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Bayesian approach to reconstruction of a dynamic system from noisy time-series

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In this report we consider applicability of the Bayesian approach to reconstruction of dynamic systems (DS) from experimental data. A significant merit of the approach is its universality. But, being correct in terms of meeting conditions of the underlying theorem, the Bayesian approach to reconstruction of DS is hard to realize in the most interesting case of noisy chaotic time series (TS). We develop a modification of the Bayesian approach that overcomes this difficulty. The main idea underlying this modification is that the loss of informational coupling of sufficiently separated in time samples of chaotic TS allows the factorization of the "correct" Bayesian probability density (PD). A whole TS in such approach is divided into (presumably) statistically independent segments and each multiplier of factorized PD is constructed from one of those. The method of integration of constructed PD function on latent variables is suggested.

We demonstrate efficiency of the modified approach for solution of two types of problems: (1) Finding values of parameters of a known DS by noisy TS. Dependence of confidence limits of parameter's reconstruction on segment's length is demonstrated, and choice of optimal segment length is discussed. (2) Classification of types of behavior of such a DS by short and pronouncedly noisy TS. We demonstrate dependences of calculated probabilities of "true" behavior type on both noise level and segment length. Results for chaotic as well as regular (periodic) TS are presented and discussed.