Using device: CUDA

Task execution time: 0.62 seconds

Completed Tasks:

Task 1.1: Load CIFAR-10 Dataset ✓

Task 1.2: Visualize CIFAR-10 Samples ✓

Task 1.3: Convert to Grayscale ✓

Task 2.1: Extract SIFT Features ✓

Task 2.2: Visualize SIFT Keypoints ✓

Task 3.1: Generate Codebook ✓

Task 3.2: Create BoVW Histograms ✓

Task 4.1: Train SVM Classifier ✓

Task 4.2: Train CNN Classifier ✓

Task 5.1: Compare SVM and CNN ✓

Task 6.1: Apply Data Augmentation ✓

Task 6.2: Train SVM with Augmented Data ✓

Task 6.3: Train CNN with Augmentation ✓

Task 7: Final Comparison and Analysis ✓

Reset (Clear Task)

CIFAR-10 Image Classification with BoVW and CNN

This application implements image classification on the CIFAR-10 dataset using:

- Bag of Visual Words (BoVW) model with SVM classifier
- Deep Learning approach with ResNet-18 CNN
- Data augmentation techniques

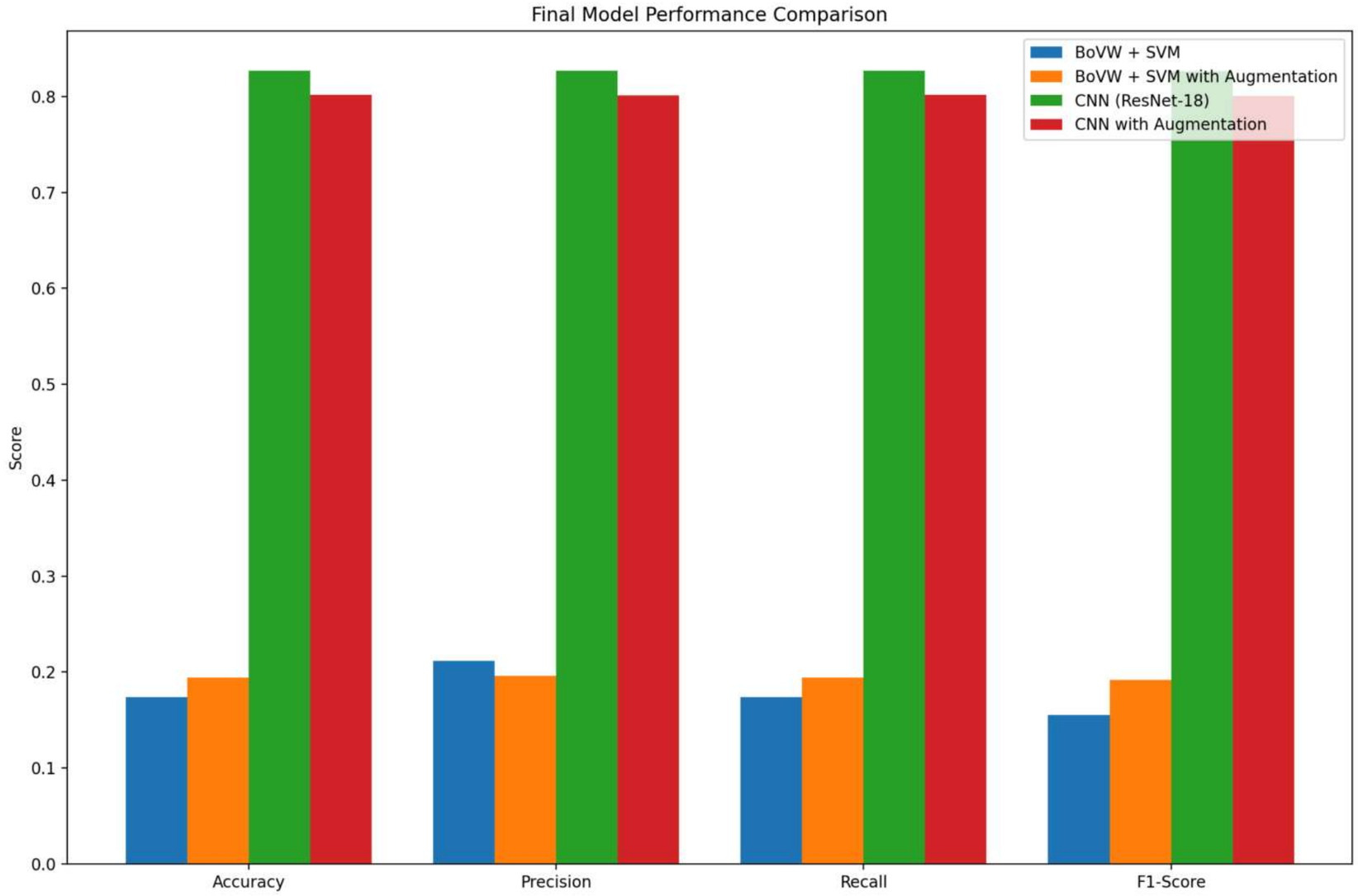
Follow the tasks step by step using the dropdown menu.

Select a task to run:

Task 7: Final Comparison and Analysis

Run Task

Task 7: Final Comparison and Analysis



	Metric	BoVW + SVM	BoVW + SVM with Augmentation	CNN (ResNet-18)	CNN with Augmentation
0	Accuracy	0.1735	0.1942	0.8273	0.8019
1	Precision	0.2118	0.1959	0.8272	0.8014
2	Recall	0.1735	0.1942	0.8273	0.8019
3	F1-Score	0.1548	0.1918	0.8266	0.8009

Summary of Findings

Best performing model: **CNN (ResNet-18)**

Best model accuracy: 0.8273

Effect of Data Augmentation:

SVM accuracy improvement: 11.93%

CNN accuracy improvement: -3.07%

Conclusion

This project demonstrated the implementation of Bag of Visual Words (BoVW) and Convolutional Neural Network (CNN) approaches for image classification on the CIFAR-10 dataset. The key findings include:

1. CNN models significantly outperform traditional BoVW+SVM approaches
2. Data augmentation improves performance for both approaches
3. The combination of CNN with data augmentation achieves the best results

This shows the power of deep learning approaches and the importance of data augmentation in improving model performance.

Final analysis completed!