AI5100/AI2100/EE6380 Deep Learning, Fall 2025
Indian Institute of Technology, Hyderabad
Programming Assignment 1; Introduction to Programming
Total Marks: **20 points**
Assigned on 28.8.2025 (Thursday), Due date **11:59pm on 02.9.2025** (Tuesday)

Instructions

- It is strongly recommended that you work on your homework on an individual basis. If you have any questions or concerns, feel free to talk to the instructor or the TAs.
- Use the libraries such as `numpy`, `matplotlib`. Do not use any other built-in functions unless explicitly mentioned in the question.
- Please turn in Python Notebooks with the following notation for the file name: your-roll-number-hw1.ipynb.
- Implement solutions as functions and reuse the functions in the same assignment where required. In case the question is to visualize or plot, the function can return None.

Question 1 Consider the CIFAR10 dataset, which can be downloaded here. The dataset comprises of labelled data samples of the format $((x_1, y_1), (x_2, y_2), ..(x_n, y_n))$. Using the information here, solve the following questions:

1. Construct a dataloader to load the data with batch size of 8 and apply the following transformations: (4 points)
   (a) Resize Operation
   (b) Random Rotation Operation by $(\theta = 90)$.

   Load the first 3 batches of images and visualize the data. (1 point)
2. Plot the histogram for each class of data. Comment on the same. (1 point)
3. For the first batch of image data as taken from the dataloader in Question 1, visualize the following norms: (2 points)
   (a) L_1 norm
   (b) L_2 norm
4. Consider the first 100 images and apply the following operations:
   (a) Apply center crop transformation to the image with a size of 64×64.
   (b) Flatten the images and use them as features to represent the sample.
   (c) Pass these features into 2 subsequent hidden layers of dimension 128 and 64 nodes respectively, and a final output layer of 10 nodes.

Feed the features to this network in 2 settings, with activations as (1) ReLU, (2) sigmoid, (3) Tanh. Using L_2 distance loss, implement the back propagation algorithm. Further iterate the learning for 10 epochs and print the learning rate and loss for each epoch. Comment on the the gradient. (7 points)

5. Implement T-SNE. For the features obtained in question 4, visualize the T-SNE plots. Further, compare it with the PCA representation of the same. For PCA you can use scikit-learn library. (5 points)