TOWARDS RECOGNITION OF EARLY WARNING SIGNALS ON FINANCIAL CRISES

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Compared to fluctuations in values of various indicators of a system's performance, extreme events are usually understood as qualitative shifts in the system's behavior. In this context, signals on the upcoming extreme events can be characterized in terms of tendencies rather than predictions on particular quantities. Roughly, one can group the tendencies in two categories – tendencies to collapse (identified with the occurrence of an extreme event) and tendencies to avoiding collapse. Under that paradigm, early warning signals can, more specifically, be treated in a binary way -- as "minus" signals registering a tendency to collapse, and "plus" signals registering a tendency to avoiding collapse.

Assessment of time series preceding a collapse observed in the past can help us identify "minus" and "plus" signals. We understand "minus" signals as patterns in the time series, which occur close to the collapse time, and "plus" signals as those occurring in earlier periods, distant from collapse. Recognition of the "minus" and "plus" patterns hidden in the data series is an inverse problem in data analysis. One can use artificial intelligence and pattern recognition tools to solve the inverse problem in each particular situation. Here, we consider a two-stage solution method. In the first stage, the historical patters occurring close to collapse are artificially classified as "minus" signals and those occurring far away from collapse as "plus" signals. In the second stage, the "minus" and "plus" groups are modified so that they do not intersect.

Once "minus" and "plus" signals are recognized, we go deeper into the past data series, in which the historical collapse is less clearly seen. We compute the frequencies of the "minus" and "plus" signals following the historical signal sequences of a given length (acting as a parameter). These frequencies provide us with estimates for the transition probabilities in a random (Markov) process realized in the past. The random process operates in the space of the signal sequences. We consider the constructed random process as a model for generation of signals.

We apply the model to assess current data on-line. A purpose is to forecast if collapse is likely to occur at a given point in the future. Following the emerging signal sequences, we use the constructed random process to update the value for the probability of collapse occurring at the given time point in the future. If the probability grows over time, we register a tendency to collapse; if the probability declines, we register a tendency to avoiding collapse.

As an illustration, we consider an application of our method to analysis of financial data series in the context of recent financial crises. To identify "minus" and "plus" signals we use data preceding the "Dot Com" financial crisis of 2000-2001. To identify the random model, we use a long data series of 1954-2000.

We use the model to assess, retrospectively, the probability of a financial crisis to occur in October 2008 (in October 2008 – February 2009 the latest global financial crisis occurred). The probability grows steadily starting from October 2007 and reaches value 1 in August 2008. Thus, our binary data inversion- and model-based analysis of the previous financial crises and a preceding long period of "normal" behavior of the financial system results in registering early warning signals on the latest financial crisis.