**Convolutional Neural Network (CNN) Image Classification Project Proposal**

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# **Abstract:**

The focus of this project lies in designing and implementing the CNN model on the CIFAR-10 dataset for image classification. To go ahead with this, first of all, the training and test the model by various metrics shall be done, and then its performance shall be compared with existing state-of-the-art models. The project will also contribute toward the developments of highly accurate and efficient models of image classification using CNNs.

# **Introduction:**

It is one of the fundamental problems in computer vision. Nevertheless, its application spans across different tasks including object recognition, scene understanding, and image retrieval. One of the famous benchmarks that had been used in testing the performance of this image classification is the CIFAR-10 benchmark. Among different models that have been studied in solving this problem, there has been a tremendous performance demonstrated by convolutional neural networks (CNN), where they have achieved the state-of-the-art performances on different image classification datasets.

The recent years have concentrated intensive research on enriching these CNN models with better performance and efficiency in image classification. While state-of-the-art models find applications in various areas of biomedical image analysis, autonomous driving, and face recognition, more accurate and efficient models are still highly in demand, especially for performing large-scale image classification tasks.

This project aims at designing and implementing a CNN model that can classify an image from the CIFAR-10 dataset into its class. It consists of 60,000 32x32 color images in 10 classes, with 6,000 images per class. The proposed model will be trained and evaluated based on various metrics and compared to other competitive state-of-the-art models.

# **Background:**

Image classification involves determining whether an image belongs to a particular class. It is one of the most fundamental tasks in computer vision; its applications span object recognition, scene understanding, and image retrieval.

In general, CIFAR-10 is a common benchmark for the performance evaluation of image classification models. It consists of a total of 60,000 32x32 colour images, where all are from 10 classes, each class having 6,000 images. These include airplanes, cars, birds, cats, deer, dogs, frogs, horses, ships, and trucks. The data has been divided into training, validation, and testing sets in a ratio of 50,000 images for training, 10,000 images for validation, and 10,000 images for testing.

Convolutional Neural Networks have been impressive in solving the problem of image classification. It is a neural network that is designed with special consideration to work on tasks of image classification. In CNNs, the network consists of a number of convolutional and pooling layers followed by totally connected layers. Convolutional layers are responsible for the extraction of features from the input images, while the pooling layers downsample the feature maps spatially. Fully connected layers classify the input images into their respective categories.

# **Literature Review:**

In recent years, considerable research effort has gone into building more accurate and efficient CNN models for image classification. [1] put forward AlexNet, a CNN model that achieved state-of-the-art performance on the ImageNet database. It had five convolutional layers, with some followed by max pooling layers and three fully connected layers. The model was trained using a ReLU activation function and the stochastic gradient descent optimizer.

Simonyan and Zisserman [2] came up with VGG, a CNN model which outperformed the state-of-the-art on the ImageNet dataset. It consisted of a number of convolutional layers using 3x3 kernels, followed by max pooling layers. It was trained using the ReLU activation and a stochastic gradient descent optimizer.

He et al. [3], came up with ResNet-a new CNN model, which achieved state-of-the-art performance over the ImageNet data set. This model introduced the concept of residual connections to enable the training of deep networks. The ResNet model followed a sequence of residual blocks; each residual block consisted of several convolutional layers. This was trained on ReLU for activation along with a stochastic gradient descent.

# **Objectives:**

**The objectives of this project are:**

Design and implement a CNN model that can classify images from the CIFAR-10 dataset with high accuracy.

Assess model performance: This is done through the use of metrics for evaluation like Accuracy, Loss, Precision, Recall, and F1-score.

Comparing the performance of the proposed model against the best of existing state-of-the-art models.

# **Methodology:**

**Approaches to be taken in this project will involve the following processes:**

**Preprocessing the Data**: The CIFAR-10 dataset has to be preprocessed for training and testing. It would also involve normalizing the pixel values and splitting them into sets of training, validation, and testing.

The model to be designed is a CNN using the Keras library, comprising a number of convolution and pooling layers followed by fully connected layers.

**Model Training**: It will be trained on the Adam optimizer with a learning rate of 0.001 and a batch size of 32. The model has to be trained for 20 epochs in total.

**Evaluation of Model Performance:** It will be necessary to check model performance with the help of different metrics, such as accuracy, loss, precision, recall, and an F1-score.

# **Expected Outcomes:**

Expected outputs of the project are the following:

A CNN model that accurately classifies images from the CIFAR-10 dataset.

A detailed evaluation of the performance of the model using various metrics.

Comparing the performance of the proposed model with that of state-of-the-art models.

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# **Timeline:**

**The timeline for the completion of this project is as shown:**

* Days 1-2: Data preprocessing and model design:
* Day 3-4: Model training and evaluation
* Day 5-6: Comparison with existing state-of-the-art models, writing of final report
* Day 7: Final project submission

# **Resources:**

**Resources required for the project:**

* This project will be conducted on kaggle
* The CIFAR-10 dataset
* Related literature and research papers

# **Conclusion:**

The goal of the work is to propose and implement a Convolutional Neural Network model for image classification on the CIFAR-10 dataset. The proposed model will be trained and tested using different metrics, which will be compared with the state-of-the-art models. This project contributes, via CNNs, to the development of more accurate and efficient image classification models that have constantly been proven to perform excellently in image classification tasks. Thus, the outcome of this project can show how well CNNs work in an image classification problem that might be used in object recognition, scene understanding, and image retrieval.

# **Refrences:**

[1] Krizhevsky, A., Sutskever, I., & Hinton, G. E. (2012). ImageNet classification with deep convolutional neural networks. In Advances in Neural Information Processing Systems (pp. 1097-1105).

[2] Simonyan, K., & Zisserman, A. (2015). Very deep convolutional networks for large-scale image recognition. In Proceedings of the IEEE International Conference on Computer Vision (pp. 1409-1418).

[3] He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 770-778).