EE 634/734 Intro to Neural Networks
Assignment #3: TensorFlow

Due Date: Monday, October 23, 2023

Objective: The aim of this assignment is to understand the nuances of Convolutional Neural Networks (CNNs) and Dense networks using the CIFAR-10 dataset and TensorFlow.

Dataset Description: The CIFAR-10 dataset consists of 60,000 32x32 color images in 10 classes, with 6,000 images per class. The classes include airplane, automobile, bird, cat, deer, dog, frog, horse, ship, truck. To access the dataset, you can use the following instructions:

```
# Load the dataset
from tensorflow.keras.datasets import cifar10
(train_images, train_labels), (test_images, test_labels) = cifar10.load_data()
```

Steps:

1. **Implement a CNN Model**:
    - Load the CIFAR-10 dataset from TensorFlow's datasets module.
    - Build a CNN model comprising of Convolutional, Pooling, Flatten, and Dense layers.
    - Compile and train the model using appropriate hyperparameters.
    - Save the model's architecture and weights for future comparisons.
2. **Evaluate CNN Model**:
    - Evaluate the model's performance on the test data.
    - Plot visualizations for training and validation accuracy and loss over epochs.
3. **Visualize Feature Maps**:
    - Use intermediate layers of the trained model to visualize feature maps for some sample images from the test set.
4. **Implement a Dense Layer Model**:
    - Build a Dense model for the CIFAR-10 dataset.
    - Compile and train the model using appropriate hyperparameters.
5. **Evaluate the Dense Model**:
    - Evaluate the model's performance on the test data.
    - Compare the Dense model's results with the CNN model's results. Discuss the advantages and limitations of each model.

6. **Modify the CNN Model**:
    - Add an additional convolutional layer to the original CNN model, making any necessary changes.
    - Retrain the modified model and save its architecture and weights.
7. **Compare the Modified CNN Model with the Original**:
    - Evaluate the performance of the modified CNN model on the test data.
    - Compare the results of the modified CNN model with the original CNN model. Discuss the observed improvements or setbacks.

Deliverables:

1. Well-documented Python notebook containing:
    - All the implemented models.
    - Evaluation metrics and plots.
    - Feature map visualizations.
    - Observations and discussions on each task.
2. A brief report containing:
    - Overview of the CNN and Dense architectures used.
    - Comparative study of the CNN, Dense, and modified CNN models.
    - Conclusions drawn from the assignment.

Evaluation Criteria:

- Correctness and completeness of the implemented models.
- Clarity and justification of chosen architectures and hyperparameters.
- Quality and interpretation of visualizations.
- Depth and clarity of observations and conclusions in the report.