HW4 – Generative Models

Machine Learning 2 – 00970209

Submission due 29/01/2026

In this exercise, you will work on a generative learning problem. Specifically, you will implement and train either a **VAE** or a **GAN** model.

You should write code that meets the following guidelines and requirements:

1. Choose an architecture - VAE or GAN.
2. Implement and train your model.

   Plot the loss as a function of the training steps:

   GAN - discriminator and generator losses.

   VAE - reconstruction loss, KL divergence, and total loss.

   Note:
   The decoder / generator should take as input a latent vector z and output an image.
   For deconvolutions operators you should use the nn.ConvTranspose2d class.
3. Output visualization:
   - Generate images using your model (by sampling vectors z from the latent space) and display them. You should generate at least 10 images. The images shouldn't belong to a single class.
   - For GAN – Generate a pool of images using your model. Choose 3 pairs of similar images and 3 pairs of dissimilar images. Plot the original vectors z of the chosen images (make the pairs and similar/dissimilar distinguishable).
     For VAE - Visualize your model's latent space: sample 20 images from each class in the dataset and plot their corresponding representations in the laten space (each class in a different color). Use the encoder's expectation output μ to obtain z (no sampling, zero variance).
     For dimension reduction, you can use the plot embeddings function from HW3.

Dataset - You will use the "102 Category Flower Dataset" (https://www.robots.ox.ac.uk/~vgg/data/flowers/102/). The dataset can be found in the moodle as well.

You are given with a json file (category_to_images.json) that includes images class labels.

Images can be resized for efficiency but not smaller than 64x64.

Discussion:

Answer the following:

1. Discuss your model architecture and training procedure (hyperparameters, optimization method, etc.). Explain your design choices and challenges you encountered.
   How sensitive was your model to hyperparameter choices?
   Did you observe any training instabilities (e.g., mode collapse in GANs and posterior collapse in VAEs)?
2. Discuss the training loss plots. Does the training converge?
3. Summarize your conclusions.
   Your conclusions and explanations should be based on the actual results you received during your attempts.
4. Display your generated images (the images your model produces).
   Discuss your results. What is the images quality?
5. Display your laten space visualization and explain the result.
   For GAN – does the laten vectors of similar images close to each other in space more than those of the dissimilar images? Answer based on the plot and based on measured distance using the L_2 norm.
   For VAE - does the latent space show class separability?

Submission

You should submit a ZIP file containing:

1. A python file (hw4_code.py) including: your model class, training, sampling, and latent space visualization.
2. The trained model's weights (hw4_model.pkl).
3. If the model size is less than 500MB, you should submit it on Moodle, otherwise, upload it to your Google-Drive and add a reference to it in your report (make it accessible via link).
4. A python file including a function called "reproduce_hw4" (hw4_generation.py). This function should load your model and generate 10 images from each class. The images should be in a similar quality to your submitted images.
5. A report file (hw4_report.pdf) including your answers to the discussion section.
6. Run 'pip freeze > requirements.txt' and attach it to your submission (for reproducibility).

- Submission is in pairs unless otherwise authorized.
- The discussion should be typed. Hand-written submissions won't be accepted.
- The zip file should be named "hw4_<id1>_<id2>.zip"