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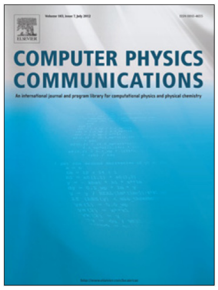

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Efficient data-driven reduced-order models for high-dimensional multiscale dynamical systems

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Abstract

We present two data-driven reduced-order models for high-dimensional multiscale dynamical systems. The methodologies proposed assume that the observed high-dimensional dynamic response is generated from some hidden low-dimensional processes. We argue that a single hidden process may not have the representative capability to accurately approximate the dynamical system exhibiting multiple timescales. Hence, the concept of *mixture of experts* is used where we represent the high-dimensional response as a function of multiple low-dimensional processes. The weight associated with each low-dimensional process is again governed by a separate dynamical process. The primary difference between the two proposed models resides in the procedure adopted for computing the parameters associated with the hidden processes. The first algorithm proposed combines expectation propagation (EP) with expectation maximization (EM) for computing the unknown parameters associated with the latent processes. While some of the parameters are treated in a deterministic sense (point estimates), the others are treated in a Bayesian manner. On the contrary, the second algorithm proposed uses variational Bayes expectation maximization (VBEM) and treats all the parameters in a Bayesian sense. Within VBEM, EP is used as an inference engine. Both the algorithms presented are data-driven. Several numerical examples are presented to certify the accuracy and efficiency of the proposed algorithms.

Keywords: Expectation Propagation, Expectation Maximization, Multiscale Dynamics,

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