Homework 02

Approximating $f(x) = 5x^2 + 10x - 2$ with a Fully Connected Feedforward Neural Network

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Objective

Learn a small Fully Connected Feedforward Neural Network (FCFNN) that approximates

$$f(x) = 5x^2 + 10x - 2$$

on the interval $[-10, 10]$, and compare the learned function with the ground truth.

Method

- **Data:** 1000 inputs sampled uniformly from $[-10, 10]$; targets $y = f(x)$.
- **Preprocessing:** Input standardized with a `Normalization` layer.
- **Model:** Input $\rightarrow$ Dense(128, ReLU) $\rightarrow$ Dense(64, ReLU) $\rightarrow$ Dense(1).
- **Training:** Loss = MSE; Optimizer = Adam; Epochs = 200; Validation split = 20%.
- **Evaluation:** Predictions on a dense grid in $[-10, 10]$; visual comparison with $f(x)$ and reporting of validation MSE/MAE.

Code Link

Source Code: Click here

Results

- The predicted curve closely follows the true quadratic over $[-10, 10]$ (Figure 1).
- Final validation metrics (from training logs):
  - Validation MSE: [**2.1700**]
  - Validation MAE: [**0.8650**]
  - Validation Loss: [**0.217%**]

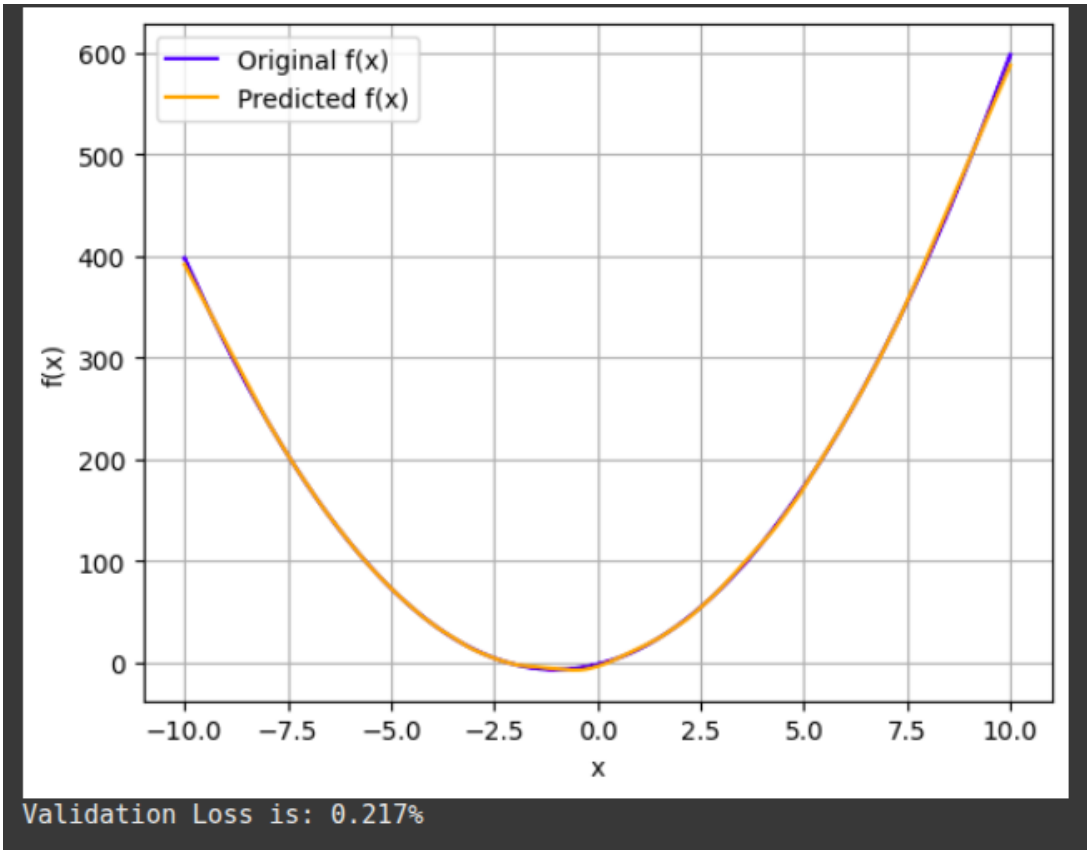

Figure 1: Ground-truth $f(x) = 5x^2 + 10x - 2$ vs. FCFNN prediction $\hat{f}(x)$ on $[-10, 10]$.

Conclusion

A simple FCFNN with ReLU activations and input normalization accurately approximates the quadratic function, yielding low validation error and near-overlapping curves with the ground truth across the domain.