Variational Autoencoder

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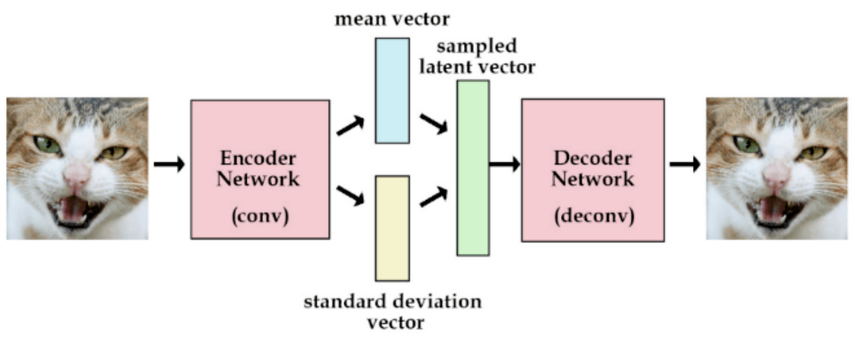
Outline

- Variational Autoencoder
- Variational Inference
- Example Code

Variational Autoencoder

- Kingma and Welling, Auto-Encoding Variational Bayes, 2014 (original paper)

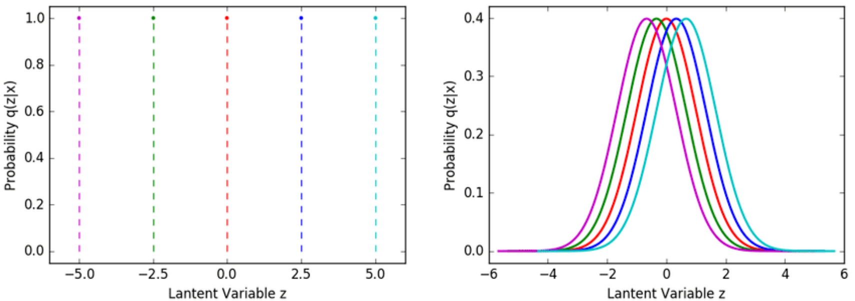


- Autoencoder does not serve as a good generative model beyond a method for dimension reduction (and associated applications)


AE vs VAE face generation
left = AE face generation, right = VAE face generation.

- AE
  - high degree of freedom enables encode/decode with no reconstruction loss $\rightarrow$ severe overfitting
  - lack of interpretable and exploitable structures in the latent space $\rightarrow$ lack of regularity
- VAE
  - tackle irregularity by making the encoder return a distribution over the latent space by adding a regularization term
  - Loss function: reconstruction term + regularization term
  - Using a statistical technique called variational inference

- Latent variable illustration: AE (left), VAE (right)



(a) (b)

Variational Inference

- Main problem: we do not know the data distribution!

- A technique to approximate complex distributions
- First, select a parameterized family of distributions (e.g., Gaussians) whose parameters are known (e.g., mean and covariance)
- Next, tune one distribution in the family to minimize the error (e.g., KL divergence) between it and the target (data distribution), using gradient descent

Example Code

VAE Code

- link