**Implementing Variational Autoencoder (VAE) on MNIST dataset using PyTorch**

**by**

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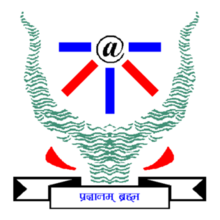
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# **Abstract**

Variational Autoencoder (VAE) is a powerful generative model that can learn a compact latent representation of the data and generate new data samples by sampling from the learned latent space. In this report, we implemented a VAE on the MNIST dataset using PyTorch and evaluated the performance of the model. The goal of this study is to develop an generative model for the MNIST dataset that can generate new images that resemble digits.

# **Introduction**

Variational Autoencoder (VAE) is a type of generative model that can learn a low-dimensional representation of the data and generate new data samples from the learned latent space. VAEs are a type of autoencoder, which is a neural network architecture that can learn to encode the input data into a low-dimensional representation and then decode it back to the original data.

VAEs are trained to maximize the evidence lower bound (ELBO) objective, which consists of two terms: the reconstruction loss and the KL divergence loss. The reconstruction loss measures the difference between the input and the reconstructed output, while the KL divergence loss regularizes the learned latent space by penalizing the deviation from a prior distribution.

The VAE model consists of two parts: an encoder and a decoder. The encoder maps the input data to a mean and variance of a normal distribution in the latent space, and the decoder takes a sample from this distribution and generates the output data. The latent space is typically of lower dimensionality than the input data, allowing for a compact representation of the data.

VAEs have many applications in generative modeling, such as image and text generation. They have also been used in unsupervised learning and semi-supervised learning tasks, where the labeled data is scarce.

One of the limitations of VAEs is that they tend to generate blurry images and lack sharpness in details. This is due to the use of the KL divergence loss, which can constrain the learned latent space too much and result in a loss of information. To overcome this limitation, many variants of the VAE model have been proposed, such as the conditional VAE (CVAE) and the adversarial autoencoder (AAE).

Overall, VAEs are a powerful generative model that can learn a useful representation of the data and generate new data samples. They have many applications in various fields and continue to be an active area of research.