

Autoencoder

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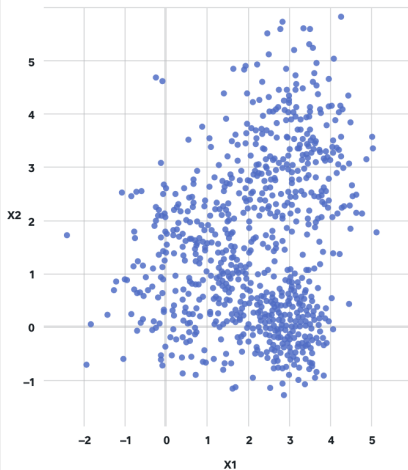


- Unsupervised Learning
- Autoencoder
- Applications

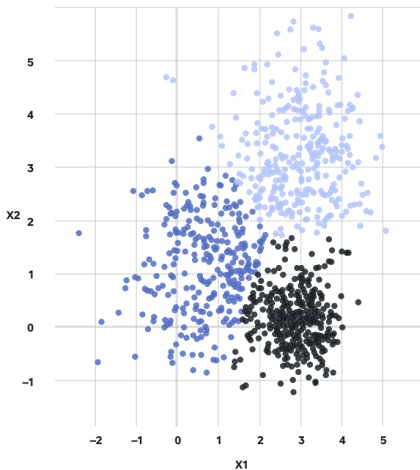
Unsupervised Learning

- Clustering: find underlying structures
 - ▶ E.g., K-Means
- Dimension reduction: fast processing, visualization
 - ▶ E.g., PCA, Autoencoder
- Generative models: generate synthetic data
 - ▶ E.g., Variational Autoencoder, Generative Adversarial Network
- Other applications are possible

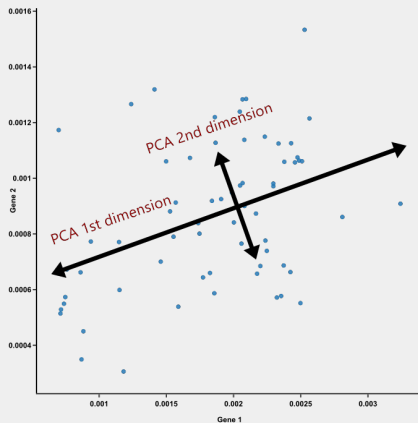
RAW DATA



CLUSTERED DATA VISUALIZATION



- N -dimensional data $\rightarrow M$ orthogonal directions in which the data have the most variance



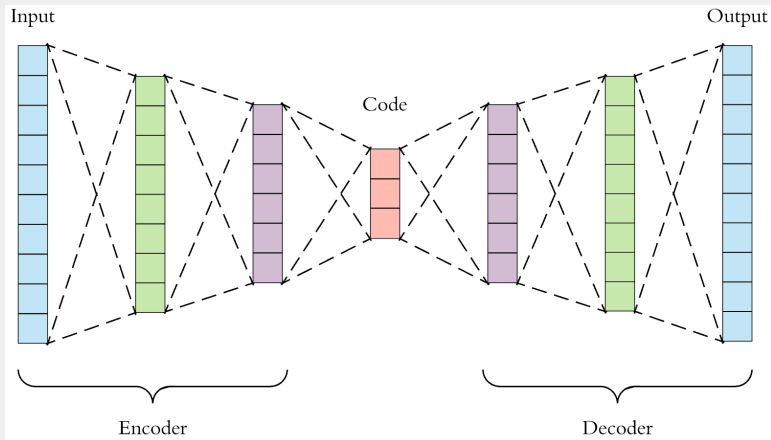
- N -dimensional data $\rightarrow M$ orthogonal directions in which the data have the most variance

```
from sklearn import decomposition  
pca = decomposition.PCA(n_components=2)  
pca.fit(diabetes_X)  
X_2d = pca.transform(diabetes_X)
```

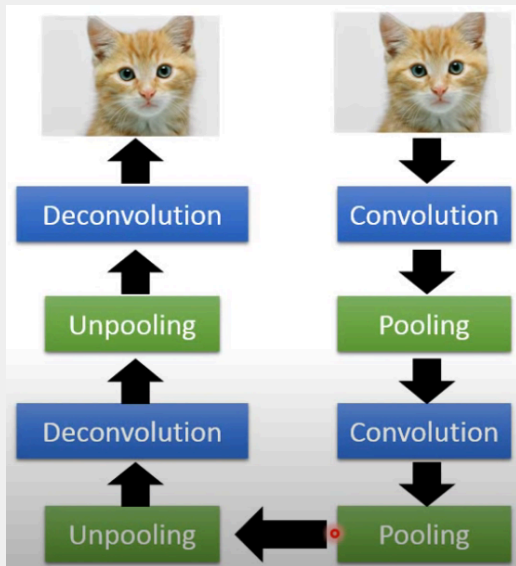


Autoencoder

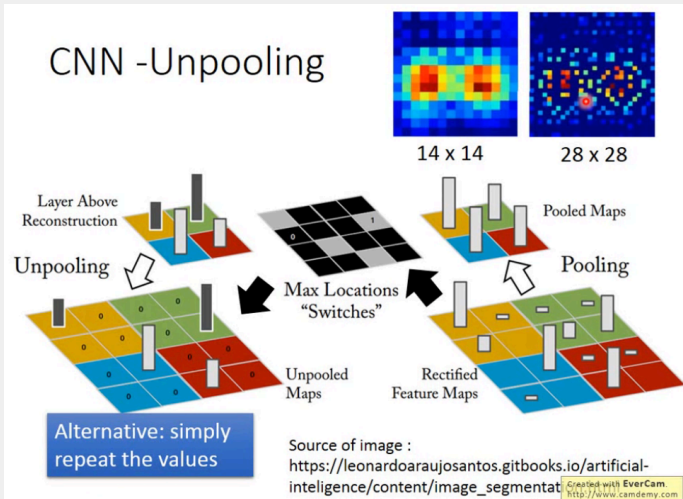
- Goal: minimize $\| \text{original data} - \text{reconstructed data} \|$



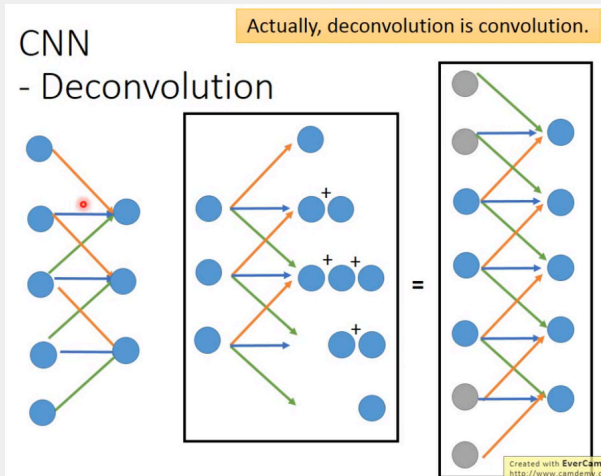
- PCA is a linear operation and can be realized using Autoencoder (w/ linear activation)
- Autoencoder can achieve non-linear dimension reduction through non-linear activation functions
- Hinton and Salakhutdinov, Reducing the Dimensionality of Data with Neural Networks, 2006 ([link](#))



- E.g., Max unpooling: keep the “max” and fill the rest with 0 or just repeat the “max” value

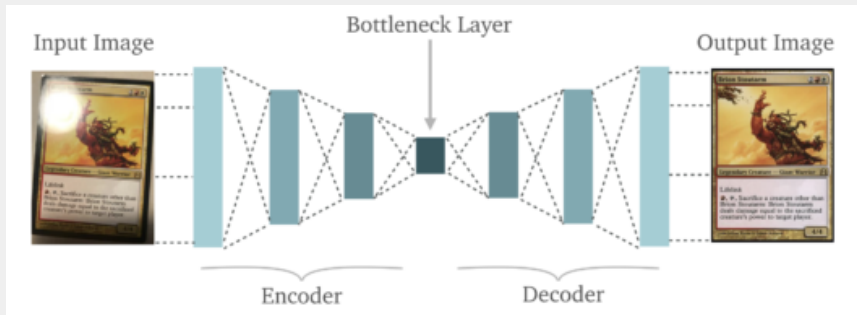


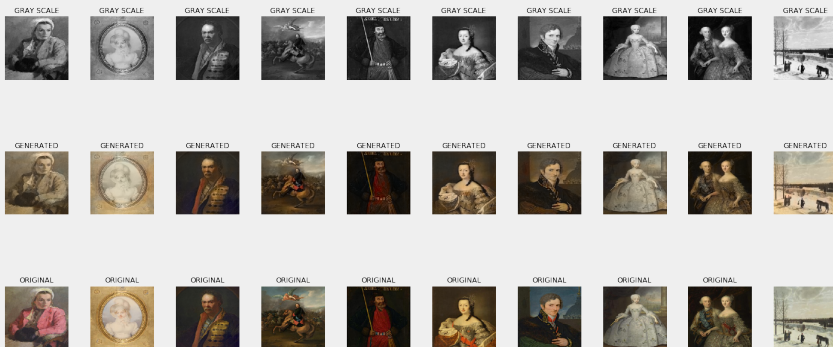
- Deconvolution is just convolution



Applications

- Denoising
 - ▶ input: noisy data
 - ▶ output: reconstructed data
 - ▶ Goal: minimize $\| \text{reconstructed data} - \text{clean data} \|$
- Vincent et al., Extracting and Composing Robust Features with Denoising Autoencoders, 2008 (influential paper on denoising AE)
- [Code](#)





■ Code