AutoEncoders

ML Instruction Team, Fall 2022

CE Department
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Autoencoders

- Autoencoders are artificial neural networks capable of learning dense representations of the input data, called *latent representations* or *codings*, without any supervision (i.e., the training set is unlabeled).
- Their job is to take an input X and predict X. To make this non-trivial, we need to add a bottleneck layer whose dimension is much smaller than the input.

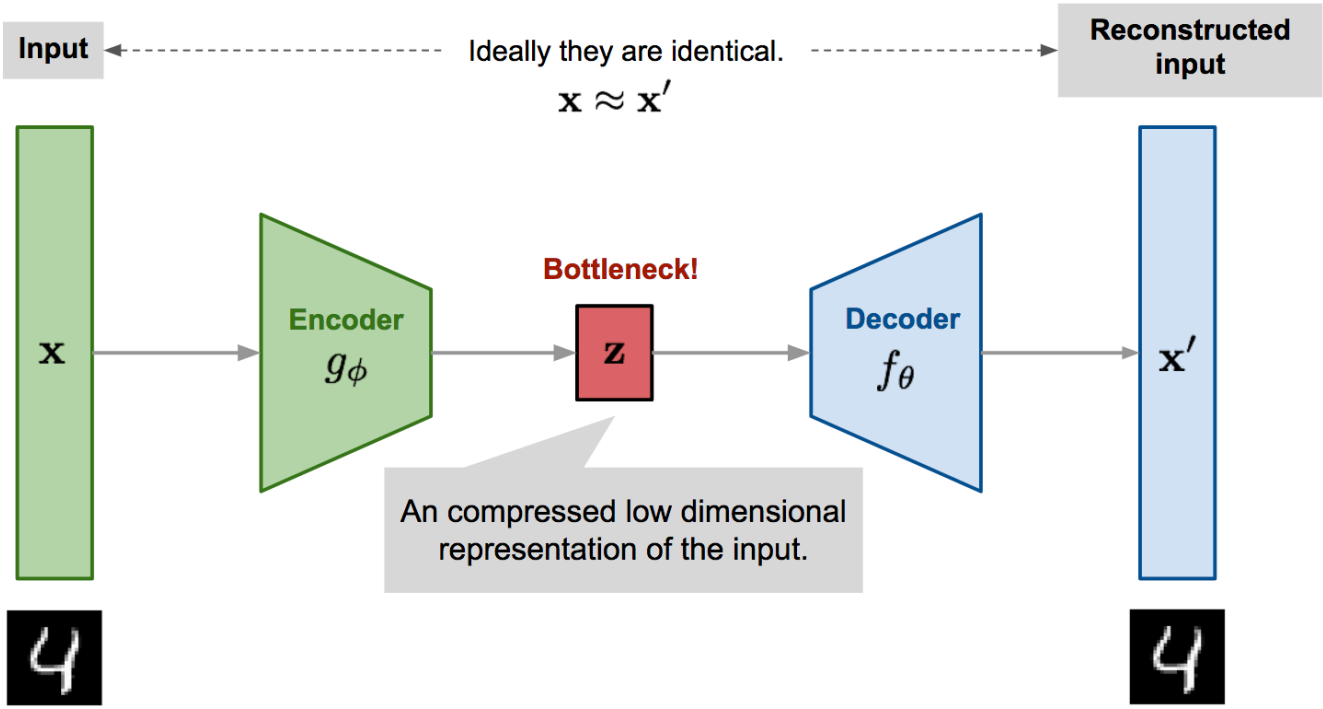

Figure: https://lilianweng.github.io/posts/2018-08-12-vae/

Autoencoders: Structure

- Encoder: compress input into a latent-space of usually smaller dimension. $h = f(x)$
- Decoder: reconstruct input from the latent space. $r = g(f(x))$ with r as close to x as possible

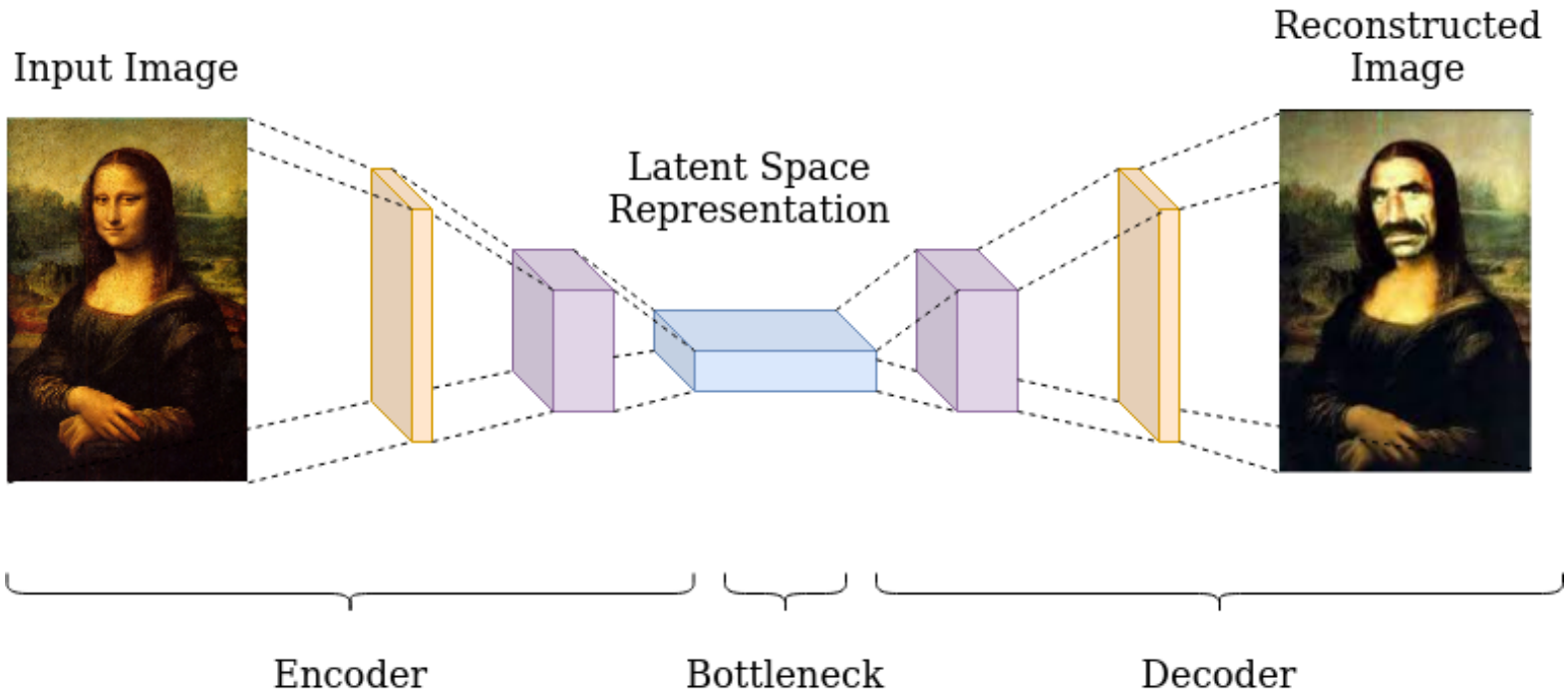

Figure:
https://emkademy.medium.com/1-first-step-to-generative-deep-learning-with-autoencoders-22bd41e56

Autoencoders: Applications

- Autoencoders can
  - act as feature detectors
  - be used for unsupervised pretraining of deep neural networks

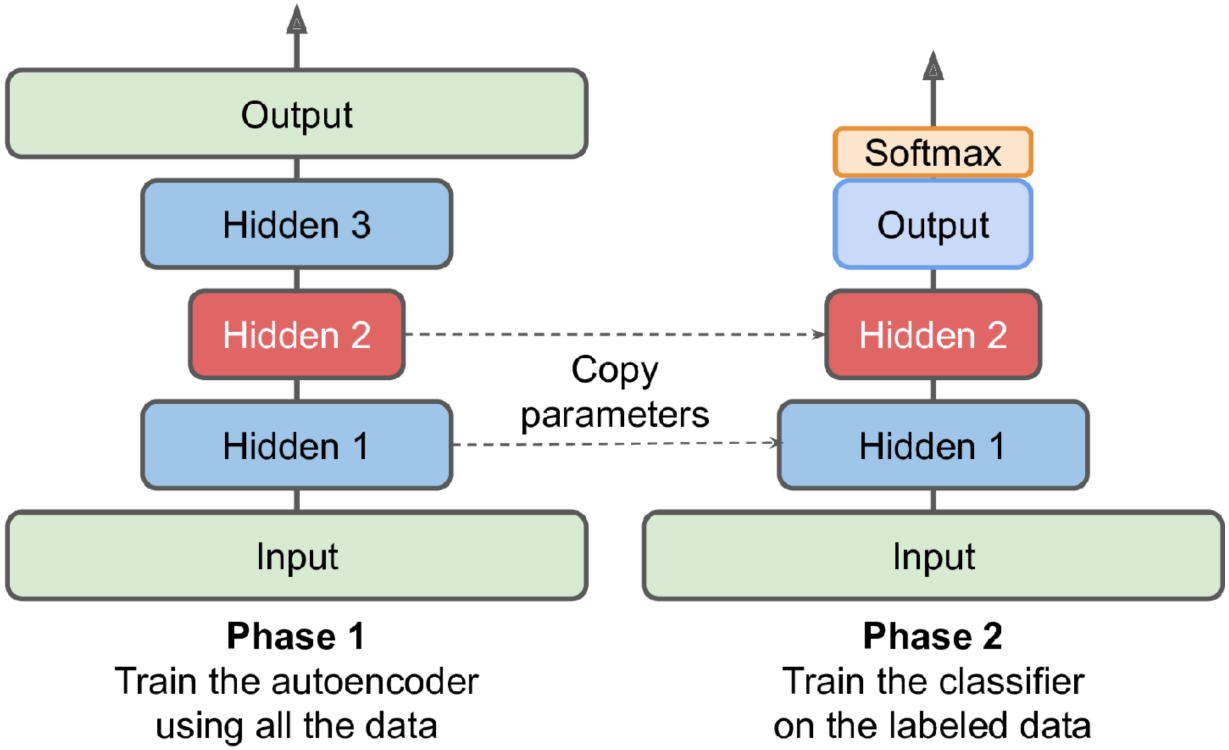

Figure: Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition by Aurélie Géron

Autoencoders: Applications

- Autoencoders can be used as generative models. (will be discussed more later in this chapter.)

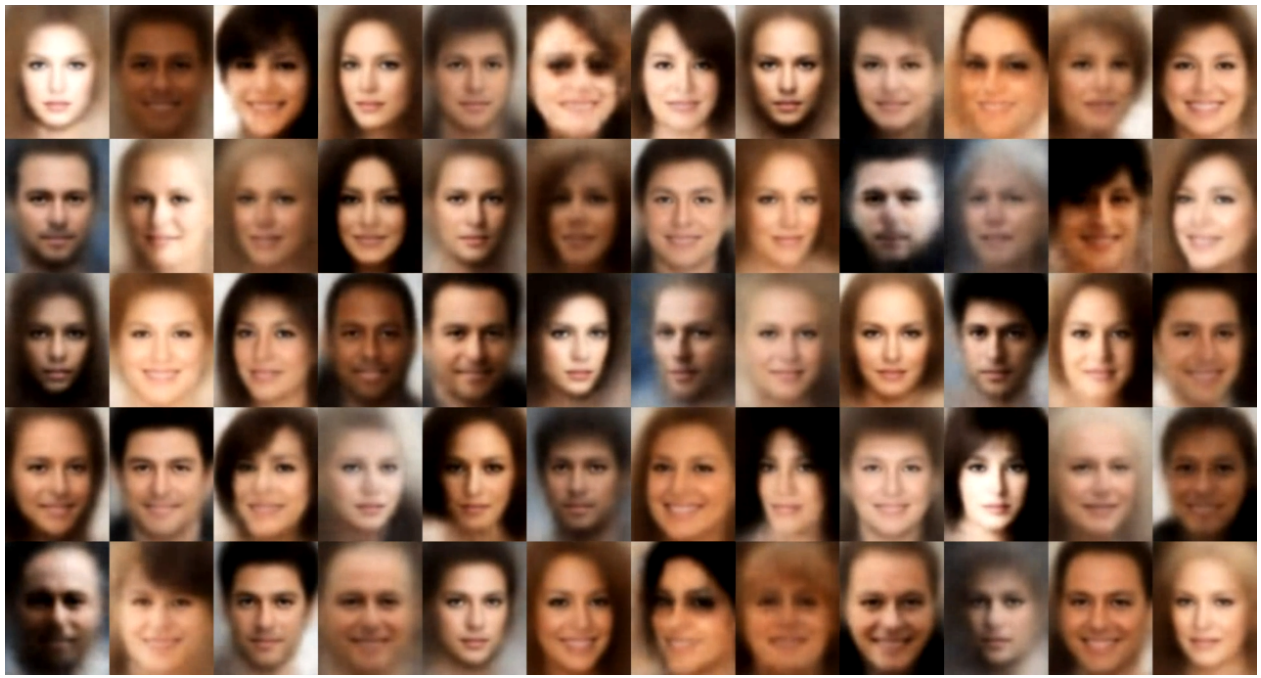

Figure: https://github.com/wojciechmo/vae

Autoencoders: Applications

- Watermark removal

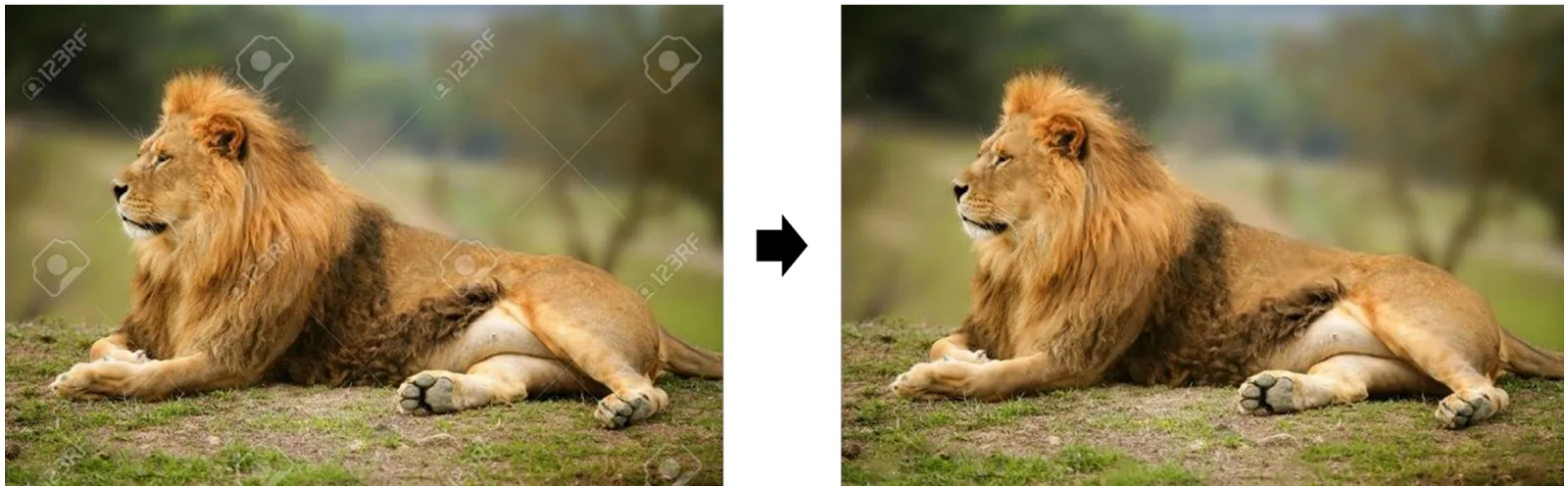

Figure: https://ai.googleblog.com/2017/08/making-visible-watermarks-more-effective.html

Autoencoders: Applications

- Noise reduction

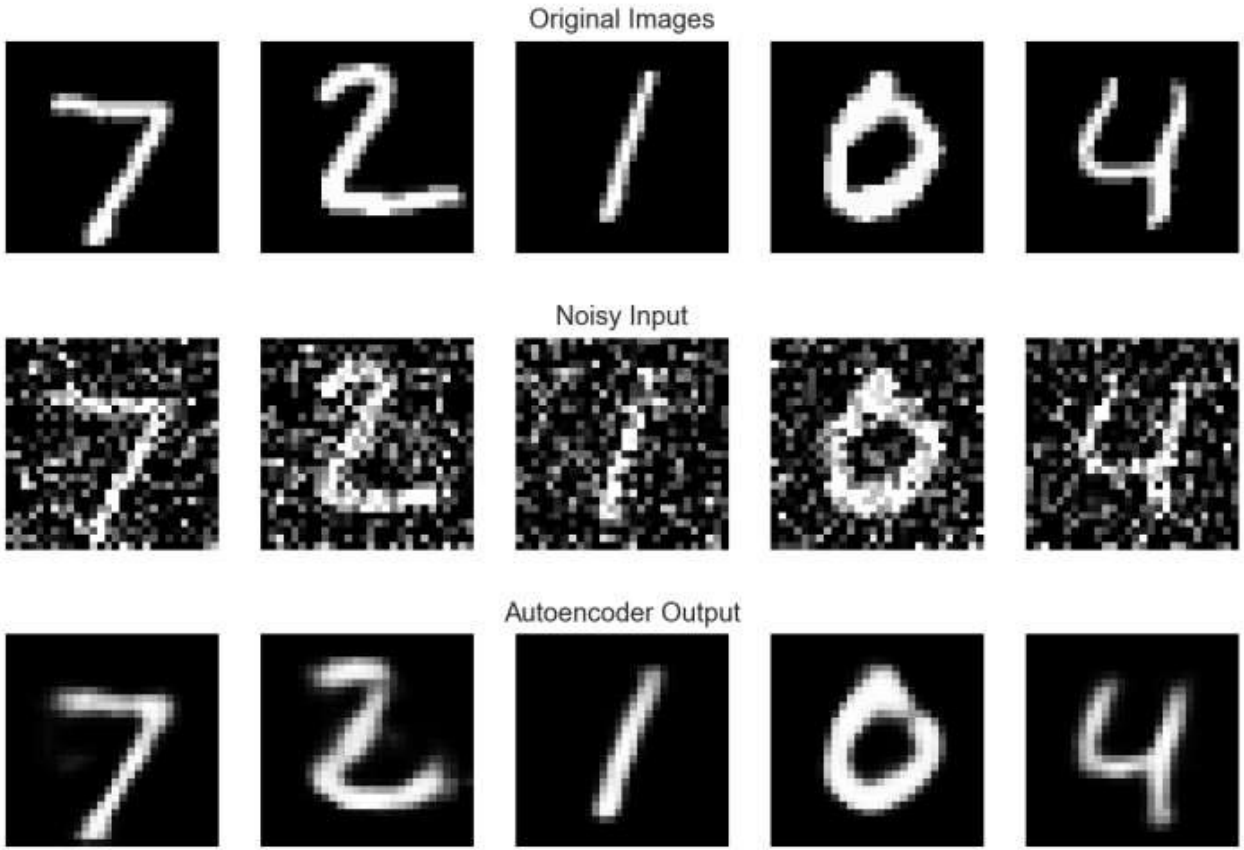

Figure: https://medium.com/@harishr2301/denoising-autoencoders-996e866e5cd0

Stacked Autoencoders

- Autoencoders can have multiple hidden layers. In this case they are called *stacked autoencoders* (or *deep autoencoders*).
- Adding more layers helps the autoencoder learn more complex codings. but be careful about overfitting!

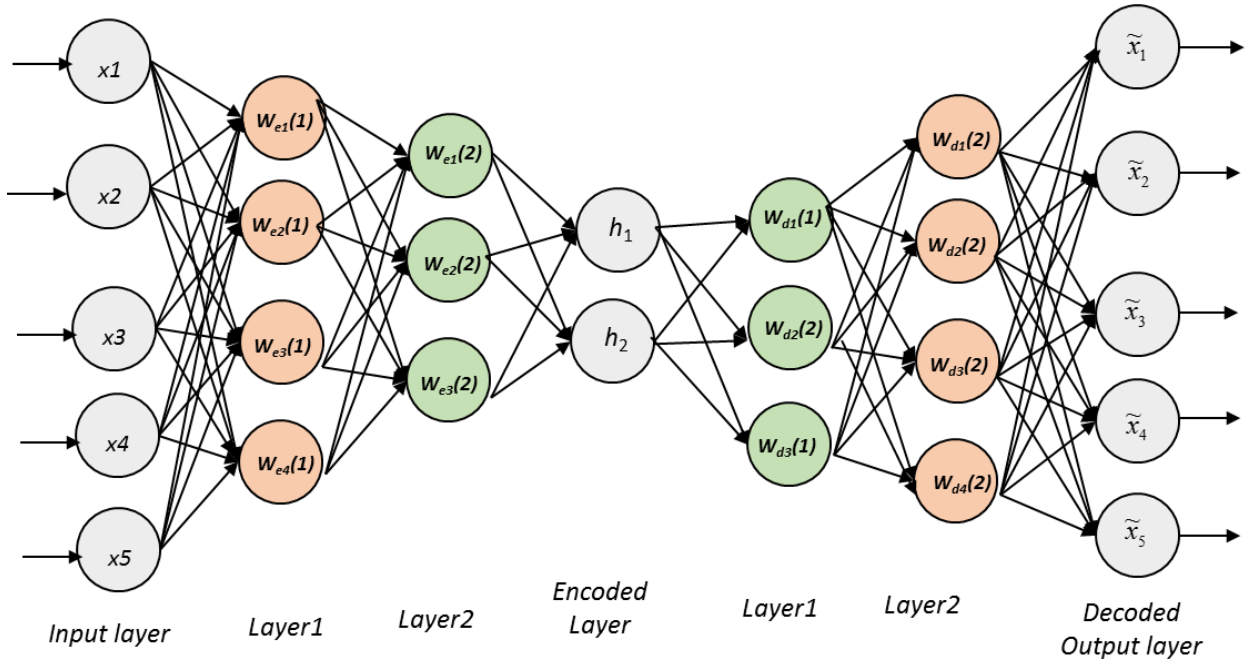

Figure: https://subscription.packtpub.com/book/big-data-and-business-intelligence/9781787121089/4/ch04lvl1sec51/setting-up-stacked-autoencoders

Test

- One
  - One
  - Two
  - Three
- For two-dimensional tensors, we have a corresponding sum with indices (a, b) for f and $(i - a, j - b)$ for g, respectively:

$$(f * g)(i, j) = \sum_a \sum_b f(a, b) g(i - a, j - b)$$

- It is given by,

$$w_{t+1} = w_t - \left(\alpha_t / \sqrt{(v_t}\right) + e) * (\delta L / \delta w_t)$$

where,

$$v_t = \beta * v_t + (1 - \beta) * (\delta L / \delta w_t)^2$$

Thank You!

Any Question?