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Natural Time Analysis and Complex Networks

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Here, we review the analysis of complex time series in a new time domain, termed natural time, introduced by our group [1,2]. This analysis conforms to the desire to reduce uncertainty and extract signal information as much as possible [3]. It enables [4] the distinction between the two origins of self-similarity when analyzing data from complex systems, i.e. whether self-similarity solely results from long-range temporal correlations (the process's memory only) or solely from the process's increments infinite variance (heavy tails in their distribution). Natural time analysis captures the dynamical evolution of a complex system and identifies [5] when the system enters a critical stage. Hence, this analysis plays a key role in predicting forthcoming catastrophic events in general. Relevant examples, compiled in a recent monograph [6], have been presented in diverse fields, including Solid State Physics [7], Statistical Physics (for example systems exhibiting self-organized criticality [8]), Cardiology [9,10], Earth Sciences [11] (Geophysics, Seismology), Environmental Sciences (e.g. see Ref. [12]), etc.

Other groups have proposed and developed a network approach to earthquake events with encouraging results. A recent study [13] reveals that this approach is strengthened if we combine it with natural time analysis. In particular, we find [13,14] that the study of the spatial distribution of the variability [15] of the order parameter fluctuations, defined in natural time, provides important information on the dynamical evolution of the system.

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