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Leveraging large deviation statistics to decipher the stochastic properties of measured trajectories

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Single-particle tracking routinely measures the motion of different particles in biological and soft-matter systems and often unveils characteristic deviations of the observed stochastic dynamics from standard Brownian motion. To identify the correct underlying physical mechanism often tools such as machine-learning and Bayesian inference are employed. These methods are technically involved and computationally expensive, with the computational cost increasing with the number of models considered. We show that the large-deviation theory applied to the time-averaged mean-squared displacements provides a simple-yet-efficient tool for the construction of decision trees to reject certain models. This facilitates the reduction of the list of feasible models and thereby complements Bayesian and machine-learning methods. We show how we can use this large-deviation theory based approach to uncover additional information from measured trajectories in complex liquids as well as climate data.

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