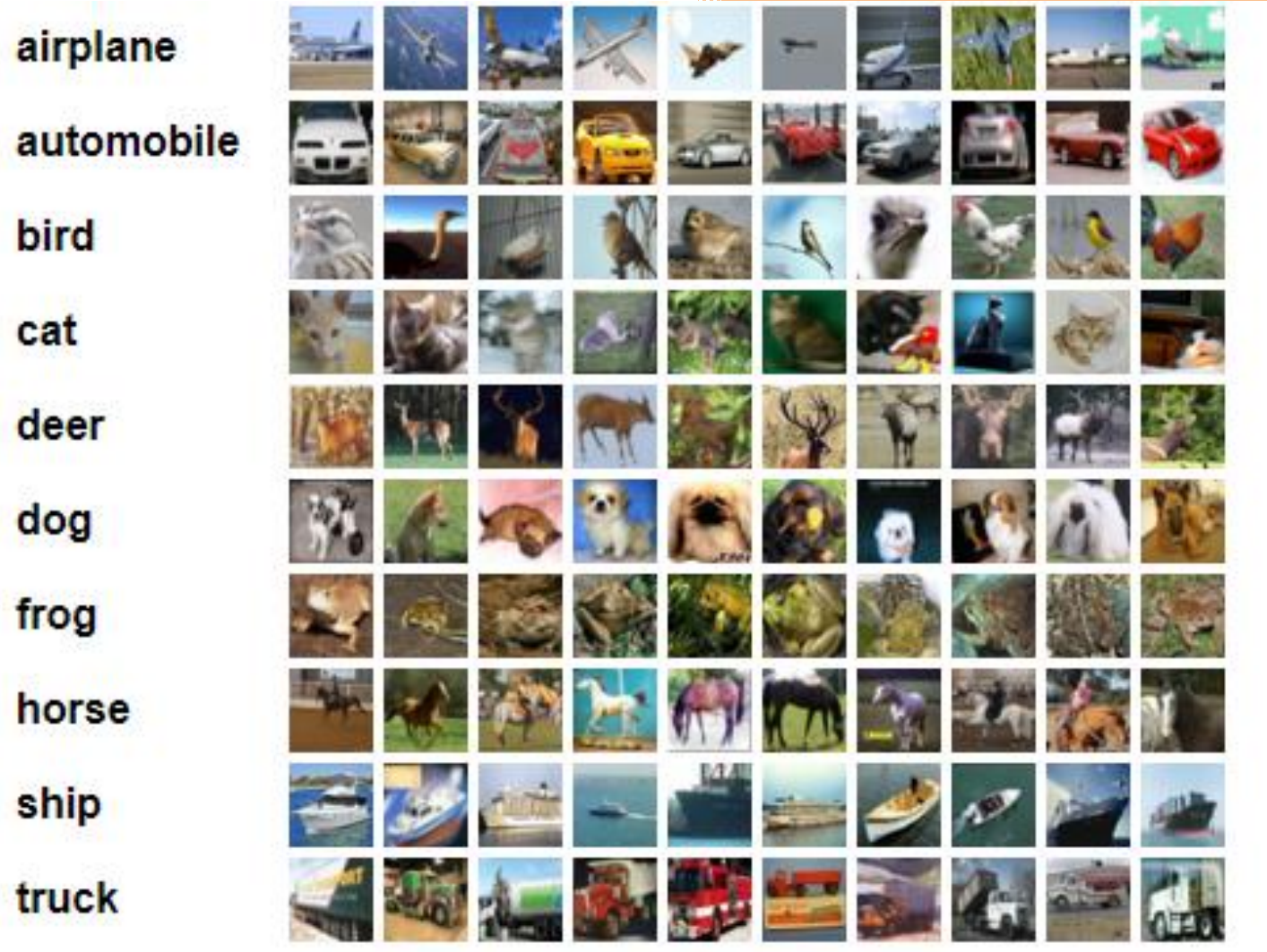
Submitted to: IITD, Delhi

CAPSTONE PROJECT: CIFAR-10



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CAPSTONE PROJECT: CIFAR-10 Object Recognition Using CNN

Problem Statement

The goal of this project is to develop a Convolutional Neural Network (CNN) to classify images from the CIFAR-10 dataset into one of ten predefined classes. The project also includes a user interface built with Streamlit to test the model with external images via URLs.

Dataset Description

The CIFAR-10 dataset is a collection of 60,000 color images, each of size 32x32 pixels, belonging to 10 different classes: Airplane, Automobile, Bird, Cat, Deer, Dog, Frog, Horse, Ship, and Truck. The dataset is split into 50,000 training images and 10,000 test images. The images are normalized to have pixel values between 0 and 1, and the labels are one-hot encoded.

Methodology

A Convolutional Neural Network (CNN) was implemented using TensorFlow and Keras. The architecture consists of convolutional layers, max-pooling layers, a dropout layer for regularization, and a fully connected softmax layer for classification. The model was trained for 10 epochs with a batch size of 64 using the Adam optimizer.

Experimental Details

Architecture Description

The CNN model architecture includes the following layers:
1. Convolutional layer with 32 filters, kernel size (3,3), ReLU activation.
2. MaxPooling layer with pool size (2,2).
3. Convolutional layer with 64 filters, kernel size (3,3), ReLU activation.
4. MaxPooling layer with pool size (2,2).
5. Convolutional layer with 128 filters, kernel size (3,3), ReLU activation.
6. Flatten layer.
7. Dense layer with 128 neurons, ReLU activation.
8. Dropout layer with rate 0.5.
9. Dense layer with 10 neurons, softmax activation.

Evaluation Metrics

The model was evaluated using categorical crossentropy loss and accuracy metrics during training and testing.

Dataset Split

The dataset was split as follows:
- Training: 50,000 images (83.3%)
- Testing: 10,000 images (16.7%)

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Implementation Details

The model was trained with the following hyperparameters:
- Optimizer: Adam
- Batch size: 64
- Epochs: 10
- Validation data: CIFAR-10 test set

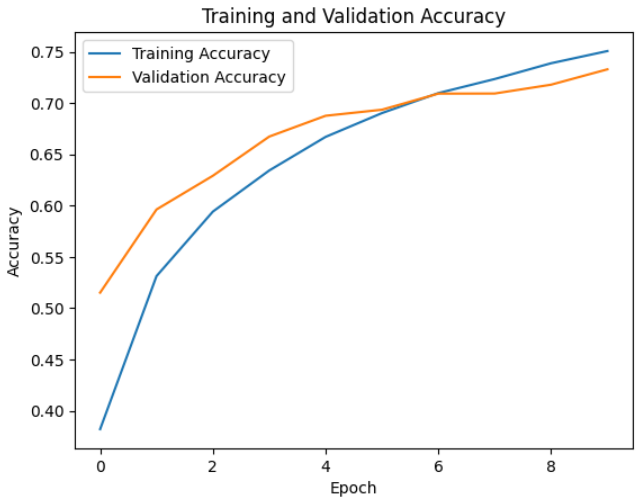
Results and Discussion

Results

The model achieved a test accuracy of approximately 70-75% after 10 epochs. The training and validation accuracy plots over epochs indicate good learning progress.

Visualizations

Below are the plots of training and validation accuracy over epochs.



Analysis

The model performed well for a basic CNN architecture. However, the accuracy could be further improved by employing techniques such as data augmentation, using a deeper network, or hyperparameter tuning.

Improvements

Future improvements could include:
1. Data augmentation to enhance the diversity of the training set.
2. Use of transfer learning with pre-trained models.
3. Experimenting with advanced optimizers and learning rate schedules.
4. Increasing the number of epochs for better convergence.

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