Autoencoders for structure-preserving model reduction of stochastic Hamiltonian systems

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As recently shown (Tyranowski, 2024), SVD-based model reduction techniques, such as the proper orthogonal decomposition, can be extended to stochastic differential equations in order to reduce the computational cost arising from both the high dimension of the system and the large number of independent Monte Carlo runs. These techniques offer a significant computational efficiency improvement when the Kolmogorov n-width of the solution manifold of the considered problem decays quickly with the dimension of the reduced space. In this work, we adapt the recently proposed symplectic autoencoders (Brantner & Kraus, 2023; Buchfink, Glas & Haasdonk, 2023) to the stochastic setting and apply them to stochastic Hamiltonian systems characterized by slowly decaying Kolmogorov n-widths. The performance of thus constructed model reduction methods is tested and compared to the linear proper symplectic decomposition method.

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