STAT 6205 Assignment 3: Image Generation Comparison

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Due: 28, April

Overview

In this assignment, you will compare the image generation performance of two models on the MNIST dataset:

1. **Probabilistic PCA (PPCA)** – used as a baseline for image generation.
2. **Convolutional Variational Autoencoder (Conv VAE)**.

Since PPCA has been covered in previous assignments, no further tuning is required for it. Your primary focus is on tuning the hyperparameters of the Conv VAE to improve its generative quality. You will then compare its reconstructions and samples with those generated by PPCA.

Note: To accelerate your training process in Google Colab, please ensure that you enable GPU support. You can do this by selecting `Runtime` → `Change Runtime Type` and choosing `Hardware Accelerator: GPU`.

Task 1: Generation Using PPCA (Baseline)

Objective

Use the provided PPCA model to generate image reconstructions and samples. This output will serve as a baseline for later comparison with the Conv VAE results.

Task 2: Hyperparameter Tuning and Comparison for Conv VAE

Objective

Improve the image generation quality of the Conv VAE through hyperparameter tuning. Your tasks include:

a. Experiment with different settings for:

- `LATENT_DIM_CONV` (e.g., 10, 20, etc.)
- `LEARNING_RATE_CONV` (e.g., 0.001, 0.0005, etc.)
- `EPOCHS_CONV` (e.g., 3, 5, etc.)

b. Monitor the ELBO (Evidence Lower Bound) convergence during training.

c. Generate reconstructions and new samples using the trained Conv VAE.

d. Save a composite image (named `model_comparison_visuals.png`) that includes:

- Original test images.
- PPCA reconstructions and generated samples (baseline).
- Conv VAE reconstructions and generated samples.

e. Provide a brief analysis comparing the generation quality between PPCA and Conv VAE under various hyperparameter settings.

Submission Requirements

1. The use of AI tools to generate the code is forbidden. Suspected cases will be forwarded to the faculty disciplinary committee.
2. You must complete the assignment using Google Colab.
3. Modify the provided Python code accordingly for hyperparameter tuning.
4. Upload three separate files to Blackboard (do not zip the files):
   a. The Colab notebook file (in .ipynb format), named as `YourStudentID.ipynb`.
   b. The PDF generated from the Colab notebook (via File → Print), named as `YourStudentID_code.pdf`.
   c. A brief report (no more than two pages, `YourStudentID_report.pdf`) including:
      - The ELBO convergence plot for the Conv VAE.
      - Visual comparisons of the generated images (both reconstructions and samples) from PPCA and Conv VAE under different hyperparameter settings.