

# Unsupervised learning

Prototyping with Deep Learning

# Learning outcomes

After this lesson you will be able to:

- Identify unsupervised problems in DL
- Understand the autoencoder architecture
- Recognize applications of self-supervised learning

# 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:

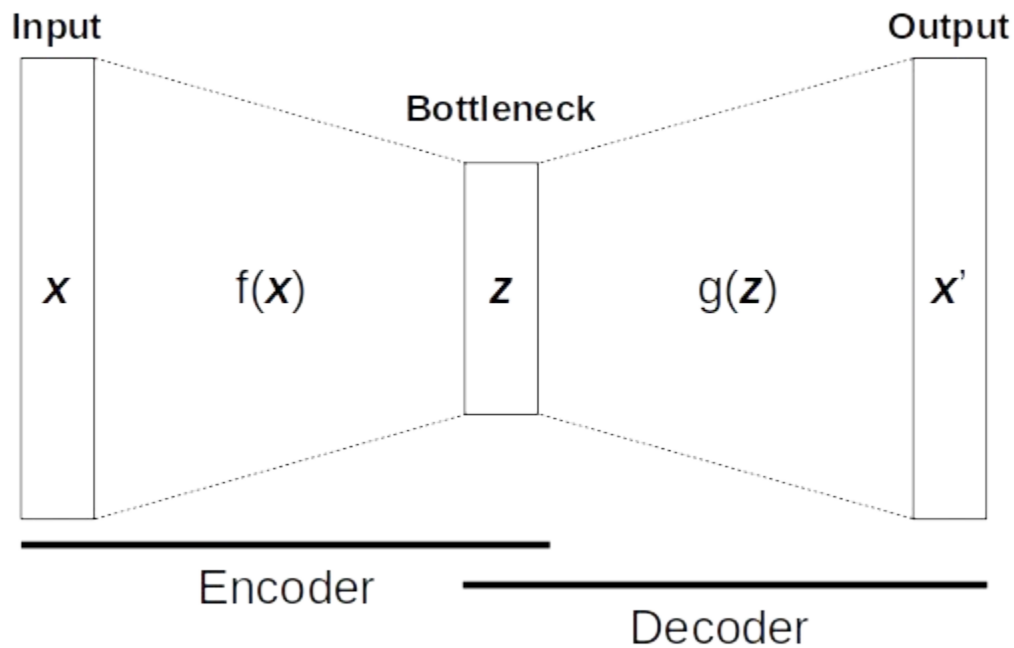
- CBOW
- Skip-gram

Image Enhancement:

- Noise removal
- Super-resolution
- Colorization

# Autoencoders

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



# Latent variables

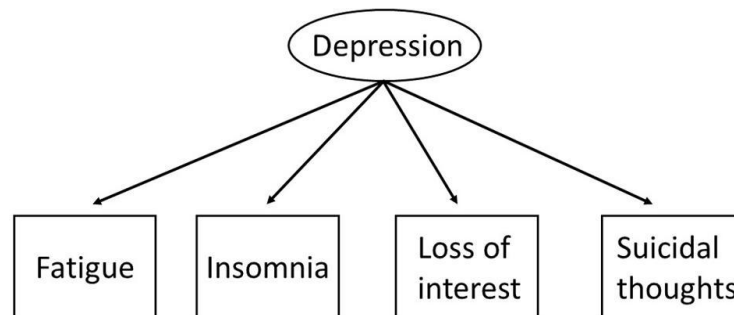
Are *implicit* data features

Cannot be observed or measured

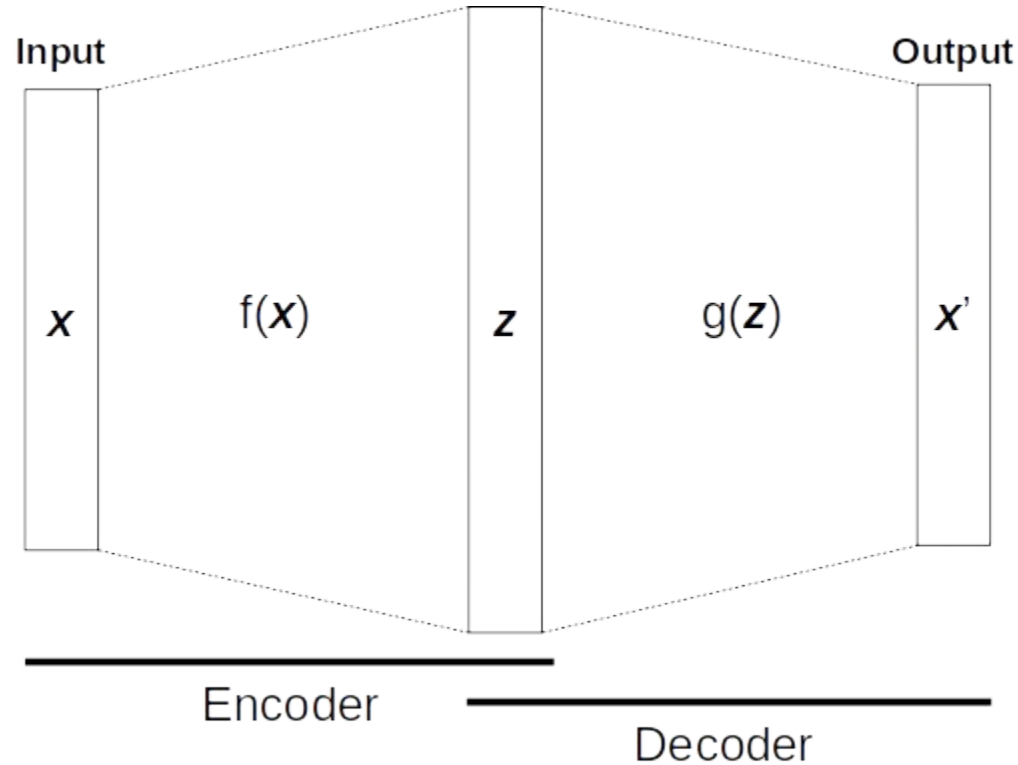
Are inferred from observable variables

Examples:

- Intelligence
- Motivation
- Depression

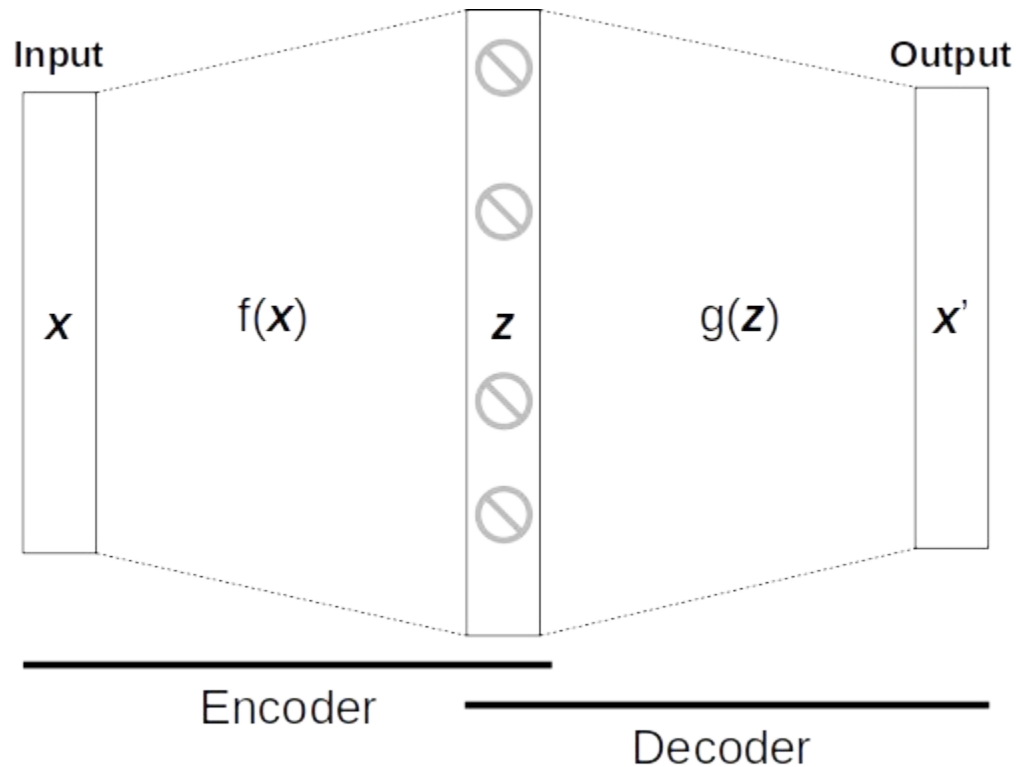


# Overcomplete autoencoders



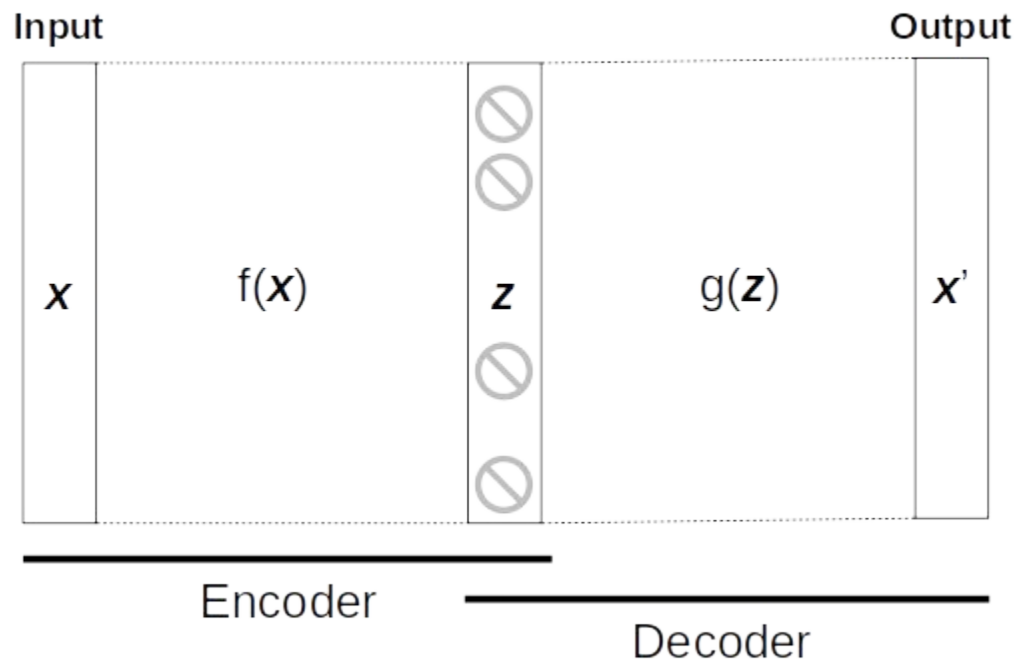


# Overcomplete sparse autoencoders

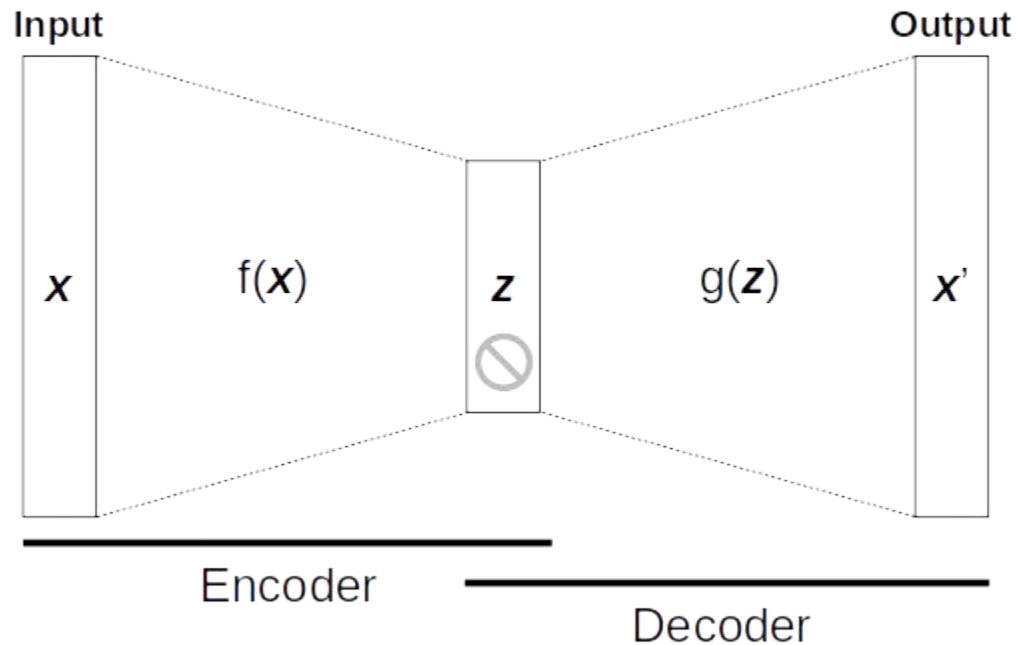


# Sparse autoencoders

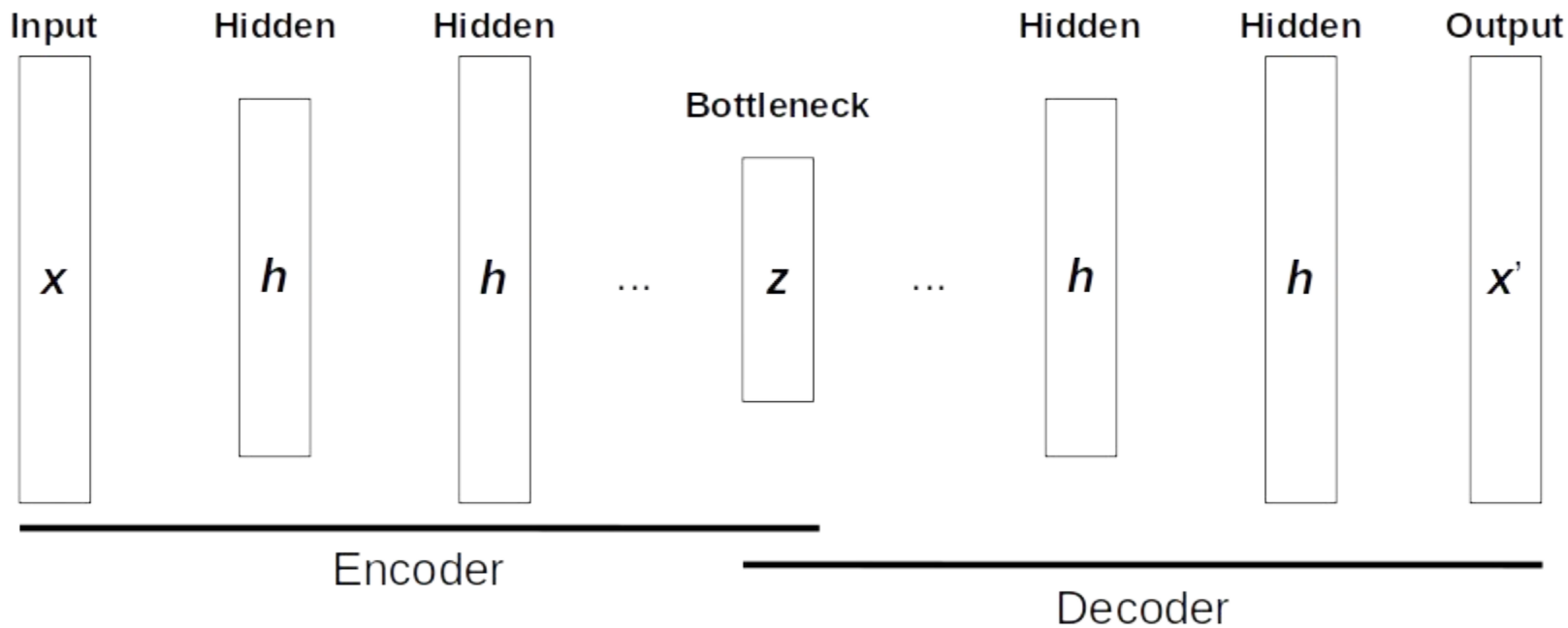
$$\mathcal{L}(\mathbf{x}, \mathbf{x}') = [\mathbf{x} - g(f(\mathbf{x}))]^2 + \Omega(\mathbf{z})$$



# Undercomplete sparse autoencoders



# Deep autoencoders



# Contractive & Denoising AEs

## Contractive

$f(\mathbf{x})$  robust to small perturbations

Resilient feature extraction (encoding)

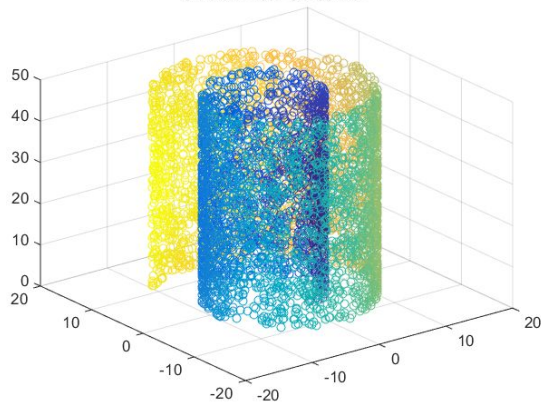
## Denoising

$g(\mathbf{z})$  robust to small perturbations

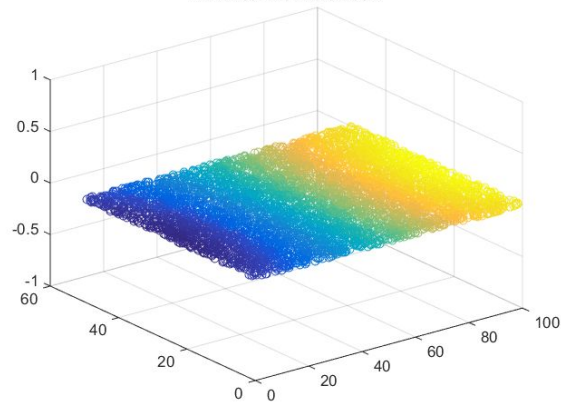
Resilient reconstruction (decoding)

# Application: Dimensionality reduction

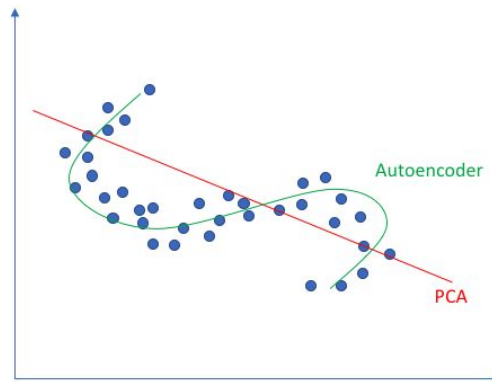
3D Nonlinear Swiss Roll



2D Linear Manifold in 3D

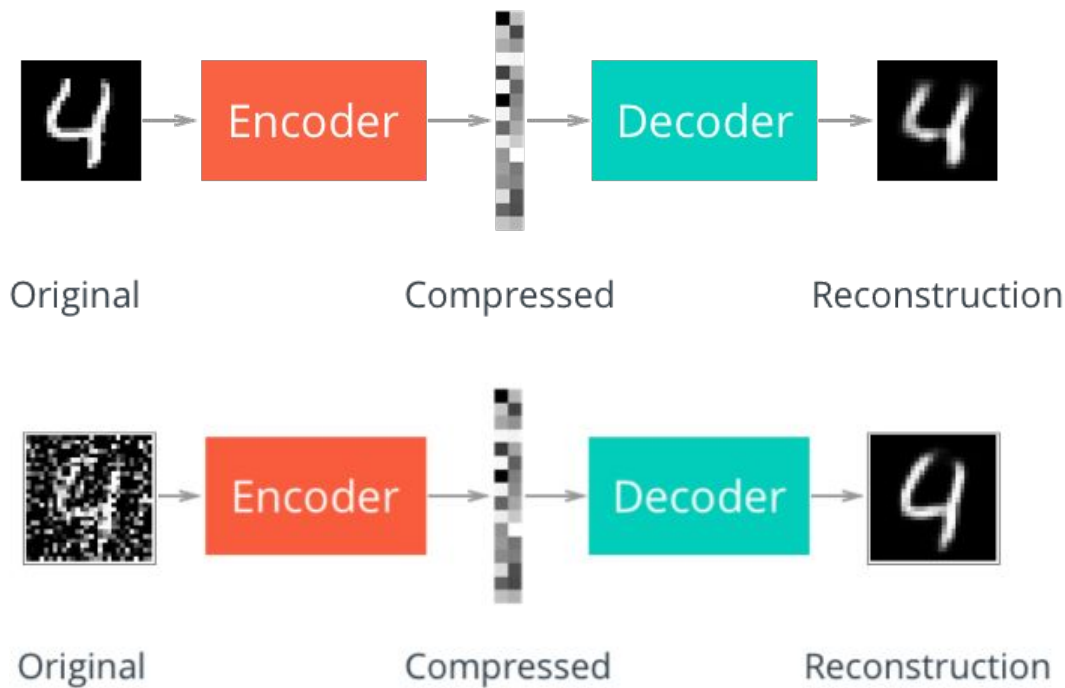


Linear vs nonlinear dimensionality reduction



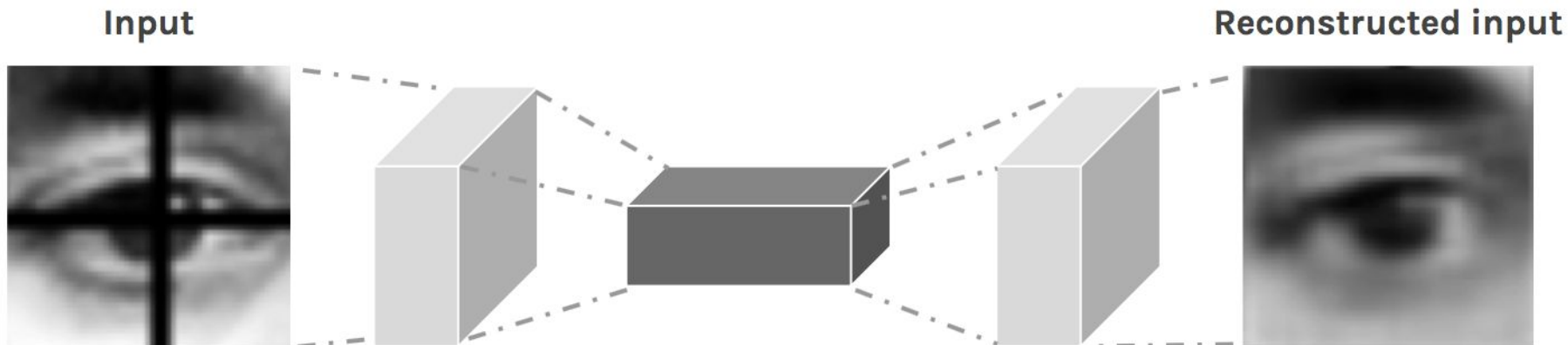
<https://www.jeremyjordan.me/autoencoders/>

# Application: Noise removal



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

# Application: Image inpainting



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



# Application: Image colorization



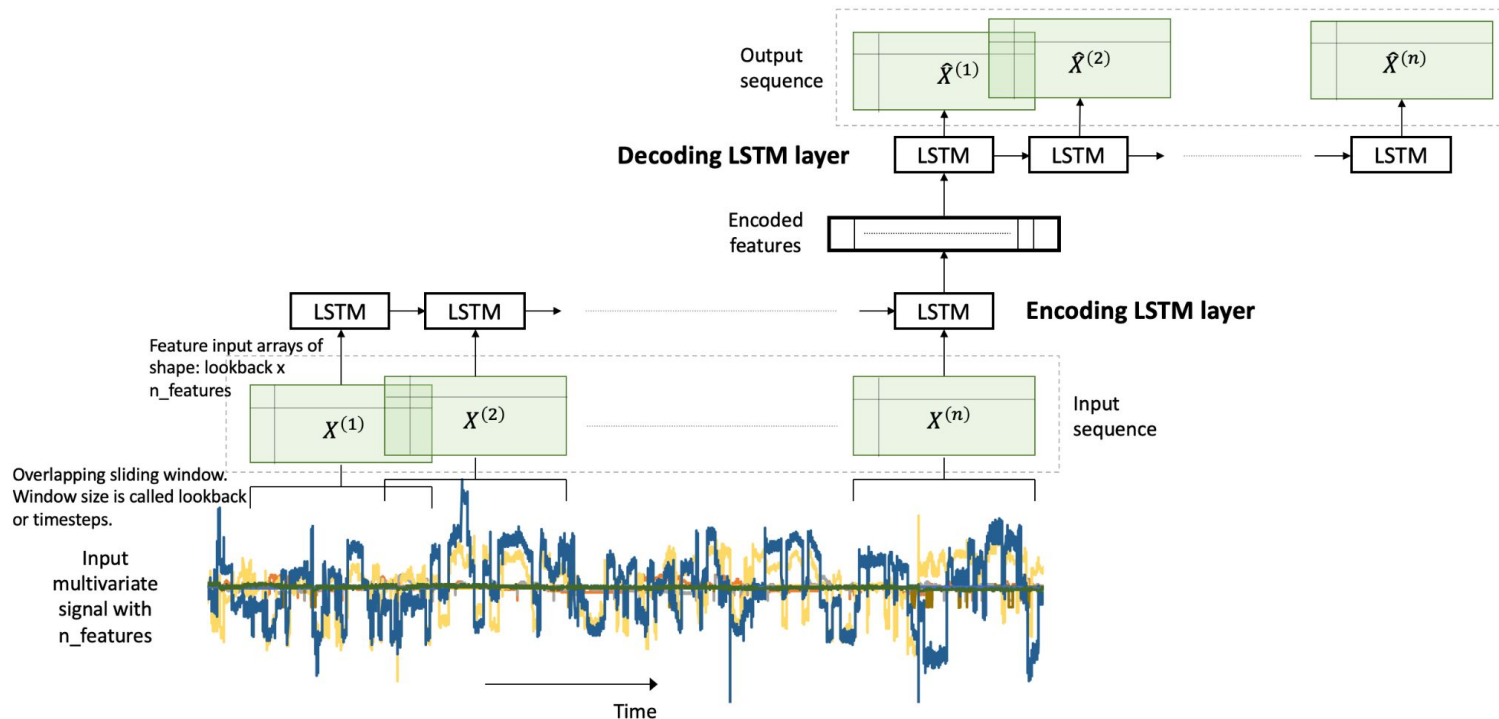
<https://medium.com/@mahmoudeljiddawi/a213b47f7339>

# Application: Image super-resolution

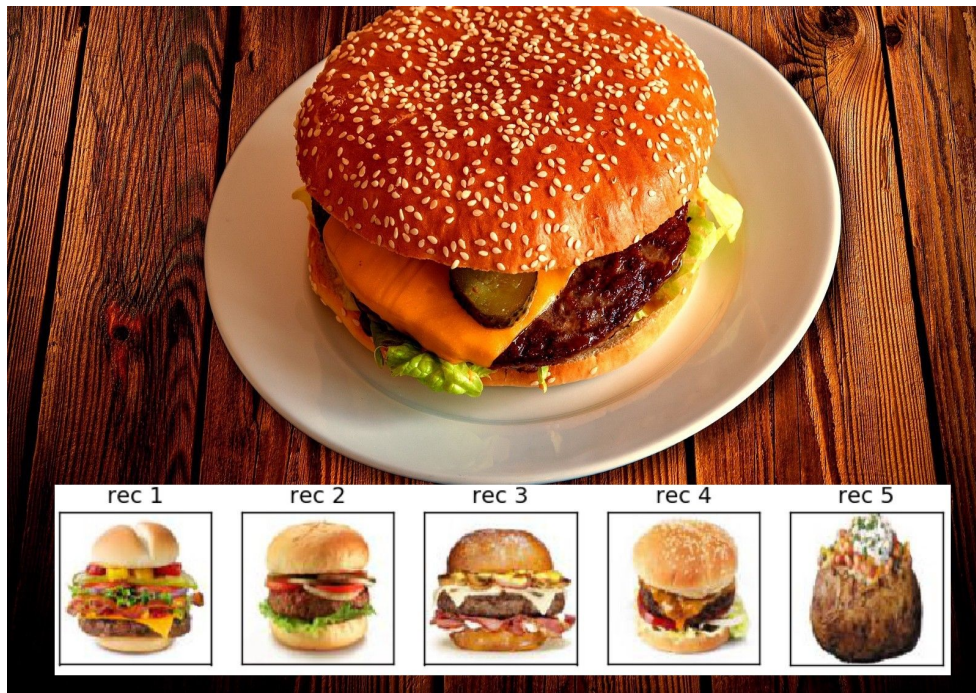


<https://hackernoon.com/autoencoders-deep-learning-bits-1-11731e200694>

# Application: Anomaly detection



# Application: Information retrieval



<https://towardsdatascience.com/315f374029ea>

# Application: Recommender systems

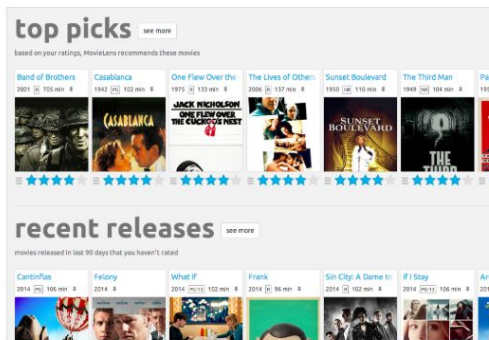
## movielens

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### recommendations

MovieLens helps you find movies you will like. Rate movies to build a custom taste profile, then MovieLens recommends other movies for you to watch.



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