

Explicit density

Implicit density  
GAN

Tractable density

Approximate density  
VAE

$$p(\bar{x}) \approx q(\bar{x}) = \prod \dots$$

$$KL(q||p) \rightarrow \min$$

Noive Bayes:

$$p(\bar{x}, y) = p(y) \prod_{i=1}^n p(x_i | y)$$



Autoregressive models

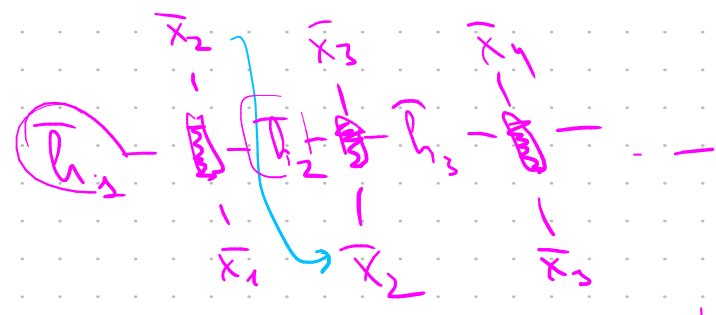
$$p(\bar{x}) = p(x_1 \dots x_n) = p(x_1) p(x_2 | x_1) p(x_3 | x_1, x_2) \dots p(x_n | x_1 \dots x_{n-1})$$

$p(x_i | x_1 \dots x_{i-1})$  - GPT

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

- MC  $D = \sum_{i=1}^N \bar{x}_i$

RNN:



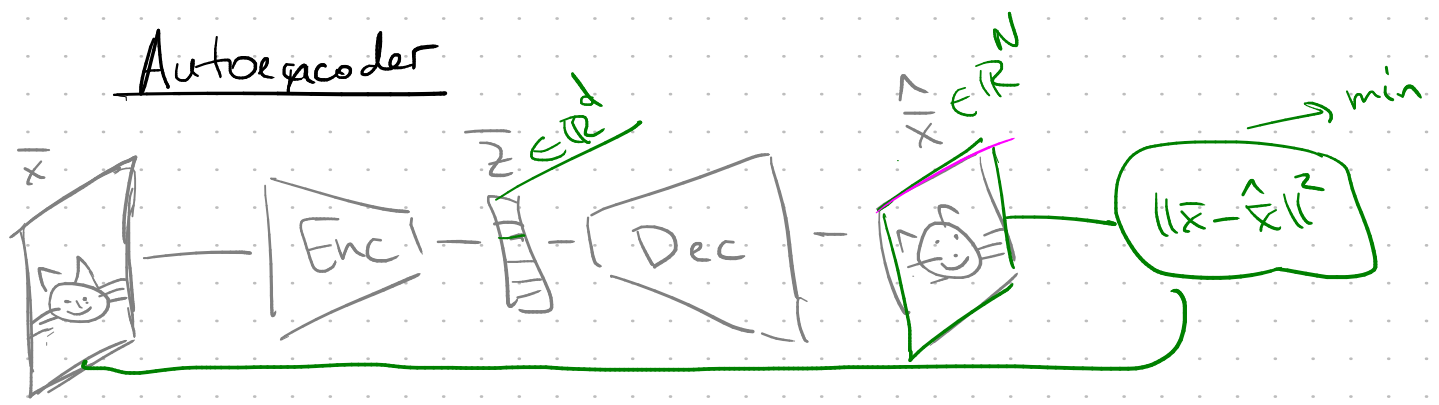
$$\bar{z} = \frac{1}{N} \sum_{i=1}^N \bar{x}_i$$

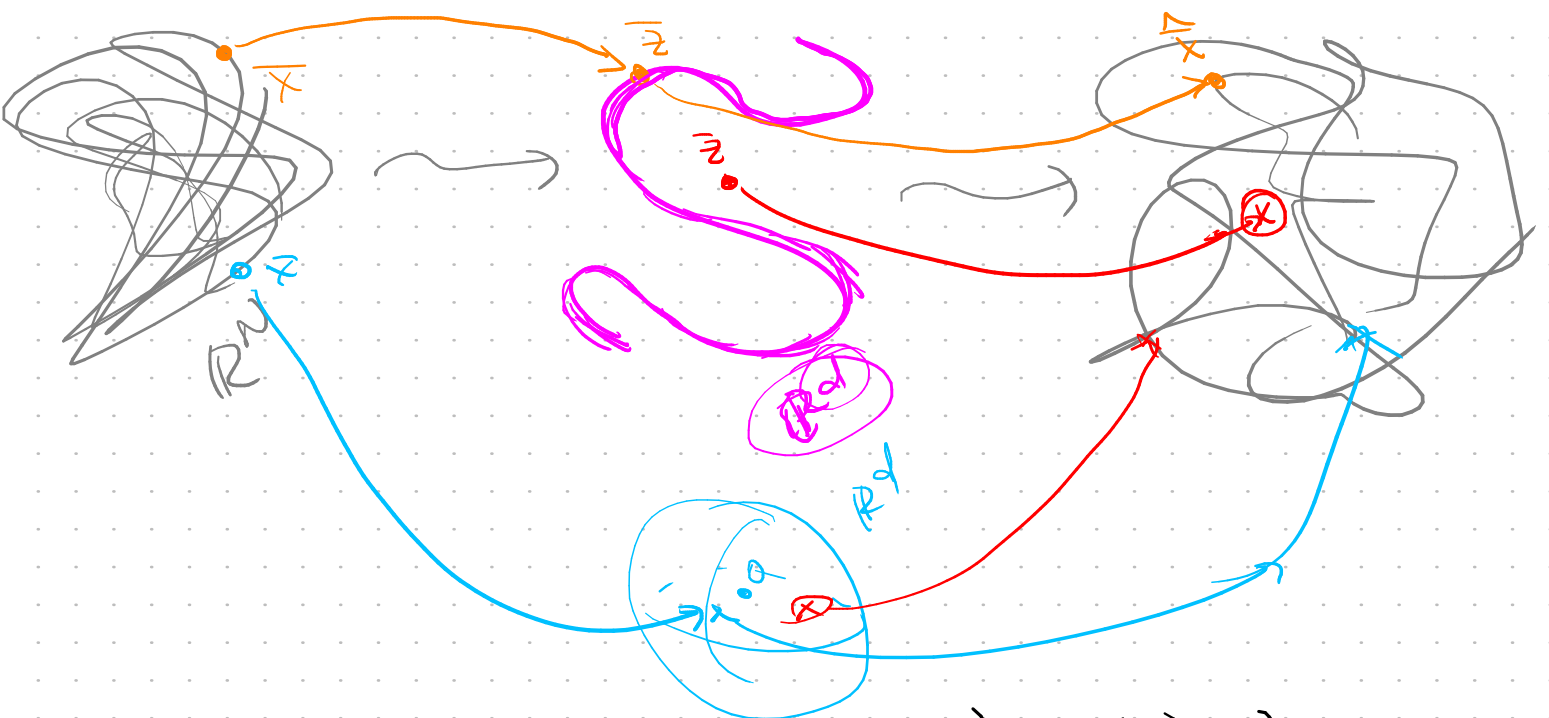
$$L(\bar{x}) = \dots$$

$$p(\bar{x}_t | \bar{x}_1 \dots \bar{x}_{t-1}, \bar{h}_0) = p(\bar{x}_t | \bar{x}_{t-1}, \bar{h}_{t-1})$$

$$\bar{h}_{t-1} = f(\bar{x}_{t-1}, \bar{h}_{t-2})$$

Autoencoder

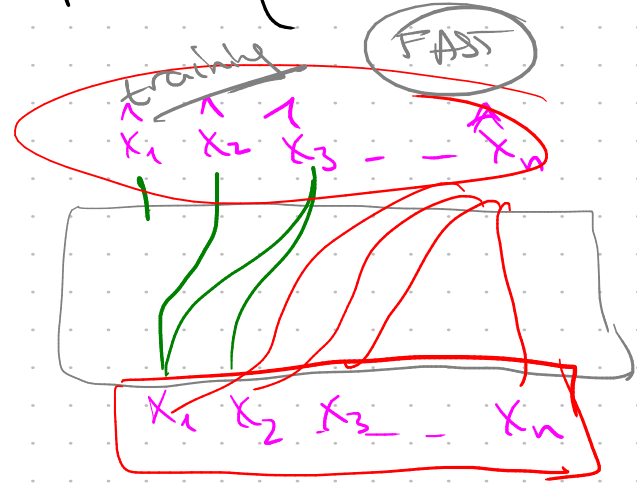
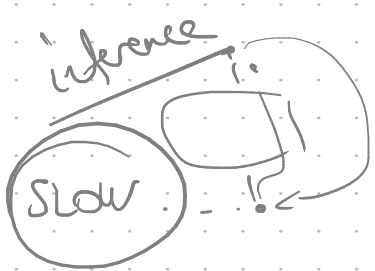




Flow-based

$$p(\bar{x}) \approx \left( f_{n^0}^{(\theta_{n^1})} \circ f_{n-1^0}^{(\theta_{n-1})} \dots \circ f_{2^0}^{(\theta_2)} \circ f_{1^0}^{(\theta_1)} \circ p_0 \right)(\bar{x})$$

Autoregressive



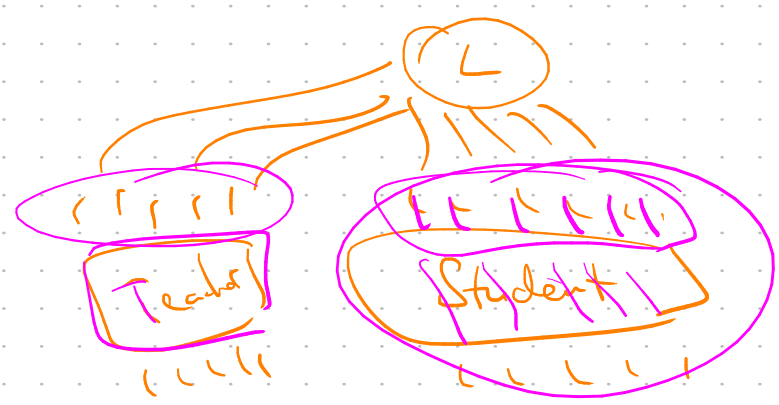
causal masking

inverse auto.



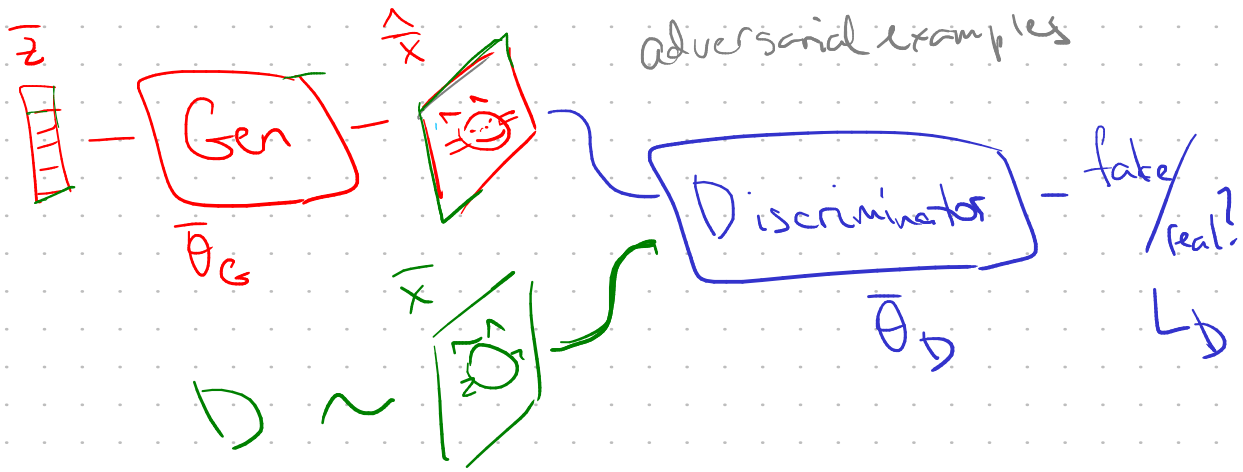
teacher-student

Teacher - wavenet



# GAN

generative adversarial networks



$$L_D \xrightarrow{\bar{\theta}_D} \min$$

$$\xrightarrow{\bar{\theta}_G} \max$$

$$E_{\hat{x} \sim p_{data}(\hat{x})} [\log D(\hat{x})] +$$

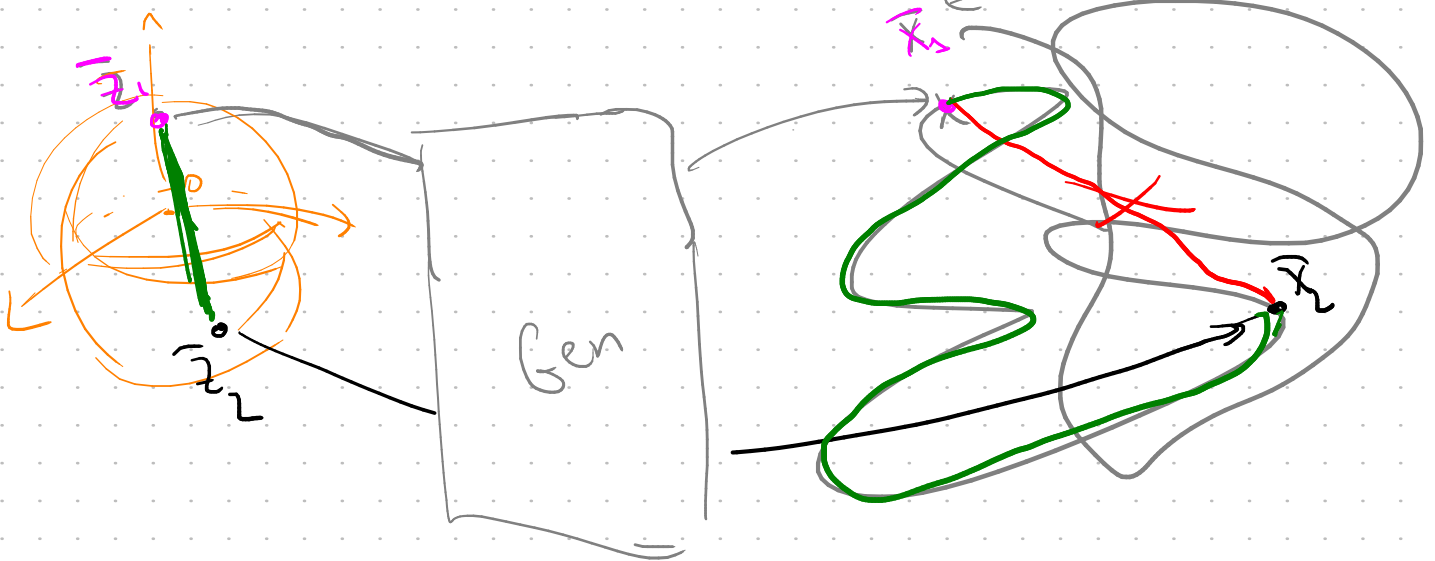
$$+ E_{\hat{x} \sim Gen(\bar{z})} [\log(1 - D(\hat{x}))]$$

$$V(\bar{\theta}_D, \bar{\theta}_G) = E_{\hat{x} \sim p_{data}(\hat{x})} [\log D(\hat{x}; \bar{\theta}_D)] +$$

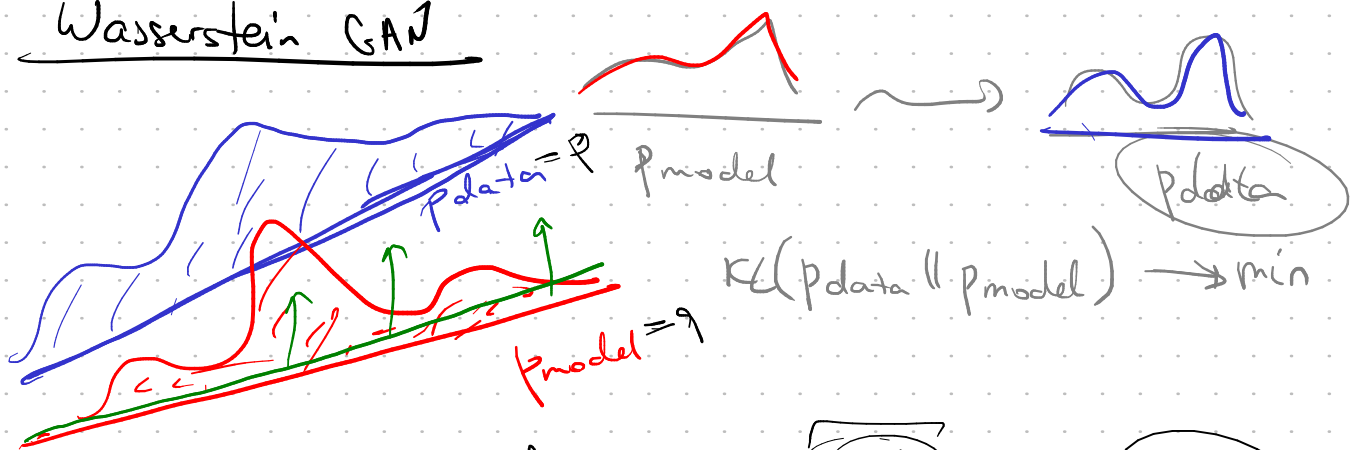
$$+ E_{\bar{z} \sim p_{\bar{z}}(\bar{z})} [\log(1 - D(G(\bar{z}), \bar{\theta}_G); \bar{\theta}_D)]$$

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

$L_G$



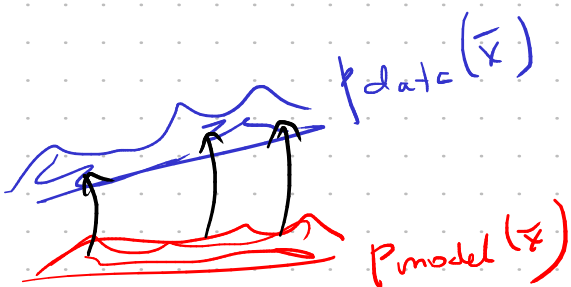
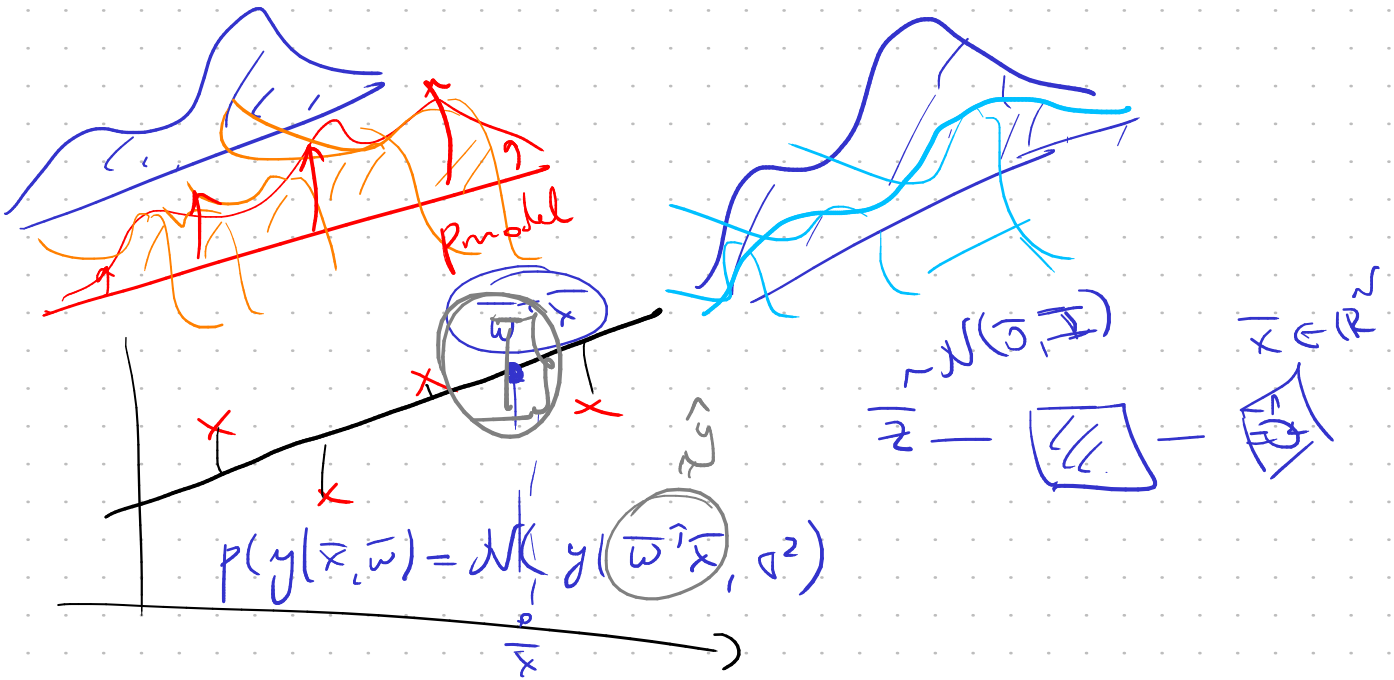
# Wasserstein GAN



$$KL(p || q) = \int p(\bar{x}) \log \frac{p(\bar{x})}{q(\bar{x})} d\bar{x} = \infty$$

$$KL(q || p) = \infty$$

$$JSD(\cdot) = KL(p || \frac{p+q}{2}) \rightarrow KL(q || \frac{p+q}{2}) = \text{Const}$$



EMD - Earth Mover Distance