4. VAE

Deadline and Submission

📅 26.oct (sunday)

🕐 Commits until 23:59

Individual

Submission the GitHub Pages' Link (yes, **only** the link for pages) via insper.blackboard.com.

Activity: VAE Implementation

In this exercise, you will implement and evaluate a Variational Autoencoder (VAE) on the MNIST or Fashion MNIST dataset. The goal is to understand the architecture, training process, and performance of VAEs.

Instructions

1. **Data Preparation**:
    - Load the MNIST/Fashion MNIST dataset;
    - Normalize the images to the range [0, 1];
    - Split the dataset into training and validation sets.
2. **Model Implementation**:
    - Define the VAE architecture, including the encoder and decoder networks;
    - Implement the reparameterization trick.
3. **Training**:
    - Train the VAE on the MNIST/Fashion MNIST dataset;
    - Monitor the loss and generate reconstructions during training.
4. **Evaluation**:
    - Evaluate the VAE's performance on the validation set;
    - Generate new samples from the learned latent space.
5. **Visualization**:

- Visualize original and reconstructed images;
- Visualize the latent space (in case of a latent space until 3-D, otherwise use a reduced visualization, e.g., using t-SNE, UMAP or PCA).

6. **Report**:
   - Summarize your findings, including challenges faced and insights gained;
   - Include visualizations of reconstructions and latent space.
7. **Extra Credit (Optional)**:
   - Experiment the same dataset with a Autoencoder (AE) and compare the results with the VAE;
   - Experiment with different latent space dimensions and report the effects on reconstruction quality and sample generation.

> **Important Guidelines**
>
> This is an **individual activity**. You must complete the work on your own. Collaboration is not allowed, but you can discuss general concepts with your peers or instructors;
>
> You could use the scratch MLP built in the exercise before, but you can use any framework you prefer (e.g., PyTorch, TensorFlow, Keras), also AI tools can be used to help you in the implementation. BUT remember that the main goal is to understand the VAE architecture and training process, then **you must be able to explain all parts of the code and analysis submitted**.

Important Notes:

- The deliverable must be submitted in the format specified: **GitHub Pages**. **No other formats will be accepted.** - there exists a template for the course that you can use to create your GitHub Pages - template;
- There is a **strict policy against plagiarism**. Any form of plagiarism will result in a zero grade for the activity and may lead to further disciplinary actions as per the university's academic integrity policies;
- **The deadline for each activity is not extended**, and it is expected that you complete them within the timeframe provided in the course schedule - **NO EXCEPTIONS** will be made for late submissions.
- **AI Collaboration is allowed**, but each student **MUST UNDERSTAND** and be able to explain all parts of the code and analysis submitted. Any use of AI tools must be properly cited in your report. **ORAL EXAMS** may require you to explain your work in detail.
- All deliverables for individual activities should be submitted through the course platform insper.blackboard.com.

Grade Criteria:

Criteria	Description
3 pts	Correctness of the VAE implementation
1 pts	Training and Evaluation: Proper training procedure, loss monitoring, and evaluation on the validation set.
2 pts	Sampling: Quality of generated samples.
2 pts	Latent Space: Quality of the learned latent space representation.
1 pts	Visualizations: Quality and clarity of plots (data distribution, decision boundary, accuracy over epochs).
1 pt	Report Quality: Clarity, organization, and completeness of the report.

October 15, 2025 October 15, 2025 Humberto Sandmann

GitHub