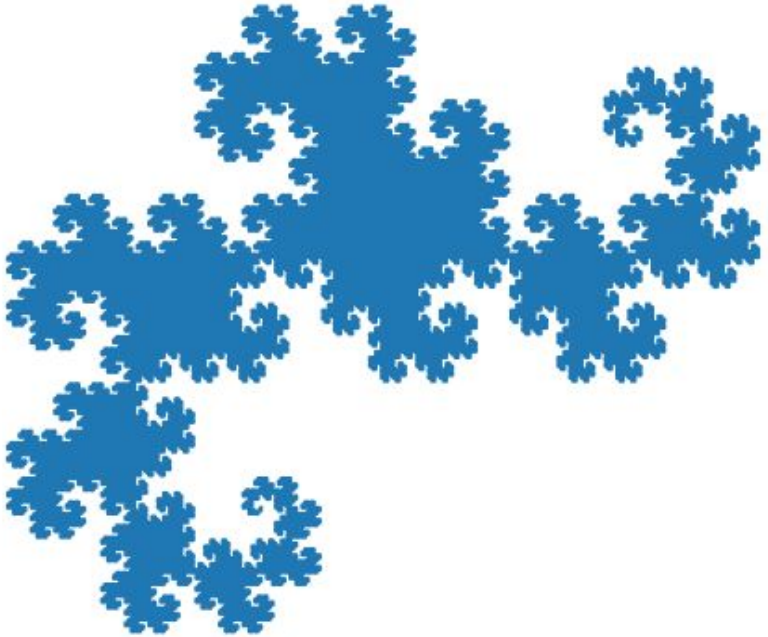
Hilbert Curve

- Continuous fractal space filling curve
- Begins with 3 sides of a square
- Bridges to further empty squares to make the shape displayed



Dragon Curve

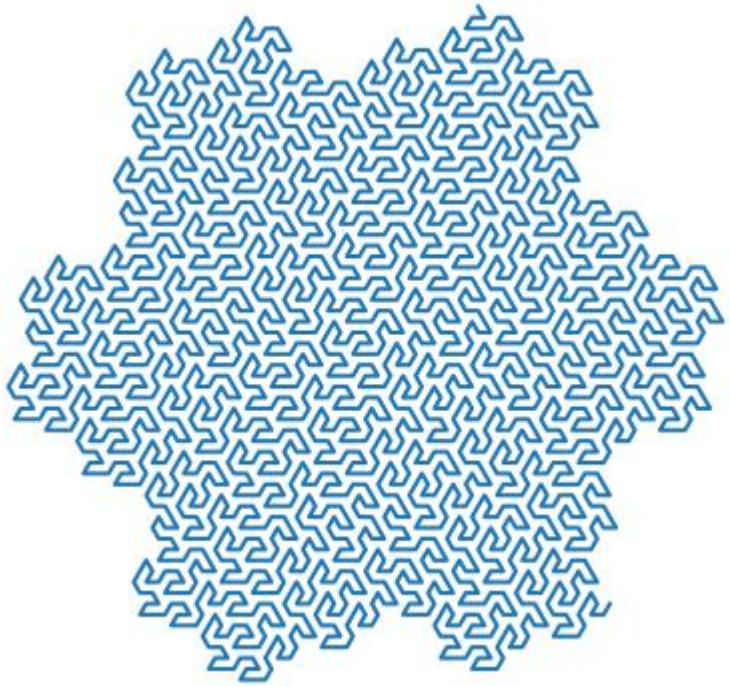
- Member of a family of fractal curves
- Self-replicating, can be scaled to create larger and smaller copies



Peano Gosper

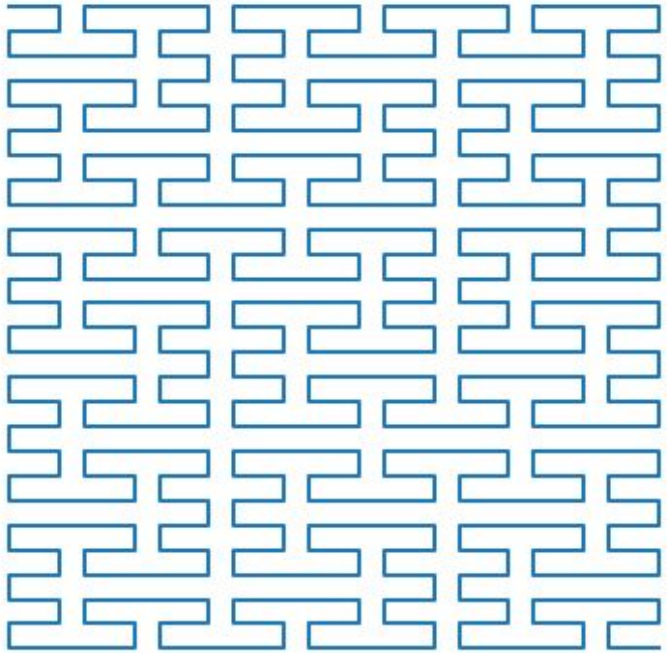
- Another member of the fractal curve family

- From mathematicians Bill Gosper and Giuseppe Peano



Hilbert Curve II

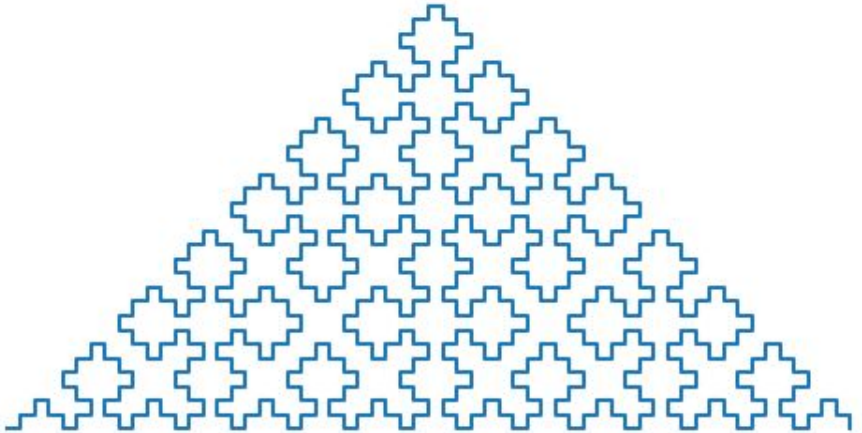
- Variant of the original Hilbert Curve
- Begins with an S instead of a U shape
- Emphasizes the butterfly effect found in fractal geometry



Square Curve

- Bottom left corner of pyramid displays the base case

- Builds off of initial structure with step shape fractals to form a larger overall pyramid shape



Algorithms

L-Systems

Formula used to describe the fractal shape using text.

- Move forward - “F”
- Turn right by specified degree - “+”
- Turn left by specified degree - “-”

Once formula is determined, use recursive function to replace patterns with scaled up versions.

Ex. F-> F+F-F turns into F+F-F+F+F-F-F+F-F by substituting the pattern into each appearance of F.

Our Program

The first few functions defined in our program were created the more difficult way, by reverse engineering the pattern from a manually created correct L-System text file for various orders of magnitude.

For the extra graphics, we found pre-existing L-system formula that we easily substituted into recursive functions, such as the Dragon Curve formula describing the two patterns used:

X-> X+YF+, Y-> -FX-Y

Python Plotter

The python plotting script was created for Lab 6. It takes the L-System text file, and creates a plot via matplotlib by following the instructions embedded within.

A commonly used analogy is the Turtle. He follows the set of rules, dictated by forward motions (F), and turns (+/-) of a specific angle, fed in as a CLA.

Sample CLA's: file.txt image.png <degrees>

Python Coloring Book

As a fun twist we added created a small python program functioning off of the *Pillow* and *tkinter* libraries. By simply running the program it allows you to color in your png after uploading it, an even has the functionality to save.

Our Source Code

Questions