


浙江大学爱丁堡大学联合学院

ZJU-UoE Institute

Lecture 18 - Autoencoders

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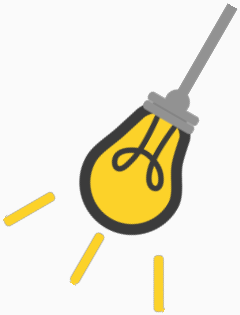
Learning objectives

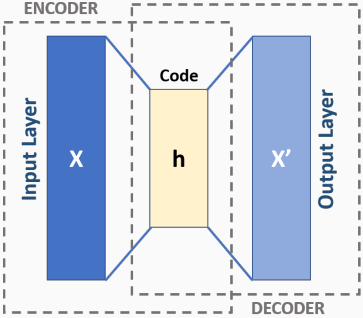
- Discuss autoencoders and their applications.
- Code a denoising autoencoder using Keras.



Introduction

What is an autoencoder?

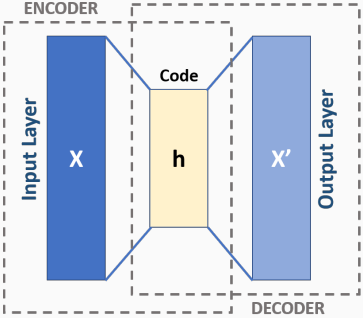
- An **autoencoder** is a neural network that is trained to reconstruct its input.
- It consists of an **encoding** part and a **decoding** part.



Source: Wikipedia

What is an autoencoder?

- An **autoencoder** is a neural network that is trained to reconstruct its input.
- It consists of an **encoding** part and a **decoding** part.
- The easiest mapping of an input to itself would be the identity function.
- Autoencoders force the input to be compressed, and then decompressed to reconstruct it.



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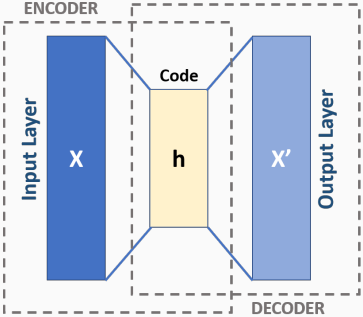
- Autoencoders force the input to be compressed, and then decompressed to reconstruct it.
- It can only reconstruct an approximated version of the input.



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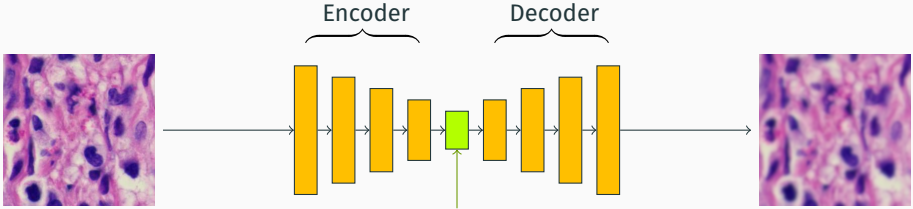
Convolutional autoencoders

A **convolutional autoencoder** is a convolutional network that is trained to reconstruct its input.



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Convolutional autoencoders

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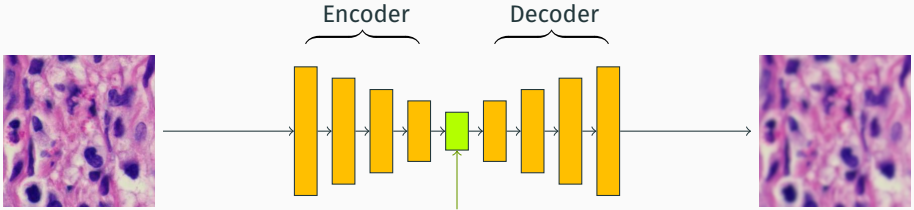


$$X \simeq X'$$

While ideally the input is identical to the output, in practice we get a slightly degraded version.

Why would we do this?

Uses of autoencoders

Autoencoders have been used in a variety of applications, including image analysis.

Examples of uses in computer vision include

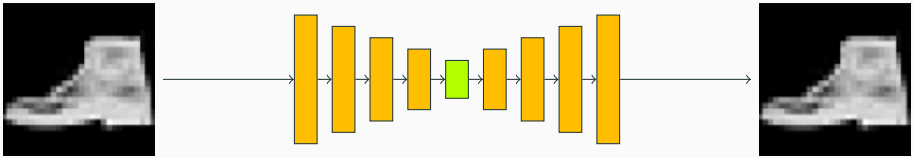
- Noise reduction
- Image colorization
- Image compression
- Image restoration
- Superresolution

Outside of computer vision, autoencoders are used in a variety of applications, including fraud detection, recommendation systems, and text translation.

Building an autoencoder in Keras

We will now build a simple autoencoder that just learns to reconstruct its input (trained on Fashion MNIST).

See `basic_autoencoder.ipynb`



Uses of autoencoders

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Compression

Autoencoders as compressors

- The **latent space** is a low-dimensional representation of the input.

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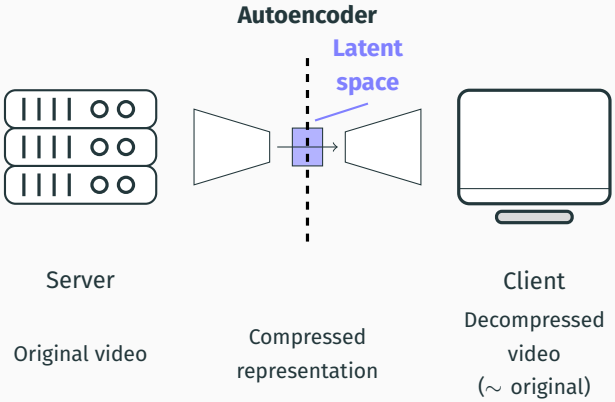
- We can use it to compress the input.
- Useful e.g. to reduce the size of images/videos for display purposes (e.g. streaming a video).



Autoencoders for feature extraction

We can think of the latent space as an *optimal* low-dimensional representation of the input, therefore we can use it to generate features from the input.

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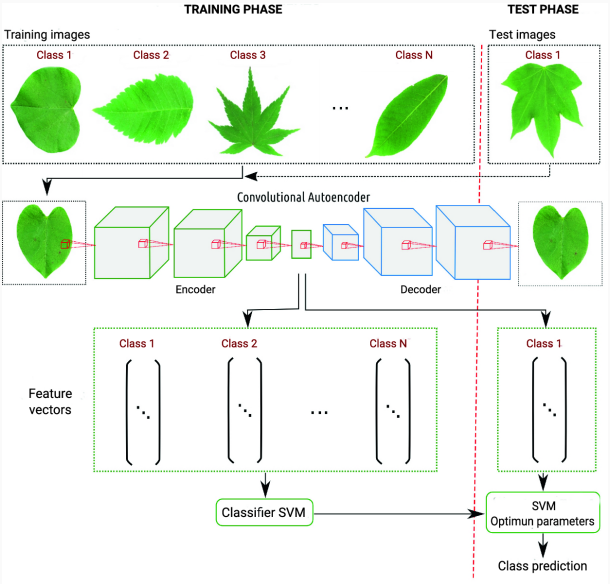
Example:

A Feature Extraction Method Based on Convolutional Autoencoder for Plant Leaves Classification

Authors | Authors and affiliations

Mery M. Paco Ramos, Vanessa M. Paco Ramos, Arnold Loaiza Fabian, Erbert F. Osco Mamani

Classification of leaves using autoencoders

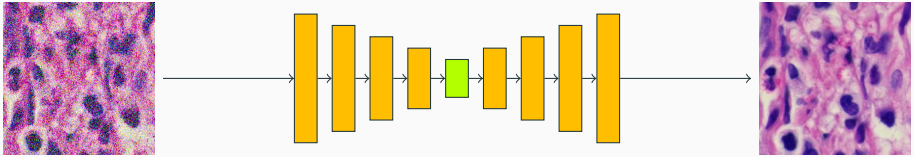


Uses of autoencoders

Denoising

Autoencoders for denoising

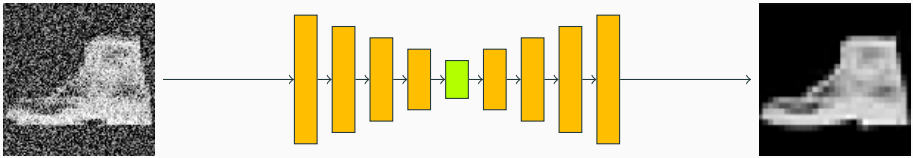
- Noisy image = original image + noise
- Since the autoencoder learns only the *important* features of the image, it will not learn random noise.
- We can *trick* the autoencoder by feeding it pairs of noisy/clean images as source and target, and it will learn to denoise the images!



Denoising using an autoencoder

Let's update our code to make a denoising autoencoder!

See `denoising_autoencoder.ipynb`

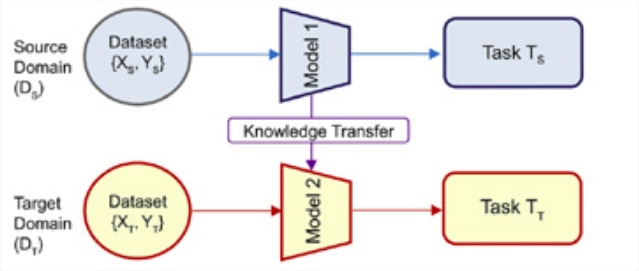


Uses of autoencoders

Domain adaptation

Domain adaptation

Domain adaptation is an approach to transfer knowledge from one domain to another.



Choudary et al. 2020.

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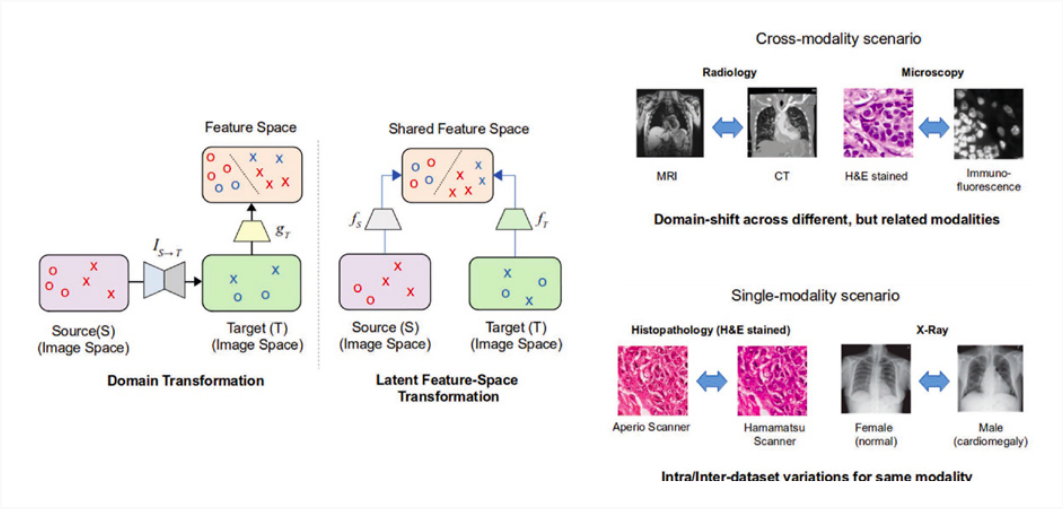

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