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Micheal K. Ng</td></tr>
<tr><th>title</th><td>Deep Ritz method for the spectral fractional Laplacian equation using the Caffarelli-Silvestre extension</td></tr>
<tr><th>publication_date</th><td>2021-12-29 00:00:00</td></tr>
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<tr><th>abstract</th><td>In this paper, we propose a novel method for solving high-dimensional spectral fractional Laplacian equations. Using the Caffarelli-Silvestre extension, the d-dimensional spectral fractional equation is reformulated as a regular partial differential equation of dimension d+1. We transform the extended equation as a minimal Ritz energy functional problem and search for its minimizer in a special class of deep neural networks. Moreover, based on the approximation property of networks, we establish estimates on the error made by the deep Ritz method. Numerical results are reported to demonstrate the effectiveness of the proposed method for solving fractional Laplacian equations up to ten dimensions. Technically, in this method, we design a special network-based structure to adapt to the singularity and exponential decaying of the true solution. Also, A hybrid integration technique combining Monte Carlo method and sinc quadrature is developed to compute the loss function with higher accuracy.</td></tr>
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<tr><th>authors</th><td>Yiqi Gu
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<tr><th>publication_date</th><td>2021-12-29 06:50:13+00:00</td></tr>
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<tr><th>abstract</th><td>In this paper, we study deep neural networks (DNNs) for solving high-dimensional evolution equations with oscillatory solutions. Different from deep least-squares methods that deal with time and space variables simultaneously, we propose a deep adaptive basis Galerkin (DABG) method, which employs the spectral-Galerkin method for the time variable of oscillatory solutions and the deep neural network method for high-dimensional space variables. The proposed method can lead to a linear system of differential equations having unknown DNNs that can be trained via the loss function. We establish a posterior estimates of the solution error, which is bounded by the minimal loss function and the term $O(N^{-m})$, where N is the number of basis functions and m characterizes the regularity of the e'quation. We also show that if the true solution is a Barron-type function, the error bound converges to zero as $M=O(N^p)$ approaches to infinity, where M is the width of the used networks, and p is a positive constant. Numerical examples, including high-dimensional linear evolution equations and the nonlinear Allen-Cahn equation, are presented to demonstrate the performance of the proposed DABG method is better than that of existing DNNs.</td></tr>
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