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Reconstruction of high dimensional dynamic systems from time series by stochastic models

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Essential complexity of the natural objects, manifesting itself in high dimension of the phase space is the main restriction for applications of known methods of dynamic systems reconstruction from time series (TS). Construction of high dimensional dynamic models requires, on the one hand, significant data set: necessary time series length grows exponentially with increasing of dimension. On the other hand the phase space dimension retrieved from TS can be more than twice as more as topological dimension of the attractor determine the observed evolution of the system. As a result the complexity of model parameter space structure increases significantly and, consequently, the model becomes very sensitive to deviation of its parameter values. The basic idea underlying represented work aims to overcome this problem. It consists in use of stochastic models for the description of observed high dimension dynamics and reconstruction of key properties of unknown investigated dynamic system. Such approach is based on a hypothesis that the robust dynamic properties of the system evolution can be described by a few equations, while other features may be considered as a stochastic disturbance. The method of parameterization of such models on the basis of artificial neural networks is developed, as well as technique of investigation of model parameter space is suggested. Possibilities of the approach with reference to the analysis of time series generated by high dimensional dynamic systems are demonstrated by model examples. In particular, the prediction of changes of characteristics of observed process is constructed. Besides efficiency of the suggested method in a case of reconstruction of the system under random external forcing is shown; the method allows to reconstruct correctly statistical characteristics of the forcing. Possible other

applications of the method are discussed.