Efficient methods for estimating stochastic gradients and sensitivity indices in complex stochastic dynamics

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We present recent work on efficient methods for sensitivity analysis, fast sensitivity screening and stochastic gradient estimation for complex stochastic dynamics. The examples we will discuss include biochemical reaction networks with a large number of parameters, many-body Langevin-type systems, and lattice kinetic Monte Carlo. The proposed methods are efficient, covariance-based Likelihood Ratio estimators with controlled variance at long times, as well as optimized, goal-oriented stochastic coupling methods. Finally, we discuss the connections of such methods with concepts of Fisher Information Matrix for dynamics through Cramer-Rao type and uncertainty quantification bounds in path-space.