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## Multi-branchness and the phase transitions in time series of inter-event times

We develop an extended multifractal analysis based on the Legendre-Fenchel transform (sometimes referred to as Legendre multi-branched one) rather than the routinely used canonical Legendre transform. In our variant of coarse-graining pre-processing, the local detrending of time series has been replaced by an appropriate averaging over days combined with properly-suited detrending on a daily time scale. This new approach is devoid of troublesome artifacts in the form of innumerable faults of these local trends that can deform the hierarchy of fluctuations and hence the final multifractality. Notably, our analysis is sensitive to the change of time scale as it should be. This analysis has developed, e.g., for empirical time series of inter-event or waiting times, which are an essential element of the popular continuous-time random walk formalism. The core of this extended multifractal analysis is the non-monotonic behavior of the generalized Hurst exponent – the fundamental exponent of the study – and hence a multi-branched spectrum of dimensions, which for our case is additionally of the left-sided one. We examine the main thermodynamic consequences of the existence of this type of multifractality. They can be expressed directly in the language of thermally stable, metastable, and unstable phases, and phase transitions between them as well. These phase transitions are of the first and second orders according to the modified Ehrenfest classification, sometimes called the Mandelbrot one.

### Summary

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