Wavelet based Multifractal Formalism For Real- World Problems

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Abstract

Wavelets and fractals were formally introduced in eighties and there has been rapid progress on theoretical as well as application fronts. However, applications of waveletbased multifractal formalism to DNA sequences, protein structure, heart diseases, stock market data and meteorological data are comparatively new developments.

As we know, real world problems are studied either as modeling them with differential, partial differential and stochastic differential equations or through their time series realizations. For the proper understanding of real-world problems related to financial market, meteorological data, molecular biology(genome sequence, protein structure microarray data) data, ECG and Mammograms, we look for properties of time series such as seasonality or periodicity, singularity or point of abrupt change, self similarity, drift, oscillating singularity. Concepts of wavelet transform, fractal dimension, thrust parameter, oscillating singularity exponents, Hausdorff spectrum function are of vital importance for studying these properties. Papanicolaou and Solna(Wavelet based estimation of local Kolmogorov turbulence, Preprint, 1999, Stanford University), besides many others have developed waveletfractal methods to study the properties of environmental data and in particular applied it to atmospheric data taken in a region in USA. In collaboration with Dr. N.A. Sontakke and her colleagues at the Indian Institute of Tropical Meteorolgy, Pune, India we have studied various properties of time series of the rainfall in India between 1810 and 1995 by using wavelet methods. We are also engaged in the analysis of time series of financial and atmospheric data by applying the concept of Hausdorff spectrum function and related software developed by Fahima and her collaborators.

Waveletfractal methods are being used to study ECG for determining the abnormality in heart functioning. We are engaged in studying these problems by using wavelet packets and Hausdorff spectrum function. The main objective of this poster is to highlight a few current applications of these two emerging areas indicating our current contributions in this field.

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