Solve Problems in Mechanical Engineering by Python

Mojtaba Hasanlu

Problems:

1. Solving and Analyzing the Kuramoto-Sivashinsky Equation Using Neural Networks and Low-Rank Approximations
2. Kuramoto-Sivashinsky Equation Simulation and Initial Condition Impact
3. Solving Mechanical Vibration Prediction Using LSTM Neural Network and SVD

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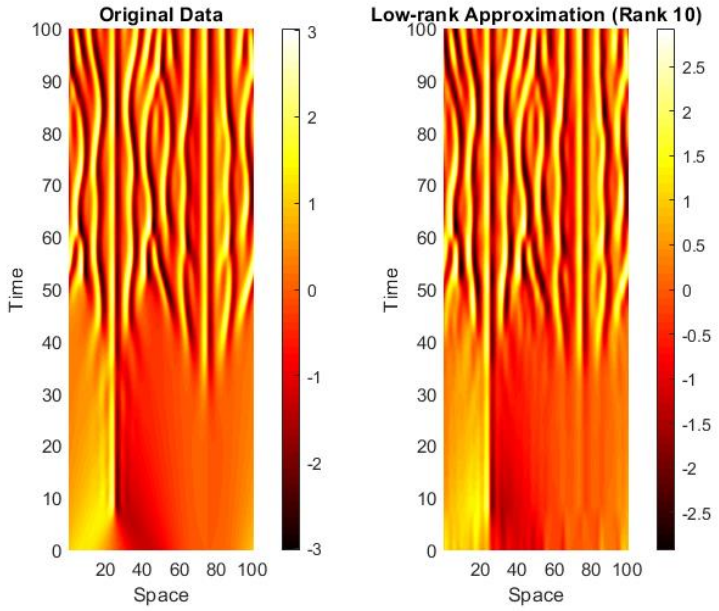
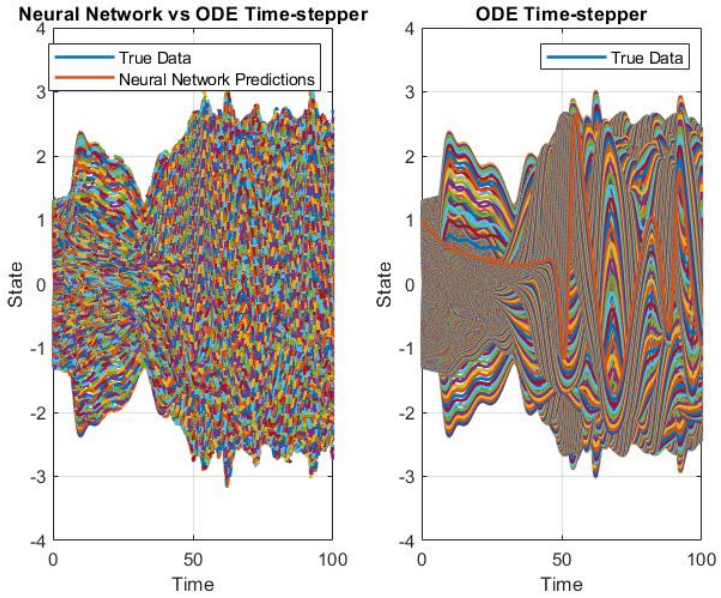
Problem 1

Solving and Analyzing the Kuramoto-Sivashinsky Equation Using Neural Networks and Low-Rank Approximations

A numerical solution of the KS equation was implemented using MATLAB. The spatial domain was discretized into 1024 points, and the time evolution was computed using a time-stepping method with a step size h=0.0 25. The Fourier spectral method was employed to handle the spatial derivatives efficiently.





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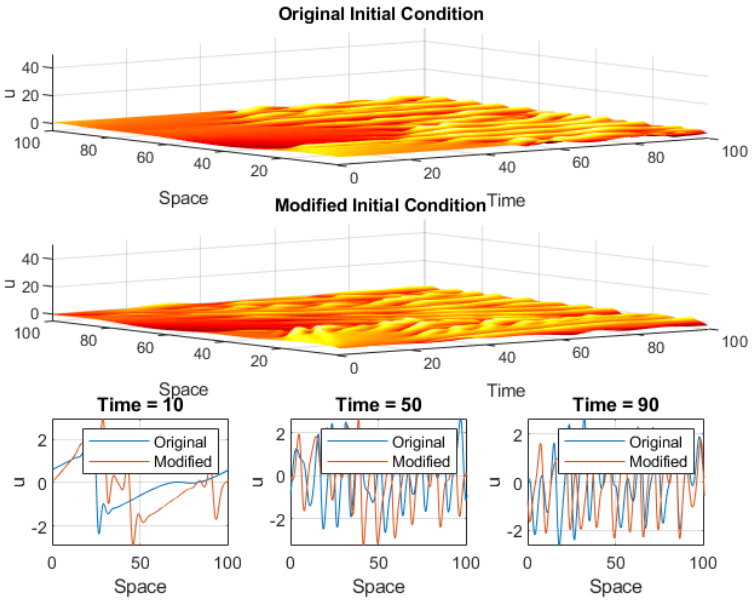
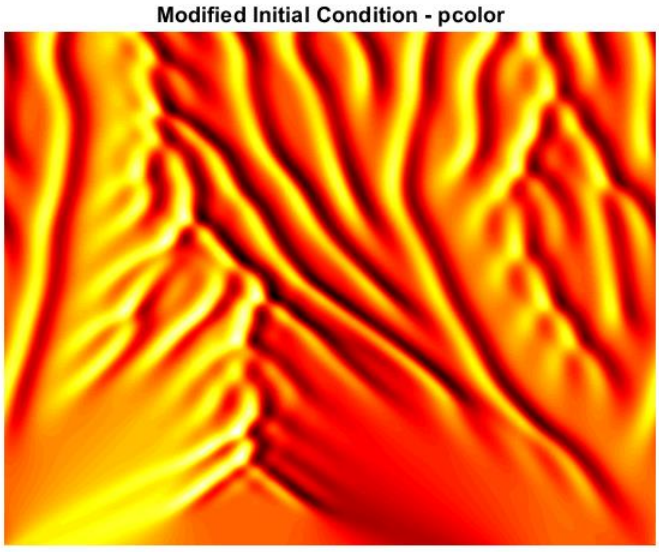
Problem 2

Kuramoto-Sivashinsky Equation Simulation and Initial Condition Impact





The study demonstrates that the initial condition has a significant impact on the evolution of the Kuramoto-Sivashinsky equation. The different initial conditions lead to markedly different spatiotemporal patterns, illustrating the sensitive dependence on initial conditions characteristic of chaotic systems. The comparison provides insights into the system's dynamics and serves as a foundation for further analysis, such as training neural networks to predict the system's behavior.

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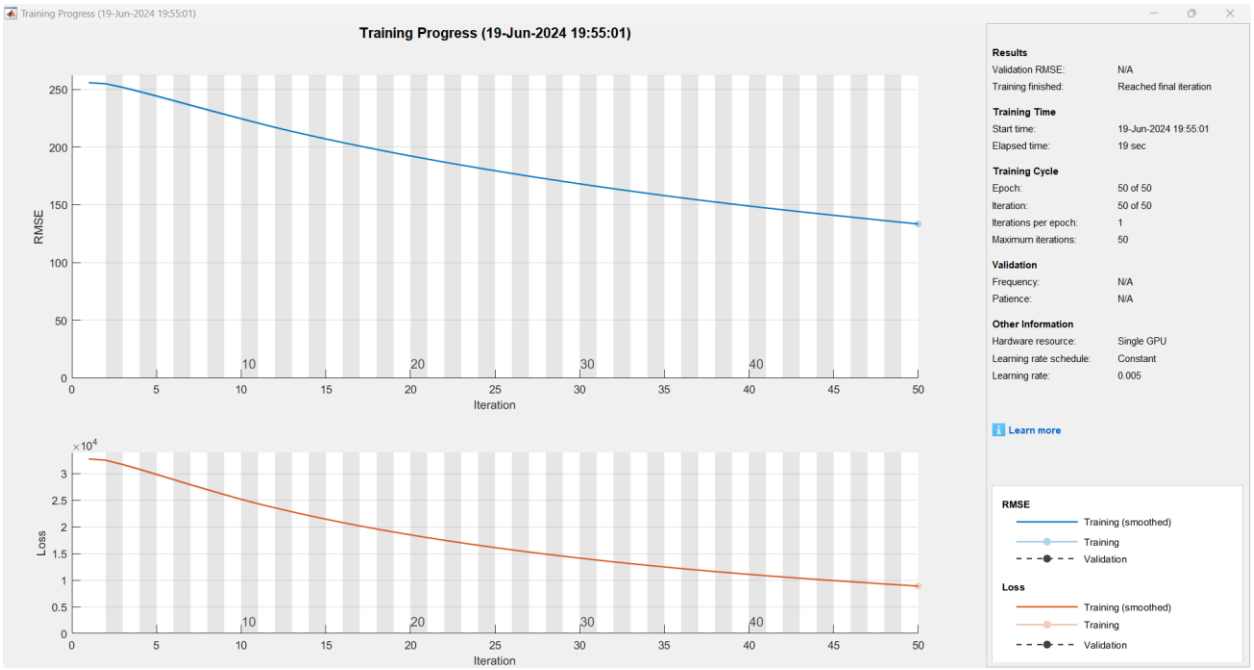
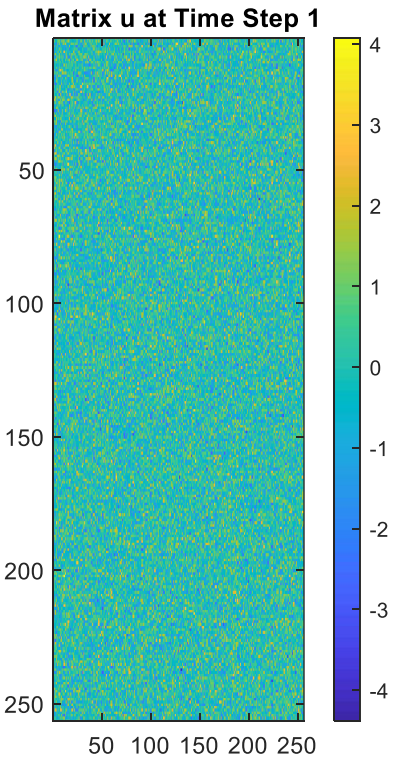
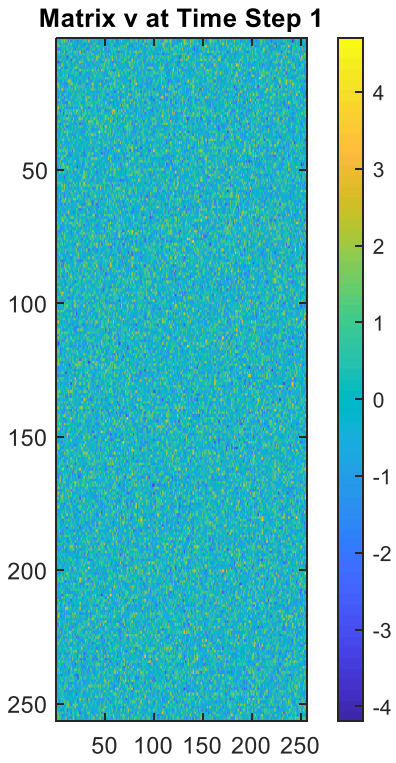
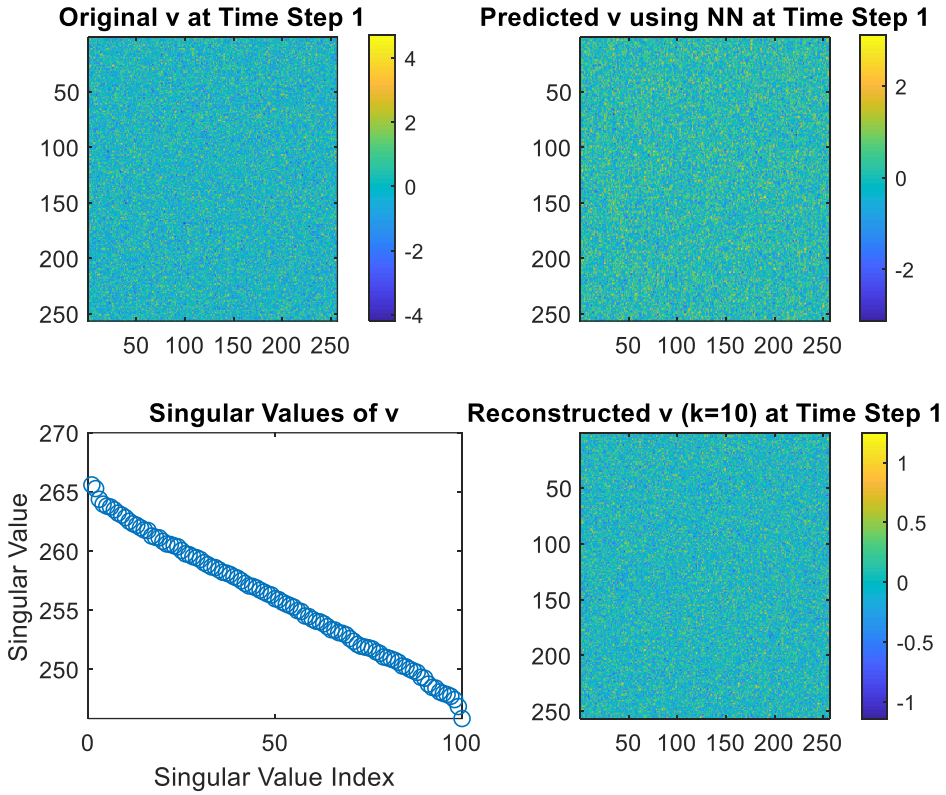
Problem 3

Solving Mechanical Vibration Prediction Using LSTM Neural Network and SVD









The combined use of LSTM neural networks and SVD for dimensionality reduction proves effective in predicting and understanding mechanical vibration systems. Further refinements could involve optimizing hyperparameters, exploring deeper LSTM architectures, or integrating additional data sources for more robust predictions.