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The Data-Driven Localized Wave Solution of the Fokas-Lenells Equation Using Physics-Informed Neural Network

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Abstract : The physics-informed neural network (PINN) method opens up an approach for numerically solving nonlinear partial differential equations leveraging fast calculating speed and high precession of modern computing systems. We construct the PINN based on a strong universal approximation theorem and apply the initial-boundary value data and residual collocation points to weekly impose initial and boundary conditions to the neural network and choose the optimization algorithms adaptive moment estimation (ADAM) and Limited-memory Broyden-Fletcher-Golfard-Shanno (L-BFGS) algorithm to optimize learnable parameter of the neural network. Next, we improve the PINN with a weighted loss function to obtain both the bright and dark soliton solutions of the Fokas-Lenells equation (FLE). We find the proposed scheme of adjustable weight coefficients into PINN has a better convergence rate and generalizability than the basic PINN algorithm. We believe that the PINN approach to solve the partial differential equation appearing in nonlinear optics would be useful in studying various optical phenomena.

Keywords : deep learning, optical soliton, physics informed neural network, partial differential equation
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