

E9 241 Digital Image Processing

Assignment 05

Due Date: November 20, 2025 - 11:59 pm

Total Marks: 60

Instructions:

For all the questions, write your own functions. Use library functions for comparison only.

- Your function should take the specified parameters as inputs and output the specified results.
 - Provide the wrapper/demo code to run all your functions and obtain results. Your code should be self-contained.
 - If you use deep learning libraries (e.g., PyTorch or TensorFlow), specify the required version.
 - Along with code, submit a **PDF report** containing all results (plots, images, tables) and **your observations and reasoning**.
 - Submit everything as a **single zip file** named with your roll number.
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1. Feature Extraction with a Pretrained Model:

Dataset: CIFAR-10 (<https://www.cs.toronto.edu/~kriz/cifar.html>)

- (a) Load a pretrained CNN model of your choice (e.g., VGG16 or ResNet50). Freeze all the layers and use the model only as a feature extractor on the given dataset (CIFAR-10).
- (b) Train a simple classifier (a fully connected layer) on top of these extracted features.
- (c) Report the classification accuracy on the test split and plot the loss curves.

(20 Marks)

2. Domain Shift Evaluation and Fine-Tuning:

Dataset: CIFAR-10-C (<https://zenodo.org/records/2535967>)

- (a) Consider a domain-shifted version of the same dataset (CIFAR-10-C). Evaluate your original model (from Part 1) on this dataset and calculate the test accuracy.
- (b) Then unfreeze the final convolutional block of the pretrained model and fine-tune it using a small labeled subset of the shifted dataset.
- (c) Report the new accuracy and explain how partial fine-tuning affected performance under domain shift.

(20 Marks)

3. Feature Representation Analysis:

- (a) Extract features from the penultimate layer of the model both before and after fine-tuning.
- (b) Use PCA to visualize the feature distributions for:
 - (a) source images, and
 - (b) domain-shifted images.
- (c) Include both plots and interpret how the feature space changed after fine-tuning.
- (d) Briefly explain whether fine-tuning improved robustness to domain shift and why this might be expected.

(20 Marks)