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The effect of critical deceleration: examples of use for monitoring the stability of complex systems

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The predictor of approaching of a complex system to the area of instability is presented, and some examples of use of such predictor are discussed. It is known that decrease in the stability level of a complex system often manifests itself by increase in the amplitudes of the low frequency domain of the system oscillations compared to the amplitudes of its high-frequency domain. Similar increase can appear as a result of changes in the external forces that are affecting the system. The problem is to separate the features in the time series that reflect the internal mechanisms of the system evolution from the effects that are caused by external forces and are not linked directly with the level of stability, and to construct a model that can reproduce such kind of behavior and help to estimate the future changes of condition of the system.

Such model was built, and the described effect was formalized in a form of a numeric indicator equal to *a linear regression of the Fourier transform of the time series (with subtracted trend) in a current frame in double logarithmic coordinates*. The choice of this predictor is based, among other reasons, on the following: the spectrums (Fourier transforms) of most examined series were found to be close to a power law (flicker-noise), in double-log coordinates being close to a linear function with its angle varying. This very angle is taken as an indicator of the size of future event (i.e. risk).

This effect in different forms was found in time series of different nature, including NYSE stock prices, daily crime statistics, seismic time series of two kinds (seismic regime, microseisms). The indicator was found to have as a rule a positive correlation with further event size (“size of event” was defined for every time series according to its nature – social, economic, seismic etc.) for all explored time series. The achieved results give grounds to suggest that similar approach can be useful for monitoring changes in the stability level of other complex systems.