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Stochastic dynamics of time correlation in complex systems with discrete time

Yulmetyev R., Hänggi P., Gafarov F.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

In this paper we present the concept of description of random processes in complex systems with discrete time. It involves the description of kinetics of discrete processes by means of the chain of finite-difference non-Markov equations for time correlation functions (TCFs). We have introduced the dynamic (time dependent) information Shannon entropy Si(t) where i=0,1,2,3, . . . , as an information measure of stochastic dynamics of time correlation (i=0) and time memory (i=1,2,3, . . .). The set of functions Si(t) constitute the quantitative measure of time correlation disorder (i=0) and time memory disorder (i=1,2,3, . . .) in complex system. The theory developed started from the careful analysis of time correlation involving dynamics of vectors set of various chaotic states. We examine two stochastic processes involving the creation and annihilation of time correlation (or time memory) in details. We carry out the analysis of vectors' dynamics employing finite-difference equations for random variables and the evolution operator describing their natural motion. The existence of TCF results in the construction of the set of projection operators by the usage of scalar product operation. Harnessing the infinite set of orthogonal dynamic random variables on a basis of Gram-Shmidt orthogonalization procedure tends to creation of infinite chain of finite-difference non-Markov kinetic equations for discrete TCFs and memory functions (MFs). The solution of the equations above thereof brings to the recurrence relations between the TCF and MF of senior and junior orders. This offers new opportunities for detecting the frequency spectra of power of entropy function Si(t) for time correlation (i=0) and time memory (i=1,2,3, . . .). The results obtained offer considerable scope for attack on stochastic dynamics of discrete random processes in a complex systems. Application of this technique on the analysis of stochastic dynamics of RR intervals from human ECG's shows convincing evidence for a non-Markovian phenomemena associated with a peculiarities in short- and long-range scaling. This method may be of use in distinguishing healthy from pathologic data sets based in differences in these non-Markovian properties.