Entropic transfer operators for data-driven analysis of dynamical systems

Bernhard Schmitzer
Göttingen University, Germany
schmitzer@cs.uni-goettingen.de

The transfer operator is an elegant way to capture the behaviour of a (stochastic) dynamical system as a linear operator. Spectral analysis can then in principle reveal (almost) invariant measures, cyclical behaviour, as well as separation of the dynamics into different time scales. In practice this analysis can rarely be done analytically, due to the complexity of the operator or since it may not be known in closed form. A central objective is therefore to numerically approximate this operator (or its adjoint: the Koopman operator) or to estimate it from data. In this talk we introduce a new estimation method based on entropic optimal transport and show convergence to a smoothed version of the original operator as more data becomes available. This involves an interplay between three different length scales: the discretization scale given by the data, the blur scale introduced by entropic transport, and the spatial scale of eigenfunctions of the operator.

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