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Hamiltonian Dynamics for Accelerated Optimization and Sampling

Optimization and sampling are fundamental computational tasks in machine learning. Classical algorithms are based on discretizations of greedy dynamics, such as gradient flow for optimization and Langevin dynamics for sampling. In this talk, we explore how Hamiltonian dynamics provides a common framework for acceleration. Concretely, simulating Hamiltonian dynamics while periodically resetting the velocity to zero gives a descent method for optimization, while refreshing the velocity from a Gaussian distribution gives Hamiltonian Monte Carlo for sampling. We show that short integration times lead to nonaccelerated rates analogous to greedy methods. With longer integration times and suitable averaging, we obtain accelerated rates for optimization and sampling. Both analyses rely on the same averaging property of Hamiltonian flow.