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Room: 402

Sponsoring Units: GSNP DCOMP
Chair: David Wolpert, Santa Fe Inst

Abstract: A25.00006 : An Energy-Accuracy Tradeoff for Nonequilibrium Receptors*

Abstract

View Presentation

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Living systems constantly collect and process information about their surroundings in order to respond to changes in the environment. In particular, single cells are capable of remarkably sensitive chemical concentration sensing using membrane-bound receptors. The physical limit of this sensing capability has been studied since the Berg-Purcell limit in 1977; however, thermodynamic constraints on the design of these sensors have remained theoretically elusive. Here we discuss two novel analytical bounds on signal estimation uncertainty in different limits of the observability of the sensing system. First, we consider estimating a signal based on a fully observable system trajectory, and second we study estimation based only on the coarse-grained occupation time of a subset of states. In the second, more biophysically plausible limit, we derive an energy-accuracy tradeoff for nonequilibrium processes using stochastic thermodynamics and large deviation theory. These lower bounds, supported by numerical simulations, reveal a theoretical limit on the estimation accuracy in terms of the energy consumption of the system and the observation time.

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