Exploring Complexity

In Science and Technology

Oct. 25, 2010

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Logistics

- Due this Wed
  - HW4 due in class
  - Lab3 (Fractals) due on Blackboard (if possible)
- Questions?
- Go over HW2
- Not starting Evolution in Computers and Genetic Algorithms until Wed
- Funds to rebuild Babbage's analytical engine using all original parts; brass and steam-powered. http://www.pledgebank.com/babbage
- Math colloquium on fractals
  - http://www.mth.pdx.edu/events/colloquium.asp?id=243

Accolades for Melanie Mitchell's Complexity Text

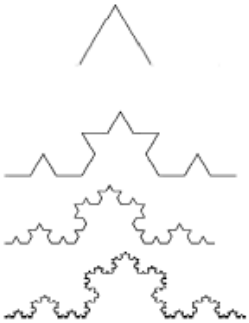
- Phi Beta Kappa Science Book Award
- Amazon.com: ten best science books of 2009
- Royal Society 2010 Prize for Science Books Longlist

Back to Information Theory

- What does "average bit per symbol" mean?
- Binary numbers
- What does it mean that the H for these frequencies is 2.186 bits / symbol?
- Huffman Algorithm for encoding

Symbol	**A**	**B**	**C**	**D**	**E**
Count	15	7	6	6	5
Probabilities	0.38461538	0.17948718	0.15384615	0.15384615	0.12820513

Review Fractals: Koch curve



- How long is it?
- What is its dimension?

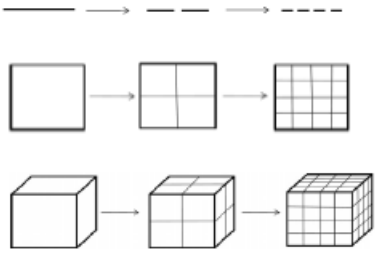
Definition of dimension

- Generalized definition of dimension:
- Let M be the magnification factor of side to get from level n+1 to level n.
- Let N be the number of copies at level n+1 of each object in level n.
- Then

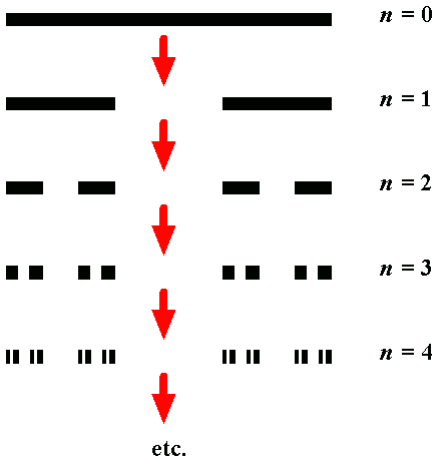
$$M^{Dimension} = N$$

or

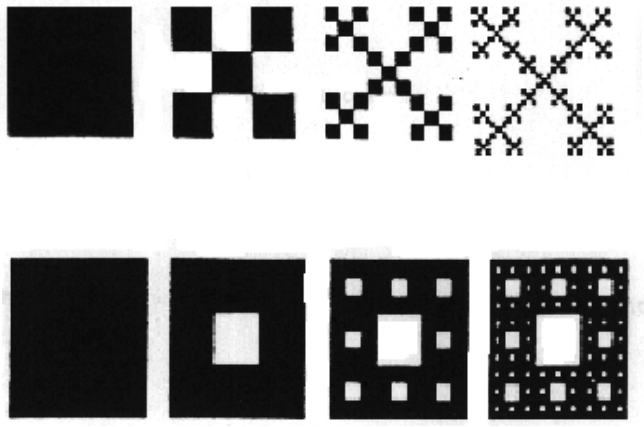
$$Dimension = \log N / \log M$$



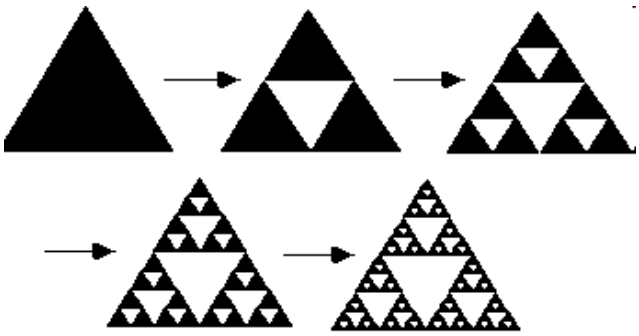
Fractal dimension of Cantor set



Fractal dimension of box fractals



Fractal dimension of Sierpinski triangle



- An Exercise!
- Algorithm for building up

L systems (Aristid Lindenmayer)

- Grammars for generating fractals (and other shapes)
- Need “axiom” and “grammar rules”
- Alphabet for rules: {F,f,+, −}
  - − Turn counterclockwise by a specified angle q
  - \+ Turn clockwise by a specified angle q
  - F Move forward one step while drawing a line
  - f Move forward one step without drawing a line

Example 1: Cantor middle thirds set

- **axiom:**
  - **S = F**
- **rules:**
  - **F ➔FfF**
  - **f ➔ fff**

F FfF FfFfffFfF

Example 2: Koch curve

- **axiom:**
  - **S = F**
- **rules:**

  F ➔F − F++F − F (where F is 1/3 as long)

  + ➔ +

  − ➔ −
- **q = 60 degrees**

Your Fractal In NetLogo

- Do L-System first
- Using code that is there—with minimum changes
- Use building blocks provided
- How to make a button and hook it to a procedure