University of Manitoba

ECE 4860-T16: Generative AI	**Winter 2026**

Assignment 1: Autoencoders

January 28, 2026

The purpose of this assignment is to give you hands-on experience designing and training auto-encoders for generative and other purposes.

Due Date: The assignment is due February 13th, 2026 by 11:59 pm (electronic submission through UMLearn).

Assignments should be performed individually, but feel free to interact with your classmates. Plagiarism will not be tolerated. All codes should be well commented and any reference material used should be cited appropriately. If you use ChatGPT (or similar) include an explanation of how you used the tool to guide your work and/or report writing.

The in-class quiz on Assignment 1 will be on Tuesday February 17th, 2026.

Important: Please include the following signed statement with your submission.

I, [insert name] attest that the work I am submitting is my own work and that it has not been copied/plagiarized from online or other sources. Any sourced material used for completing this work has been properly cited. [Signature]

Introduction

As discussed in class, Autoencoders (AEs) are sort of a gateway to Generative AI: Autoencoder models are often used for non-generative purposes (de-noising, inpainting) but if we throw away the encoder after training, we can choose samples from the latent space and hope that they lead to some meaningful generation.

In this assignment we will investigate how the various parts of an autoencoder (data, model, loss function) affect training and performance, and get some experience using a trained autoencoder for different purposes.

Problem 1

The lecture notes have provided you with a Jupyter Notebook for an AE (adapted from https://keras.io/examples/generative/vae/) that:

1. uses CNN encoders and decoders,

2. uses a latent space of size 2,

3. uses a binary cross-entropy loss function, and

4. uses the MNIST dataset.

Your job is to modify this autoencoder in a variety of different ways (each change being applied directly to the original provided code).

> Graduate students: You are responsible for each of the following changes.
>
> Undergraduate students: Choose three of the following four changes.

1. Select a different architecture (e.g., more layers, fully connected layers, anything else you think might be of interest).

2. Uses a different latent space. Specifically, we want you to try a latent space size of your choice, but we also want you to try a latent space with dimension 1.

3. Use a different loss function.

4. Use a different data set, specifically something with more than 1 channel.

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Note, you may find that training meta parameters (e.g., batch size, step size) may also need adjustments.

For each of these modifications we want you to report on a) why you made the changes you did and b) how these changes affected the <u>training</u> of the model (time/performance). How does the training/loss compare to the original example? Include a brief (but complete) discussion of what you observe and a justification/explanation supporting your observations.

Problem 2

Give a trained AE (you are free to choose any of the models from Problem 1, including the original model), you will evaluate the AE for the following tasks.

> Graduate students: You are responsible for each of the following tasks.
>
> Undergraduate students: Choose one of tasks 1-3, and complete task 4.

1. Inpaiting. From the test set, select samples and remove chunks of various sizes from the input image. Use the AE and attempt to reconstruct the original image.

2. Denoising. From the test set, select samples and add noise to the data. Use the AE and attempt to reconstruct the original image.

3. Anomaly detection. Choose an image from a different dataset and apply it to the AE. Use the AE and attempt to reconstruct the original image.

4. Generation. Choose samples from the latent space. Use the Decoder to generate new images.

For each task undertaken, report on a) how you generated the input and b) provide a (written) summary of results supported by images. Support the discussion of your findings with concrete arguments.

Additional Discussion Questions

1. For any given application, how might you go about determining an appropriate latent space size for a given AE model?

2. Your tests for Problem 2 focused on samples from the test set. Would performance change significantly if you took samples from the training set? Why or why not?

3. (Graduate students only) Can residual blocks be included in an Autoencoder network? Why or why not?

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Hand-in Report

Submit a report summarizing the relevant answers to Problems 1, 2, and the Discussion Questions. Include code snippets and explanations that facilitate our understanding of your changes and allow us to interpret your results without resorting to running your code.

When you submit your report, also submit your code in the event that we need to run it to validate your claims.