Autoencoder

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Embedding

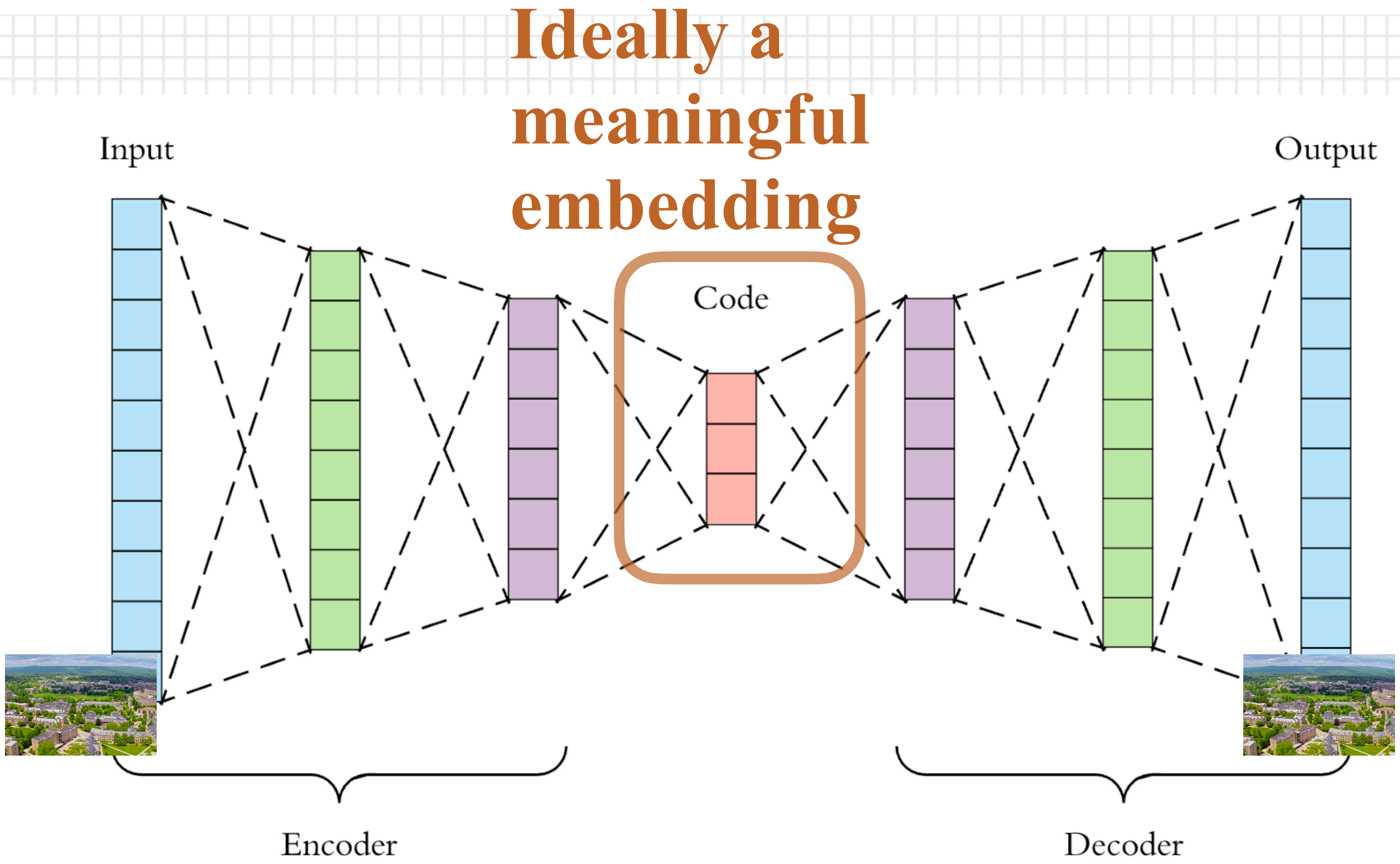
- Represent higher dimensional data in a lower dimensional data while still containing useful information

- Embed this picture?
- Depending on tasks

Photo credits: [VT]

Autoencoder

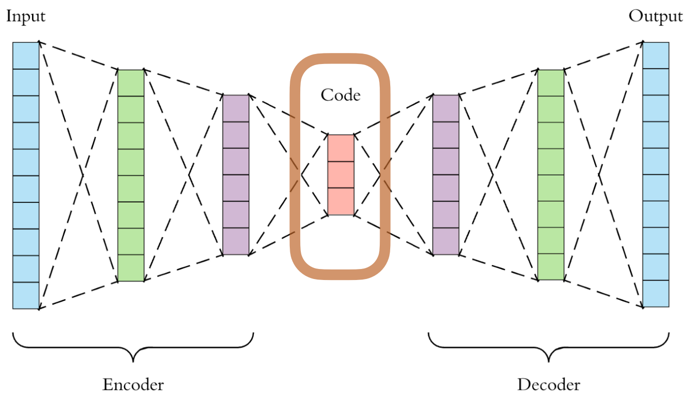
- 'Auto' means self



- A bottleneck shape neural networks
- Retrieve hidden state values as embeddings

Advantages of autoencoder

- Parameter savings, fewer dimensions
- Compression
- Denoising
- Data generation
  - Manipulate the input to the decoder part



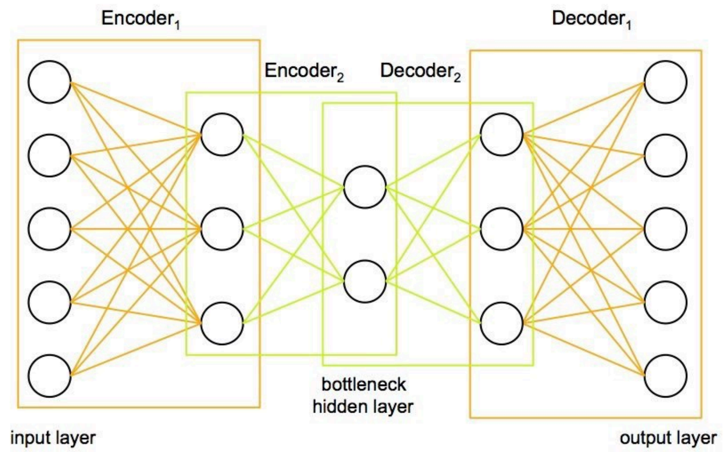
Autoencoder with Maths

- Encoder: $f(\cdot)$
- Decoder: $g(\cdot)$

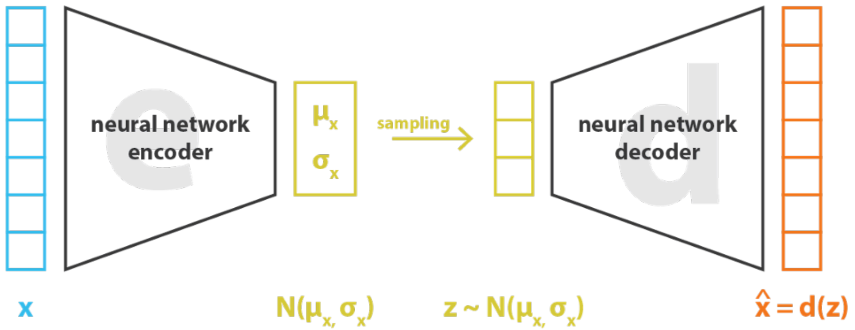
- Autoencoder $g(f(\mathbf{x})) = \mathbf{x}$
- For a training sample (x^l, y^l), $y^l = x^l$
  - Thus, auto

Autoencoder Variants

- Deep
- Stacked



- Variational

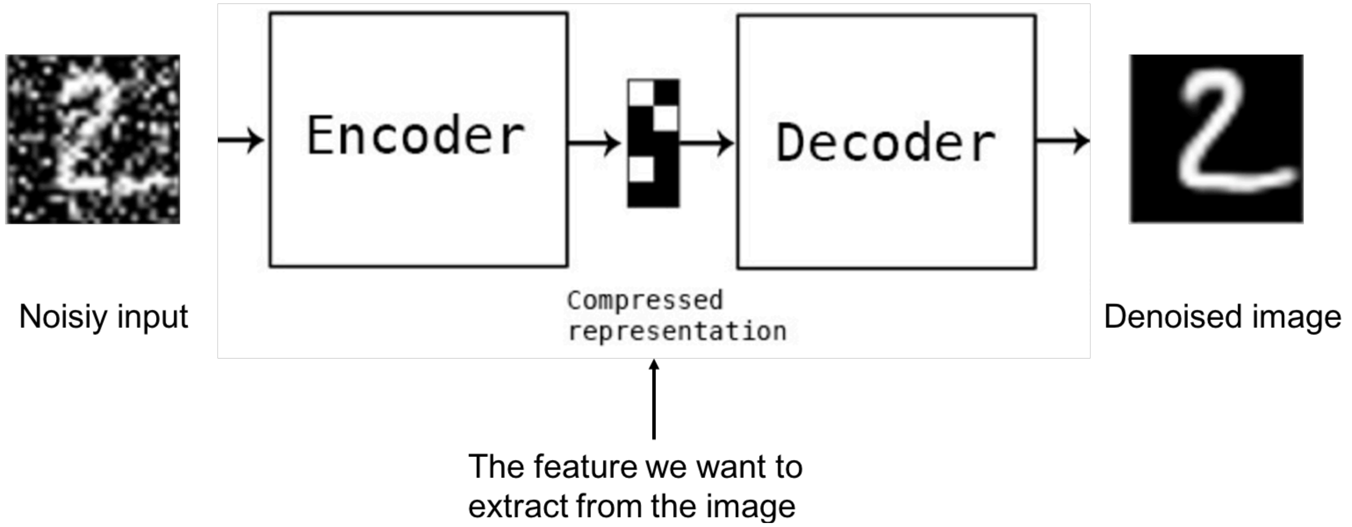


$$\text{loss} = \| x - \hat{x} \|^2 + KL[\, N(\mu_x, \sigma_x), N(0, I)\,] = \| x - d(z) \|^2 + KL[\, N(\mu_x, \sigma_x), N(0, I)\,]$$

- And more?

Denoising Autoencoder

- Intentionally add noise to input
  - $\tilde{x} = x + \mathcal{N}(0,\sigma)$
- Output remains the same
  - $y = x$



More on Dimension Reduction

- Principle Component Analysis (PCA)
- Singular-value Decomposition (SVD)

- Both are deterministic and do not need extra parameters or external training