Home Assignment 03

Deep Learning Foundations — Due by **29th January, 2025 at 23:59 CET**

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Submission Details

- Please submit a single compressed folder (.zip) containing one PDF file with all text responses and one Jupyter Notebook per coding task. Please keep all generated outputs in the Jupyter Notebooks so we can grade your submission without rerunning your code.
- For each answer/code snippet, clearly state what task you are referencing. If you are not confident in an answer, try nonetheless, as it is possible to receive partial points.
- You may work in groups of up to three students. Add all team members' names and matriculation numbers at the top of the PDF file **and** your notebooks.
- You may use online resources for help, but copying online resources is prohibited. Cite or link any resources you use.
- If you have any questions, create a post in the forum.

1 Self-Supervised Learning - Denoising Autoencoder [40 points]

In this task you are supposed to train cats vs. dogs classifiers using the CIFAR-10 dataset[1]. Specifically, you would compare the training time (steps) and performance of a basic CNN classifier to the training time requirements of a denoising autoencoder (which was previously trained on images of the remaining 8 classes of CIFAR-10).

1. Train a CNN to discriminate cats and dogs using CIFAR-10 data
2. Pre-train a denoising autoencoder on images from CIFAR-10 (**except** for cats and dogs)
3. Fine-tune the pre-trained model to discriminate cats and dogs
4. Experiment with the amount of fine-tuning data and the number of training steps. Fine-tune the model several times with different amounts of data. Do you see faster convergence? How is the final performance? Does the pre-trained model need less data/time for similar performance? Plot your results.

2 Pen & Paper Exercises [30 points]

1. VAE vs. Diffusion: Explain the differences and similarities between VAE and Diffusion models. Name at least two differences and two similarities.
2. Dequantization: In your own words, explain how dequantization helps us with discrete data.
3. Flow: Explain the significance of the Coupling Network in Coupling Flow

[1] https://www.cs.toronto.edu/ kriz/cifar.html

4. Reverse Diffusion: In your own words, explain why we need intermediate steps in the reverse diffusion process, and we don't reconstruct the input from the noisy image directly.
5. Self-Supervised Learning: In your own words, describe the idea and purpose of SSL. Include how SSL can help for downstream tasks.
6. Contrastive Learning: Explain when it can be applied and describe the idea of the triplet loss function.