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“On Markov state models for metastable processes”

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**Review**

Markov processes with a unique stationary distribution on large state spaces are considered. The task of obtaining a low-dimensional approximate description of the slow-scale dynamics has been treated by many authors with various applications in mind. In this paper Markov state models (MSMs) are reviewed, with the typical setup being a continuous state space and a metastable stochastic process. Intuitively, if the waiting time in each metastable set is long relative to the transition time in between these sets the process can be viewed approximately as a jump Markov process on this coarser scale.

With a low-dimensional subspace chosen beforehand a MSM is constructed by performing a Galerkin projection of the transfer operator of the original process. Theoretical results assessing the quality of this approximation under the assumption of reversibility are presented in the paper. A feature of the approach presented here is that the subspace is a small fraction of the full state space as opposed to a full partition. Unfortunately, how to choose the subspace in a constructive way is not implied by the theory outlined here, but is left for future research. The performance of the method when applied to a one-dimensional diffusion with a double well potential is examined and discussed in some detail.

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