COL333 Assignment 3.2

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1 Introduction

This report explores the Variational Autoencoder (VAE) model for classifying MNIST digits 1, 4, and 8. The model extracts latent space representations for these digits, which are further used with a Gaussian Mixture Model (GMM) for classification.

2 Latent Space Visualization

The following figure shows the 2D latent space of the VAE, highlighting how the digits 1, 4, and 8 are separated in this space. As expected, the images seem to have a Gaussian distribution on the latent space of 2 dimensions, with good separation. However, we see some mixing due to poorly written digits.

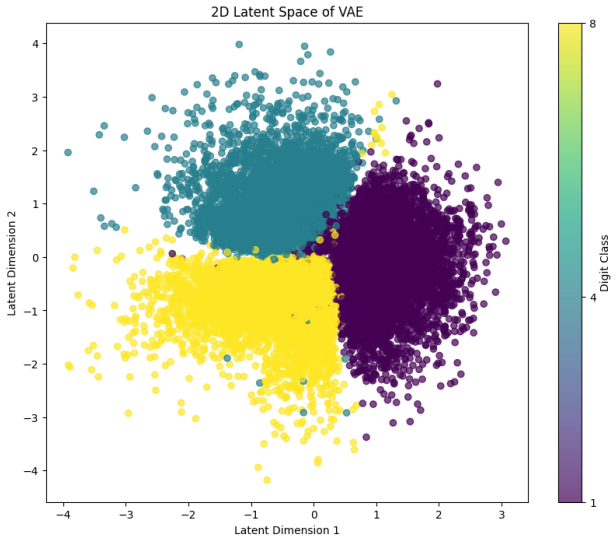

Figure 1: 2D Latent Space of MNIST Digits (1, 4, 8)

3 Reconstruction

Here, we display the reconstructed images of the MNIST digits 1, 4, and 8 from their respective latent representations.

Figure 2: Reconstructed Images

4 Manifold of Latent Space

This figure shows the manifold of latent space for the digits 1, 4, and 8. It visualizes the smoothness and continuity of the latent space learned by the VAE.

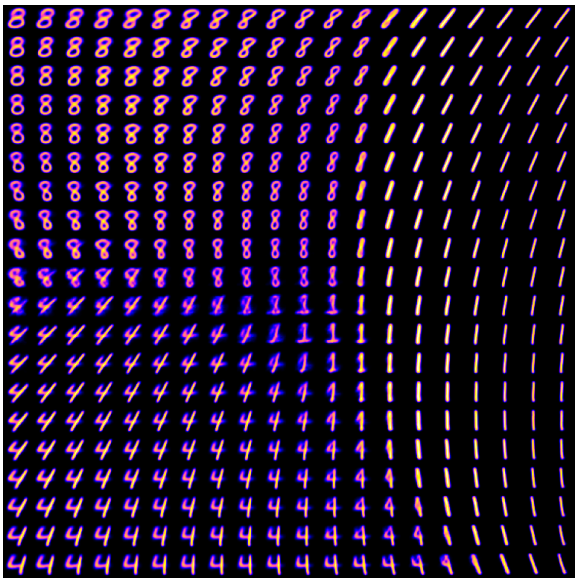

Figure 3: Latent Space Manifold for MNIST Digits (1, 4, 8)

5 Gaussian Mixture Model (GMM) Clustering Visualization

In this section, we visualize the Gaussian distributions learned by the GMM. Each Gaussian is represented as an ellipse, where the center indicates the mean of the distribution and the shape represents the covariance matrix. This visualization helps assess how well the GMM clusters the digits 1, 4, and 8 in the latent space.

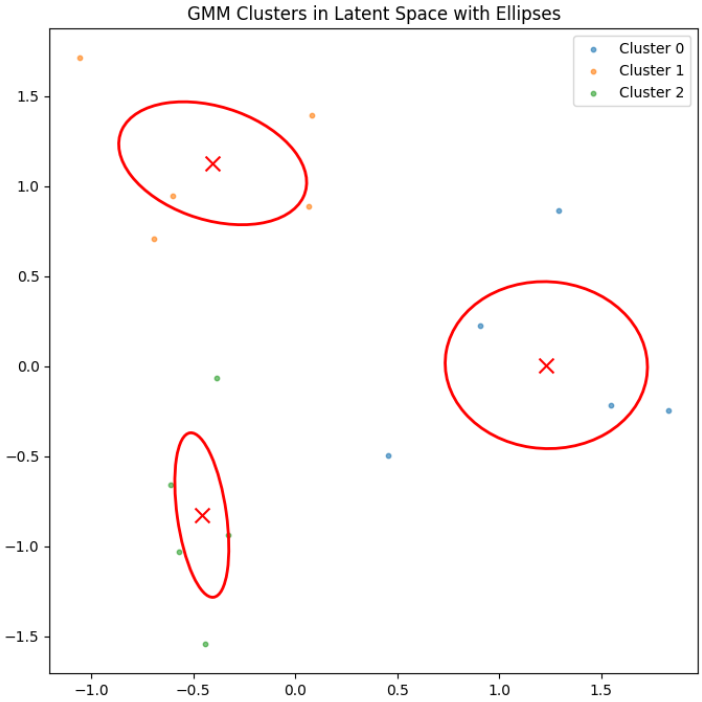

Figure 4: GMM Cluster Visualization with Ellipses Representing Gaussian Distributions

The plot shows how distinct or overlapping the clusters are. If the ellipses overlap significantly, it may indicate misclassification or insufficient separation in the latent space.

6 Conclusion

The VAE has successfully learned a continuous latent space for digits 1, 4, and 8. However, further refinement may be necessary to improve cluster separation for better classification accuracy.