

Variational Autoencoder

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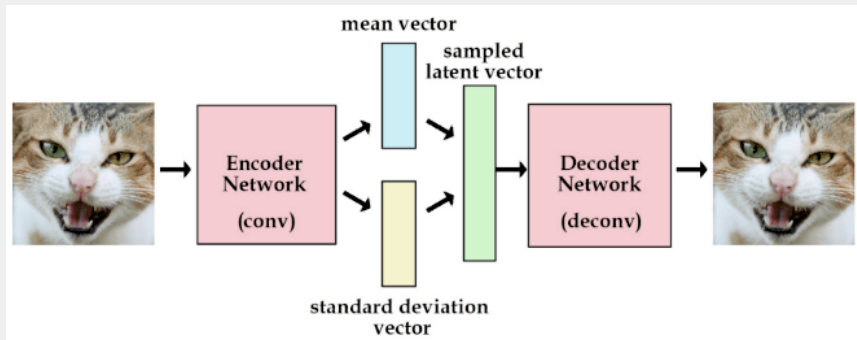
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- Variational Autoencoder
- Variational Inference
- Example Code

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

AE vs VAE face generation

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



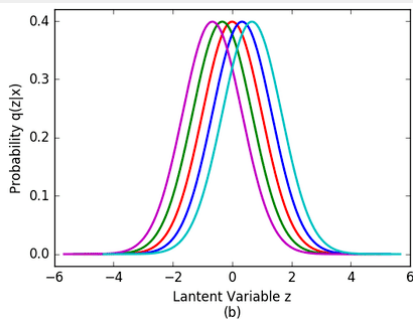
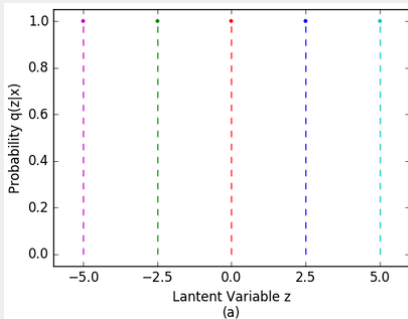
■ AE

- ▶ high degree of freedom enables encode/decode with no reconstruction loss → severe overfitting
- ▶ lack of interpretable and exploitable structures in the latent space → 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)



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

- [link](#)