# Challenge 0

Group 4

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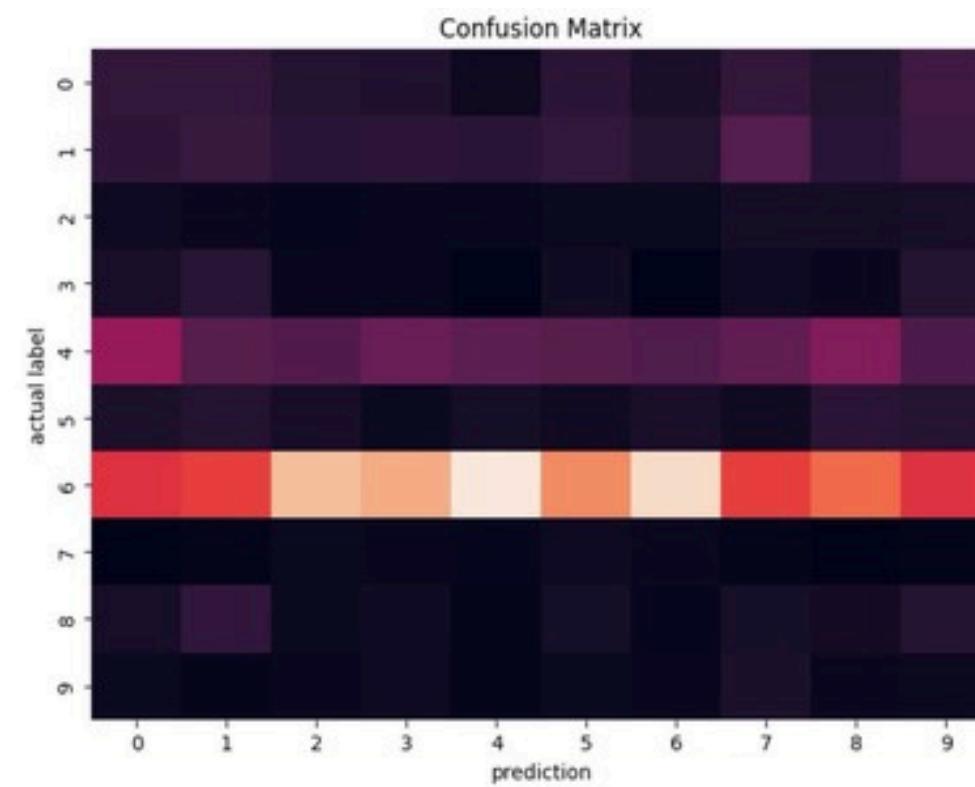
Introduction

- - The CIFAR-10 dataset consists of 60,000 images across 10 classes.
- - Real-world datasets often have imbalances, affecting model performance.
- - This study investigates ResNet18 performance on class-imbalanced CIFAR-10.
- - Training accuracy and per-class accuracy are analyzed.
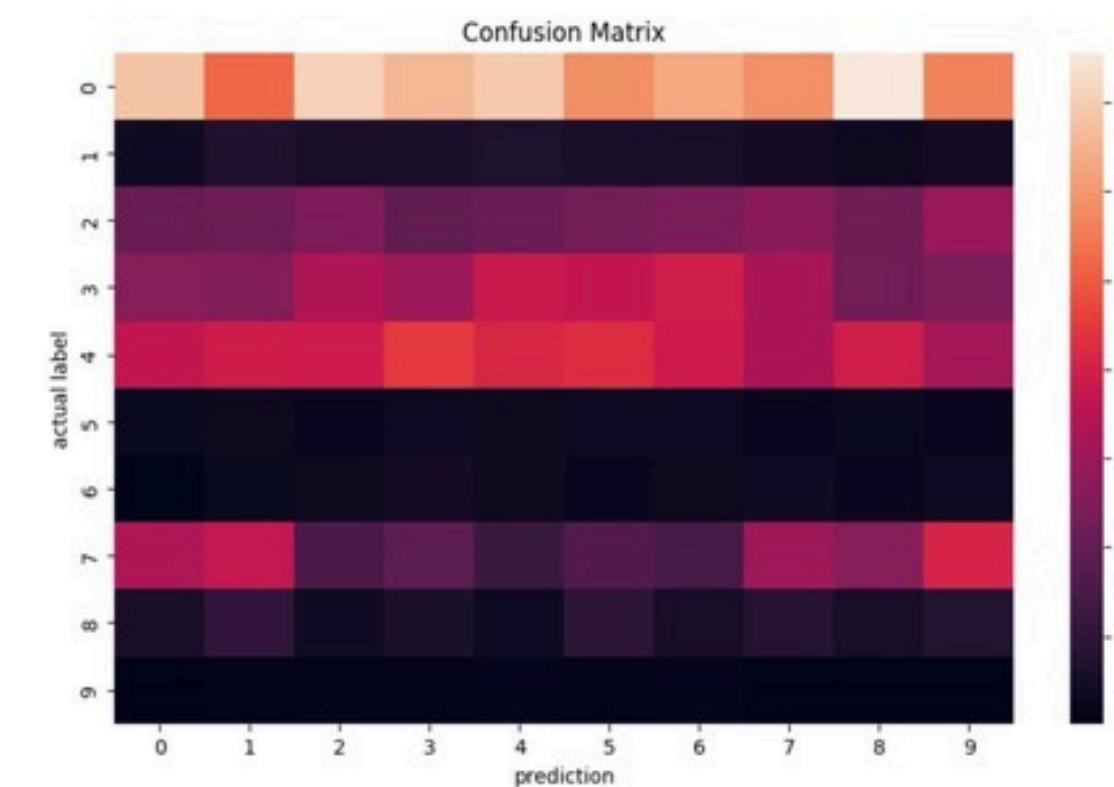
Objective

- To assess the performance of a ResNet-18 model trained on CIFAR-10.
- To compare traditional loss functions with class-balanced loss techniques.
- To analyze classification errors through confusion matrices.
- To determine the effectiveness of different colormap visualizations in highlighting classification errors.
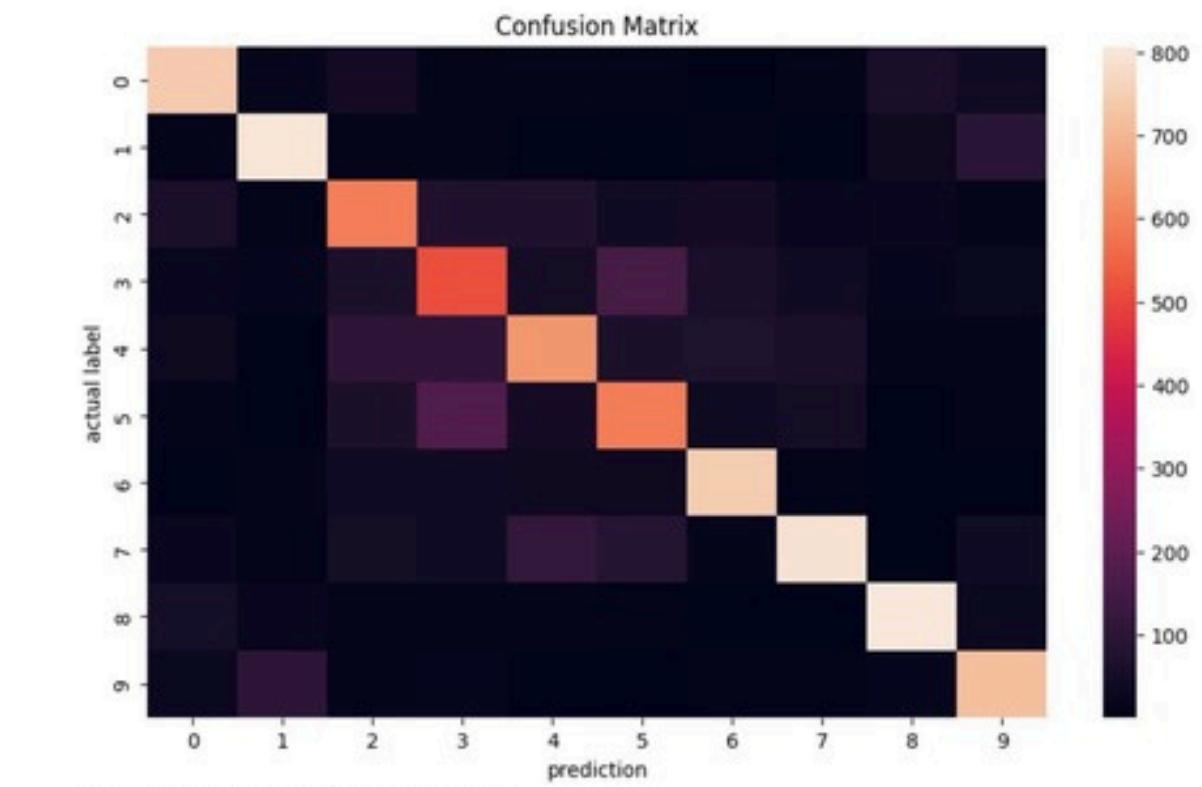
Observation 1 - Confusion Matrix


imbalanced random guess

balanced random guess
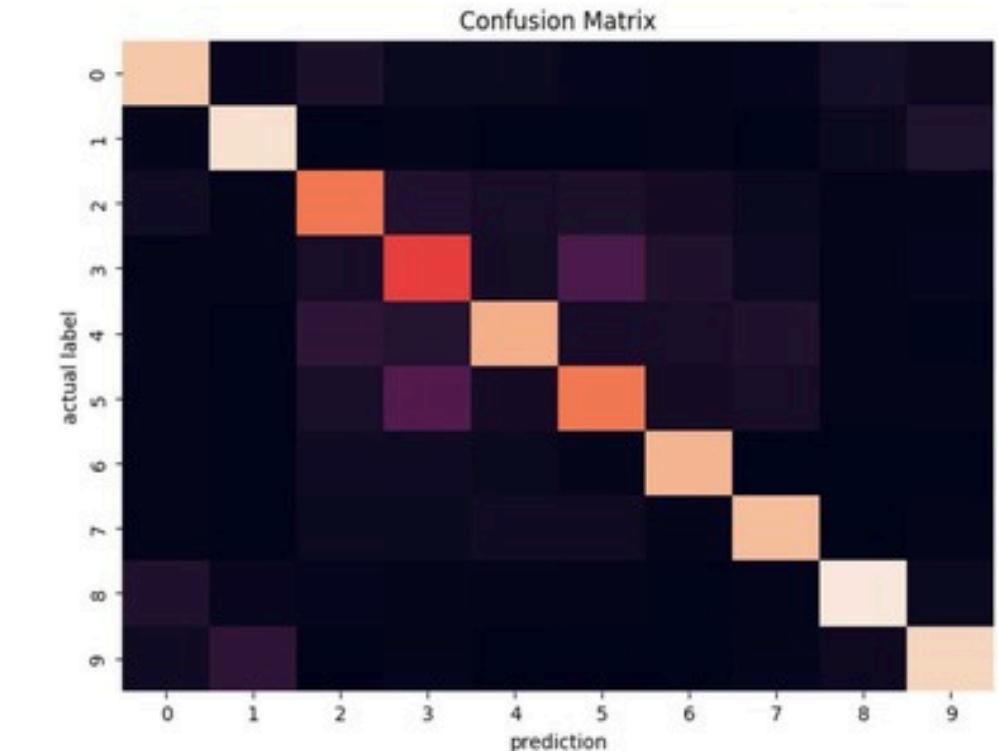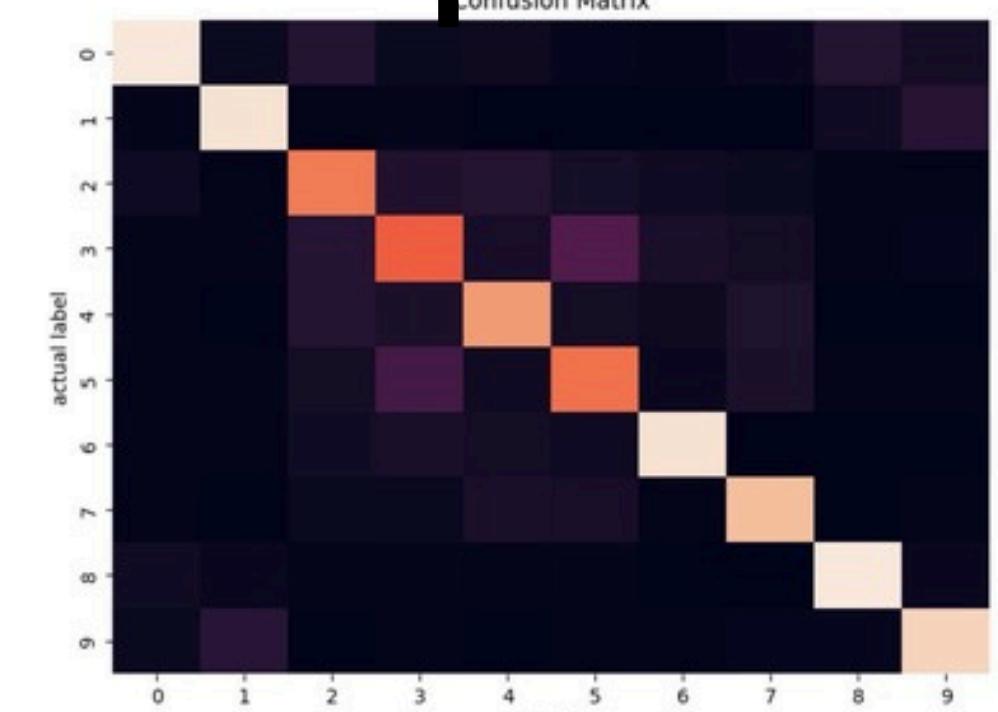
balanced

Observation 2 Confusion Matrix
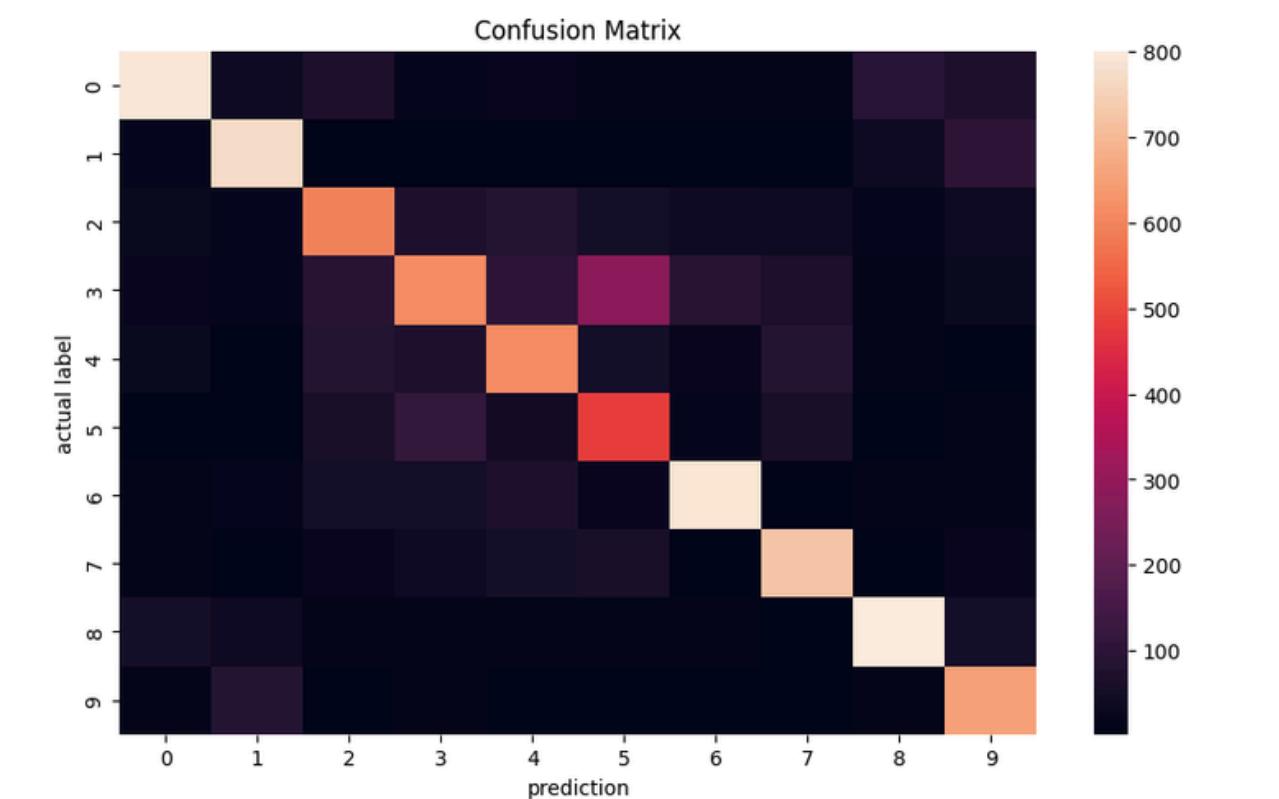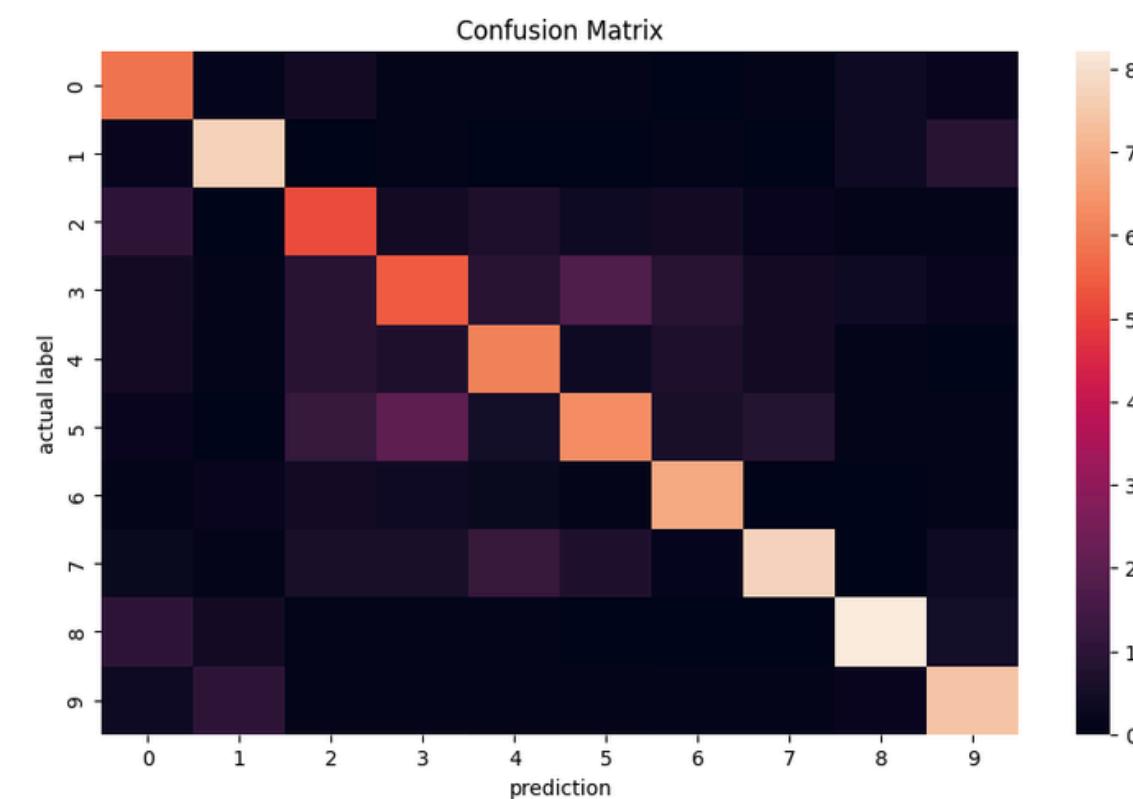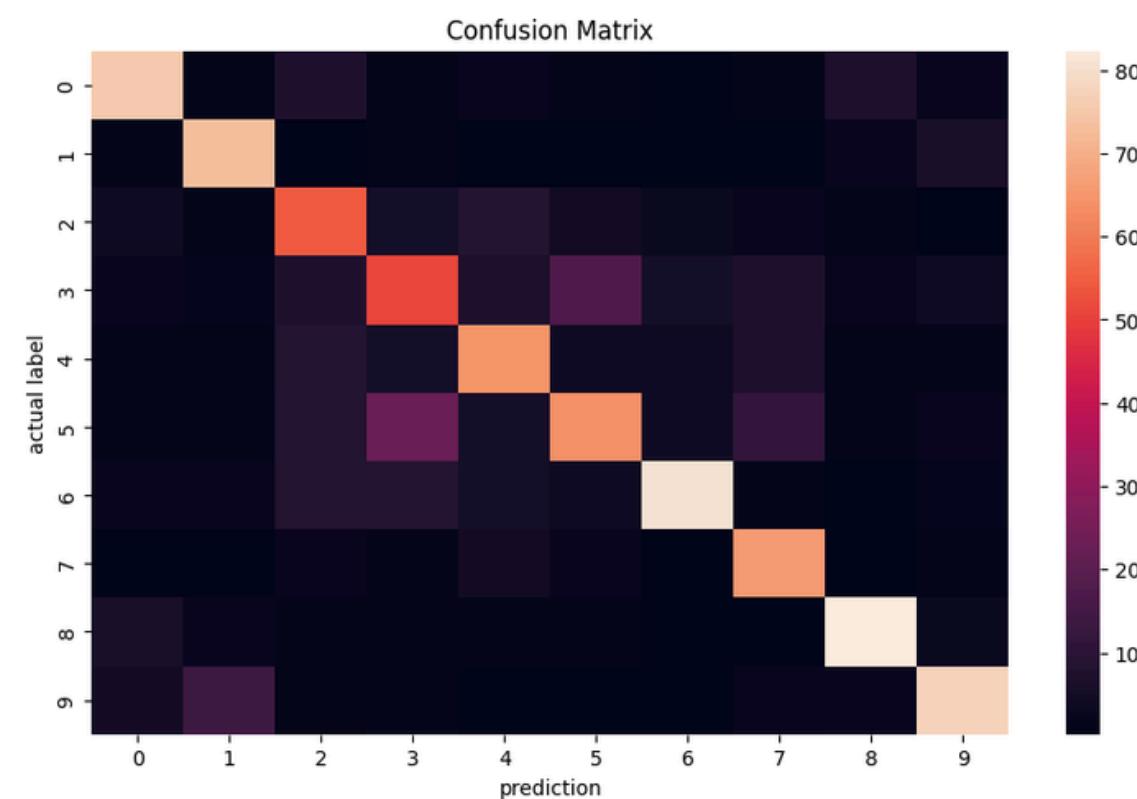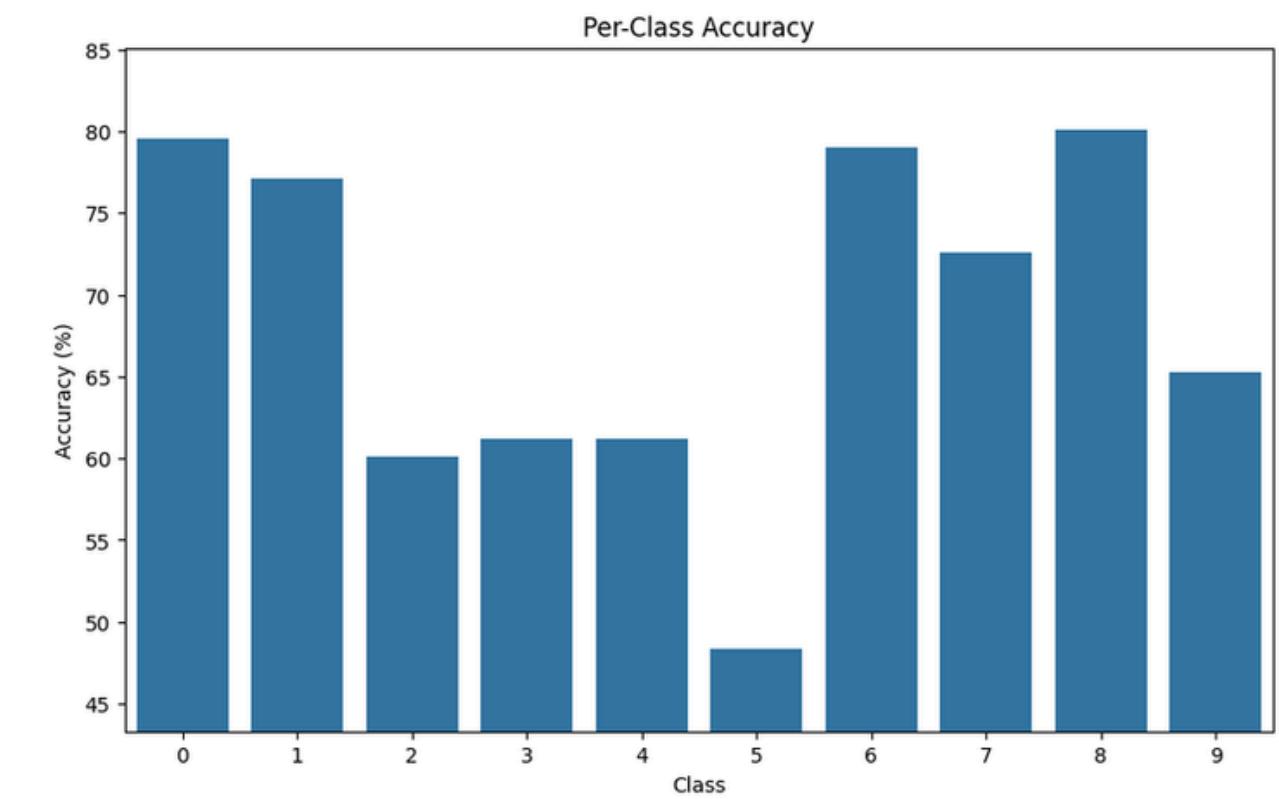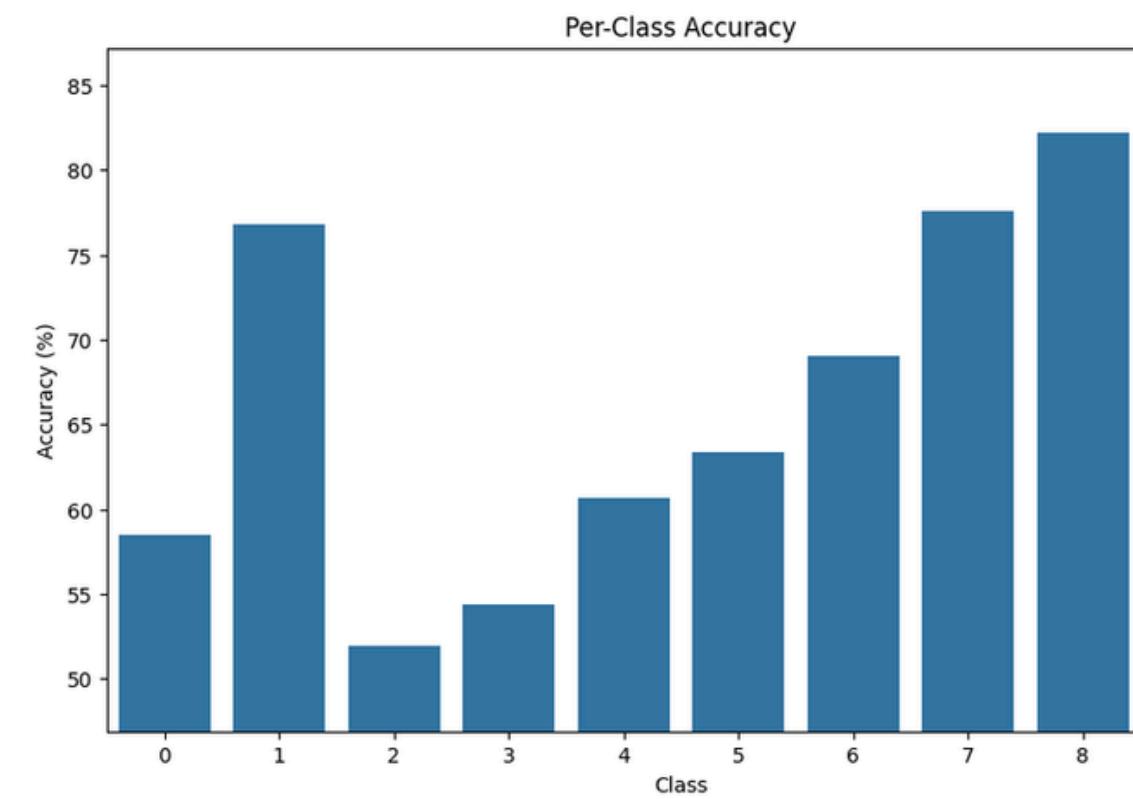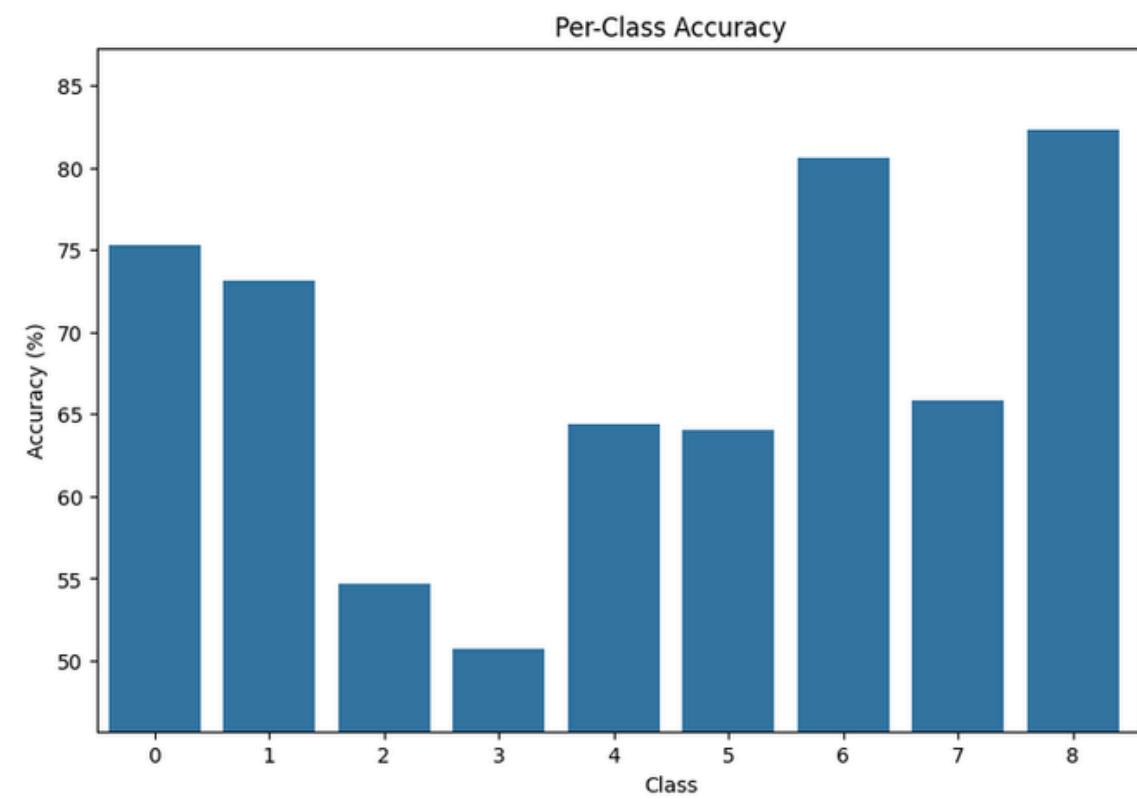
imbalanced airplance
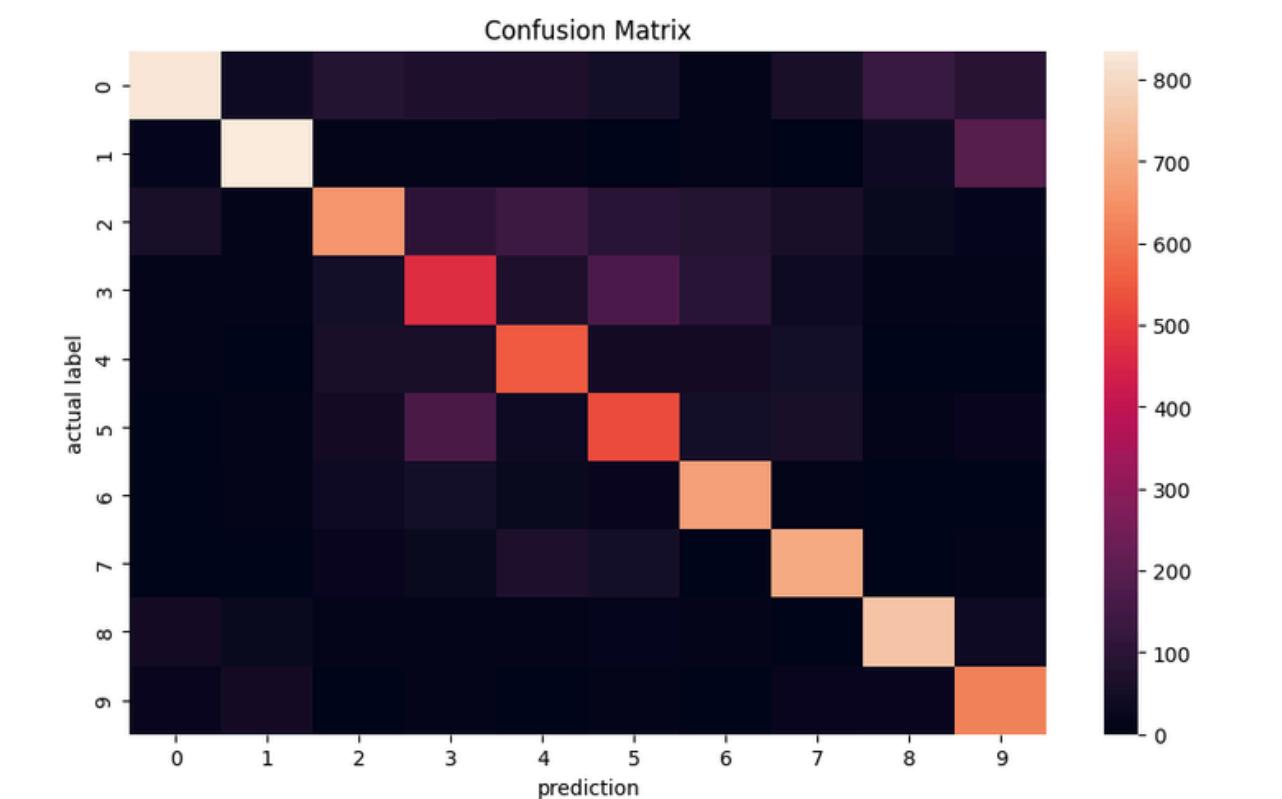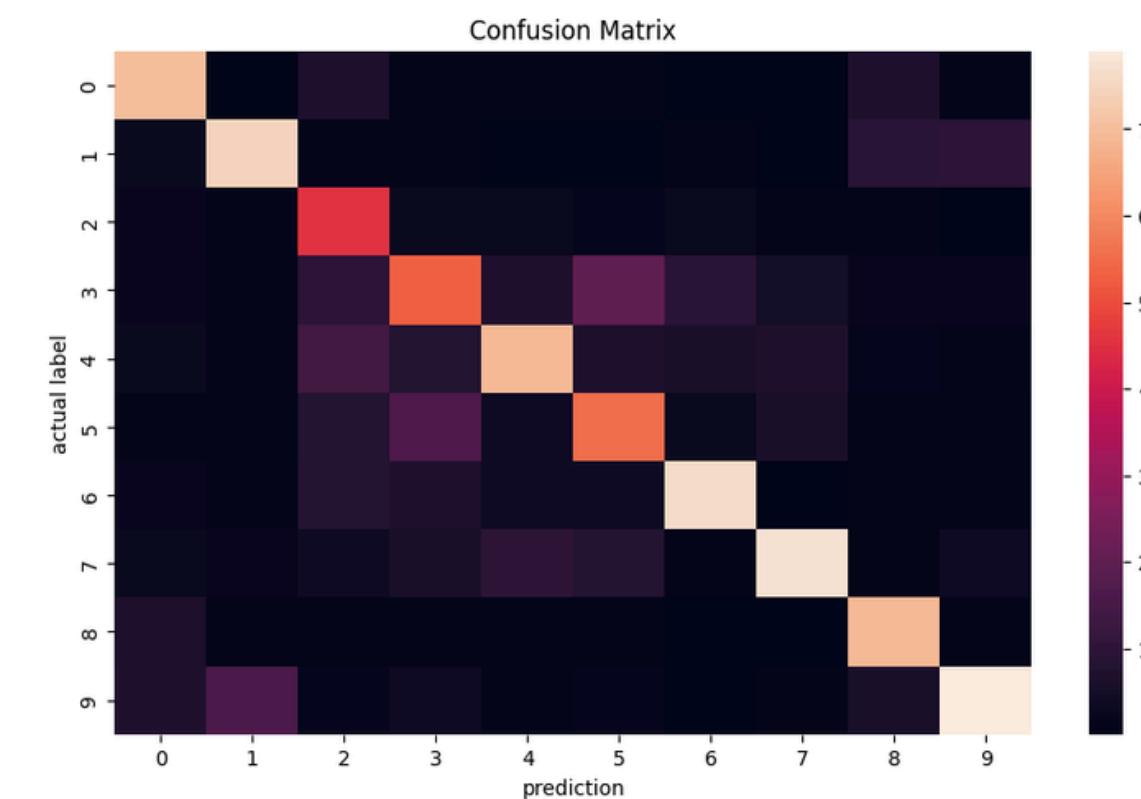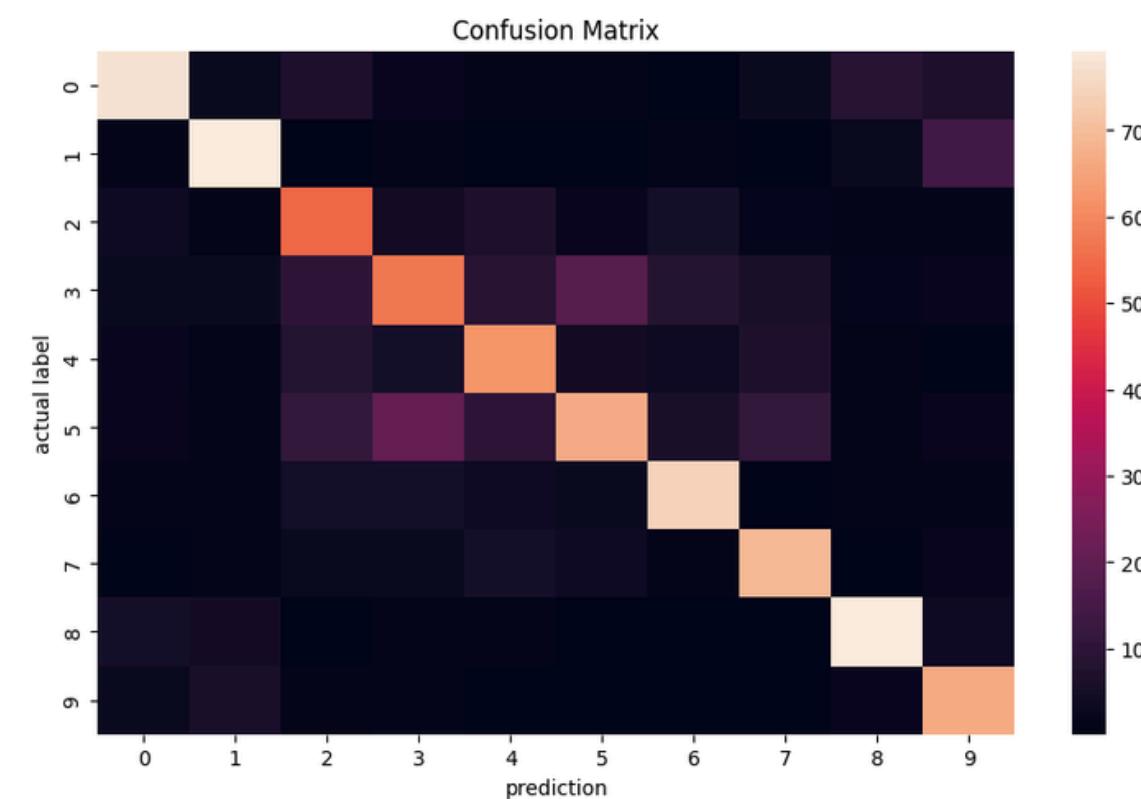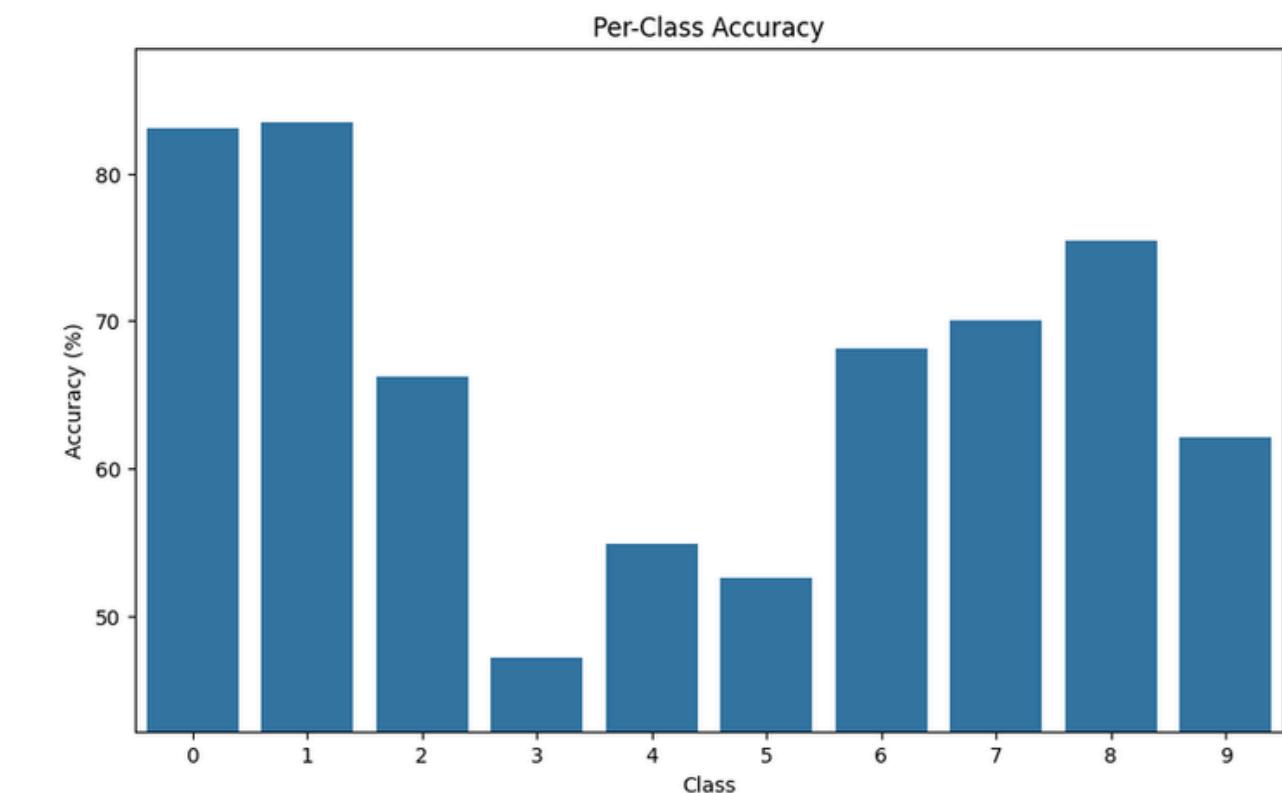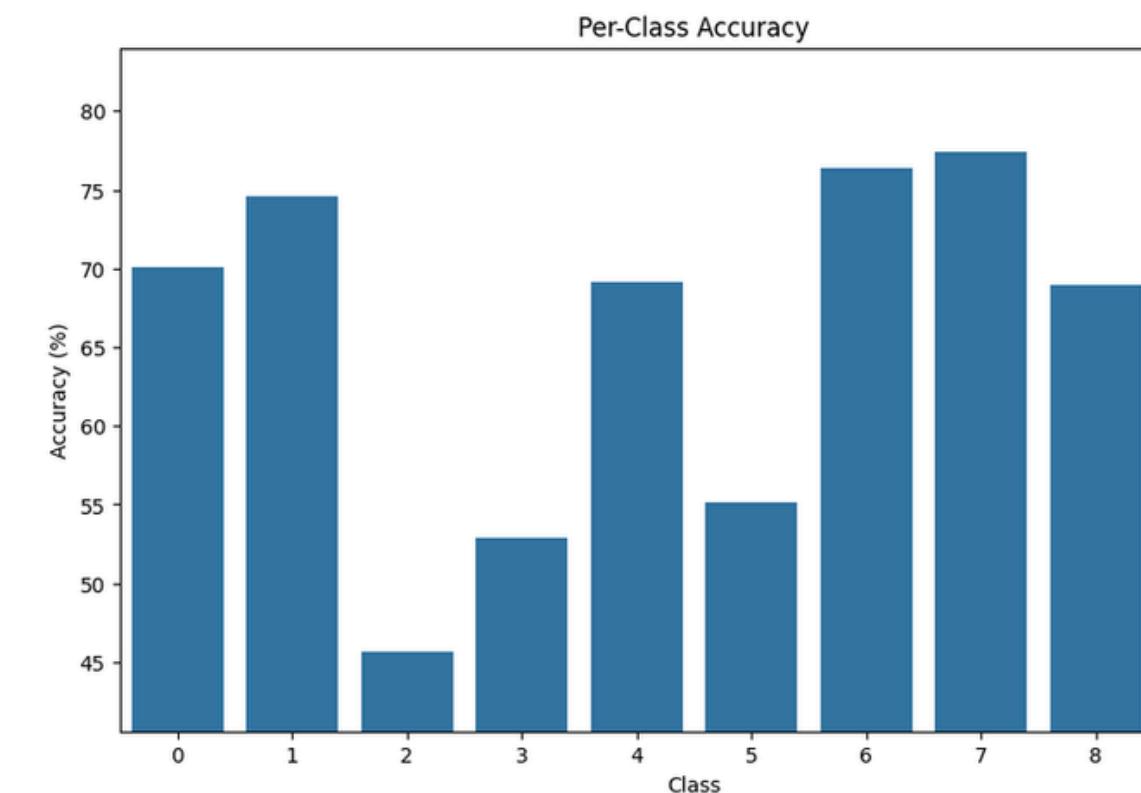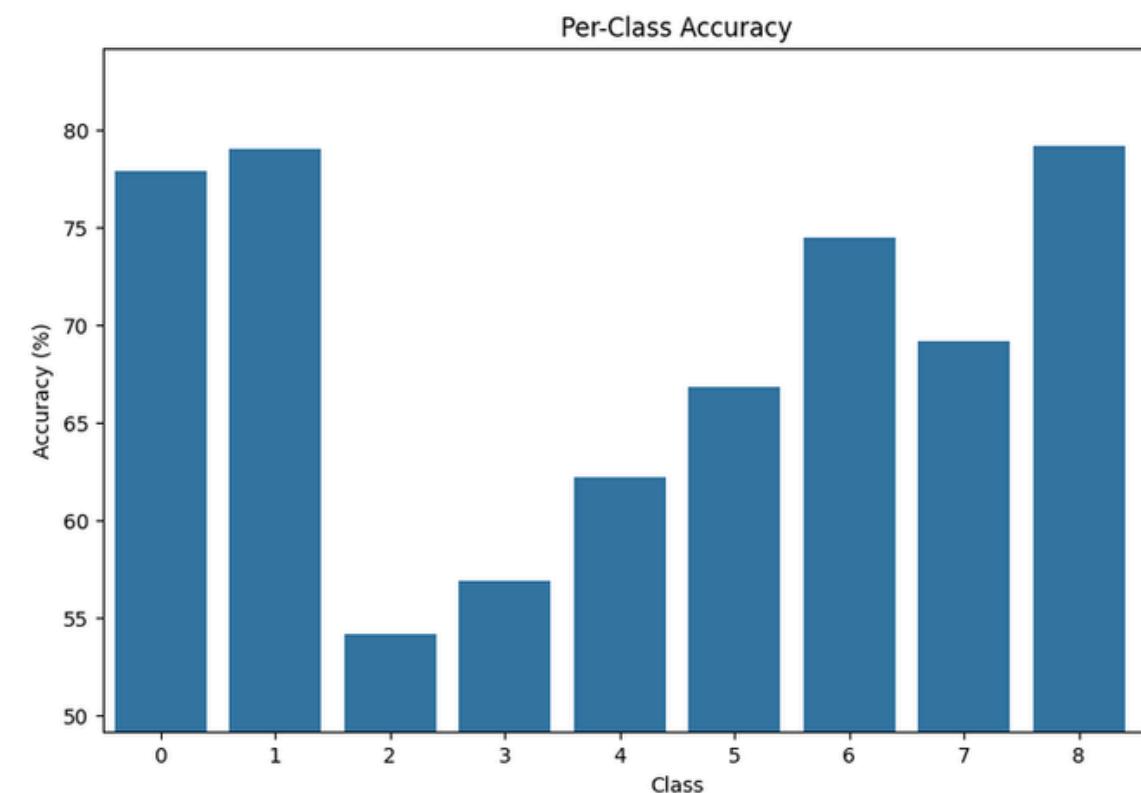


weighted-CrossEntropy Loss

Class-Balanced Loss
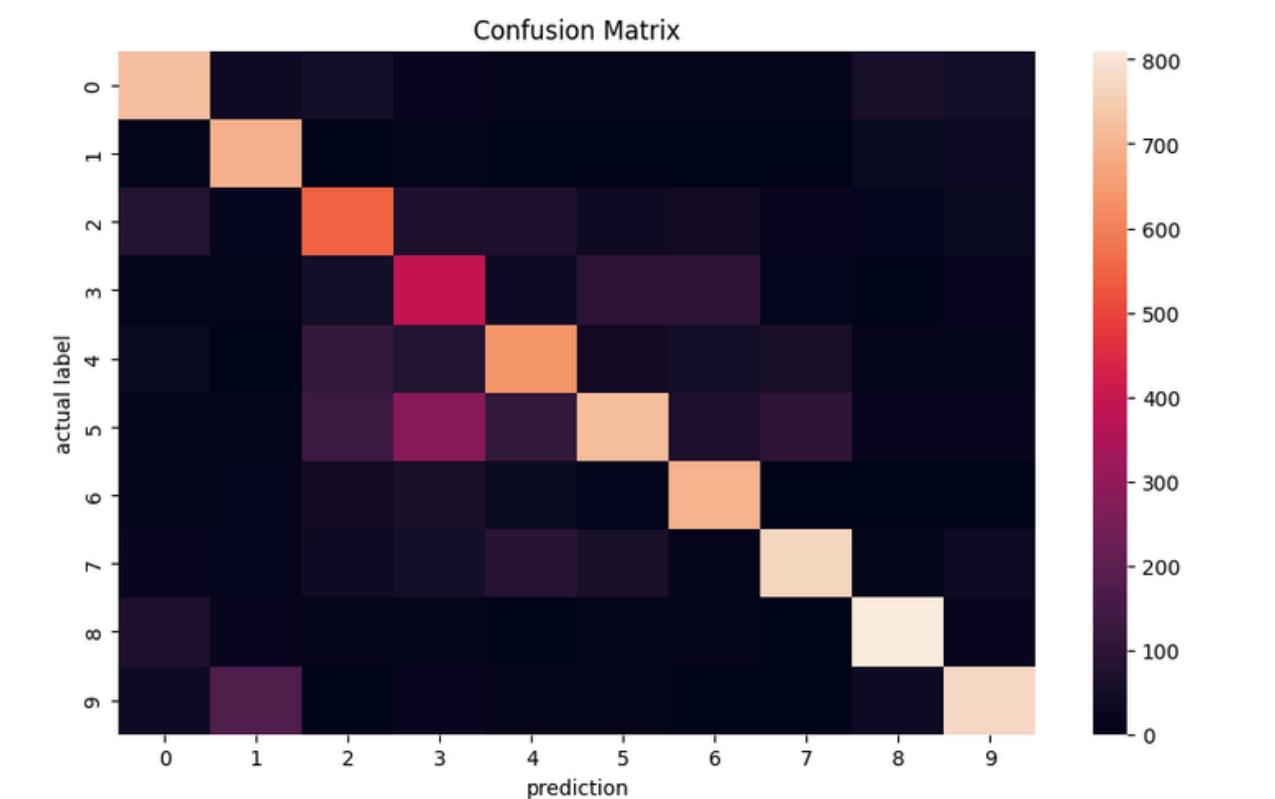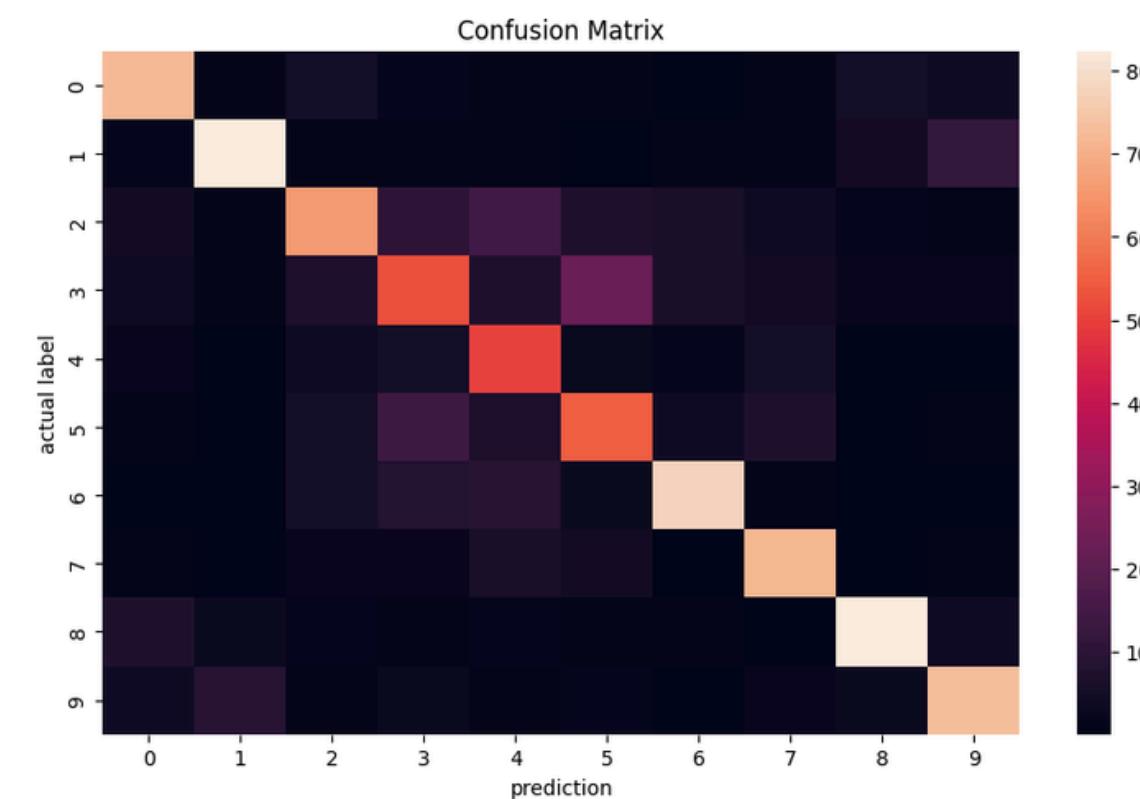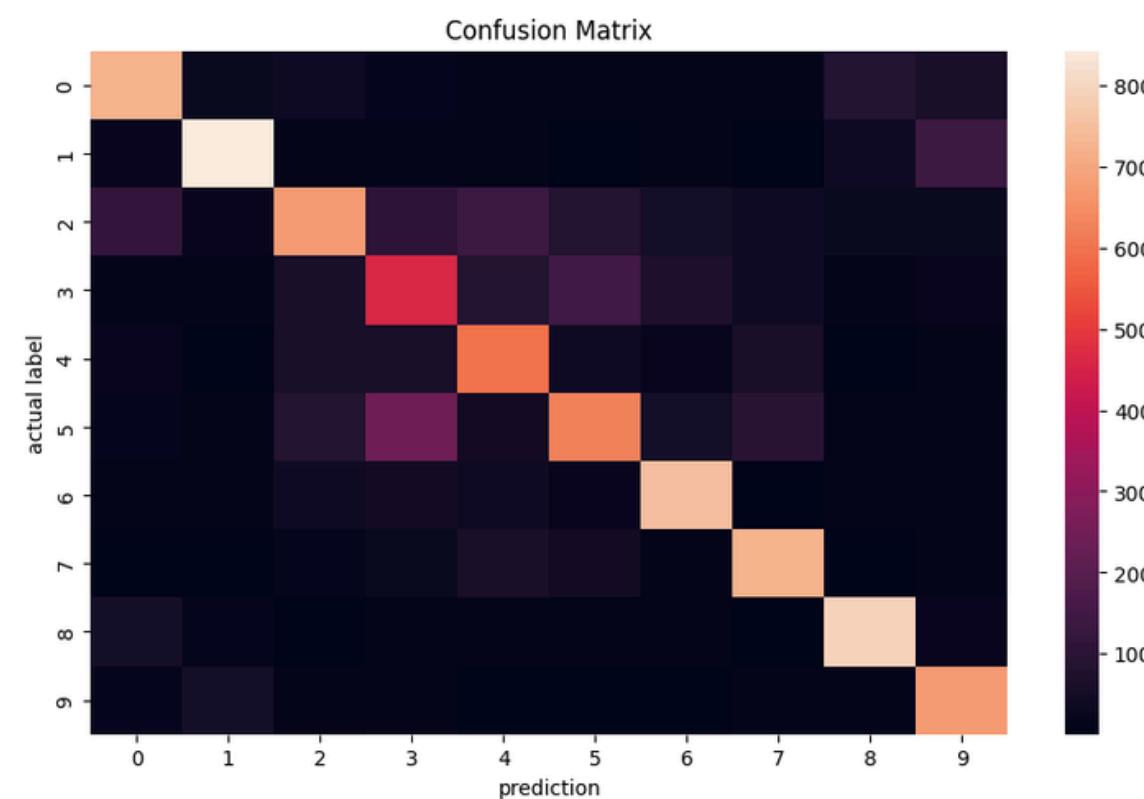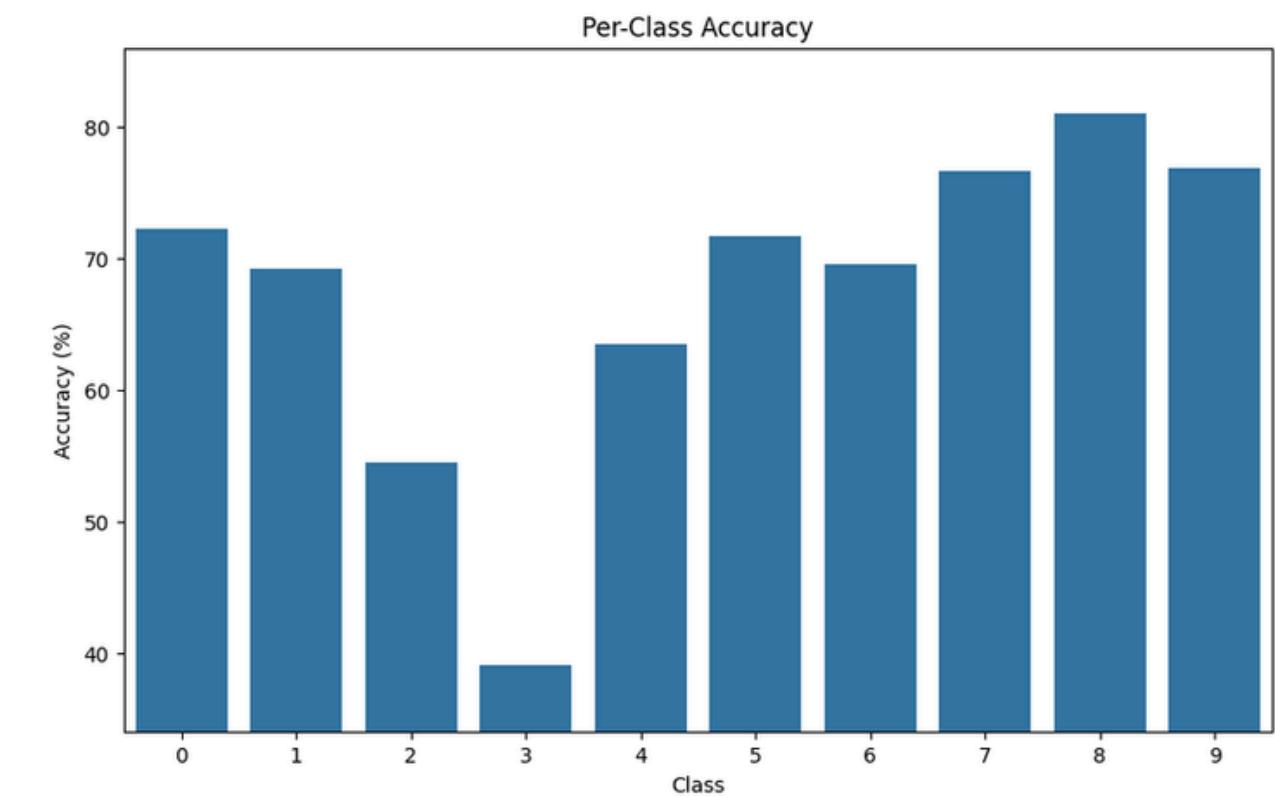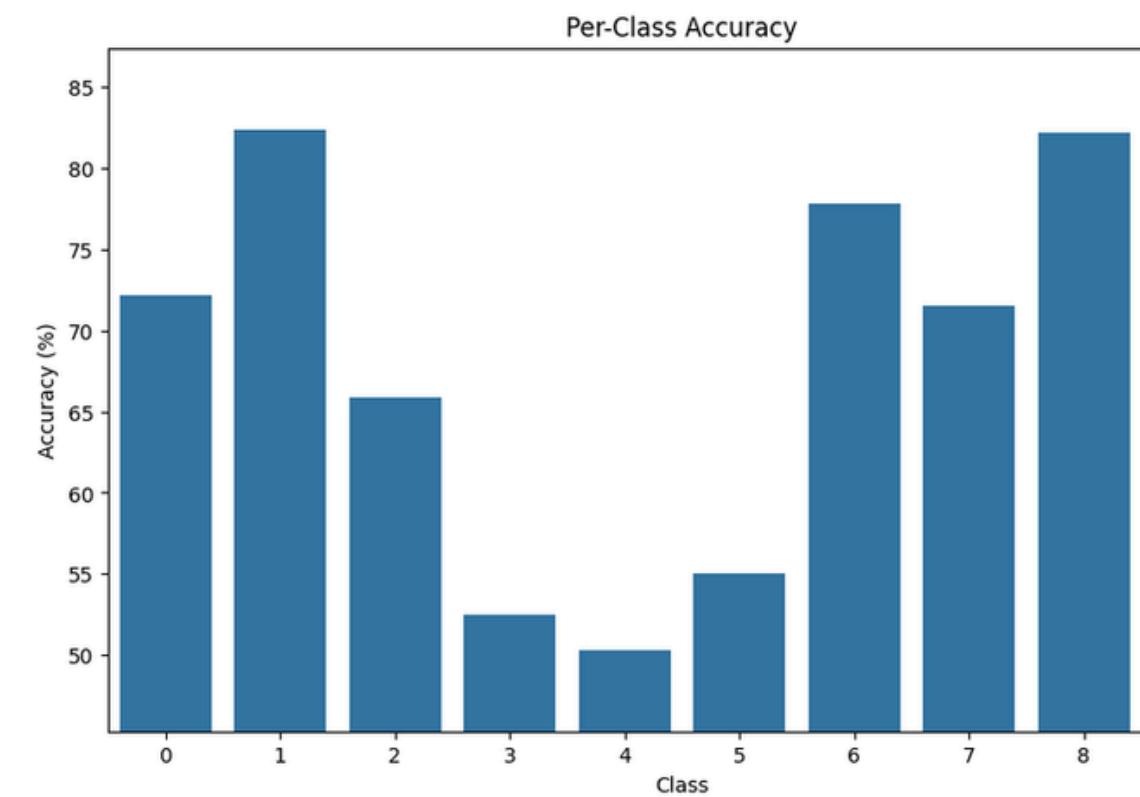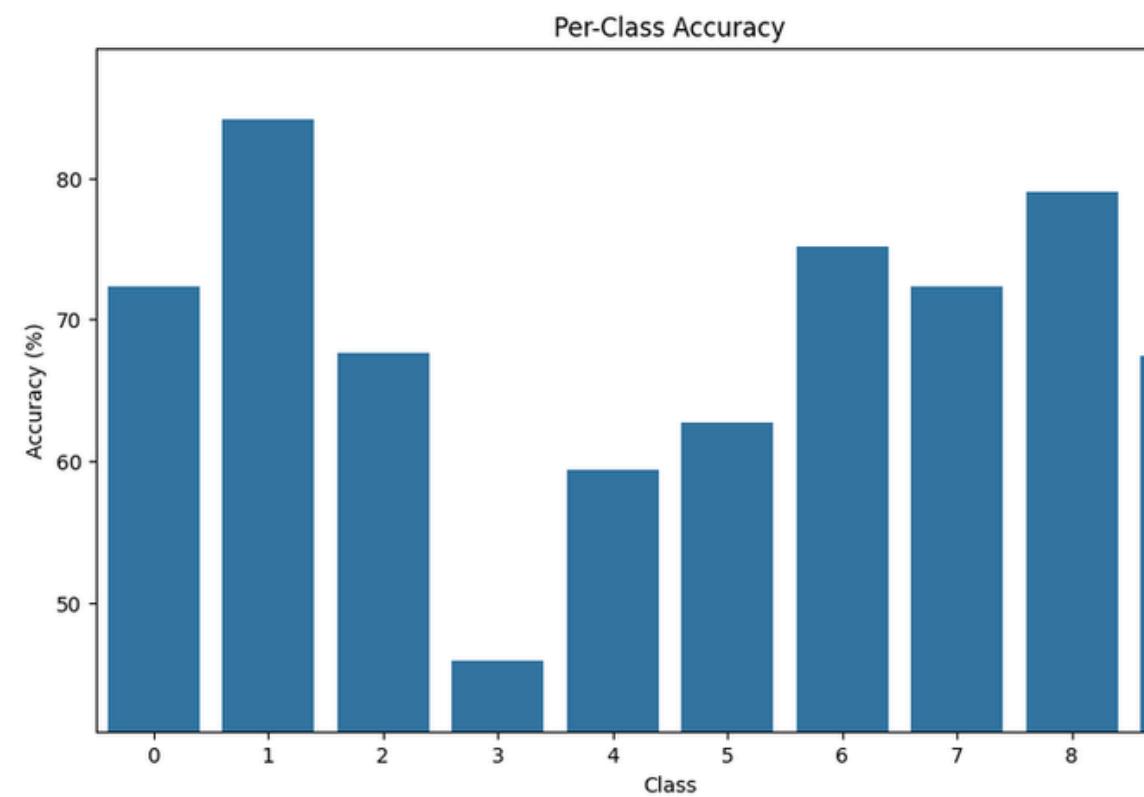
Observation 3 - Confusion Matrix
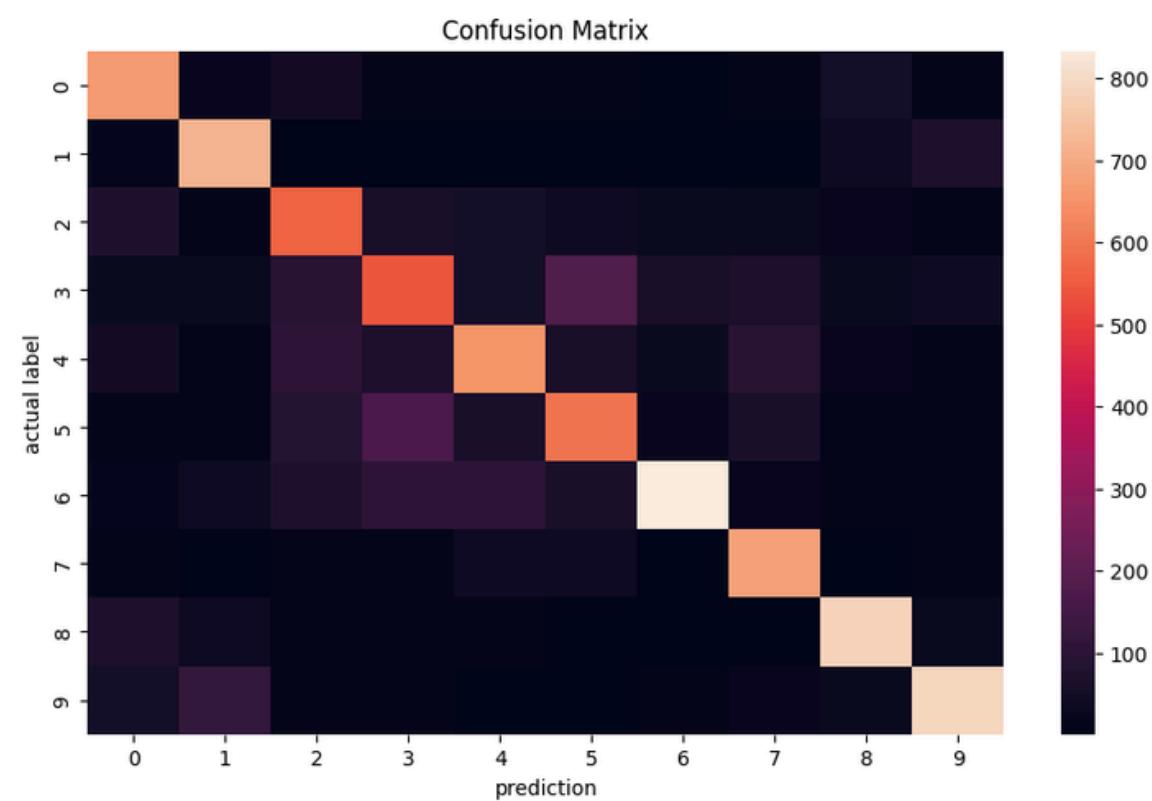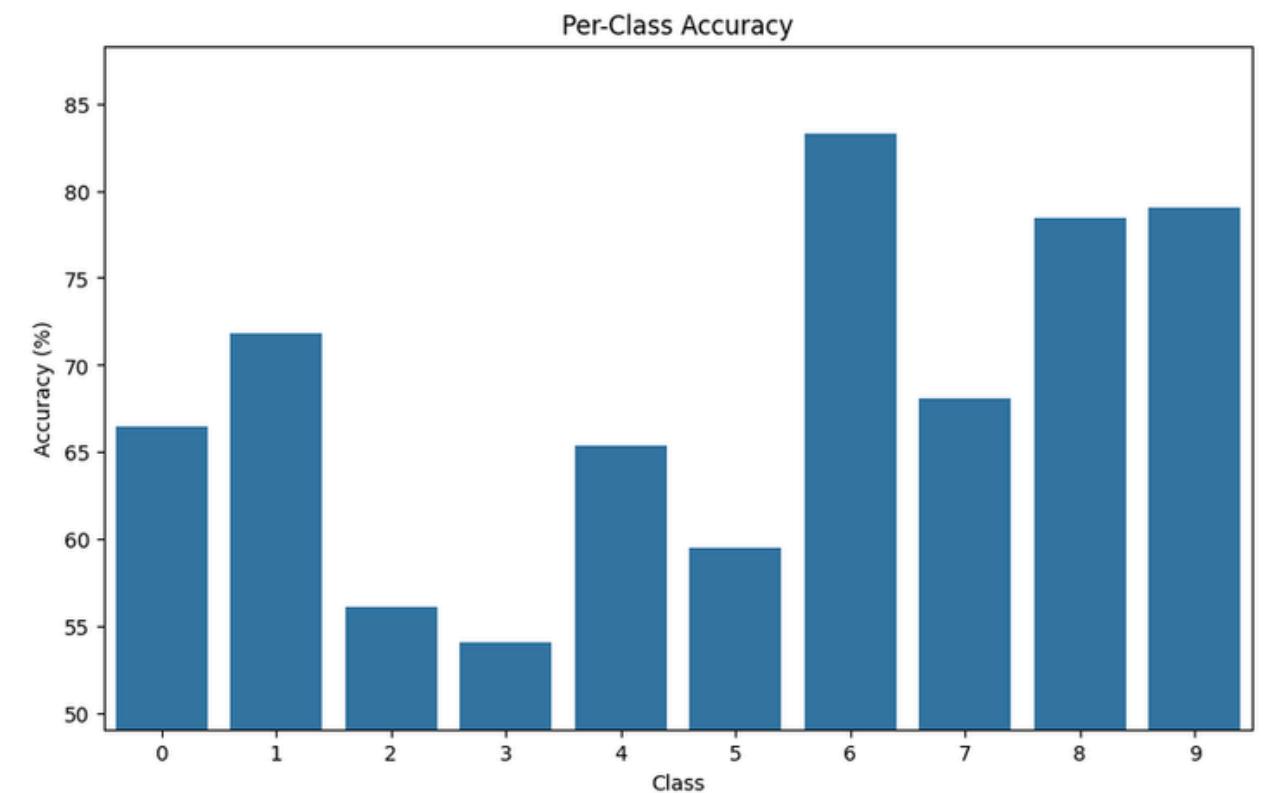
Observation 3 - Confusion Matrix
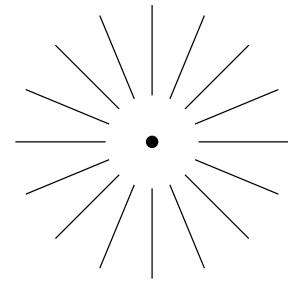
Observation 3 - Confusion Matrix
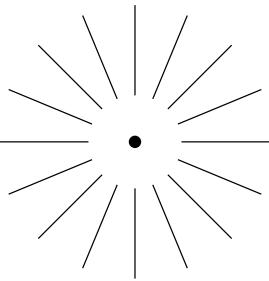
Observation 3 - Confusion Matrix
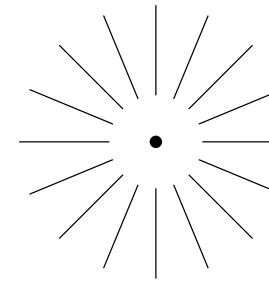
Training Accuracy Progression

In all runs, the training accuracy starts around 42%-44% in the first epoch.

It increases steadily over the epochs, reaching around 92%-93% by epoch 10.
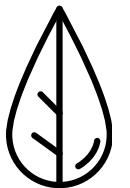
In the last experiment, where the model was trained for 20 epochs, the accuracy reached 100% at epoch 18, indicating possible overfitting.

Confusion Matrices Analysis
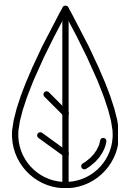
- The confusion matrices represent the model's classification performance across 10 different classes.
- Common misclassification patterns exist across different runs, suggesting that certain classes are consistently more challenging for the model.
- Some matrices show higher off-diagonal values, indicating that specific classes are being frequently misclassified.

Training Accuracy Trends

10-Epoch Runs:

- The model shows steady and smooth improvement in training accuracy across epochs.
- The training accuracy plateaus around 92%, suggesting the model has learned most of the patterns in the dataset.
- This suggests that 10 epochs are sufficient for the model to learn general patterns without excessive overfitting.

20-Epoch Run:

- The accuracy surpasses 99% by epoch 14 and reaches 100% by epoch 18.
- This indicates overfitting, as it suggests the model is memorizing the training data rather than generalizing.
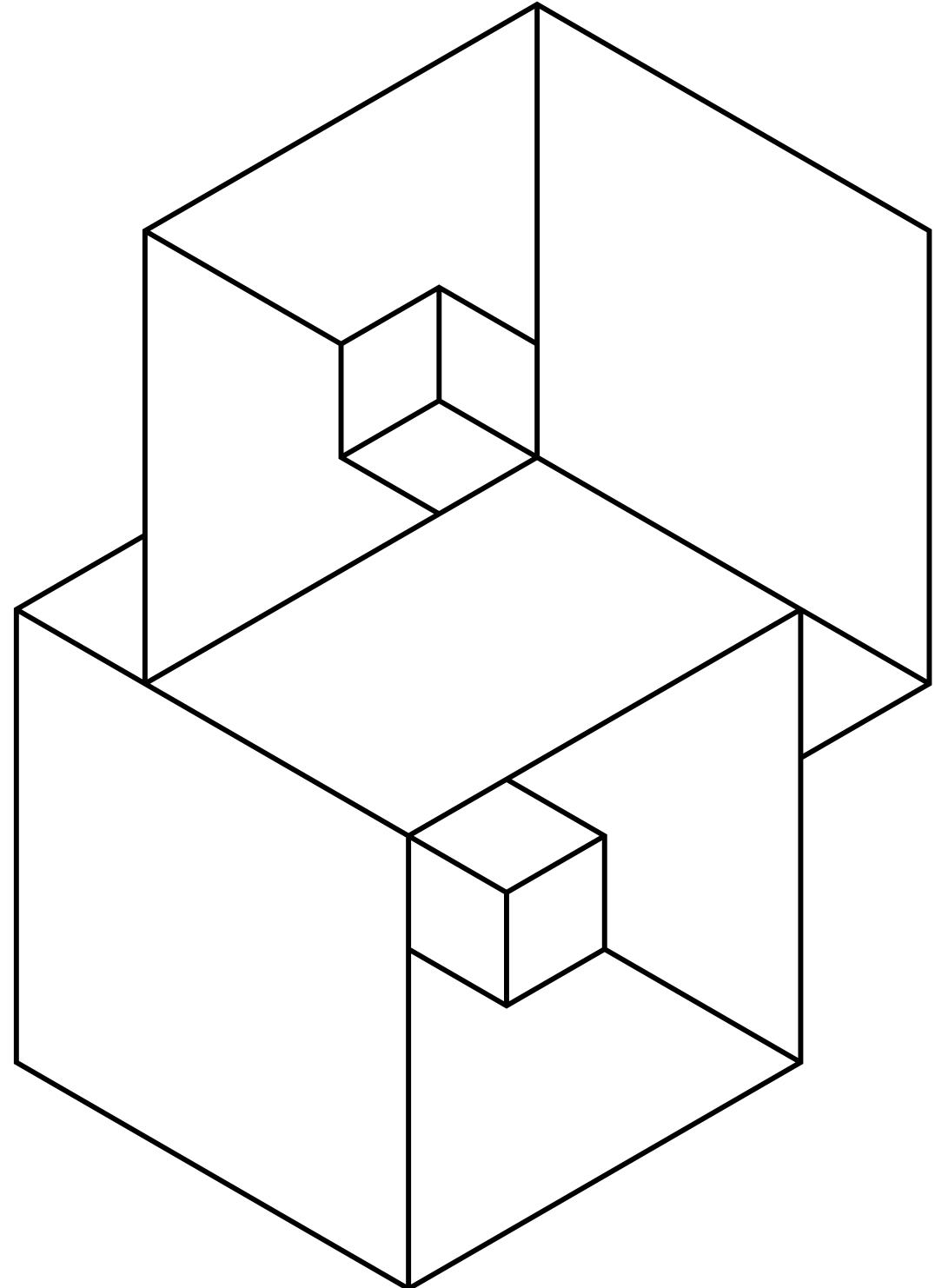
Class Imbalance and Confusions

- Some classes are more frequently misclassified than others.
- The confusion matrices indicate that the model struggles with specific categories.
- Misclassification appears concentrated in certain classes, which could mean:
  - Some classes have similar features and are hard to distinguish.
  - Some categories might have lower representation in the dataset, leading to fewer samples for learning.
  - The dataset might have overlapping feature distributions among certain classes.

Impact of Longer Training

The final confusion matrix in the 20-epoch run still shows some misclassifications, but the model has improved in recognizing certain classes.

However, a perfect 100% training accuracy suggests that the model has learned the training set too well and may not generalize well to unseen data.

Conclusion

 • - Dataset heterogeneity significantly impacts deep learning models.
 • - Weighted loss functions help mitigate imbalances but require fine-tuning.
 • - Future work: experiment with advanced loss functions and data augmentation.
 • - Study findings contribute to improving model robustness in real-world applications.

Thank you