Neural Network Methods for the Power Series of Perron-Frobenius Operators

Tanakorn Udomworarat, Ignacio Brevis, Sergio Rojas, Martin Richter, Kristoffer G. van der Zee

Abstract

Perron-Frobenius operators play an important role in capturing behaviors of dynamical systems. One particularly interesting problem involves finding the power series of these operators applied to a given initial density, which has direct applications in determining equilibrium energy distributions. In this work, we propose neural network methods for approximating the power series of Perron-Frobenius operators that are non-expansive under a given L^p-norm with a constant damping parameter in $(0, 1)$. We use Physics-Informed Neural Networks (PINNs) and Variational Physics-Informed Neural Networks (VPINNs) to approximate solutions in their strong and variational forms, respectively. Additionally, we provide a priori error estimates for quasi-minimizers of the associated loss functions. Finally, we present some numerical results for 1D and 2D examples to support our theoretical results.