THE FRACTAL PROCESSES: A COMPLEX NETWORK APPROACH

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The Hurst exponent [1] estimation for a process provides a measure of whether the data is a pure white noise random process or has underlying trend, and has been applied in a diverse range of fields, including hydrology, economics, biology, social sciences, geophysics, medicine, and neurosciences. However, calculating the Hurst exponent of a series is a tricky task, and the accuracy of the estimation can be questioned, therefore, the search for the alternatives is obvious. Recently, it has been shown [2-4] that one can use the complex network theory to map a time series into a (complex) graph, and to extract possible information of the process by studying the topological characteristics of the graph. Here, we investigate the recently proposed visibility graph algorithm [3], and show that this algorithm may not be a well-defined method to extract correlation information of a time series. However, by using a simpler version, called horizontal visibility algorithm, we study the correlation aspects of (stationary or non-stationary) fractal processes [5]. The corresponding degree distributions are found to fit with a stretched exponential function (in contrast with the power-law one proposed before [3]) with Hurst dependent fitting parameter. Further, we take into account other topological properties such as the maximum eigenvalue of the adjacency matrix, the degree assortativity, and the correlation information between the degree sequence and the series data points, and then we demonstrate that one can use such features in estimating the Hurst exponent as well as the persistent/antipersistent nature of the fractal processes. This formalism can apply to real data from physics, biology, economy, medicine, engineering, and among others.

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