

Generative vs Discriminative Models

Understanding Machine Learning

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Prediction of Probability Distributions

... pdf assumption and estimation of moments

... quantile regression

... generative method and sampling

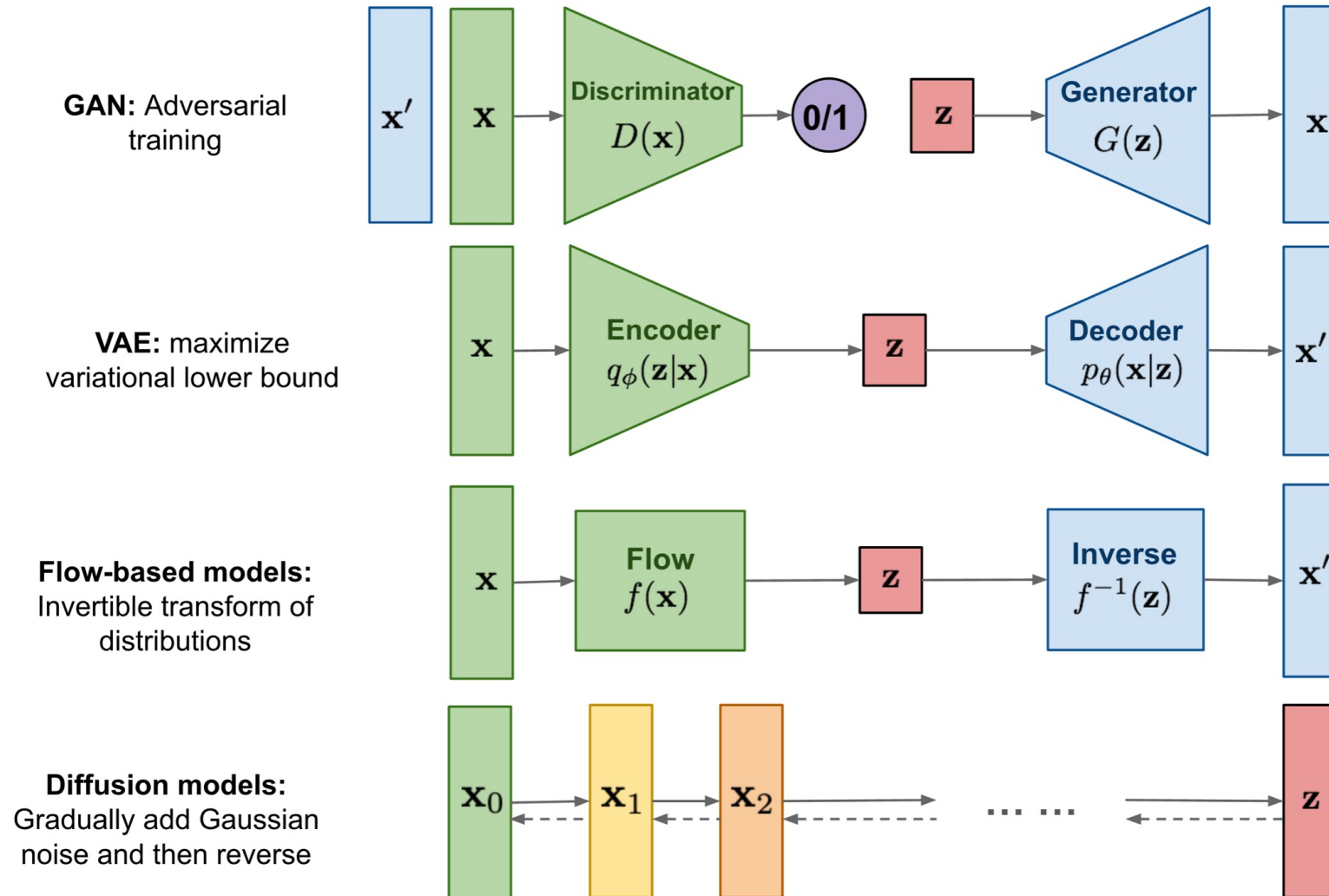
Generative Methods

Example: Naïve Bayes

Generative vs Discriminative

- $P(Y, X)$ vs $P(Y|X)$
- generative-discriminative pair of algorithms: Naïve Bayes and Logistic Regression

Different Types of Generative Models



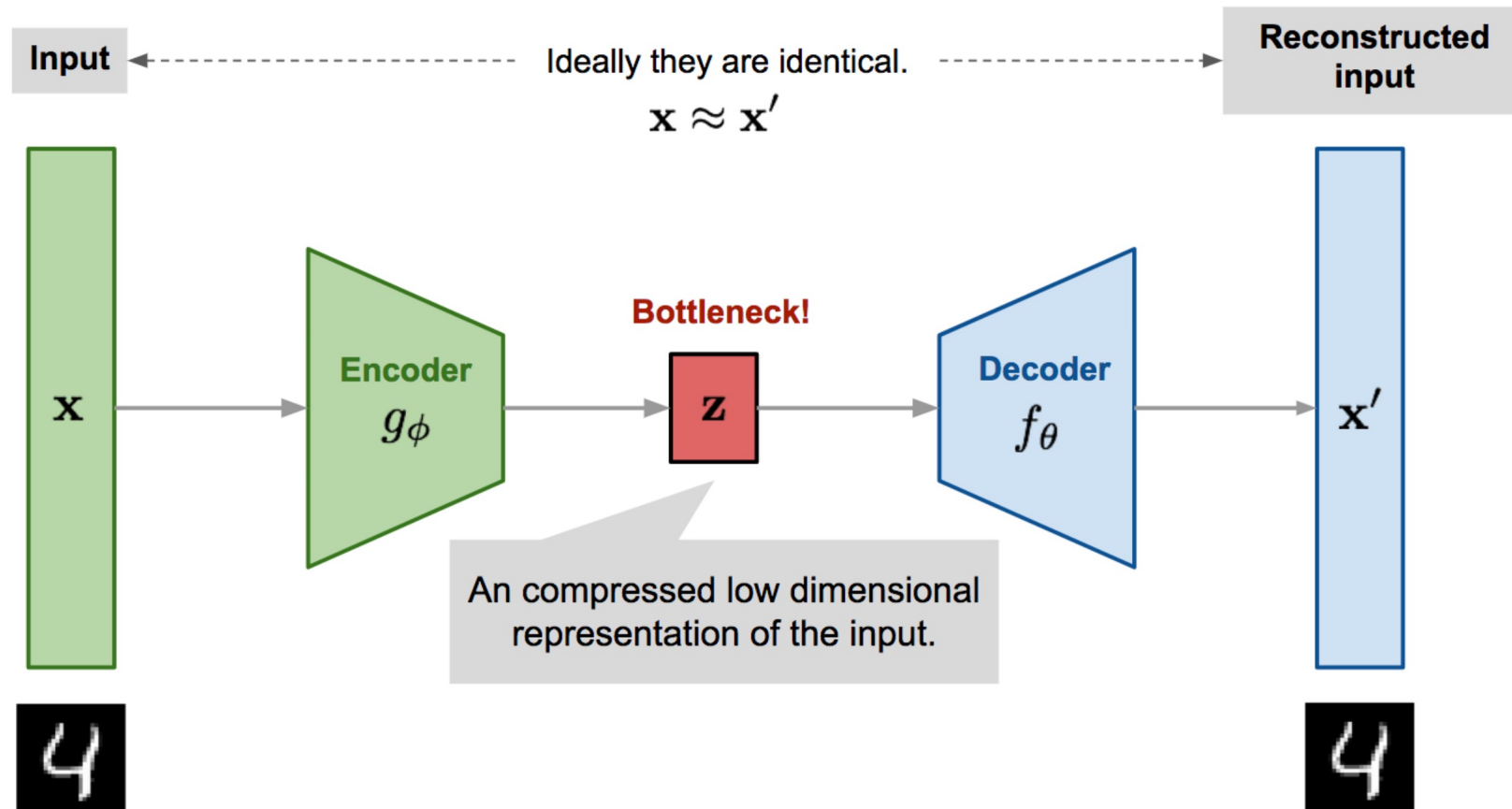
Variational Inference

- Bayesian ...

Recap: Autoencoder

(deep) encoder network
(deep) decoder network
learned together by
minimizing differences
between original input and
reconstructed input
(expressed as losses)

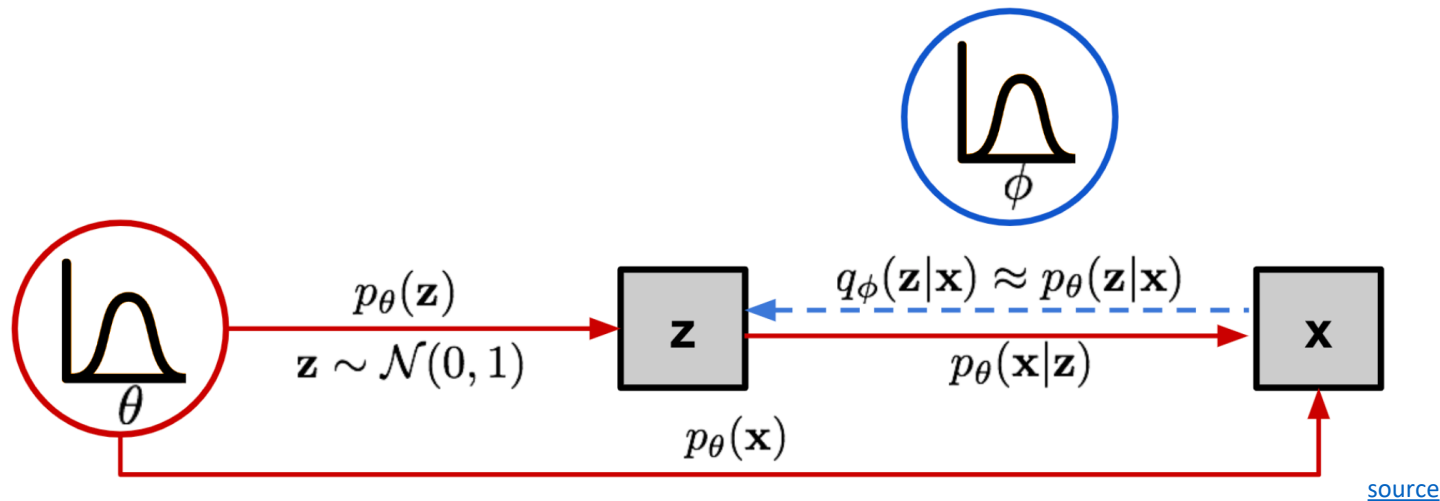
compressed intermediate
representation:
dimensionality reduction



[source](#)

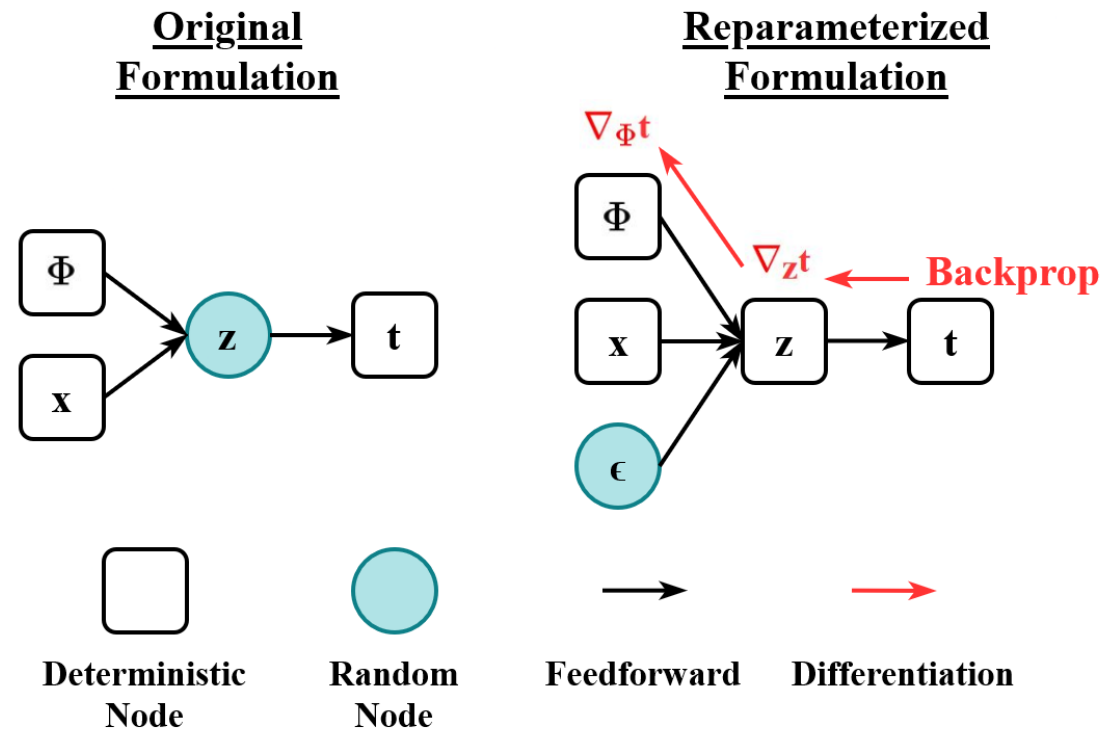
Variational Autoencoder (VAE)

- ...
- VAE relies on a surrogate loss



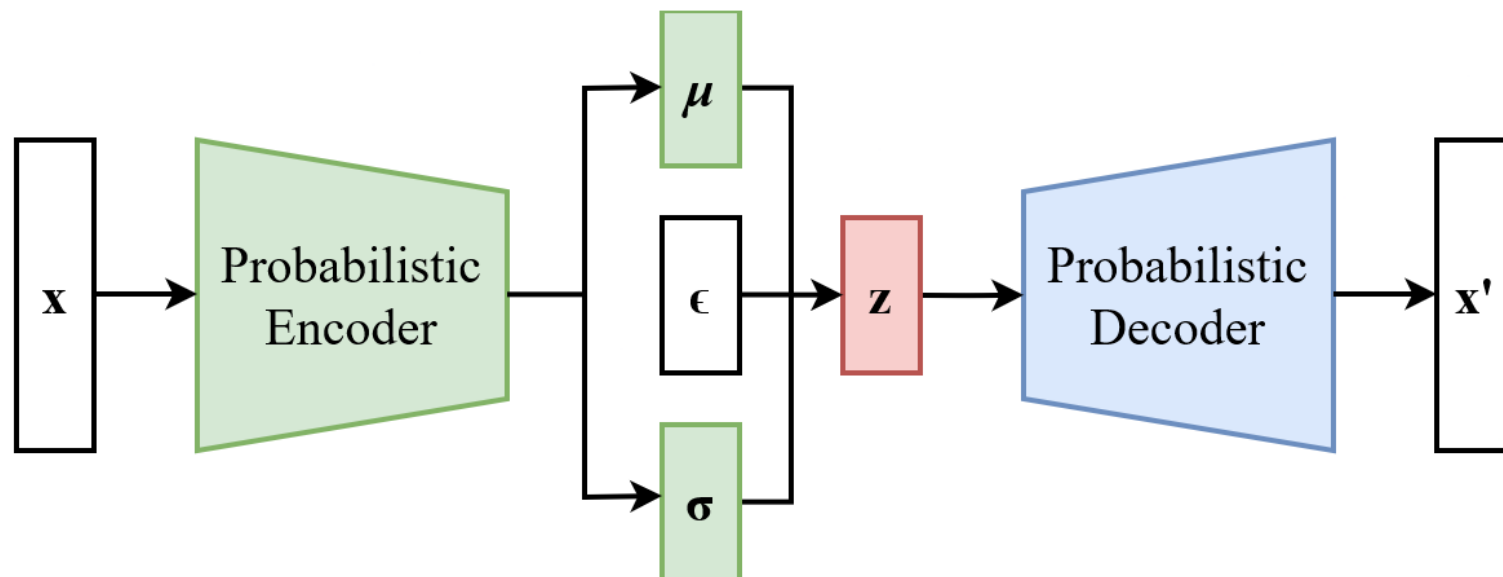
ELBO

- reparameterization trick



from wikipedia

• ...



from wikipedia

Generative Adversarial Networks (GAN)

● ...

- GAN models are known for potentially unstable training and less diversity in generation due to their adversarial training nature.

Flow-Based Methods

● ...

- Flow models have to use specialized architectures to construct reversible transform.

Energy-Based Methods

● ...

Diffusion Models

● ...

- Diffusion models are inspired by non-equilibrium thermodynamics. They define a Markov chain of diffusion steps to slowly add random noise to data and then learn to reverse the diffusion process to construct desired data samples from the noise. Unlike VAE or flow models, diffusion models are learned with a fixed procedure and the latent variable has high dimensionality (same as the original data).

Image Generation

[DALL-E 2](#)

...

Stable Diffusion DreamStudio



A dream of a distant galaxy, by Caspar David Friedrich, matte painting trending on artstation HQ

Literature

papers:

- [variational autoencoder](#)
- [GAN](#)
- [normalizing flows](#)
- [latent diffusion](#)



Movie-like Intelligence

emergent capabilities of complex
systems almost impossible to foresee

examples for (potential) emergence
in ML: [large language models](#), [multi-agent reinforcement learning](#),
[reward is enough](#)

philosophical: emotions or
consciousness might also occur as
emergent capabilities

