

## EXP NO: 11: Experiments using Variational

Aim:-

To implement a Variational Autoencoder (VAE) on the MNIST dataset and generate new handwritten digits from the learned latent space

Objectives

1. To understand probabilistic representation learning using VAEs
2. To generate new data samples from a learned latent distribution
3. To explore the concept of mean, variance, and reparameterization trick in generative models.
4. To visualize the latent space and generated images.

Algorithm:-

1. Load and normalize MNIST dataset.
2. Define encoder network to output mean ( $\mu$ ) and log variance ( $\log \sigma^2$ ) for latent variables.
3. Apply reparameterization trick  

$$z = \mu + \sigma * \epsilon \text{ where } \epsilon \sim \mathcal{N}(0, 1)$$
4. Define decoder network to reconstruct image from latent vector  $z$ .
5. Compute VAE loss  

$$\text{Loss} = \text{Reconstruction-Loss} + kL\text{-Divergence}$$

where KL divergence regularizes latent space towards a normal distribution

6. Train the VAE model
7. Visualize reconstructed and generated samples.

Pseudo Code:-

Load MNIST dataset

Normalize to  $[0, 1]$

Define encoder:

Dense(256, relu)

Dense(latent-mean)

Dense(latent-log-var)

Reparameterization:

$$z = \text{mean} + \exp(\text{log-var}) * \epsilon$$

Define decoder:

Dense(256, relu)

Dense(784, sigmoid)

Compute VAE loss:

reconstruction loss + KL-divergence

Train model

visualize reconstructed and generated images.

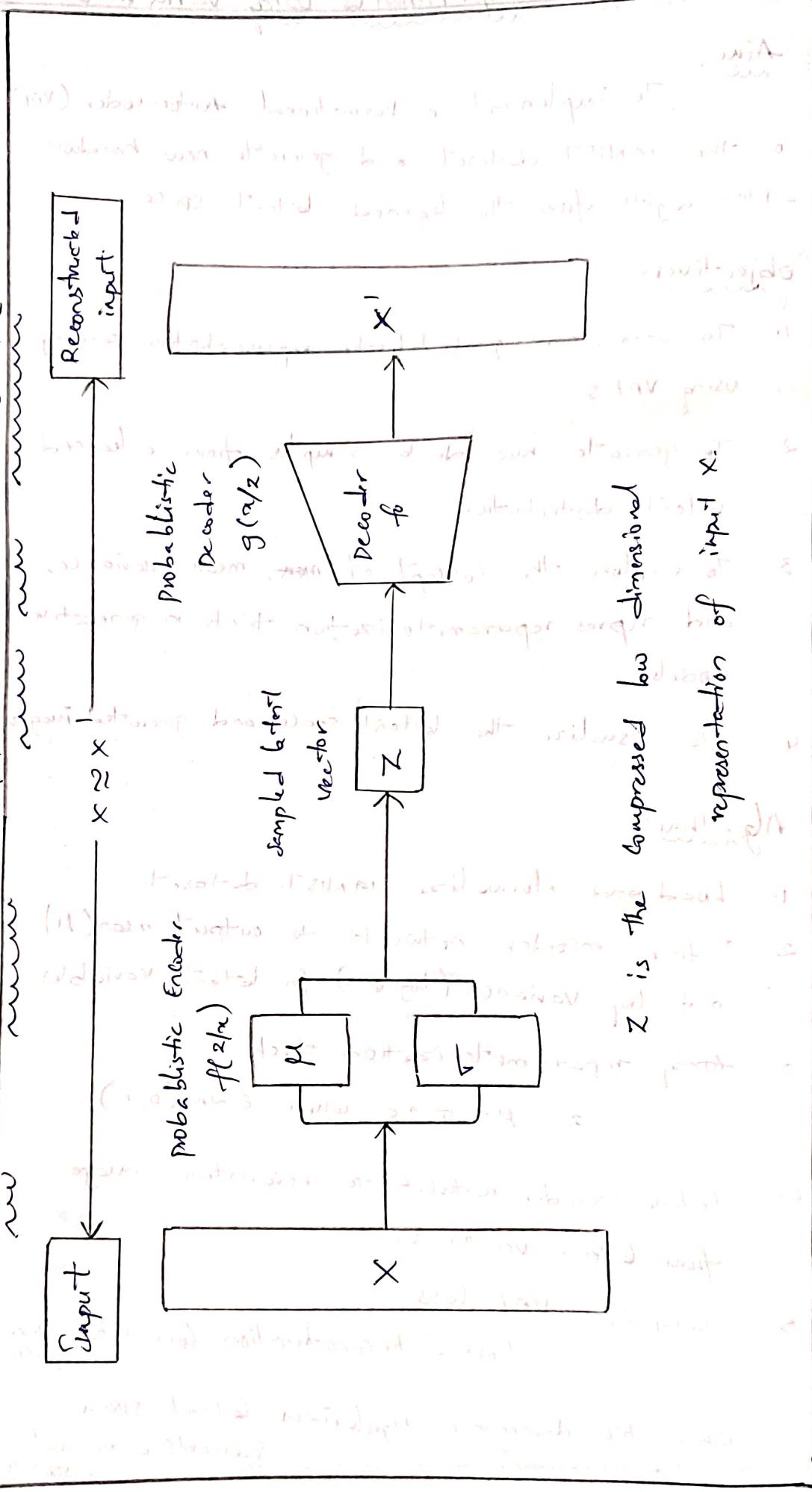
Observations

- The VAE learns a smooth, continuous latent space where similar digits are close to each other.
- Random sampling in latent space generates realistic digits.

Conclusion:

VAEs enhance autoencoders by adding probabilistic latent space, enabling both data compression & generation.

# VAE BASIC ARCHITECTURE.



Output!

Epoch [1/10] Loss: 164.3748  
Epoch [2/10] Loss: 121.2820  
Epoch [3/10] Loss: 114.5211  
Epoch [4/10] Loss: 111.6053  
Epoch [5/10] Loss: 109.8342  
Epoch [6/10] Loss: 108.6767  
Epoch [7/10] Loss: 107.8205  
Epoch [8/10] Loss: 107.1637  
Epoch [9/10] Loss: 106.6910  
Epoch [10/10] Loss: 106.2222

Training loss of VAE

