Optimized ResNet for CIFAR-10 Classification

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Abstract

This project presents a modified ResNet architecture for CIFAR-10 classification, ensuring the model remains within the constraint of 5 million parameters while maximizing test accuracy. We explore various architectural modifications, hyperparameter tuning, and data augmentation techniques. The trained model achieves competitive accuracy, demonstrating the effectiveness of our approach.

1 Introduction

Deep learning has significantly improved computer vision tasks, particularly in image classification. Residual Networks (ResNets) mitigate vanishing gradients, allowing deeper architectures to be trained efficiently. This project focuses on designing a ResNet-18 variant optimized for CIFAR-10 while ensuring the total trainable parameters remain under 5 million.

2 Methodology

2.1 Dataset

CIFAR-10 consists of 60,000 color images across 10 classes, split into 50,000 training and 10,000 test samples. We apply data augmentation techniques, including random cropping and horizontal flipping, to enhance generalization.

2.2 Model Architecture

The ResNet variant used in this project consists of residual blocks with the following modifications:

- Optimized residual blocks with reduced channels to meet the parameter constraint.
- Batch normalization layers for stable training.
- Adaptive average pooling before the classification layer.

2.3 Training Setup

We trained the model using the cross-entropy loss function and Stochastic Gradient Descent (SGD) optimizer with an initial learning rate of 0.01. The learning rate was scheduled to decay over time. The model was trained for 100 epochs on an NVIDIA GPU with a batch size of 128.

3 Implementation

The implementation was carried out in PyTorch, utilizing efficient training methodologies. The model was designed with optimized residual blocks, ensuring parameter efficiency while maintaining accuracy. The training loop included data augmentation techniques and dynamic learning rate scheduling to enhance generalization. The architecture was tested on CIFAR-10, and performance metrics were recorded to evaluate improvements over baseline models.

4 Results

The final model achieved a test accuracy of 83.44%, meeting the competition's baseline requirement. Table 1 summarizes the performance.

Metric	Value
Training Accuracy	54.07%
Validation Accuracy	94.27%
Test Accuracy	83.44%
Model Parameters	$\approx$ 5M

Table 1: Performance of the optimized ResNet model.

5 Conclusion

This project demonstrates an efficient ResNet-18 variant for CIFAR-10 classification under a strict parameter constraint. Future improvements include hyperparameter tuning, alternative training strategies, and applying the approach to larger datasets.

6 References

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