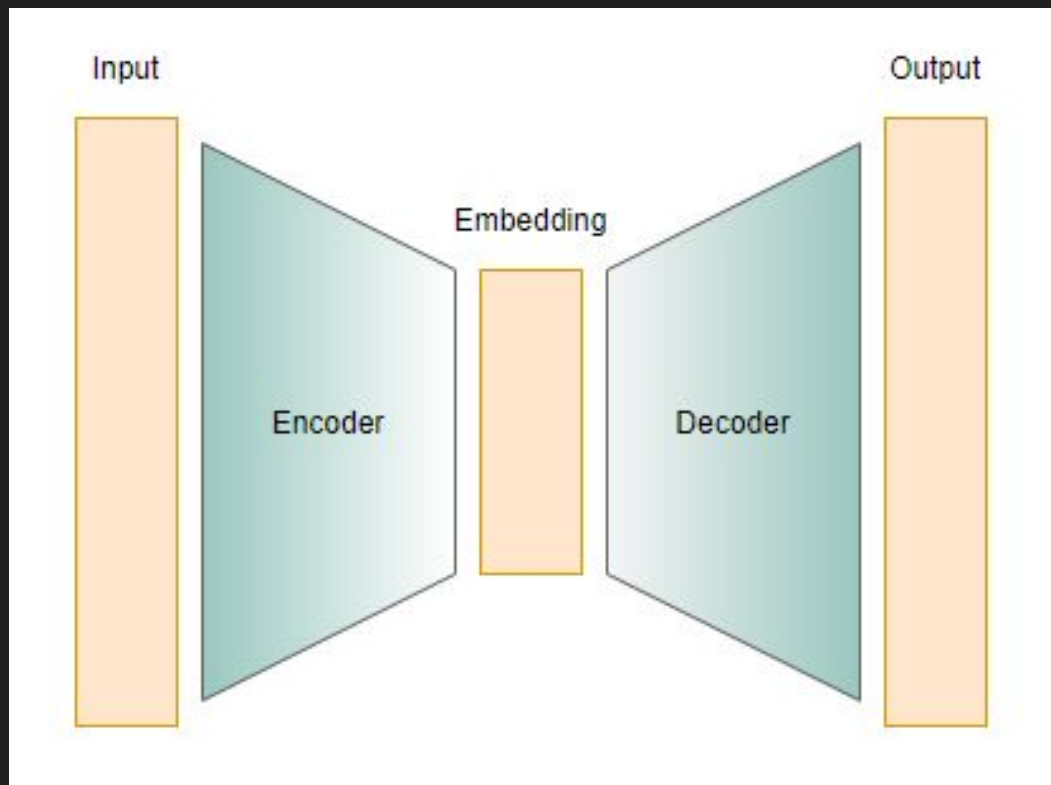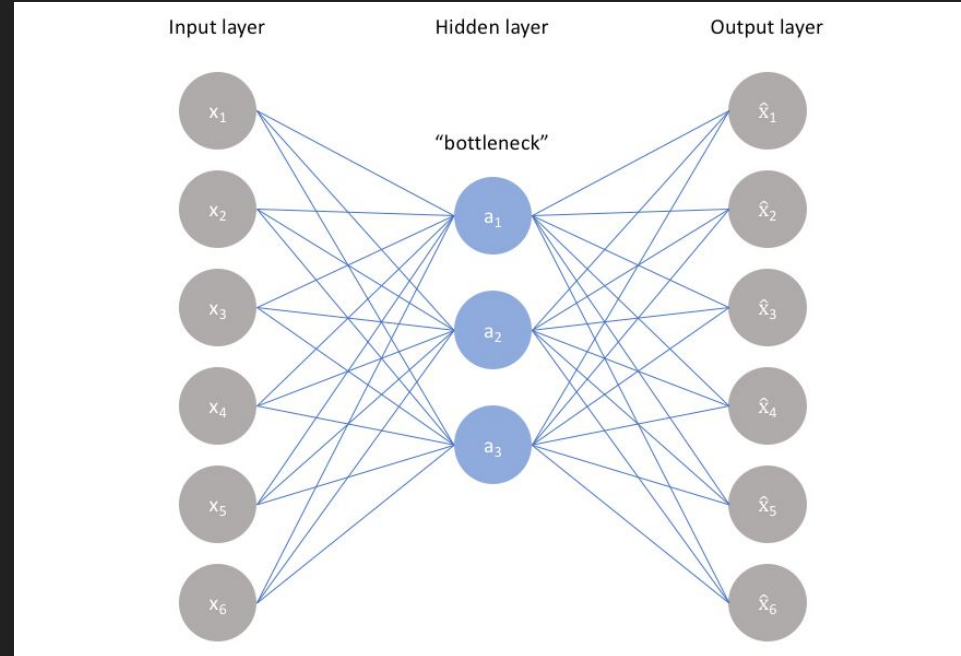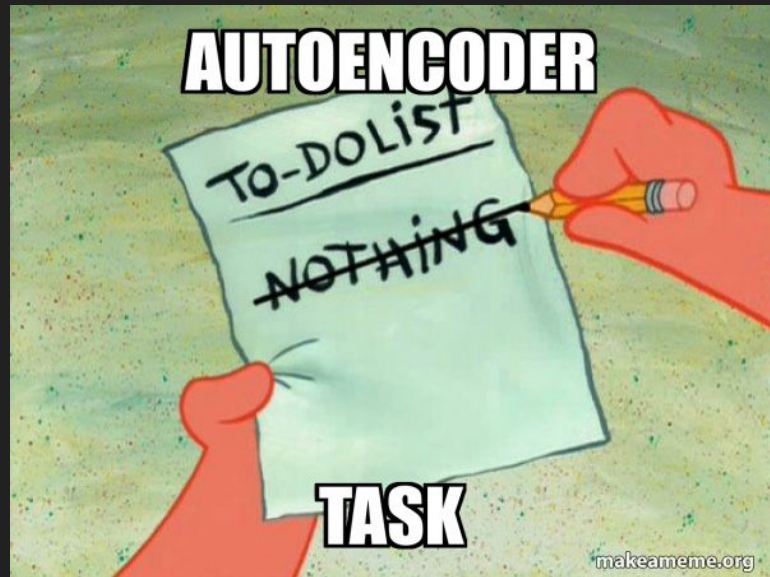# L11

Autoencoders

Autoencoder

Autoencoder

- #inputs == #outputs
- on a hidden layer the number of neurons is ALWAYS less than on input/output
- the same data used as input and as label (mostly)

Autoencoder Task

Reconstruction of the original input!
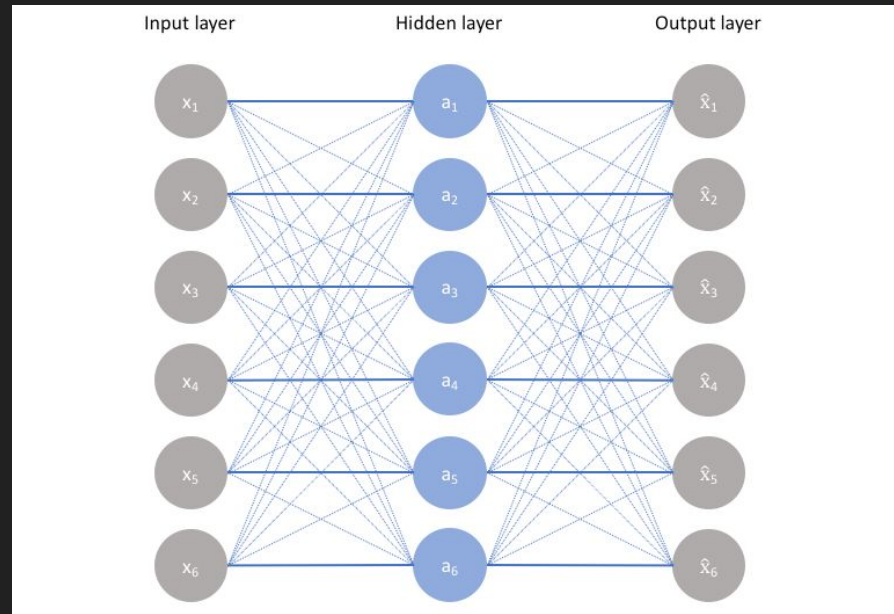
What is the trivial architecture to do so?

How to do nothing?

y = E*E*x,

where E is identity matrix

But it violates autoencoder feature.

When error is 0?

WHAT??? A QUIZ !!!
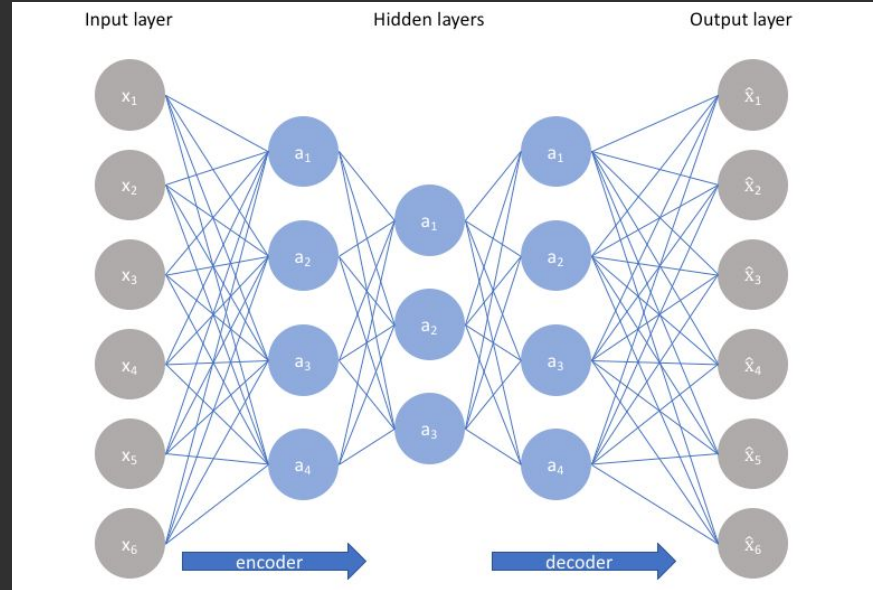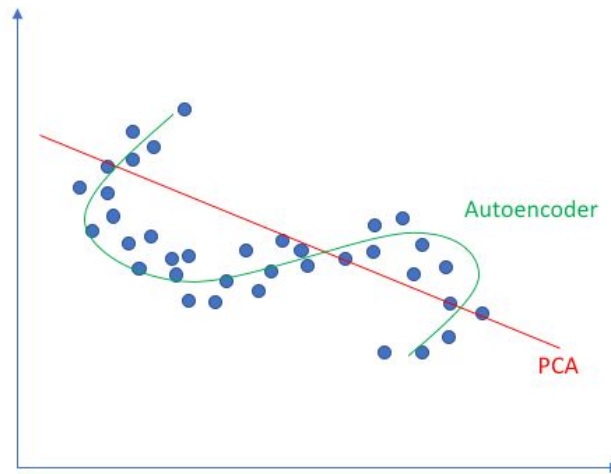
What does autoencoder learn?

It learns and describes latent attributes of the input data

Autoencoder VS PCA

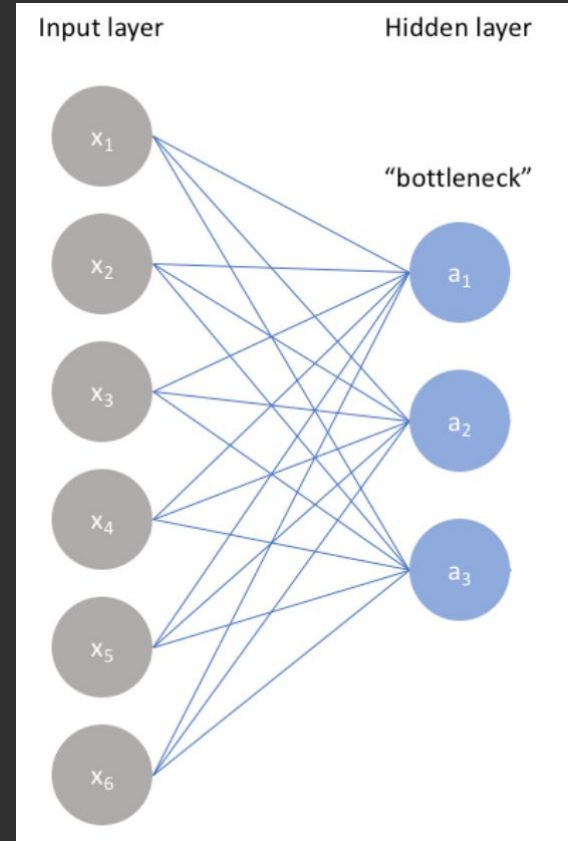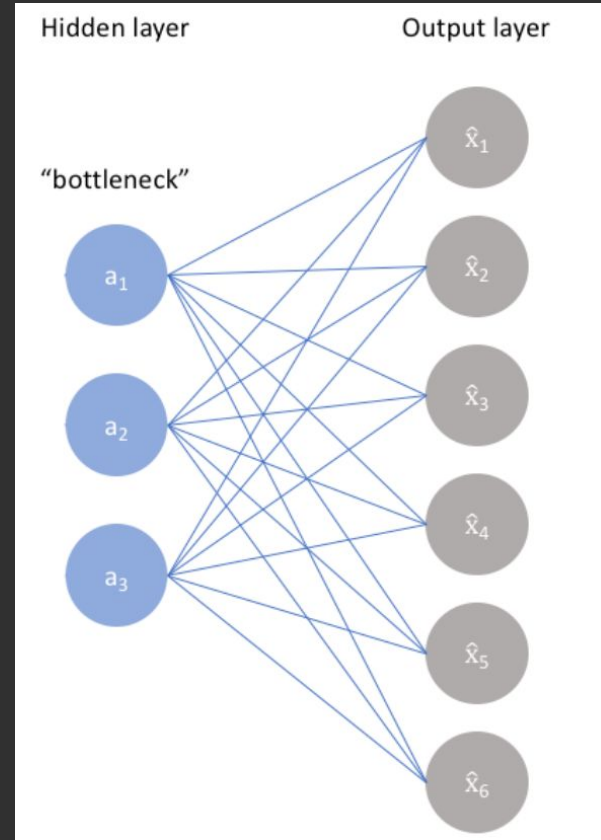Linear vs nonlinear dimensionality reduction

Autoencoder

PCA

What is the value of trained Encoder?

What is the value of trained Decoder?

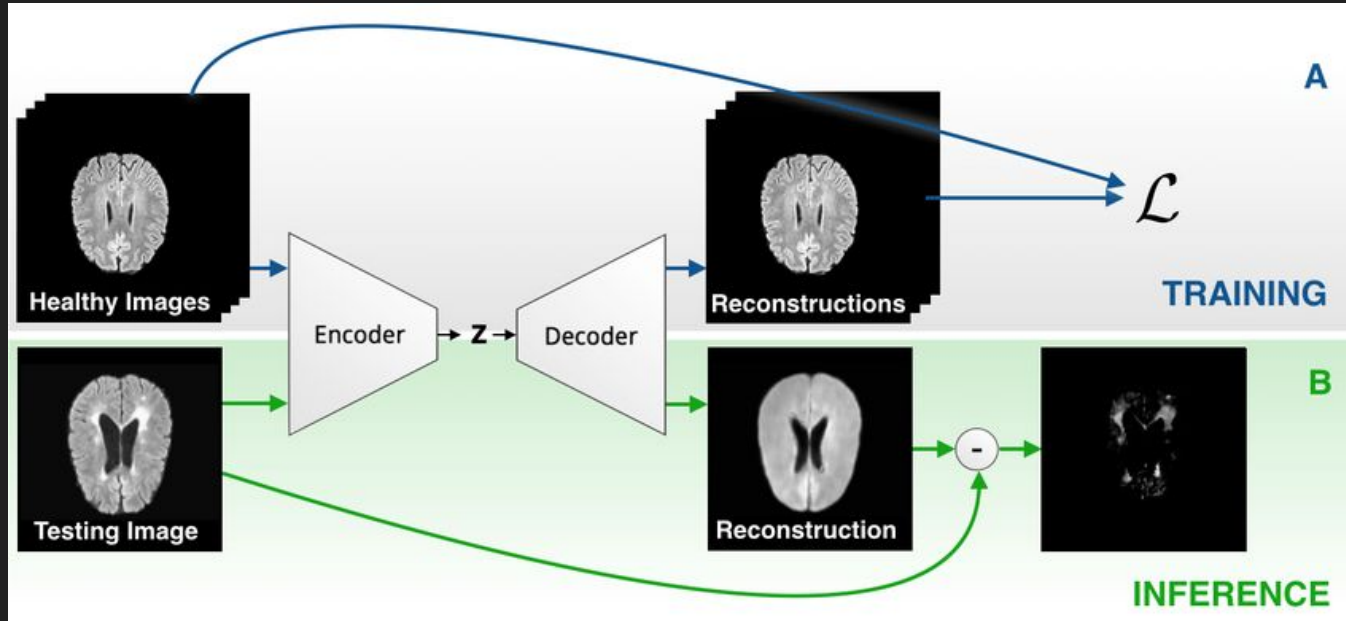# Autoencoder Applications

- anomaly / outlier / fraud detection
- data denoising
- getting embeddings (feature-vectors)
- dimensionality reduction
- generation of new data ([VAE](), [music generation]())

Denoising with Autoencoders. MNIST Example
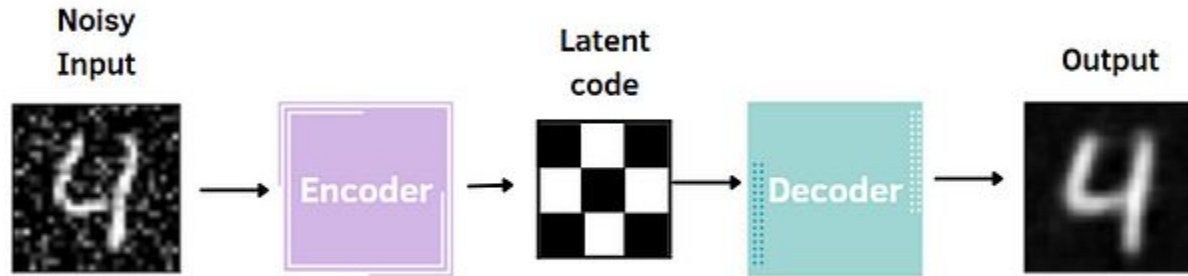
Fraud / Outlier Detection. MNIST Example

Real world example: https://mobidev.biz/blog/defect-detection-in-manufacturing-with-unsupervised-learning

Encoder-Decoder Application

Stable diffusion:

- https://learnopencv.com/stable-diffusion-generative-ai/
- https://huggingface.co/spaces/stabilityai/stable-diffusion

Well-known Libraries

- Anomalib: https://github.com/openvinotoolkit/anomalib
- Alibi Detect: https://github.com/SeldonIO/alibi-detect

Outlier Detection

Detector	Tabular	Image	Time Series	Text	Categorical Features	Online	Feature Level
Isolation Forest	✔				✔		
Mahalanobis Distance	✔				✔	✔	
AE	✔	✔					✔
VAE	✔	✔					✔
AEGMM	✔	✔					
VAEGMM	✔	✔					
Likelihood Ratios	✔	✔	✔		✔		✔
Prophet			✔				
Spectral Residual			✔			✔	✔
Seq2Seq			✔				✔
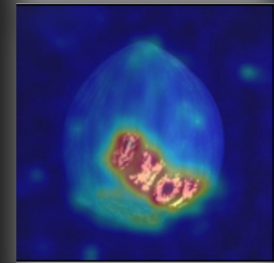
NO HW

- Try different losses, for example, BCE
- Investigate influence AE's symmetry and Encoder / Decoder sizes on:
    - Anomaly detection accuracy
    - Image restoration accuracy
- Investigate influence latent space size on:
    - Anomaly detection accuracy
    - Image restoration accuracy
- Visualize latent space as image. Try find patterns and connections between input image, its class, and latent space visualization
- Try to cluster latent space for 10 classes and investigate if it's suitable for image classification
- Read about VAE, try found code on MNIST dataset for image generation