Image Generation using VAE

VAEs work as follows:

- Map an input into a distribution over the latent space
- Pick a point from the distribution in the latent space
- Decode the sampled point and compute the reconstruction and KL Divergence errors.

UE22CS645BC2-TDL-Lecture - VAE

Image Generation using VAE

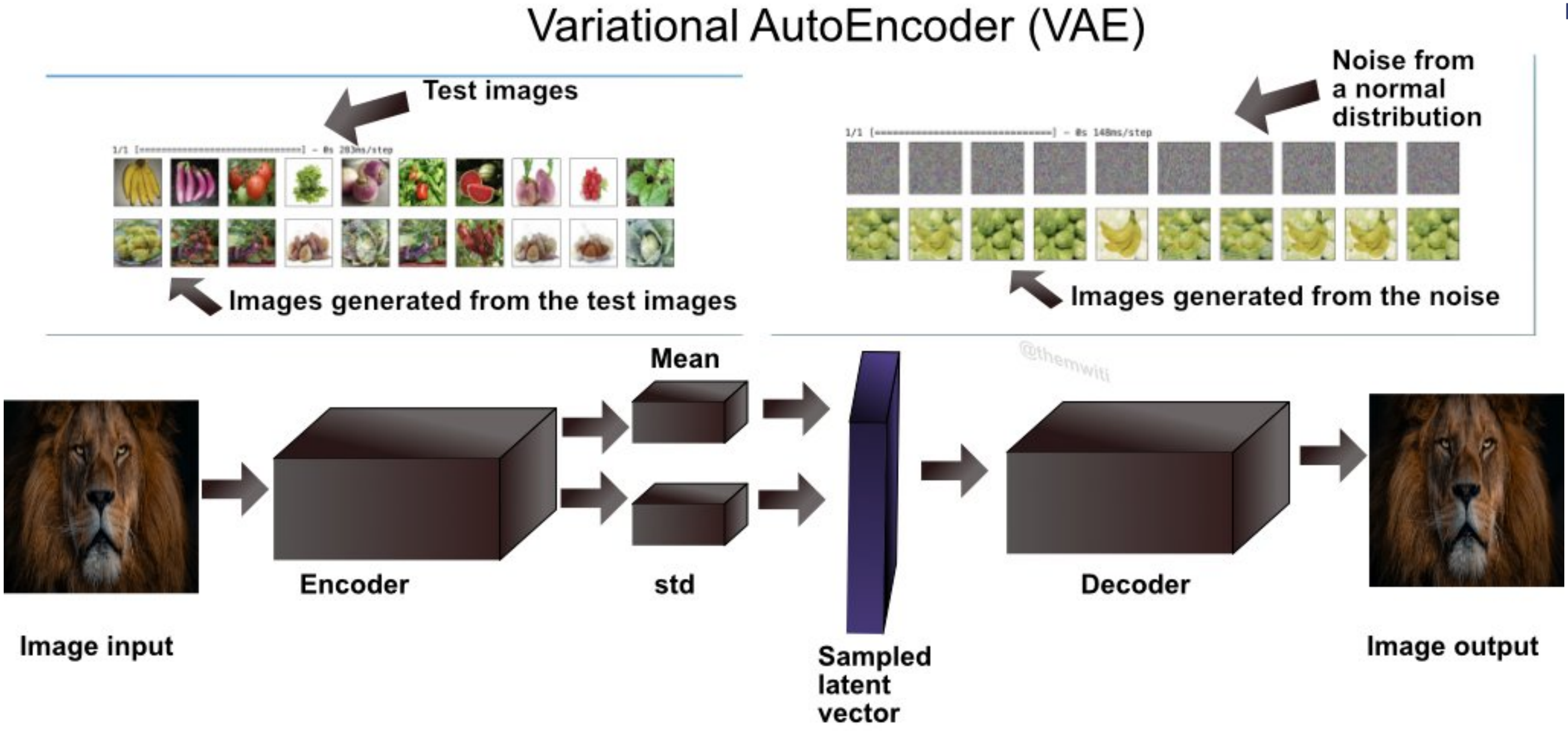
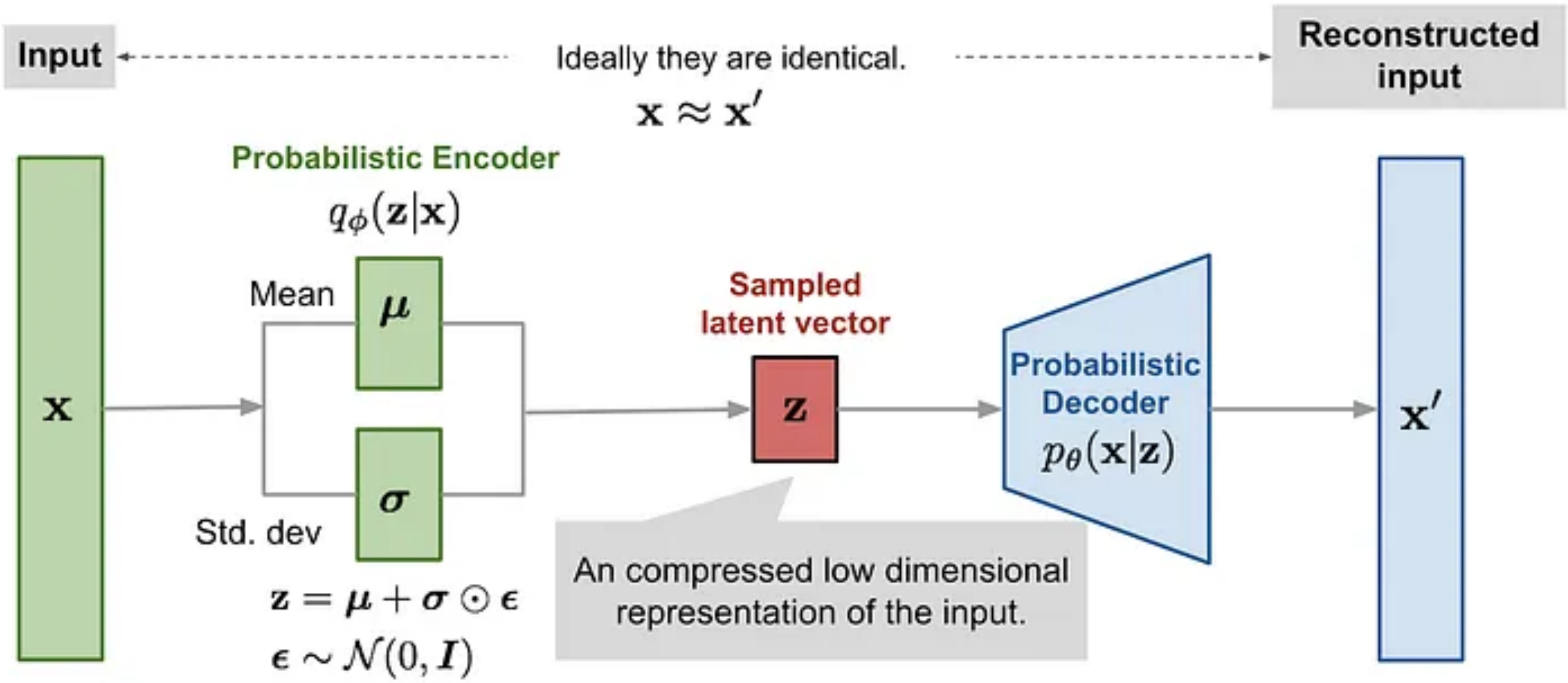


Image Generation using VAE



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- We observed that traditional autoencoders learn to compress and reconstruct data but not really help with generating new data.
- VAE learns the distribution of data instead of just a compressed image, and by using the distribution, we can decode and generate new data.
- The encoder tries to learn the parameters ϕ to compress data input x to a latent vector z, and the output encoding z is drawn from Gaussian density with parameters ϕ.
- As for the decoder, its input is encoding z, the output from the encoder. It parametrizes the reconstructed x' over parameters θ, and the output x' is drawn from the distribution of the data.

- The loss function includes two terms.
- The first term is the negative log-likelihood of the decoder which measures that for each data point i, how effectively is the latent vector z reconstructed to x’
- The second term is the KL divergence, which is a regularizer that measures the information loss when we use the encoder q_φ to produce z, and in the VAE, p(z) is a standard Gaussian distribution N(0,1).
- This is to encourage the encoder to produce z that are close to the gaussian distribution and this means to keep z representations of each different kind of data

- Key differences between VAEs and GANs lies in training approach, as VAEs' training follows an **unsupervised** approach in contrast with GANs that follow a **supervised** technique.

- During their training phase VAEs aim to maximize the probability of the generated output with respect to the input and produce an output from a target distribution by compressing the input into a latent space. On the other hand, GANs try to find the balance point between the generator's and discriminator's two-player game in which the first tries to deceive the second one.

- In addition, VAE's loss function is **KL-divergence**, while a GAN uses two loss functions, the **generator's and discriminator's loss**, respectively.
- Moreover, VAEs are frequently **simpler to train** than GANs as they don't need a good synchronization between their two components.
- Nevertheless, once this balancing is achieved, GANs are likely to recognize **more complicated insights** of the input and generate higher and more detailed plausible data than VAEs.
- Due to their superiority, GANs are used in more demanding tasks like **super-resolution, and image-to-image translation**, while VAEs are widely used in **image denoising and generation.**

Thank You

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