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Symplectic networks: Intrinsic structure-preserving networks for identifying Hamiltonian systems

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This work presents a framework of constructing the neural networks preserving the symplectic structure, so-called symplectic networks (SympNets). We theoretically proved that SympNets can approximate any symplectic map. With the symplectic networks, we show some numerical results about 1) solving the Hamiltonian systems by learning abundant data points over the phase space, and 2) predicting the phase flows by learning a limited number of points depending on time. The experiments show that the symplectic networks outperform the fully-connected networks, especially in the task of predicting, which is impossible even for conventional numerical methods.