

① Generative models

Deep generative models

$$\bar{z} \sim \mathcal{N}(0, I) \rightarrow \bar{x} \in \mathbb{R}^N$$

$$p(\bar{x}) = \dots$$

Explicit density

Implicit density

GAN

$$\bar{z} \sim \mathcal{N}(0, I) \rightarrow \bar{x} \sim p(\bar{x})$$

Tractable density

$$p(\bar{x}) = \dots$$

$p(\bar{x}) \approx q(\bar{z})$
Approximate density
VAE

Flow-based models

$$p(\bar{x}) = f_{k0} \circ f_{k-1} \circ \dots \circ f_{20} f_1(\bar{z})$$

Autoregressive models

LLMs / PixelCNN
 $p(x_k | x_1, \dots, x_{k-1})$

$$p(\bar{x}) = p(x_1) p(x_2 | x_1) p(x_3 | x_1, x_2) \dots p(x_n | x_1, \dots, x_{n-1})$$

RNN

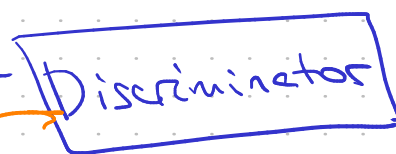
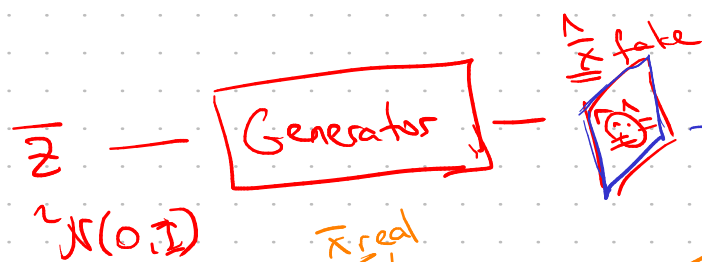


② Generative adversarial networks (GAN)

adversarial training

$$D = \{ \bar{x}_n \}_{n=1}^N$$

$$D = \{ \bar{x}_n, \bar{x}_n \}_{n=1}^N$$



$$L_D = - \left(\mathbb{E}_{\bar{x}_{real} \sim D} [\log D(\bar{x})] + \mathbb{E}_{\bar{x}_{fake} \sim p_G(\bar{x})} [\log (1 - D(\bar{x}))] \right)$$

$$L_G = \mathbb{E}_{\bar{z} \sim p(\bar{z})} [\log (1 - D(G(\bar{z})))] \rightarrow \min_{\theta_G}$$

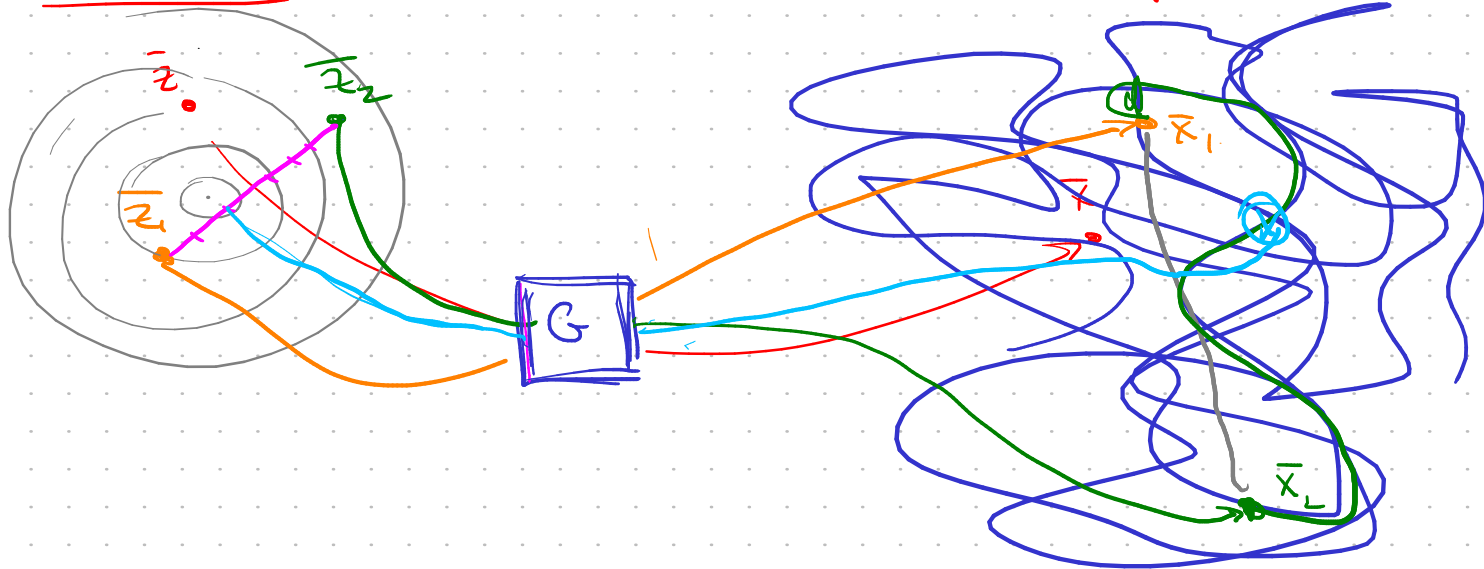
$\rightarrow \min_{\theta_D}$

$$\min_{\bar{\theta}_G} \max_{\bar{\theta}_D} L(\bar{\theta}_D, \bar{\theta}_G)$$

minimax game

Latent Space

Pixel Space



③ Wasserstein GAN (WGAN)

$$\underline{p_G(\bar{x})} \approx \underline{p_{data}(\bar{x})}$$

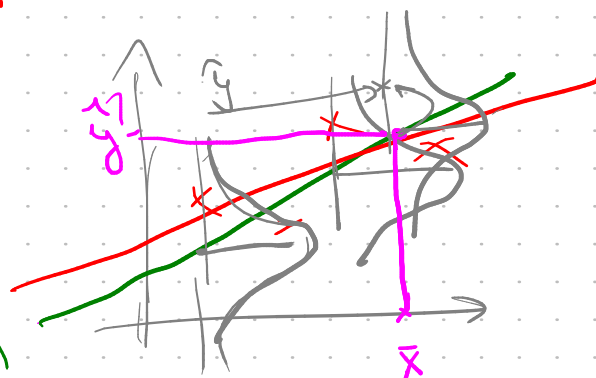
Kullback-Leibler divergence:

$$\left\{ \begin{array}{l} KL(p||q) = \int p(\bar{x}) \log \frac{p(\bar{x})}{q(\bar{x})} d\bar{x} \\ KL(q||p) \end{array} \right.$$

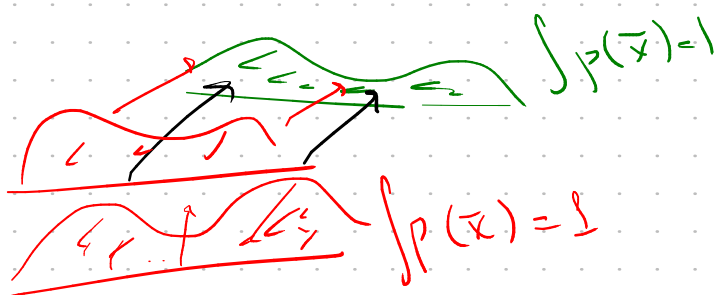
$$\begin{array}{l} p \rightarrow q \\ q \rightarrow p \end{array} \rightarrow 0$$



$$\begin{array}{l} p_{data}(\bar{x}) > 0 \rightarrow p_G(\bar{x}) > 0 \\ p_{data}(\bar{x}) = 0 \Leftarrow p_G(\bar{x}) > 0 \end{array}$$



Earth Mover distance



④ Adversarial autoencoders (AAE)

