Autoencoder

Diane Lingrand and many contributors

Polytech SI4

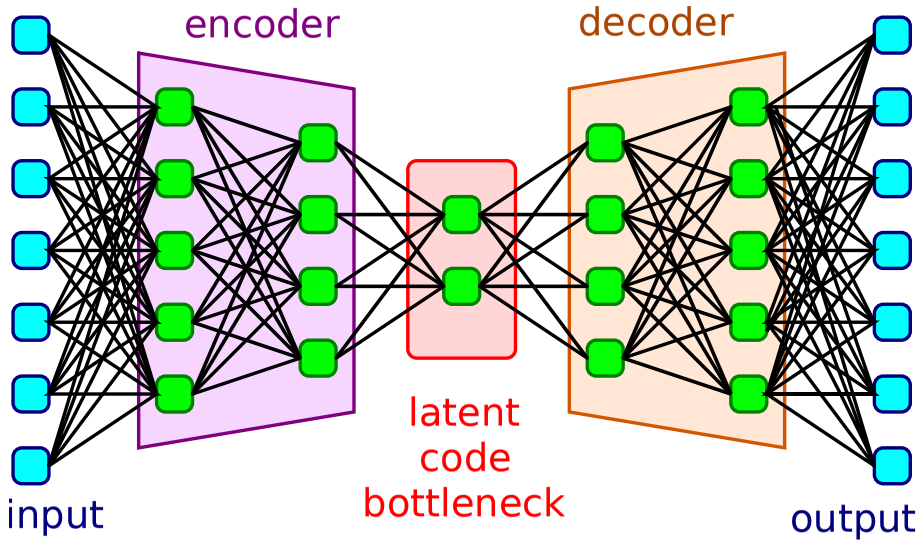
2018 - 2019

Outline

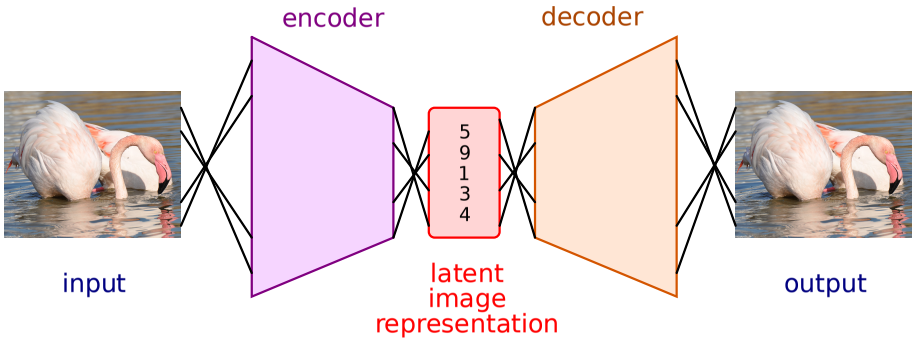
Context

- non supervised
- reduction of the size of the data
- applications :
  - denoising / inpainting
  - segmentation
  - data representation
  - data compression (not as good as JPEG for images)

Principle

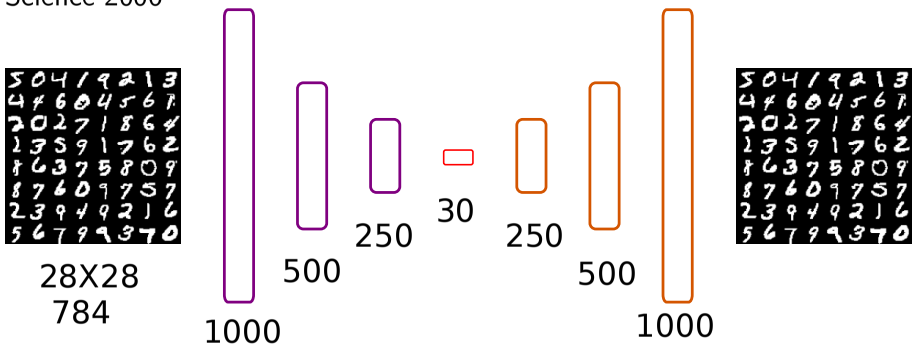


Application to images



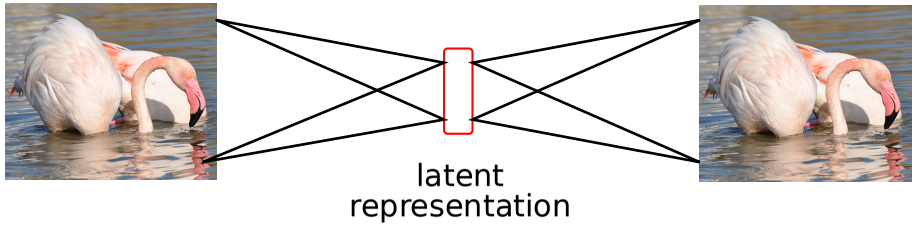
Historic autoencoder

The first really successfull autoencoder : Hinton and Salakhutdinov, Science 2006



The simplest autoencoder : Vanilla autoencoder

- one hidden layer
- similarities with PCA (linear functions of data, minimisation of square reconstruction error)



Vanilla autoencoder in keras

```
from keras.layers import Input, Dense
from keras.models import Model
from keras.datasets import fashion_mnist
import numpy as np

(x_train, y_train), (x_test, y_test) = fashion_mnist.load_data()

x_train = x_train.astype('float32') / 255.
x_test = x_test.astype('float32') / 255.
x_train = x_train.reshape((len(x_train), np.prod(x_train.shape[1:])))
x_test = x_test.reshape((len(x_test), np.prod(x_test.shape[1:])))

input_image = Input(shape=(784,))
encoded = Dense(32, activation='relu')(input_image)
decoded = Dense(784, activation='sigmoid')(encoded)
autoencoder = Model(input_image, decoded)
autoencoder.compile(optimizer='adam', loss='mse')
autoencoder.fit(x_train, x_train,epochs=100,batch_size=256,\\
  shuffle=True,validation_data=(x_test, x_test))
decoded_images = autoencoder.predict(x_test)
score = autoencoder.evaluate(x_test, x_test, batch_size=128)
print("score = ", score)
```

Multilayer autoencoder

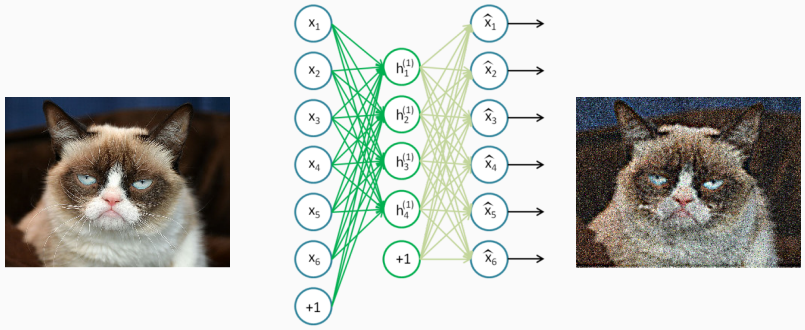
slides from Mélanie Ducoffe and Frédéric Precioso

AutoEncoder: a piece of unsupervised

- Learning a compact representation of the data

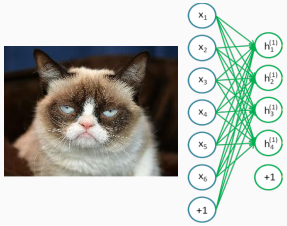
(**no classification**)

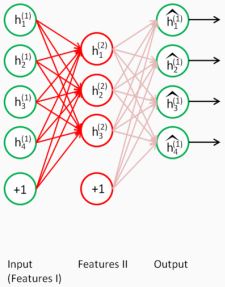
First we train an AutoEncoder layer 1.



AutoEncoder: a piece of unsupervised

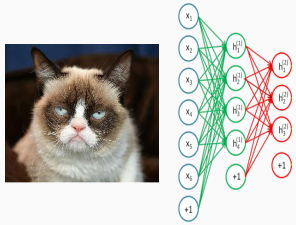
Second we train an AutoEncoder layer 2.

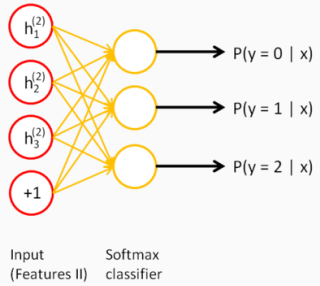




AutoEncoder: a piece of unsupervised

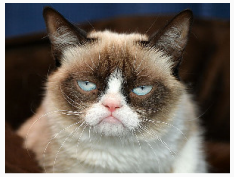
Then we train an output layer of non linearities based on softmax.

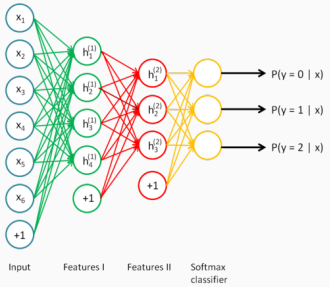




AutoEncoder: a piece of unsupervised

Finaly, we fine tune the whole network in a supervised way.





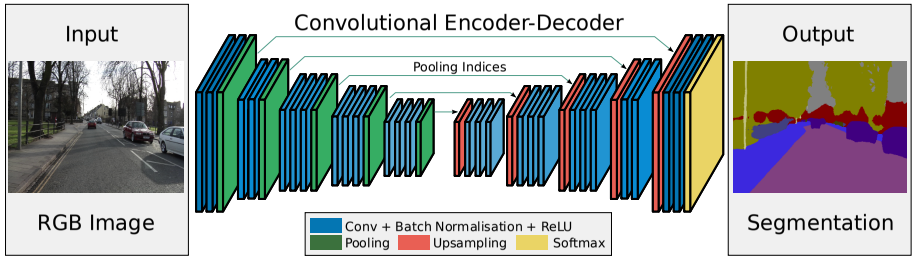
Multilayer autoencoder in keras

```
encoded = Dense(128, activation='relu')(input_image)
encoded = Dense(64, activation='relu')(encoded)
encoded = Dense(32, activation='relu')(encoded)
encoded = Dense(10, activation='relu')(encoded)

decoded = Dense(32, activation='relu')(encoded)
decoded = Dense(64, activation='relu')(decoded)
decoded = Dense(128, activation='relu')(decoded)
decoded = Dense(784, activation='sigmoid')(decoded)
```

Convolution Autoencoder

- simply replace dense layers by convolutional layers
  - in keras, replace `Dense` by `Conv2D`
- application to segmentation : SegNet



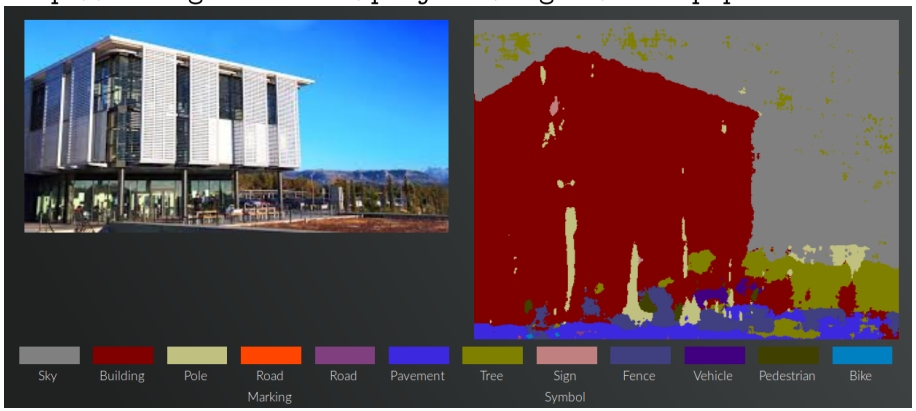
from Badrinarayanan etal, arXiv :1511.00561v3

SegNet example I

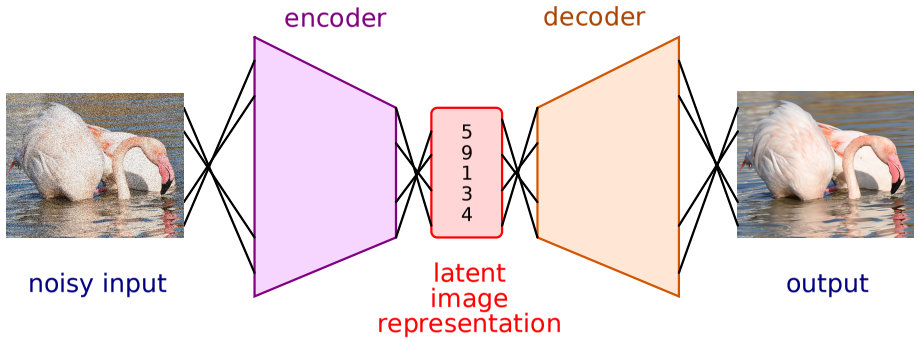
also on youtube : `https://www.youtube.com/watch?v=CxanE_W46ts`

SegNet example II

try it yourself :
`http://mi.eng.cam.ac.uk/projects/segnet/demo.php`



Denoising an image



Experiment : representing an image using autoencoder

- classification task
- representation of image using autoencoder
- classification with standard MLP

Variational Autoencoder (VAE)

- Autocoders learn a latent representation of data
- Variational autoencoders learn the parameter of a probability function modeling the latent data
  - for example : latent parameters μ and σ, assuming the distribution is gaussian
- It is thus a generative model able to generate similar data