A large deviation principle for Metropolis-Hastings sampling

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Sampling algorithms from the class of Markov chain Monte Carlo (MCMC) methods are widely used across scientific disciplines. Good performance measures are essential to analyse these methods, to compare different MCMC algorithms, and to tune parameters within a given method. Common tools that are used for analysing convergence properties of MCMC algorithms are, e.g., mixing times, spectral gap and functional inequalities (e.g. Poincaré, log-Sobolev). A further, rather novel, approach consists in the use of large deviations theory to study the convergence of empirical measures of MCMC chains. At the heart of large deviations theory is the large deviation principle, which allows us to describe the rate of convergence of the empirical measures through a so-called rate function.

In this talk we will consider Markov chains generated via MCMC methods of Metropolis-Hastings type for sampling from a target distribution on a Polish space. We will state a large deviation principle for the corresponding empirical measure, show examples of algorithms from this class for which the theorem applies, and illustrate how the result can be used to tune algorithms' parameters.

[1] Milinanni, F., & Nyquist, P. (2024). A large deviation principle for the empirical measures of Metropolis–Hastings chains. *Stochastic Processes and their Applications, 170*, 104293.

[2] Milinanni, F., & Nyquist, P. (2024). On the large deviation principle for Metropolis-Hastings Markov Chains: the Lyapunov function condition and examples. *arXiv preprint arXiv:2403.08691.*