



Employing physics-informed neural network to derive approximate solutions for fourth-order ordinary differential equations

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The research confirms Physics-Informed Neural Networks (PINNs) as an effective computational approach for obtaining approximate solutions to fourth-order ordinary differential equations (ODEs) through neural network structures inspired by biological neural systems that identify patterns and address intricate problems via interconnected neuron layers and the PINN framework was constructed to resolve fourth-order ODEs by creating and applying a neural network design by carefully considering hyperparameters to carry out the experiments and compare its output with the results of traditional numerical solver methods. The rationale for employing PINNs framework from their ability to approximate non-linear equations offering a flexible and powerful substitute for traditional approaches especially in nonlinear and complex equation. The PINN architecture comprises of input, hidden, and output layers in that the output layer that predicts the solutions of the fourth-order ODEs, and the hidden layers identify underlying patterns in the data by training collocation points in the ODEs domain with the back propagation of weights and biases to optimize the solution. The results from five experiments were contrasted with the variational iteration method (VIM) and the PINN model exhibited better performance recording absolute errors between 10^{-8} and 10^{-1} whereas VIM displayed greater errors ranging from 10^{-1} to 10^{-5} with deviations from absolute solutions increasing progressively over time thereby restricting its effectiveness for extended predictions and the PINN framework proved more reliable and precise producing predictions that closely align with absolute solutions. The study also investigates the impact of design choices and hyperparameters such as activation functions and the number of hidden layers on PINN performance emphasizing the importance of these parameters in determining model accuracy and further studies aimed at enhancing its accuracy by optimization and hybrid techniques will be built into the framework of the PINN.

Keywords: Physics-Informed neural networks, fourth-order ODE, optimization algorithms, loss function and backpropagation.
