QUANTITATIVE INDICATORS OF CHAOTICITY IN THE DYNAMICS OF TIME SERIES

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The methods of statistical analysis are widely applied for the researching of random processes. At the same time, the methods of processing of time series, based on fractal analysis, have been extended in recent years. The distinctive feature of these methods is that they can indicate the features of their local structure, in addition to the global characteristics of stochastic processes.

The fractal analysis of time series consists in determining the chaotic indicators and analyzing the special states of the system. The analysis of fractal regularities makes it possible to obtain a quantitative estimate of randomness of studied process.

The Hausdorff's fractal dimension D is an indicator of process complexity, the value of which can predict system behavior and identify unstable states. The Hurst indicator H allows to distinguish a random series from a non-random one, and to determine the cycle length, necessary to evaluate the process inertia, as well.

The empirical estimate of the Hurst indicator is following:

$$H = \frac{\log(R/S)}{\log(n/2)},$$

where R value is the maximum range of the series, S is the standard deviation of observations, and n is the number of observations. The fractal dimension D and the Hurst indicator H are related through the expression: $D = 2 - H$. The pointwise method is standard one for computing the fractal dimension.

The randomness vector $\vec{P} = (H, D)$ determines, depending on H and D values, three possible states in the behavior of the investigated series: 1) the antipersistence, that means there is so-called "return to the mean", i.e. changing in the trend in the series dynamics on opposite; 2) the random walk ("the pink noise"), which is characteristic for the stochastic series; 3) the persistence, that means saving of the trend ("the black noise"). Thus, the series analyzed are trend-resistant and characterized by long-term memory.

The investigation of these properties of the time series allows relatively simple and reliable prediction of further development of the studied process. The performed computations have made it possible to determine the antipersistence of the time series of the morbidity indicator value for some skin pathologies in Ukraine.