Introduction to Complexity

Homework 3

Graded Part: This part you will submit on the course webpage, by doing the exercises, and then clicking on the "Homework 3" link in Unit 3.7, filling out the answers, and then clicking on the "Submit" button at the bottom of the page.

1. Suppose the initial (level 0) line segment in the Koch curve is 3 centimeters. What is the length in centimeters of the Koch curve at level 3?

A. 16 / 3

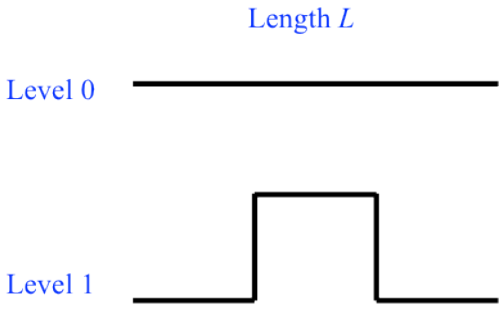
B. 16 / 27

C. 64 / 27

D. 64 / 9

E. 27 / 3

2. 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.



What is the length of this curve at level 2 ?

A. (25 / 9) L

B. (10 / 6) L

C. (9 / 5) L

D. (16 / 9) L

E. (10 / 9) L

3. What is the length of the fractal in question 2 at level *N* ?

A. $(4 / 3)^N$ L

B. $(5 / 3)^N$ L

C. $(6 / 3)^N$ L

D. (5 N / 3) L

E. $(3 / 5)^N$ L

4. What is the fractal (Hausdorff) dimension of the fractal in question 2?

A. log 4 / log 3

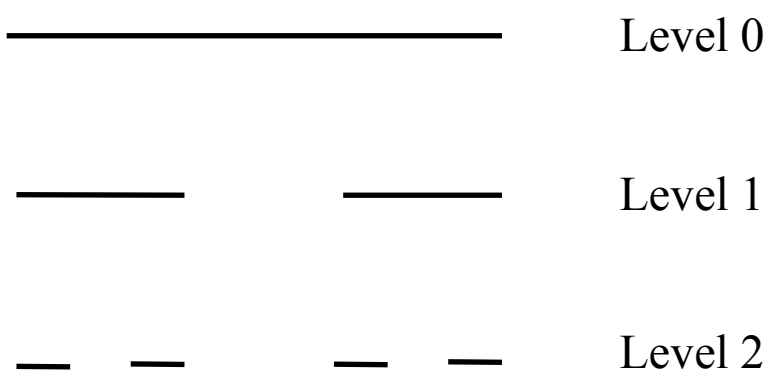
B. log 3 / log 4

C. log 5 / log 3

D. log 5 / log 4

E. log (4 / 3)

5. Consider the Cantor Set, a fractal that is formed by starting with a line segment of length *L*, and at each level, the middle third of that line segment is erased (and not replaced by anything!). Here is a picture of this process:



What is the length of the Cantor set (i.e., the sum of the length of the segments) at level *N*?

A. $(1 / 3)^N$ *L*

B. $(3 / 2)^N L$

C. $(4 / 3)^N L$

D. $(2 / 5)^N L$

E. $(2 / 3)^N L$

6. What is the fractal (Hausdorff) dimension of the Cantor set?

A. log 3 / log 2

B. log 2 / log 3

C. log 2 / log 4

D. log (2/3)

E. log (3/2)

Ungraded Part:

Beginner option:

Download BoxCountingDimension.nlogo from the Course Materials page. Run box counting, for several iterations, on each of the four different fractal examples (cantor-dust, Koch-curve, sierpinski-triangle, dragon-curve). How well does the box-counting dimension approximate the Hausdorff dimension? Does increasing the number of box-counting iterations increase the accuracy of the approximation?

Intermediate/Advanced option:

Download KochCurve.nlogo from the Course Materials page. Modify the code to produce (1) the fractal described in question 2 above; (2) the Cantor set, described in question 5 above; (3) the Sierpinski triangle.