Intro to Neural Networks

BA865 – Mohannad Elhamod
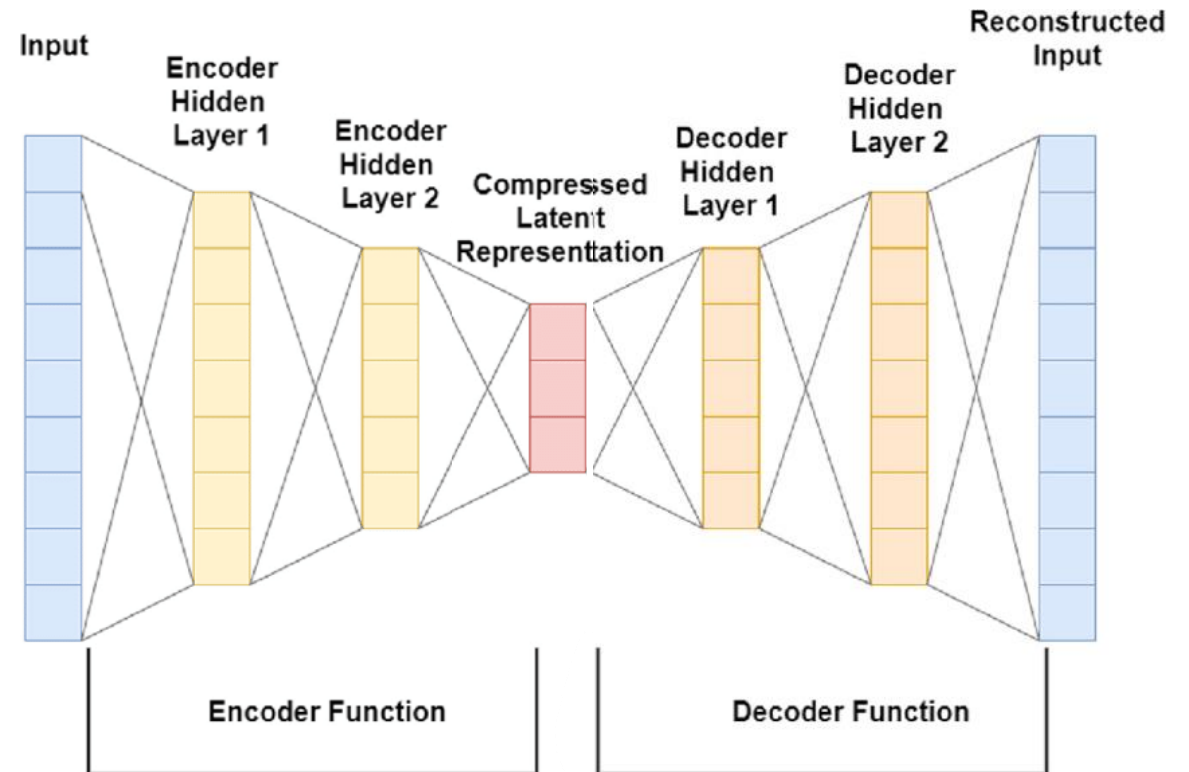
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Auto-Encoders

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Compression and Reconstruction

- Given an input (e.g., image), I may want to…
  - compress it and reconstruct it.
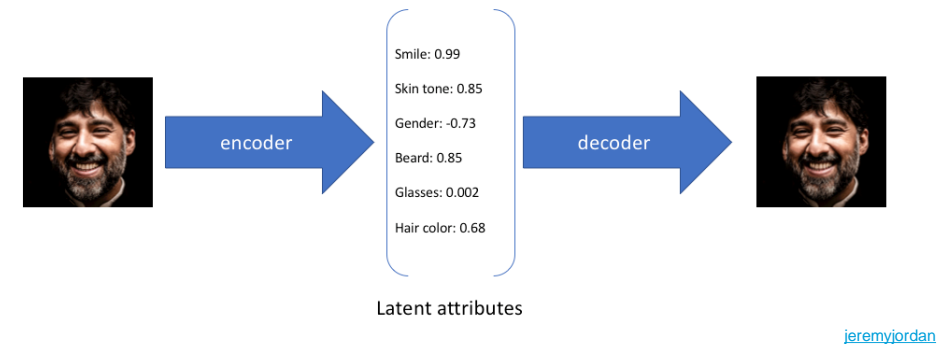 - modify it as it is reconstructed

Auto-Encoder

- Given an input, we need to learn a representation (i.e., code, embedding)
- This embedding is the compressed version of the data.
- The embedding should be sufficient to obtain the desired reconstruction.
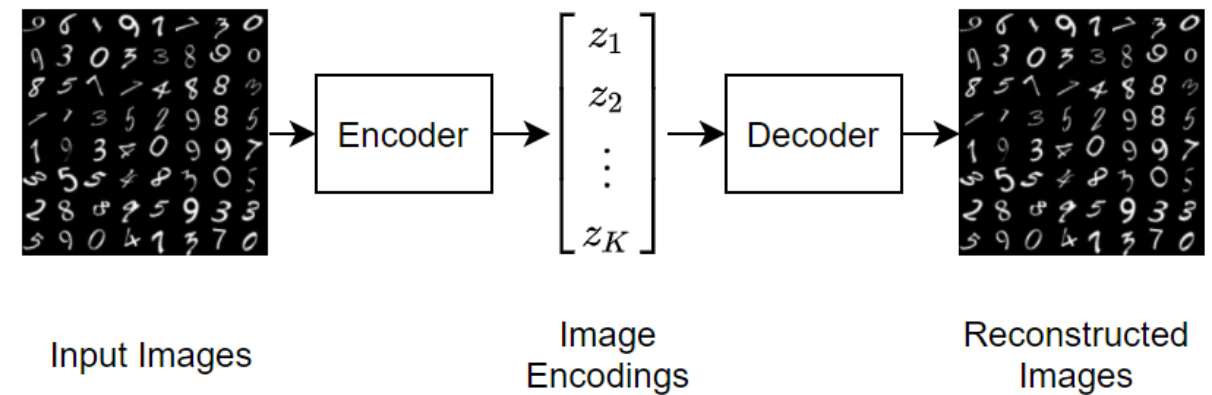
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Auto-Encoder

- Given an input, we need to learn a representation (i.e., code, embedding)
- This embedding is the compressed version of the data
- The embedding should be sufficient to obtain the desired reconstruction.

Input Images   Image Encodings   Reconstructed Images

Smile: 0.99

Skin tone: 0.85

Gender: -0.73

Beard: 0.85

Glasses: 0.002

Hair color: 0.68

encoder   decoder

Latent attributes

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Auto-Encoder

- It is a *non-linear* dimensionality reduction method.

Linear vs nonlinear dimensionality reduction

Autoencoder

PCA

Herminarto Nugroho

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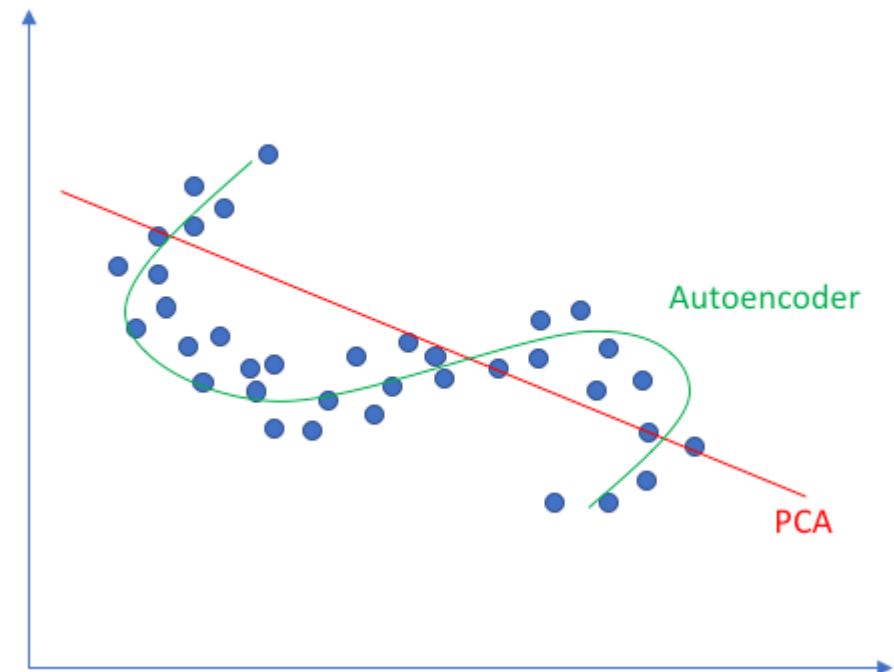
The Error Function

- ## The error is the *"reconstruction loss"*
  - ### The MSE between the input and the output.
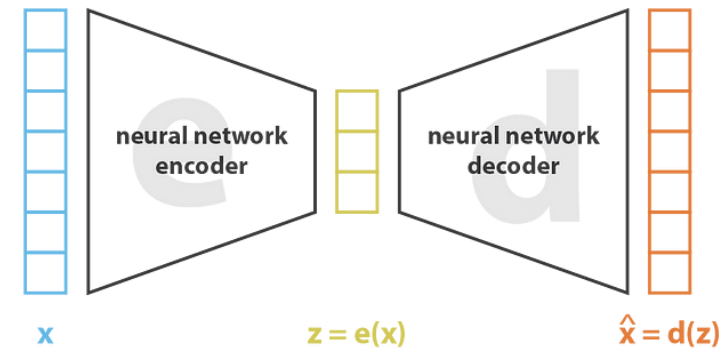
$$\text{loss} = \| \mathbf{x} - \hat{\mathbf{x}} \|^2 = \| \mathbf{x} - \mathbf{d(z)} \|^2 = \| \mathbf{x} - \mathbf{d(e(x))} \|^2$$

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The Auto-Encoder as a Generator

- Once the model is trained, we could use the decoder to generate new content!

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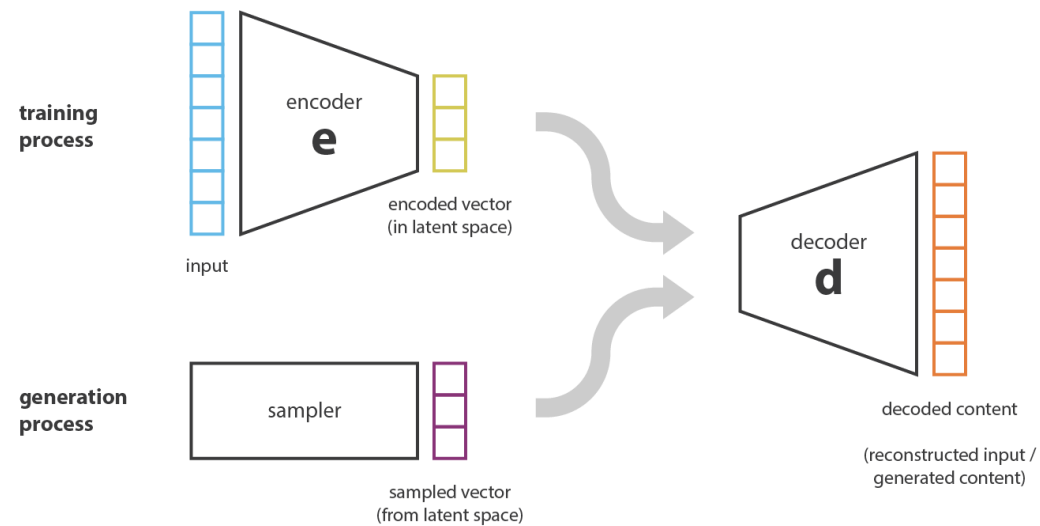
Variational Auto-Encoder

- What if I *"make"* the embedding to follow a nice Gaussian distribution
- Demo
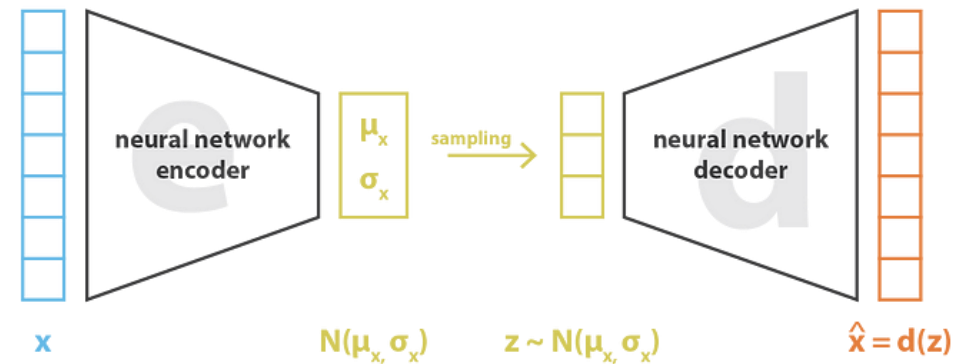
$$\text{loss} \;=\; \| \, x - \hat{x} \, \|^2 + KL[\, N(\mu_x, \sigma_x), N(0, I) \,] \;=\; \| \, x - d(z) \, \|^2 + KL[\, N(\mu_x, \sigma_x), N(0, I) \,]$$

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Variational Auto-Encoder

- Consequently, a traversal of the latent space would lead to smoother transitions in the reconstructed data.

what can happen without regularisation ❌   ✔️ what we want to obtain with regularisation

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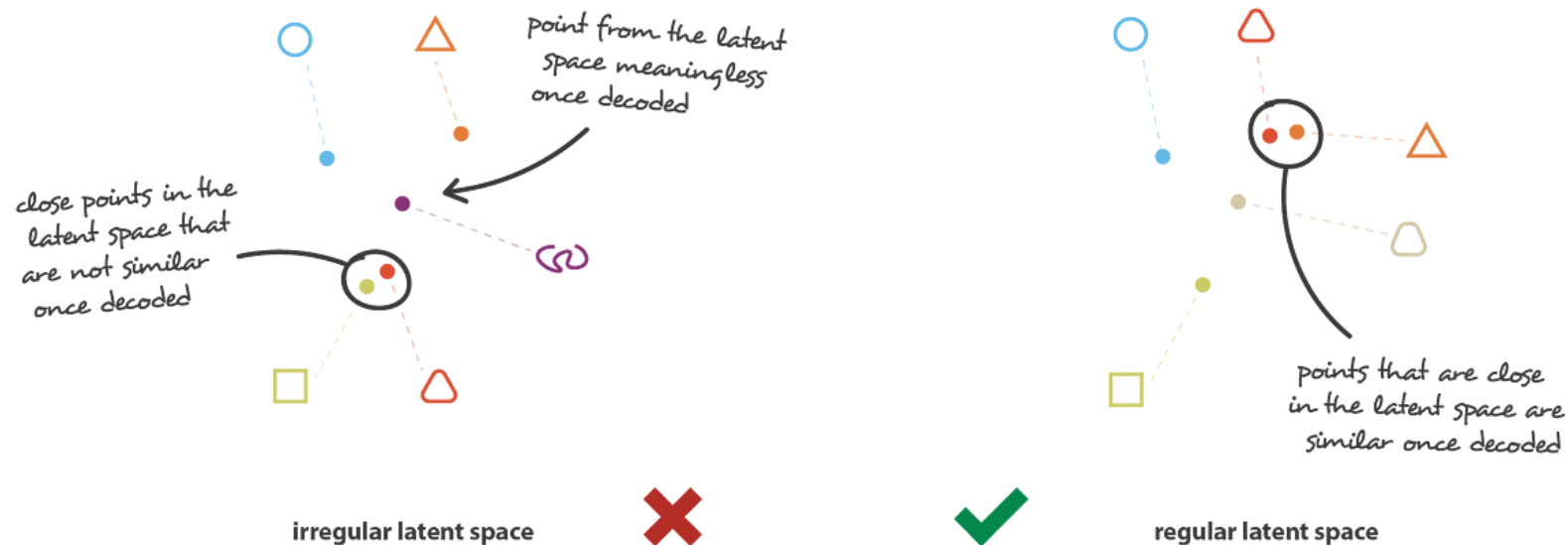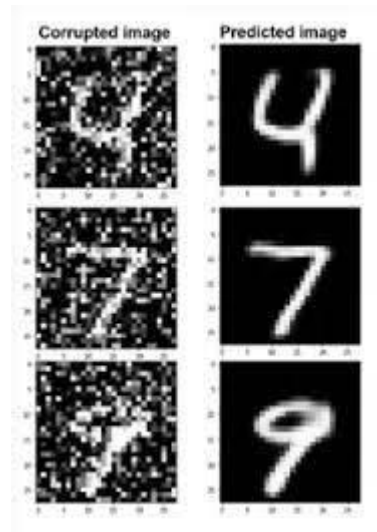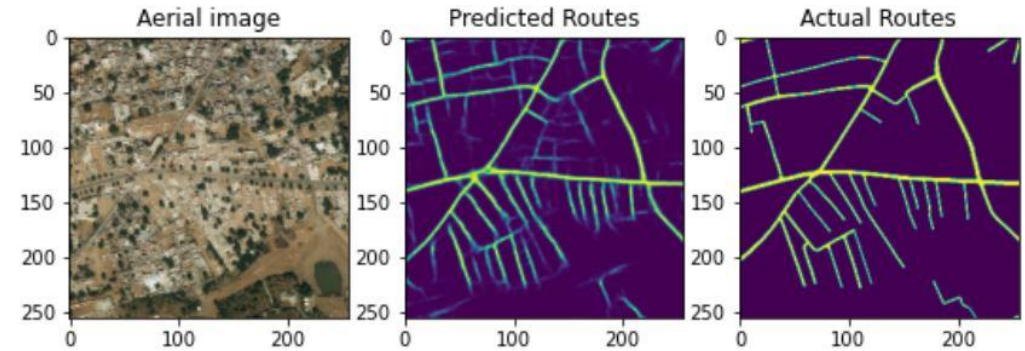**Boston University** Questrom School of Business

Variational Auto-Encoder

- Consequently, a traversal of the latent space would lead to smoother transitions in the reconstructed data.

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Examples in Computer Vision

AI enhance

IMAGE COLORING

Before   After

Corrupted image   Predicted image

Aerial image   Predicted Routes   Actual Routes

Semantic segmentation

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