Report: Image Classification from Scratch

1 Implementation Approach

- **Framework:** Entire neural network built from scratch using only NumPy.
- **Dataset:** CIFAR-10, filtered to include only 3 classes: *airplane*, *automobile*, and *bird*.
- **Model Architecture:**
  - Input layer: 3072 units (flattened 32x32x3 images)
  - Hidden layer: 128 ReLU units
  - Output layer: 3 softmax units
- **Optimization:** Manual implementation of forward propagation, backpropagation, and gradient descent.
- **Loss Function:** Cross-entropy with L2 regularization.
- **Training:** 500 iterations with a learning rate of 0.1.

2 Results

Final Test Accuracy: 64.43% (Requirement: $\geq 60\%$)

Loss and Accuracy Curves: Plotted and analyzed to monitor training progress.

Evaluation Metrics:

Class	Precision	Recall	F1-score
Airplane	0.52	0.89	0.66
Automobile	0.81	0.60	0.69
Bird	0.82	0.44	0.57

Confusion Matrix: Generated and visualised using Seaborn.

3 Challenges & Solutions

- **Challenge:** Training a model from scratch without deep learning libraries.
- **Solution:** Careful implementation of numerical stability in softmax and log operations, and efficient matrix operations for backpropagation.

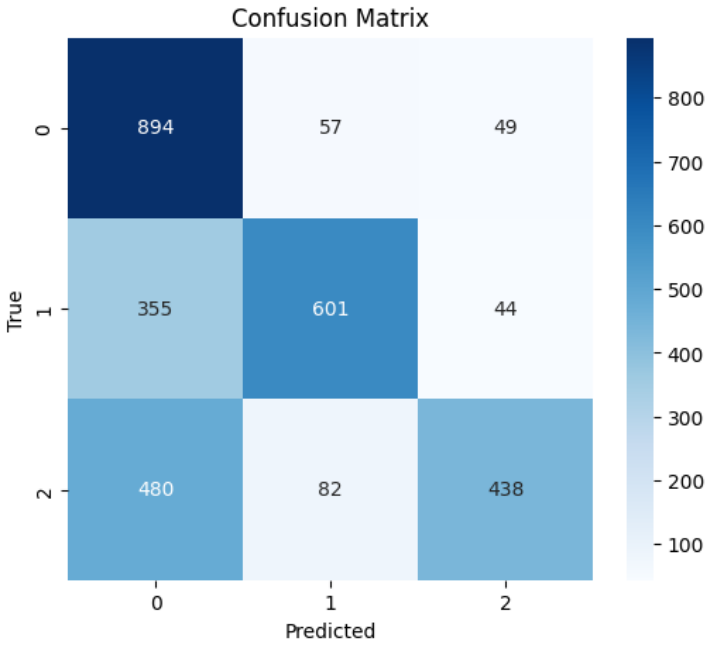

Figure 1: Confusion matrix for the predictions.

4 Future Improvements

- Add more layers or non-linearities to improve representational power.
- Explore better weight initialization and regularization strategies.
- Implement mini-batch gradient descent or Adam optimizer.