EXPERIMENT 5

Image Classification using Resnet-18 (CIFAR-10)

OBJECTIVE

To train a deep convolutional neural network, specifically ResNet-18, on the CIFAR-10 dataset and evaluate its performance. The experiment aims to demonstrate the effectiveness of residual learning and batch normalization in improving generalization and accuracy.

DATA PREPROCESSING

- **Dataset**: CIFAR-10
- **Image Size**: 32x32 RGB images
- **Normalization**: Per-channel mean and standard deviation normalization:
    - Mean: (0.4914, 0.4822, 0.4465)
    - Std Dev: (0.2023, 0.1994, 0.2010)
- **Augmentation**: Applied to training data only
    - Random cropping with padding
    - Random horizontal flip

Data Split:

- 80% Training
- 20% Validation
- Test set provided separately

MODEL ARCHITECTURE

Network Used: ResNet-18

- Consists of residual blocks with identity shortcuts
- Four major stages with increasing filter sizes: 64, 128, 256, 512
- Uses Batch Normalization after every convolution layer
- Final layer is a fully connected layer with 10 output units

Implementation Details:

- Custom classes used: `BasicBlock`, `ResNet`
- Residual connections help prevent vanishing gradients and improve training

TRAINING CONFIGURATION

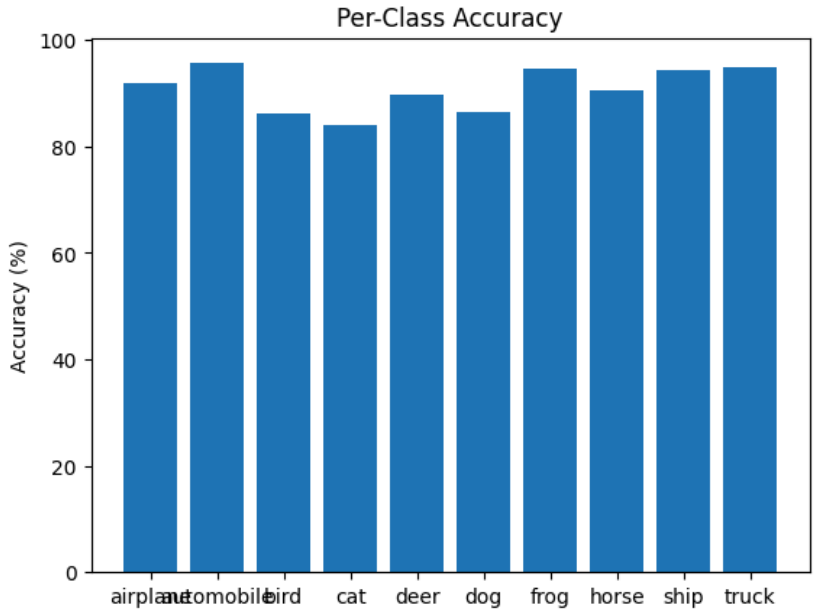
Hyperparameter	Value
Optimizer	SGD
Learning Rate	0.01
Momentum	0.9
Weight Decay	0.0
Epochs	200
Loss Function	CrossEntropyLoss
Batch Size	20

TEST PERFORMANCE

Test Loss: 0.329196

Overall Test Accuracy: 90% (9078/10000)

Per-Class Accuracy:



Airplane: 92% (920/1000)
Automobile: 95% (956/1000)
Bird: 86% (862/1000)
Cat: 84% (840/1000)
Deer: 89% (896/1000)
Dog: 86% (864/1000)
Frog: 94% (946/1000)
Horse: 90% (904/1000)
Ship: 94% (942/1000)
Truck: 94% (948/1000)

CONCLUSION

- ResNet-18 achieves excellent accuracy on the CIFAR-10 dataset.
- Training and validation losses decreased consistently, demonstrating successful convergence.
- The network effectively generalizes across classes, with the lowest performance on the 'cat' class.
- Residual connections greatly aid in learning deep representations.

FUTURE WORK

- Apply learning rate scheduling for faster convergence
- Add regularization methods like dropout
- Experiment with deeper networks (ResNet-34, ResNet-50)
- Evaluate on other datasets like CIFAR-100 or TinyImageNet