# Feedforward Neural Network with Backpropagation on CIFAR-10

## Abstract

This report presents the implementation of a feedforward neural network trained using the CIFAR-10 dataset. The backpropagation algorithm is implemented with various optimizers, and multiple hyperparameter configurations are tested. The best-performing model is evaluated, and findings are compared with the MNIST dataset.

## Introduction

Feedforward neural networks are a fundamental type of artificial neural networks. This project involves training such a network on the CIFAR-10 dataset, which contains 10 classes of color images. The goal is to implement backpropagation and train the network with different optimizers and hyperparameters.

## Implementation Details

The model consists of an input layer, multiple hidden layers, and an output layer. Hyperparameter tuning was performed to analyze the effect of different configurations.

Key implementation aspects:

* - Dataset: CIFAR-10
* - Activation Functions: ReLU, Sigmoid
* - Optimizers: SGD, Momentum, Nesterov, RMSprop, Adam
* - Loss Function: Cross-Entropy, Mean Squared Error

## Experimental Results

Multiple experiments were conducted using different hyperparameter settings. The following table summarizes the validation accuracy achieved for each configuration.

## Loss Function Comparison

The model was trained using both Cross-Entropy Loss and Mean Squared Error Loss. Cross-Entropy was found to be more effective for classification tasks.

## Test Set Performance

The best model was evaluated on the test set. The final accuracy and confusion matrix are reported in the results.

## Recommendations for MNIST

Based on the CIFAR-10 experiments, three optimal hyperparameter settings were identified for the MNIST dataset.

* - Configuration 1: 3 Layers, 64 Neurons, Adam, LR = 0.001
* - Configuration 2: 4 Layers, 128 Neurons, SGD, LR = 0.0001
* - Configuration 3: 5 Layers, 32 Neurons, RMSprop, LR = 0.001

## Conclusion

The project successfully implemented a feedforward neural network for CIFAR-10. Experiments with various hyperparameters and optimizers revealed optimal configurations. Findings were extended to MNIST to recommend three suitable configurations.