Signal Processing in Practice

Assignment 1

Due Date: 16/03/2025

General Instructions:

- You can use Google Colab to run the codes. You can use any deep learning libraries like PyTorch, Tensorflow, etc. for the experiments.

- Please submit a brief one page report for the observations.

- Submit the codes and the report in a single zip file. Name this zip file in the format $SPP\_<YourName>\_Incremental.zip$.

Humans can learn new classes continuously with evolving time, without forgetting previous knowledge. Can models do the same?   (30 Marks)

Download the train and test images from here. The given dataset has 37 classes. Split this dataset into two segments, one with 20 classes and the other with 17 classes.

1. (Marks = 5) Train a ResNet18 or ResNet50 model from scratch on the 20 classes and test it on the test set of 20 classes. Report the test accuracy. Let F_0, G_0 be the feature extractor and classifier at this stage. $G_0 \in R^{20 \times f}$, where f is the feature dimension.

2. (Marks = 10) Modify the last FC layer to incorporate the 17 new classes such that $G_1 \in R^{37 \times f}$ and then finetune the above model on these 17 classes. Evaluate this model (F_1, G_1) on the whole test set. Report the total accuracy along with the accuracies on the previous 20 classes and the new 17 classes.

   What do you observe? Does the accuracy on the previous classes decrease? Why do you think this happens?

3. (Marks = 15) Mitigating the forgetting effect: 1) Store 5 examples per class from the first 20 classes. These samples are referred to as exemplars, which we denote as E_0. Pass them through the feature extractor of the trained model (F_0) from step (b).
   2) Repeat step (c) but finetune the model with the following additional loss function:

$$\mathcal{L}_{distillation} = - \sum_{x,y \in E_0} G_1(F_0(x)) \; log G_1(F_1(x)) \tag{1}$$

   Compare the performance with and without the distillation loss.