Autoencoder Homework: Hindi MNIST Digit Reconstruction

Deep Learning - COL775/COL7375

1 Objective

The goal of this assignment is to implement and experiment with auto-encoders for digit reconstruction using the Hindi MNIST dataset. You will gain hands-on experience with neural network fundamentals, dimensionality reduction, and the effects of various hyperparameters on reconstruction quality. **Maximum intended time that you should spend on this homework is upto 2 hours (excluding model training time). Kindly try to finish it within that time limit**

2 Dataset

You will work with the Hindi MNIST dataset available at:

`https://www.kaggle.com/datasets/anurags397/hindi-mnist-data`

This dataset contains handwritten Hindi digits (0-9) in 28x28 grayscale images, similar to the standard MNIST dataset but with Hindi numerals.

2.1 Neural Network Implementation

You must use the provided NeuralNetwork code for consistency across submissions. This also gives you insight into the internal workings of neural networks. You can find the reference code and further instructions here.
`https://colab.research.google.com/drive/16iBO-8v9HwEw5Qq8-B4YFqIaZX52O-lK?usp=sharing`

3 Required Ablation Studies

3.1 Parameter Experiments

You should perform ablation studies on the parameters listed below:

- **Latent Space**: Start with a reasonable latent size (e.g., 32 dimensions) and gradually reduce to smaller sizes: 16, 4, 1.
- **Learning rates**: Test values like 0.1, 0.01, 0.001
- **Training epochs**: Study trend of more training epochs

For each of the above ablations **Qualitatively compare** the generated images.

3.2 Comparison with PCA

Implement PCA for dimensionality reduction and compare:

- Apply PCA to reduce Hindi MNIST to the same latent dimensions as your best autoencoder
- Reconstruct images using PCA and Qualitatively compare with autoencoder reconstructions
- Discuss the differences in reconstruction quality and what this reveals about linear vs non-linear dimensionality reduction

4 Deliverables

4.1 Report

Submit a concise report (upto 2 pages) containing:

- A link to Complete Python script with data loading, training, and evaluation
- Visual comparison of original vs reconstructed images for the ablations
- **Discussion**: Analysis of findings and insights gained
- **Conclusion**: Summary of key learnings

5 Additional Considerations

- The model will train on CPU so you might need to adjust batch size and model hidden layers to reduce training time. There is no fixed hidden layer configuration, so you are free to experiment with any configuration that works for you. The same goes for epochs as well. Try to include as many epochs as you can train in a reasonable time.
- We would recommend platforms such as Colab or Kaggle to do this homework.