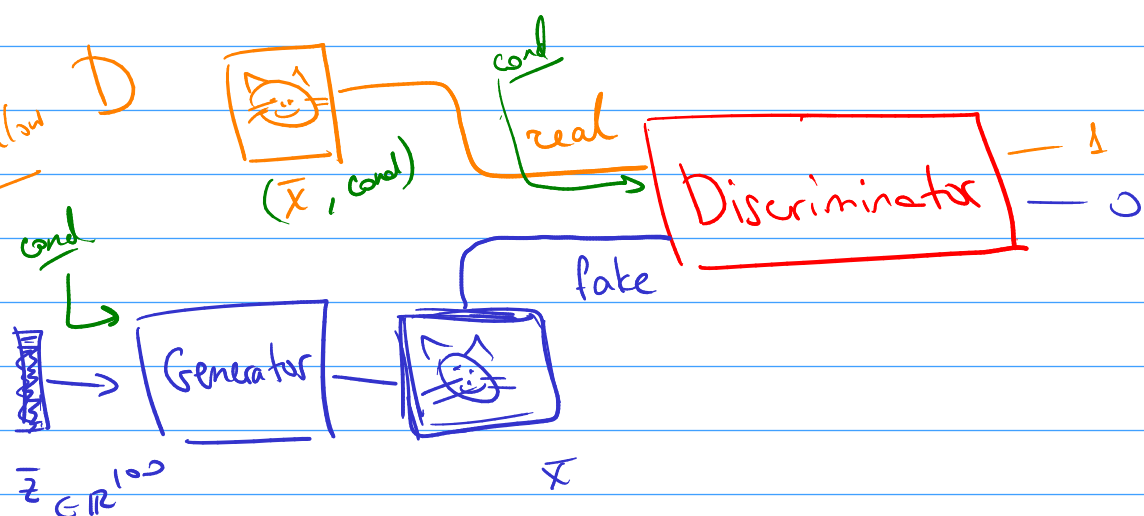


2014

Jan Good fellow



$$G: z \rightarrow X$$

$$D: X \rightarrow [0, 1]$$

$$V(D, G)$$

$$L_D = \mathbb{E}_{x \sim p_{data}} [\log D(x)] + \mathbb{E}_{x \sim p_g} [\log (1 - D(x))] \rightarrow \max_D$$

$$L_G = \mathbb{E}_{x \sim p_g} [\log (1 - p(x))] = \mathbb{E}_z [\log (1 - D(G(z)))] \rightarrow \min_G$$

$$\min_G \left[ \max_D V(D, G) \right]$$

$$L_D = \int \left( p_{\text{data}}(\bar{x}) \log D(\bar{x}) + p_g(\bar{x}) \log (1 - D(\bar{x})) \right) d\bar{x} \rightarrow \max$$

$$p_{\text{data}}(\bar{x}) \log a + p_g(\bar{x}) \log (1-a) \rightarrow \max_a$$

$$\frac{p_d}{a} - \frac{p_g}{1-a} = 0 \quad a^* = \frac{p_d}{p_d + p_g}$$

$$D_G^*(\bar{x}) = \frac{p_{\text{data}}(\bar{x})}{p_{\text{data}}(\bar{x}) + p_g(\bar{x})}$$

$$\min_G V(D_G^*(\bar{x}), G)$$

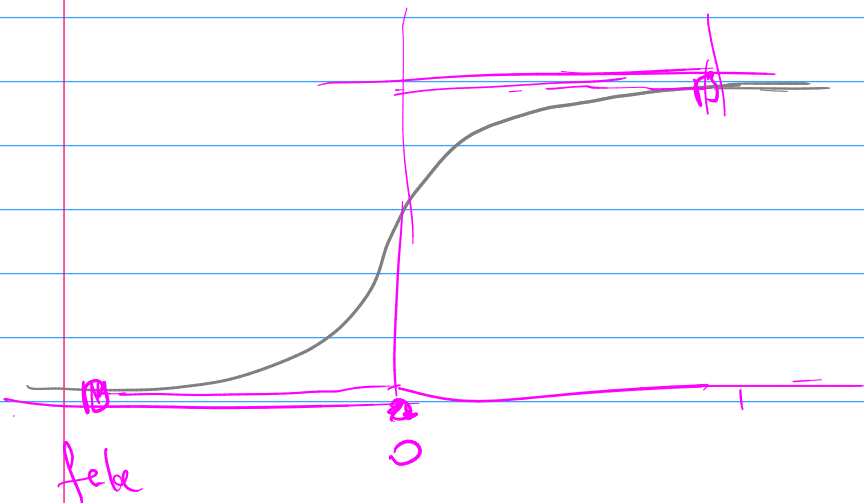
$$\int \left( p_{\text{data}}(\bar{x}) \log \frac{2 p_{\text{data}}(\bar{x})}{p_{\text{data}}(\bar{x}) + p_g(\bar{x})} + p_g(\bar{x}) \log \frac{2 p_g(\bar{x})}{p_{\text{data}}(\bar{x}) + p_g(\bar{x})} \right) d\bar{x}$$

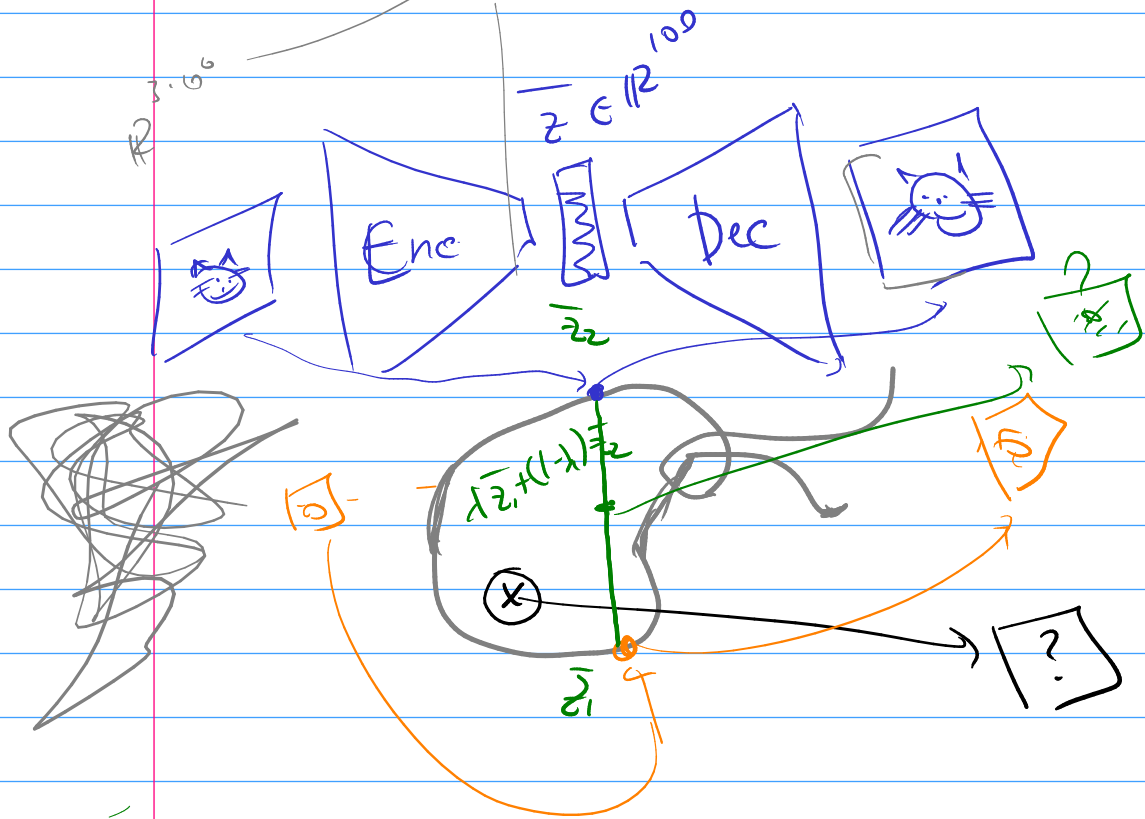
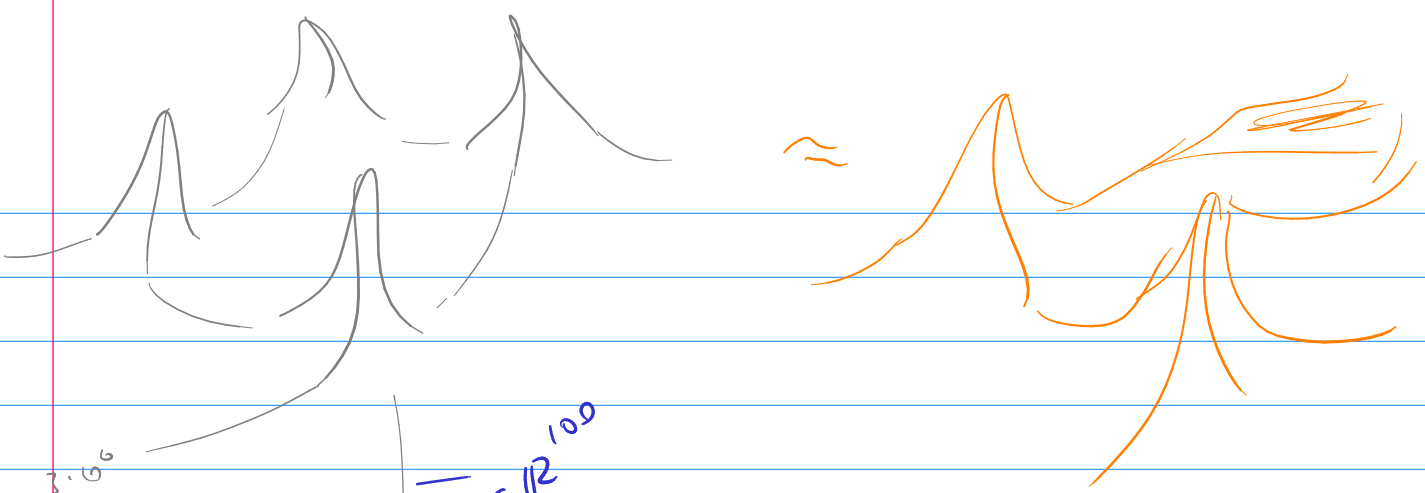
$$KL(p||q) = \int p \ln \frac{p}{q} d\bar{x}$$

$$= KL(p_{\text{data}} \parallel \frac{p_{\text{data}} + p_g}{2}) + KL(p_g \parallel \frac{p_{\text{data}} + p_g}{2}) =$$

$$V(D_G^*, G) = JSD(p_{\text{data}} \parallel p_g)$$

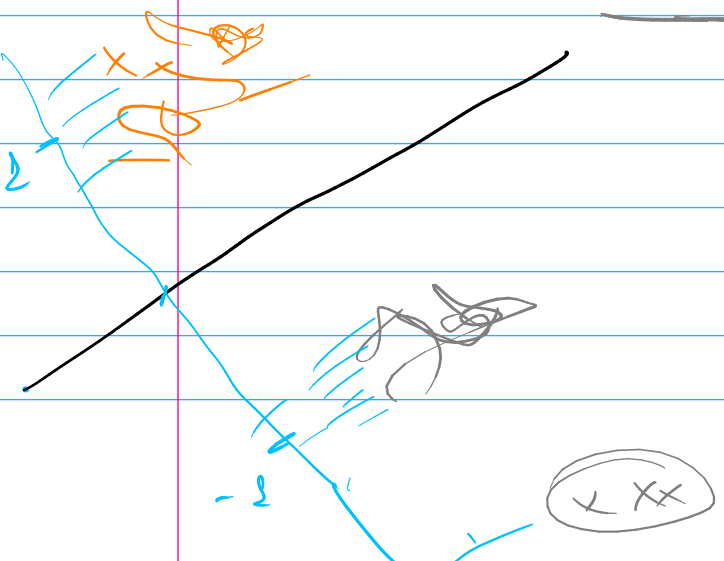
Jensen-Shannon divergence



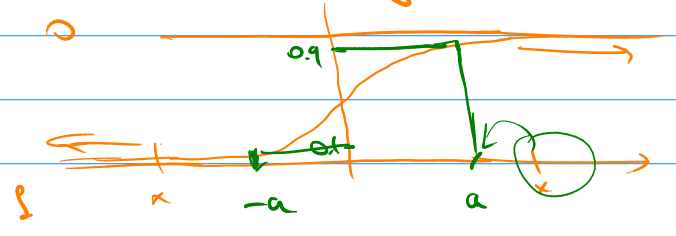


Adversarial loss

Least squares GAN



Label smoothing



$$V_{\text{LSGAN}}(D) = E_{\bar{x} \sim p_{\text{data}}} [(D(\bar{x}) - b)^2] + E_{\bar{z} \sim p_z} [D(G(\bar{z})) - a]^2$$

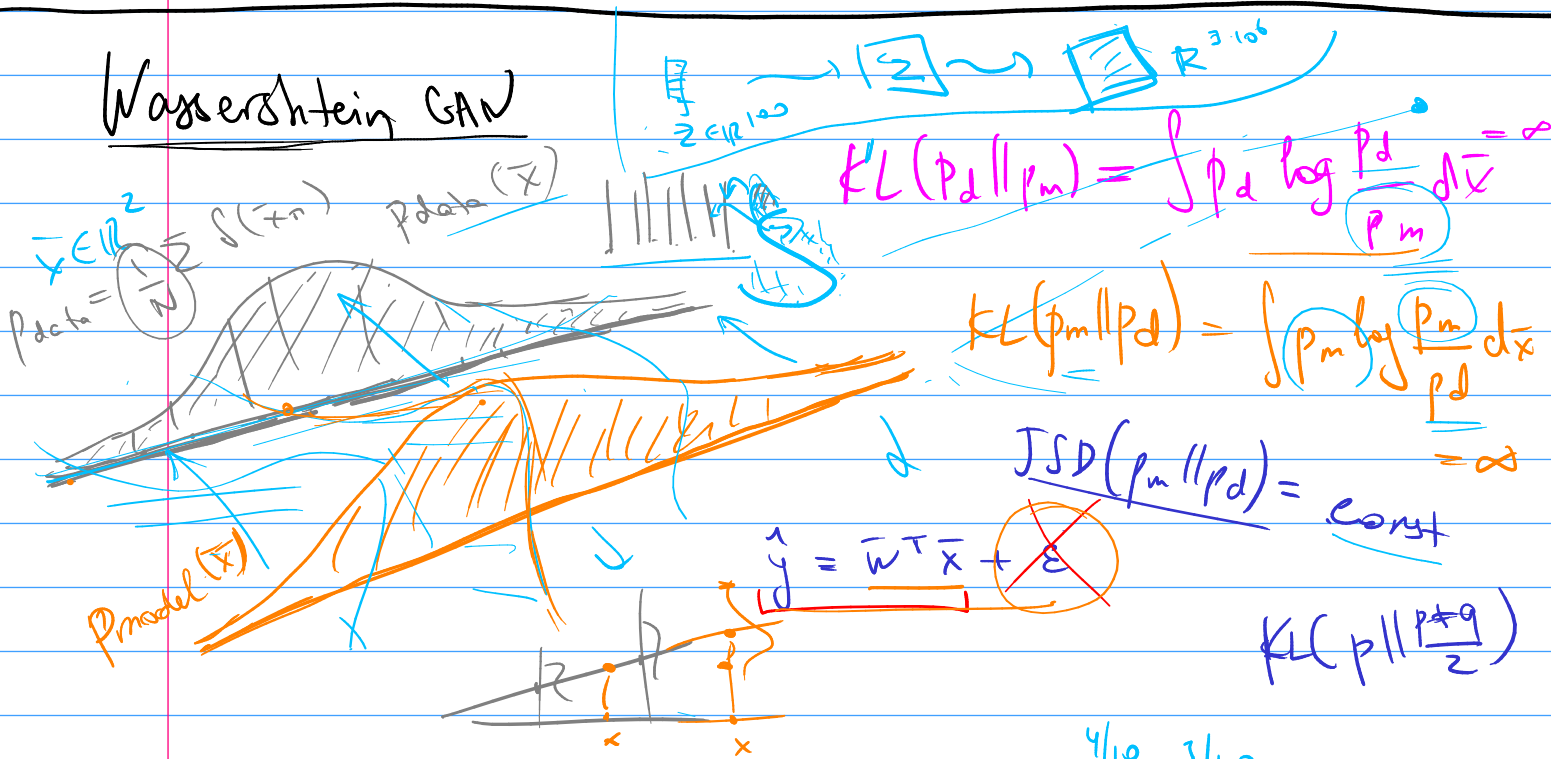
$$V_{\text{LSGAN}}(G) = E_{\bar{z} \sim p_z} [(D(G(\bar{z})) - c)^2]$$

$a = 0$

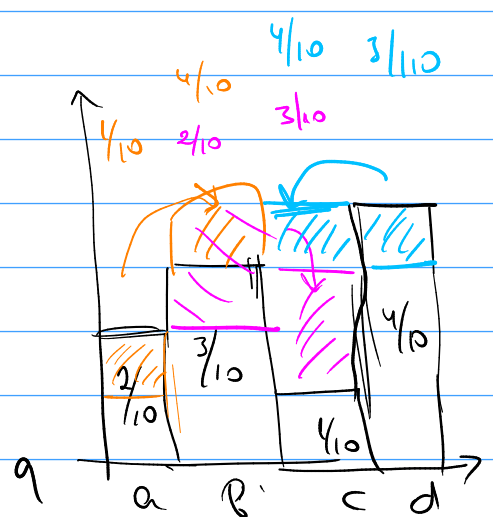
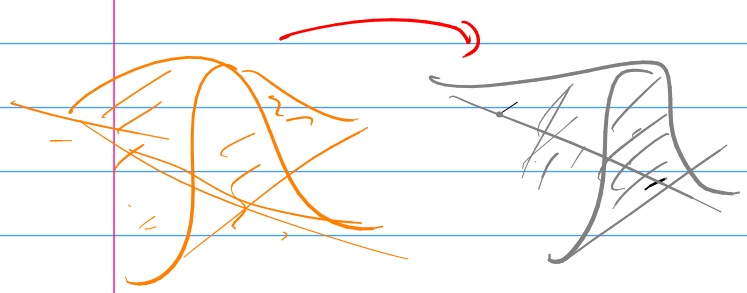
$b = -1$

$c = 1$

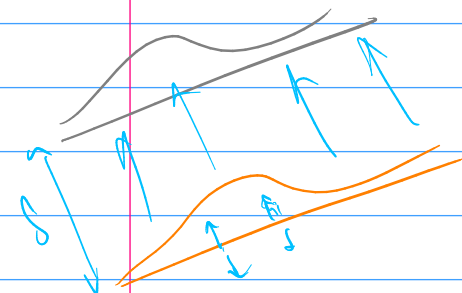
## Wasserstein GAN



## EMD Earth Mover Distance



$$\frac{1}{10} + \frac{2}{10} + \frac{1}{10} = \frac{4}{10}$$



$$p_{\text{model}}(\bar{x}) = q(\bar{x}) + \epsilon(\bar{x})$$

