

Introduction to Complexity

Unit 3 Homework

(optional)

You can choose whether you want to do the Beginner, Intermediate, or Advanced level. You are free to discuss this part of the homework with anyone, or to ask questions about it on the course forum. Not that homework in this course is not turned in or graded.

Beginner Level:

1. Design your own fractal (on paper), different from the ones described in the videos and quizzes. If possible, compute the fractal dimension of your fractal. If you come up with an interesting fractal, feel free to share it on the Course Forum.

2. If you didn't do Exercise 1 in Unit 3.5, do this one: Download BoxCountingDimension.nlogo from the Course Materials page.

- Set initial box length to 5 and increment to 0.5.
- Iterate the Koch curve to four levels.
- Run box counting on this curve for about 15 iterations, and find the best-fit line for the points (using the button on the right-hand side). Record the Box Counting Dimension you obtain.

Repeat this procedure for initial box length 10 and initial box length 20. (Remember to reset and iterate the Koch curve before running box-counting. Which parameter setting gives the best approximation to the Hausdorff dimension?

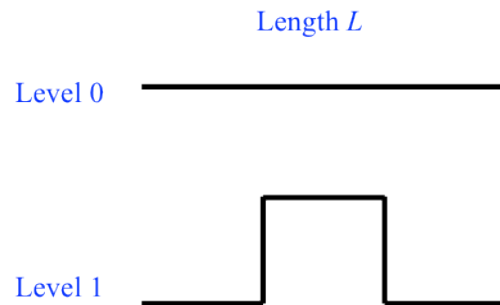
3. Repeat Question 2, but this time iterate the Koch curve to six levels. Do you get a better or worse approximation to the Hausdorff dimension?

4. Repeat Questions 2 and 3, but for the Cantor Set fractal.

5. Download BoxCountingApplied.zip. Unzip the file, and open BoxCountingApplied.nlogo. Open the "coastline" picture. Try a few settings of initial box length and increment, running box-counting for 15 iterations. Which of these settings gives the best approximation to the published value of the fractal dimension for the coastline of Great Britain (~1.26)?

Intermediate Level:

Consider a variation on the Koch curve. Start with a line segment of length L . The iteration rule is illustrated below, where each segment is replaced by five segments, each of length $1/3$ the original segment.



1. Download KochCurve.nlogo from the Course Materials page. Modify the code to iterate the fractal above.
2. Download BoxCounting.nlogo from the Course Materials page. Modify the code to include this fractal, and compare the results from computing its box-counting dimension with its Hausdorff dimension.

Advanced Level:

1. Read one or more articles or web pages about L-Systems, which give a method for generating fractals. Implement a NetLogo model that allows users to input an L-system string, and which will then iterate the L-system to draw the fractal specified by the input string. (Try to do this without first looking at the existing L-System model in the NetLogo models library.)

Here is a website about L-systems:

<http://www.cs.unm.edu/~joel/PaperFoldingFractal/L-system-rules.html>

2. Read one or more articles or web pages about Iterated Function Systems, which give a very general method for generating fractals. Implement a NetLogo model that uses iterated function systems to create the fractals shown in this unit.

Some links to websites about iterated function systems:

<http://www.susqu.edu/brakke/ifs/>

<http://ecademy.agnesscott.edu/~lriddle/ifs/ifs.htm>

<http://www.stsci.edu/~lbradley/seminar/ifs.html>

<http://classes.yale.edu/fractals/introfrac/IFS/IFS.html>