# CS 5710 Project

## Project Report on Neural Network


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**Dataset description**:

The CIFAR-10 dataset is a widely used benchmark dataset in the field of computer vision and machine learning. It consists of 60,000 32x32 color images in 10 classes, with 6,000 images per class. The dataset is divided into a training set of 50,000 images and a test set of 10,000 images. Each image belongs to one of the following classes: airplane, automobile, bird, cat, deer, dog, frog, horse, ship, and truck.

CIFAR-10 serves as a standard dataset for evaluating algorithms in image classification tasks due to its diverse range of object classes and relatively low resolution, making it computationally tractable for experimentation. It presents challenges such as variations in scale, orientation, and lighting conditions, making it suitable for testing the robustness and generalization capabilities of machine learning models.

Researchers and practitioners use the CIFAR-10 dataset for tasks such as benchmarking new algorithms, developing and evaluating deep learning architectures, and conducting experiments in areas like image recognition, object detection, and image segmentation.

**NN Architectures :**

**Model 1: Deeper Neural Network**

Architecture:

- Input Layer: 784 neurons (flattened input images of size 32x32x3)
- Hidden Layers:
    - Dense layer with 512 neurons and ReLU activation, followed by dropout (0.2)
    - Dense layer with 512 neurons and ReLU activation, followed by dropout (0.2)
    - Dense layer with 256 neurons and ReLU activation, followed by dropout (0.2) - Modified
    - Dense layer with 256 neurons and ReLU activation, followed by dropout (0.2) - Modified

- Output Layer: 10 neurons (corresponding to 10 classes) with softmax activation

Changes Made:

- Added two extra hidden layers with 256 neurons each to increase the depth of the network.

```
[4] model1.summary()

Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_8 (Dense)             (None, 512)               1573376

 dropout_6 (Dropout)         (None, 512)               0

 dense_9 (Dense)             (None, 512)               262656

 dropout_7 (Dropout)         (None, 512)               0

 dense_10 (Dense)            (None, 256)               131328

 dropout_8 (Dropout)         (None, 256)               0

 dense_11 (Dense)            (None, 256)               65792

 dropout_9 (Dropout)         (None, 256)               0

 dense_12 (Dense)            (None, 10)                2570

=================================================================
Total params: 2035722 (7.77 MB)
Trainable params: 2035722 (7.77 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

**Model 2: Wider Neural Network**

Architecture:

- Input Layer: 784 neurons (flattened input images of size 32x32x3)
- Hidden Layers:

    - Dense layer with 1024 neurons and ReLU activation, followed by dropout (0.2) - Modified
    - Dense layer with 1024 neurons and ReLU activation, followed by dropout (0.2) - Modified
- Output Layer: 10 neurons (corresponding to 10 classes) with softmax activation

Changes Made:

- Increased the number of neurons in the hidden layers to 1024 to make the network wider.

```
model2.summary()
```

```
Model: "sequential_3"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_13 (Dense)            (None, 1024)              3146752

 dropout_10 (Dropout)        (None, 1024)              0

 dense_14 (Dense)            (None, 1024)              1049600

 dropout_11 (Dropout)        (None, 1024)              0

 dense_15 (Dense)            (None, 10)                10250

=================================================================
Total params: 4206602 (16.05 MB)
Trainable params: 4206602 (16.05 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

Both models were trained on the CIFAR-10 dataset with early stopping to prevent overfitting. Training was performed for a maximum of 10 epochs with a batch size of 128 and a validation split of 0.2. After training, the models were evaluated on the test data to assess their performance.

We can draw the following conclusions based on the results obtained from training and testing the two modified neural network models on the CIFAR-10 dataset:

1. Model Performance:

- Model 1 (Deeper Neural Network) achieved a test accuracy of approximately 43.37% with a test loss of approximately 1.587.
- Model 2 (Wider Neural Network) achieved a slightly higher test accuracy of approximately 43.83% with a slightly lower test loss of approximately 1.580.

2. Comparison:
    - Both Model 1 and Model 2 exhibited similar performance in terms of test accuracy and test loss.
    - Model 2 (Wider Neural Network) showed a marginal improvement in test accuracy compared to Model 1 (Deeper Neural Network), but the difference is not significant.
3. Conclusion:
    - The performance of both models on the CIFAR-10 dataset is modest, with test accuracies around 43-44%.
    - While increasing the depth or width of the neural network architectures led to marginal improvements in test accuracy, neither approach resulted in a significant enhancement in performance.
    - Further experimentation with different architectural modifications, hyperparameter tuning, or alternative approaches may be necessary to achieve better performance on the CIFAR-10 dataset.

In conclusion, while both Model 1 and Model 2 showed modest performance on the CIFAR-10 dataset, further experimentation and refinement are needed to achieve higher accuracy and better generalization.