Thermodynamic geometry for control of stochastic systems

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Optimal control of stochastic systems seeks to minimize dissipation while driving between specified end states. For slow driving, linear-response theory gives a geometric description in which dissipation is governed by a thermodynamic friction metric, and optimal protocols are geodesics on the associated manifold. In this talk, I present a unified foundation for this geometric framework; show how parametric control corresponds to inherited metrics on submanifolds of the full-control manifold; and link thermodynamic friction to random walks on graphs, electrical-resistance networks, and optimal transport. This synthesis conceptually clarifies thermodynamic geometry, practically simplifies the calculation of optimal protocols, and gives physical intuition relating optimal protocols to system dynamics and their projection onto control modes.