The processes of anomalous diffusion in the application to describe the indoor air quality

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Abstract

Indoor air quality has become an issue in the modern society, where people spend about 70-90% of their time indoors. Although certain efforts have been made to create an appropriate indoor air microclimate, complaints about discomfort and health problems have increased during recent years. Due to these facts, estimation of indoor air quality has become major concern in many countries and its importance might be intensified in the near future. In the thesis we make an attempt to model the CO_2 concentration using anomalous diffusion processes.

In the first part of the thesis we introduce three subordinated processes: fractional Brownian motion time-changed by gamma, inverse Gaussian and tempered stable processes. We indicate the main properties of all systems and focus mainly on the distributional properties and the structure of dependence. We show that all of them still have long-range dependence (LRD) property and obtain the asymptotic behavior of the absolute moments. These processes can be useful in the analysis of data having LRD property and "heavy tails".

In the next step we focus on fractional Brownian motion time-changed by inverse of subordinators mentioned above. We analyze similar set of statistical properties, among others using Tauberian theorem we derive the asymptotic behavior of moments. Further, we obtain asymptotic covariance structure and show that all systems have LRD property. This type of processes can be applied to time-series data exhibiting LRD property and constant time periods.

Furthermore, we introduce new techniques for estimation and statistical investigation of the distribution of waiting times. These methods are based on the truncated discretized distribution, which can be used to model rounded data such as waiting times visible in continuous time random walk trajectories. We prove main properties of discretized distribution such as existence of moments and mean-preserving property.

Using simulated data we demonstrated effectiveness of the proposed techniques. Finally, we considered a stochastic system that allows modeling of the time series of CO_2 concentration which is one of the main parameters

influencing indoor air quality. The model we applied for data analysis is the continuous time random walk, which exhibits anomalous diffusion behaviour. The new estimation technique was applied to analyse time series of CO_2 concentration data recorded in an indoor environment. It was shown that the method leads to valuable conclusions concerning sampling frequency.

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