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Software
FORA DE SÉRIE
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2019

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Buyers
9 million
active buyers

elo7

Sellers
30 thousand
active sellers

2019

enterpreneurship
innovation
artisanship
creativity
technology
humanization
personalization
handcraft

Since maternity, Elo7 has been involved in the growth of many babies and children

1 out of 4 brides organize their wedding with Elo7

What it is like to be a data scientist at Elo7?

Creativity → Research + Product development
Study groups → Research + Product development
Autonomy → Research + Product development
Teamwork → Research + Product development

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Igor Bonadio, PhD
Computer Science
Lead Data Scientist @ Elo7

Cinthia Tanaka, PhD
Applied Math
Data Scientist @ Elo7

Samara Alves, MSc.
Statistics
Data Scientist @ Elo7

Junior A. Koch, PhD
Mathematical Physics
Data Scientist @ Elo7

Renato Cordeiro
Computer Science
ML Engineer @ Elo7

About me

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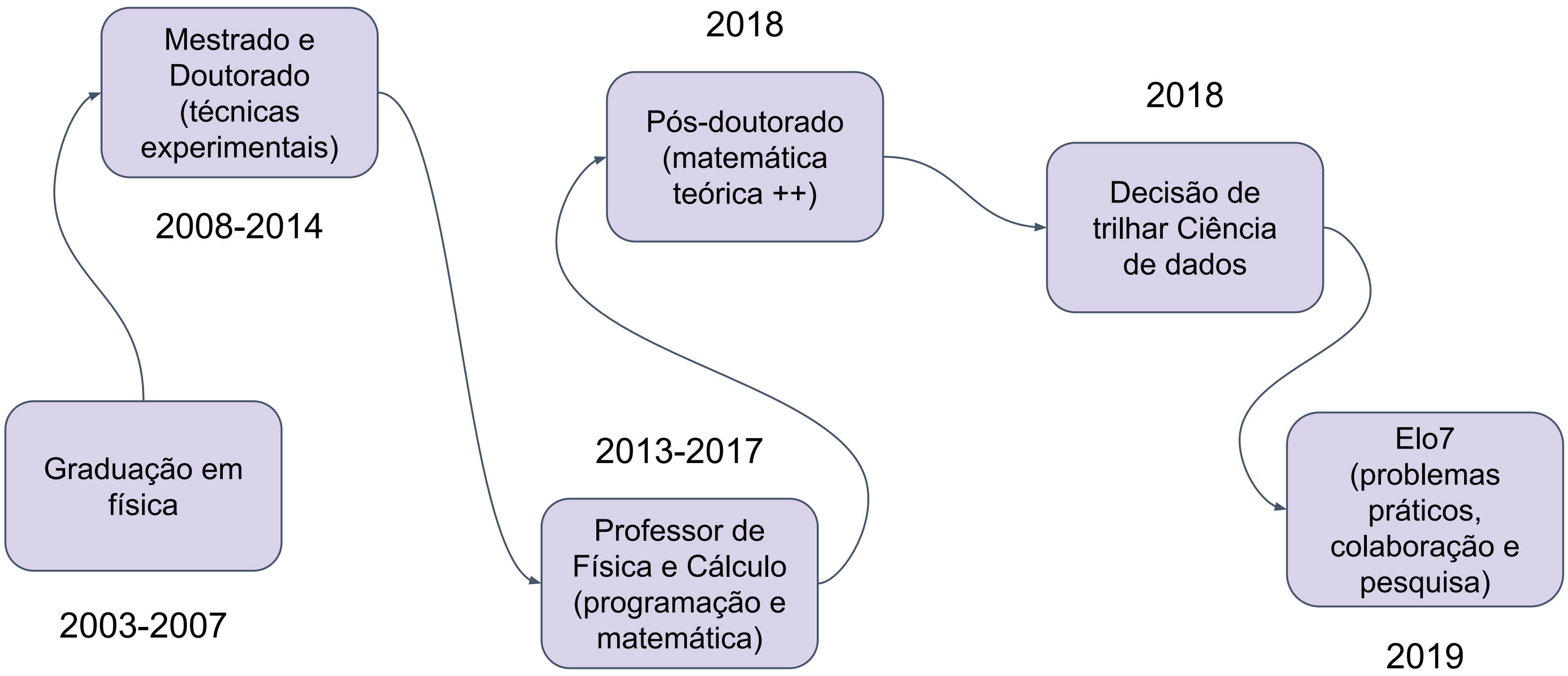

2019

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www.elo7.com.br

https://elo7.gupy.io/

Engenheir@ de Software Backend	São Paulo-SP	Full-time employee
Engenheiro de Software - DevOps	São Paulo-SP	Full-time employee
Engenheiro de Software Pleno (Nativo)	São Paulo-SP	Full-time employee
Engenheiro de Software Pleno (Nativo) - Remoto	São Paulo-SP	Full-time employee
Não encontrou uma vaga com o seu perfil? Cadastre-se aqui e faça parte do nosso banco!	São Paulo-SP	Talent pool

Modelos Geradores

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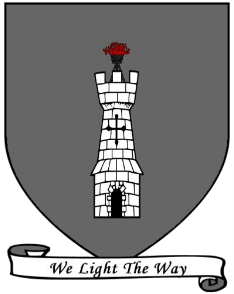
Team Hightower
PhD. Junior A. Koch
Data Scientist @ Elo7



I need data, lots of data

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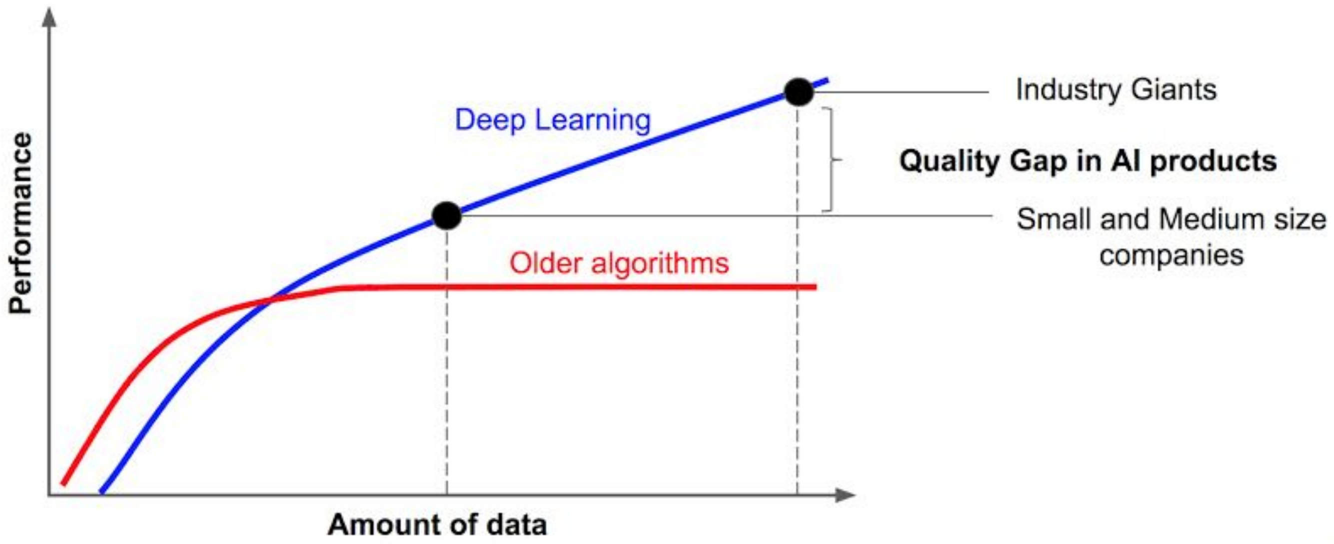

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O que é um modelo gerador?

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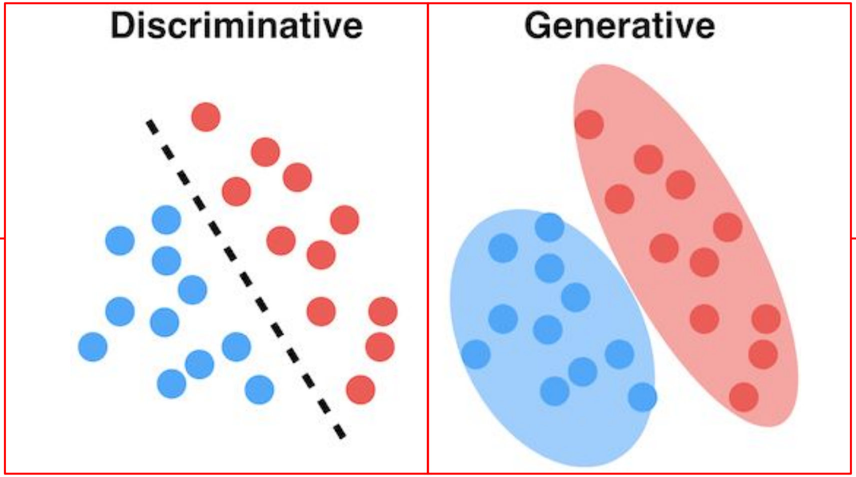

Machine learning tradicional: temos os dados e queremos uma função ou regra que categoriza os dados.

Abordagem de geradores: estamos preocupados em aprender a distribuição dos dados de cada umas das classes presentes.

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O que é um modelo gerador? Exemplo

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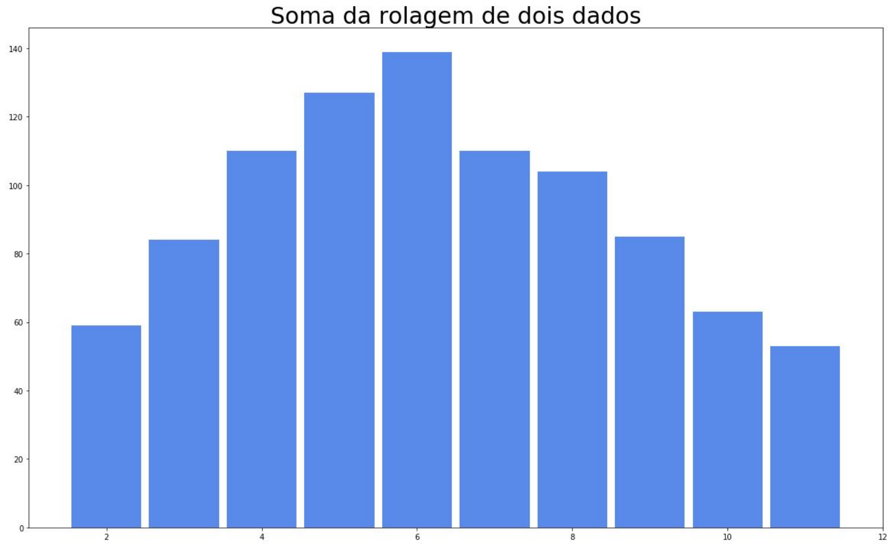

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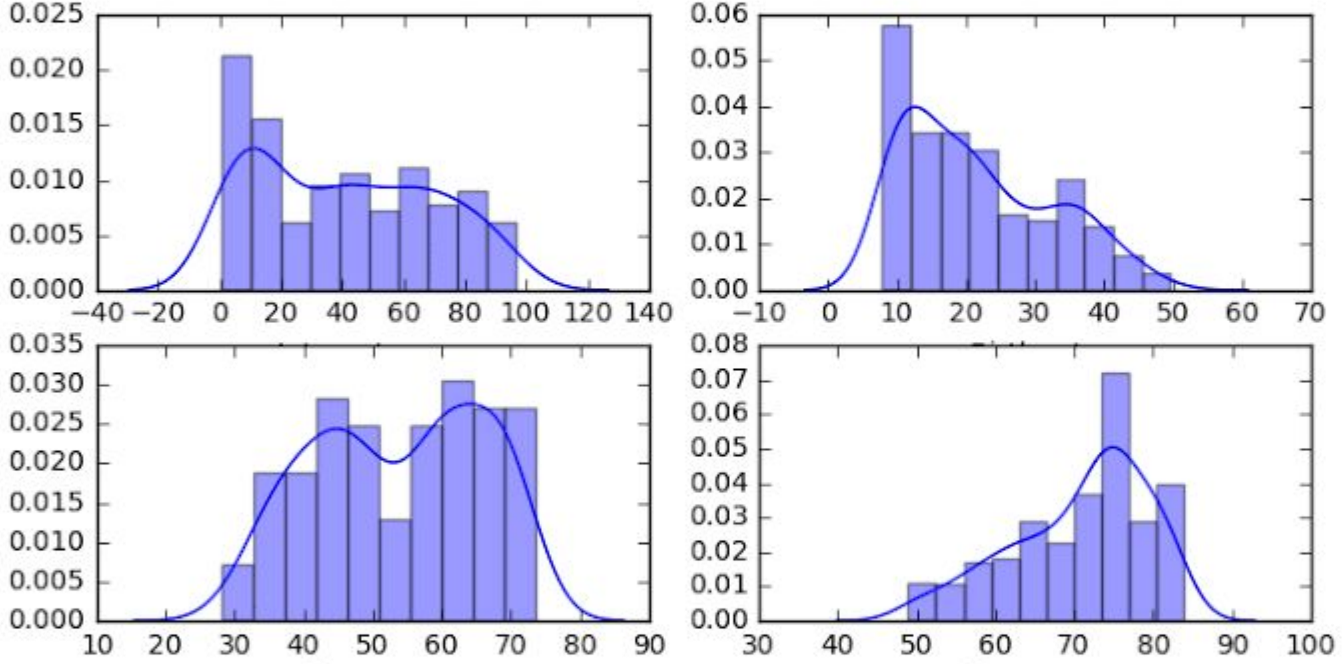
Distribuição dos dados

Preço dos produtos

Preço do frete



Idade dos compradores

Tempo mensal no site

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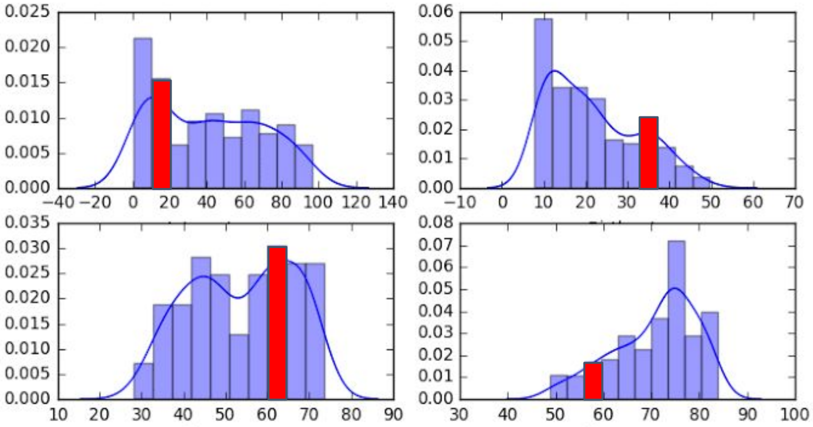
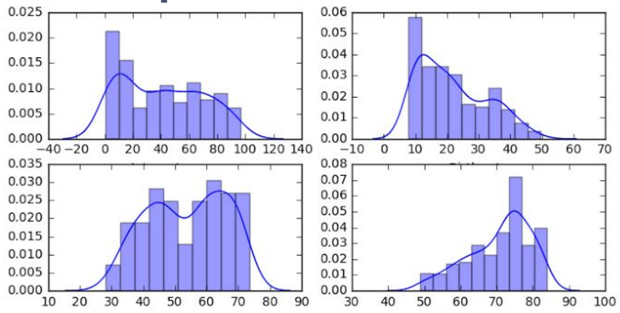
Distribuição dos dados

Amostragem de novos dados



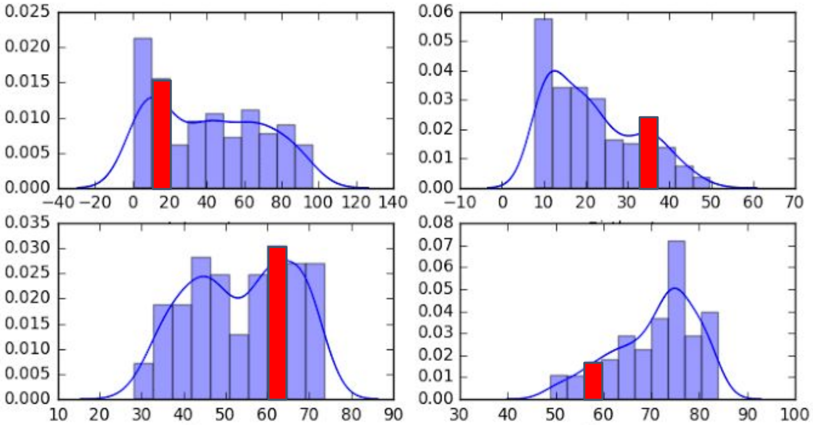
$$p_{data}(X) \Rightarrow x \sim p_{data}(X)$$



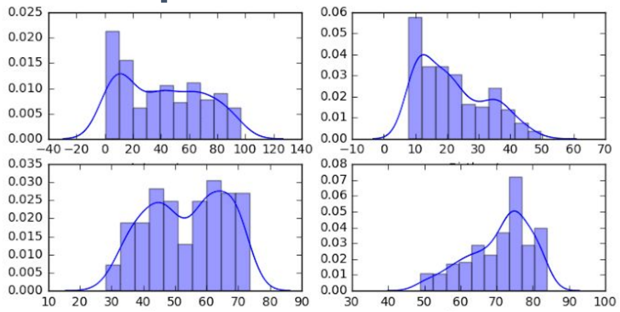
Dados originais

Distribuição dos dados

Amostragem de novos dados



$$p_{data}(X) \Rightarrow x \sim p_{data}(X, \boxed{Y})$$



Dados originais

Tipos de modelos geradores

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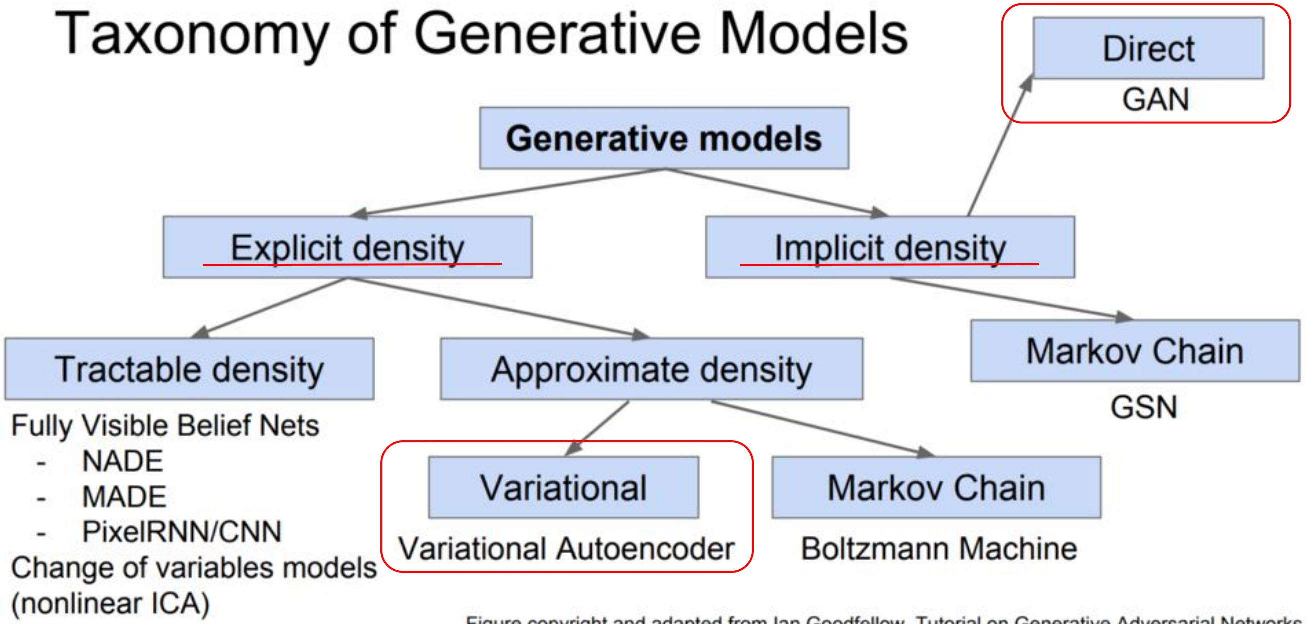

Figure copyright and adapted from Ian Goodfellow, Tutorial on Generative Adversarial Networks, 2017.

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Tipos de modelos geradores

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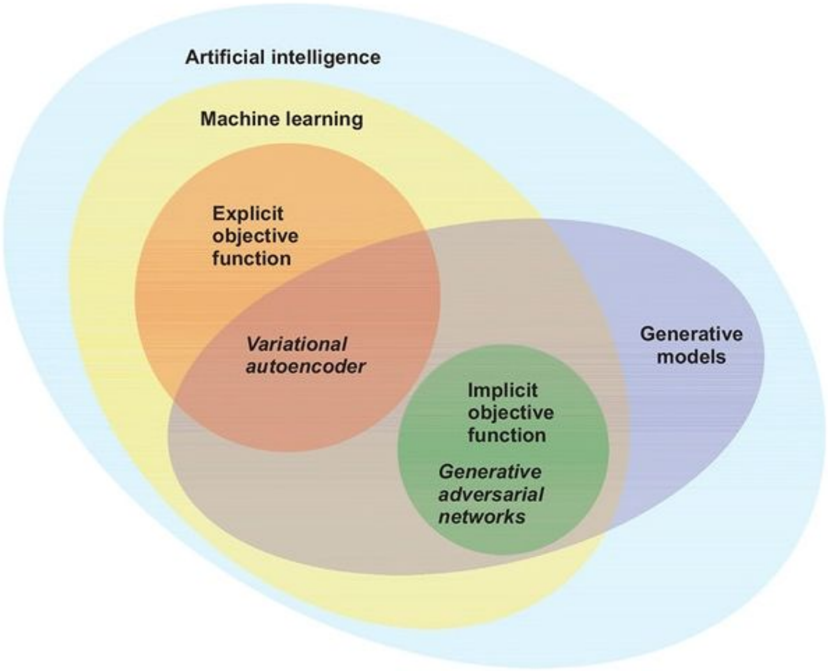

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Modelos Geradores são difíceis

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Pipeline de aprendizado comum no estudo de machine learning:

1. Basics
    1. Supervised,unsupervised,reinforcement
    2. Bias-variance trade-off
    3. Overfitting, underfitting
2. Gradient descent:
3. Linear discriminant analysis (LDA)
4. Principal Component Analysis(PCA)
5. Learning Vector Quantization (LVQ)
6. Regularization methods
7. Kernel smoothing methods
8. Ensemble learning
9. Ordinary least squares
10. ...

Por que (na minha opinião)?

1. Exige mais modelagem
2. É difícil criar uma biblioteca standard
3. Cada aplicação apresenta suas próprias peculiaridades

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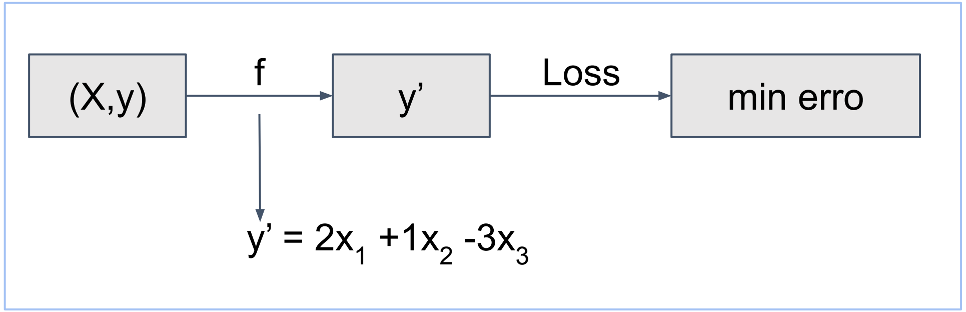
Associação e causa



Podemos dizer que **SE** aumentarmos x_1 e x_2 **então** y' vai aumentar também?

Lei zero de inferência causal:

Associação e causa são diferentes.

Em ML tradicional apenas aprendemos uma função que de adequa aos dados e isso não quer dizer que podemos inferir que as features escolhidas são a causa da variável de saída.

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Como fazer inferência causal?

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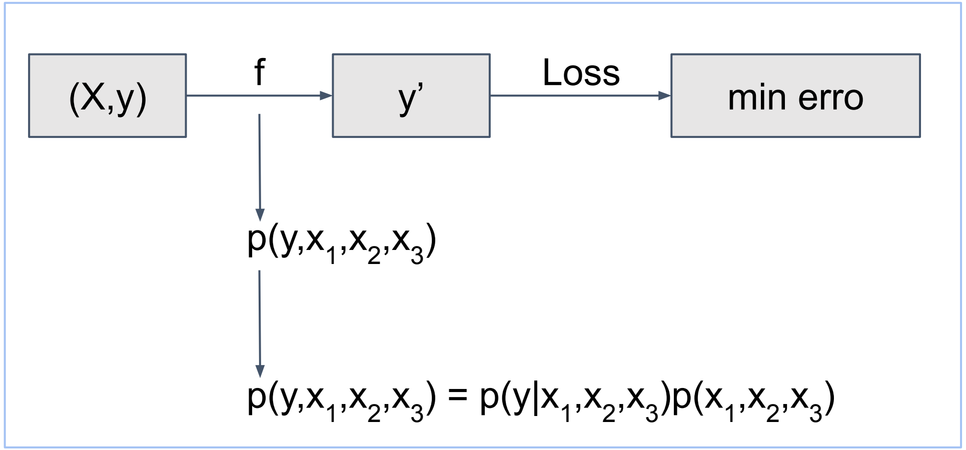
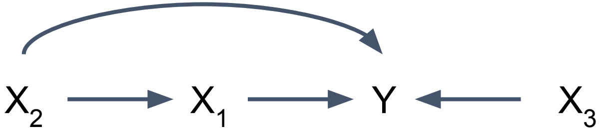


Precisamos conhecer muito bem o problema para escolher boas features e então aprender distribuições condicionais para o grafo causal escolhido.

Nota: podemos fazer tudo isso e perceber que não foi suficiente.

Exemplo de gráfico causal:



Wasserman, Larry. *All of statistics: a concise course in statistical inference*. Springer Science & Business Media, 2013.

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Dependência entre características dos dados

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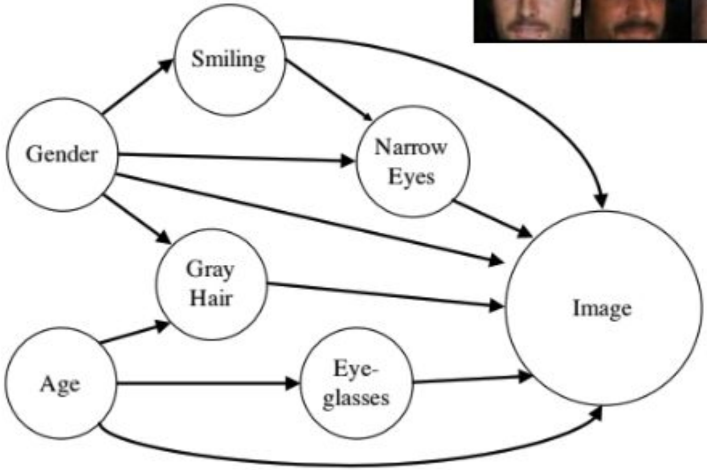

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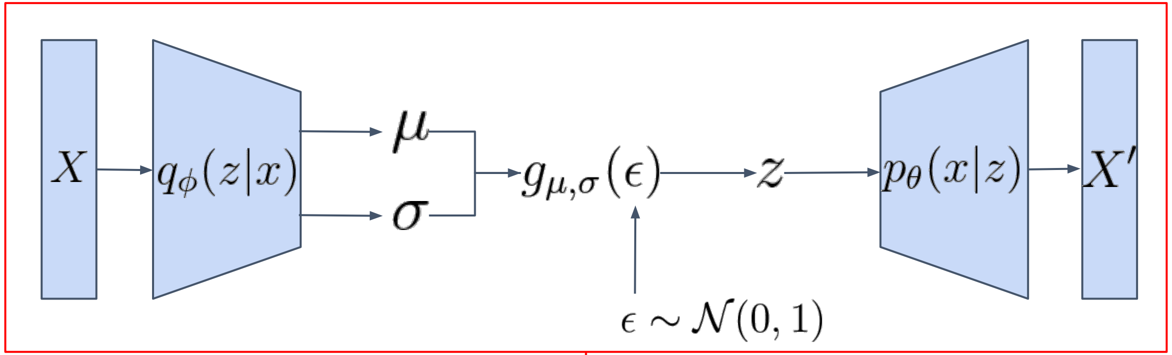
Kocaoglu, Murat, et al. "Causalgan: Learning causal implicit generative models with adversarial training." *arXiv preprint arXiv:1709.02023* (2017).

Variational Autoencoder



$$Loss = \mathbb{E}\left[\log p(x|z)\right] - KL\left[q(z|x)||p(z)\right]$$

$$min \begin{cases} \mathbb{E}\left[\log p(x|z)\right] \rightarrow \text{cross entropy}(x, x') \\ KL\left[q(z|x)||p(z)\right] \rightarrow \dfrac{1}{2}\sum_n \left(e^\sigma + \mu^2 - 1 - \sigma\right) \end{cases}$$

Kingma, Diederik P., and Max Welling. "Auto-encoding variational bayes." *arXiv preprint arXiv:1312.6114* (2013).

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Variational Autoencoder

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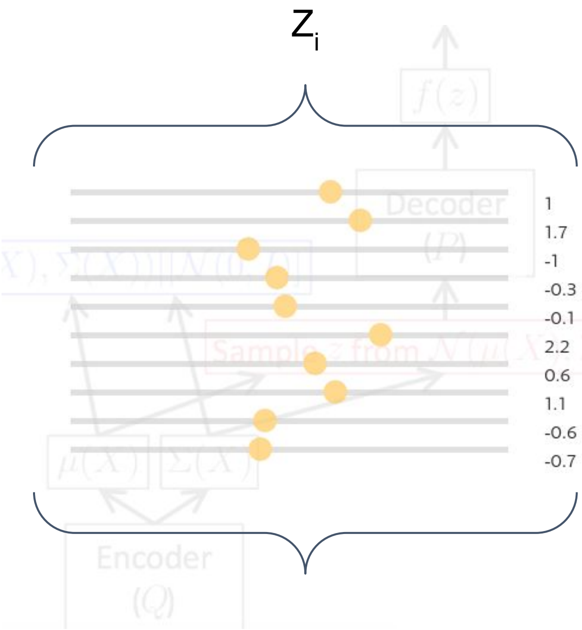

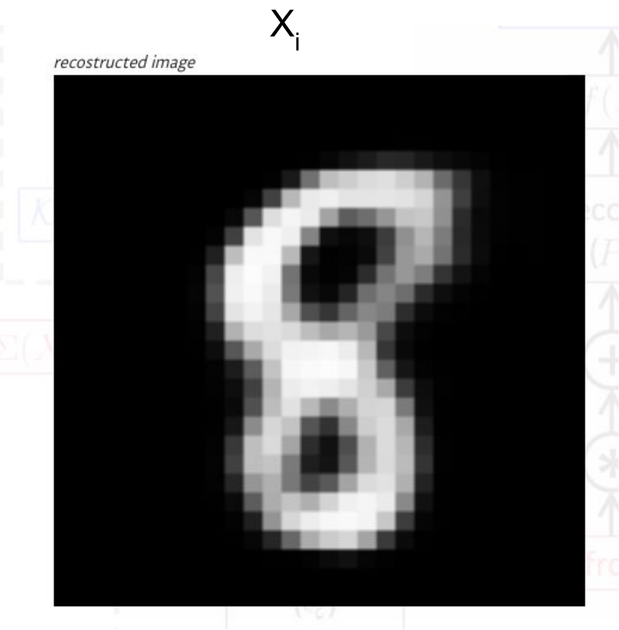

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GANs e Treino Adversarial

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Team Hightower
PhD. Junior A. Koch
Data Scientist @ Elo7

Por que GANs?

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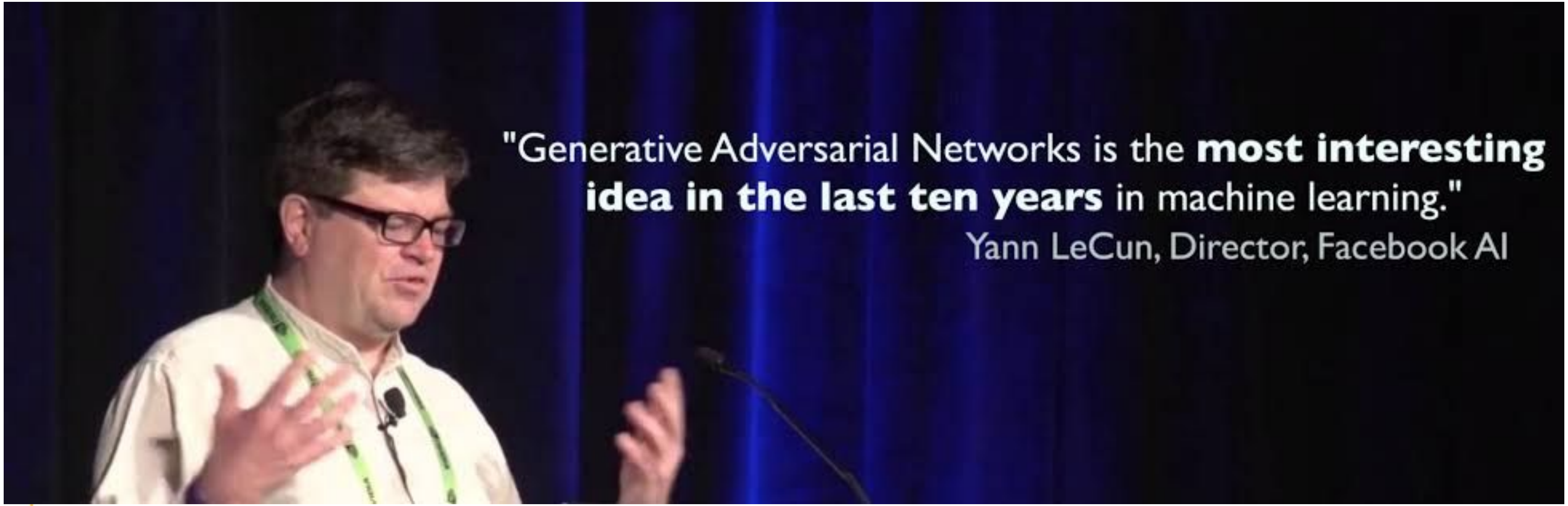
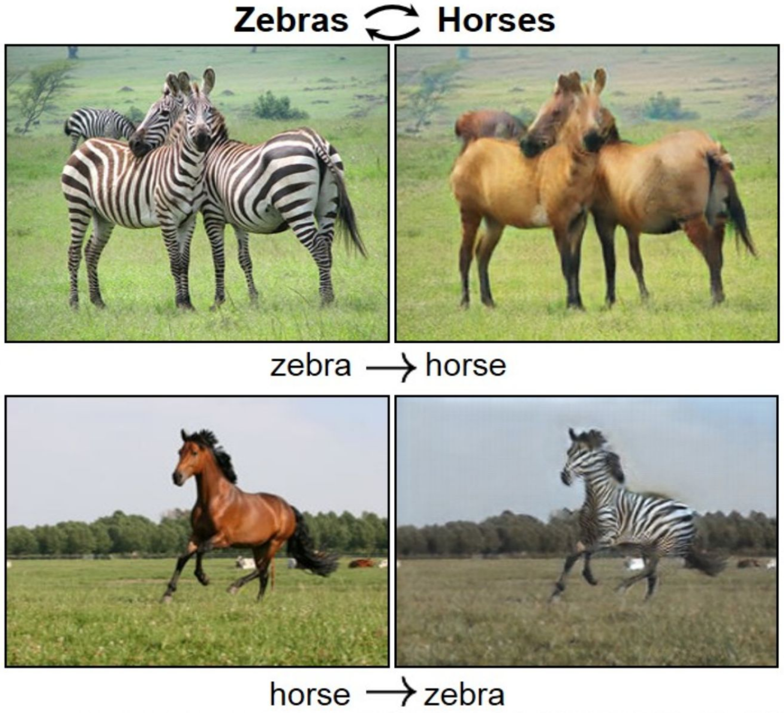


Aplicações: CycleGAN

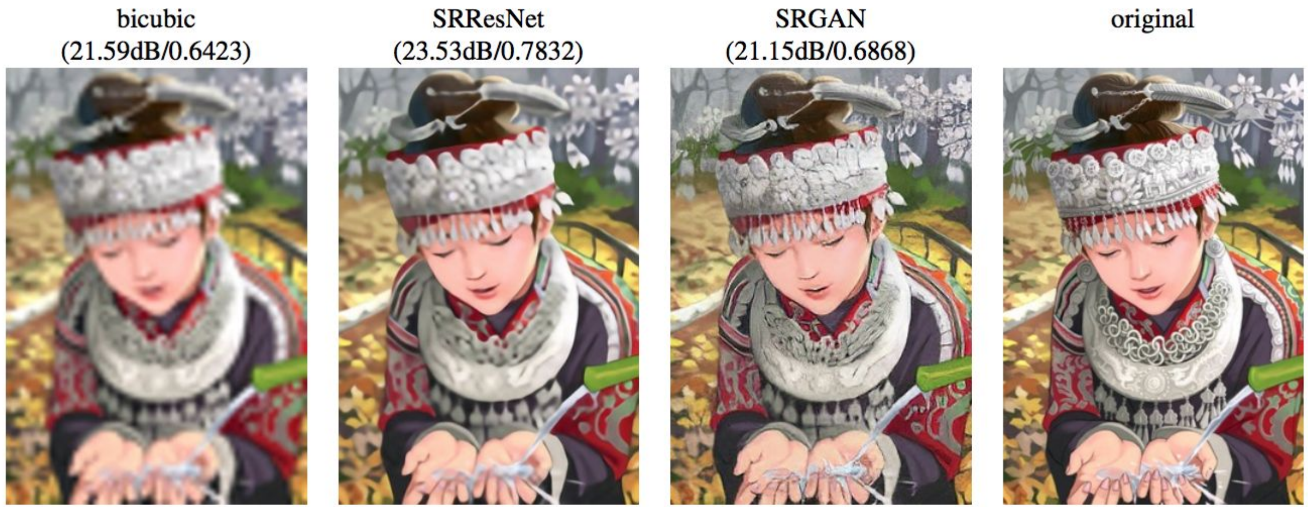
Zhu, Jun-Yan, et al. "Unpaired image-to-image translation using cycle-consistent adversarial networks." *Proceedings of the IEEE international conference on computer vision*. 2017.

Text description	this large yellow blossom has numerous yellow stamen and hundreds of very thin yellow petals.	this white flower has rounded petals and a yellow orange stamen.	this flower is purple in color, and has petals that are very skinny.	this flower is yellow in color, and has petals that are rounded and curled around the center.	the flower has pointed pale pink petals and several white anthers.	the flower has yellow petals with a yellow stigma and green pedicel.	this flower has petals that are yellow and has red dots
Stage-2 images							
Stage-2 with cycle consistency							
Generated Captions	this flower has petals that are yellow and very thin	this flower has petals that are white with yellow lines	this flower has petals that are pink and has purple dots	this flower has petals that are orange and has yellow edges	this flower has petals that are pink with white shading	this flower has petals that are yellow and has yellow stamen	this flower has petals that are red and has yellow tips



Aplicações: SRGAN

elo7



Ledig, Christian, et al. "Photo-realistic single image super-resolution using a generative adversarial network." *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2017.

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Aplicações: InfoGAN

elo7

Chen, Xi, et al. "Infogan: Interpretable representation learning by information maximizing generative adversarial nets." *Advances in neural information processing systems*. 2016.

(a) Azimuth (pose) (b) Elevation

(c) Lighting (d) Wide or Narrow

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Dados reais ou falsos?

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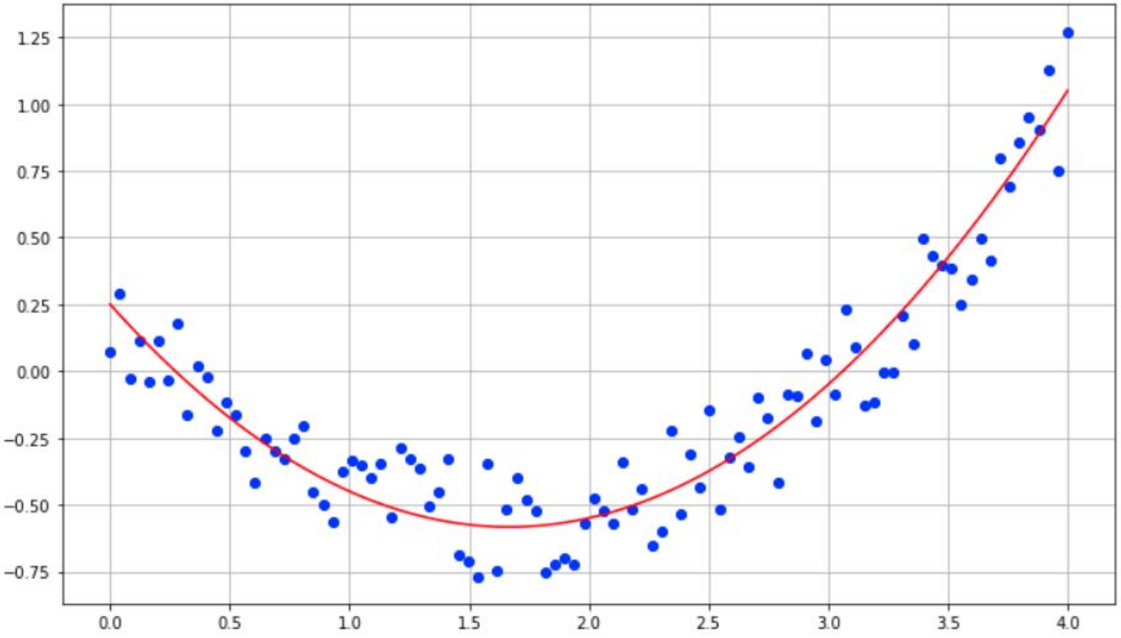

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Dados reais ou falsos?

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Nome	Entrada 1	Saída 1	Entrada 2	Saída 2
John The Armless	09:03	11:47	13:05	18:15
John The Armless	08:40	12:03	12:54	17:50
John The Armless	09:05	11:50	13:15	19:12
John The Armless	10:20	11:55	13:04	18:39

Nome	Entrada 1	Saída 1	Entrada 2	Saída 2
John The Armless	09:00	12:00	13:00	18:00
John The Armless	09:00	12:00	13:00	18:00
John The Armless	09:00	12:00	13:00	18:00
John The Armless	09:00	12:00	13:00	18:00

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Real ou Falso?

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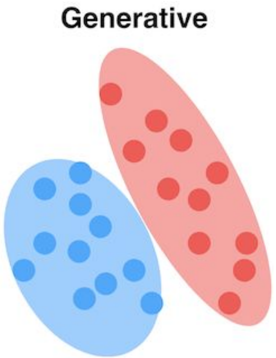
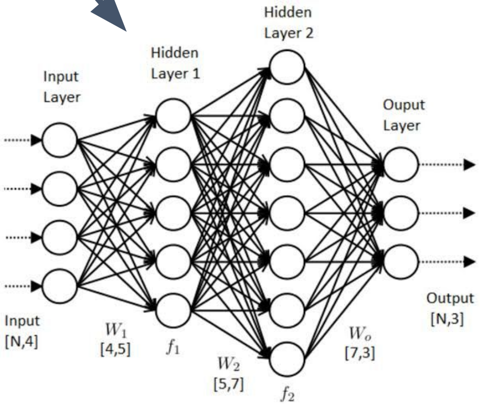
Generative Adversarial Networks





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The GANfather - Ian Goodfellow, 2014

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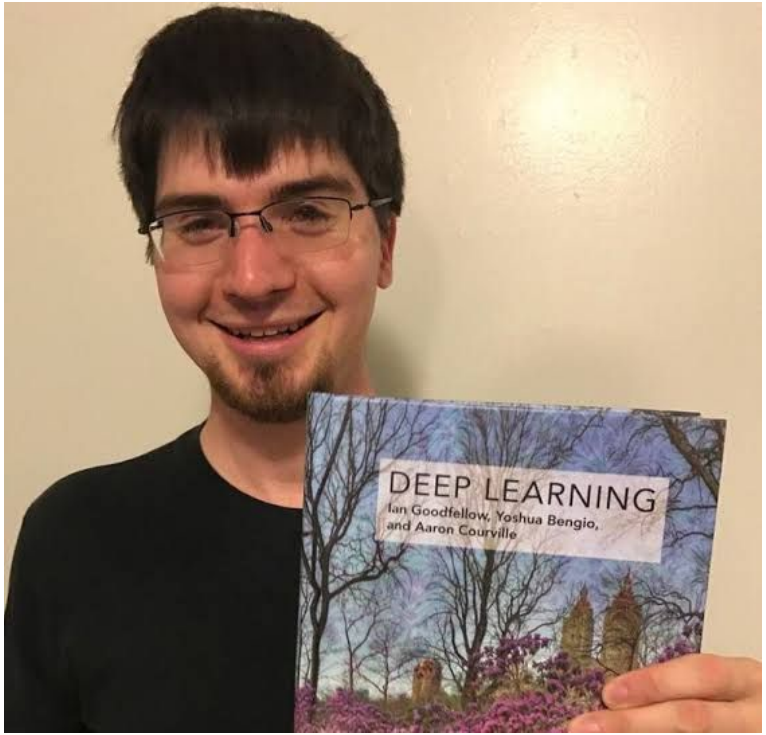

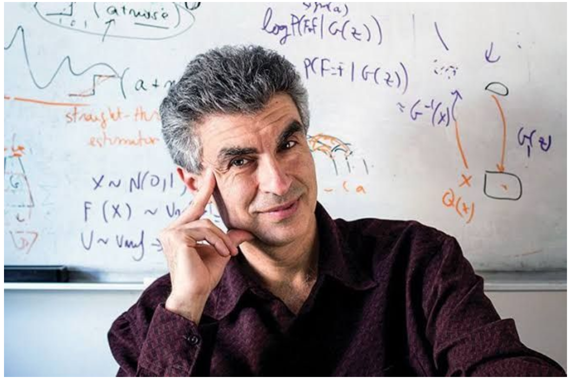

Yoshua Bengio

Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep learning*. MIT press, 2016.

Let`s play a game

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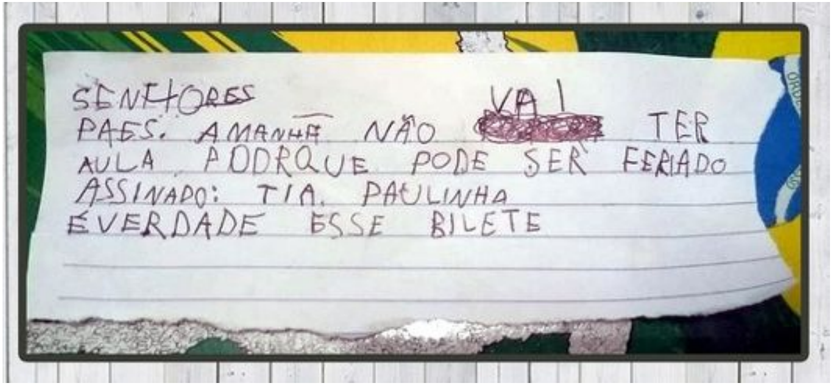

Investigador - Discriminador

Falsificador - Gerador

Adversarial Training

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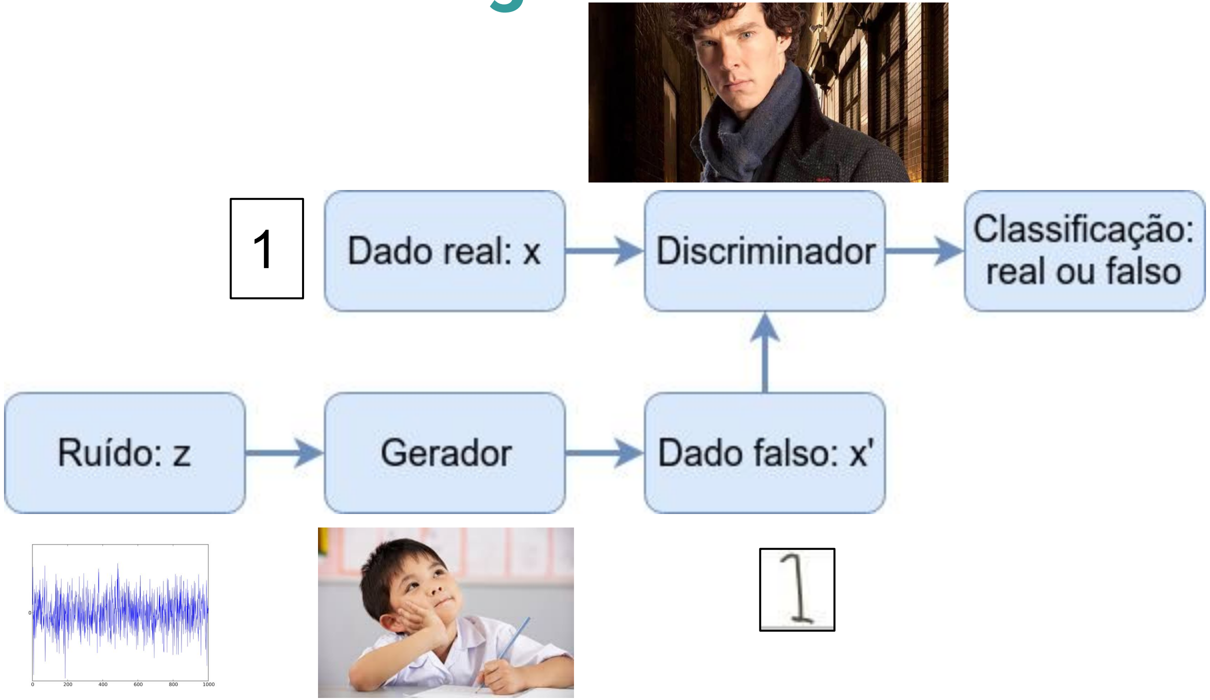

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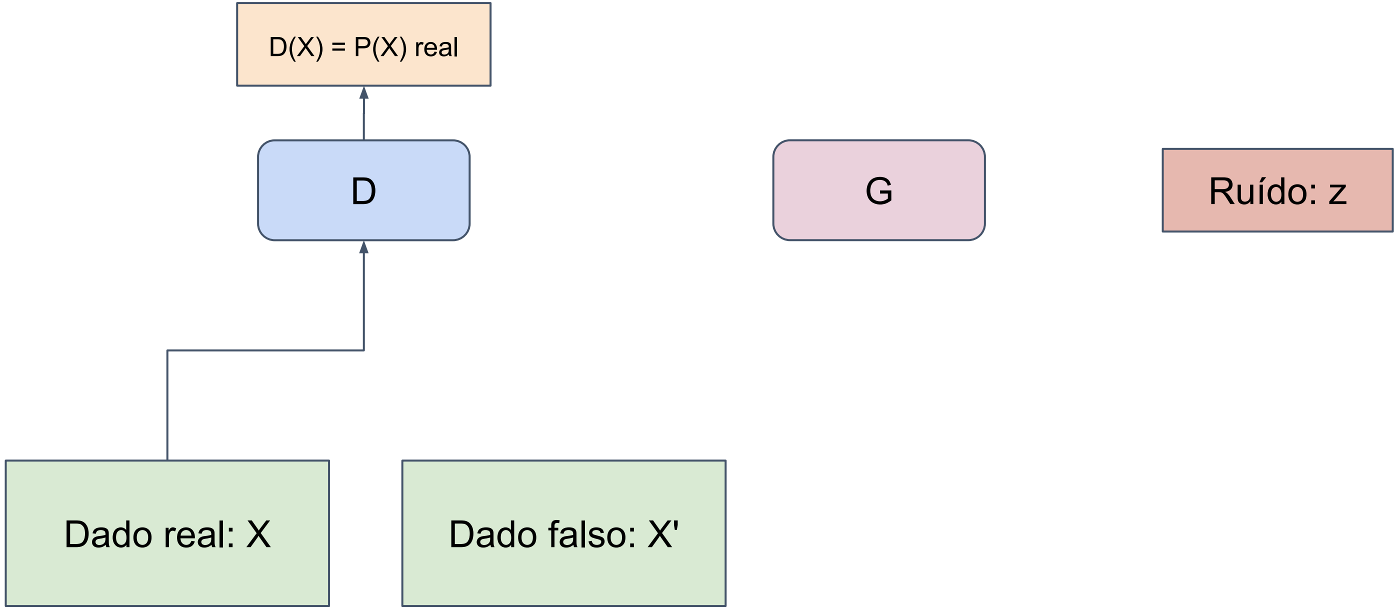
Adversarial Training

Etapa 1: dados reais



Adversarial Training

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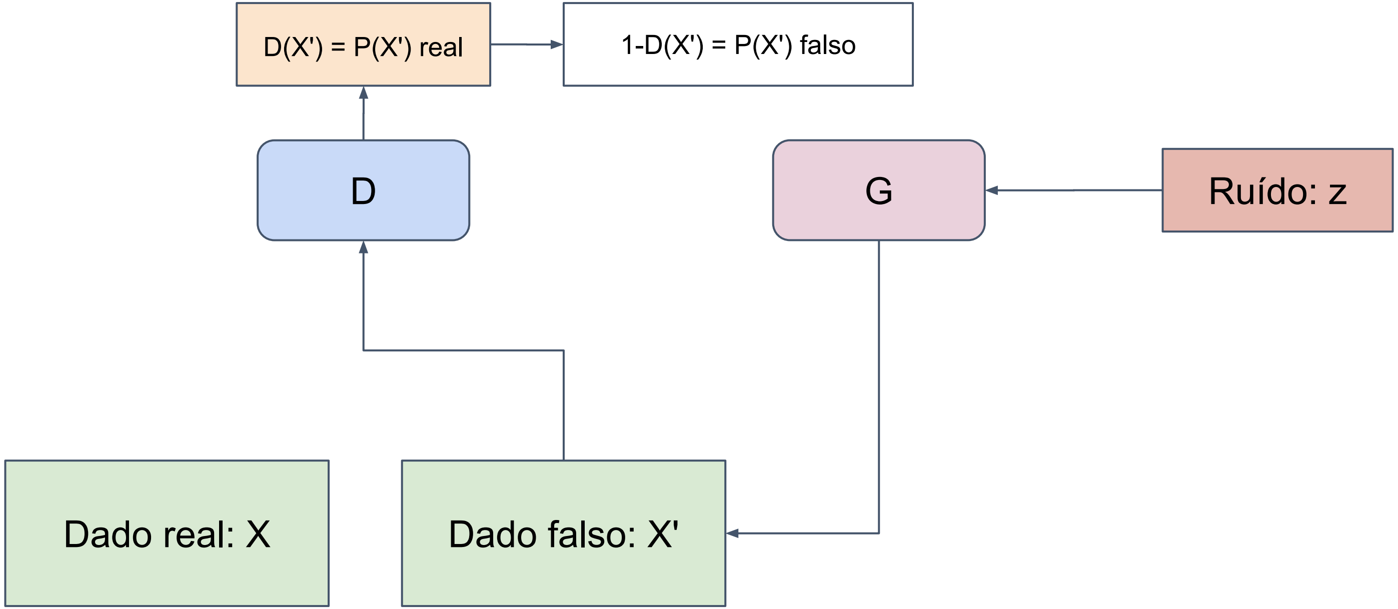
Etapa 2: dados falsos



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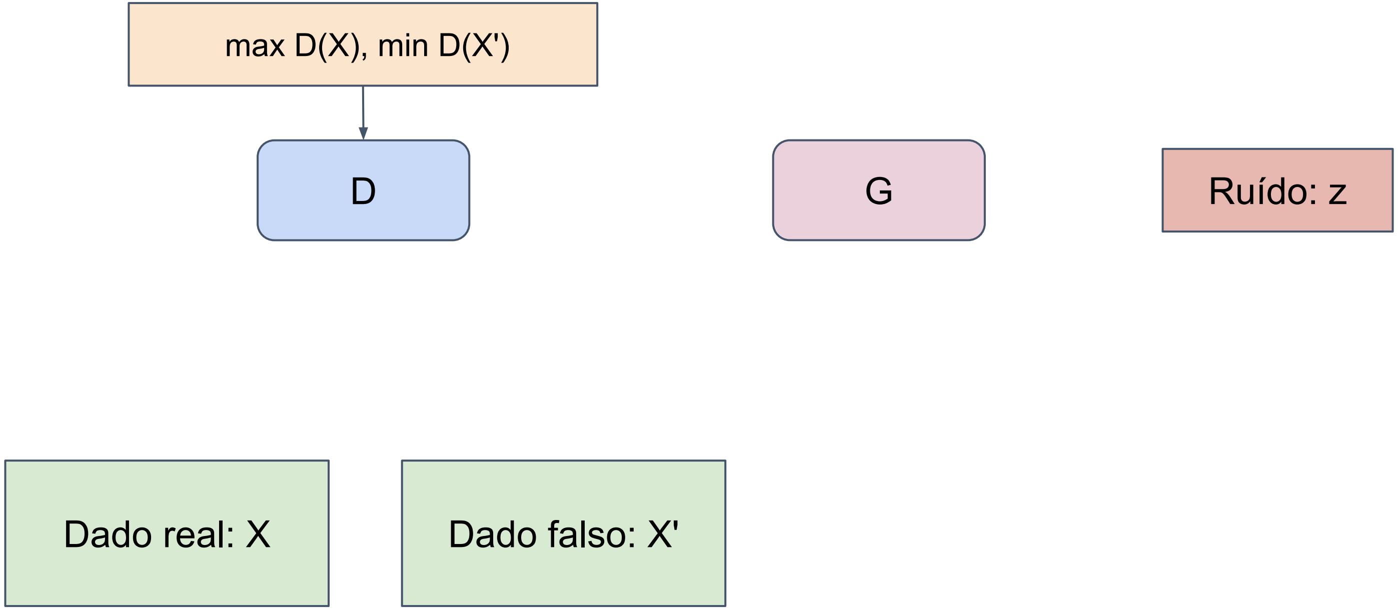
Adversarial Training

Etapa 3: treino do discriminador



Adversarial Training

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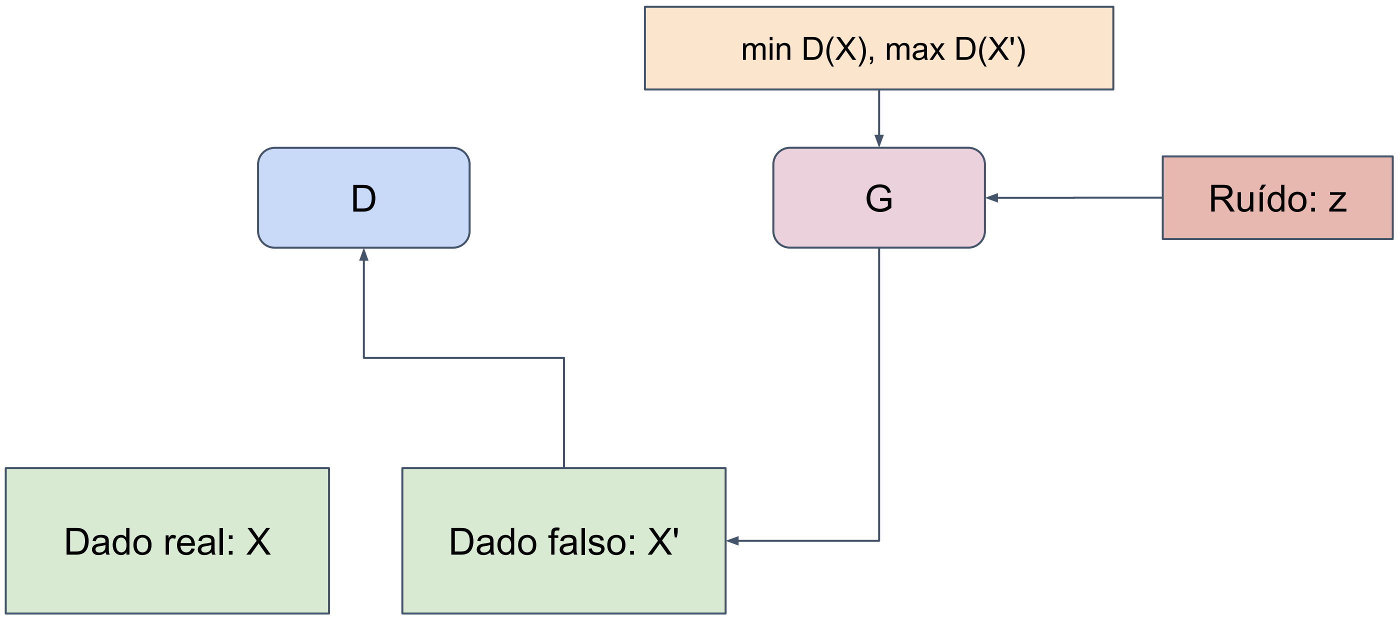
Etapa 4: treino do gerador



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Adversarial Training

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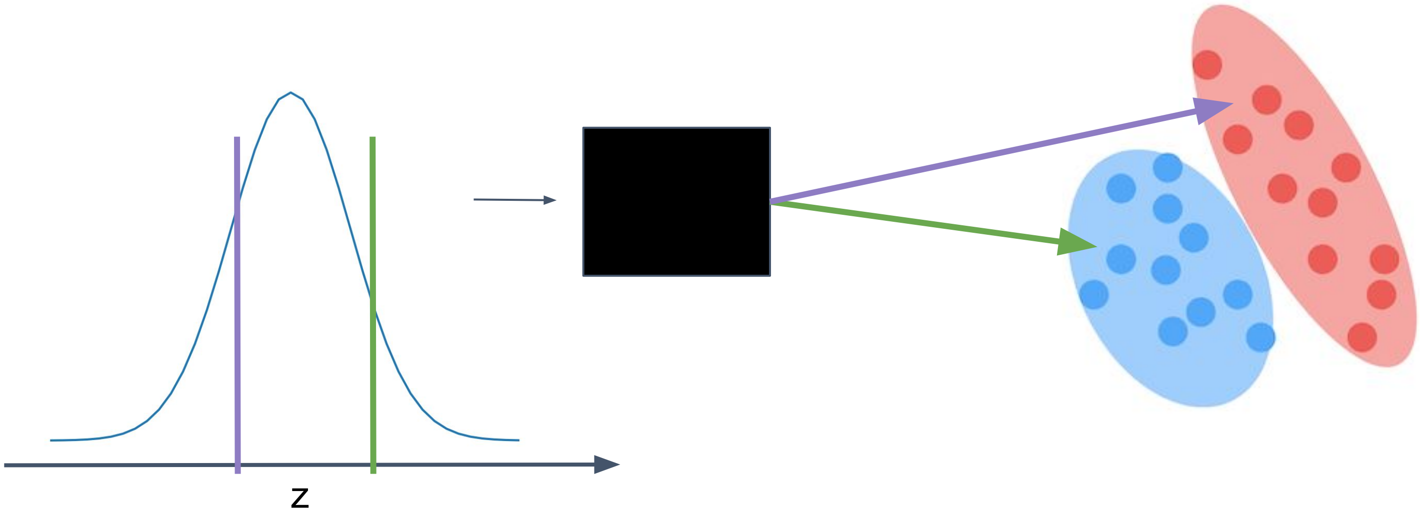

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Adversarial Training

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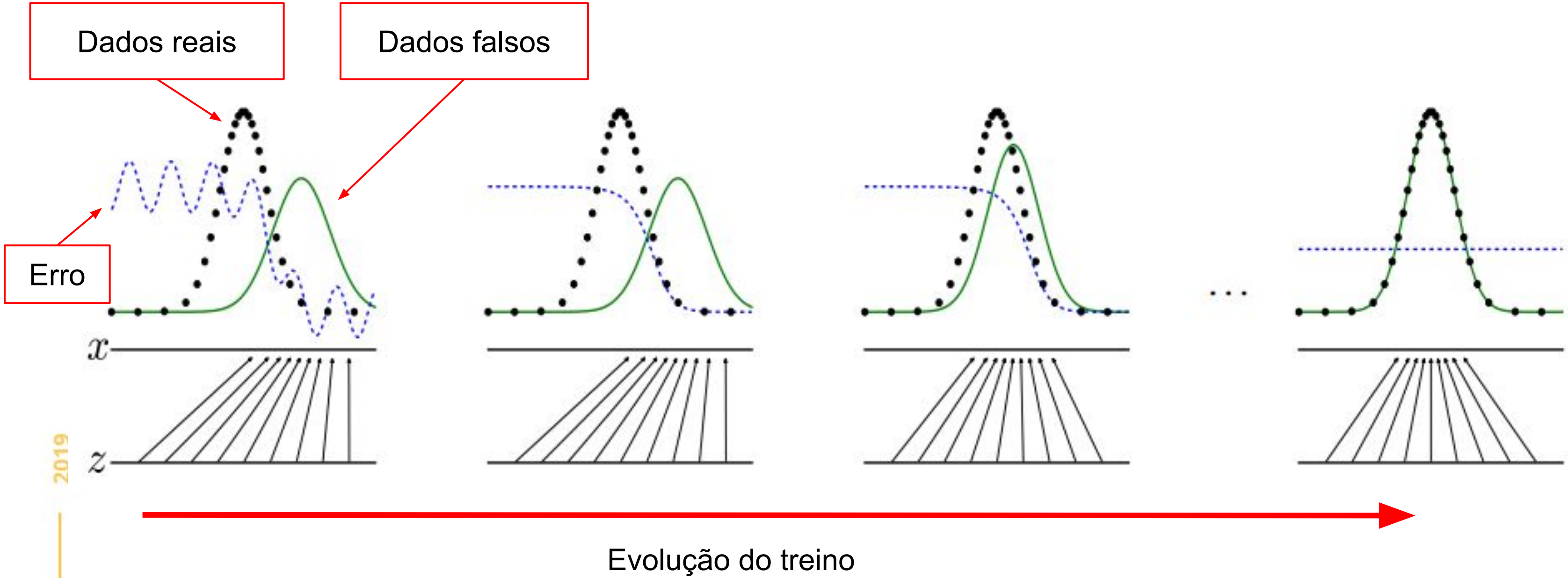

2019

https://cs.stanford.edu/people/karpathy/gan/

Loss - MinMax Game

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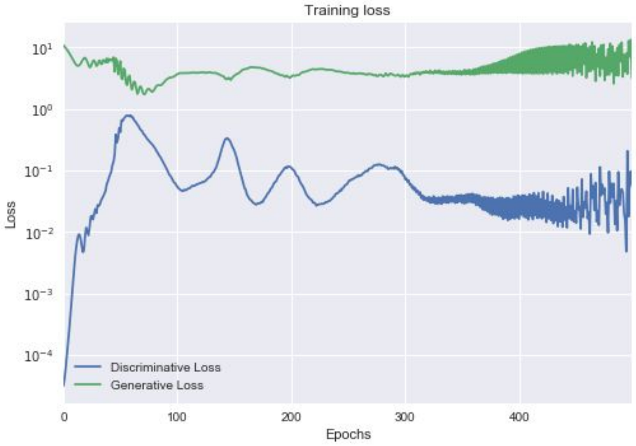
$$min_G \ max_D \ V(D,G) = \mathbb{E}_{x \sim P_{data}}[log D(x)] + \mathbb{E}_{z \sim noise}[log(1 - D(G(z)))]$$

D: tenta maximizar a probabilidade de X ser real e G(z) ser falso

G: tenta minimizar a probabilidade de X real e G(z) ser falso

```
for epoch in epochs:
  prob_X_real = D(X)
  prob_X_fake = D(G(z))
  loss_D = max{log(prob_X_real) + log(1-prob_X_fake)}
  loss_G = min{log(prob_X_real) + log(1-prob_X_fake)}
```



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Adversarial Training

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O primeiro desafio: instabilidade

$J_D - J_G = 0$

$$
\begin{aligned}
C(G) &= \max_D V(G, D) \\
&= \mathbb{E}_{\boldsymbol{x} \sim p_{\text{data}}}[\log D_G^*(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{z} \sim p_{\boldsymbol{z}}}[\log(1 - D_G^*(G(\boldsymbol{z})))] \\
&= \mathbb{E}_{\boldsymbol{x} \sim p_{\text{data}}}[\log D_G^*(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{x} \sim p_g}[\log(1 - D_G^*(\boldsymbol{x}))] \\
&= \mathbb{E}_{\boldsymbol{x} \sim p_{\text{data}}}\left[\log \frac{p_{\text{data}}(\boldsymbol{x})}{P_{\text{data}}(\boldsymbol{x}) + p_g(\boldsymbol{x})}\right] + \mathbb{E}_{\boldsymbol{x} \sim p_g}\left[\log \frac{p_g(\boldsymbol{x})}{p_{\text{data}}(\boldsymbol{x}) + p_g(\boldsymbol{x})}\right]
\end{aligned}
$$

$$\text{No equilíbrio: } p_{data}(x) = \frac{1}{2} \text{ e } p_g(x) = \frac{1}{2}$$

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Loss - Non Saturating GAN (NSGAN)

$$max_D \, V(D,G) = \mathbb{E}_{x \sim P_{data}} [\log D(x)] + \mathbb{E}_{z \sim noise} [\log (1 - D(G(z)))]$$

$$max_G \, V(D,G) = \mathbb{E}_{z \sim noise} [\log D(G(z))]$$

D: tenta maximizar a probabilidade de X ser real e G(z) ser falso

G: tenta maximizar a probabilidade de G(z) ser real

```
for epoch in epochs:
  prob_X_real = D(X)
  prob_X_fake = D(G(z))
  loss_D = max{log(prob_X_real) + log(1-prob_X_fake)}
  loss_G = max{log(prob_X_fake)}
```

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GAN Zoo

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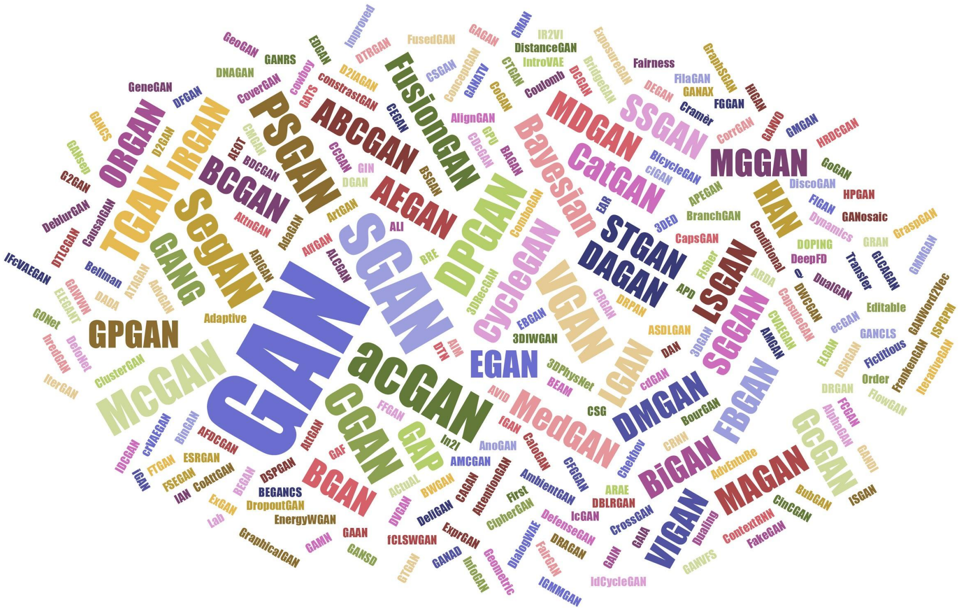
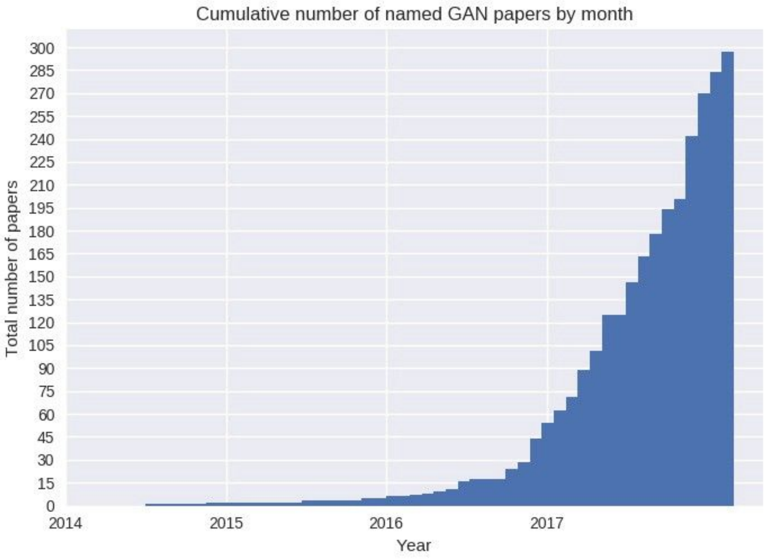

GAN
SGAN
acGAN
McGAN
CGAN
VGAN
DPGAN
PSGAN
FusionGAN
ABCGAN
AEGAN
BCGAN
SegGAN
TGAN
IRGAN
ORGAN
GANG
GPGAN
EGAN
CycleGAN
Bayesian
MDGAN
SSGAN
CatGAN
MGGAN
STGAN
DAGAN
LSGAN
SGGAN
HAN
MedGAN
DMGAN
FBGAN
BiGAN
MAGAN
VIGAN
GcGAN
LGAN
BGAN
GAP


Cumulative number of named GAN papers by month
Total number of papers
Year
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
270
285
300
2014
2015
2016
2017

Mão na massa...

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2019

Conditional GAN

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CGAN

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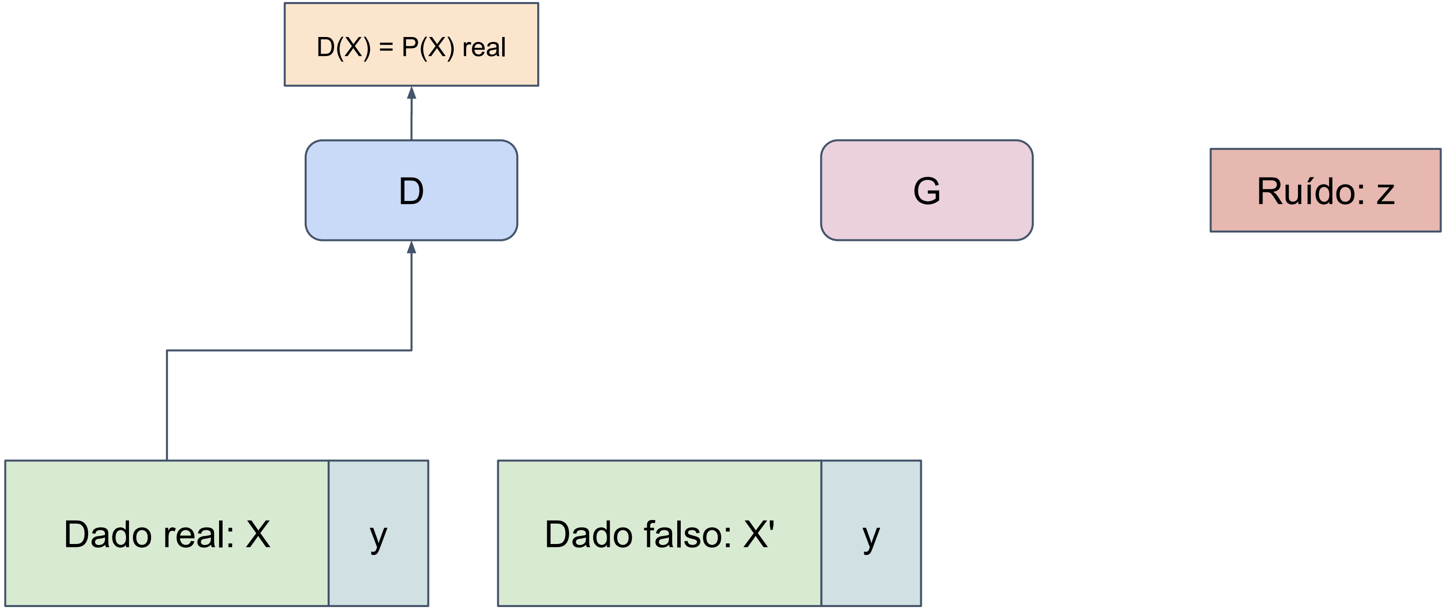
Etapa 1: dados reais



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Adversarial Training

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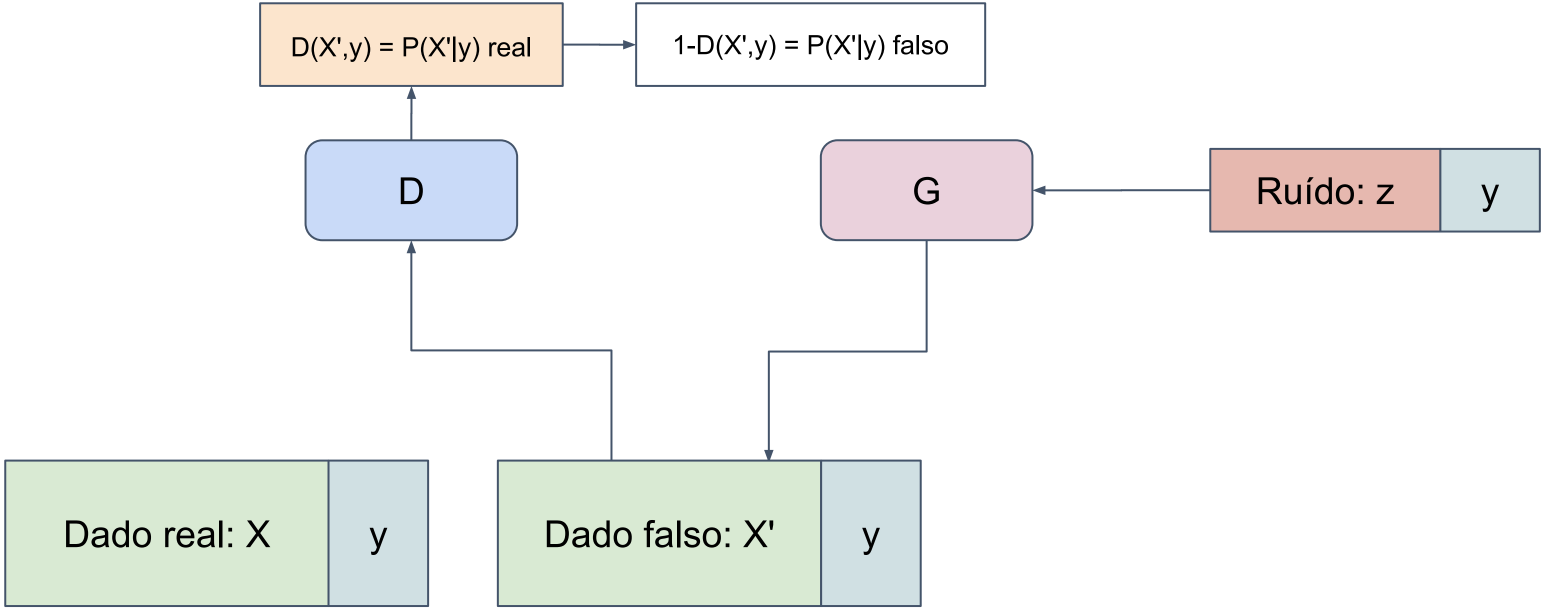
Etapa 2: dados falsos



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Adversarial Training

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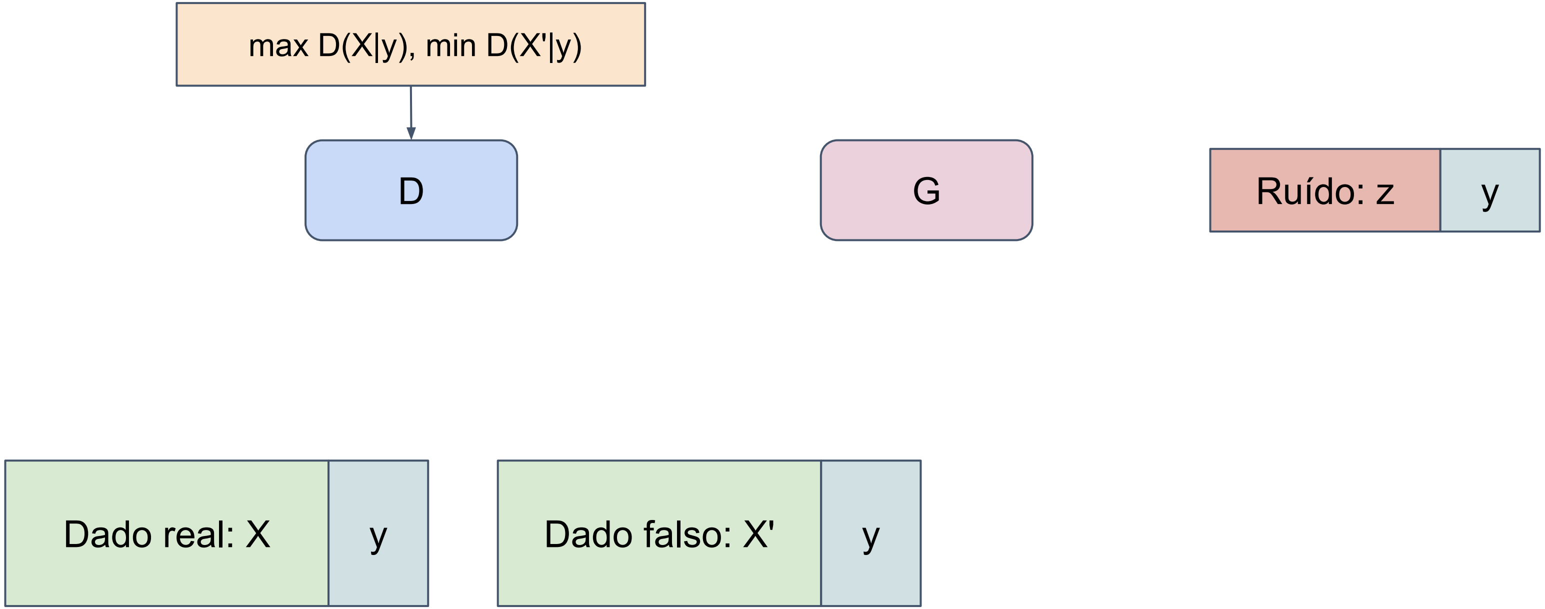
Etapa 3: treino do discriminador



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Adversarial Training

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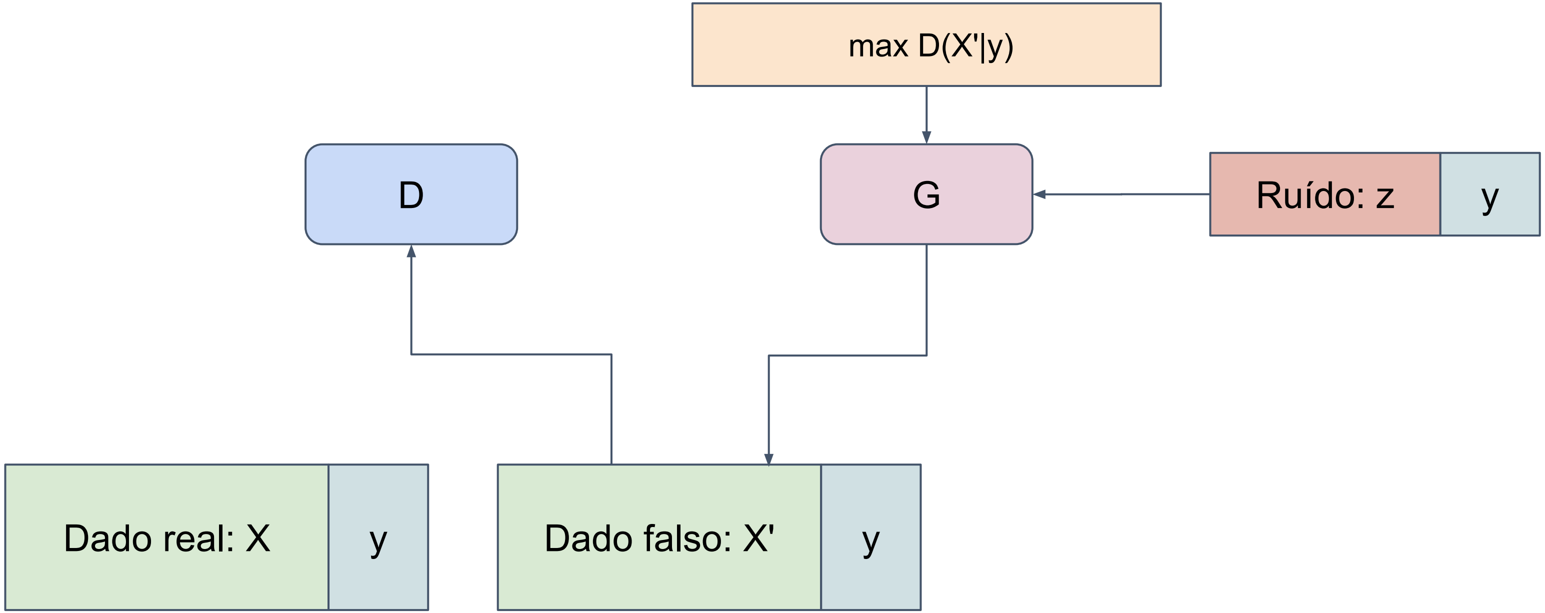
Etapa 4: treino do gerador



2019

Loss - MinMax Game

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$$max_D \, V(D,G) = \mathbb{E}_{x \sim P_{data}} [\log D(x|y)] + \mathbb{E}_{z \sim noise} [\log (1 - D (G(z|y)) |y)]$$
$$max_G \, V(D,G) = \mathbb{E}_{z \sim noise} [\log D (G(z|y)|y)]$$

D: tenta maximizar a probabilidade de (X|y) ser real e (G(z|y)|y) ser falso

G: tenta maximizar a probabilidade de (G(z|y)|y) ser real

```
for epoch in epochs:
  prob_X_real = D(X,y)
  prob_X_fake = D(G(z,y),y)
  loss_D = max{log(prob_X_real) + log(1-prob_X_fake)}
  loss_G = max{log(prob_X_fake)}
```

2019

Vantagens do CGAN

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Mode collapse

Maior controle

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Mão na massa...

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