CSC212 Final Project

RECURSIVE GRAPHICS

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TABLE OF CONTENTS

01

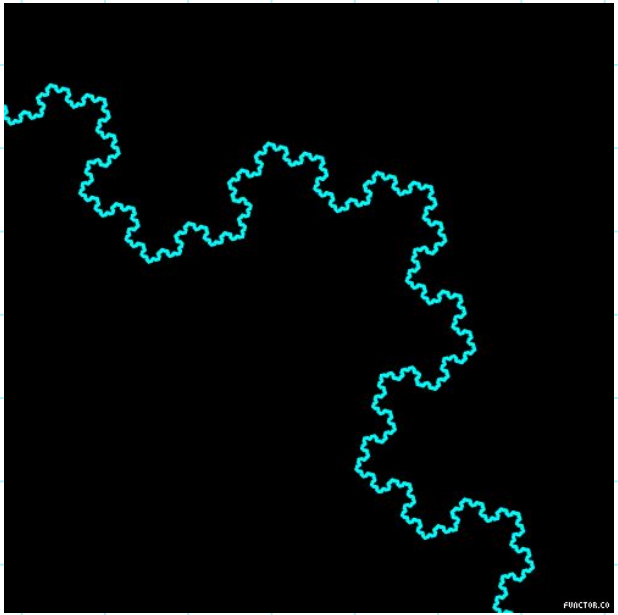
RECURSIVE GRAPHICS

INTRODUCTION

Recursive graphics use simple shapes drawn repeatedly to form complex images. We implemented Sierpinski triangle, Koch Snowflake, and the Hilbert Curve using Python Turtle to visualize and C++ to implement the recursive algorithms.

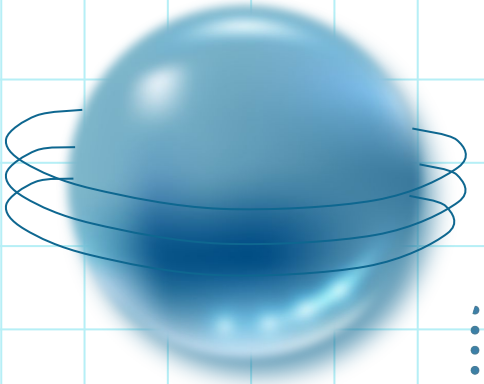
FRACTALS

- Fractals are infinitely complex patterns that repeat a simple process over and over in an ongoing feedback loop, driven by recursion.
- Fractal patterns are prevalent in nature, appearing in various forms such as trees, rivers, and mountains. They can also be generated by computers through simple equations.



02

PYTHON TURTLE

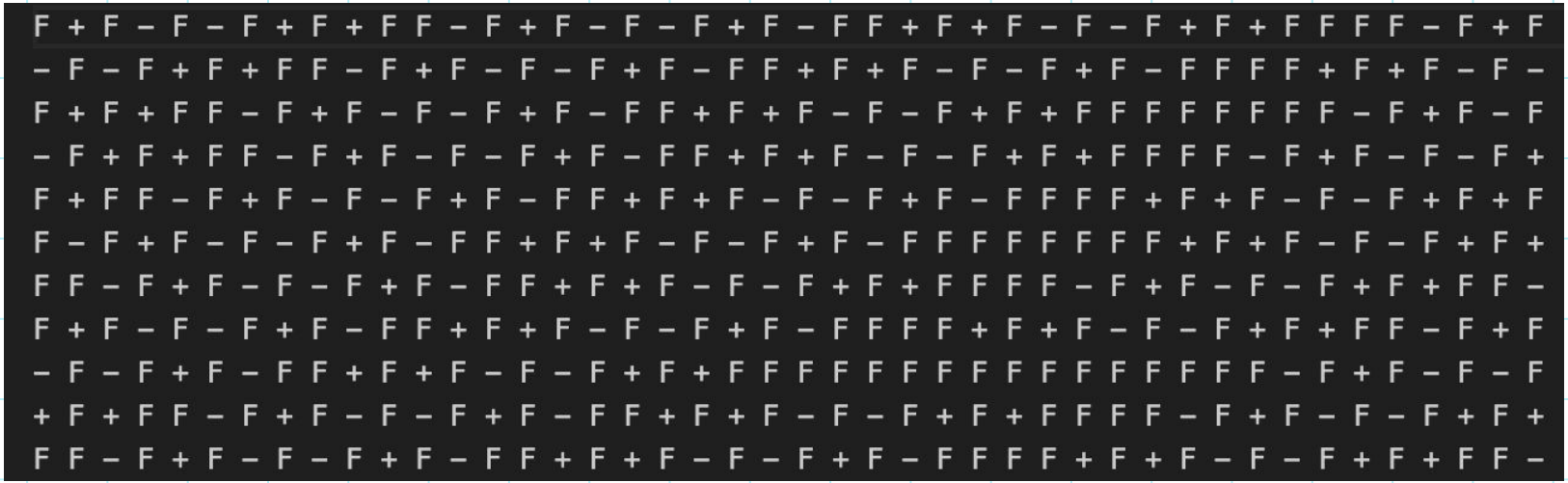


L-SYSTEM INSTRUCTIONS

F	Draw a line and move forward
+	Turn right
-	Turn left

- These instructions are used by the Python turtle in order to draw each graphic

AN EXAMPLE OF L-SYSTEMS



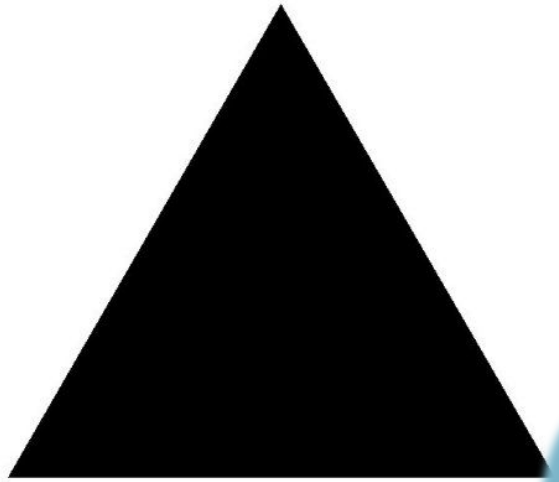
- This is the first 60 characters of the l-systems.txt file used to command the python turtle in order to draw a Sierpinski Triangle

03

SIERPINSKI TRIANGLE

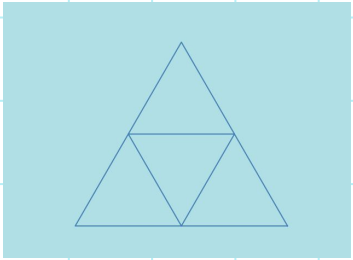
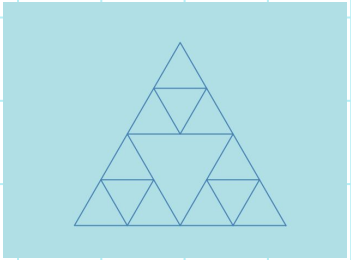
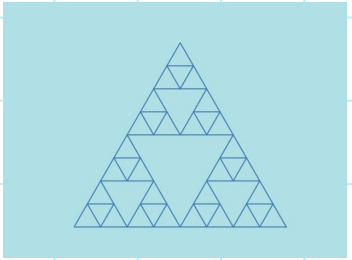
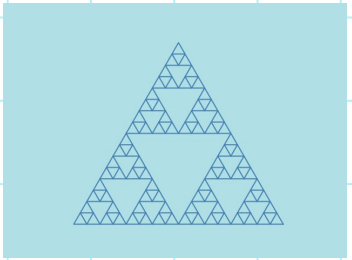
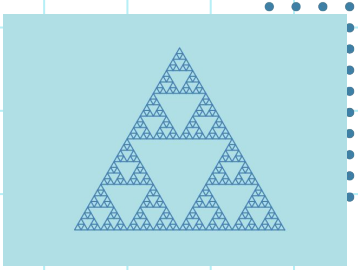
SIERPINSKI TRIANGLE

- Named after the Polish mathematician Wacław Sierpiński
- Constructed by recursively dividing an equilateral triangle into smaller equilateral triangles and removing the central triangle at each iteration.
- The result is a self-replicating pattern with intricate triangular voids.



SIERPINSKI TRIANGLE ITERATIONS

LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 | LEVEL 5

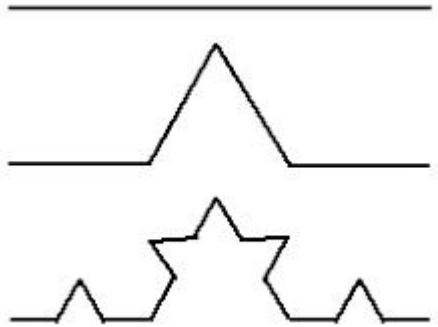






04

KOCH SNOWFLAKE

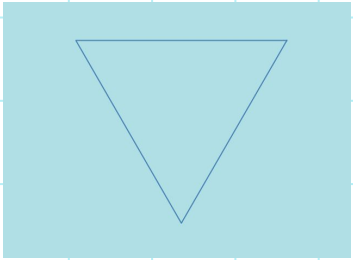
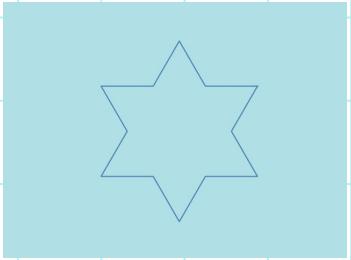
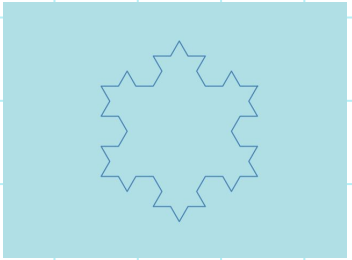
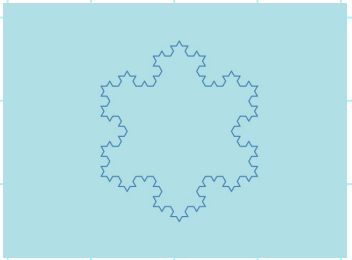
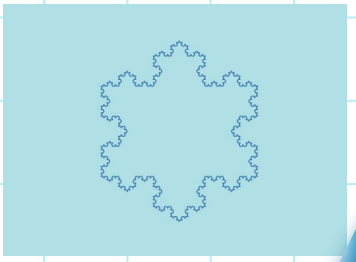
KOCH SNOWFLAKE

- Created by Niels Fabian Helge von Koch; one of the first fractals to be described
- Shape begins as an equilateral triangle and gets more complex as smaller equilateral triangles are added to the edges
- Made up of three Koch Curves.



KOCH SNOWFLAKE ITERATIONS

LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 | LEVEL 5

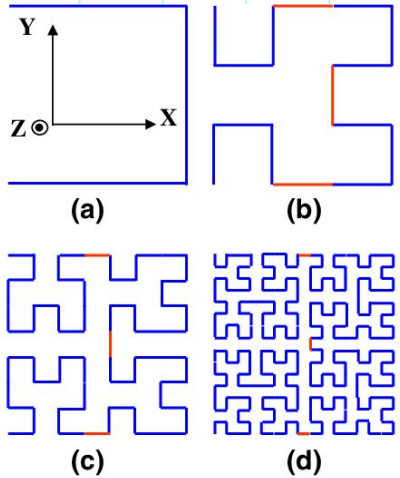






05

HILBERT CURVE

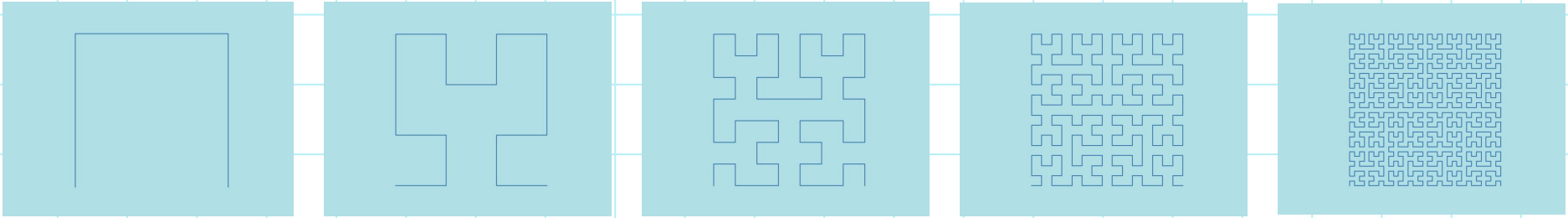
HILBERT'S CURVE

- Originally proposed by David Hilbert in 1891
- Constructed using a recursive algorithm, where the curve at each level is built by connecting straight lines and making 90-degree turns.
- Known for its space-filling properties, and the code effectively generates a curve that covers a 2x2 square, filling it progressively with each level of recursion.
- Way to determine the size of m x m matrix is $m = 2^n$, where n is the number of levels
- The angle parameter plays a crucial role in shaping the curve, and the code manages these parameters to ensure proper turns and connections.
    - Takes in both positive and negative angles



HILBERT CURVE ITERATIONS

LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 | LEVEL 5



06

CONCLUSION