

Report: CIFAR-10 Neural Network Classifier

This project implements a simple neural network from scratch using NumPy to classify images from the CIFAR-10 dataset. It focuses on three classes: Airplane, Automobile, and Bird.

How it Works:

1. Data Loading and Preprocessing:

The CIFAR-10 data batches are loaded, filtered to include only the selected classes, normalized to have pixel values between 0 and 1, and labels are converted to one-hot encoded vectors.

2. Model Structure:

The neural network has one hidden layer with 128 neurons using ReLU activation, followed by an output layer with softmax activation to produce class probabilities.

3. Training:

The model is trained using mini-batch gradient descent. Forward propagation computes outputs, loss is calculated using cross-entropy, and backpropagation updates weights and biases. The learning rate decays slightly each epoch.

4. Evaluation:

After training, the model is evaluated on test data. Performance metrics including accuracy, precision, recall, and F1-score are calculated. A confusion matrix helps visualize class-wise predictions.

5. Visualization and Analysis:

Training loss and accuracy curves and the confusion matrix are plotted. An analysis report summarizes performance and suggests improvements like adding convolutional layers and data augmentation.

Approach:

The approach is to build a simple fully connected neural network from first principles without deep learning frameworks. This helps understand the fundamentals of neural networks, training with gradient descent, and multi-class classification. Although this basic model lacks convolutional layers which capture spatial features, it serves as a good starting point for learning.