ECE 5460:
Image Processing
Fall 2023
Ertin

Project 4

Due: Friday 23:59, December 8, 2023

We recommend you use the basic Python notebook discussed in the tutorials. You can run it locally or on Google Colab. To use Colab, upload it to Google Drive and double-click the notebook (or right-click and select Open with Google Colaboratory), which will allow you to complete the problems without setting up your own environment. Once you have finished, make sure all the cells are run before downloading the notebook).

Submission Instructions: Please submit three categories of files on Canvas: (1) the Python jupyter notebook with the relevant source code and with all the cells run, and (2) The input output images in jpeg format (3) A typed !! brieef(latex, word, etc) report saved as as a pdf file that includes all input and output images and a brief description the processing details and description of each input/output image.

Late Submission Policy: As discussed in the late policy. Due dates will be strictly enforced. 20% penalty for every late day. Solutions will be posted to the course web page in 5 days. After solutions are posted, no credit will be issued for late work.

In this exercise you are going to train a simple linear classifier for the CIFAR10 dataset and analyze/interpret the resulting classifier. A comprehensive notebook is given, feel free to use as many parts as you like.
The popular CIFAR-10 dataset contains 60,000 RGB color images of 32x32 pixels and 10 classes. There are 6000 images per class, 5000 of which belong to the training set and 1000 to the test set.

1. Train a linear classifier with the cross-entropy loss function. Report the classification accuracy on the test set. How does the cross-entropy loss compare to random guessing? For which class the classification performance is the best? For which class the classification performance is the worst?

2. In class we have discussed that each row of the weight matrix can be interpreted as a template for a given class. Extract rows for each class and reshape them into color images and plot them. Explain and interpret your findings in couple sentences.

3. We also discussed how each row of the weight matrix (together with the bias term) forms a hyper-plane that separates the image space into two halves. For every hyperplane that is defined by each row of the weight matrix, go over the test data and find the two images farthest away from the hyperplane on each side (Hint: for example for the dog class, find the test images that your classifier assigns the highest (positive) and the lowest score (negative) for the dog class). Plot the two images for each class. Explain and interpret your findings in couple sentences.

4. Is color information helpful? Convert your train and test data to grey level. Train a new linear classifier that uses only grey-level images. Compare the test performance of the new linear classifier to the test performance of the classifier that uses color images. Explain and interpret your findings in couple sentences.

5. Is your classifier rotation invariant? Take the test data and rotate them 90 degrees before applying your classifier. Compare the test performance on the rotated images to the original test performance. Explain and interpret your findings in couple sentences. Discuss ways you can make your classifier rotation invariant.