Neural Network from Scratch

Implementation Approach:

1. Loaded CIFAR-10 dataset and filtered 3 classes (e.g., cat, dog, automobile).
2. Preprocessed data (flattening + normalization).
3. Built a fully connected network:
   - Input layer (3072 units)
   - Hidden layer(s) with ReLU
   - Output layer with softmax activation
4. Forward propagation implemented using dot products and activations.
5. Backpropagation computed layer-wise gradients.
6. Updated weights with gradient descent.

Results & Performance:

- Accuracy: ~60–70%
- Precision, Recall, and F1-score computed for each class
- Plotted loss vs epoch curve to monitor training convergence
- Confusion matrix revealed most misclassifications happened between visually similar classes.

Challenges Faced:

- Gradient computation errors due to shape mismatches
- Overfitting due to limited training data and simple architecture
- Long training time without vectorized batch operations

Solutions:

- Debugged using shape assertions and intermediate print statements
- Implemented mini-batch gradient descent for stability
- Tuned learning rate and weight initialization

Future Improvements:

1. Use Convolutional Neural Networks (CNNs) for spatial feature extraction
2. Add momentum or Adam optimizer for faster convergence
3. Introduce dropout and batch normalization
4. Expand to all 10 classes of CIFAR-10