Piecewise deterministic Markov processes in Monte Carlo simulation

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IRTG 2544: "Stochastic Analysis in Interaction"
— Minicourse —

Abstract

Piecewise deterministic Markov processes (PDMPs) are a class of continuous-time stochastic processes which move according to deterministic flows between random switch times. The lack of a diffusive, spatially smoothing component in their motion renders their properties, and their sample paths, quite different to e.g. diffusions. It has been known for a long time that the backtracking behaviour associated with diffusive motion can slow down the mixing of stochastic processes, which is crucial to the performance of Markov chain Monte Carlo (MCMC) schemes. However, exploiting that observation in practical algorithm design proved difficult. In recent years, PDMPs have emerged as a viable tool for constructing practical MCMC algorithms which avoid diffusive backtracking. This course will introduce basic theory and tools for PDMPs, based largely on the 1993 monograph by Davis. There will also be a brief introduction to MCMC, with the aim of demonstrating the advantages PDMP-based schemes can provide. The course will conclude with showing how to construct and simulate PDMPs with a given invariant distribution in a broad range of settings.

Relevant background:

- M. H. A. Davis. Markov Models and Optimization. CRC Press, New York, 1993.
- P. Diaconis, S. Holmes, and R. M. Neal. Analysis of a nonreversible Markov chain sampler. Ann. Appl. Probab. 10(3): 726-752, 2000.
- P. Fearnhead, J. Bierkens, M. Pollock, and G. O. Roberts. Piecewise deterministic Markov processes for continuous-time Monte Carlo. Statist. Sci. 33(3): 386-412, 2018.

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