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Rising above chaotic likelihoods

Hailiang Du & Leonard Smith

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Abstract

Berliner (Likelihood and Bayesian prediction for chaotic systems, J. Am. Stat. Assoc. 1991) identified a number of difficulties in using the likelihood function within the Bayesian paradigm both for state estimation and for parameter estimation of chaotic systems. Even when the equations of the system are given, he demonstrated "chaotic likelihood functions" both of initial conditions and of parameter values in the Logistic Map. Chaotic likelihood functions, while ultimately smooth, have such complicated small scale structure as to cast doubt on the possibility of identifying high likelihood states in practice. In this paper, the challenge of chaotic likelihoods is overcome by embedding the observations in a higher dimensional sequence-space, which is then shown to allow good state estimation with finite computational power. An importance sampling approach is introduced, where Pseudo-orbit Data Assimilation is employed in the sequence-space, first to identify relevant pseudo-orbits and then relevant trajectories. Estimates are identified with likelihoods orders of magnitude higher than those previously identified in the examples given by Berliner.

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