Intro to Neural Networks

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Auto-Encoders

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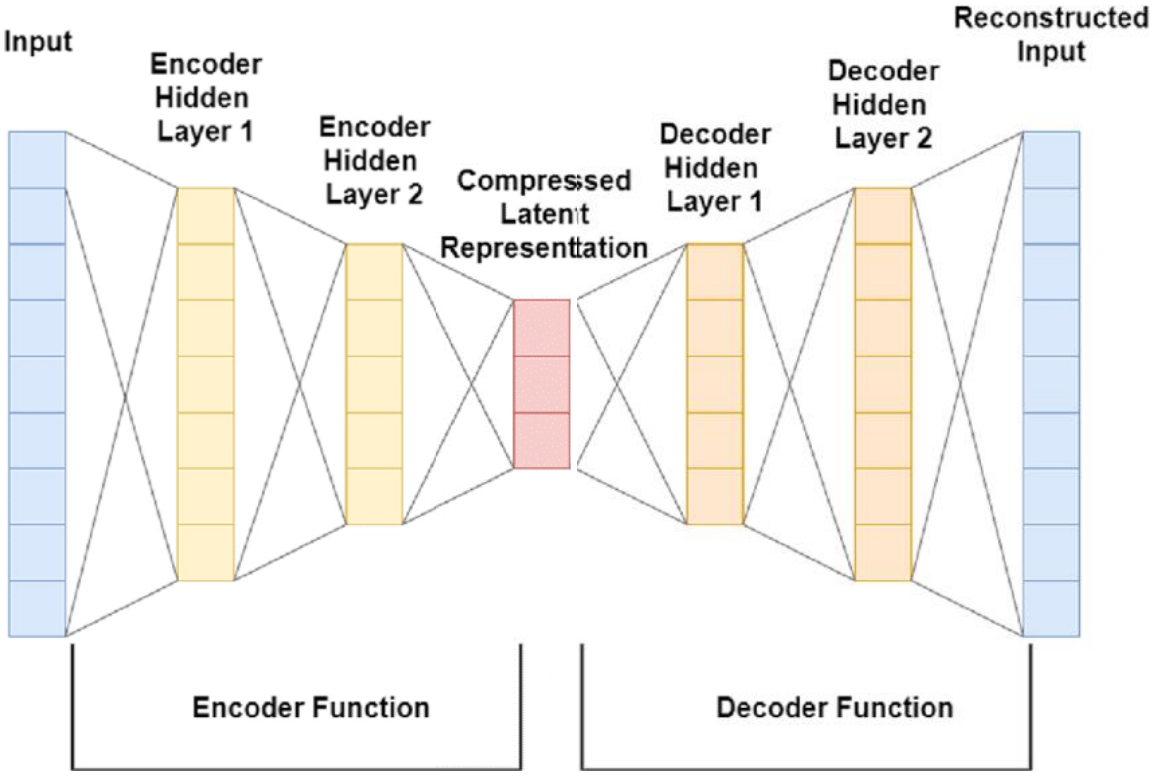
Compression and Reconstruction

- Given an input (e.g., image), I may want to…
  - compress it and reconstruct it.
  - modify it as it is reconstructed.

Auto-Encoder

- Given an input, we need to learn a representation (i.e., code, embedding)
- This embedding is the compressed version of the data.
- The embedding should be sufficient to obtain the desired reconstruction.



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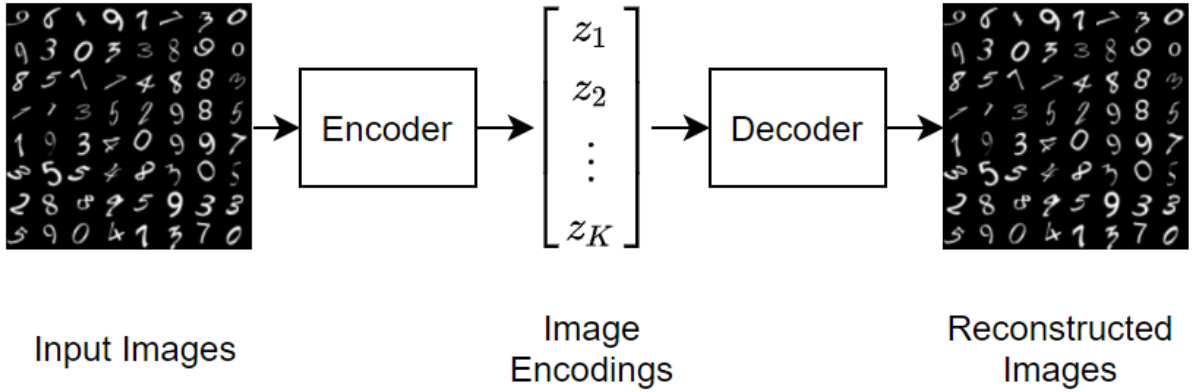
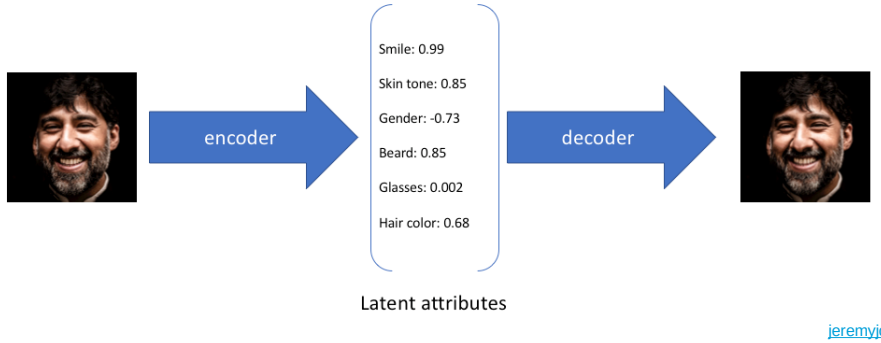
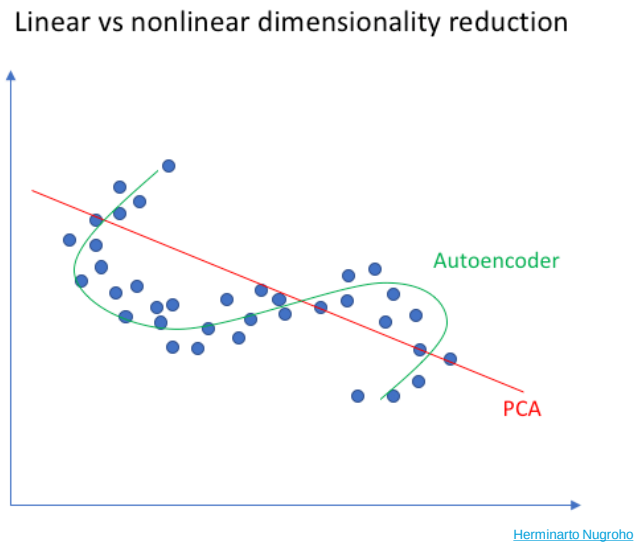


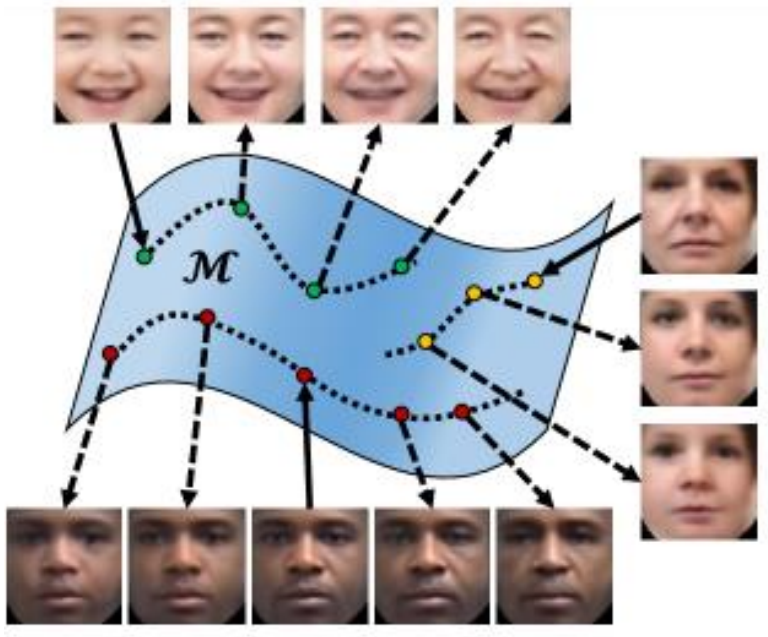


Auto-Encoder

- It is a *non-linear* dimensionality reduction method.
- Demo



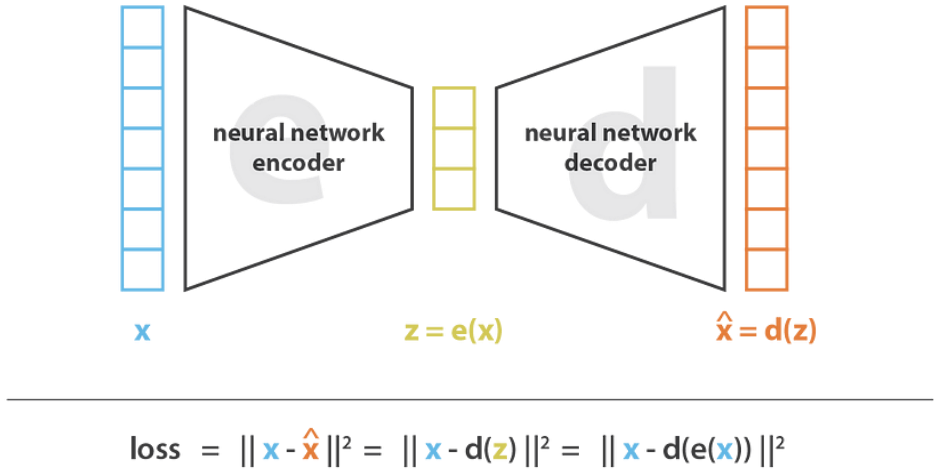
Herminarto Nugroho



Zhang et al.

The Error Function

- The error is the *“reconstruction loss”*
  - The MSE between the input and the output.



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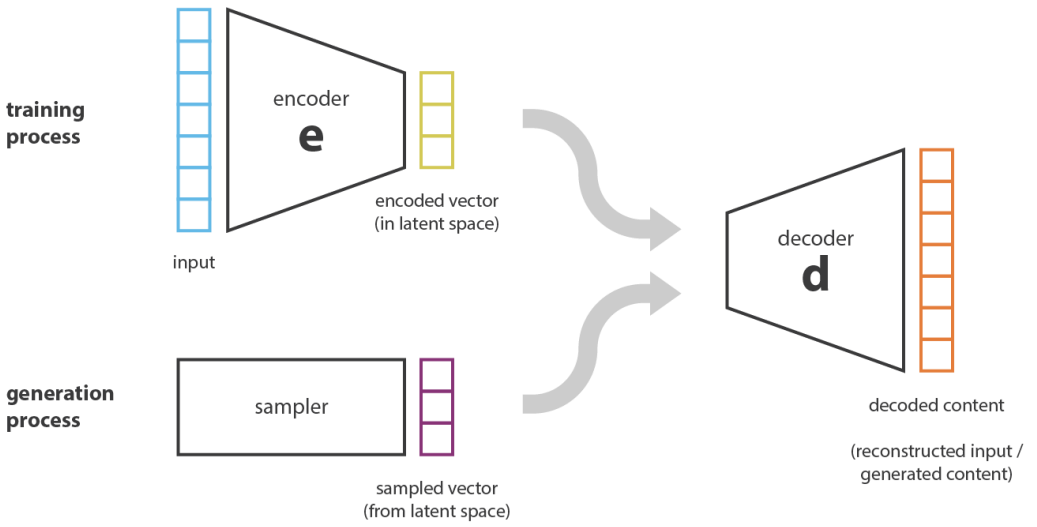
The Auto-Encoder as a Generator

- Once the model is trained, we could use the decoder to generate new content!
- Demo



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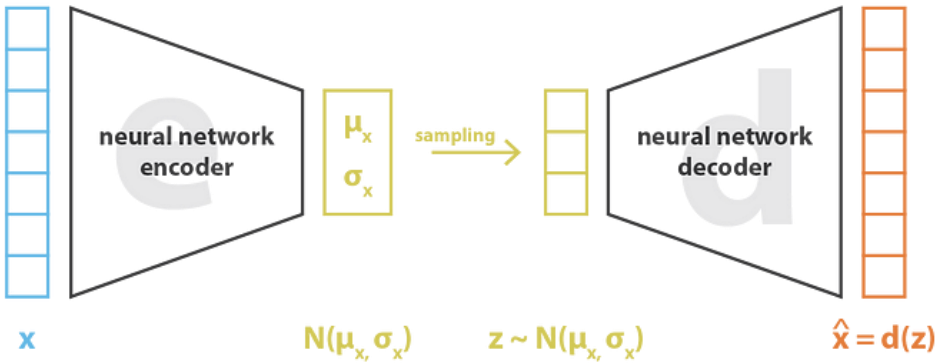
Variational Auto-Encoder

- What if I *"make"* the embedding to follow a nice Gaussian distribution
- Demo



$$\text{loss} = ||x - \hat{x}||^2 + KL[N(\mu_x, \sigma_x), N(0, I)] = ||x - d(z)||^2 + KL[N(\mu_x, \sigma_x), N(0, I)]$$

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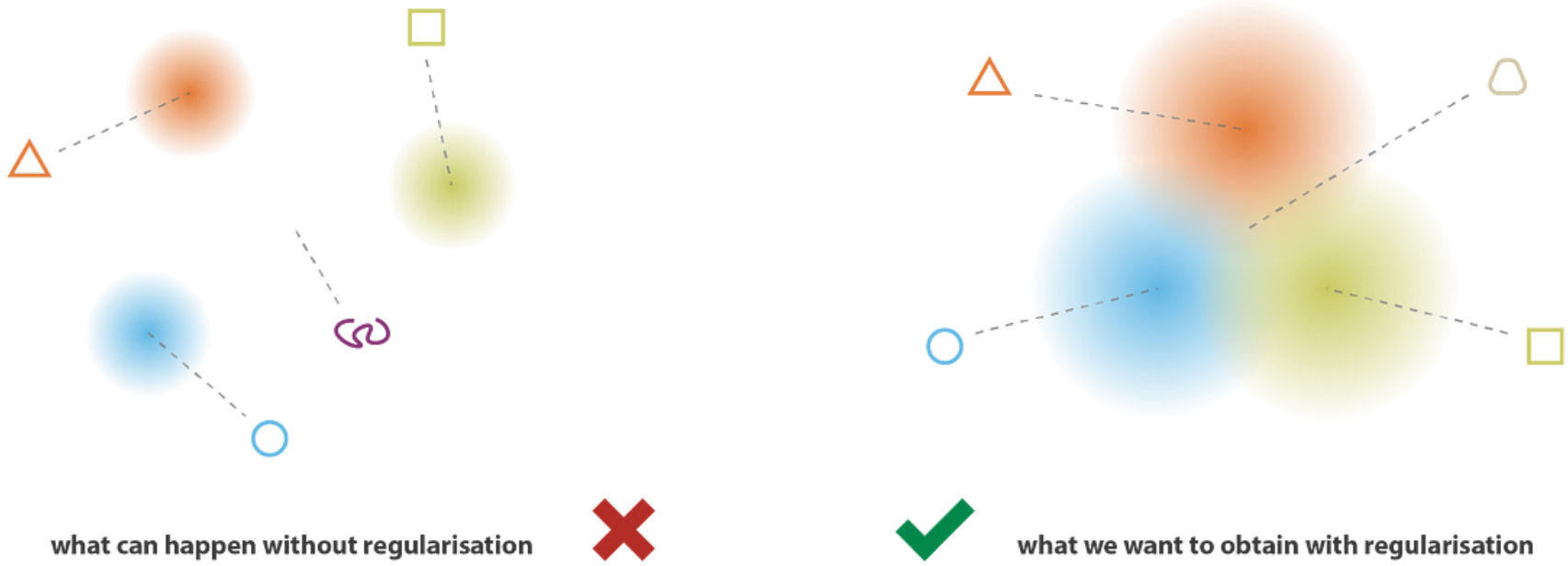
Variational Auto-Encoder

- Consequently, a traversal of the latent space would lead to smoother transitions in the reconstructed data.



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Variational Auto-Encoder

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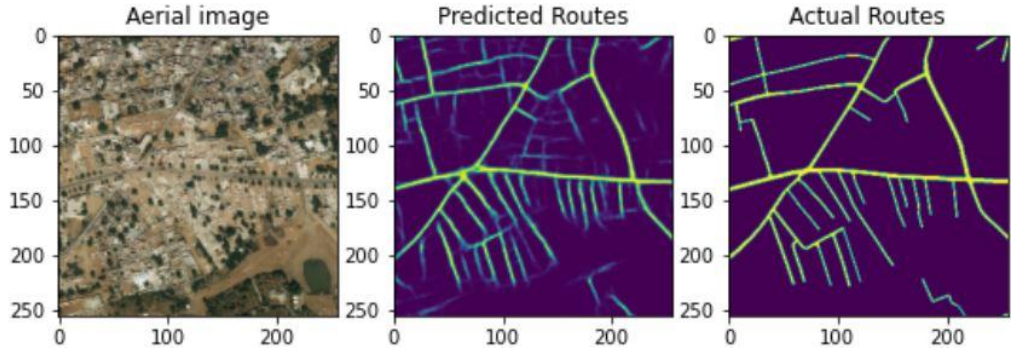
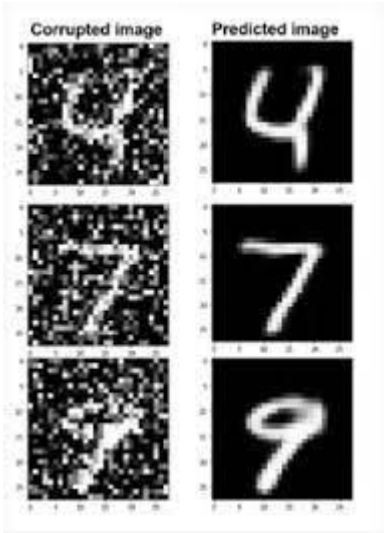
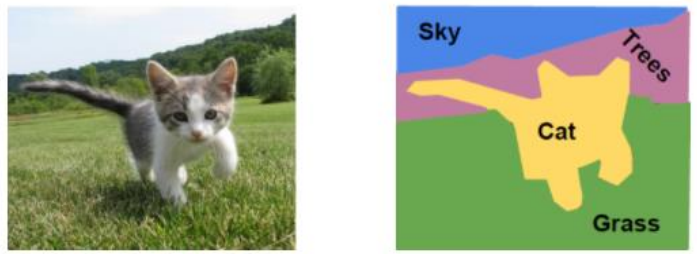
Examples in Computer Vision

Sketch2pix







Semantic segmentation

Debugging Neural Nets

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Results are bad?

- Check against a benchmark!
  - paperswithcode.com
  - kaggle.com
- Are you overfitting or underfitting?

How do I improve my results?

- Best way: Get more **GOOD** data
  - If not, clean-up existing data.
- Are you overfitting or underfitting?
  - Overfitting: get more data, use a less complex model, regularization, or transfer learning.
  - Underfitting: get a more complex model.
- Keep it simple!
  - Start with a simple model, simple data, simple code.
  - Test by component (e.g., loss, forward pass, etc.).
  - Test by example (e.g., outliers).