Image Classification using Neural Network

**Problem Statement**: Build a neural network for image classification using CIFAR-10 dataset.

Data Collection: Images are collected from the CIFAR dataset, which consists of 60,000 color images containing one of 10 classes, with 6,000 images per classe. The classes are airplane, automobile, bird, cat, deer, dog, frog, horse, ship and truck.

Images are divided into two sets, training(50,000 images) and testing(10,000 images) set. In the training set, each class contains 5,000 images. In the testing set, each class contains 1,000 images.

Model Design: A convolutional neural network(CNN) is used for this classification. The model contains 3 convolutional layer followed by batch normalization, max pooling for spatial down-sampling and dropout for preventing overfitting problem. These layers extract hierarchical features from input images while reducing dimensions. In this model, rectified Linear Unit(ReLU) activation function is used to decide whether a neuron can be activated or not. The model uses categorical cross-entropy as loss function which is suitable for multi class classification and the Adam optimizer for increasing the efficiency of the model's learning process.

Model Training: The model is trained by defining 50 epochs with specified steps_per_epoch, which is calculated as the total number of training images divided by the batch size, which is 32.

The training vs validation loss/accuracy curves are given below:
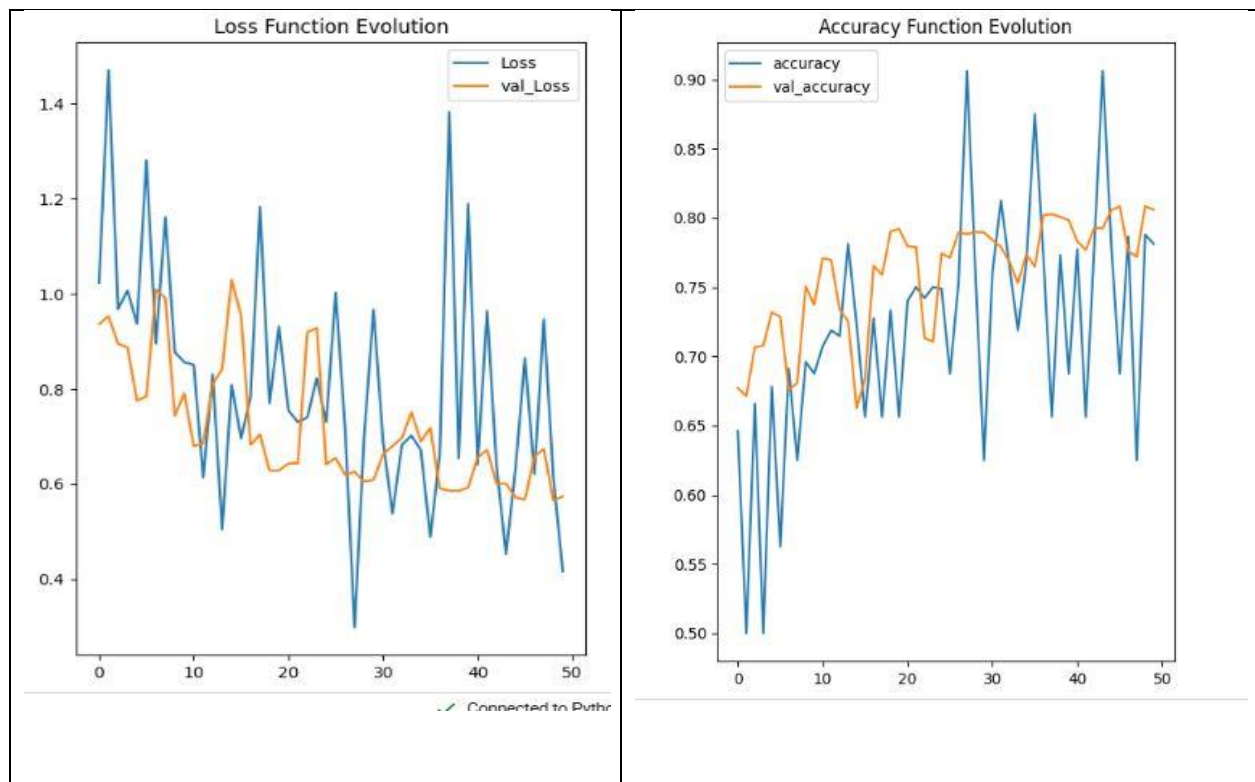
Model Evaluation: Model evaluation is a process which uses some metrics to analyze the performance of the model. Among them, confusion matrix is widely used to evaluate a model.

Confusion matrix for the model is given below:
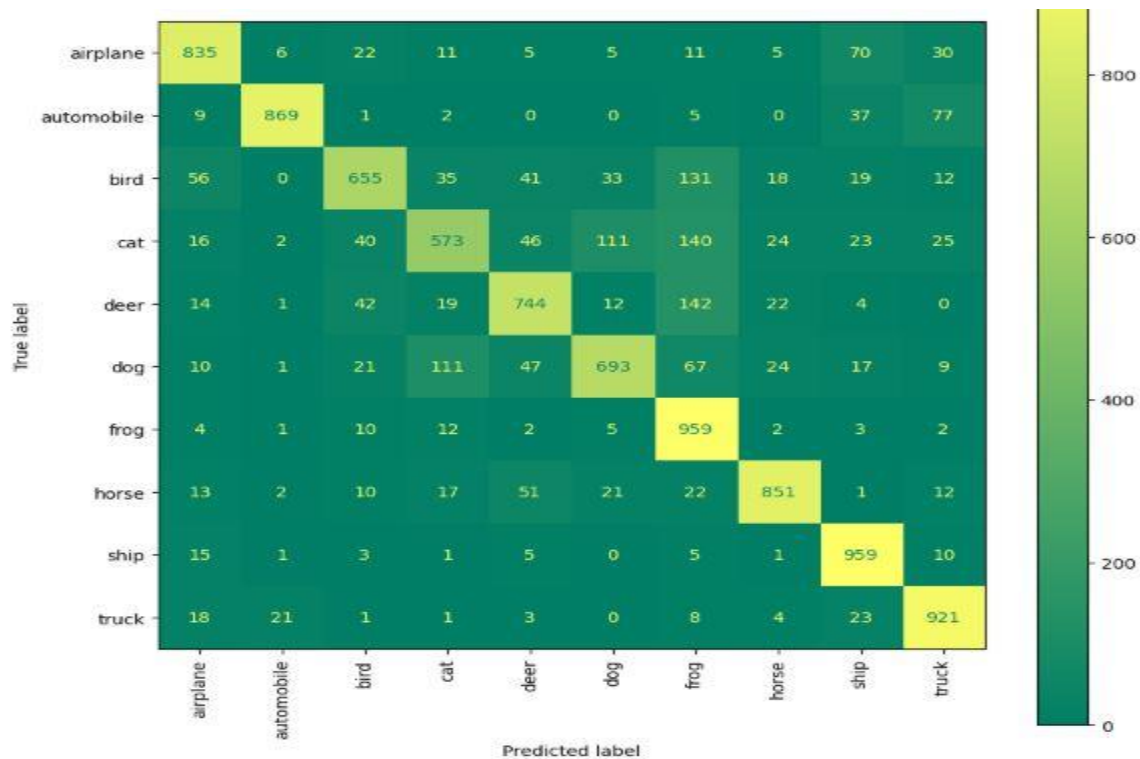
Classification report represents the overall performance of a model. The overall accuracy is 0.81 which indicates that this cnn model correctly classifies 81% samples.

	precision	recall	f1-score	support
0	0.84	0.83	0.84	1000
1	0.96	0.87	0.91	1000
2	0.81	0.66	0.73	1000
3	0.73	0.57	0.64	1000
4	0.79	0.74	0.77	1000
5	0.79	0.69	0.74	1000
6	0.64	0.96	0.77	1000
7	0.89	0.85	0.87	1000
8	0.83	0.96	0.89	1000
9	0.84	0.92	0.88	1000
accuracy			0.81	10000
macro avg	0.81	0.81	0.80	10000
weighted avg	0.81	0.81	0.80	10000

Error Analysis: From the Confusion matrix, it can be highlighted that some classes are misclassified. And model accuracy is less than 85%. To improve feature extraction, Transfer Learning with pre-defined model like ResNet, VGG etc. can be used.