Generative Models
Generative Adversarial Network
GAN

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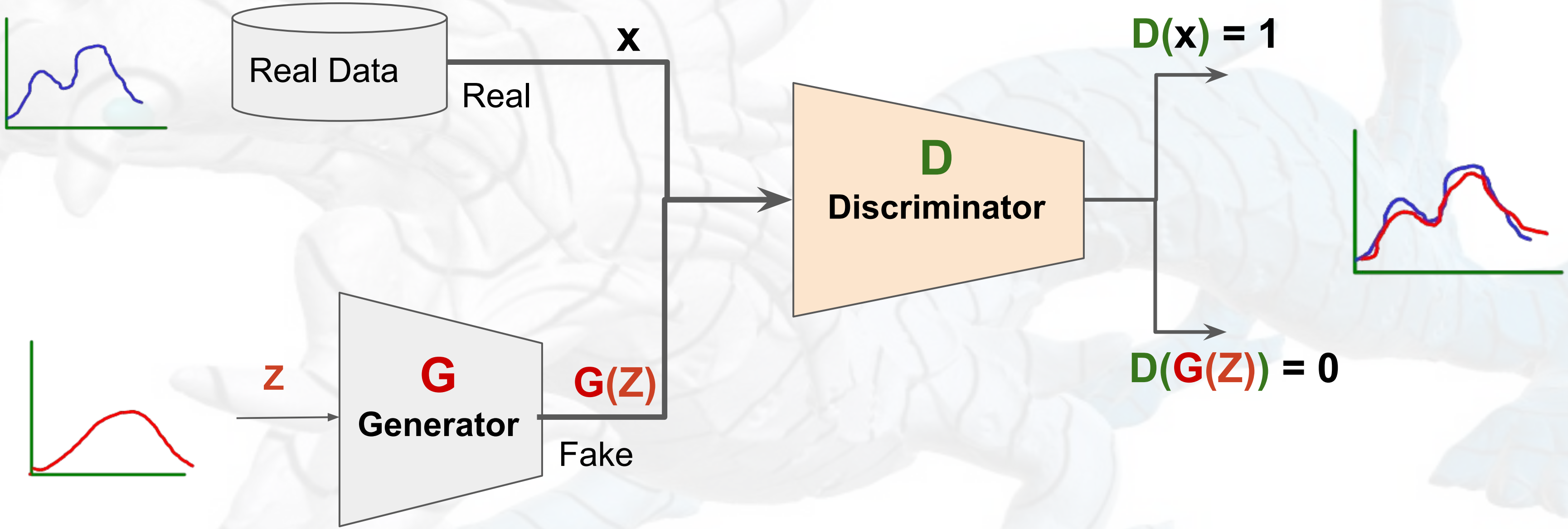
2022

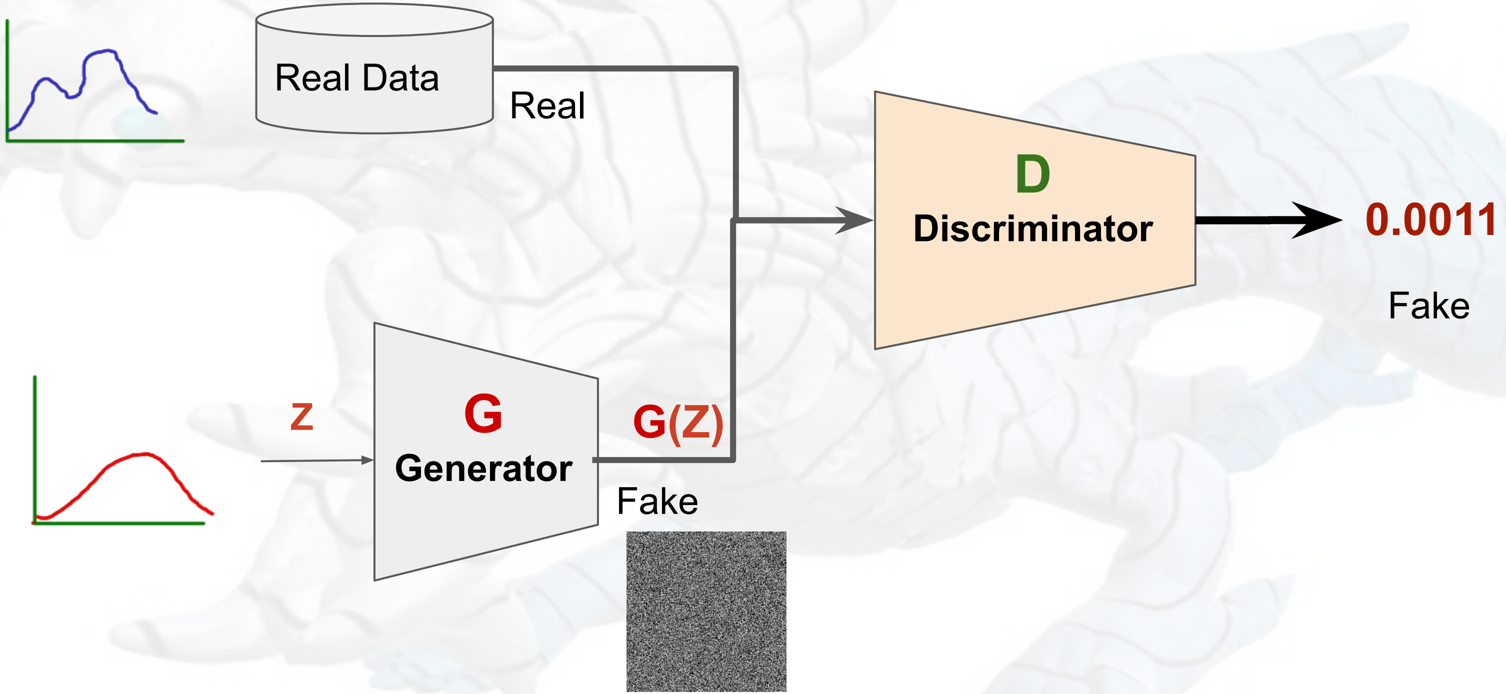
Source click

Face generation with generative modelling. Source: David Foster. “Generative Deep Learning.”

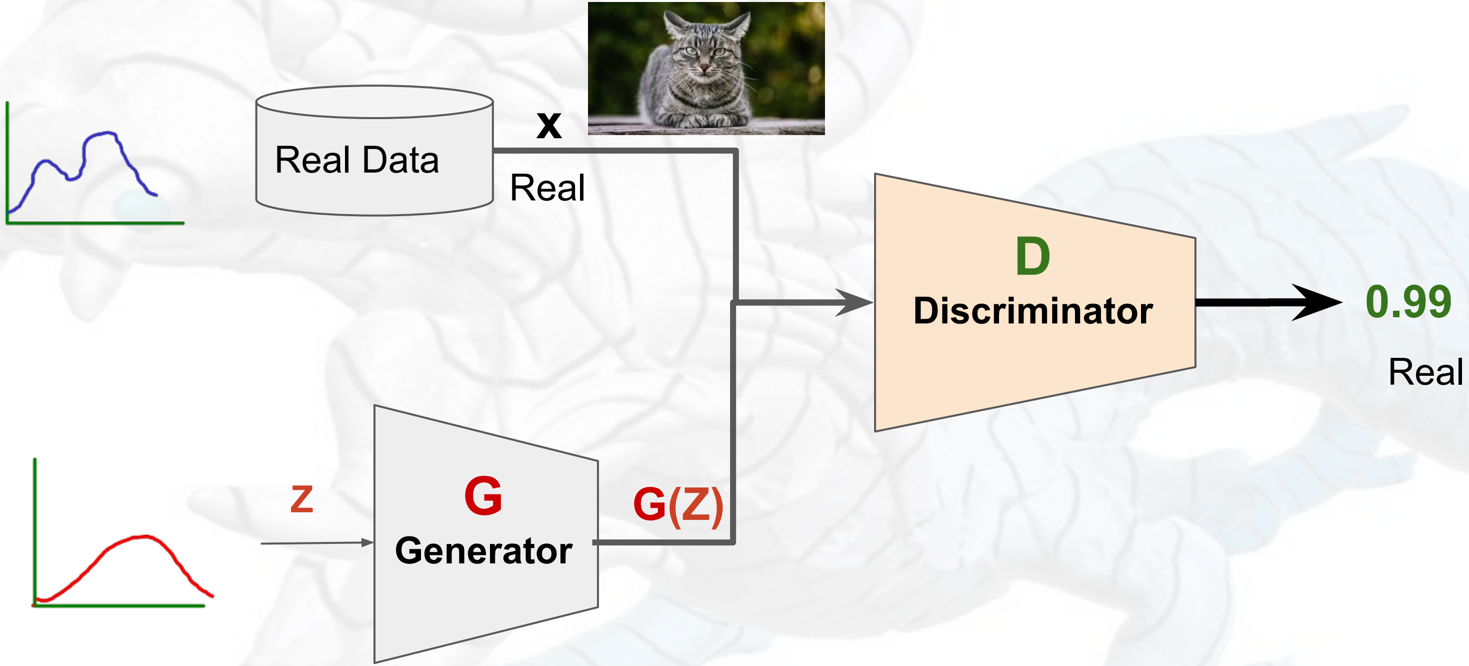
GAN


Real Data
x
Real
D(x) = 1
D
Discriminator
z
G
Generator
G(Z)
Fake
D(G(Z)) = 0

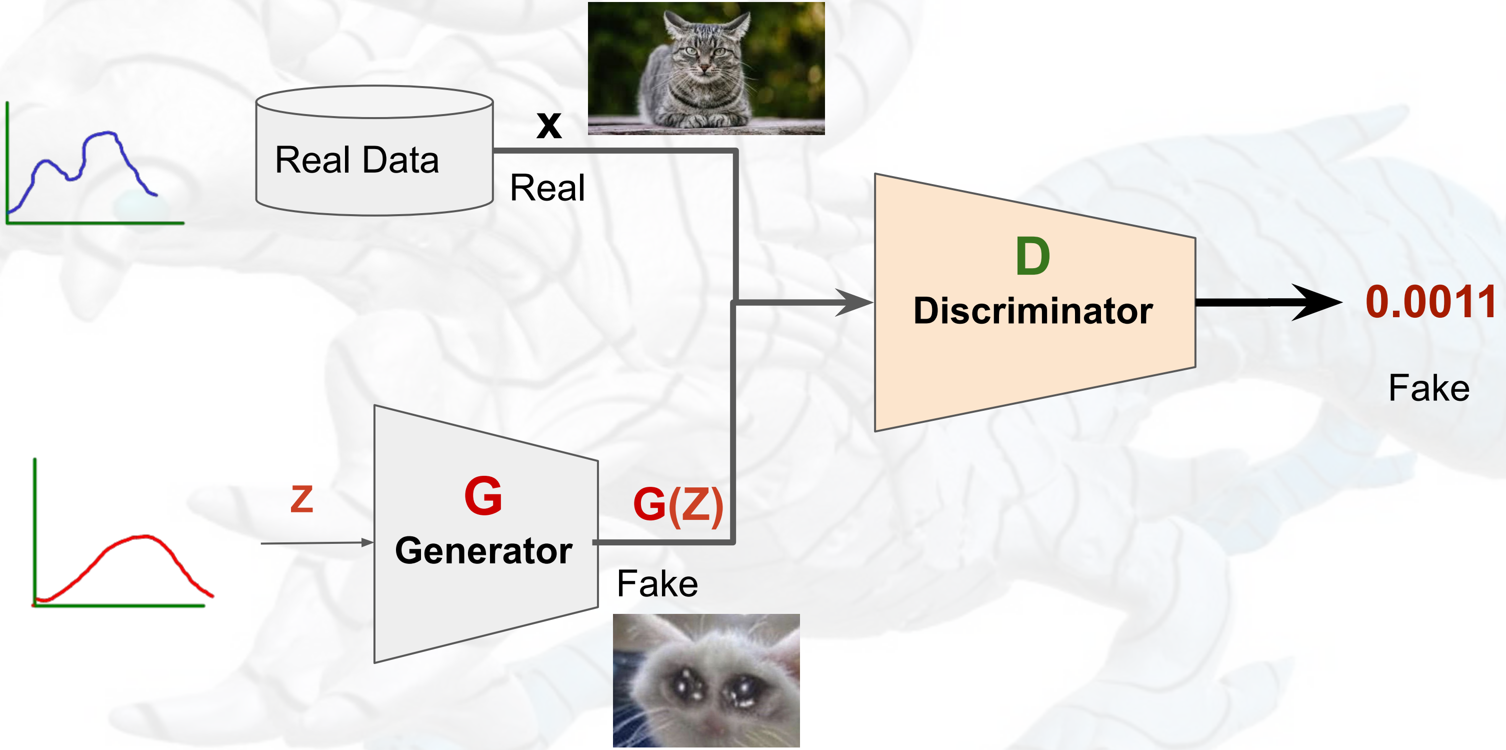
GAN


Real Data
Real
D
Discriminator
0.0011
Fake
z
G
Generator
G(Z)
Fake

GAN



GAN


Real Data
x
Real
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0.0011
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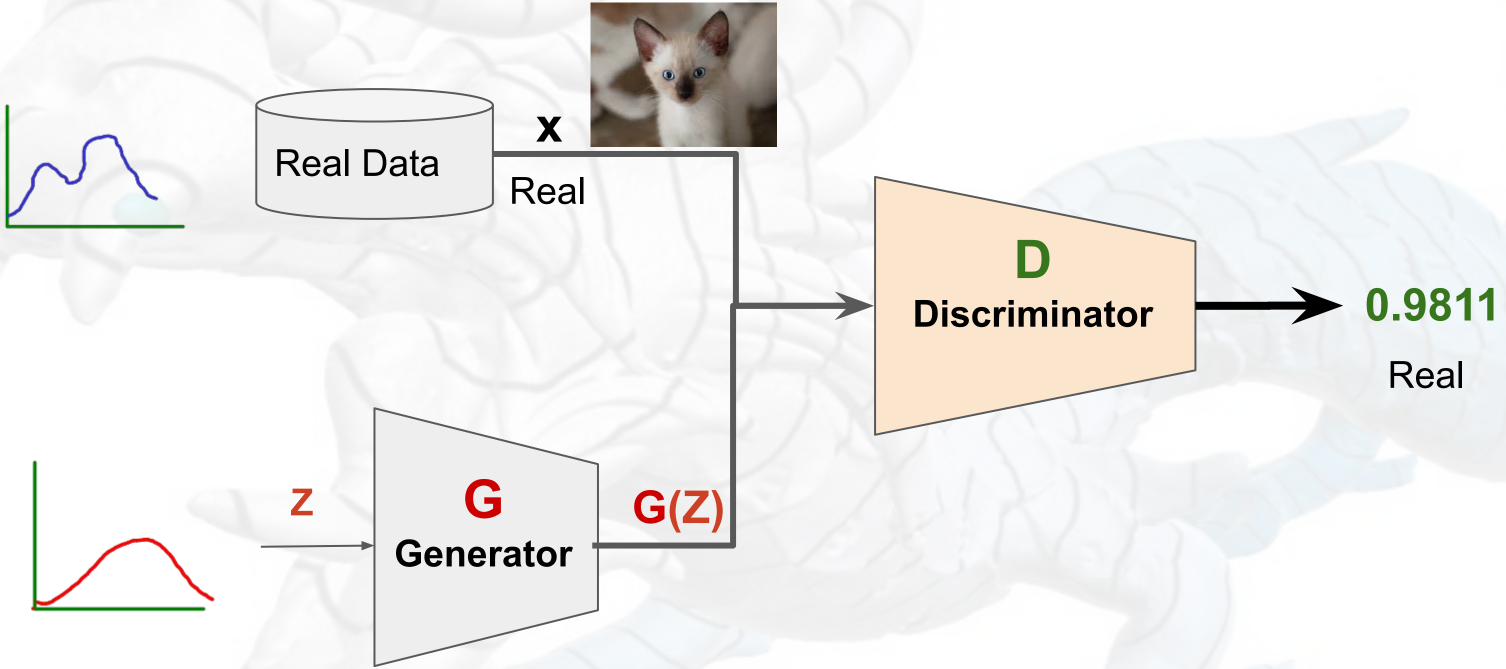
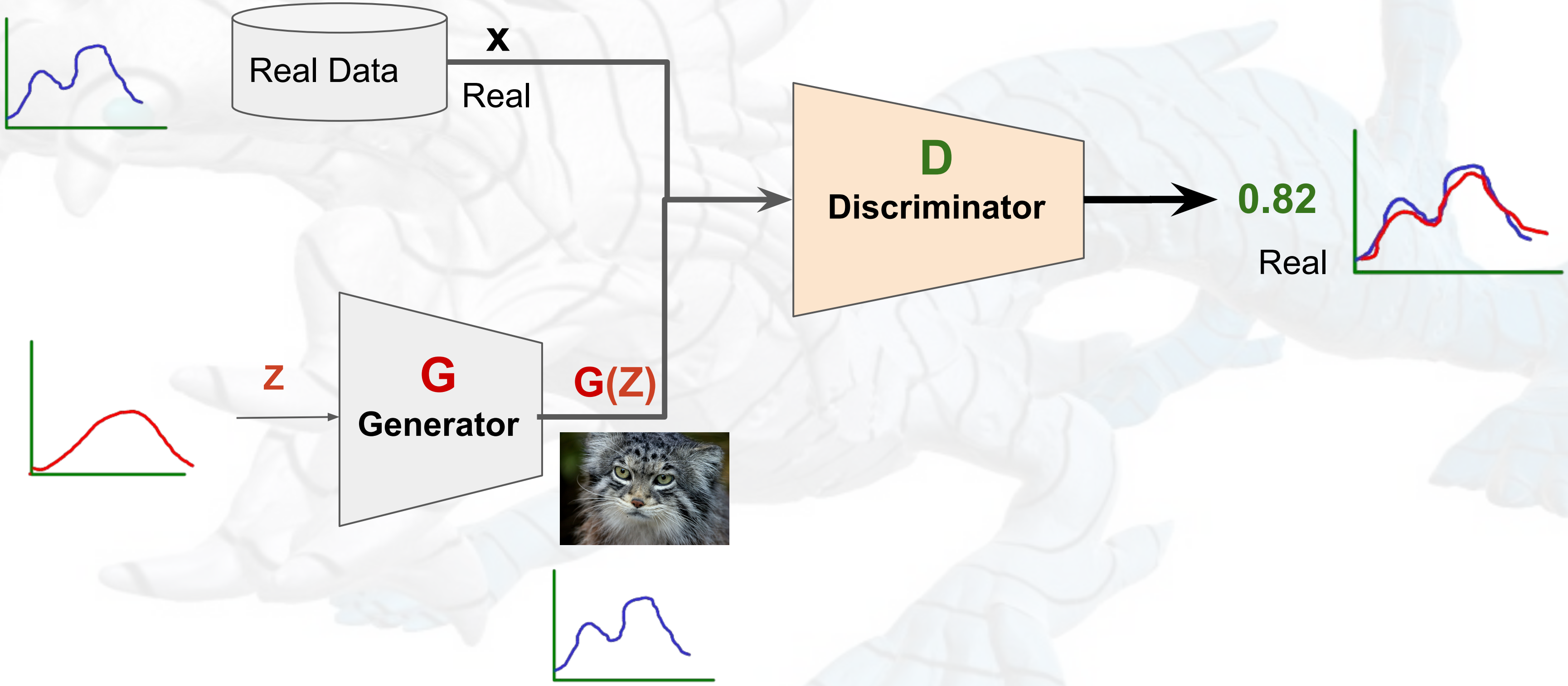
GAN



GAN



GAN: Loss Function

- Loss Function Discriminator

$$\mathcal{L}_D(\theta_D, \theta_G) = \underbrace{\boxed{-\frac{1}{2}E_{x\sim p_{data}(x)}[log(D(x))]}}_{\text{Positive classification}} \underbrace{\boxed{-\frac{1}{2}E_{z\sim p_z(x)}[log(1 - D(G(z)))]}}_{\text{Negative classification}}$$

- Loss Function Generator

$$\mathcal{L}_G(\theta_D, \theta_G) = \underbrace{\boxed{\frac{1}{2}E_{x\sim p_{data}(x)}[log(D(x))]}}_{\text{Positive classification}} \underbrace{\boxed{+\frac{1}{2}E_{z\sim p_z(x)}[log(1 - D(G(z)))]}}_{\text{Negative classification}}$$

GAN: Loss Function

$$\mathcal{L}_G(\theta_D, \theta_G) = -\mathcal{L}_D(\theta_D, \theta_G)$$

$$\boxed{\min_{G} \max_{D} = -\mathcal{L}_D(\theta_D, \theta_G)}$$

GAN: Loss Function Discriminator

$$\mathcal{L}_D(\theta_D, \theta_G) = -\frac{1}{2}E_{x\sim p_{data}(x)}[log(D(x))] - \frac{1}{2}E_{z\sim p_z(x)}[log(1 - D(G(z)))]$$

$$\mathcal{L}_D(\theta_D, \theta_G) = -\frac{1}{2}\left[\int_x p_{data}(x)log(D(x))dx + \int_z p_z(z)log(1 - D(G(z)))dz\right]$$

GAN: Loss Function Discriminator

$$\mathcal{L}_D(\theta_D, \theta_G) = -\frac{1}{2}\left[\int_x p_{data}(x)log(D(x))dx + \int_x p_G(x)log(1 - D(x))dx\right]$$

$$\mathcal{L}_D(\theta_D, \theta_G) = -\frac{1}{2}\left[\int_x p_{data}(x)log(D(x))dx + p_G(x)log(1 - D(x))dx\right]$$

$$\frac{\partial \mathcal{L}_D(\theta_D, \theta_G)}{\partial D(x)} = \frac{p_{data}(x)}{D(x)} - \frac{p_G(x)}{1 - D(x)}$$

$$\frac{p_{data}(x)}{D(x)} - \frac{p_G(x)}{1 - D(x)} = 0$$

$$\boxed{D^*(x) = \frac{p_{data}(x)}{p_{data}(x) + p_G(x)}}$$

GAN: Loss Function Discriminator

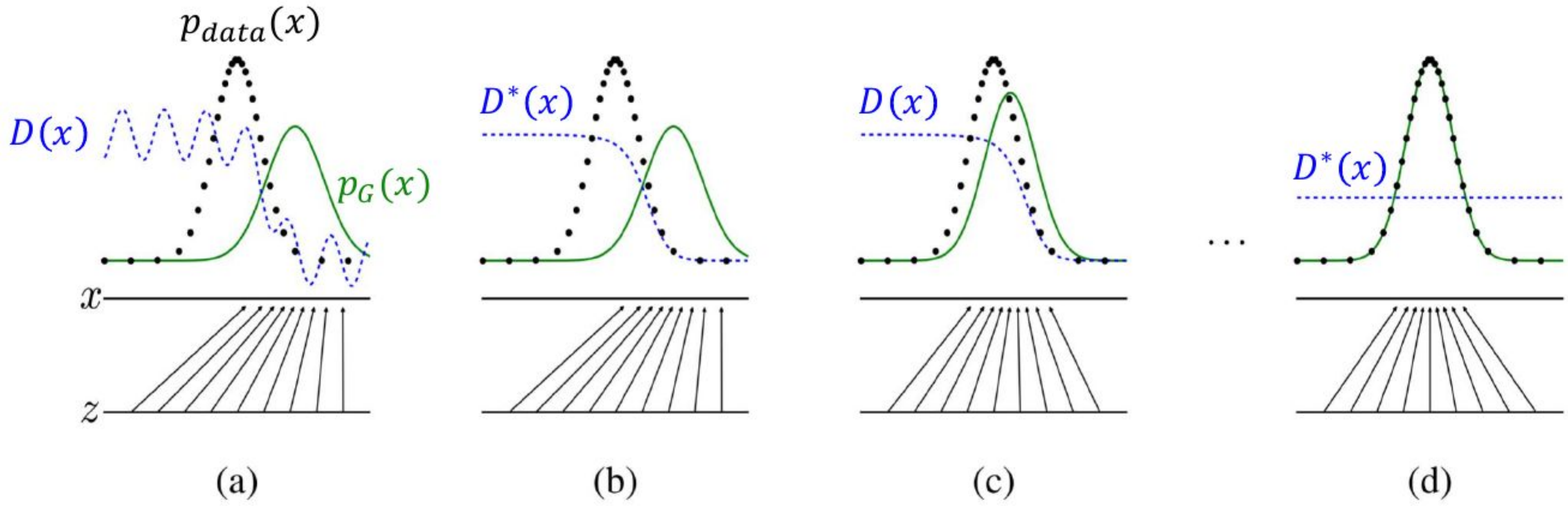
Replacing D(x) with optimo $D^*(x)$

$$\mathcal{L}_D(\theta_D, \theta_G) = -\frac{1}{2}\left[\int_x p_{data}(x) log(\frac{p_{data}(x)}{p_{data}(x) + p_g(x)})dx + p_G(x) log(\frac{p_{data}(x) + p_g(x)}{p_{data}(x)})dx\right]$$

$$\mathcal{L}_D(\theta_D, \theta_G) = -\frac{1}{2}\left[\int_x p_{data}(x) log(\frac{p_{data}(x)}{\frac{p_{data}(x)+p_g(x)}{2}})dx + p_G(x) log(\frac{p_{data}(x) + p_g(x)}{\frac{p_{data}(x)}{2}})dx - log(4)\right]$$

$$\mathcal{L}_D(\theta_D, \theta_G) = -\frac{1}{2}\left[D_{KL}\left(p_{data}(x)||\frac{p_{data}(x) + p_g(x)}{2}\right) + D_{KL}\left(p_G(x)||\frac{p_{data}(x) + p_g(x)}{2}\right) - log(4)\right]$$

GAN



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GAN

- Initialize $\theta^{(G)}, \theta^{(D)}$
- For $t = 1 : b : T$
  - Initialize $\Delta\theta^{(D)} = 0$
  - For $i = t : t + b - 1$
    - Sample $z_i \sim p(z_i)$
    - Compute $D(G(z_i)), D(x_i)$
    - $\Delta\theta_i^{(D)} \leftarrow$ Compute gradient of **Discriminator loss**, $J^{(D)}(\theta^{(G)}, \theta^{(D)})$
    - $\Delta\theta^{(D)} \leftarrow \Delta\theta^{(D)} + \Delta\theta_i^{(D)}$
  - Update $\theta^{(D)}$

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GAN

- Initialize $\Delta\theta^{(G)} = 0$
- For $j = t : t + b - 1$
  - Sample $z_j \sim p(z_j)$
  - Compute $D\left(G(z_j)\right), D(x_j)$
  - $\Delta\theta_j^{(G)} \leftarrow$ Compute gradient of **Generator loss,** $J^{(G)}\left(\theta^{(G)}, \theta^{(D)}\right)$
  - $\Delta\theta^{(G)} \leftarrow \Delta\theta^{(G)} + \Delta\theta_j^{(G)}$
- Update $\theta^{(G)}$

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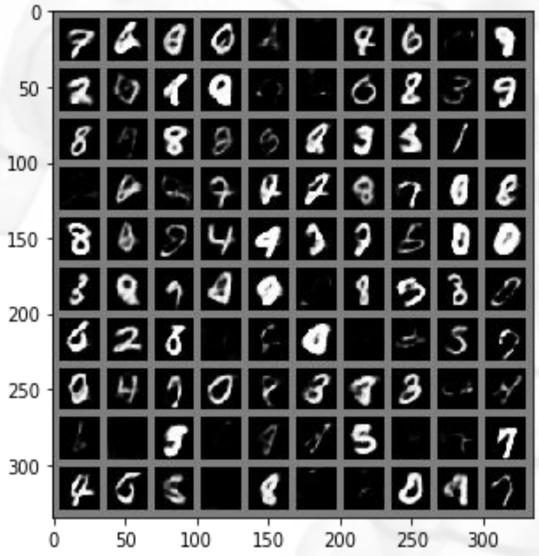
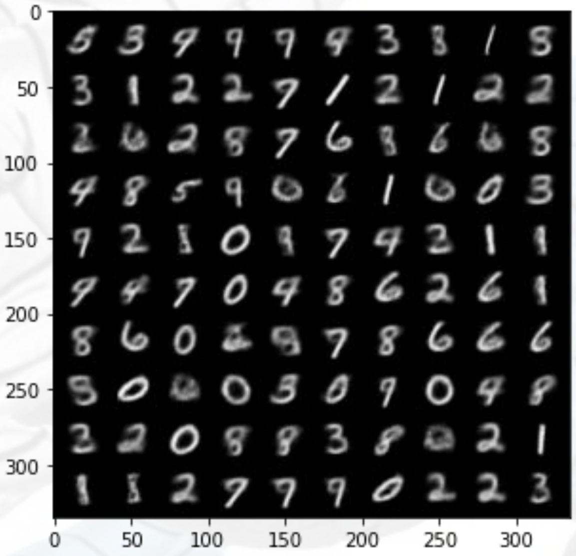
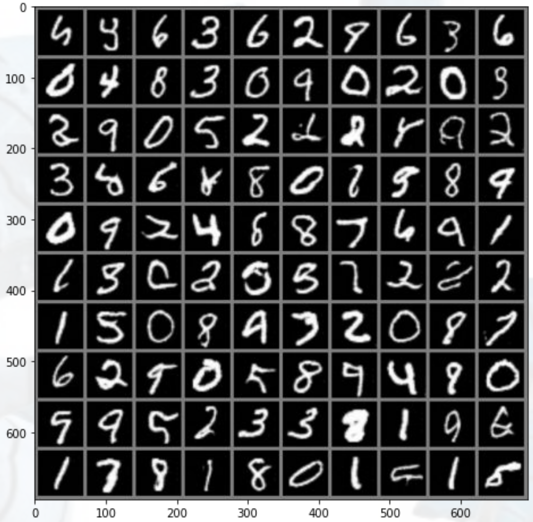
GAN



Autoencoder



VAE



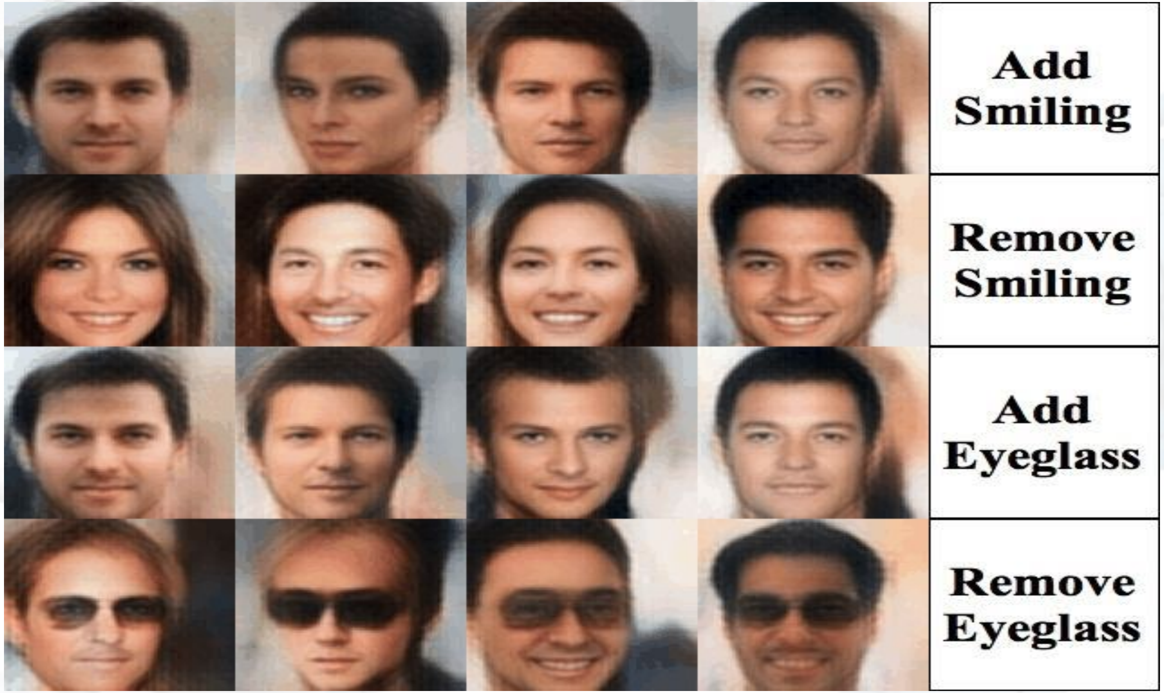
GAN

Pytorch example

GAN pytorch code example : souce click

GAN in action : source click

Applications



Fuente: https://medium.com/analytics-vidhya/an-introduction-to-generative-deep-learning-792e93d1c6d4

Applications

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IS THIS FACE REAL OR FACE?

Thank alot for your participation

Modelos Generativos
Autoencoders
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RESEARCHGROUP
IPRODAM3D

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