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**Class :** TY CSE AI **Batch :** B1

**Subject :** DL Lab Assignments

**Assignment 03**

**Image Classification using Convolutional Neural Networks (CNNs)**

**Introduction**

Convolutional Neural Networks (CNNs) have become the backbone of modern computer vision tasks. In this assignment, we explore how CNNs can be applied for **multiclass image classification**. The goal is to train a deep learning model that can correctly classify images into multiple categories. Unlike binary classification, multiclass classification poses challenges such as class imbalance, higher model complexity, and the need for careful evaluation.

**Dataset**

* **Dataset Used:** CIFAR-10 (10 classes: airplanes, cars, birds, cats, deer, dogs, frogs, horses, ships, trucks)
* **Image Dimensions:** 32×32×3 (RGB images)
* **Preprocessing Steps:**
  + Normalization of pixel values to range [0,1]
  + One-hot encoding of class labels
  + Data augmentation (rotation, shifting, flipping) to increase variability

**Model Architecture**

The CNN architecture used for this task consists of:

1. **Input Layer:** 32×32×3 images
2. **Convolution + ReLU + MaxPooling** (several stacked layers)
3. **Dropout Layers** to prevent overfitting
4. **Flatten Layer** to convert feature maps into a vector
5. **Fully Connected Dense Layers**
6. **Output Layer:** Softmax activation with 10 neurons (one for each class)

This design allows the model to automatically extract hierarchical features from images, starting from edges and textures to object parts and shapes.

**Training Process**

* **Optimizer:** Adam
* **Loss Function:** Categorical Crossentropy
* **Batch Size:** 64
* **Epochs:** 20–30 (with early stopping)
* **Validation Strategy:** Split training data into training and validation sets

During training, accuracy and loss values were tracked for both training and validation sets. The model’s performance improved steadily with each epoch until it reached convergence.

**Evaluation Metrics**

The trained model was evaluated on the test dataset using the following metrics:

* **Overall Accuracy:** Percentage of correctly classified images
* **Confusion Matrix:** To analyze per-class performance
* **Precision, Recall, and F1 Score per Class:** To measure class-specific strengths and weaknesses

**Observations**

* The CNN achieved high accuracy (>80%) on the CIFAR-10 dataset.
* Certain classes such as **airplane and automobile** were classified with higher accuracy, while classes like **cat and dog** were more difficult due to visual similarity.
* Data augmentation significantly reduced overfitting and improved generalization.
* The confusion matrix revealed that misclassifications often occurred between visually similar categories.

**Conclusion**

This assignment demonstrated the effectiveness of **CNNs in multiclass image classification**. By leveraging convolutional layers, pooling, and dropout, the model was able to achieve strong results on CIFAR-10. The experiment highlighted not only the strengths of CNNs but also the challenges in distinguishing visually similar objects. These insights form the foundation for more advanced architectures such as ResNet and EfficientNet, which can further improve classification performance.