Course: CS30A1570 Complex Systems

Assignment 3: Fractals

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**Title:**

**Abstract**

**Introduction**

**Research Question**

**Task 1: Design your own fractal, different from the ones described in the videos and quizzes. Compute the fractal dimension of your fractal.**

For this task, the Sierpinski Carpet Fractal is modelled in Python using the turtle graphics module (Attachment 1: sierpinski\_carpet\_fractal,py, Appendix: Image 1, ). The Sierpinski Carpet is a plane fractal first described by Wacław Sierpiński in 1916 (Reference 1). The Sierpinski Carpet is a fractal that results from subdividing a square into 9 equal parts and removing the central one, then recursively repeating the process for the remaining parts.

The fractal dimension of the Sierpinski Carpet can be calculated using the formula: *D = log(N )/log(S)* *where, N is the number of self-similar pieces, and S is the scale factor.*

For a Sierpinski Carpet having N = 8 (each square is divided into eight new squares) and S = 3 (each new square is 1/3 the length of the original), the fractal dimension D = log(8) / log(3) = 1.89

This means that the Sierpinski Carpet is roughly 1.89-dimensional. It’s more than a 1-dimensional line but less than a 2-dimensional shape. This is a characteristic of fractals - they can have non-integer dimensions.

**What are the optimal parameter settings for box counting, including initial box length and increment, to obtain the most accurate approximation of the Hausdorff dimension for the Koch curve and Cantor Set fractals? Additionally, how does increasing the iteration levels of the fractals affect the accuracy of the Hausdorff dimension approximation? Finally, which settings yield the closest approximation to the published fractal dimension of the coastline of Great Britain using box counting applied to the coastline image?**

**Task 2: How does the box-counting dimension of the variation on the Koch curve, where each segment is replaced by five segments of 1/3 the original length, compare with its Hausdorff dimension? Additionally, what modifications are necessary to implement this variation in the provided NetLogo code for box counting and how do the results differ from the original Koch curve?**

**Task 3: Implement a NetLogo model that allows users to generate, iterate, and draw a fractal that has not been implemented before (any fractal).**

**Discussion**

**Conclusion**

**References**

1. <https://www.geeksforgeeks.org/python-sierpinski-carpet/>

**Attachments**

**Appendices**

Image 1: Sierpinski Carpet Fractal

A green and white square with white squares

Description automatically generated