Report of Programming assignment

Abstract

A two-layer tanh feedforward network trained with MSE (Adam) accurately approximates $f(x) = 1/(1 + 25x^2)$ on $[-1,1]$, showing smooth predictions, steadily decreasing training/validation losses, and low MSE and max error while avoiding endpoint oscillations typical of high-degree polynomial interpolation.

Method

- Data

  Sample 200 equally spaced points on $[-1,1]$ and compute targets by $y = 1/(1 + 25x^2)$. Split the dataset into 80% training and 20% validation.

- Network architecture

  Use a fully connected feedforward network: input dimension 1, two hidden layers with 20 units each, tanh activation, and a single linear output neuron.

- Training setup

  Optimize the mean squared error (MSE) with Adam for 300 epochs while monitoring validation loss to detect overfitting.

Figures and results

- Figure 1 shows the true curve and the network prediction nearly overlapping across [-1,1], with no endpoint oscillations.
- Figure 2 shows steadily decreasing training/validation MSE that plateaus without overfitting.
- Errors: report MSE and maximum absolute error; both are small under the given setup.

Discussion

- A small two-layer tanh network suffices for accurate, stable approximation.
- Unlike high-degree polynomial interpolation on equally spaced nodes, the network avoids endpoint oscillations and generalizes well.
- Model size balances bias–variance; use validation loss or simple regularization if overfitting appears.

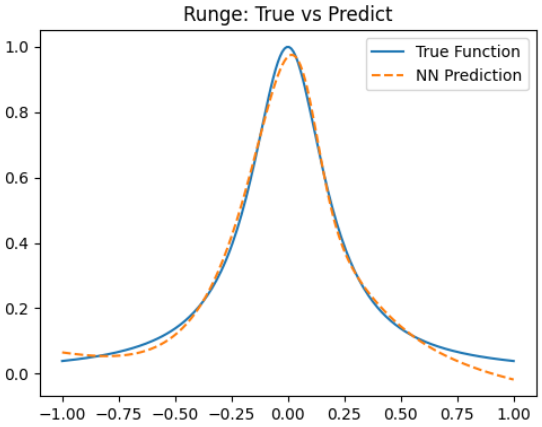

Figure 1

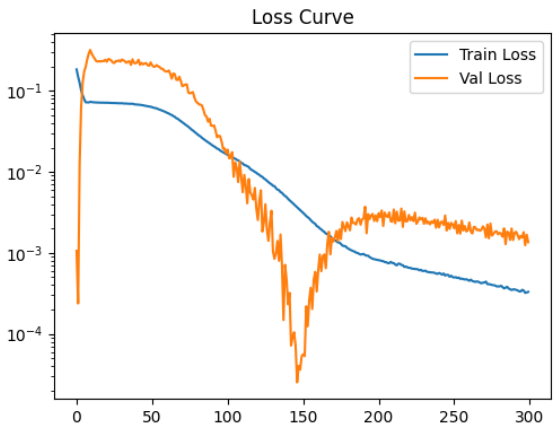

Figure 2

MSE: 5.25615e-04, Max Error: 5.66961e-02