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Randomized Neural Networks with Petrov-Galerkin Methods for Solving PDEs

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Abstract: We present a new method for solving partial differential equations (PDEs) based on randomized neural networks and Petrov-Galerkin formulation, which we call RNN-PG method. This method uses randomized neural networks to approximate unknown functions and allows for a flexible choice of test functions, such as finite element basis functions, Legendre or Chebyshev polynomials, or neural networks. We apply RNN-PG method to various problems, including Poisson problems with primal or mixed formulations, and time-dependent problems with a space-time approach. Numerical experiments show that RNN-PG method can achieve high accuracy with a small number of degrees of freedom. Moreover, RNN-PG has several advantages, such as being mesh-free, handling different boundary conditions easily, solving time-dependent problems efficiently, and solving high-dimensional problems quickly. These results demonstrate the great potential of RNN-PG method in the field of numerical methods for PDEs.