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## Visualization of Chaos for Finance Majors

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### Abstract

Efforts to simulate turbulence in the financial markets include experiments with the logistic equation:  $x(t) = \kappa x(t-1)[1-x(t-1)]$ , with  $0 < x(t) < 1$  and  $0 = \kappa < 4$ . Visual investigation of the logistic equation show the various stability and instability regimes for the various value of the Feigenbaum number  $\kappa$ . Visualizations for  $t=20$  observations provide clear demonstrations of the stability regimes. We visually investigate these regimes in more detail in the  $t=101-110$  range. For  $0 < \kappa < 3$ , the process settles to a unique stable equilibrium. For  $3 = \kappa < 3.6$  the process bifurcates, or, as colored visualization shows but not black-and-white, its pitchfork bifurcation branches "bang-bang" switch between two regimes. For  $3.6 = \kappa < 4.0$  the process becomes chaotic, i.e., deterministically random. In this regime are windows of stability, e.g., at  $\kappa = 3 + 2\sqrt{2} = 3.8284$ . At  $\kappa = 4$ , pure chaos, the process is extremely sensitive to initial values, as visually is clearly demonstrated. We increase the number of observations to  $t=1000$  and compute the homogeneous Hurst exponent of the process at  $\kappa=4$ :  $H=0.004$ , indicating that  $x(t)$  is blue noise, i.e., extreme anti-persistent. A histogram shows a highly platykurtic distribution of  $x(t)$ , with an imploded "mode," with extremely fat tails higher than the "mode," against the reflecting values at  $x=0$  and  $x=1$ . Several plots of the state directory of the system in the  $(x(t), x(t-1))$ -space trace out the parabolic strange attractor. Although the strange attractor is a well-defined parabole, the points on the attractor set are deterministically random and unpredictable.

**Keywords:** Logistic Equation, Visualization, Strange Attractor, Chaos, Hurst Exponent**JEL Classification:** C15, C19, C33, C49[Suggested Citation](#) >[Show Contact Information](#) >[Download This Paper \(Delivery.cfm/SSRN\\_ID253357\\_code010106530.pdf?abstractid=253357&mirid=1\)](https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID253357_code010106530.pdf?abstractid=253357&mirid=1)[Open PDF in Browser \(Delivery.cfm/SSRN\\_ID253357\\_code010106530.pdf?abstractid=253357&mirid=1&type=2\)](https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID253357_code010106530.pdf?abstractid=253357&mirid=1&type=2)

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