

Emergence lec 16 2011

Fractals \leftrightarrow chaos.

Mandelbrot set.

Logistic map.

Julia Set.

$$x_{n+1} = R x_n (1 - x_n) \quad \text{logistic "map"}$$

\rightarrow iteration

\rightarrow self reference.

$x_{n+1} \rightarrow x_{n+2}$ etc.

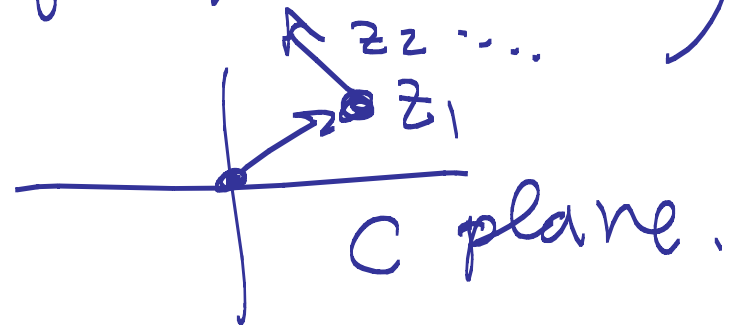
Mandelbrot:

$$z = x + iy \quad i = \sqrt{-1}$$

$$z_{n+1} = z_n^2 + c$$

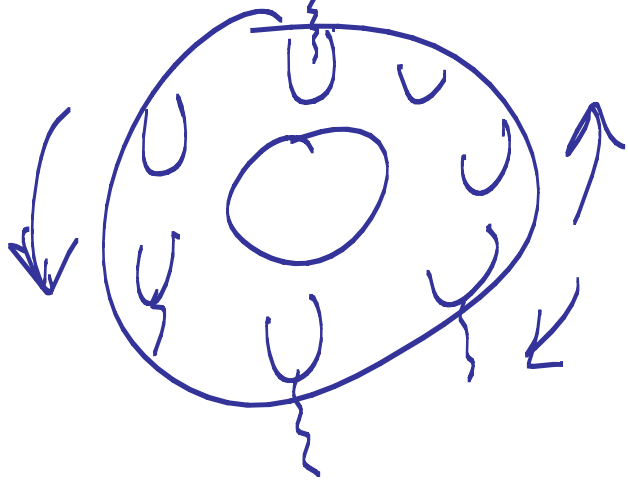
$M = \left\{ c : \begin{array}{l} z_\infty \rightarrow \text{stays finite} \\ z_\infty \rightarrow \infty \text{ "outside"} \end{array} \right\}$
 (color the # of steps to go to ∞)

$$z_0 = 0$$



Julia Set: z plane for different c
 M set is a kind of "attractor" for iteration.

More physical examples of an attractor = Lorenz attractor
— leaky bucket fountain.



chaotic fountain.

→ hidden
fractal
in "phase space"

→ broccoli flower