SAARBRÜCKEN

6TH SUMMER SCHOOL ON COMPUTATIONAL INTERACTION

INFERENCE, OPTIMIZATION AND MODELING FOR THE ENGINEERING OF INTERACTIVE SYSTEMS | 13 - 18 JUNE 2022

Deep Learning for Human–Computer Interaction

Session 3: Unsupervised learning

Luis Leiva & **Bereket Yilma**
University of Luxembourg

UNIVERSITÉ DU LUXEMBOURG

Learning outcomes

After this lecture you will be able to:

- Identify unsupervised problems
- Understand the autoencoder architecture

What is unsupervised learning?

Learn from data (e.g. structure, associations) without human supervision

Labeled data is a luxury!

https://cloud.google.com/products/ai/ml-comic-1/

Definitions

Unsupervised learning	No labeled data at all
Semi-supervised learning	Small amount of labeled data involved
Self-supervised learning	Labels are inferred from data

https://medium.com/intuitionmachine/744a6819ce08
https://www.facebook.com/722677142/posts/10155934004262143/

Some applications

Clustering

Dimensionality Reduction

Information Visualization

Learning Associative Rules

Anomaly Detection

Information Retrieval

Word Embeddings:

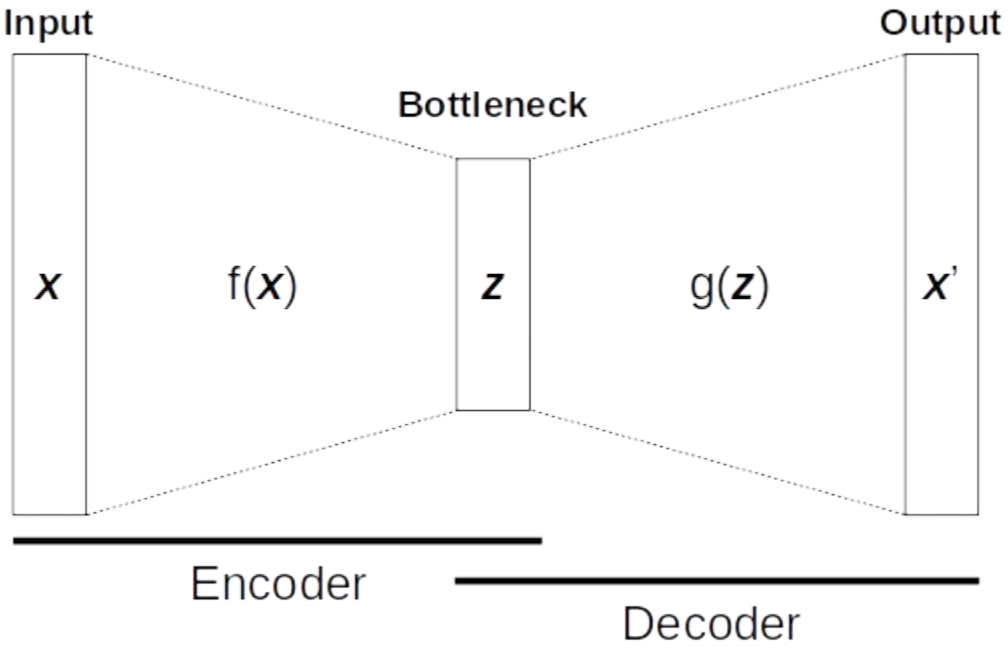
- CBOW
- Skip-gram

Image Enhancement:

- Noise removal
- Super-resolution
- Colorization

The autoencoder architecture

$$\mathcal{L}(\mathbf{x}, \mathbf{x}') = [\mathbf{x} - g(f(\mathbf{x}))]^2$$



Latent variables

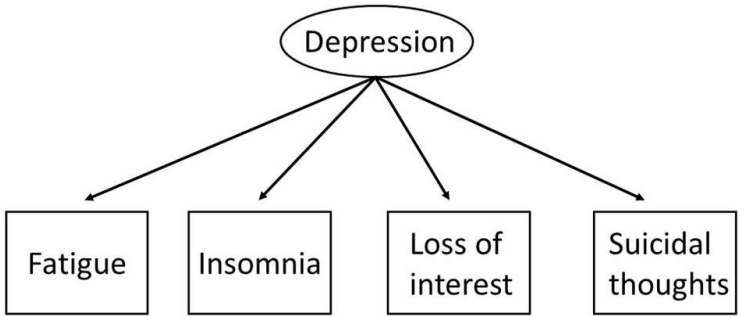
Are *implicit* data features

Cannot be observed or measured

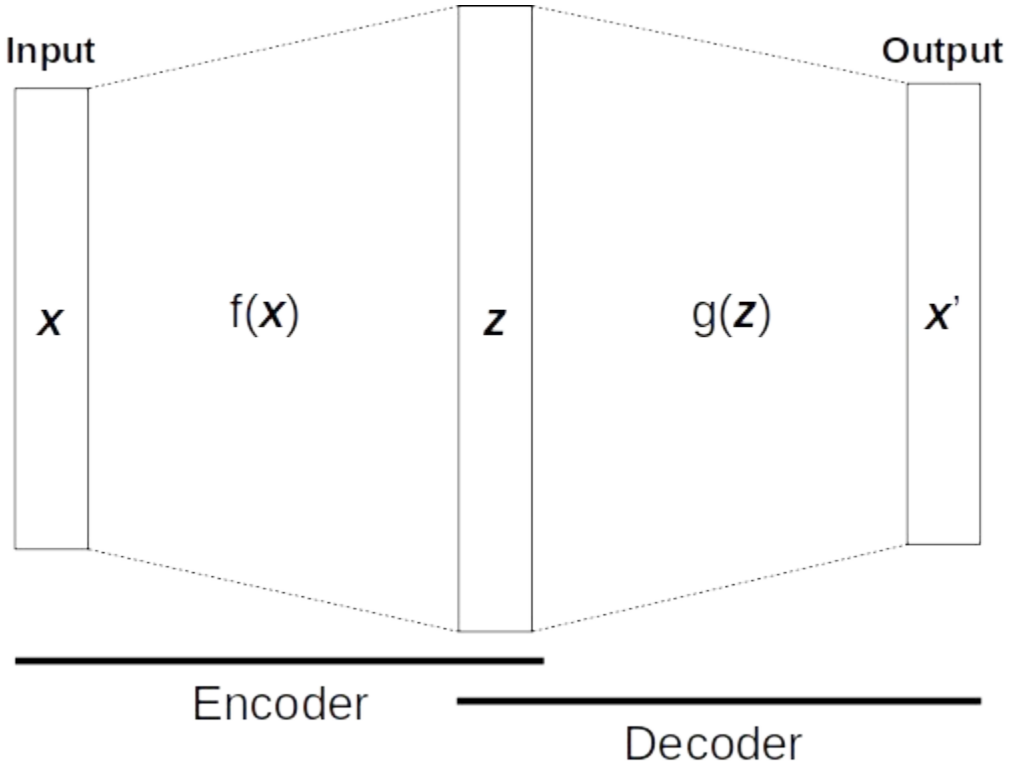
Are inferred from observable variables

Examples:

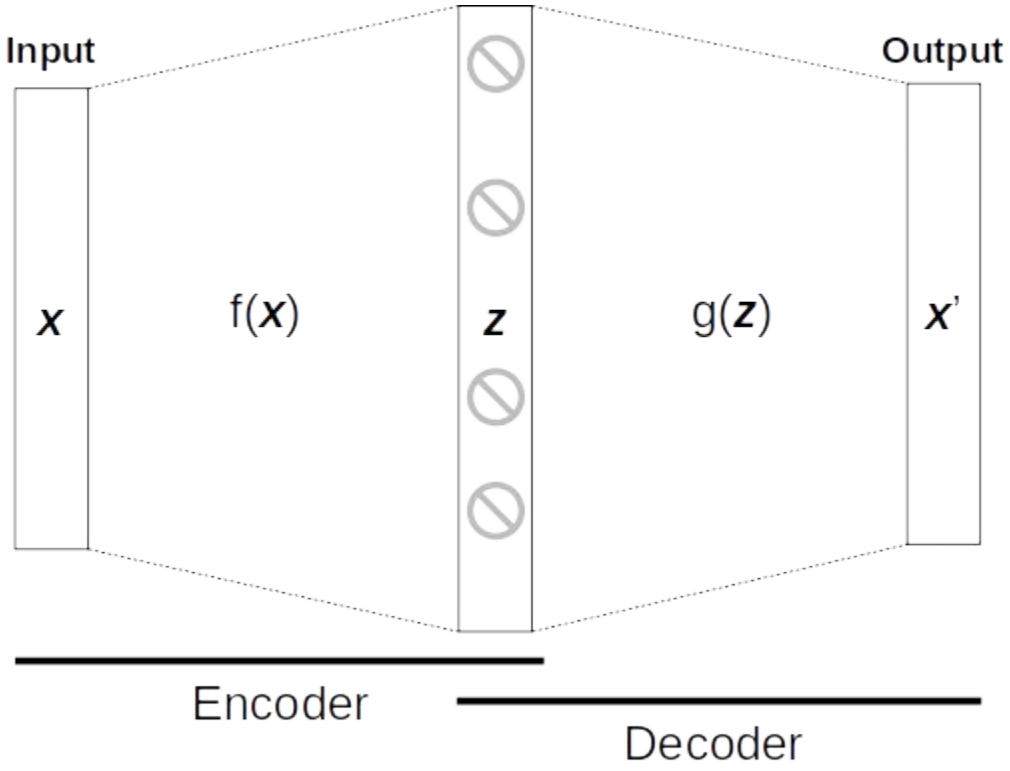
- Intelligence
- Motivation
- Depression



Overcomplete autoencoders

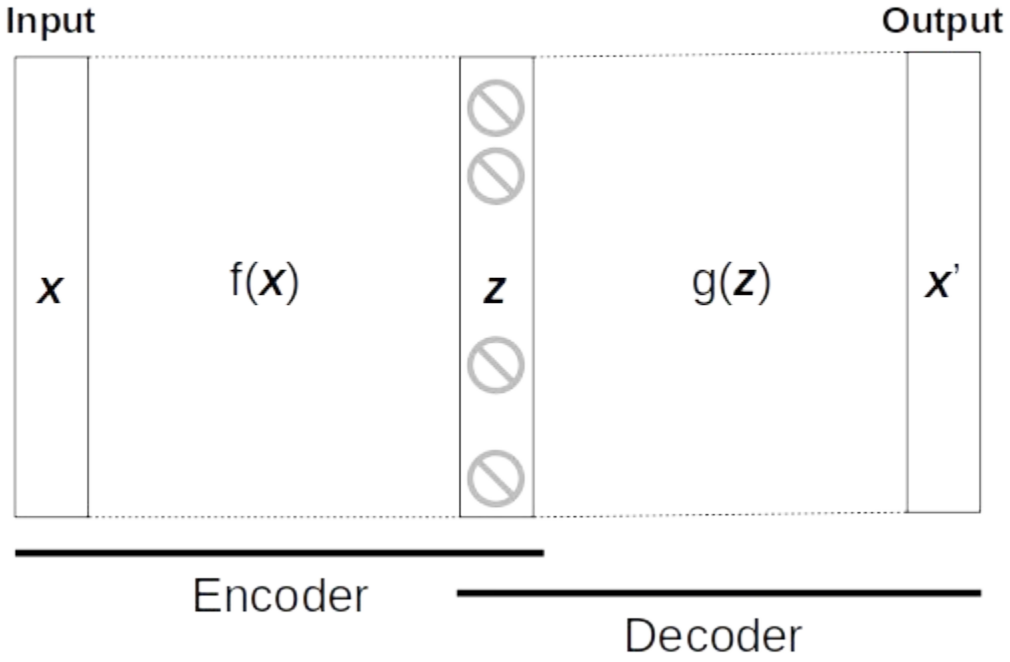


Overcomplete **sparse** autoencoders

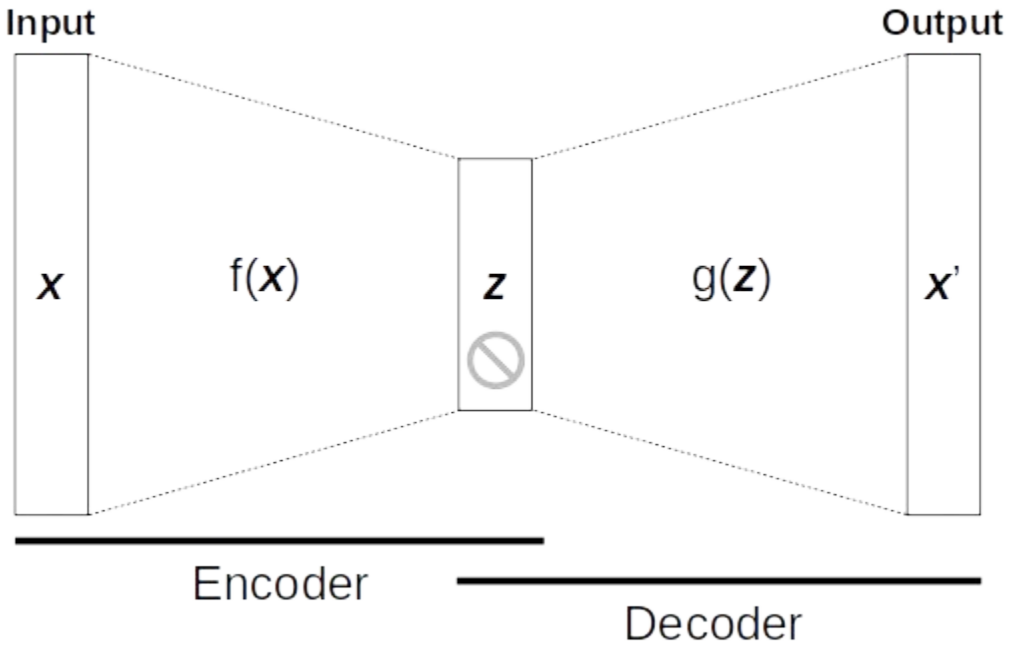


Sparse autoencoders

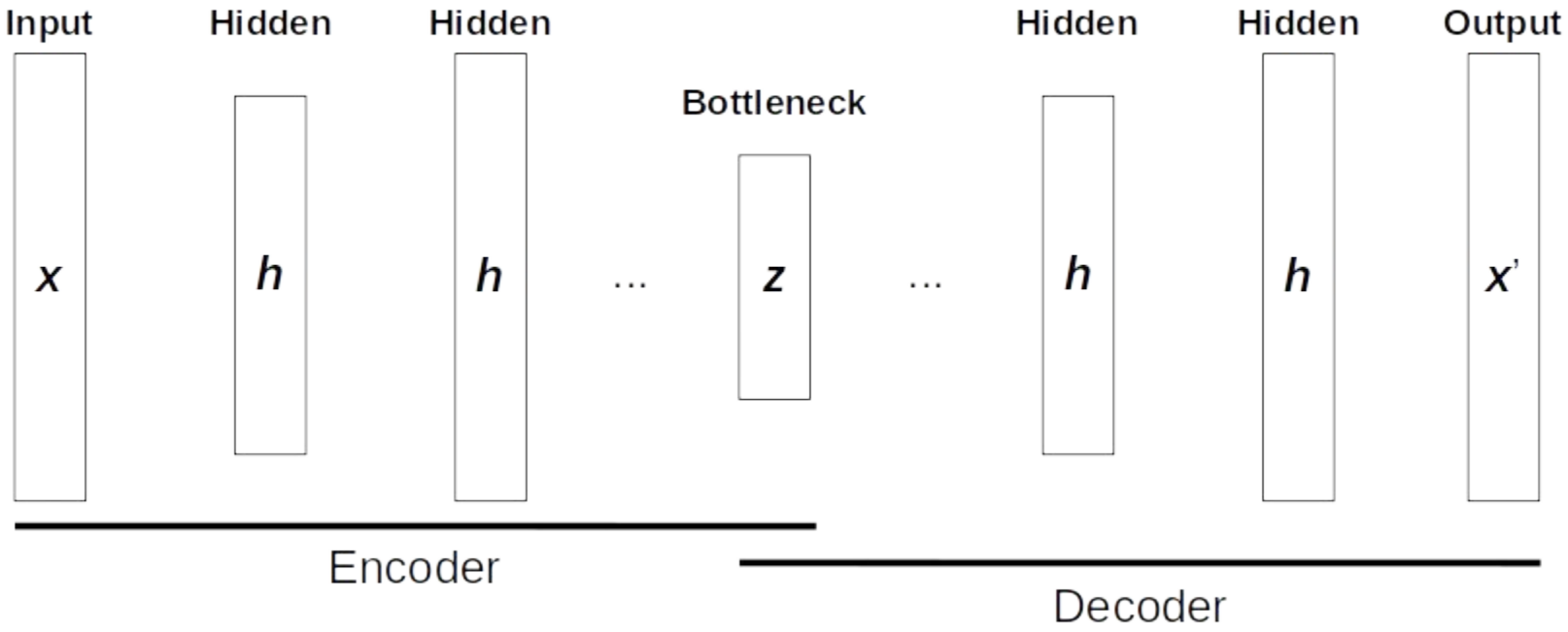
$$\mathcal{L}(\mathbf{x}, \mathbf{x}') = [\mathbf{x} - g(f(\mathbf{x}))]^2 + \Omega(\mathbf{z})$$



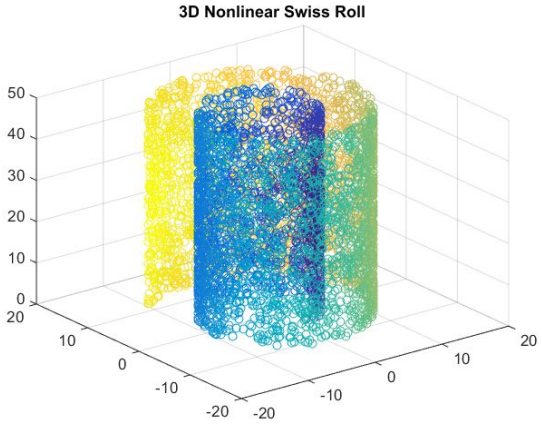
Undercomplete sparse autoencoders

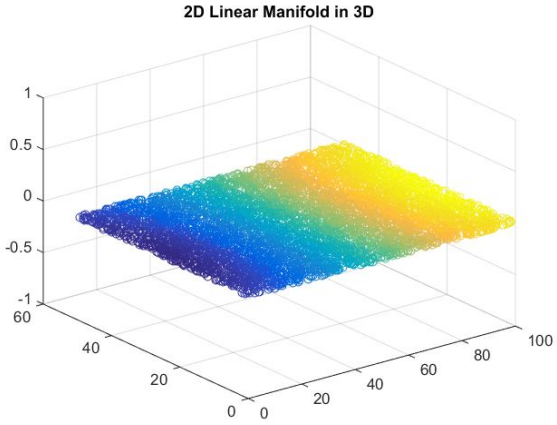


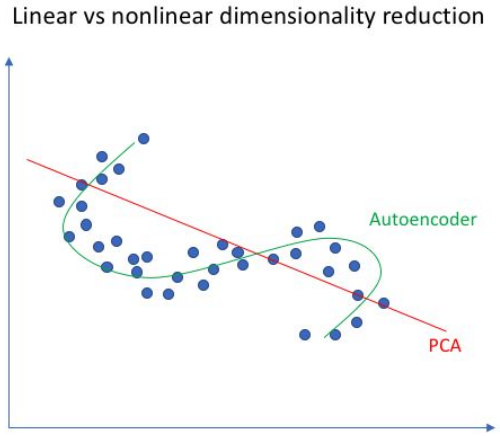
Deep autoencoders



Application: Dimensionality reduction

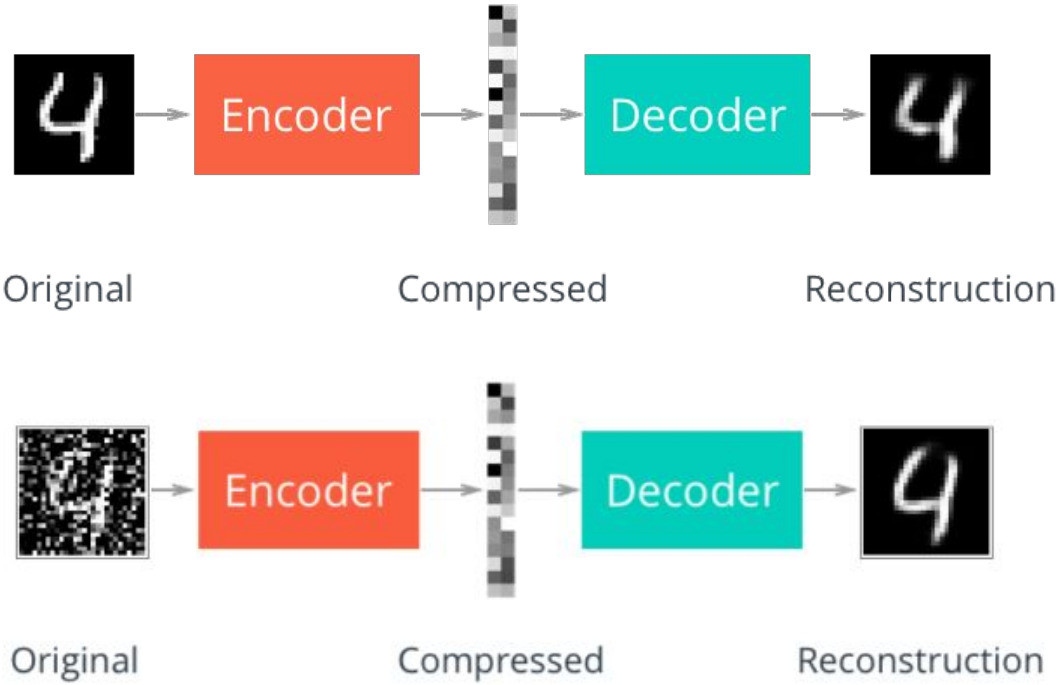






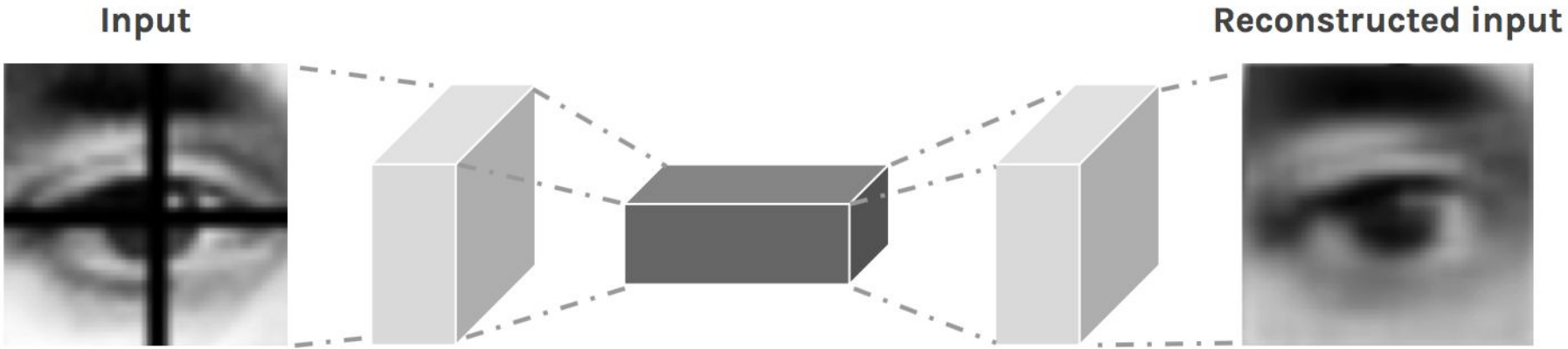
https://www.jeremyjordan.me/autoencoders/

Application: Noise removal



https://iq.opengenus.org/autoencoder/

Application: Image inpainting

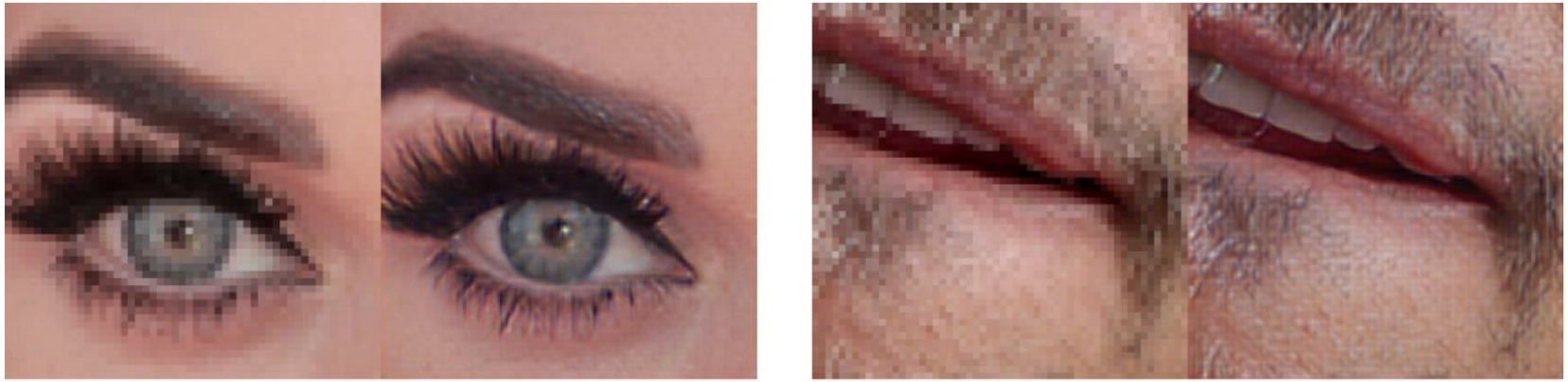


https://hackernoon.com/autoencoders-deep-learning-bits-1-11731e200694

Application: Image colorization

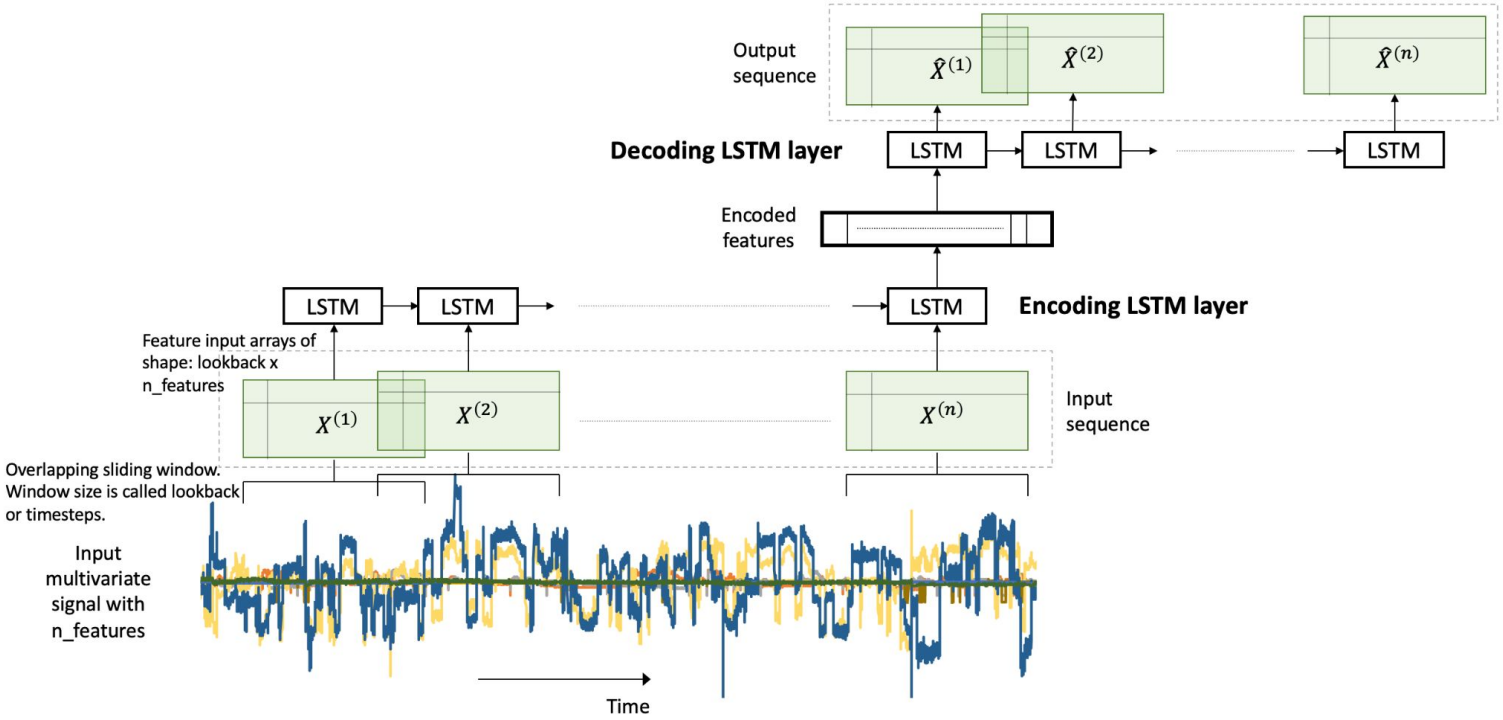
https://medium.com/@mahmoudeljiddawi/a213b47f7339

Application: Image super-resolution



https://hackernoon.com/autoencoders-deep-learning-bits-1-11731e200694

Application: Anomaly detection

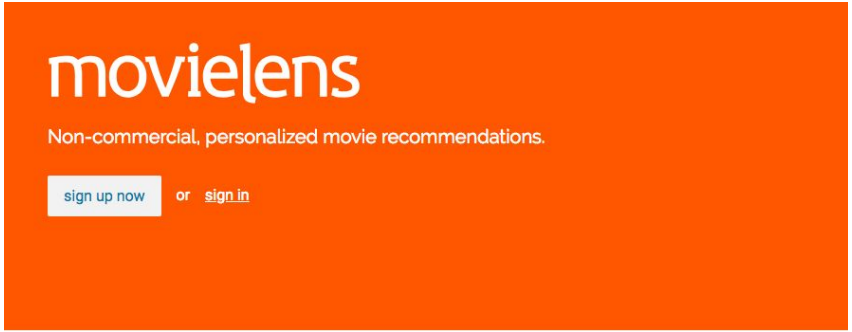


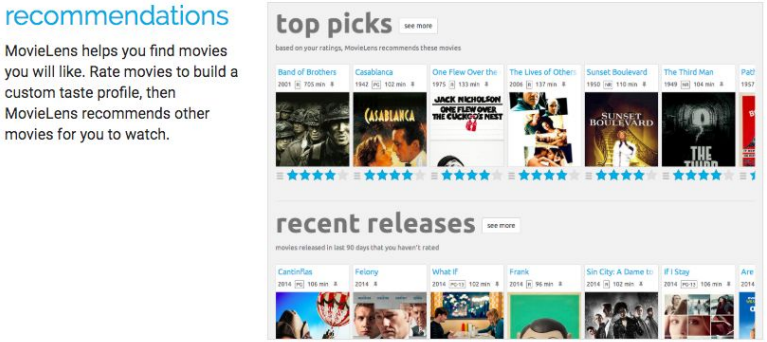
https://towardsdatascience.com/ce209a224cfb

Application: Information retrieval

https://towardsdatascience.com/315f374029ea

Application: Recommender systems





https://nipunbatra.github.io/blog/ml/2017/12/18/recommend-keras.html