

## EXP No: II: 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~~, mean, variance, and ~~reparam~~ 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

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

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\_dim)

Dense(latent\_dim, log-var)

Reparameterization:

$$z = \text{mean} + \exp(0.5 * \log\text{-var}) * \epsilon$$

Define decoder:

Dense(256, relu)

Dense(784, sigmoid)

Compute VAE loss:

reconstruction loss + KL-divergence

Train model

visualize reconstructed and generated images.

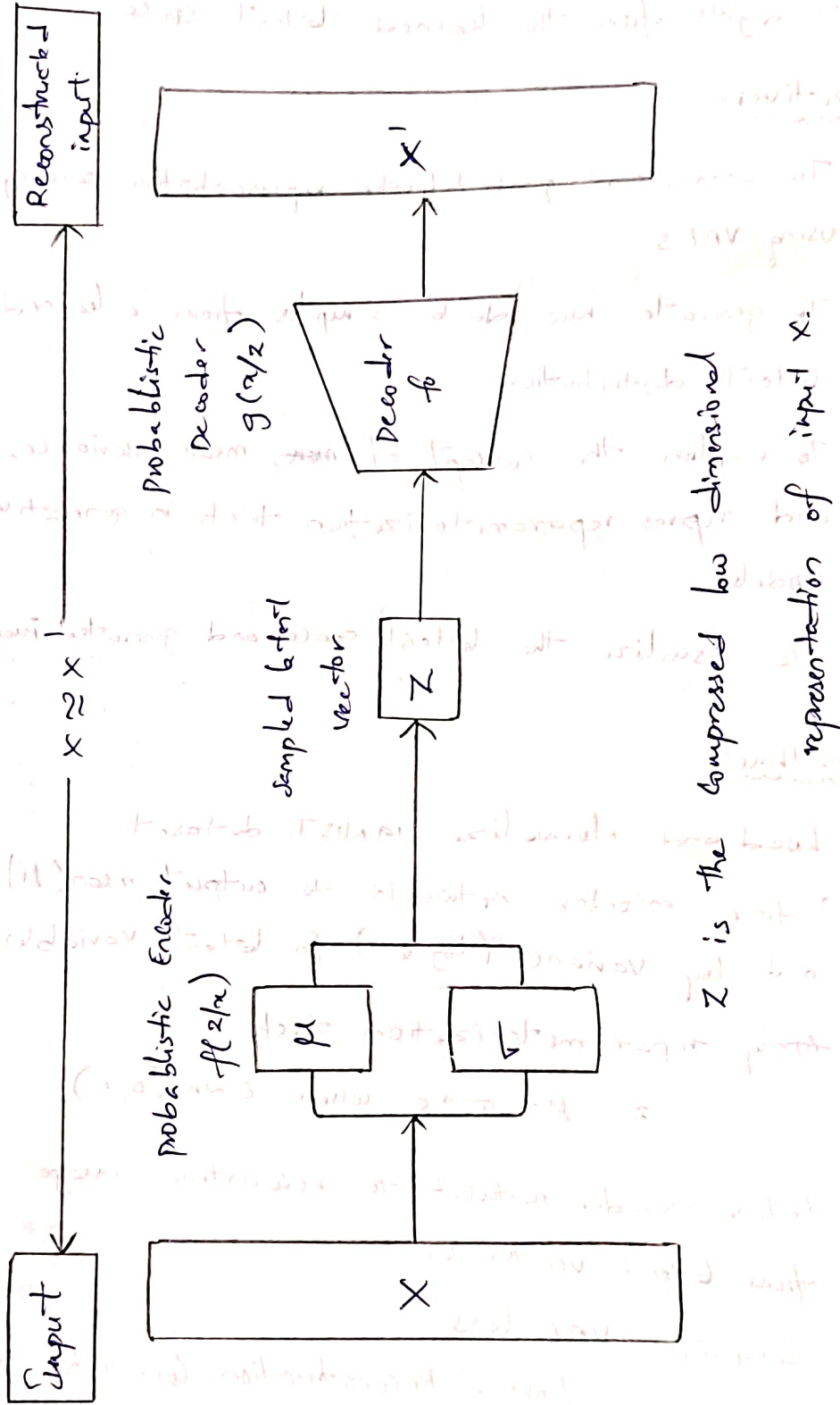
Observation:-

- 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

