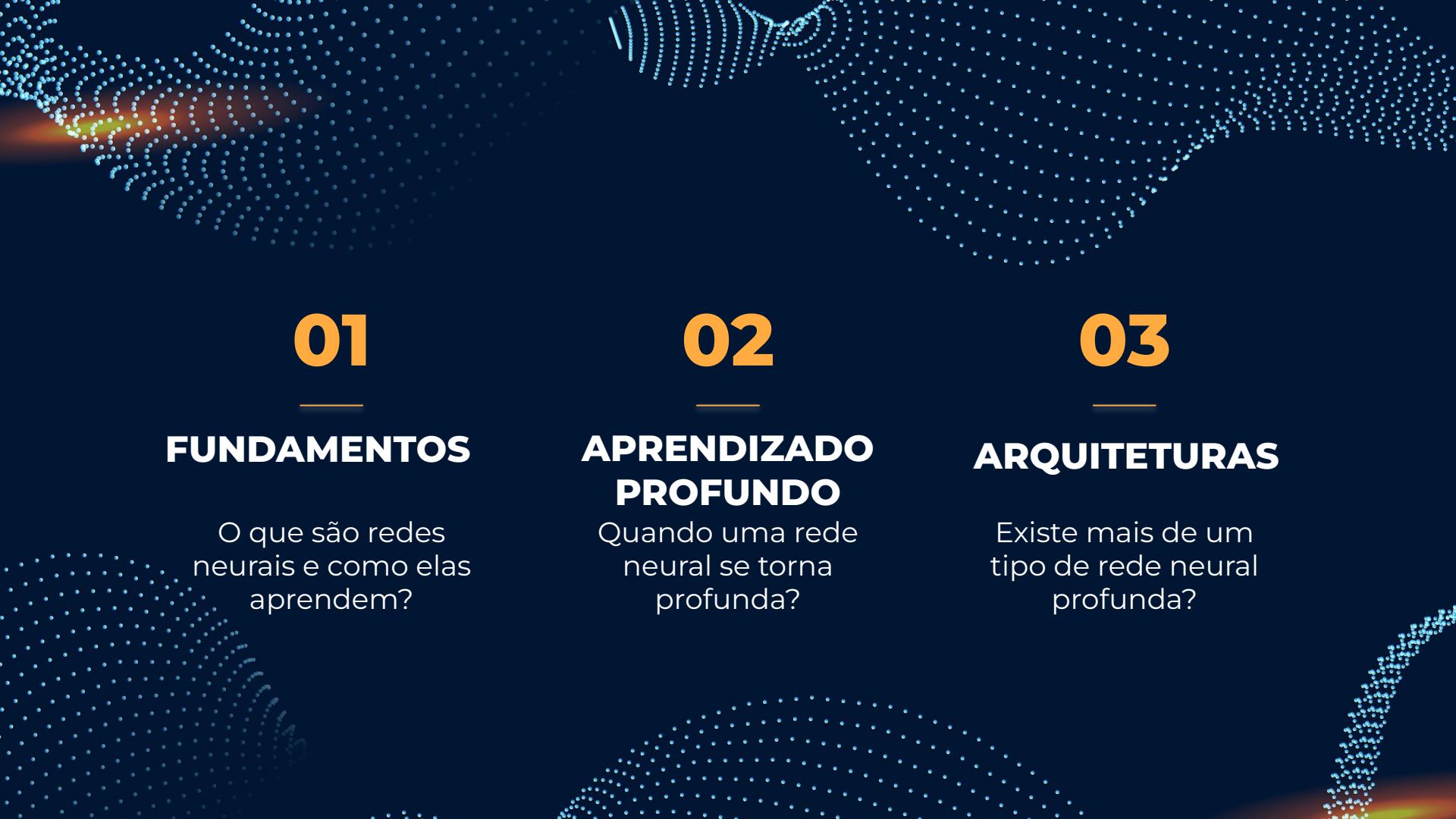


QUEM É QUEM EM DEEP LEARNING?

Lucas Grassano Lattari
lucas.lattari@ifsudestemg.edu.br



01

FUNDAMENTOS

O que são redes neurais e como elas aprendem?

02

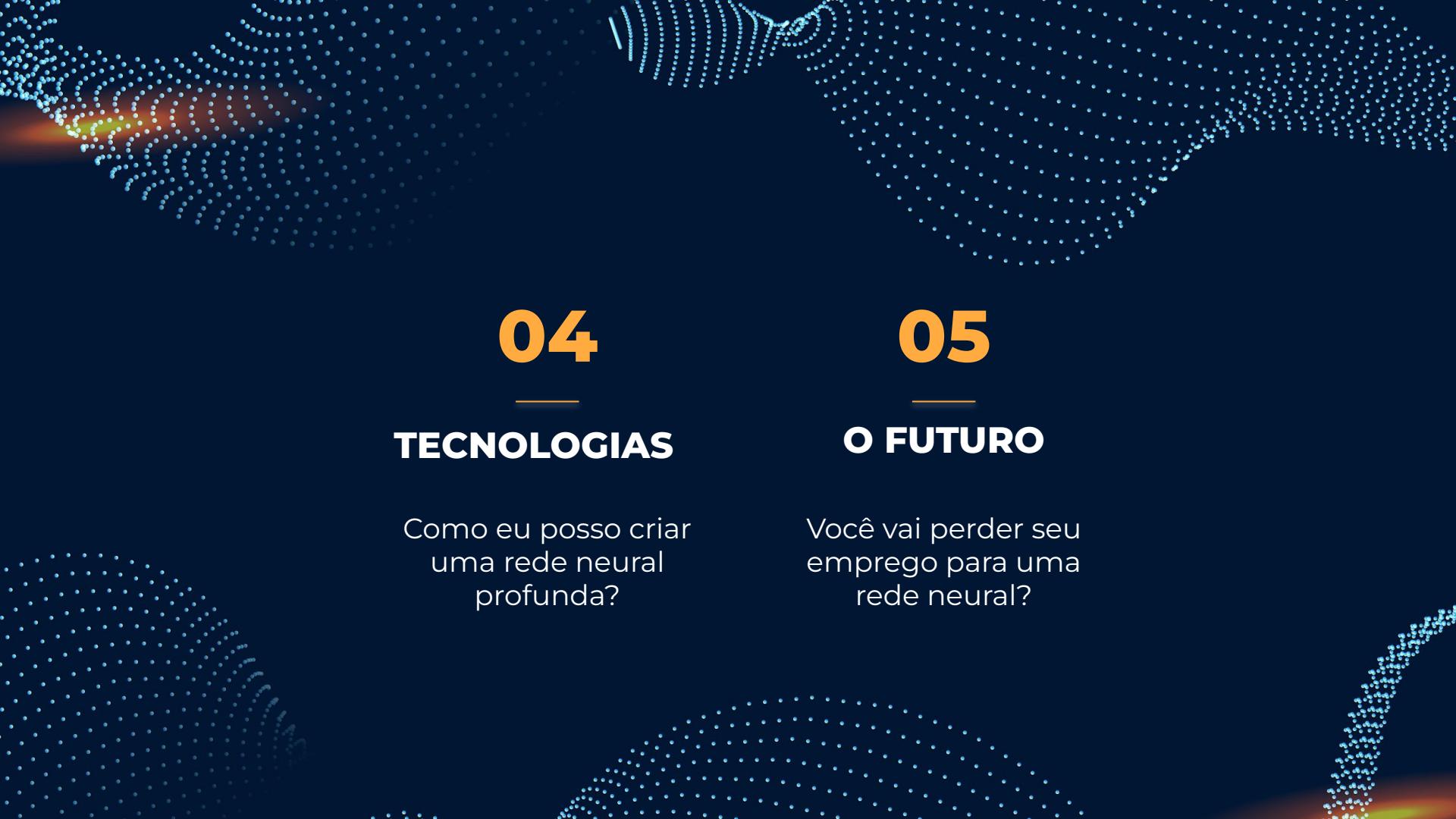
APRENDIZADO PROFUNDO

Quando uma rede neural se torna profunda?

03

ARQUITETURAS

Existe mais de um tipo de rede neural profunda?



04

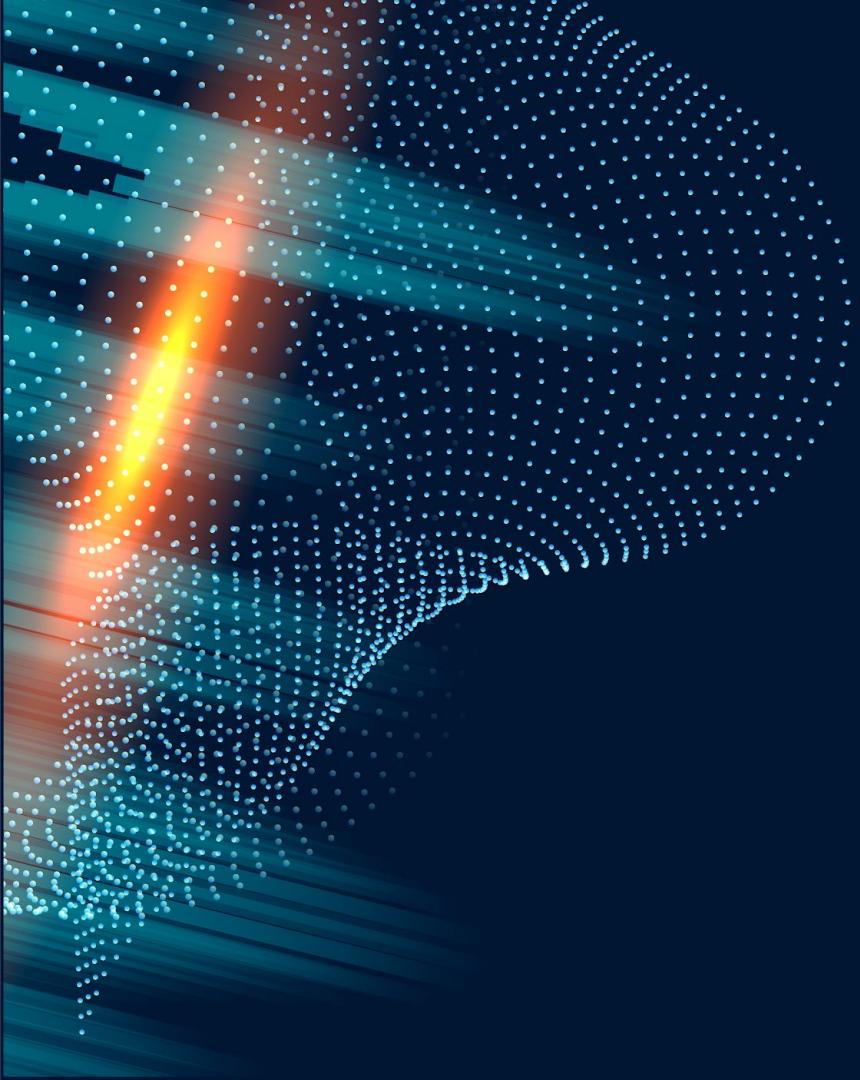
TECNOLOGIAS

Como eu posso criar
uma rede neural
profunda?

05

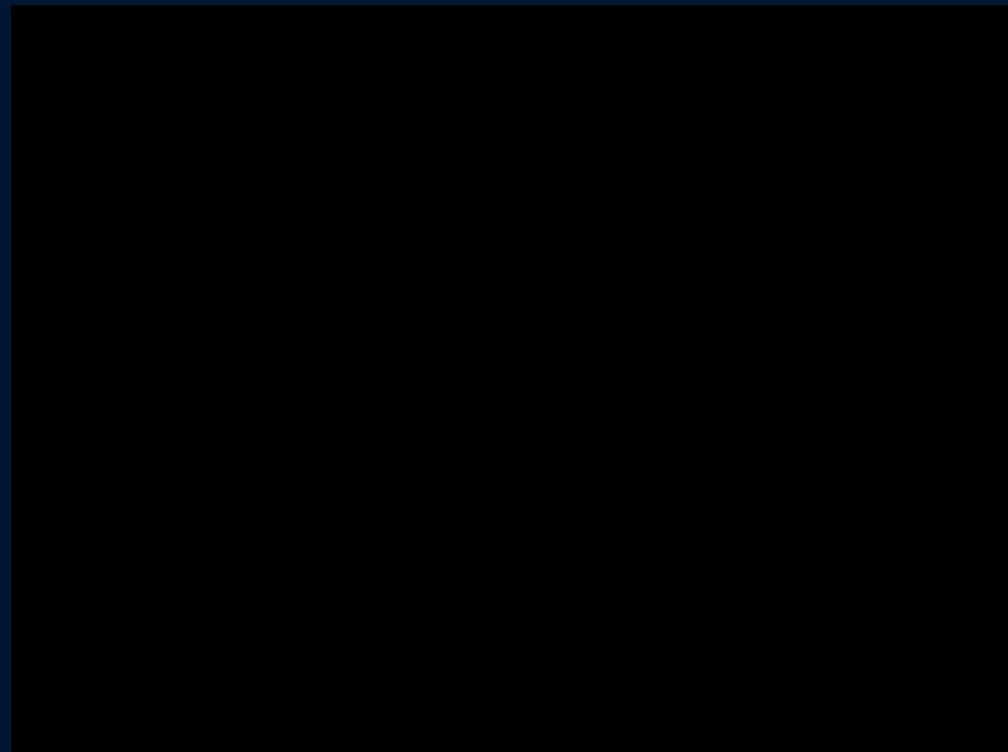
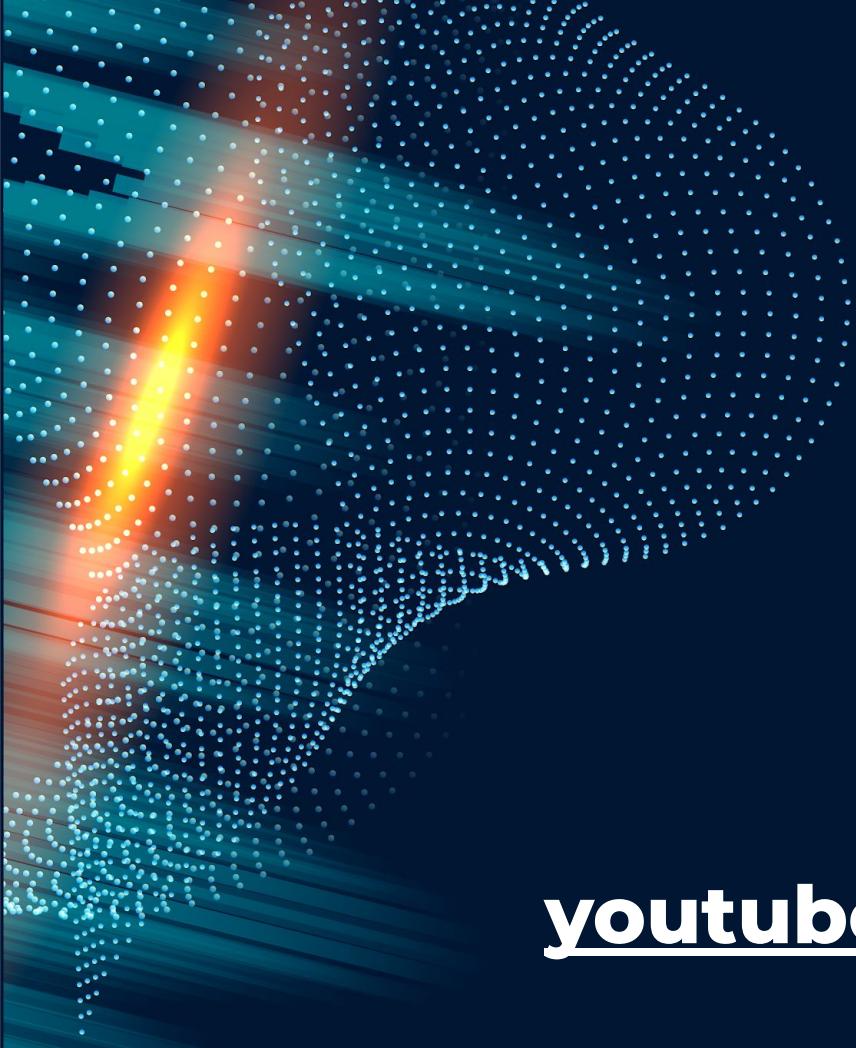
O FUTURO

Você vai perder seu
emprego para uma
rede neural?



QUEM SOU EU?

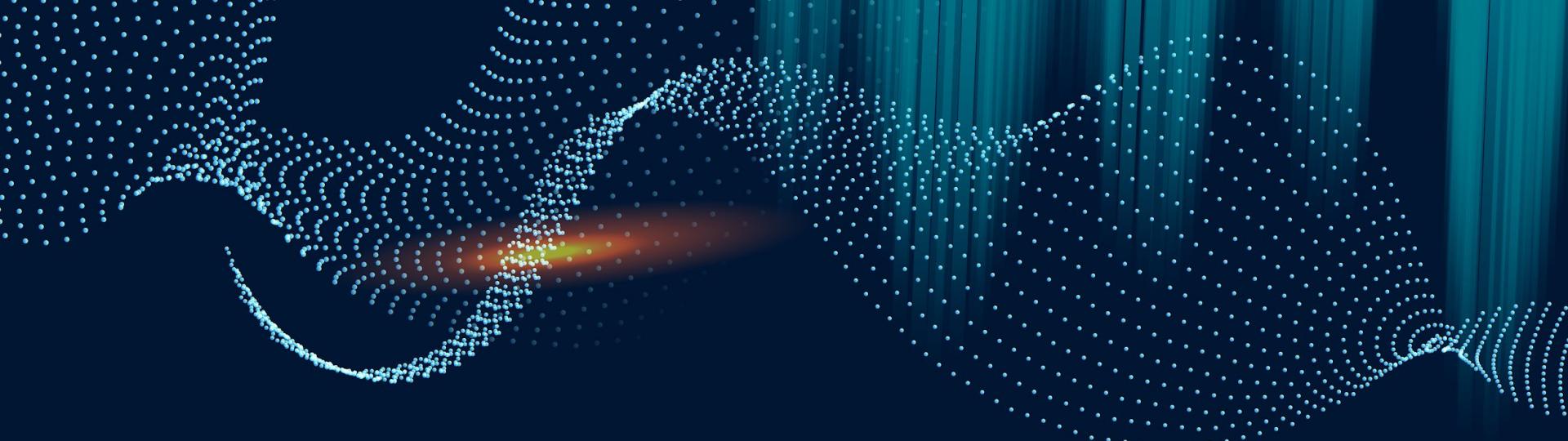
- Doutor em Ciência da Computação pela Universidade Federal Fluminense
- Professor há 10 anos no Instituto Federal do Sudeste de MG, Campus Rio Pomba
- Criador de conteúdo no Universo Discreto



youtube.com/universodiscreto

**“Qualquer IA inteligente
o suficiente para passar
em um teste de Turing é
inteligente o suficiente
para saber que pode
falhar.”**

—Ian McDonald

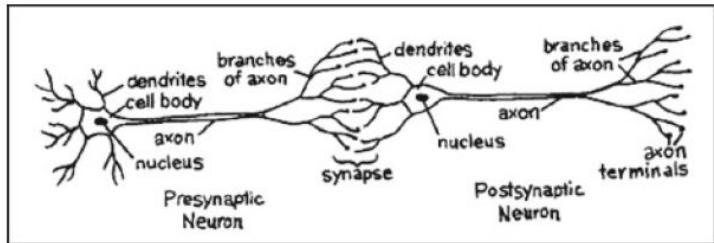


01 e 02

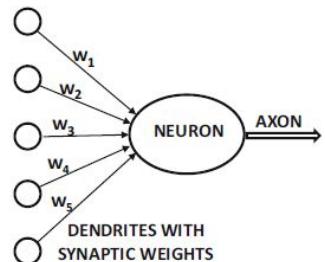
**FUNDAMENTOS DE
REDES NEURAIS
PROFUNDAS**

INTRODUÇÃO

Redes Neurais Artificiais são uma tentativa de se fazer uma engenharia reversa do **aprendizado e tomada de decisões** de um cérebro biológico



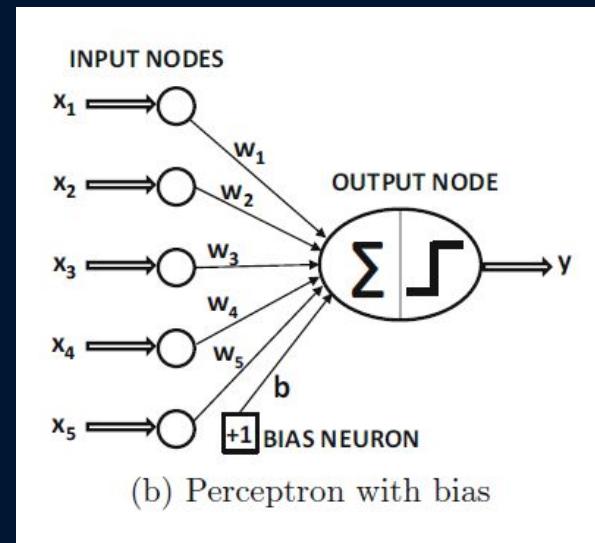
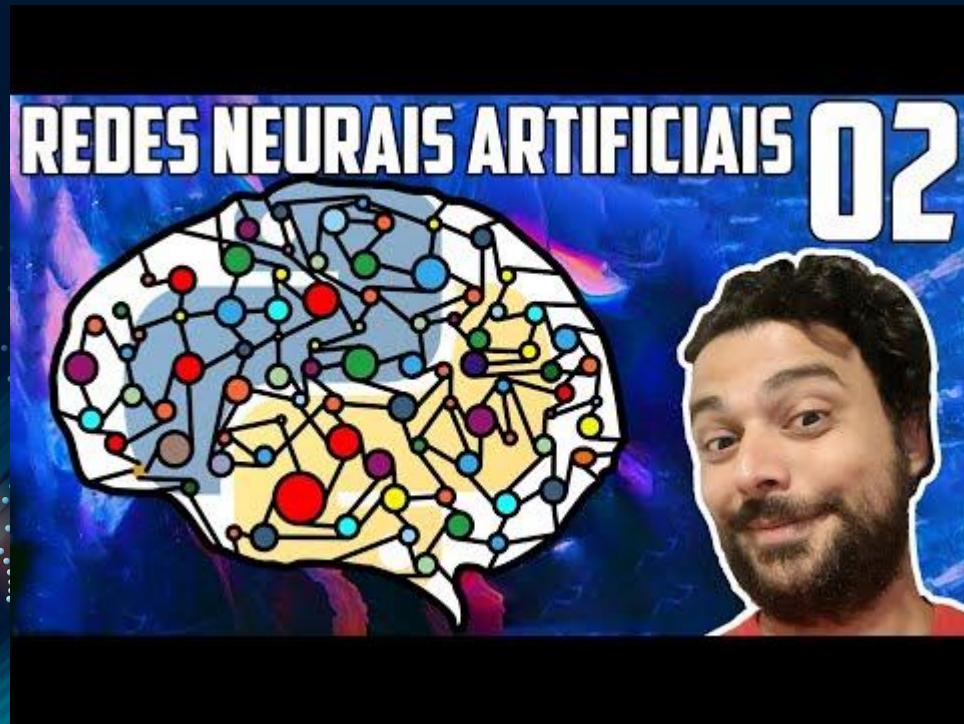
(a) Biological neural network



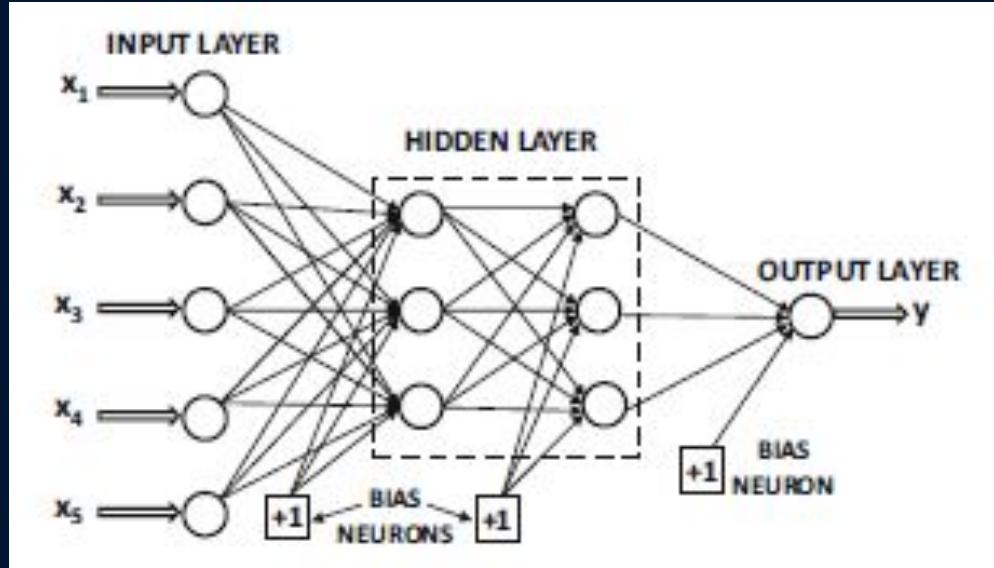
(b) Artificial neural network

Figure 1.1: The synaptic connections between neurons. The image in (a) is from “*The Brain: Understanding Neurobiology Through the Study of Addiction* [598].” Copyright ©2000 by BSCS & Videodiscovery. All rights reserved. Used with permission.

A REDE NEURAL MAIS SIMPLES: PERCEPTRON



REDES NEURAIS

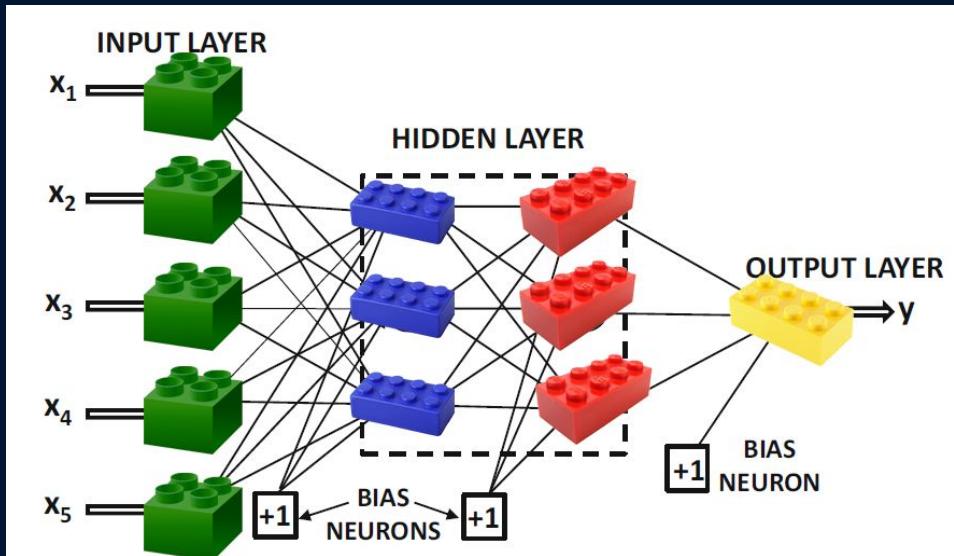


Um neurônio artificial é uma unidade de computação que **não difere** de alguns algoritmos de Machine Learning tradicionais

Quando essas unidades são **combinadas**, funções complexas podem ser **representadas** de maneira mais facilitada

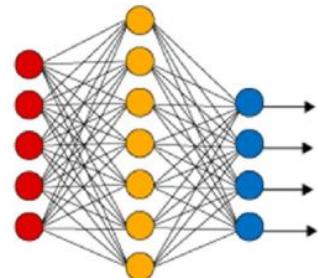
REDES NEURAIS

Cada unidade de processamento pode ser pensada como um “bloco de construção”, com características particulares

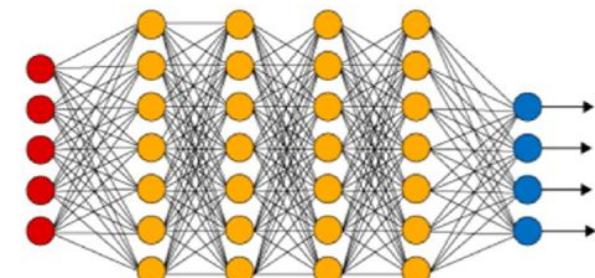


REDES RASAS X REDES PROFUNDAS

Rede Neural Rasa

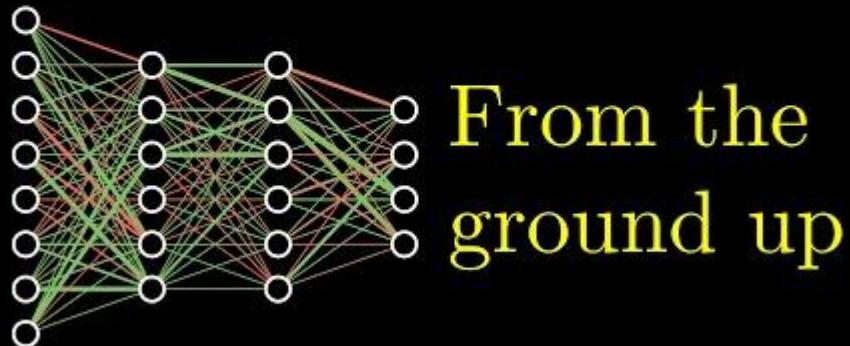


Rede Neural Profunda



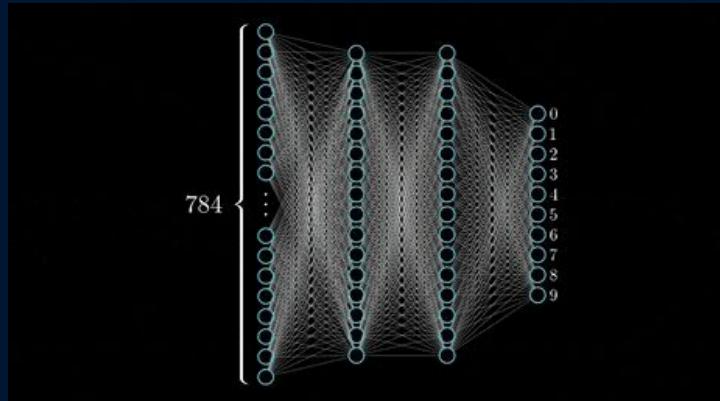
Costuma-se dizer que uma rede neural é “deep” quando ela possui **várias camadas ocultas** de processamento

Neural Networks

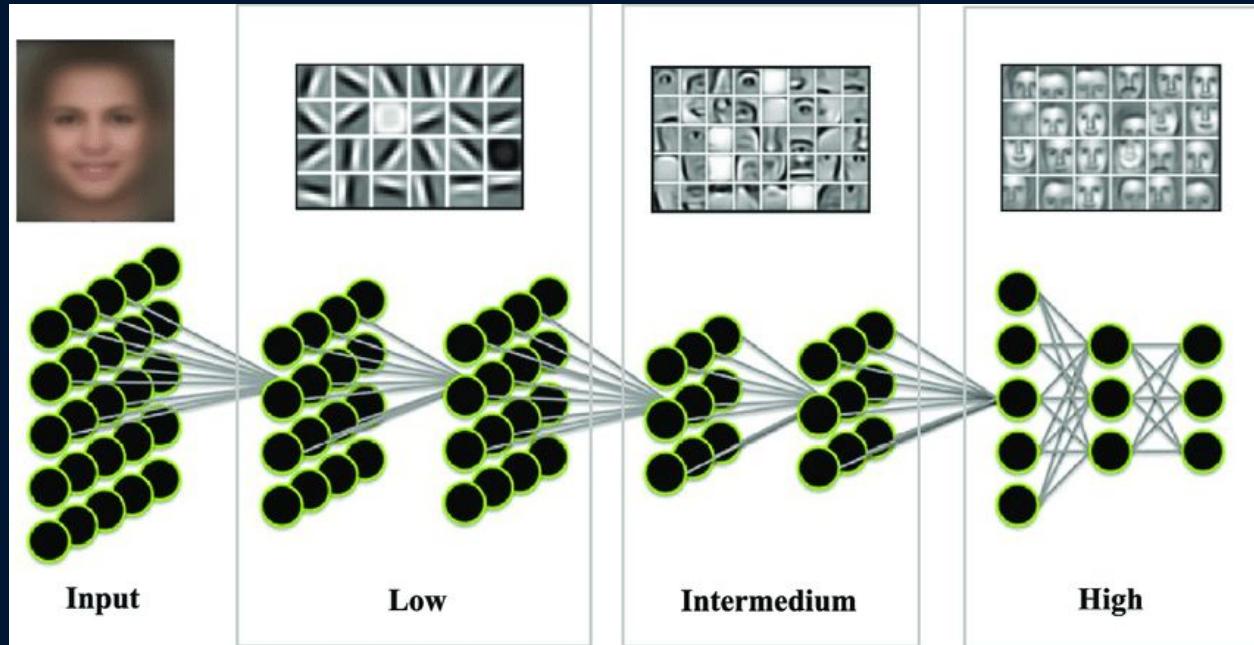


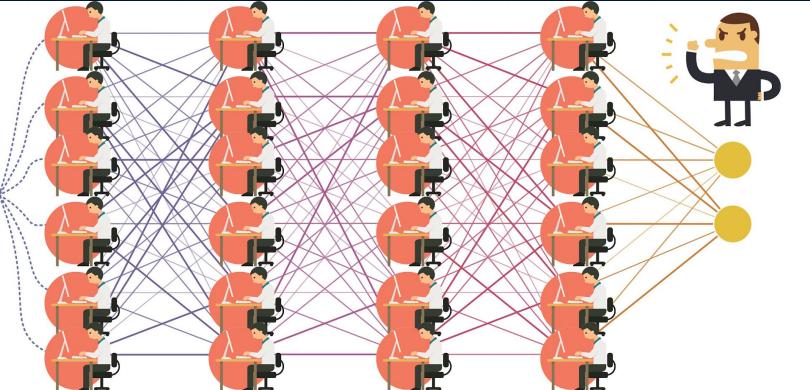
From the
ground up

**UMA REDE NEURAL
PRECISA SER
PROFUNDA?**



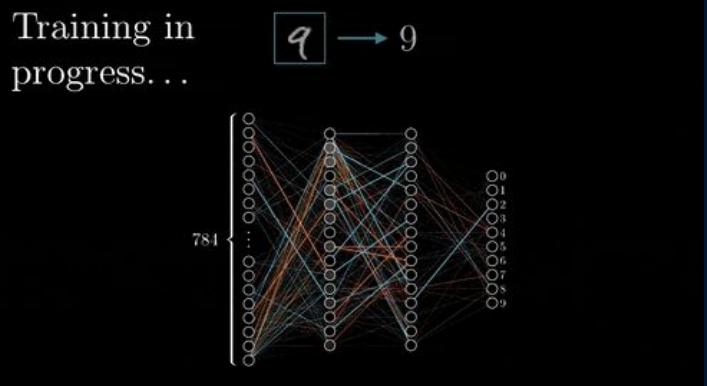
RECONHECIMENTO EM UMA REDE NEURAL PROFUNDA





COMO UMA REDE NEURAL APRENDE? (BACKPROPAGATION)

Training in
progress. . .



CONCEITOS IMPORTANTES COM ANALOGIAS



TREINAMENTO

“Fazer exercícios,
estudar pra prova,
assimilar
conhecimento novo”



TESTE

Hora do “vamos ver”,
será que sei o bastante?

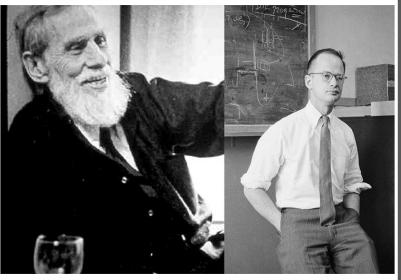
Depois vejo pelo
gabarito (*ground truth*)
se estou sabendo



OVERFITTING

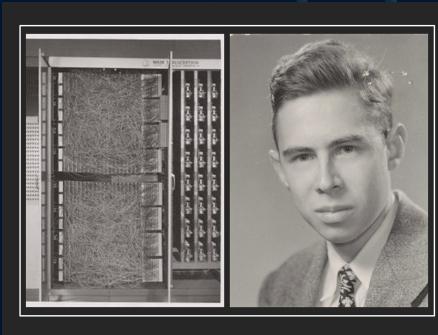
“Vou decorar o livro
todo, inclusive o
número das páginas,
o tamanho da fonte
e as cores do papel”

LINHA DO TEMPO



1943 - REDES NEURAIS

Pitts e McCulloch modelaram matematicamente um neurônio biológico



1957 - PERCEPTRON

Rosenblatt apresentou o Perceptron, capaz de aprender e fazer classificação binária



1986 - BACKPROPAGATION

Hinton, Rumelhart e Williams fizeram uma implementação bem sucedida da propagação

Learning representations by back-propagating errors

& Ronald J. Williams*

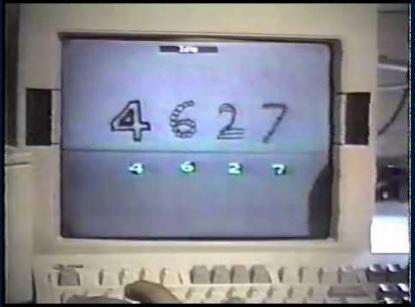
*Center for Cognitive Science, C-CSI, University of California, San Diego, La Jolla, CA 92093, USA
Proteobots, Inc., Philadelphia, PA 19103, USA

We describe a new learning procedure, back-propagation, for networks of neurons that units. The procedure repeatedly adjusts the weights connecting the units based on the error between the desired values of the output units and those actually produced. The adjustments, termed "hidden" units which are not part of the input or output layers, are made in the direction which minimizes the error, and the regulations in the task are captured by the interactions of the hidden units with the rest of the network. This allows us to eliminate gradient back-propagation from earlier, simpler methods such as the Hebb rule and the delta rule.

There have been many attempts to design self-organizing neural networks that can learn to represent the input space of a function. One approach is to use a feedforward neural network to develop an internal structure that is appropriate for a given task. In this paper we show how to use back-propagation to derive state vector of the output units and the state vector of the input units. We also show how to use back-propagation to learn the output units. It is relatively easy to find learning rules that minimize the error between the desired output and the actual output, and to propagate this error through the network. However, it is difficult to propagate the error through the network because more interesting but

*The authors' names should be swapped

LINHA DO TEMPO



1989 - CNN

LeCun apresentou o conceito de **Rede Neural Convolucional** para reconhecer dígitos escritos à mão

The image shows a portrait of Simon Osindero on the left and a screenshot of a scientific paper on the right. The paper is titled "Fast learning algorithm for deep belief nets" and is authored by Geoffrey Hinton and Simon Osindero. It discusses the use of "plasticity priors" to make self-connected belief layers. The paper also mentions a fast, greedy algorithm for learning features and includes a diagram of a neural network architecture.

2006 - DEEP LEARNING

Hinton, Salakhutdinov, Osindero e Teh publicaram um paper que popularizou o termo



2009, 2012 - IMAGENET E ALEXNET

Fei-Fei Li criou uma **enorme base de dados** de imagens (14 milhões)

A AlexNet (criada por Krizhevsky) conseguiu a **acurácia de 84,7%** na ImageNet, vencendo a competição

LINHA DO TEMPO



Generative Adversarial Nets

below: Jean Pouget-Abadie, Mehdi Mirza, Bing Xu, David W. Sherril Ozair, Yoshua Bengio¹
Département d'informatique et de recherche opérationnelle
Université de Montréal
Montréal, QC H3C 3J7

Abstract

pose a new framework for estimating generative models via an adversarial process, in which we simultaneously train two models: a generative model that captures the data distribution, and a discriminative model D that estimates the probability that a sample came from the training data rather than G . The generator G can then be improved by maximizing the probability D assigns to a sample. This work corresponds to a minimax two-player game. In the space of all pairs G and D , a unique solution exists, with G recovering the training distribution and D equal to $\frac{1}{2}$ everywhere. In the limit where G and D are optimally paired, the generator G is trained with the true data distribution, so no need for Markov chains or unrolled approximate inference.

arxiv.org/pdf/1406.2891.pdf

2014 - GANS

Goodfellow criou as Redes Generativas Adversárias, capazes de **criar conteúdo realista** em imagens, áudios e vídeos



2016 - ALPHAGO

Computador do Google aprende sozinho e vence campeão mundial de Go, com **jogadas nunca vistas**



2019 - NOBEL DA COMPUTAÇÃO

LeCun, Hinton e Bengio vencem o Turing Awards dada a imensa contribuição do trio nos avanços promovidos em Deep Learning

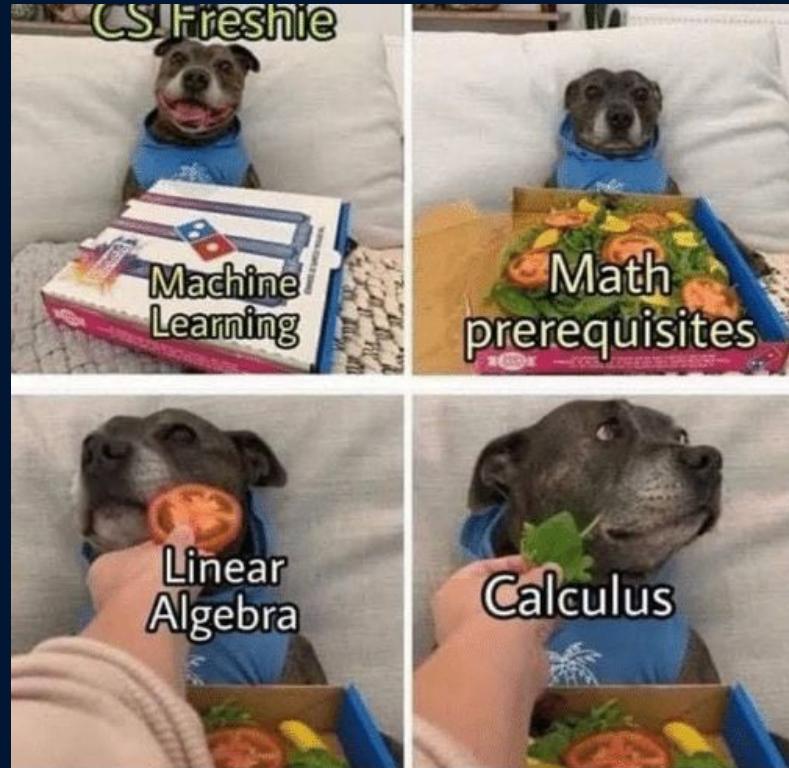
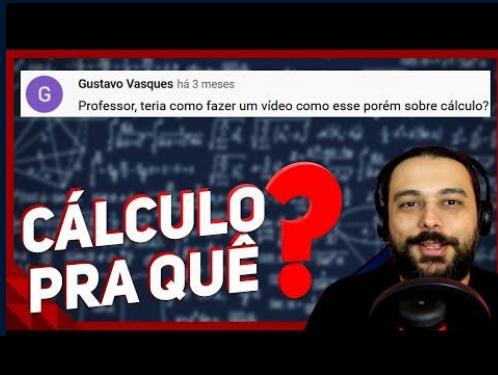
PRECISA MESMO DE DEEP LEARNING?



- Deep Learning é uma ferramenta capaz de aprender **padrões** e **tomar decisões** em cima de **dados** sem depender tanto de **pessoas**

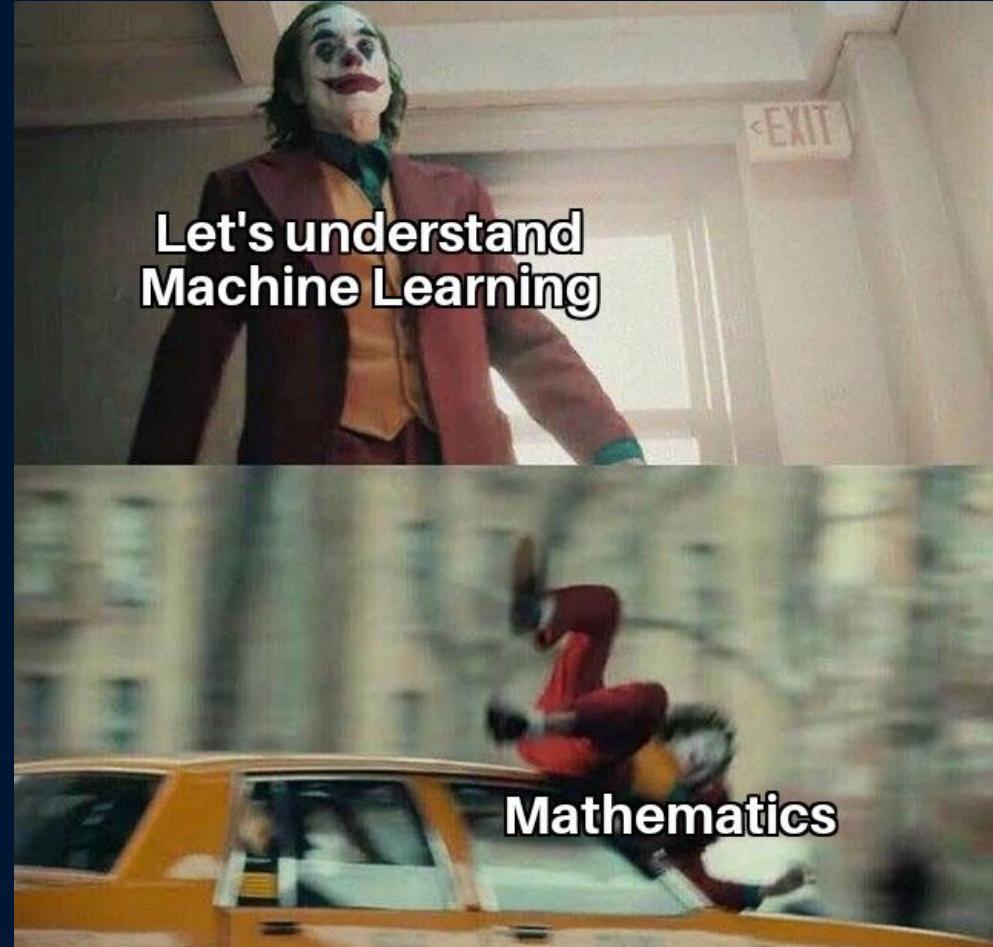


DEEP LEARNING DEVE SER FÁCIL, CERTO?



Every first year CS student be
like:

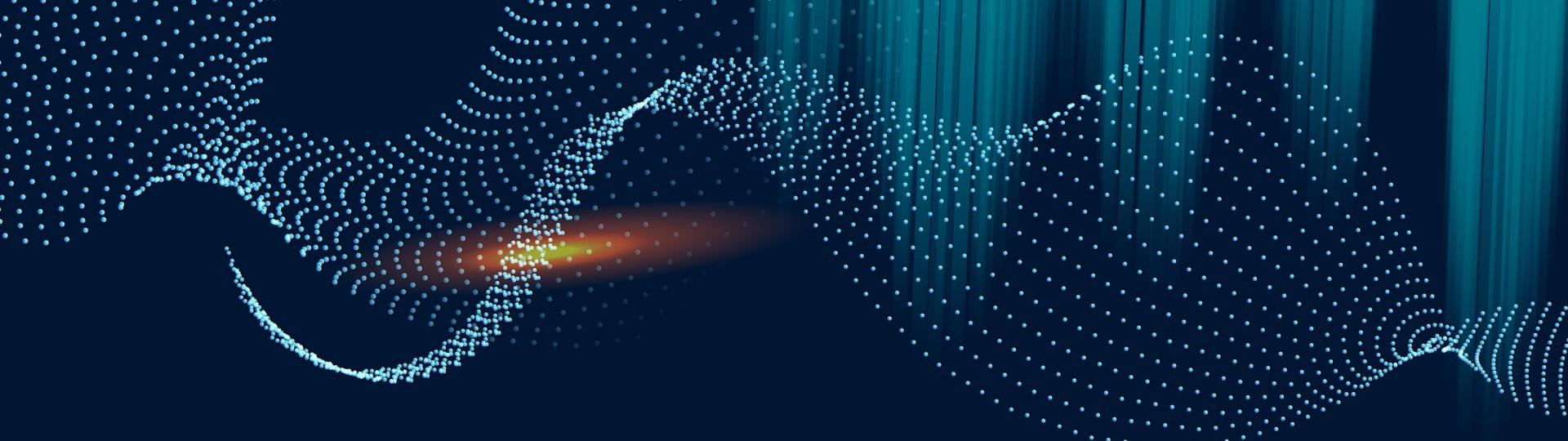
DEEP LEARNING DEVE SER FÁCIL, CERTO?



**VAMOS CRIAR UMA
REDE NEURAL
AGORA MESMO?**

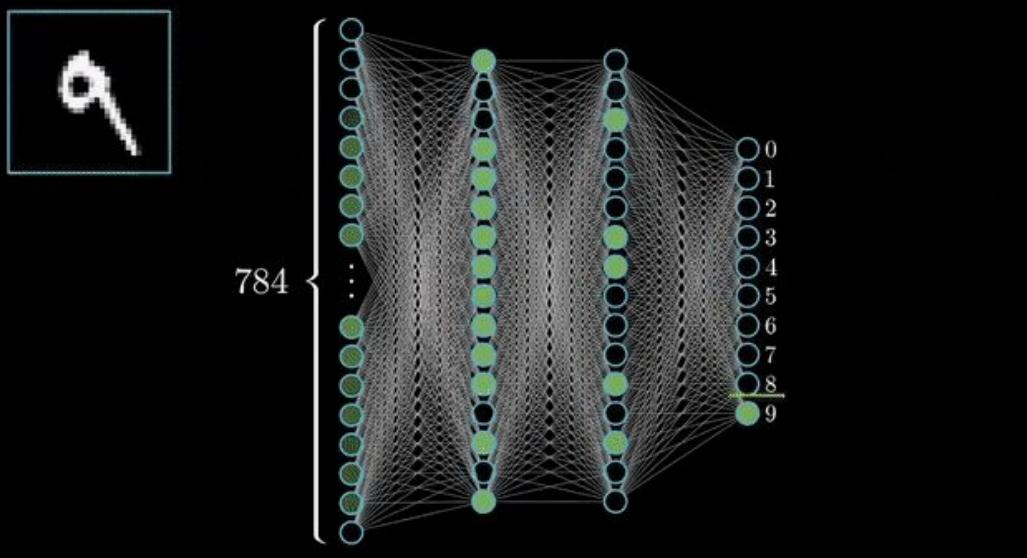
CLIQUE AQUI!



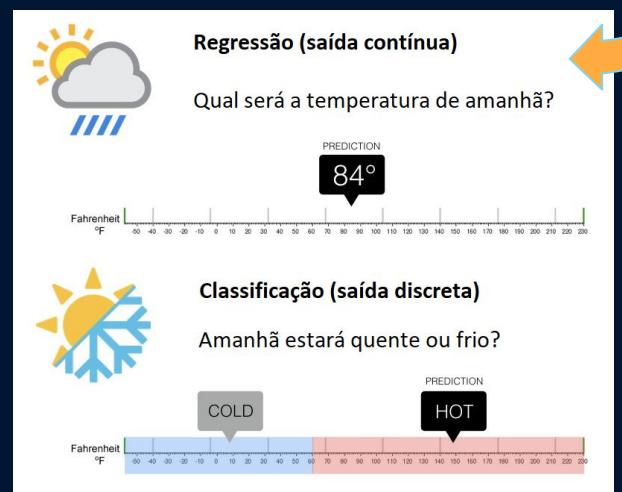


**03 | ARQUITETURAS
MAIS CONHECIDAS**

PERCEPTRON MULTICAMADA



- Fundamental para entender arquiteturas mais complexas
- Útil para dados simples em formato de tabela, como documentos em formato excel (csv) e imagens muito simples
- Séries temporais, problemas de classificação e regressão

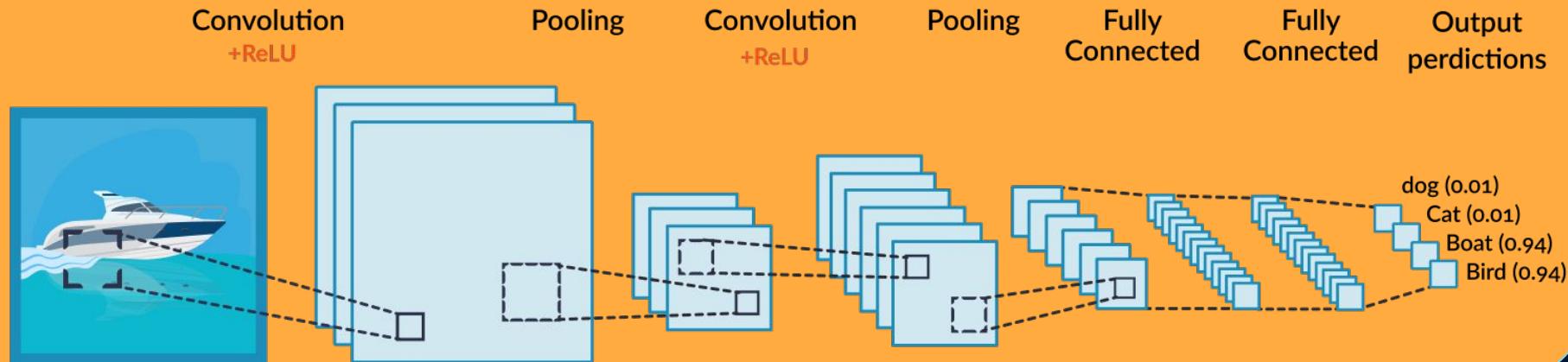
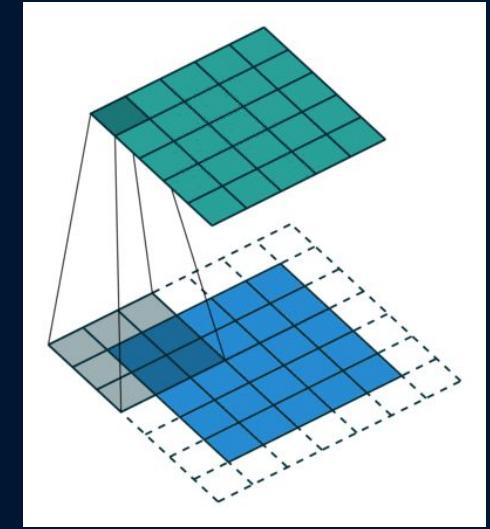


EXEMPLO DE PERCEPTRON MULTICAMADA PARA DETECÇÃO DE AVC

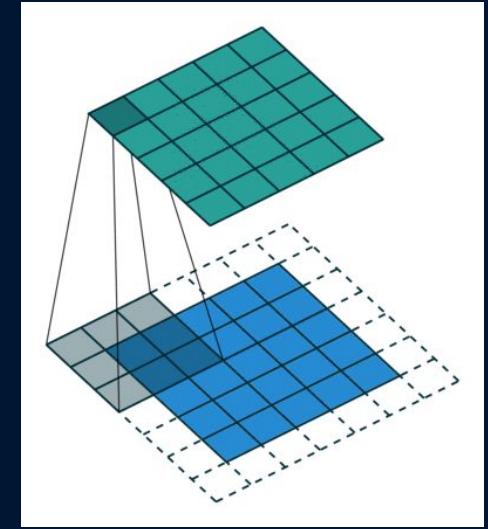


REDES NEURAIS CONVOLUCIONAIS

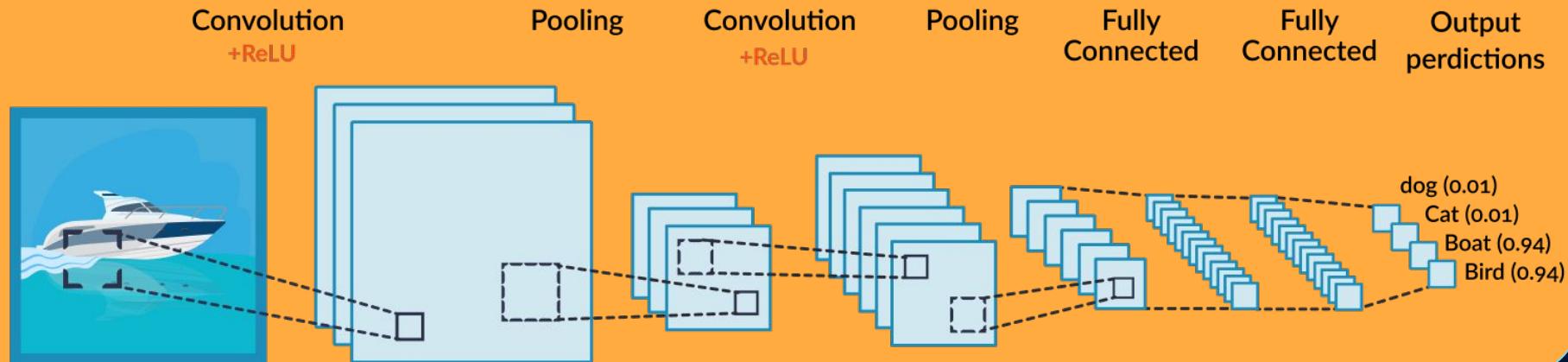
- Criada para operações envolvendo imagens, independente da resolução
- Uma das versões da ResNet, implementação CNN, possui até **152 camadas**



REDES NEURAIS CONVOLUCIONAIS



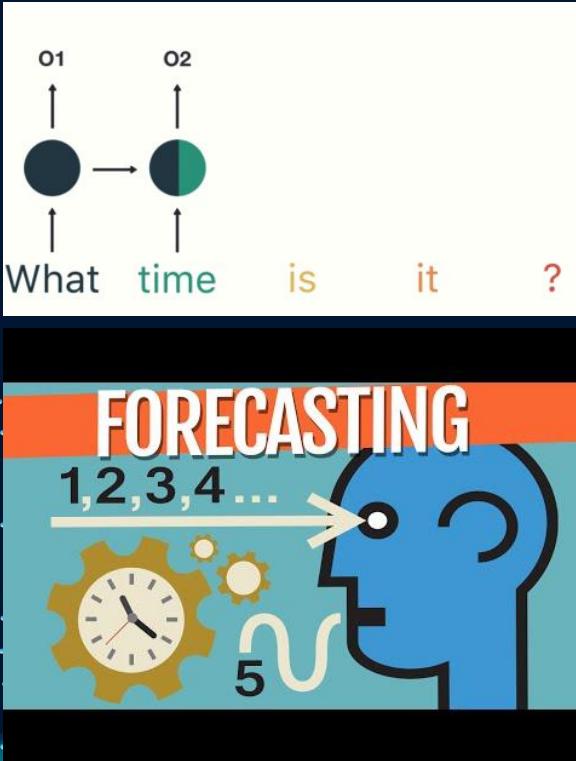
- Criada para operações envolvendo imagens, independente da resolução
- Uma das versões da ResNet, implementação CNN, possui até **152 camadas**



EXEMPLO DE REDE CONVOLUCIONAL PARA DETECTAR CÃES E GATOS



REDES NEURAIS RECORRENTES



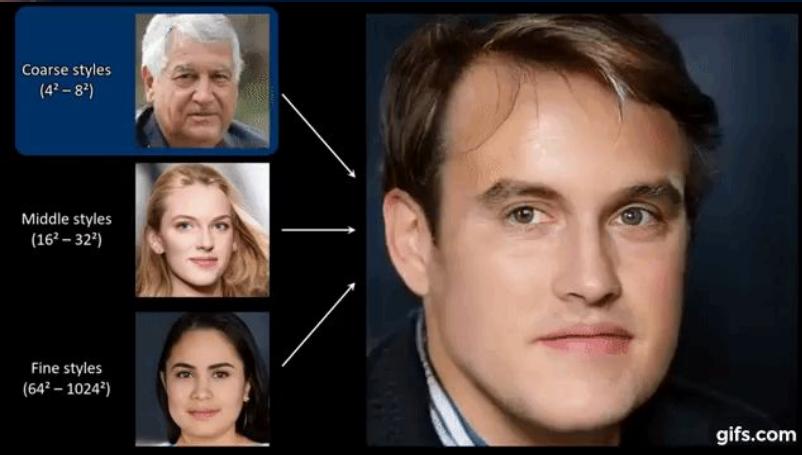
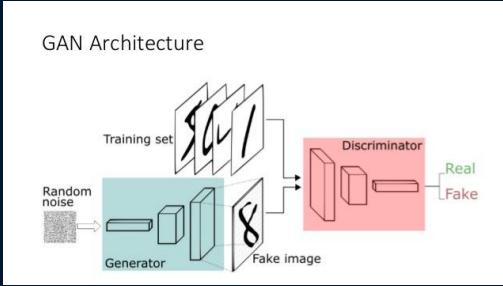
- Boa para dados baseados no tempo
- Predizer dados sequenciais
- Muito usada em reconhecimento de voz, tradução, previsões de mercado de ações, legenda de conteúdo em imagens, carros autônomos



EXEMPLO DE REDE RECORRENTE PARA MERCADO DE AÇÕES



REDES GENERATIVAS ADVERSÁRIAS



- Competição entre duas redes neurais (geradora e discriminadora)
- A geradora produz conteúdo sintético
- A discriminadora tenta discriminar entre conteúdo real e “falso” (natural e sintético)
- O objetivo do gerador é enganar o discriminador



TEXT-TO-IMAGE GENERATORS

TEXT DESCRIPTION

An astronaut Teddy bears A bowl of soup

riding a horse lounging in a tropical resort in space playing basketball with cats in space

in a photorealistic style in the style of Andy Warhol as a pencil drawing



DALL-E 2



Stable Diffusion Demo

Stable Diffusion is a state of the art text-to-image model that generates images from text.

For faster generation and API access you can try [DreamStudio Beta](#)

A high tech solarpunk utopia in the Amazon rainforest

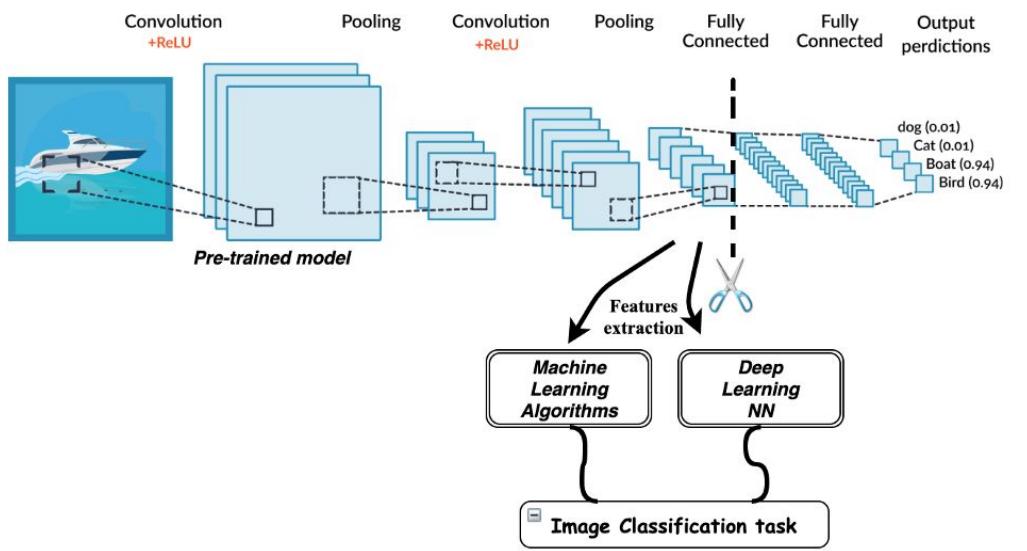
Generate image



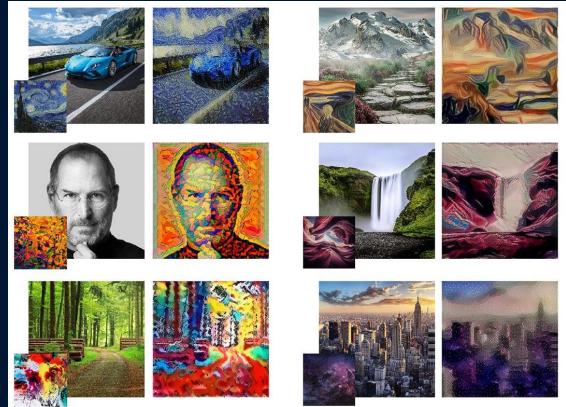
<https://openai.com/dall-e-2/>

<https://huggingface.co/spaces/stabilityai/stable-diffusion>

APRENDIZADO POR TRANSFERÊNCIA

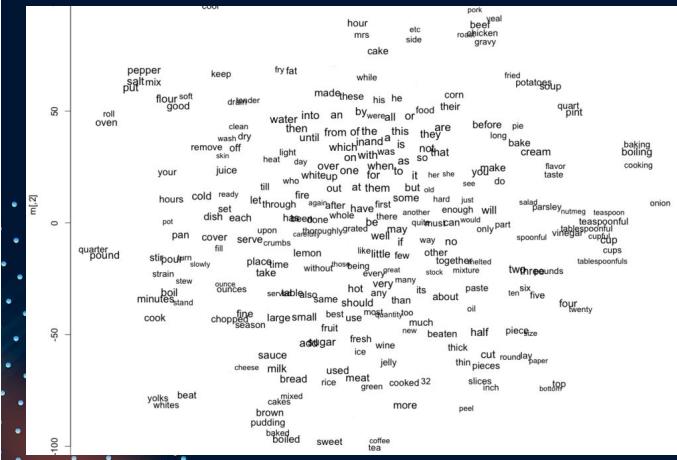
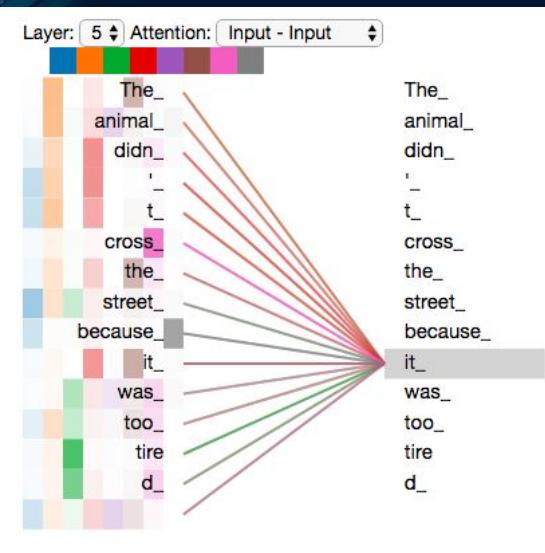


- Usar uma rede neural treinada em uma situação para outro contexto



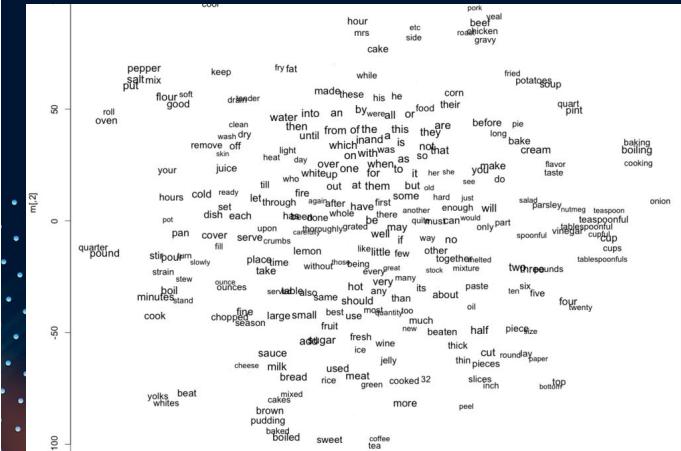
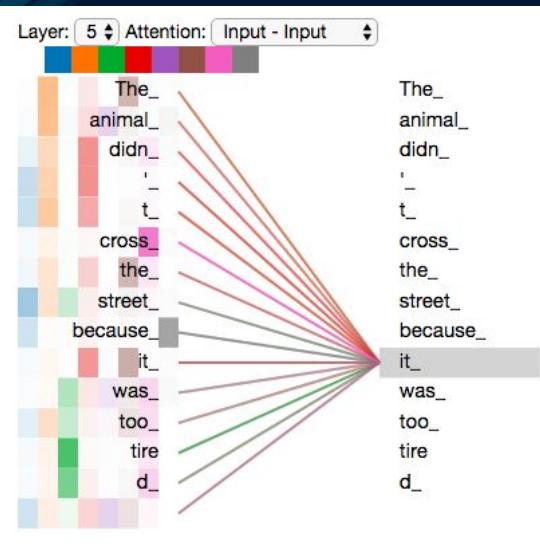
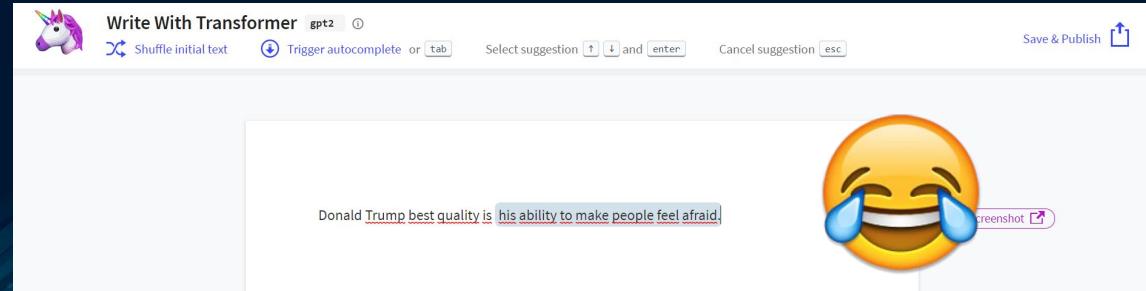
TRANSFORMER

Clique
aqui para
testar!

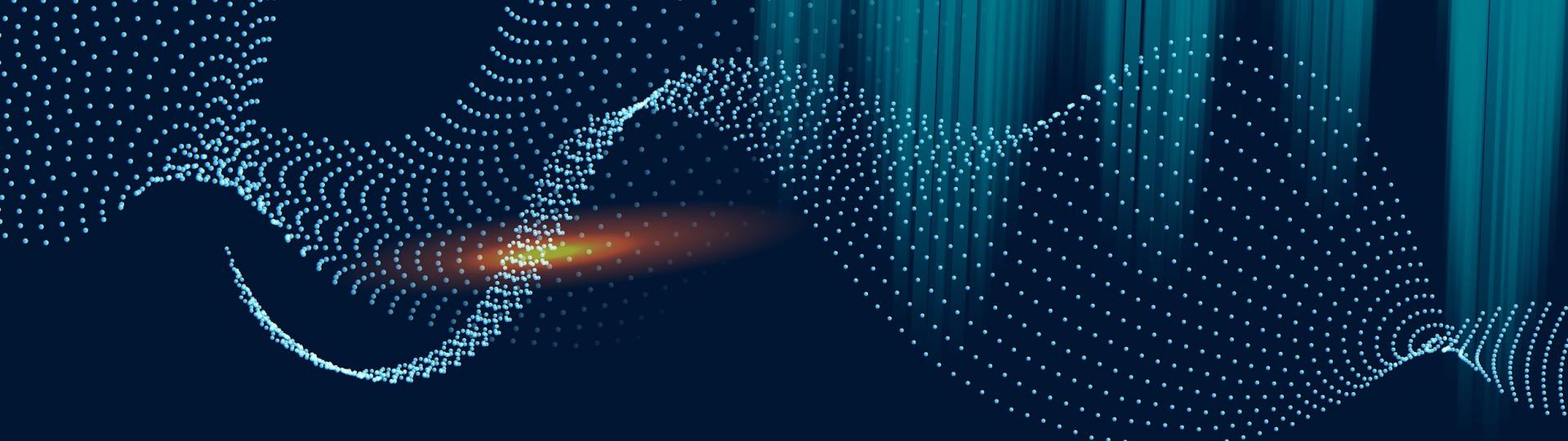


- Relação entre palavras de uma sequência
- Representação de palavras em domínio espacial
- Exemplos:
 - BERT (Google)
 - GPT-2 e GPT-3 (OpenAI)
 - RoBERTa (Facebook)
 - Megatron (Nvidia)

TRANSFORMER



- Relação entre palavras de uma sequência
- Representação de palavras em domínio espacial
- Exemplos:
 - BERT (Google)
 - GPT-2 e GPT-3 (OpenAI)
 - RoBERTa (Facebook)
 - Megatron (Nvidia)



04 | TECNOLOGIAS
MAIS USADAS

PRINCIPAIS BIBLIOTECAS



- Google
- Programação Imperativa
- Integração com Keras
- Tensorflow.js



- Facebook
- Representação em Grafos
- “Mais Pythonica”
- PyTorch Lightning, Fast.Ai

PRINCIPAIS LINGUAGENS



PYTHON

- Mais usada
- Fácil de usar
- Escalável
- Propósito geral
- Open-Source
- Sklearn, MXNet, Keras, Tensorflow, Pythorch



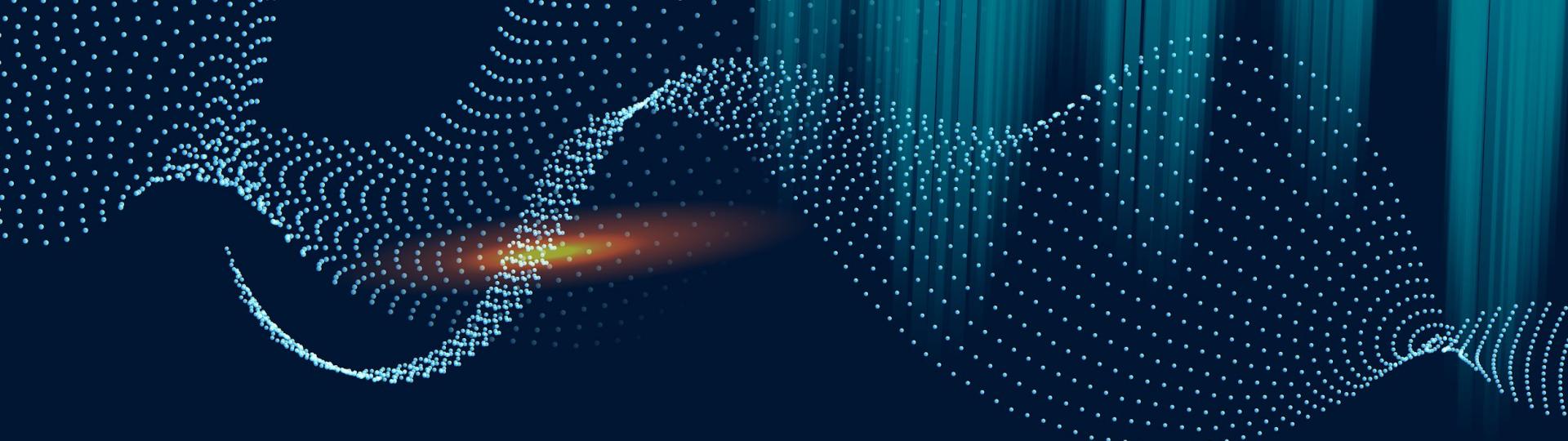
R

- Análise de Dados e Visualização
- Mais apropriada para Estatística
- Curva de Aprendizado mais longa



JULIA

- Na teoria é computacionalmente mais eficiente do que Python
- Não tem o mesmo suporte da comunidade do que Python e R



05 | FUTURO

SELF-SUPERVISED LEARNING



- Humanos aprendem com muito menos dados do que computadores. Por quê?
- A ideia é permitir que máquinas aprendam dados sem depender tanto de supervisão humana
- Passo para IAG (IA Geral)
- Transformer (BERT, GPT) é um avanço nessa direção



SELF-SUPERVISED LEARNING

The world is not entirely predictable / stochastic

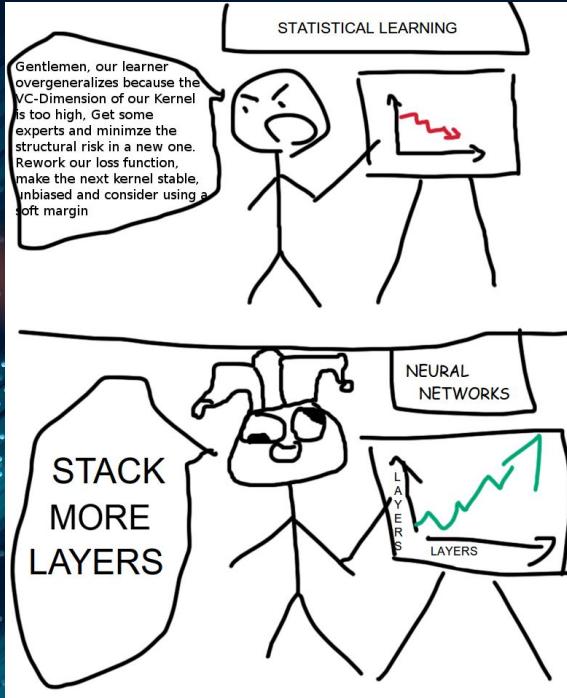
Y. LeCun

- ▶ **Video prediction:**
- ▶ Multiple futures are possible.
- ▶ Training a system to make a single prediction results in “blurry” results
- ▶ the average of all the possible futures

The collage includes:

- A photograph of three children at a table, one pointing at a decorated cake, illustrating stochasticity in real-world events.
- A close-up image of a hand holding a pen over a dark surface, with several blurry, overlapping pen strokes visible, illustrating the concept of multiple futures or blurry predictions.
- A diagram showing a central point from which many thin, grey, radiating lines extend outwards, resembling a sunburst or a fan of possibilities.
- A photograph of Yann LeCun, a man with glasses and a dark jacket, speaking at a podium during a presentation.
- The ACM FCRC logo, featuring the letters "acm" above a right-pointing arrow and "FCRC" to its right, all set against a blue circular background.

MELHOR FUNDAMENTAÇÃO TEÓRICA



- A teoria sobre Redes Neurais ainda não está completamente fundamentada
- Não deu certo? “Empilha mais camadas”
- Redes Neurais não possuem o conceito de memória associativa como humanos, nem são capazes de técnicas simples como recursão

AUTOML



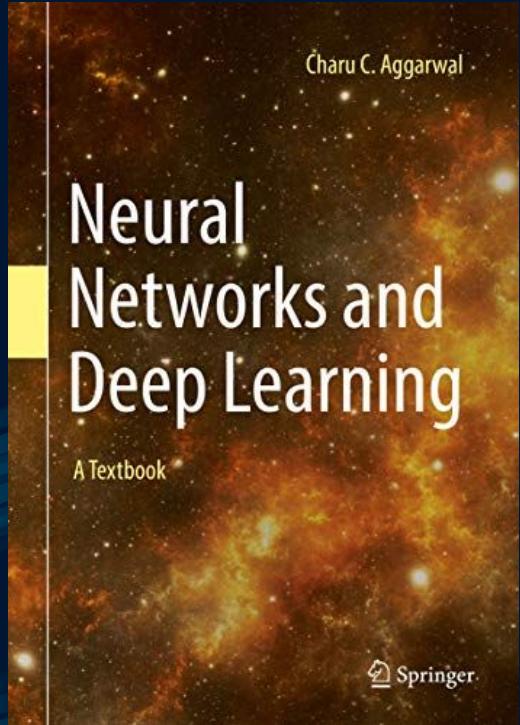
Google's AutoML

É só uma piada, a maior ameaça envolvendo IA ainda são os próprios humanos

- Imagine que você tem um problema e os dados e pede pra um programa resolver
- Nisso, o programa vai criar a rede neural perfeita pro seu problema
- Redes neurais produzindo redes neurais sob medida... Skynet?



SAIBA MAIS



Neural Networks and Deep Learning:
A Textbook (English Edition)

Charu C. Aggarwal

1st ed. 2018

SAIBA MAIS

Neural Networks and Deep Learning

Neural Networks and Deep Learning is a free online book. The book will teach you about:

- Neural networks, a beautiful biologically-inspired programming paradigm which enables a computer to learn from observational data
- Deep learning, a powerful set of techniques for learning in neural networks

Neural networks and deep learning currently provide the best solutions to many problems in image recognition, speech recognition, and natural language processing. This book will teach you many of the core concepts behind neural networks and deep learning.

For more details about the approach taken in the book, [see here](#). Or

[Neural Networks and Deep Learning](#)

[What this book is about](#)

[On the exercises and problems](#)

► [Using neural nets to recognize handwritten digits](#)

► [How the backpropagation algorithm works](#)

► [Improving the way neural networks learn](#)

► [A visual proof that neural nets can compute any function](#)

► [Why are deep neural networks hard to train?](#)

► [Deep learning](#)
[Appendix: Is there a *simple* algorithm for intelligence?](#)

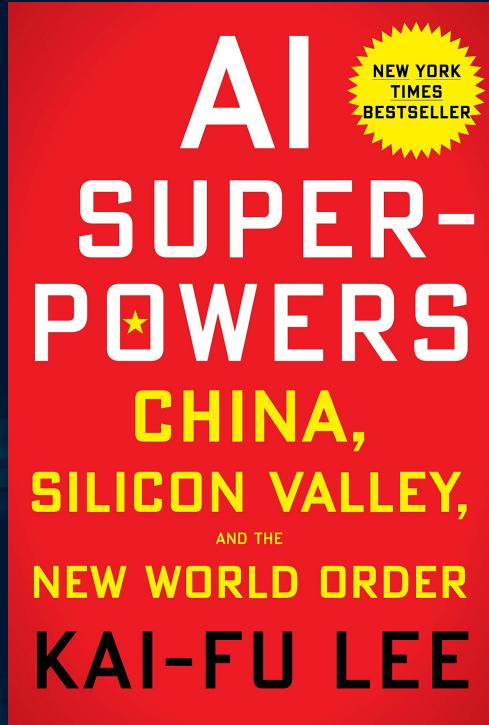
[Acknowledgements](#)

[Frequently Asked Questions](#)

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<http://neuralnetworksanddeeplearning.com/>

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AI Superpowers

Kai-Fu Lee

2018

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ALGORITMOS DE DESTRUIÇÃO EM MASSA

COMO O BIG DATA AUMENTA A DESIGUALDADE E AMEAÇA A DEMOCRACIA

Cathy O'Neil

Algoritmos de Destruição em Massa

Cathy O'Neil

2021

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Ciclo de Seminários Online Instituto de Computação

**Redes Neurais Profundas: O que são?
Como vivem? De que se alimentam?**

Prof. Eduardo Bezerra
Centro Federal de Educação Tecnológica Celso Suckow da Fonseca (CEFET/RJ)

16 de Junho
17:00

TRANSMISSÃO AO VIVO

DEEP LEARNING

YouTube http://tiny.cc/icuff_youtube **Facebook** <https://web.facebook.com/informieic/>

#Instituto de Computação #UFFContraoCoronaVirus #FiqueEmCasa



2018 ACM A.M. Turing Lecture

June 23, 2019
5:15pm MST

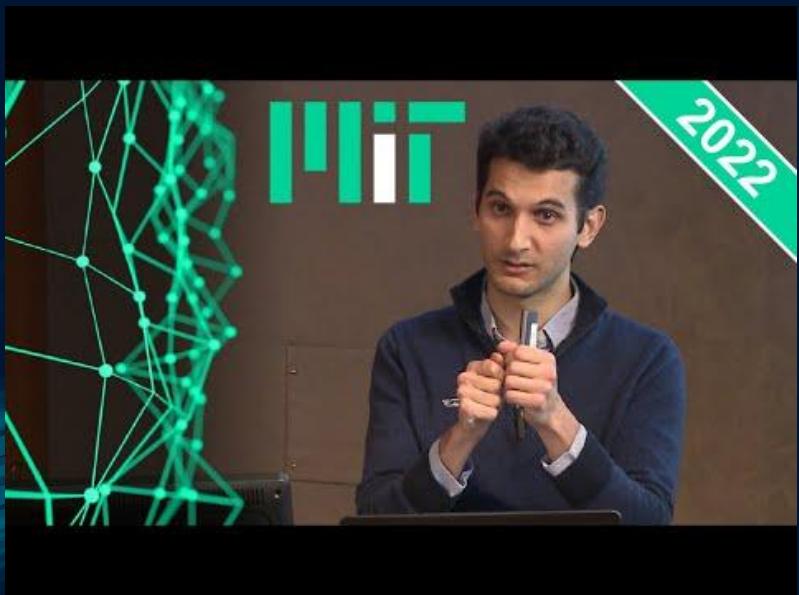
TURING AWARD 59th ACM SIGART

Geoffrey Hinton Yann LeCun

<https://www.youtube.com/watch?v=etebnvblYLY>

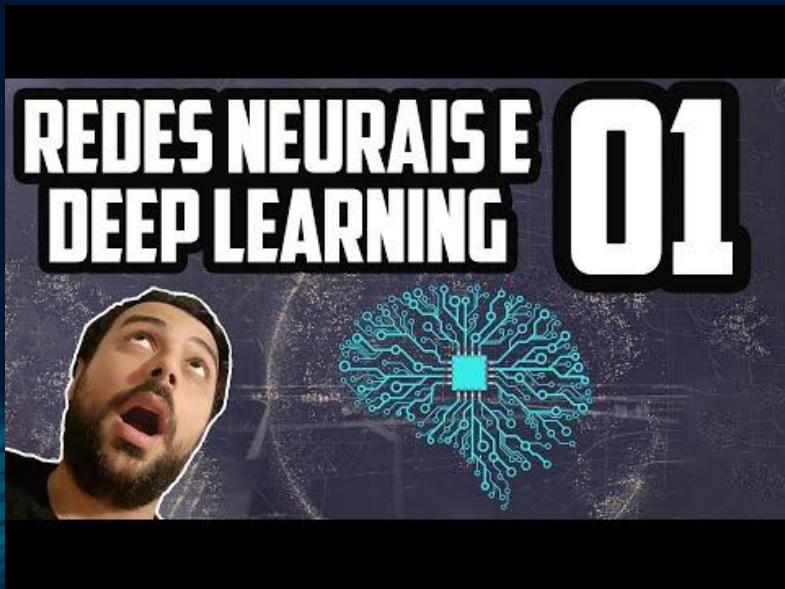
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iCjho](https://www.youtube.com/playlist?list=PL-t7zzWJWPtygNTsgC_M8c9a-p5biCjho)

OBRIGADO

Para falar comigo

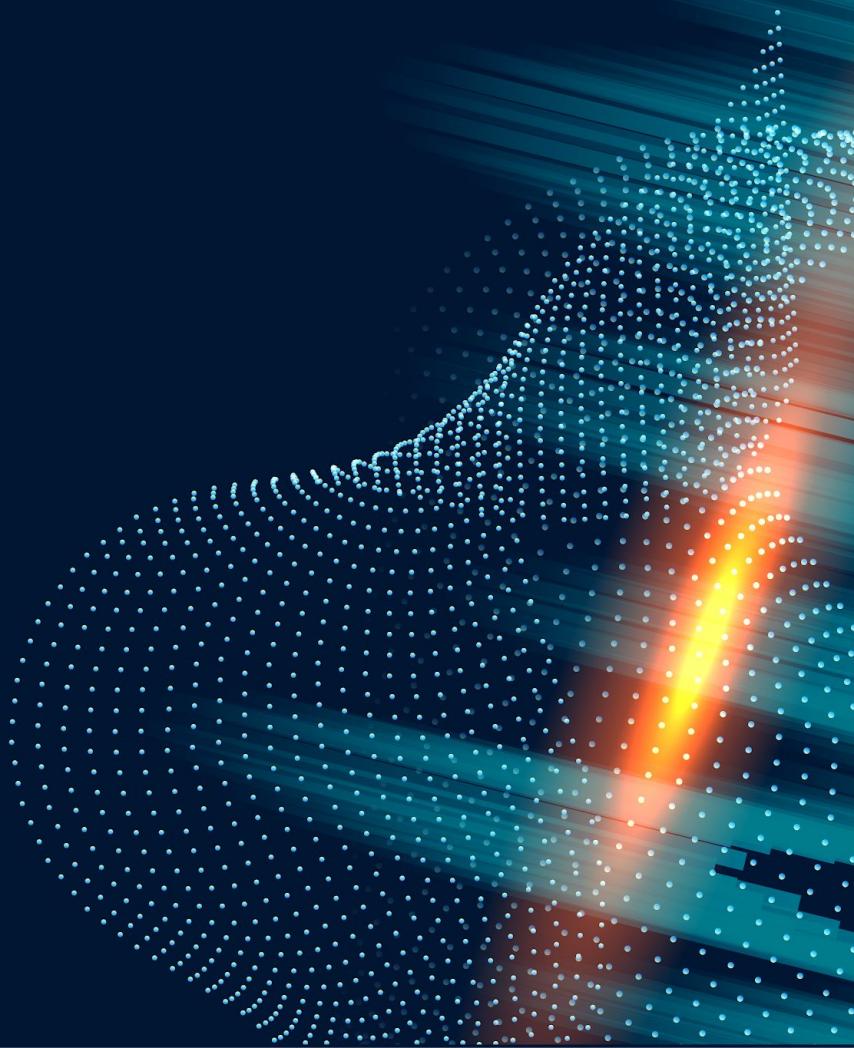
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MELHOR FUNDAMENTAÇÃO TEÓRICA



Thread completa

Lucas Lattari (Universo Discreto) @1iversoDiscreto · 17 de jun
Já Hinton é mais irônico ao dizer que "o que a maioria das pessoas fazem, não temos ideia como funciona, então se vc trocar pessoas por redes neurais, não ficará pior" =)

"sem falar que podemos lidar melhor com o viés de redes neurais do que com o viés de pessoas" OUCH

A screenshot of a Twitter thread. The top part shows a video frame of Geoff Hinton speaking on stage at the ACM FCRC conference. The bottom part shows a tweet from Lucas Lattari with a red arrow pointing to it. The tweet text is: "Ele também fala que "pessoas tem intuições que dizem a elas o que fazer e, similamente, redes neurais também tem intuições que dizem o que fazer"". Below this tweet is another video frame of Hinton speaking.

Thank you

acm FCRC

than you can with a person.

1 1 2 1 1

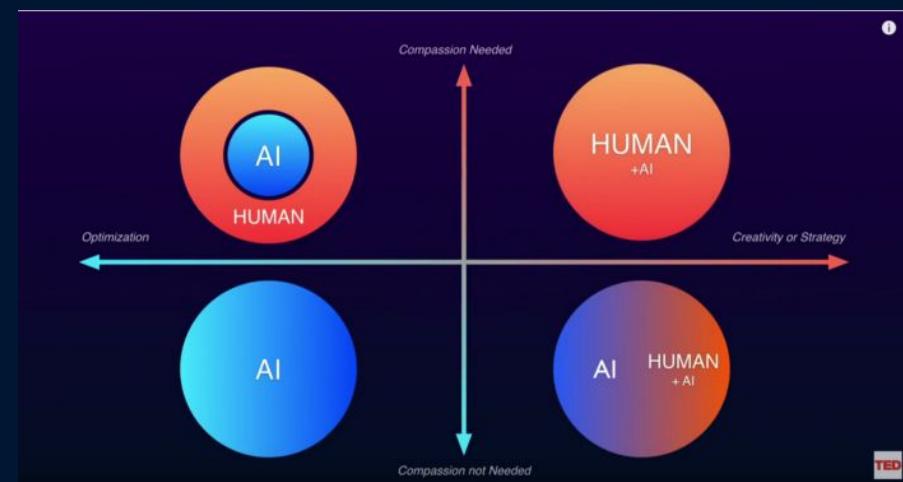
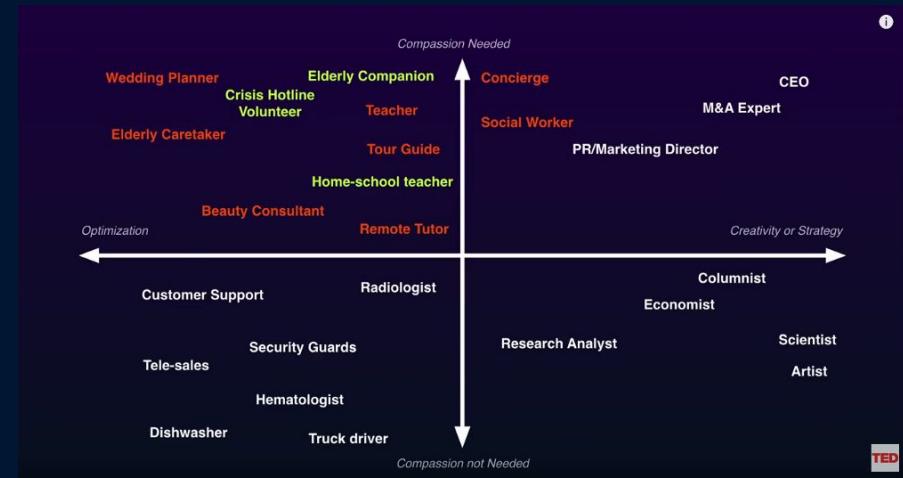
Lucas Lattari (Universo Discreto) @1iversoDiscreto · 17 de jun
Ele também fala que "pessoas tem intuições que dizem a elas o que fazer e, similmente, redes neurais também tem intuições que dizem o que fazer"

Thank you

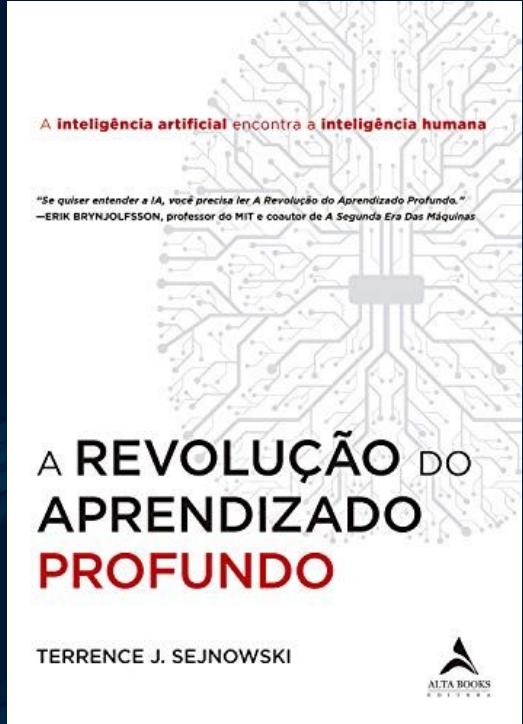
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is more likely than that.

FUTURO DO TRABALHO



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A Revolução do Aprendizado Profundo

Terrence J. Sejnowski

2020