

# Autoencoders

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MLST PRESENTATION – 08/11/2017

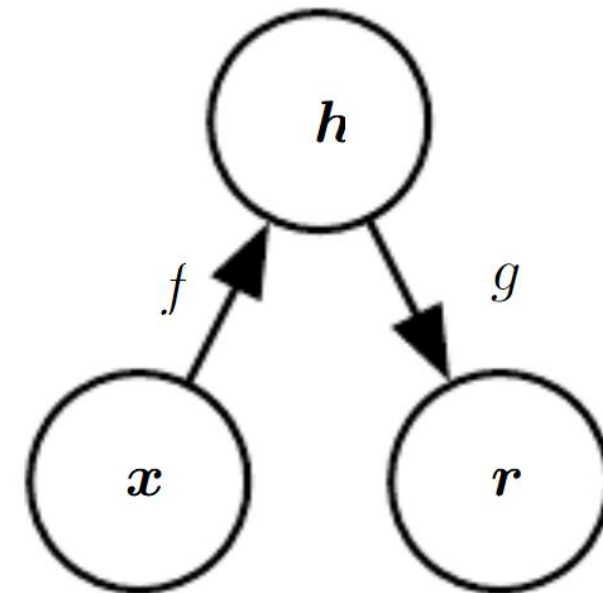
FANNY ROCHE

# Autoencoders

## Basic principle

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- Objective :  $r = g(f(x)) \approx x$
- BUT  $r \neq x$  !  
    ➔ no Identity function !
- $f$  : encoder function
- $g$  : decoder function
- $h$  : latent features

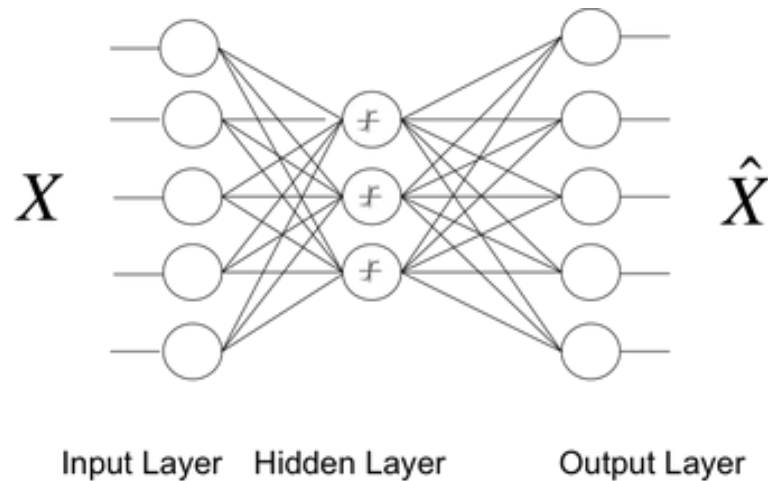


# Autoencoders

## How does it work ?

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- Encoder : extract useful properties of the data
- Decoder : reconstruct the input
- Undercomplete AE



# Autoencoders

## How does it work ?

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- Special case of **feedforward** networks
- Use **gradient descent backpropagation**
- Comparison to **PCA** :
  - Linear + MSE
    - PCA decomposition
  - Nonlinear
    - more powerful nonlinear generalization

# Autoencoders

## History

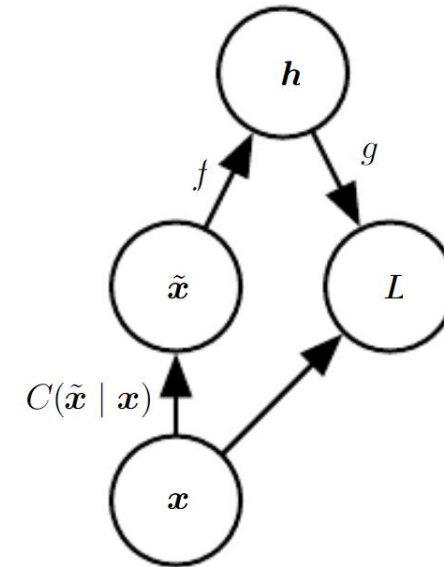
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- **Before :**
  - Dimensionality reduction
  - Feature Learning
- **Now :**
  - Generative Models

# Variations of Autoencoder

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- Denoising Autoencoder (DAE)
  - Add **noise** to the input
  - Loss :  $\mathcal{L}(x, f(g(\tilde{x})))$
- Sparse Autoencoder (SAE)
  - Sparsity constraint on  $h$



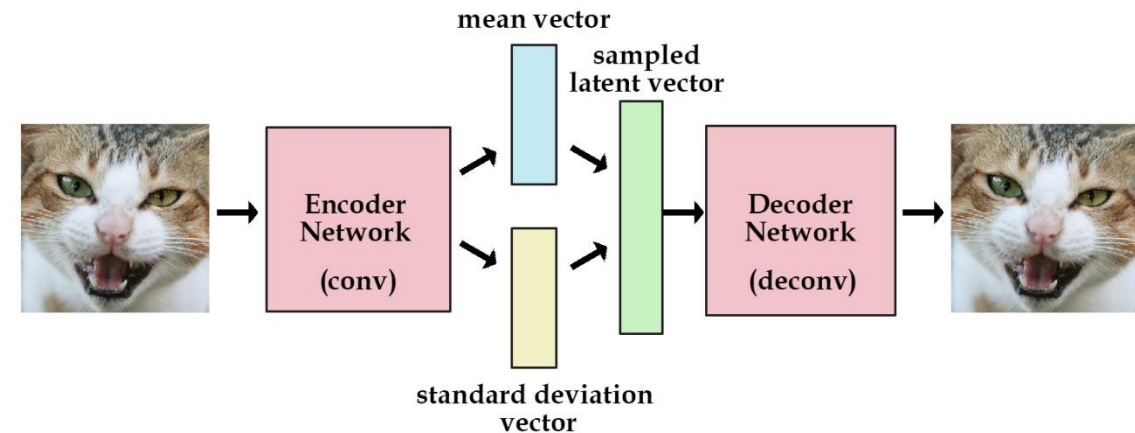
# Variations of Autoencoder

- Contractive Autoencoders (CAE)

- $\frac{\partial f}{\partial x}$  as small as possible  
→ contractive penalty

- Variational Autoencoder (VAE)

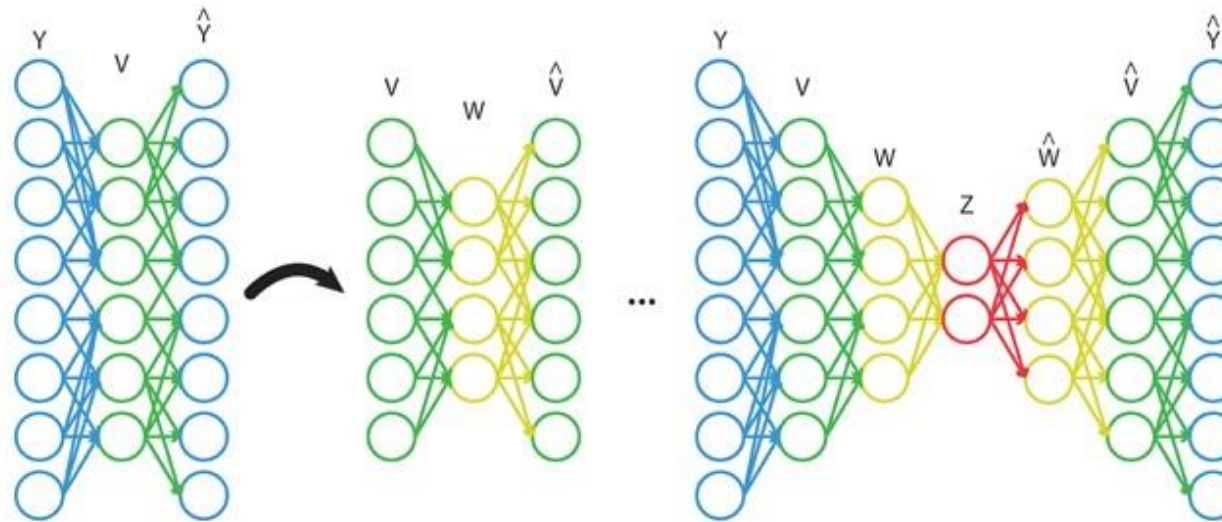
- $h \sim N(\mu, \sigma)$   
→ variational penalty



# Deep Autoencoders (or Stacked Autoencoders)

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- Much better compression
- Greedy layer-wise pre-training





# Autoencoder Tutorial

## (with Keras by François Chollet)

<https://blog.keras.io/building-autoencoders-in-keras.html>

## The Keras Blog

Keras is a Deep Learning library for Python, that is simple, modular, and extensible.

[Archives](#) [Github](#) [Documentation](#) [Google Group](#)

### Building Autoencoders in Keras

In this tutorial, we will answer some common questions about autoencoders, and we will cover code examples of the following models:

- a simple autoencoder based on a fully-connected layer
- a sparse autoencoder
- a deep fully-connected autoencoder
- a deep convolutional autoencoder
- an image denoising model
- a sequence-to-sequence autoencoder
- a variational autoencoder

Sat. 14. May. 2016  
By [François Chollet](#)  
In [Tutorials](#).

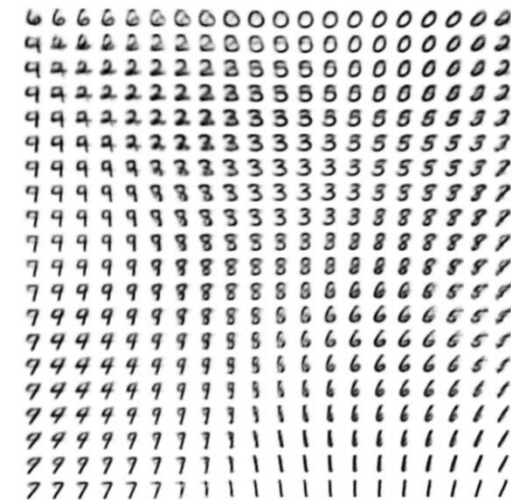
**Note:** all code examples have been updated to the Keras 2.0 API on March 14, 2017. You will need Keras version 2.0.0 or higher to run them.

#### What are autoencoders?

```
graph LR; Input[Original input: 2] --> Encoder[Encoder]; Encoder --> Comp[Compressed representation]; Comp --> Decoder[Decoder]; Decoder --> Output[Reconstructed input: 2]
```

# Examples of applications (non exhaustive )

- Dimensionality reduction
- Information Retrieval
- Image generation
- Voice conversion
- Instrument interpolation
- ...



# Bibliography

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