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> Section 'F'

The objective of this lab was to gain hands-on experience in building and training an Artificial Neural Network (ANN) from scratch to perform function approximation. The core tasks involved implementing the fundamental components of a neural network, including activation functions, loss functions, forward propagation, and backpropagation. A synthetically generated dataset was used to train the network to approximate a polynomial curve, and various experiments were conducted by tuning hyperparameters to observe their impact on model performance.

Dataset Description

The dataset used for this experiment was synthetically generated based on SRN.

- Total Samples: 100,000
- Training Set Size: 80,000 (80%)
- Testing Set Size: 20,000 (20%)

Methodology

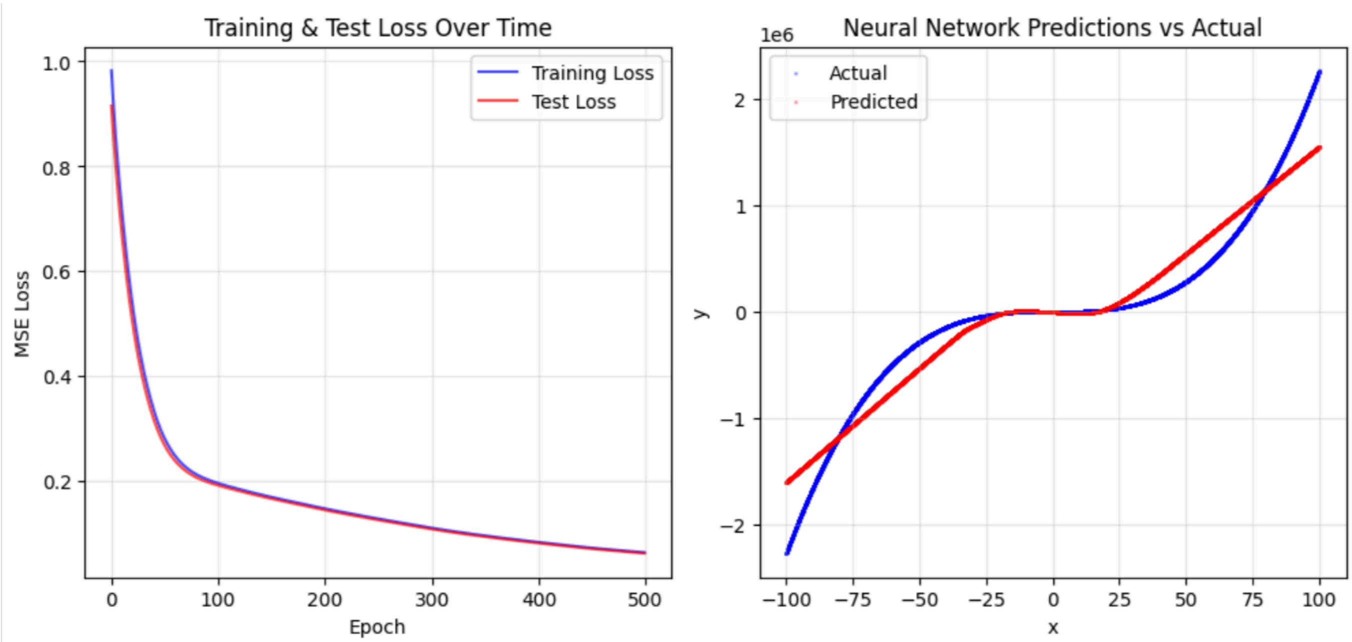
The neural network was implemented from the ground up without using high-level machine learning frameworks. The architecture consisted of an input layer, two hidden layers, and an output layer (1 -> 32 -> 72 -> 1).

The implementation steps were as follows:

1. Activation Function: The ReLU (Rectified Linear Unit) activation function and its derivative were implemented.
2. Loss Function: The Mean Squared Error (MSE) was implemented to quantify the model's prediction error.
3. Forward Propagation: A forward pass function was created to pass input data through the network and generate predictions.
4. Backpropagation: The backpropagation algorithm was implemented to calculate the gradients of the loss with respect to the network's weights and biases.
5. Training Loop: A training loop was established to iteratively update the model's parameters using gradient descent, minimizing the loss over a set number of epochs.

Results & Analysis

The initial model was trained with a baseline set of hyperparameters to establish a performance benchmark. The model trained steadily, with both training and test loss decreasing consistently over 500 epochs.



Exp	Learning Rate	Batch Size	Epochs	Optimizer	Activation Function	Training Loss	Test Loss	R^2
Exp. 1	0.005	80000	500	Gradient Descent	ReLU	0.136520	0.134130	0.86
Exp. 2	0.007	80000	500	Gradient Descent	ReLU	0.104652	0.102595	0.89
Exp. 3	0.009	80000	500	Gradient Descent	ReLU	0.081343	0.079576	0.91
Exp. 4	0.011	80000	500	Gradient Descent	ReLU	0.063742	0.062231	0.93