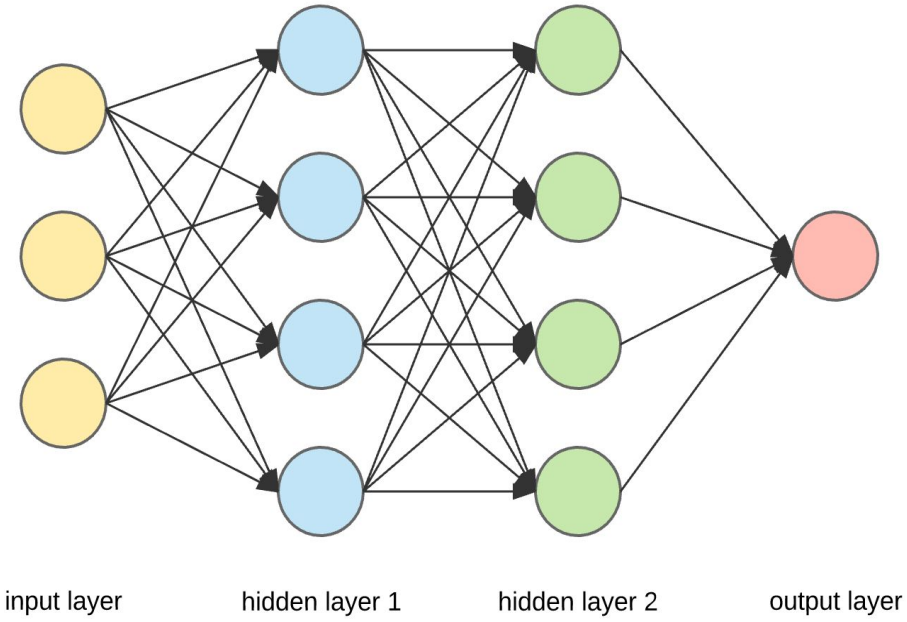
Generative Models

Redes Neurais

- Método de aprendizado de máquina
- "Inspirado" no cérebro humano
- Relativamente antigo
- Ganhando popularidade
- Consegue aproximar qualquer função
- Com o aumento da profundidade aprende melhores representações dos dados

Redes Neurais



Tipos comuns de camadas

- Densas
- Convolucionais
- Recorrentes

Generative Models

- Capturam a probabilidade conjunta P(X, Y) ou se não houver rótulos P(X)
- Em contraste um modelo discriminativo captura a probabilidade condicional P(Y | X)
- Mais informalmente: Modelos que conseguem gerar novas instâncias de dados

Poesia e Prosa

Redes Recorrentes

- Criadas para reconhecer padrões em sequências de dados
  - Textos
  - Aúdios
  - Mercado financeiro
  - Vídeos
  - etc
- Usam neurônios com retroalimentação
  - Ou seja, o resultado do input i - 1, faz parte do input i
  - Podemos ver isso como sendo uma rede com memória
  - Isso nos permite ter uma noção de tempo ou de dados sequenciais
- Dizemos que é um modelo profundo no tempo e não no espaço

Geração de texto: A nível de caractere

- Podemos criar uma rede recorrente que tenta prever o próximo caractere num texto
- Então usamos a própria previsão como entrada para a rede
  - Mais simples
  - Menor número de possíveis saídas (no máximo 256)
  - Não gera textos tão reais

```
PANDARUS:
Alas, I think he shall be come approached and the day
When little srain would be attain'd into being never fed,
And who is but a chain and subjects of his death,
I should not sleep.

Second Senator:
They are away this miseries, produced upon my soul,
Breaking and strongly should be buried, when I perish
The earth and thoughts of many states.

DUKE VINCENTIO:
Well, your wit is in the care of side and that.

Second Lord:
They would be ruled after this chamber, and
my fair nues begun out of the fact, to be conveyed,
Whose noble souls I'll have the heart of the wars.

Clown:
Come, sir, I will make did behold your worship.

VIOLA:
I'll drink it.
```

Fonte: karpathy.io

```
Naturalism and decision for the majority of Arab countries' capitalide was grounded
by the Irish language by [[John Clair]], [[An Imperial Japanese Revolt]], associated
with Guangzham's sovereignty. His generals were the powerful ruler of the Portugal
in the [[Protestant Immineners]], which could be said to be directly in Cantonese
Communication, which followed a ceremony and set inspired prison, training. The
emperor travelled back to [[Antioch, Perth, October 25|21]] to note, the Kingdom
of Costa Rica, unsuccessful fashioned the [[Thrales]], [[Cynth's Dajoard]], known
in western [[Scotland]], near Italy to the conquest of India with the conflict.
Copyright was the succession of independence in the slop of Syrian influence that
was a famous German movement based on a more popular servicious, non-doctrinal
and sexual power post. Many governments recognize the military housing of the
[[Civil Liberalization and Infantry Resolution 265 National Party in Hungary]],
that is sympathetic to be to the [[Punjab Resolution]]
(PJS)[http://www.humah.yahoo.com/guardian.
cfm/7754800786d17551963s89.htm Official economics Adjoint for the Nazism, Montgomery
was swear to advance to the resources for those Socialism's rule,
was starting to signing a major tripad of aid exile.]]
```

Fonte: karpathy.io

Proof. Omitted. □

Lemma 0.1. *Let $\mathcal{C}$ be a set of the construction.*

Let $\mathcal{C}$ be a gerber covering. Let $\mathcal{F}$ be a quasi-coherent sheaves of $\mathcal{O}$-modules. We have to show that

$$\mathcal{O}_{\mathcal{O}_X} = \mathcal{O}_X(\mathcal{L})$$

.

Proof. This is an algebraic space with the composition of sheaves $\mathcal{F}$ on $X_{\acute{e}tale}$ we have

$$\mathcal{O}_X(\mathcal{F}) = \{morph_1 \times_{\mathcal{O}_X} (\mathcal{G}, \mathcal{F})\}$$

where $\mathcal{G}$ defines an isomorphism $\mathcal{F} \to \mathcal{F}$ of $\mathcal{O}$-modules. □

Lemma 0.2. *This is an integer $\mathcal{Z}$ is injective.*

Proof. See Spaces, Lemma ??. □

Lemma 0.3. *Let S be a scheme. Let X be a scheme and X is an affine open covering. Let $\mathcal{U} \subset \mathcal{X}$ be a canonical and locally of finite type. Let X be a scheme. Let X be a scheme which is equal to the formal complex.*

The following to the construction of the lemma follows.

Let X be a scheme. Let X be a scheme covering. Let

$$b : X \to Y' \to Y \to Y \to Y' \times_X Y \to X.$$

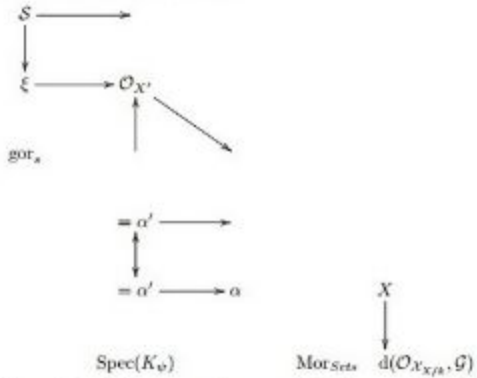
be a morphism of algebraic spaces over S and Y.

Proof. Let X be a nonzero scheme of X. Let X be an algebraic space. Let $\mathcal{F}$ be a quasi-coherent sheaf of $\mathcal{O}_X$-modules. The following are equivalent

(1) $\mathcal{F}$ is an algebraic space over S.
(2) If X is an affine open covering.

Consider a common structure on X and X the functor $\mathcal{O}_X(U)$ which is locally of finite type. □

This since $\mathcal{F} \in \mathcal{F}$ and $x \in \mathcal{G}$ the diagram



is a limit. Then $\mathcal{G}$ is a finite type and assume S is a flat and $\mathcal{F}$ and $\mathcal{G}$ is a finite type f_*. This is of finite type diagrams, and

- the composition of $\mathcal{G}$ is a regular sequence,
- $\mathcal{O}_{X'}$ is a sheaf of rings.

□

Proof. We have see that $X = \mathrm{Spec}(R)$ and $\mathcal{F}$ is a finite type representable by algebraic space. The property $\mathcal{F}$ is a finite morphism of algebraic stacks. Then the cohomology of X is an open neighbourhood of U. □

Proof. This is clear that $\mathcal{G}$ is a finite presentation, see Lemmas ??.
A *reduced above* we conclude that U is an open covering of $\mathcal{C}$. The functor $\mathcal{F}$ is a "field

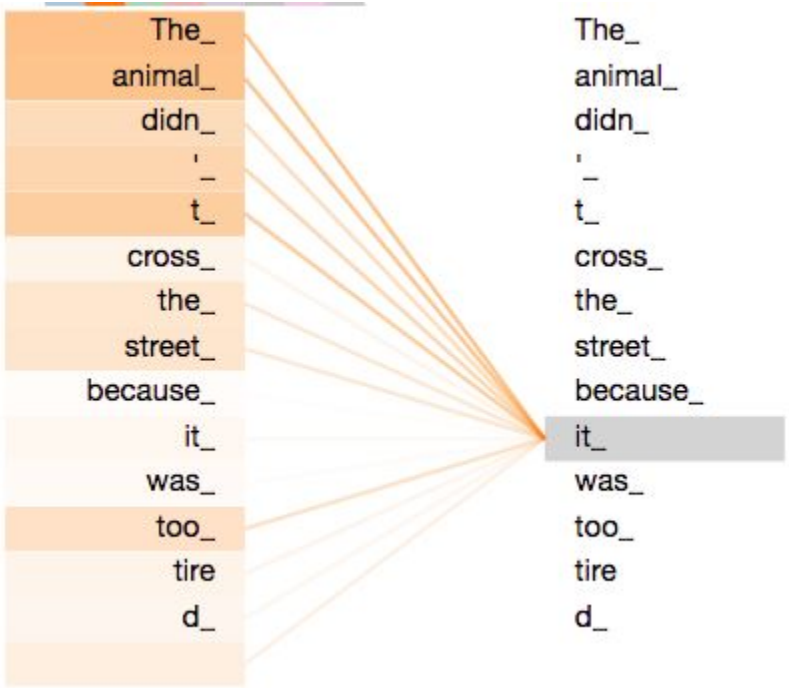
$$\mathcal{O}_{X,x} \longrightarrow \mathcal{F}_{\overline{x}} \quad \text{-1}(\mathcal{O}_{X_{\acute{e}tale}}) \longrightarrow \mathcal{O}_{X_i}^{-1}\mathcal{O}_{X_\lambda}(\mathcal{O}_{X_\eta}^{\overline{s}})$$

is an isomorphism of covering of $\mathcal{O}_{X_i}$. If $\mathcal{F}$ is the unique element of $\mathcal{F}$ such that X is an isomorphism.
The property $\mathcal{F}$ is a disjoint union of Proposition ?? and we can filtered set of presentations of a scheme $\mathcal{O}_X$-algebra with $\mathcal{F}$ are opens of finite type over S.
If $\mathcal{F}$ is a scheme theoretic image points. □

If $\mathcal{F}$ is a finite direct sum $\mathcal{O}_{X_\lambda}$ is a closed immersion, see Lemma ??. This is a sequence of $\mathcal{F}$ is a similar morphism.

Fonte: karpathy.io

Self-Attention



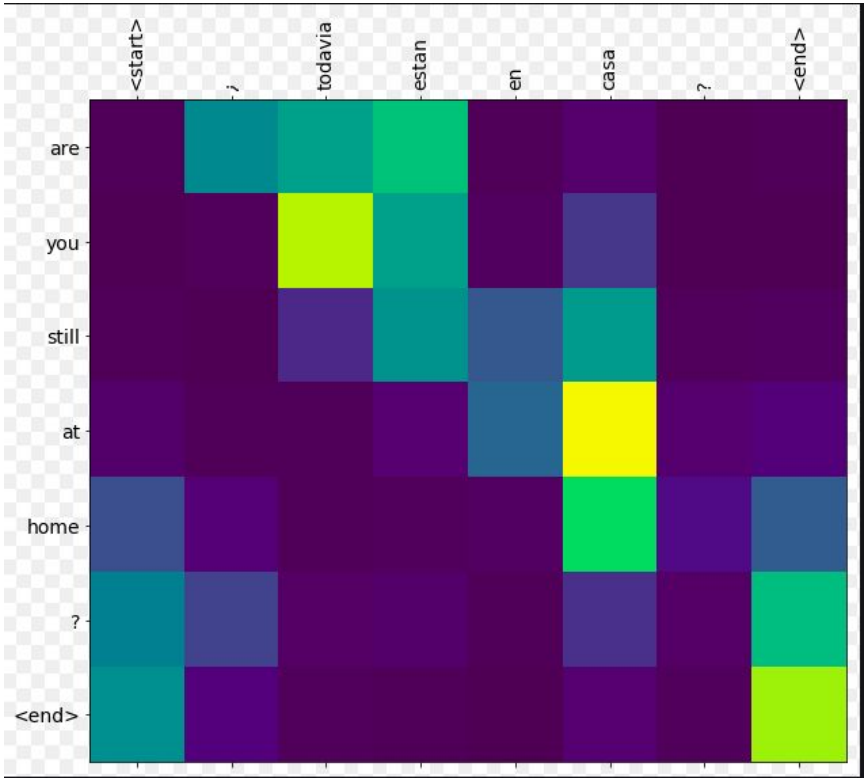
Fonte: [The Illustrated Transformer]

Self-Attention

$K = X W_K \quad V = X W_V \quad Q = X W_Q$

$$\text{Attention}(Q, K, V) = \text{softmax}(\frac{QK^T}{\sqrt{d_k}})V$$

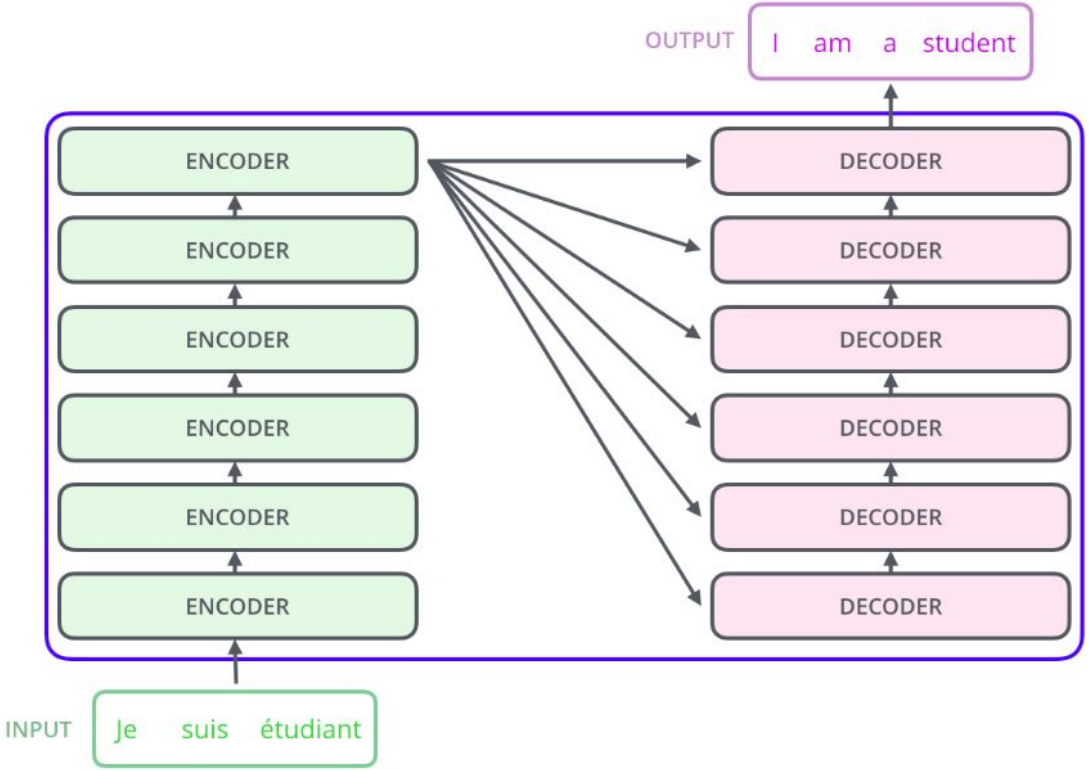
Attention



Transformer: Attention is all you need

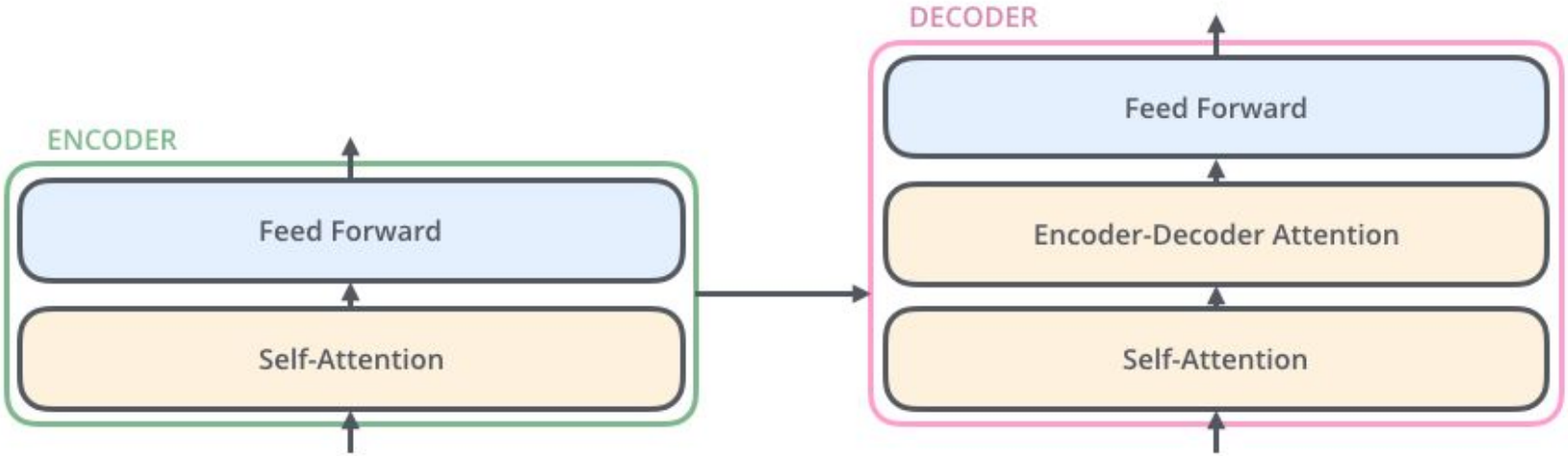
- Inicialmente atenção era só um "extra" que você adicionava ao seu modelo para tentar conseguir uma melhora
- No transformer tudo é baseado em attention
  - Vários blocos compostos por camadas de attention seguidas de feed-forward
  - Várias "cabeças" de attention em cada bloco

Transformer: Attention is all you need



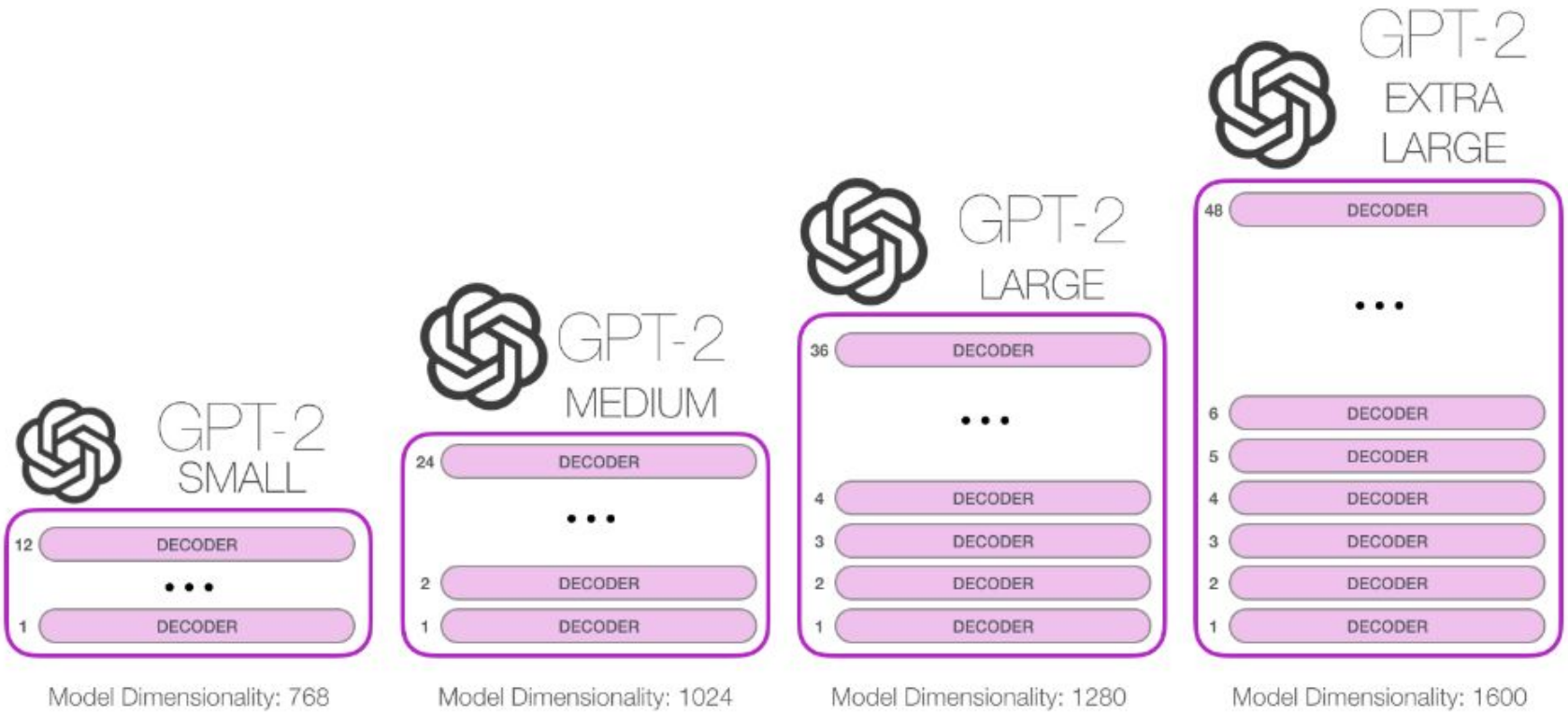
Fonte: The Illustrated Transformer

Transformer: Attention is all you need

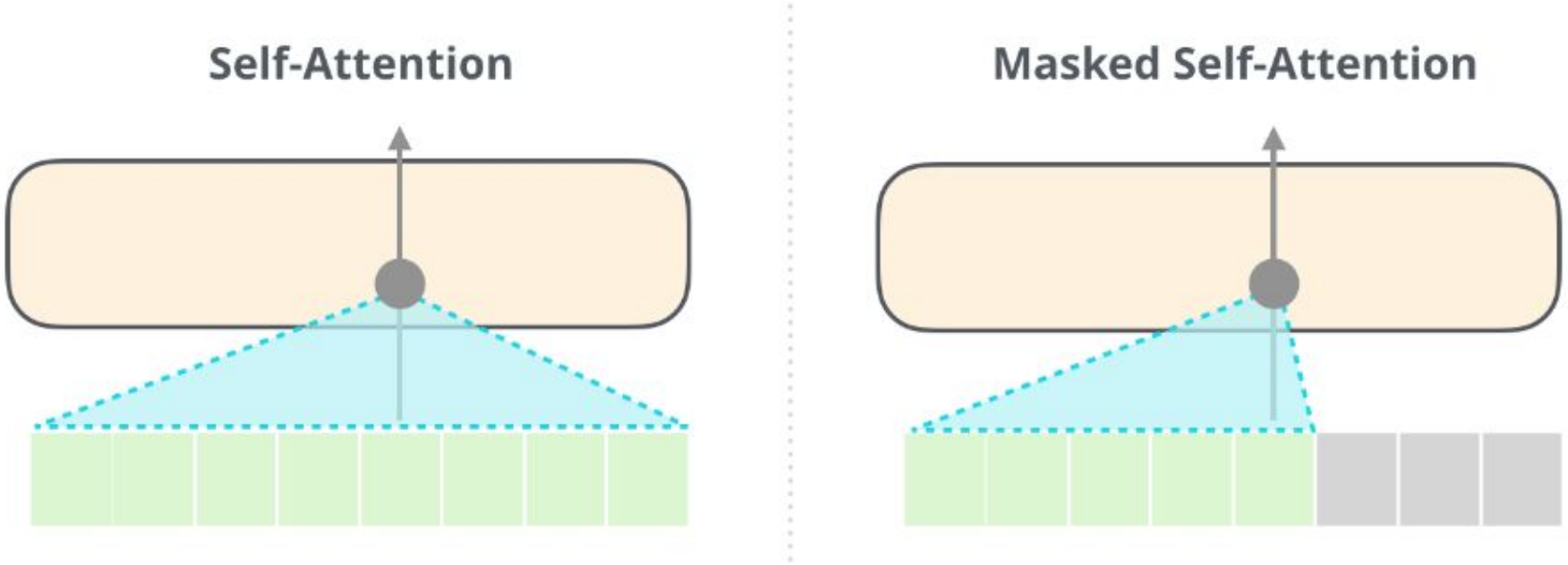


Fonte: [The Illustrated Transformer]

GPT-2


GPT-2
SMALL
12
DECODER
1
DECODER
Model Dimensionality: 768
GPT-2
MEDIUM
24
DECODER
2
DECODER
1
DECODER
Model Dimensionality: 1024
GPT-2
LARGE
36
DECODER
4
DECODER
3
DECODER
2
DECODER
1
DECODER
Model Dimensionality: 1280
GPT-2
EXTRA
LARGE
48
DECODER
6
DECODER
5
DECODER
4
DECODER
3
DECODER
2
DECODER
1
DECODER
Model Dimensionality: 1600

GPT-2



Exemplo de Texto

Prompt: In a shocking finding, scientist discovered a herd of unicorns living in a remote, previously unexplored valley, in the Andes Mountains. Even more surprising to the researchers was the fact that the unicorns spoke perfect English.

Texto gerado:
The scientist named the population, after their distinctive horn, Ovid's Unicorn. These four-horned, silver-white unicorns were previously unknown to science.
Now, after almost two centuries, the mystery of what sparked this odd phenomenon is finally solved. Dr. Jorge Pérez, an evolutionary biologist from the University of La Paz, and several companions, were exploring the Andes Mountains when they found a small valley, with no other animals or humans. Pérez noticed that the valley had what appeared to be a natural fountain, surrounded by two peaks of rock and silver snow.
Pérez and the others then ventured further into the valley. "By the time we reached the top of one peak, the water looked blue, with some crystals on top," said Pérez.

Música

MuseNet

- Usa uma versão modificada da Transformer (Transformer Sparsa) com 24 cabecas, 72 camadas e uma janela de 4096 tokens
- São passados tokens de instrumentos e compositor para facilitar o treinamento
- Tem uma outra rede que avalia o se a música vem da base de dados ou se foi gerada pela rede
- https://openai.com/blog/musenet/

CocoNet

- Foi treinada para restaurar e harmonizar músicas
- Usaram 306 corais compostos por Bach
- Durante o treino eles removiam algumas notas e a rede tinha que aprender a restaurar a música
- https://magenta.tensorflow.org/coconet

Geração de Imagens

Redes Adversariais (GANs)

- Duas redes neurais
  - Discriminador
    - Rede que julga se a imagem gerada é verdadeira (pertence a distribuição) ou não
  - Gerador
    - Rede que gera novas imagens e tenta enganar o discriminador
    - Em geral aprende a mapear de um espaço latente (vetor de dimensão bem menor que a imagem) para a distribuição das imagens

As training progresses, the generator gets closer to producing output that can fool the discriminator:

Finally, if generator training goes well, the discriminator gets worse at telling the difference between real and fake. It starts to classify fake data as real, and its accuracy decreases.

Fonte: https://developers.google.com/machine-learning/gan/gan_structure

Primeira GAN

Fonte: Generative Adversarial Nets Paper (Goodfellow et al)

Big GAN

- Attention
- Recebe informação da classe que deve gerar
- Mais updates para o discriminador que para o gerador
- Mais parâmetros
- Alguns outros truques








Style GAN

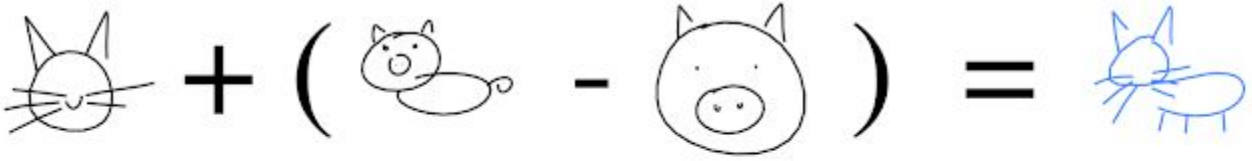
- Tenta dá mais controle sobre as imagens que são geradas
- Pode ser vista mais como um conjunto de técnicas que você pode aplicar a outras GANs
- Muitas técnicas complexas que fogem ao escopo da Palestra
- https://www.thispersondoesnotexist.com/
- https://www.thiswaifudoesnotexist.net/

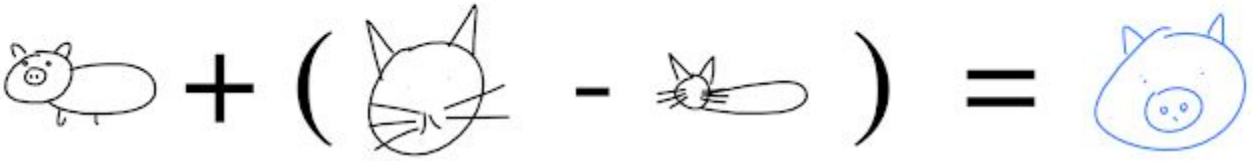
Fonte: https://github.com/NVlabs/stylegan

Pinturas e Esboços

Sketch RNN

- Usa uma RNN
- O Dataset foi gerado com o jogo Quick! Draw
  - Dados representados como ações motoras, em que direção se mover, quando levantar a caneta e quando parar de desenhar
- Gera um espaço latente onde podemos combinar desenhos
- https://magic-sketchpad.glitch.me/





Human Input

Human Input

Spiral e Spiral++

- Usa aprendizado por reforço
  - Porém bastante semelhante ao funcionamento de uma GAN
- Busca gerar programas que desenham, não gerar os pixels das imagens de uma vez
- Spiral++ usa técnicas de treinamento de GANs para melhorar o Spiral
- https://www.youtube.com/watch?v=iSyvwAwa7vk&feature=youtu.be
- https://learning-to-paint.github.io/

Impactos na Sociedade

Geração de Fake News

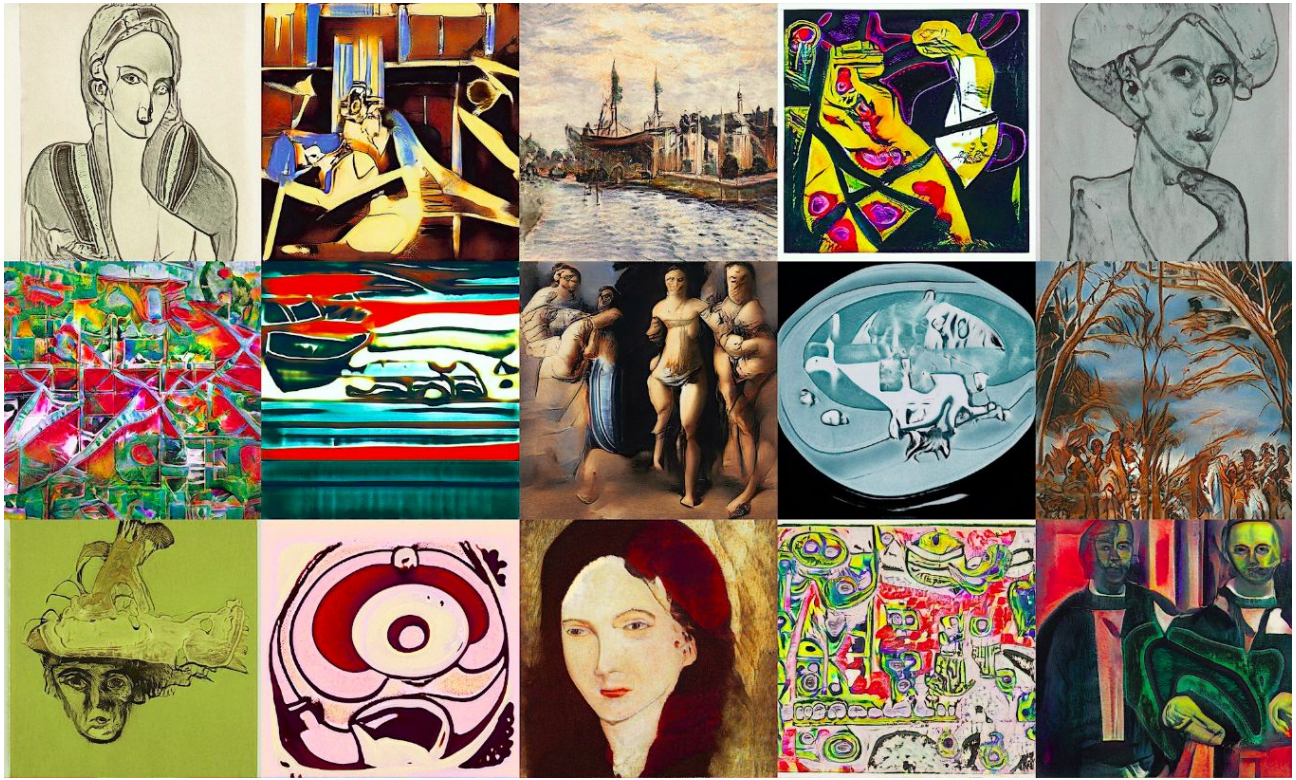
- Uso de modelos de linguagem para criar fake news
- A medida que os modelos de linguagem melhoram eles conseguem fazer textos cada vez mais convincentes
- Estão estudando meios de contra atacar isso (Grover)

Deep Fake

- https://www.youtube.com/watch?v=_m2dRDQEC1A
- https://www.youtube.com/watch?v=p1b5aiTrGzY
- Também estão sendo estudados métodos de Machine Learning para detectar deepfakes

Arte: Helera Sarin

Arte: Abraham



Tudo: How to Generate Almost Anything

https://howtogeneratealmostanything.com/

Recursos

- Luba Elliot: Newsletter sobre IA e art
- Coucou: Interface para brincar mais com a CocoNet
- How to generate almost anything
- Neural Bricolage: Site da Helena Sarin
- Generative Deep Learning
- http://jalammar.github.io/: Explicações de vários tópicos de Machine Learning