Chaos, Fractals, and the Arts

Ralph Abraham
www.ralph-abraham.org/courses/porter34b14

Porter College 34B, UCSC
Spring 2014

Meeting #3, April 24

- Comments

- A. Art history

- B. Basic chaos theory

- C. Computer programming

Comments

- Return Quiz #1, comment

- Homework #2, comment

- Browse fractal-notes.org

- Project demo #3

Satchmo

A. Art History

- Complexity measures: FD, LE, IE

- FD and aesthetic judgement (Pickover, 1990)

- IE and bifurcation (MS#133)

Complexity measures

- FD: Fractal Dimension (for B&W images)

- LE: Lyapounov Exponent (for dyn systems)

- IE: Image Entropy (for monochrome images)

Fractal dimensions in nature (Taylor, 2002)

Natural pattern	Fractal dimension	Source
Coastlines:		
South Africa, Australia, Britain	1.05-1.25	Mandelbrot
Norway	1.52	Feder
Galaxies (modeled)	1.23	Mandelbrot
Cracks in ductile materials	1.25	Louis et al.
Geothermal rock patterns	1.25-1.55	Campbel
Woody plants and trees	1.28-1.90	Morse et al.
Waves	1.3	Werner
Clouds	1.30-1.33	Lovejoy
Sea Anemone	1.6	Burrough
Cracks in non-ductile materials	1.68	Skejltorp
Snowflakes (modelled)	1.7	Nittman et al.
Retinal blood vessels	1.7	Family et al.
Bacteria growth pattern	1.7	Matsushita et al.
Electrical discharges	1.75	Niemyer et al.
Mineral patterns	1.78	Chopard et al.

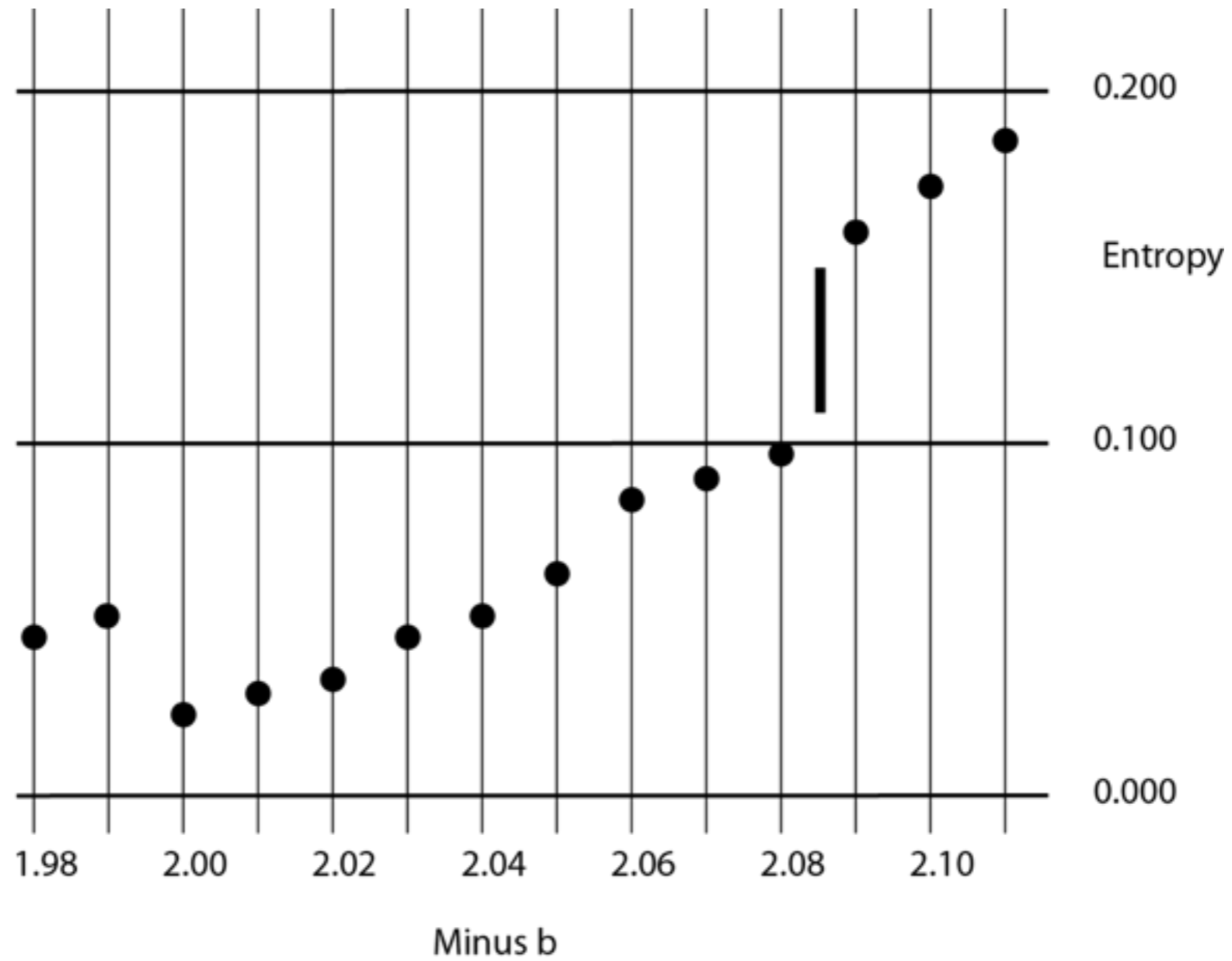**Table 1**. D values for various natural fractal patterns

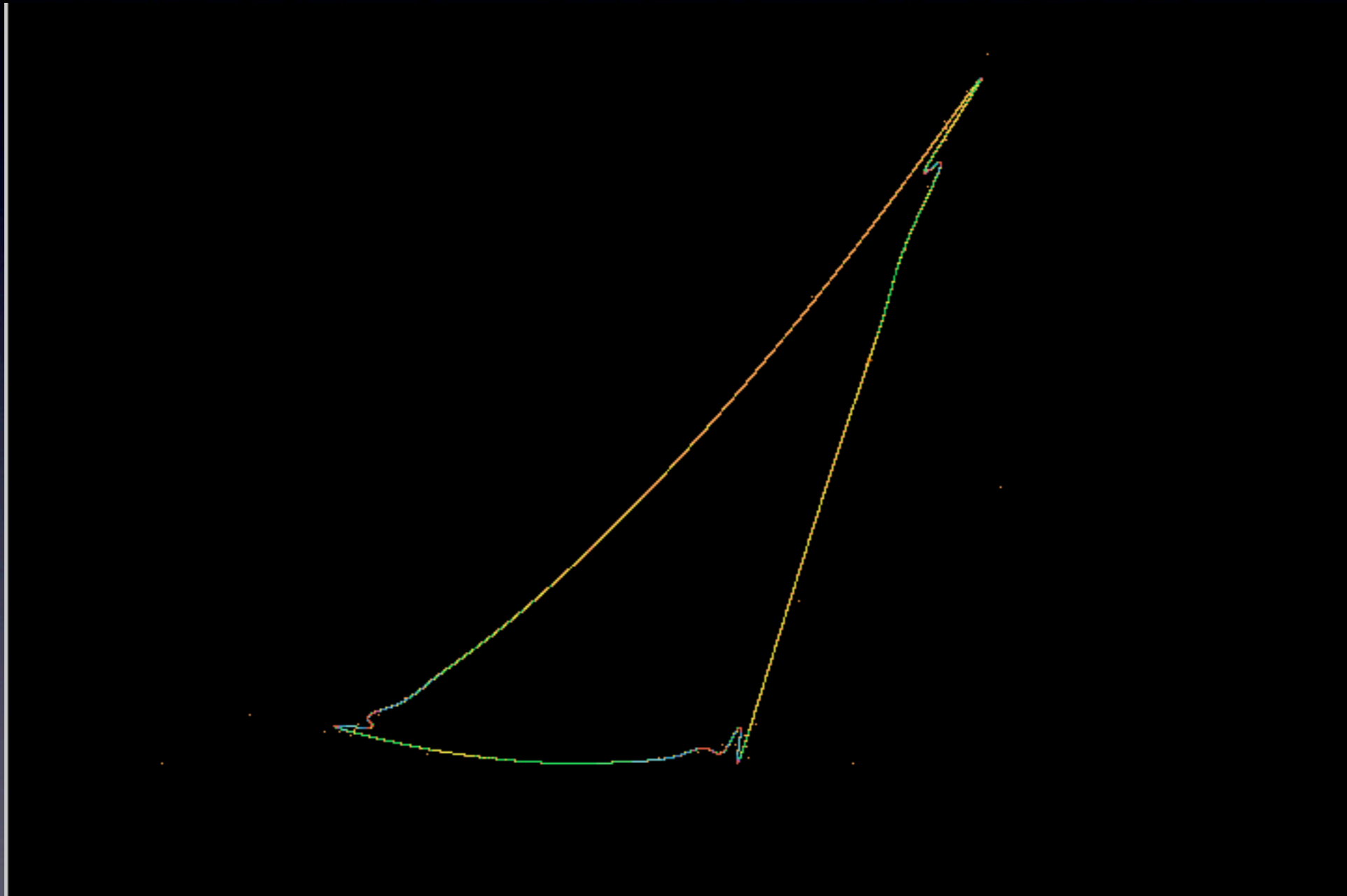Fractal dimensions in computer graphics (Pickover, 1995; p. 48)
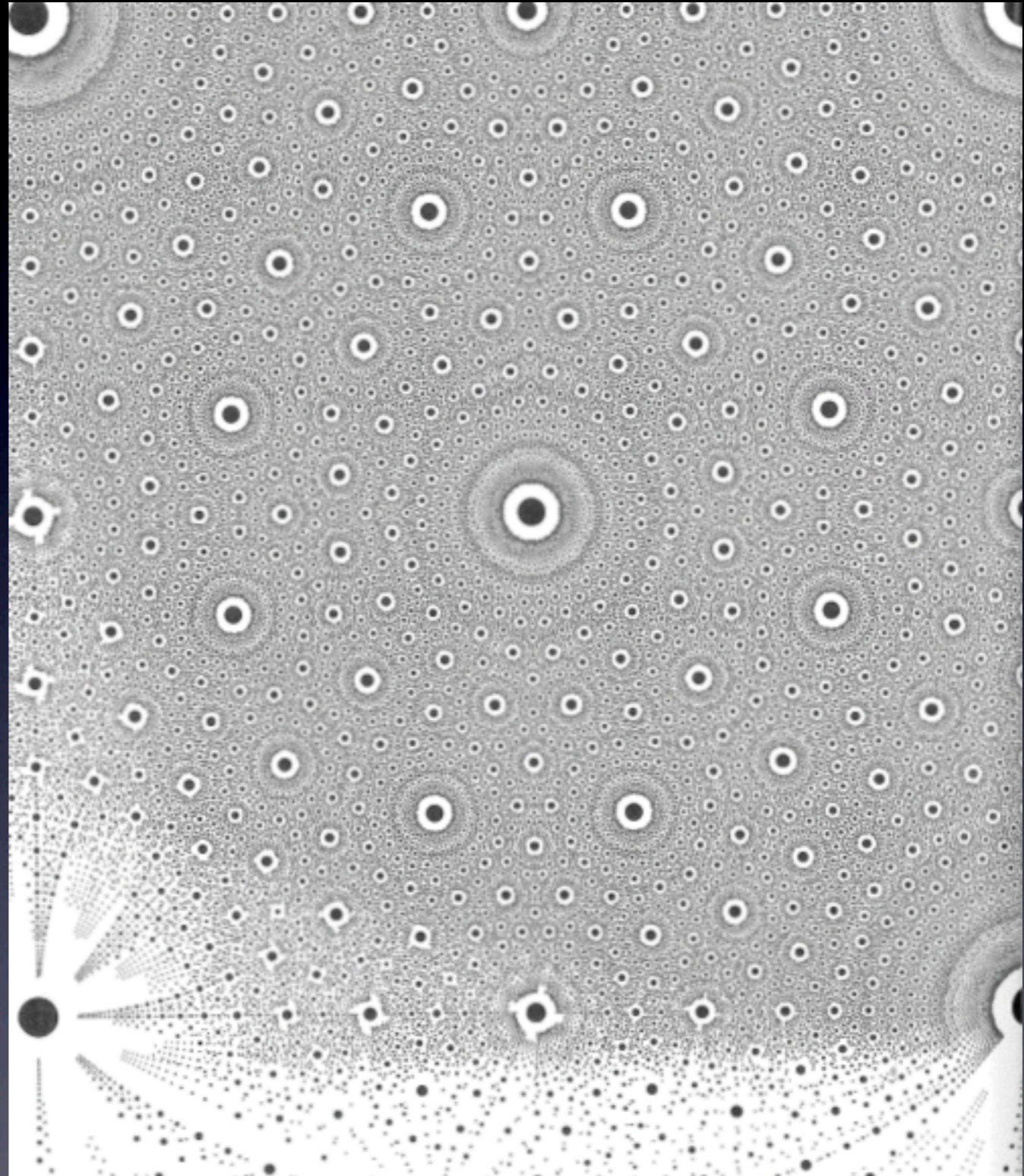
Image entropy of chaotic attractors
MS#133, Fig. 3

Image entropy of chaotic attractors
JPX Fig, 6-23 (before bifurcation)

Image entropy of chaotic attractors
JPX Fig, 6-28,
http://www.vismath.org/fractal-notes/Videos/mira2D/mira-628-long-MD.html
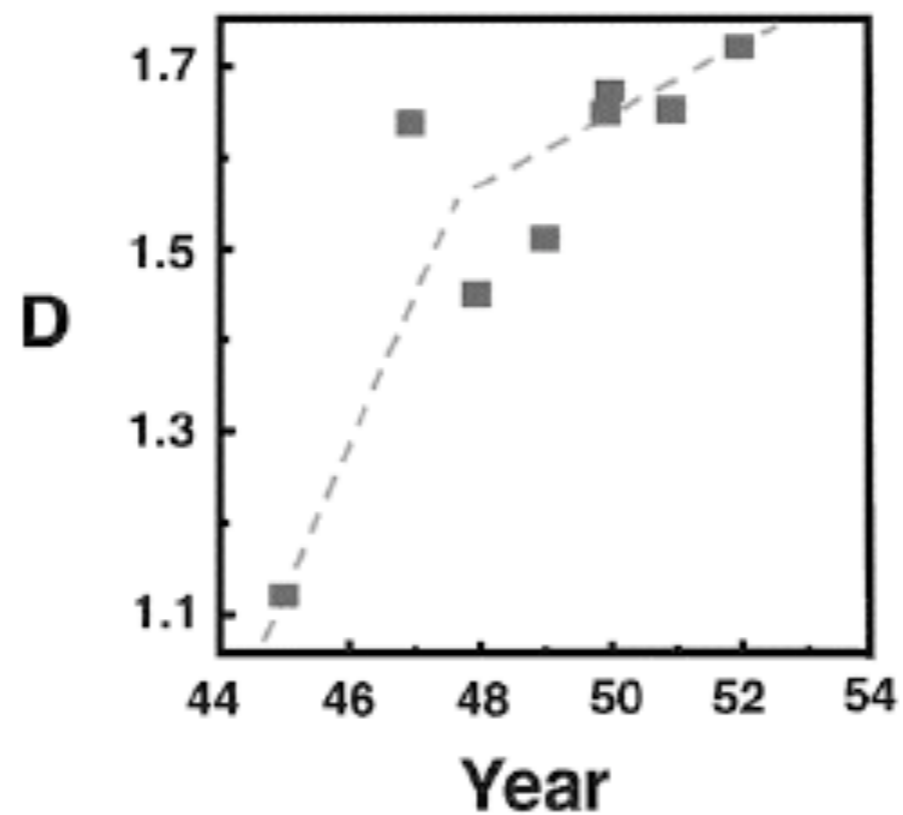
B. Basic Chaos Theory

- FD vs aesthetic judgement
  (for chaotic attractors)

  - Aks and Sprott, 1996

  - Draves et al, 2006

  - FD and Jackson Pollack
    (Taylor et al, 1999)

Jackson Pollack, Lavender Mist (1950)

Pollack FD vs time (Taylor, 20052 fig. 3)

Figure Three. The fractal dimension D of Pollock paintings plotted against the year in which they were painted (1944 to 1954). See text for details.

C. Computer Programming

- Dissect play-image model

- Dissect play-movie model

References for #2

See course website for details:
www.ralph-abraham.org/courses/porter34b14/refs-2014.html

- The visual complexity of Pollack's dripped fractals, R.P. Taylor (2002)
  pages.uoregon.edu/msiuo/taylor/art/TaylorICCS2002.pdf

- MS#120, Electric sheep (2006)

- MS#133, Image entropy (2011)

Porter 34B 2014 Meeting #2

The End