Exploring Fractals

BMC Advanced Spring 2020

April 1, 2020

"Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line."

— Benoît Mandelbrot

In this class, we are going to break the rules of traditional Euclidian Geometry with new ways of thinking about mathematics using Fractal Geometry and Chaos Theory. You are all encouraged, as Steve Jobs said, to "Think Different."

Assignment 1: Watch the "Think Different" video and name the folks you might recognize. Then choose one and explain how they thought differently and what contributions they made in two sentences. You can also choose someone else who thought differently.

Exploring Fractals

Read Chapter

Chapter 1 Fractals in our World

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Assignment 2: Forest Fire Game

See how percolated fractal structures help to control forest fires. With the forest fire game, you explore the spread of fires through two forests, each with different densities. The densities represent different fractal dimensions. By starting identical fires randomly in each forest graph, you compare the rate at which the fires spread.

A.

See how percolated fractal structures help to control forest fires. With the forest fire game, you explore the spread of fires through two forests, each with different densities. The densities represent different fractal dimensions. By starting identical fires randomly in each forest graph, you compare the rate at which the fires spread.

1. Get a 4-sheets of graph paper a 6-sided dice.
2. Create 4 "forest" boxes of 6 x 6 squares on each page.
3. Then populate the squares of 6 x 6 boxes with "X" using different patterns and densities. Make sure at least one is random, and one has a geometrical density.
4. Then roll the dice to see which of the 36-grid squares get hit—the first roll for the row (1-6) and the second for coulomb (1-6).
5. The lightning burns down any of the (X) trees in the grid-square and any square that touches the side box side of any (X) box tree. Then if any adjacent (X) tree is touching on the side, it burns down too. Continue the process until all touching (X) trees connected to the original grid-box burns down. Do this for every sheet, recording the process 5-times. Record how many spaces, how many trees and, how many trees burnt down.

Example:

Roll	1	2	3	4	5	6
1	X		X			X
2		X			X	
3	X	X			X	
4			X	X	X	
5	X					
6		X		X		X

B. Can you see any optimal patterns or densities emerging assuming with the ideal is to have as many unburnt trees as you can after a fire? These ratios correspond to Hausdorff dimension (a.k.a. fractal dimension). Show your outcomes and do a brief analysis of your results.

C. Can you a see how else this may relate to other topics (maybe virus transmission)? List a few.

Extra credit:
Describe the parameters you need to set up such a system and model its implementation.

Extra-extra credit: Do the same problem with a finer grid or write a computer program to simulate the process.

1. Get a 4-sheets of graph paper a 6-sided dice.
2. Create 4 "forest" boxes of 30 x 30 squares on each page.
3. Then populate the squares of 30 x 30 boxes with "X" using different patterns and densities. Make sure at least one is random, and one has a geometrical density.
4. Now lay a 6 x 6 grid of 5 x 5 boxes on top of each forest. This will designate the lightning strike area.
5. Then roll the dice to see which of the 36-grid squares get hit- the first roll for the row (1-6) and the second for coulomb (1-6).
6. The lightning burns down any of the (X) trees in the grid-square and any square that touches the side box side of any (X) box tree. Then if any adjacent (X) tree is touching on the side, it burns down too. Continue the process until all touching (X) trees connected to the original grid-box burn down. Do this on every grid, record the process 5-times. Then count how many spaces, how many trees and, how many burnt down.
7. If you want to get more granular, you can roll the dice again to divide the grid square by 5 x 5, using 1-5 values and disregarding 6.

Note: National Parks often let naturally occurring fires burn to help clear out the underbrush and prevent larger fires from occurring.

Chapter 2 Fractals Basic – Taking a Closer Look

Assignment 3: Chaos Game

1. Draw three dots on your page.
2. First chose a starting point.
3. Then randomly go halfway to one of the 3 dots and draw a point.
4. Then from that point, go randomly halfway to one of the three dots again.
5. Continue the same process until an image emerges.
6. What does it look like?

Extra credit: what is the name of the fractal that emerges?

Now create four different images using the Chaos Game .

Resources:

Video

Fractals- The Hidden Dimension

Fractals to Fashion

Software

Fractasketch Manual

Next week

Read Chapter 3 – Creating Classical Fractals

I will try to have a link to Fractasketch so you can download the program. Currently, it only runs on the Macintosh.

Also, I will try to have my TedX talk slides available too.

1. Draw three dots on your page.
2. Chose a starting point.
3. Then randomly go halfway to one of the 3 dots and draw a point.
4. The from that point go randomly halfway to one of the three dots again.
5. Continue the same process until an image emerges.
6. What does it look like?
7. Extra credit: what is the name of the fractal that emerges?