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Enhanced Parameter Estimation in the Generalized Kuramoto-Sivashinsky Equation Using Physics-Informed Neural Networks and Maximum Likelihood Estimation

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Abstract

When modeling phenomena with Ordinary Differential Equations (ODEs) or Partial Differential Equations (PDEs), ensuring the accuracy of numerical simulation results is crucial. The parameters of a model significantly influence its output and, consequently, its accuracy. One effective approach to improving numerical solutions' precision is parameter estimation. Therefore, a reliable tool for parameter estimation is essential. We perform parameter estimation on the Generalized Kuramoto-Sivashinsky (GKS) equation using statistical methods based on Maximum Likelihood Estimation (MLE) and machine learning techniques that employ Physics-Informed Neural Networks (PINNs). This equation is a fourth-order nonlinear PDE and has different parameters. We compare the results obtained from both approaches, demonstrating that the outcomes achieved with PINNs significantly surpass the accuracy of those obtained using MLE.

Keywords: Partial Differential Equations, Ordinary Differential Equation, Generalised Kuramoto-Sivashinsky equation, Maximum Likelihood Estimation, and Physics-Informed Neural network

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