

Variational Auto Encoder

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Abstract

Variational auto-encoder [1] is a very powerful generative model. It can be used to generate or convert videos, images, texts, sounds etc.

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1 What is VAE?

Variational auto-encoder is a brilliant combination of deep learning and variational inference. It was proposed by Kingma in 2013. It provides a probabilistic manner for describing an observation in latent space. The encoder is aimed to describe a probability distribution for each latent attribute.

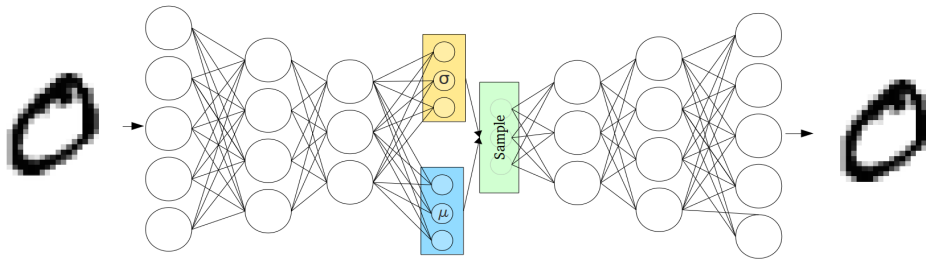


Figure 1: VAE graph model

1.1 Intuition

In the past, we want the encoder to learn some dimensions of input as the compressed feature. Using a variational autoencoder, we describe those latent dimensions in probabilistic terms. we'll now instead represent each latent attribute for a given input as a probability distribution. And we will perform random sampling on the distribution to feed the decoder. We expecting the decoder can accurately reconstruct the input.

1.2 Statistical motivation

Suppose there exists some latent variable z controls the observation x . We would like to infer the posterior $p_\theta(z|x)$

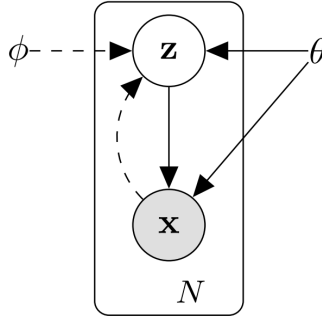


Figure 2: Solid lines denotes the generative model $p_\theta(z)p_\theta(x|z)$. Dash lines denote the variational inference $q_\phi(z|x)$ which is a approximation of intractable $p_\theta(z|x)$.

$$p_\theta(z|x) = \frac{p_\theta(x|z)p_\theta(z)}{p_\theta(x)} = \frac{p_\theta(x|z)p_\theta(z)}{\int p_\theta(z)p_\theta(x|z)dz}$$

As we **do not** make the common simplifying assumptions about the marginal or posterior probabilities, the $\int p_\theta(z)p_\theta(x|z)dz$ is intractable, and EM algorithm or mean-field variational bayesian is also intractable.

So the VAE introduce a recognition model $q_\phi(z|x)$, which is a approximation to the posterior. Note the ϕ can not be computed from some closed-form expectation like mean-field variational inference. It will be learned jointly with θ .

References

- [1] Diederik P. Kingma and Max Welling. Auto-encoding variational bayes. *CoRR*, abs/1312.6114, 2013.



Figure 3: Generated images