

Modelling of Anomalous Diffusion Using Monte Carlo Method

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Abstract

In 1827, Scottish botanist Robert Brown noticed that particles in a liquid move chaotically in different directions. In 1905 Albert Einstein and in 1906 Marian Smoluchowski showed that for long times mean squared displacement (MSD) of Brownian particles is proportional to time. This kind of diffusion is called *normal diffusion*. On the other hand, anomalous diffusion, characterized by a deviation from Brownian motion, is a phenomenon observed in various complex systems. Unlike normal diffusion, where mean squared displacement (MSD) is linearly proportional to time, anomalous diffusion exhibits nonlinear relationship, described by $\langle x^2 \rangle \propto t^\alpha$, $\alpha \neq 1$, where :

if $\alpha < 1$ we have *Subdiffusion*, when particles spread more slowly than Brownian Particles.

if $\alpha > 1$ we have *Superdiffusion*, when particles spread faster than in normal diffusion.

In this report, we will provide a brief introduction into anomalous diffusion and the results of modelling using Monte-Carlo method will be shown. Moreover, we will discuss some examples of anomalous diffusion and provide diffusion coefficients in each case. Furthermore, we will show how “memory” affects random processes.

Diffusion has significance in various physical, biological and financial stochastic processes. Due to its importance, understanding these models will enhance our comprehension of complex systems and it will also pave the way for further researches.

Keywords: Anomalous Diffusion, Modelling, Monte Carlo Method, Stochastic Processes.

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