Non-linear Signals/Grid Frequency Modelling// Performance of MCMC Techniques on Surrogate Data.

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"To develop this idea within a proper statistical paradigm requires treating the system states as stochastic instead of deterministic. We therefore consider the more realistic case that the system dynamics are subject to random disturbances. The states are assumed to follow a stochastic transition over time, given by the state equations..."
Meyer and Christensen
Phys. Rev. E **62**, *p3535 (2000)*

Abstract

Nowadays the use of Bayesian inference in parameter estimation of chaotic systems is becoming more common. Possibly because this approach incorporates in a *natural way* considerations of unknown parameters that could be interpreted as experimental information, such as different types of noise, present in the signal of interest [*J. Am. Statis. Ass.* **86** 416 (1991)]. In those cases it seems that the use of stochastic models on chaotic systems, by the implementation of Markov chain Monte Carlo (MCMC) techniques, provides impressively correct and unbiased parameter estimations [*Phys. Rev. E* **62**, p3535 (2000) and *Physica D* **160** p116 (2001)].

We implement MCMC methods for a Bayesian probability model of the Logistic map presented in [*Phys. Rev. E* **62**, p3535 (2000)]. We apply the technique to two different sets with noise levels between 0 and 2. From the Monte Carlo output we estimate the logistic parameter and the logistic noise free states for both data sets. The second data set is constructed in such a way that is a surrogate of the Logistic map, *i.e.* it has the same mean, variance and noise level. One data set contains the invariant measure of the map whilst the other is composed by normally distributed values.

Surprisingly, the MCMC estimations for both data sets are indistinguishable, showing the method identifies an invariant measure in the surrogate data. We discuss the possible shortcomings of the Bayesian approach for chaotic time series. Despite this fact, we recognise the validity of the approach in the case of parameters estimation for the grid frequency model in conjunction with non-linear ensembles and cost function methods.

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