PARAMETER AND STRUCTURE INFERENCE FOR NONLINEAR DYNAMICAL SYSTEMS

R. D. Morris[1], V. N. Smelyanskiy[2] and M. Millonas[2]

(1) USRA-RIACS, NASA Ames Research Center, MS 269-2, Moffett Field, CA 94035

(2) NASA Ames Research Center, Moffett Field, CA 94035

Abstract

A great many systems can be modeled in the non-linear dynamical systems framework, or as $\dot{x} = f(x) + \zeta$, where $f()$ is the potential function for the system, and ζ is the excitation noise. Modeling the potential using a set of basis functions, we derive the posterior for the basis coefficients. We show experimentally that the correct parameter values are inferred, even for chaotic time-series. A more challenging problem is to determine the set of basis functions that are required to model a particular system. We show that using the Bayesian Information Criteria (BIC) to rank models, and the beam search technique, that we can accurately determine the structure of simple non-linear dynamical system models, and the structure of the coupling between non-linear dynamical systems where the individual systems are known. This last case has important ecological applications.

Key Words: non-linear dynamical system, BIC, beam search