Machine Learning and Pattern Recognition Practice
Session V: Autoencoder

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Overview

Perceptron

Parametrized supervised learning

optimization problem in supervised learning

$$\hat{y} = f_w(x)$$

$$\hat{w} = \underset{w}{\text{argmin}}\ L(y, \hat{y}) = \underset{w}{\text{argmin}}\ L(y, f_w(x))$$

Dimensionality Reduction with Neural Networks

Dimensionality Reduction

$$\mathcal{X} \in \mathbb{R}^d$$
$$\mathcal{Z} \in \mathbb{R}^p$$
$$p < d$$

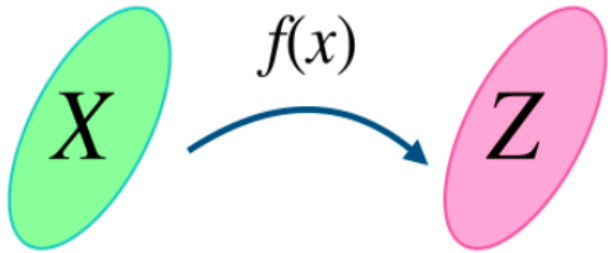


Figure: Dimensionality reduction.

The dimensionality reduction goal is to learn a mapping function $f(x) = z$ that maps input samples x into z.

Autoencoder concept

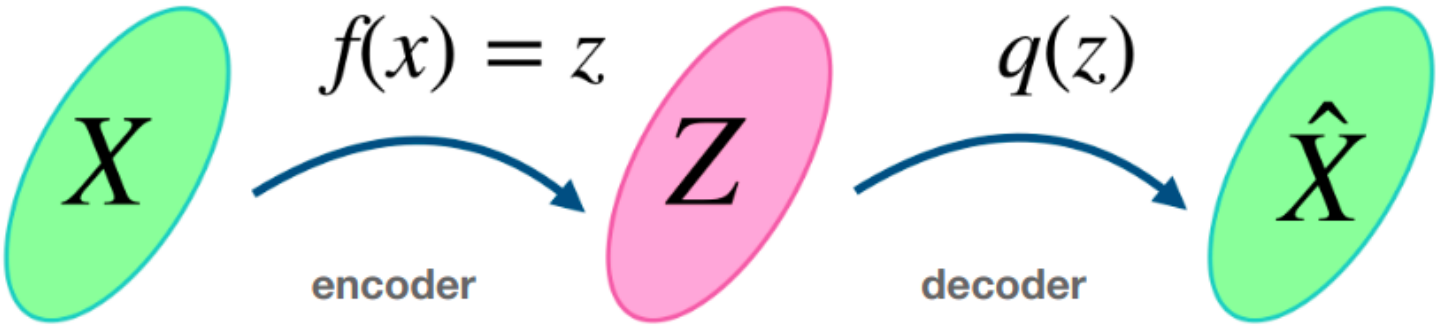
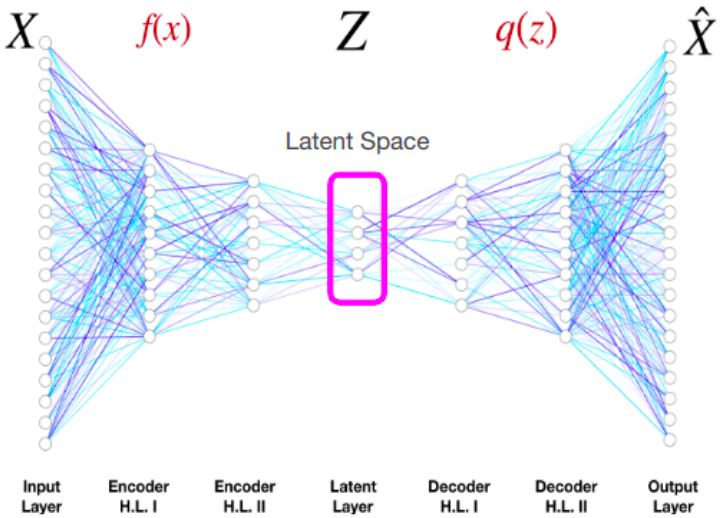


Figure: Encoder and decoder functions.

The autoencoder model is composed by two functions. The encoder $f(x) = z$ maps the input data into a low dimensional latent space. The decoder function reconstructs the samples from the latent space to the original input space.

Autoencoder model

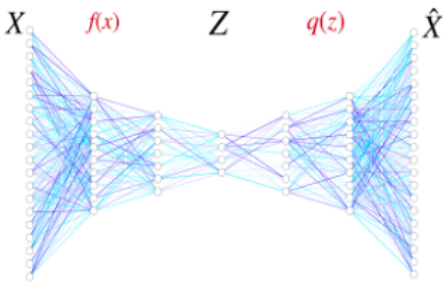


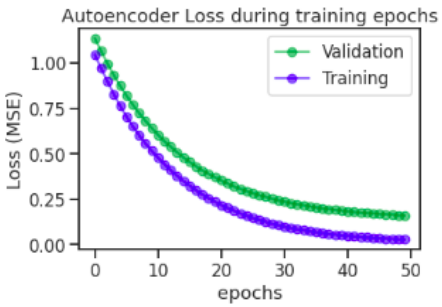
$$\boldsymbol{z} = f\left(\boldsymbol{x}, \mathbf{W}_f\right) = \sigma\left(\mathbf{W}_f \boldsymbol{x} + \mathbf{b}_f\right)$$
$$\tilde{\boldsymbol{x}} = q\left(\boldsymbol{z}, \mathbf{W}_q\right) = \sigma\left(\mathbf{W}_q \mathbf{z} + \mathbf{b}_q\right)$$

Figure: Autoencoder architecture

The autoencoder is a neural network model with one or multiple hidden layers. The hidden layer of the middle is named bottle neck or latent space.

Autoencoder loss function





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$$L(x, \hat{x}) = L(x, q(f(x))) = \|x - \hat{x}\|^2$$

Figure: The landscape of activation functions

Dimensionality Reduction

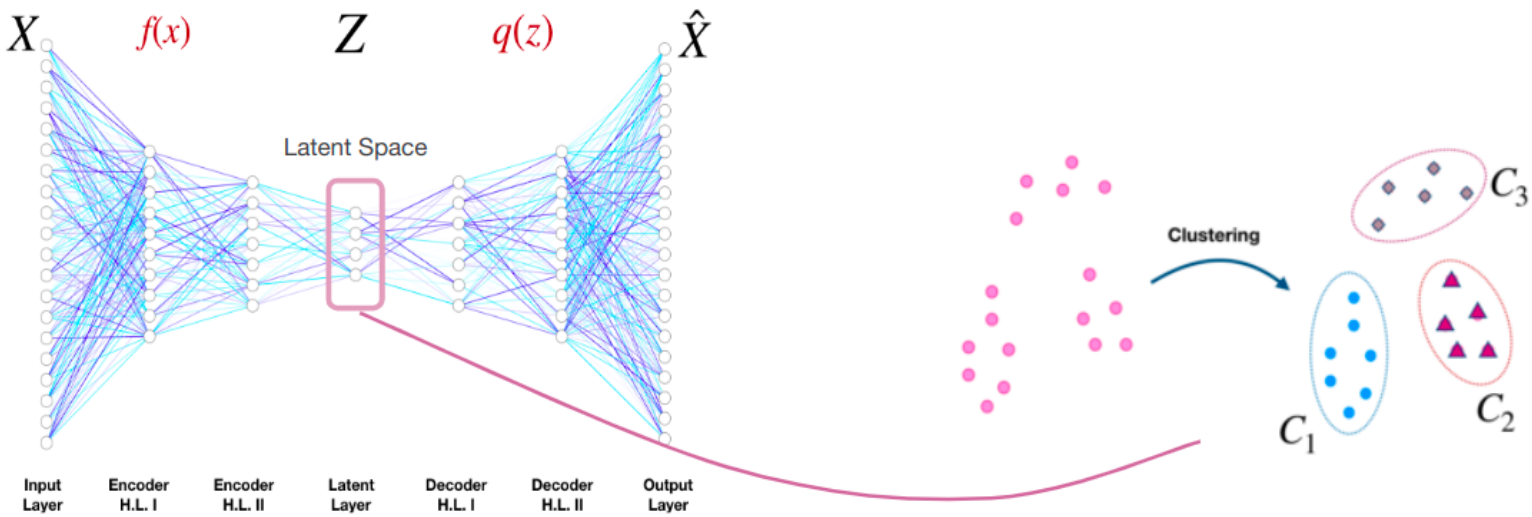

Figure: The landscape of activation functions


Stevens, E., Antiga, L., & Viehmann, T. (2020). Deep learning with PyTorch. Manning Publications.


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