Strange Attractors, Topology, and the Stock Market

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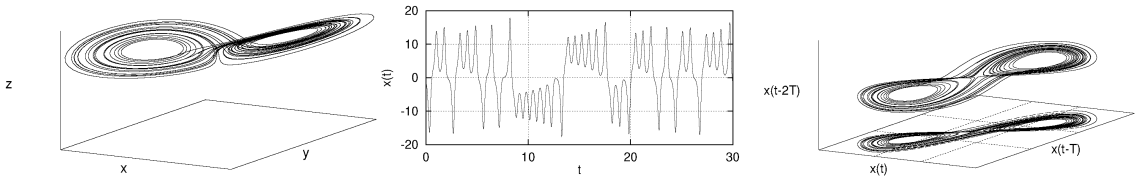
Takens's theorem [2] says, in rough terms, that if we can observe a signal from a dynamical system possessing a so-called strange attractor, we can reconstruct the attractor from the observed signal. Consider, for example, the classical Lorenz attractor (Figure 1). By observing only the x coordinate location of the system at time t, the attractor can be reconstructed using the vector $(x(t), x(t-T), x(t-2T))$ for some delay $T > 0$.



(a) (b) (c)

Figure 1: Lorenz attractor (a), observation of x coordinate at each time (b), reconstructed attractor (c). Figures are from [1].

Is the price (or another metric) of a financial instrument/asset a signal from an underlying dynamical system? The aim of this project is to use Takens's theorem and to study the resulting embedding(s) using methods from topological data analysis (persistent homology).

Can we, for example, detect whether we are in certain regimes (stock price increase, decrease, etc.)? Can we detect whether there are conditions that are predictive of an impending market crash?

References

[1] T. D. Sauer. Attractor reconstruction. *Scholarpedia*, 1(10):1727, 2006. revision #91017.

[2] F Takens. Detecting strange attractors in turbulence. *Lecture Notes in Mathematics*, 898:366–381, 1981.