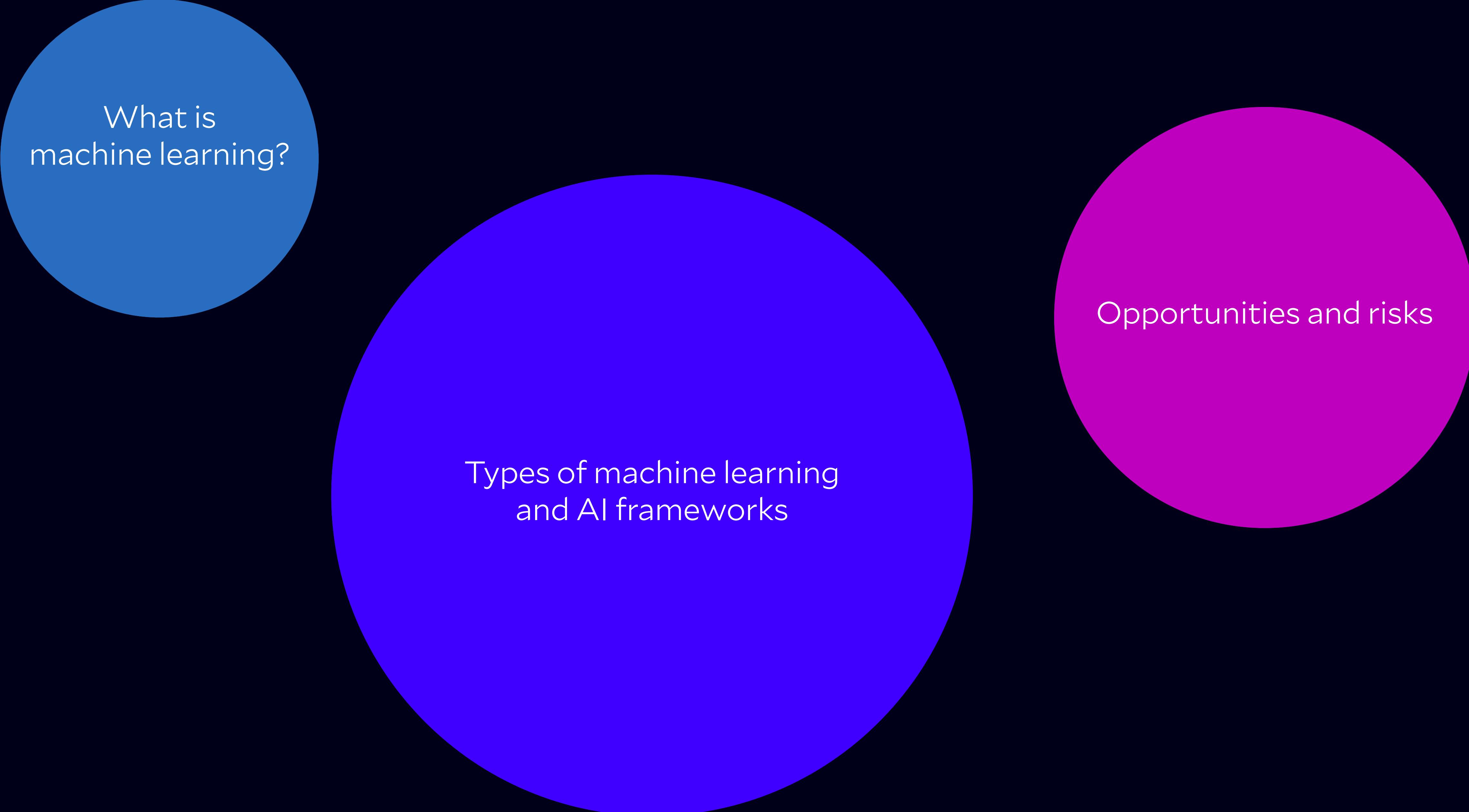


Machine Learning

What's all the fuss about?

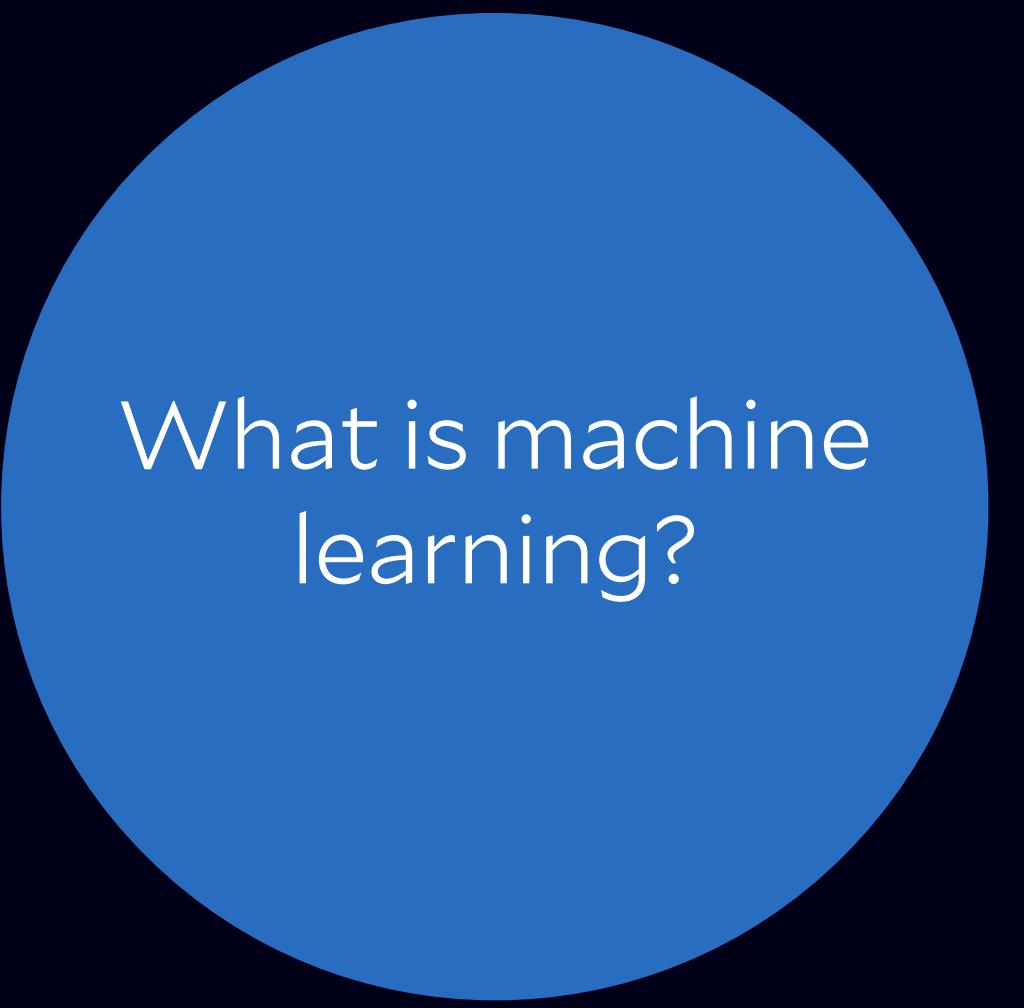
John Lafferty
Yale Reunion Weekend
June 4, 2022



What is
machine learning?

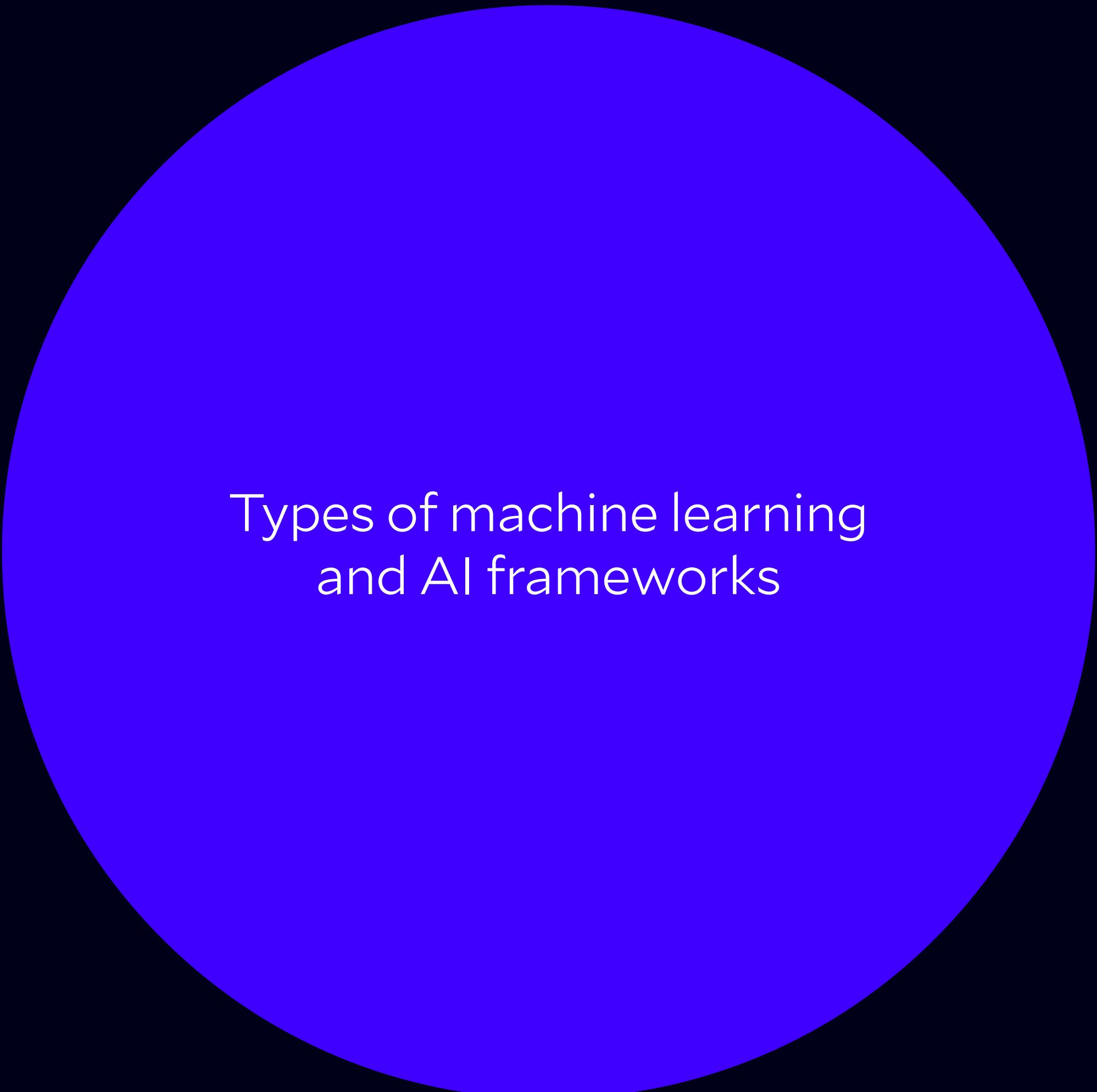
Types of machine learning
and AI frameworks

Opportunities and risks



What is machine
learning?

Examples in daily life
Examples in science
Connection with AI



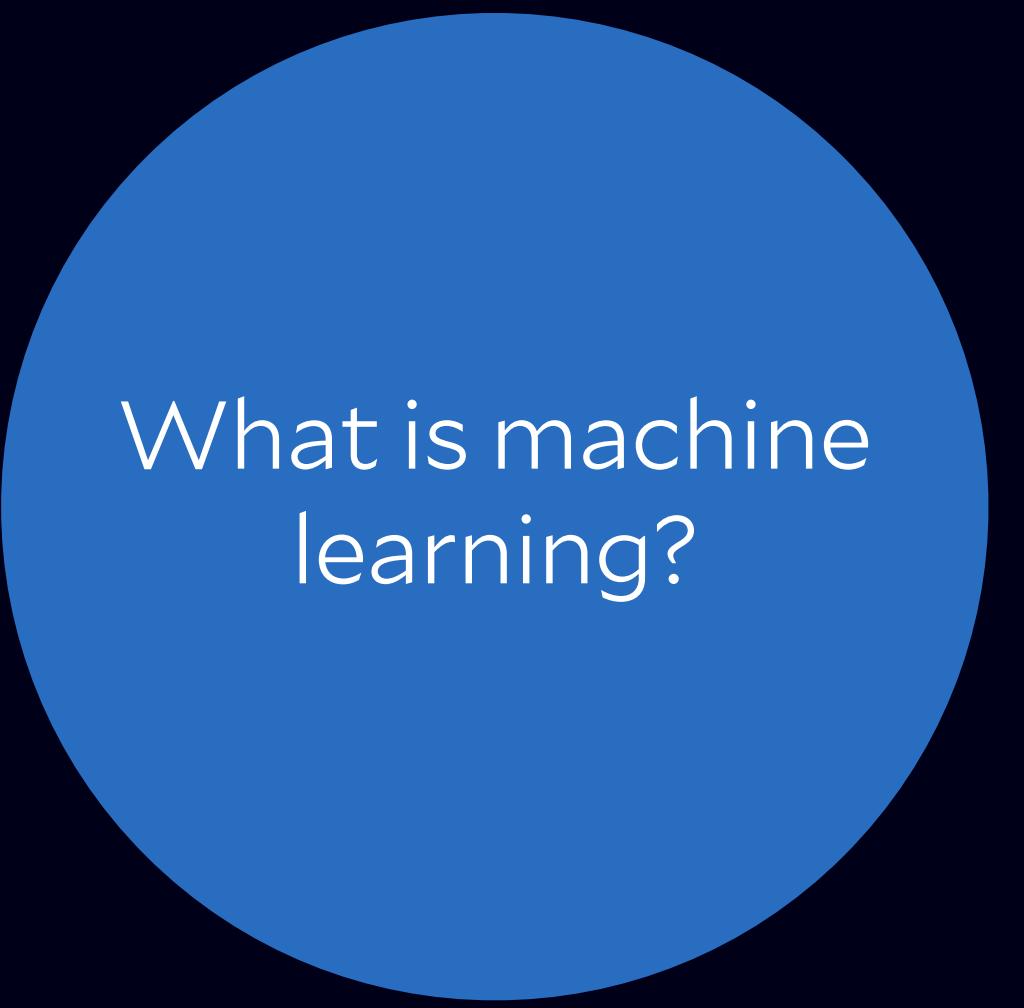
Types of machine learning
and AI frameworks

Supervised and unsupervised
Latent variable models
Deep learning
Reinforcement learning



Opportunities and risks

Prospects for science and health
Ethics and safe AI
The next frontier
Wu Tsai Institute at Yale

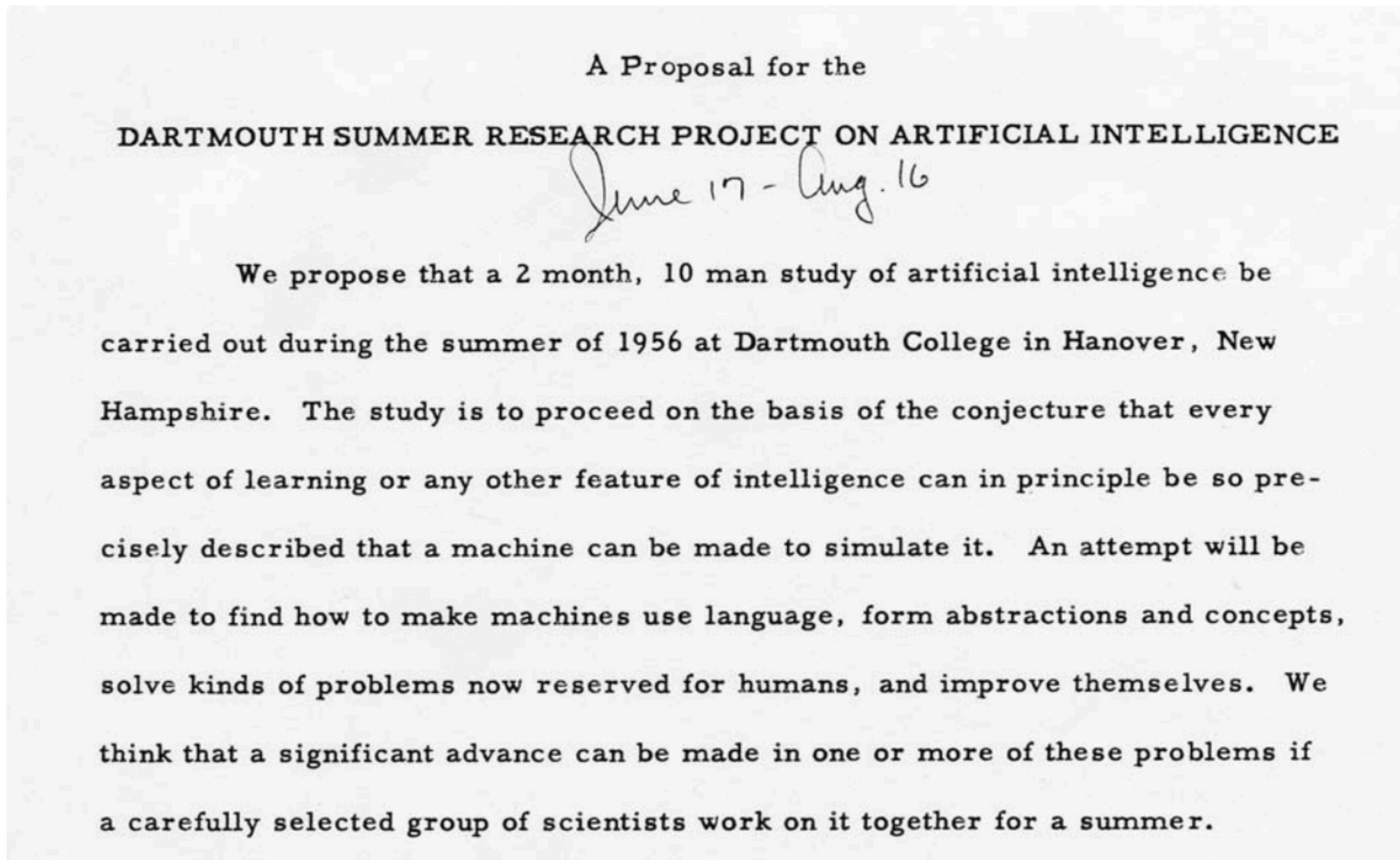


What is machine
learning?

Examples in daily life
Examples in science
Connection with AI

Early hubris

Summer 1955: John McCarthy, Marvin L. Minsky, Claude E. Shannon



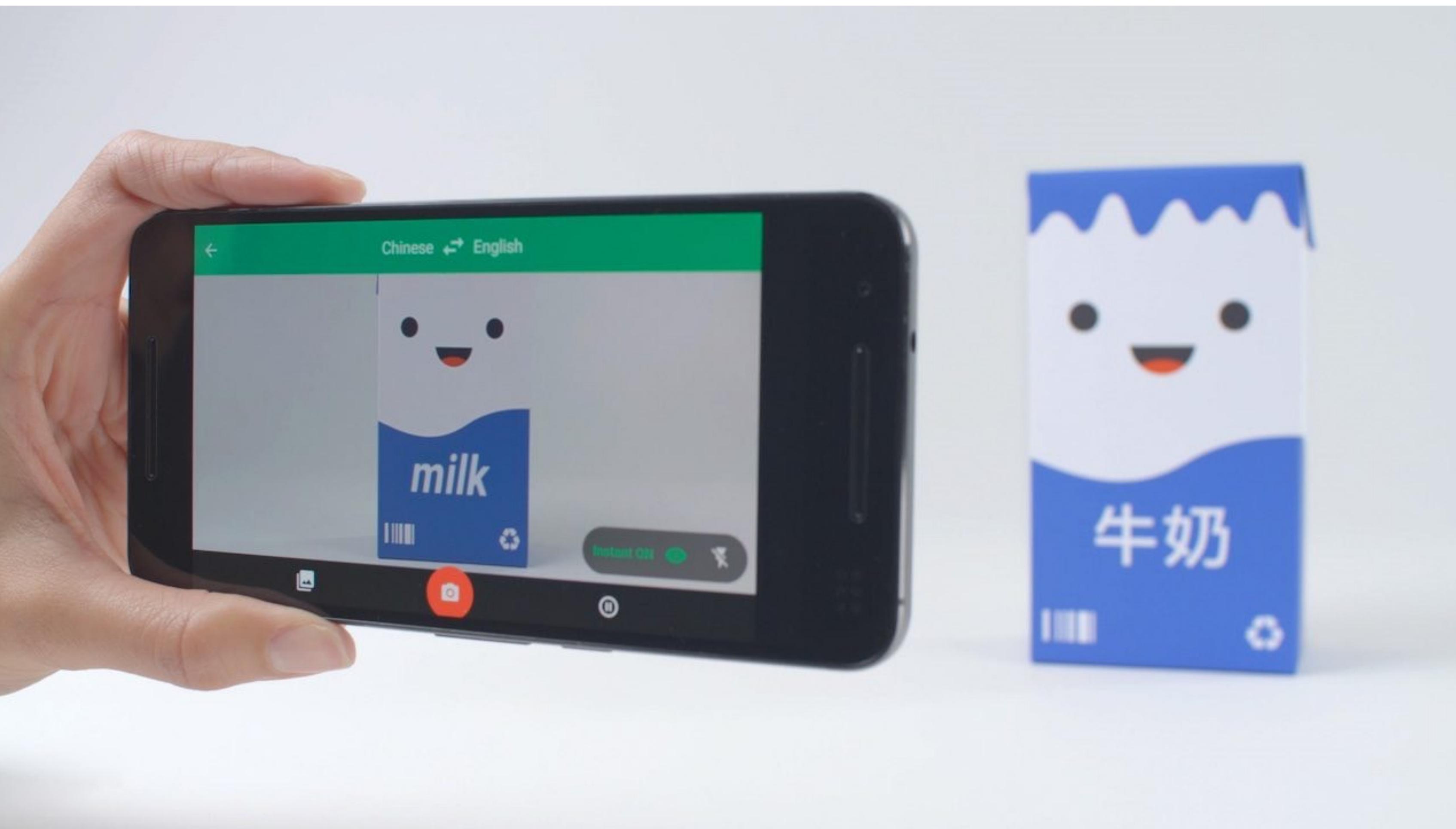
June 4, 2022

How have you used ML already today?

Today



Today



A Belarusian Olympian who complained about her coaches used Google Translate to relay her plea for help to Japanese police

Lauren Frias Aug 5, 2021, 6:46 PM



Belarusian Olympic sprinter Krystsina Tsimanouskaya said she was taken to the airport against her wishes and would not return home. Reuters

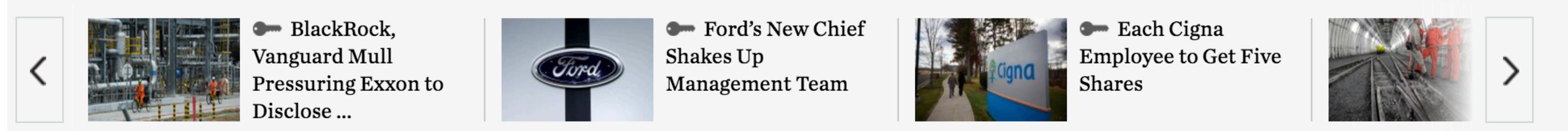


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CIO JOURNAL.



Zillow Develops Neural Network to 'See' Like a House Hunter

Granite or stainless steel countertops? Zillow's visual recognition effort can recognize the difference

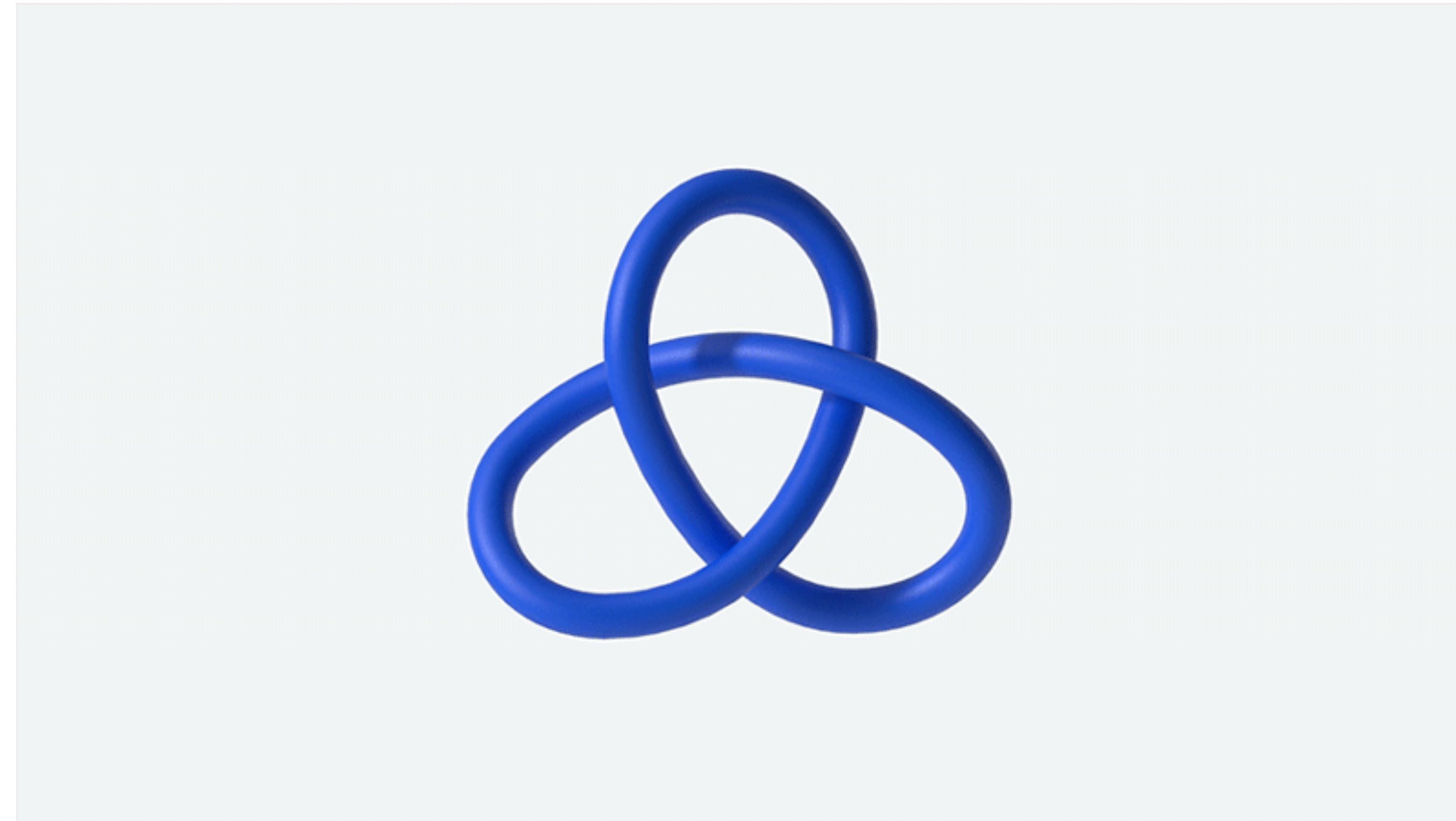
By **SARA CASTELLANOS**

Nov 11, 2016 3:29 pm ET

Data scientists at Zillow Group are developing complex computer programs that detect specific attributes in photographs of homes, which could aid in estimating their value. Advances in deep learning, big data and cloud computing have converged to allow the online real estate database firm and others to develop technology that mimics how the human brain [...]

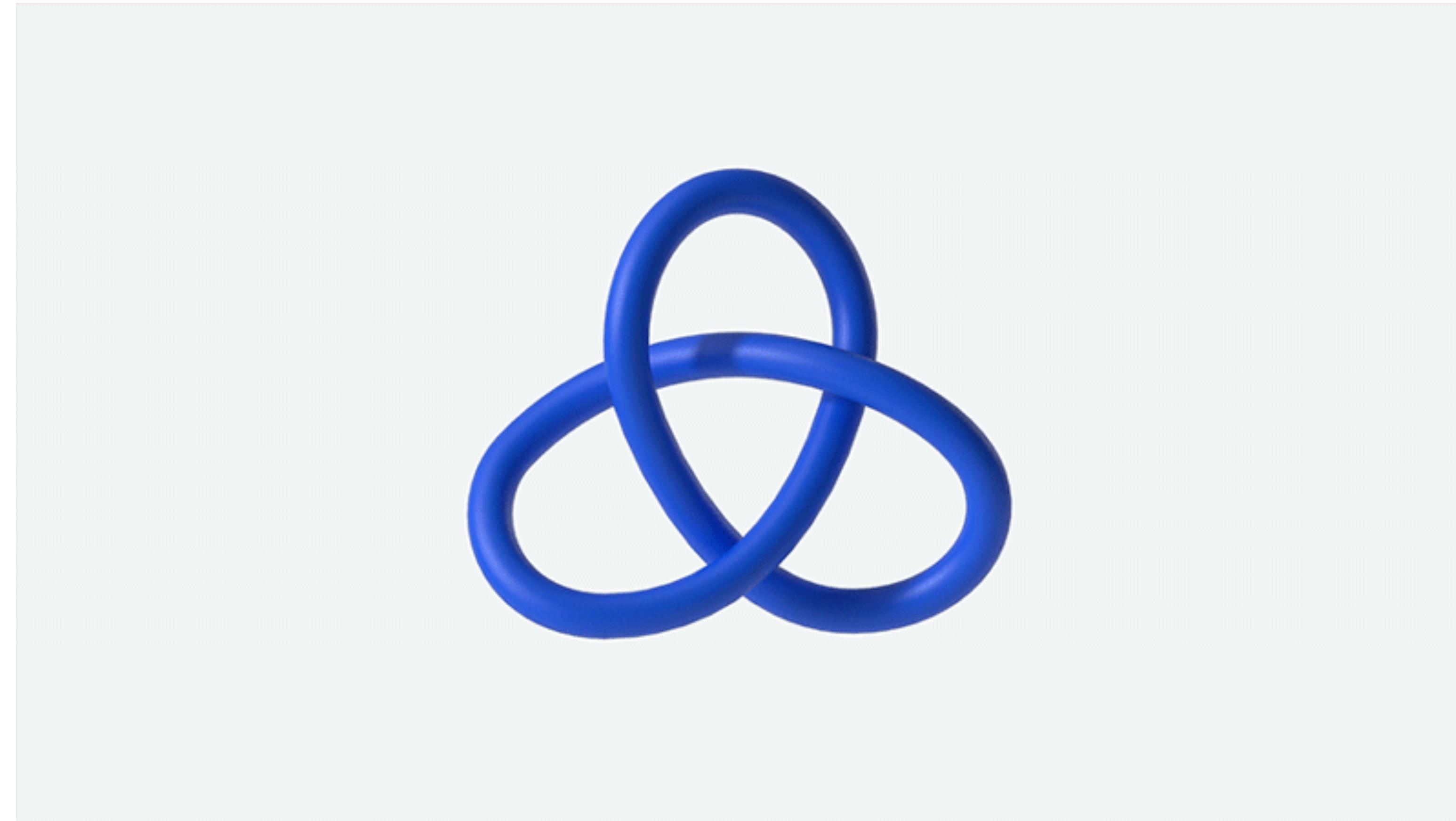
Recommended Videos

1. Film Clip: 'Pirates of the Caribbean: Dead Men Tell No Tales'
2. What to do in your 40s to retire a millionaire



Knot theorists proved the correctness of a mathematical formula about knots after using machine learning to guess what the formula should be.

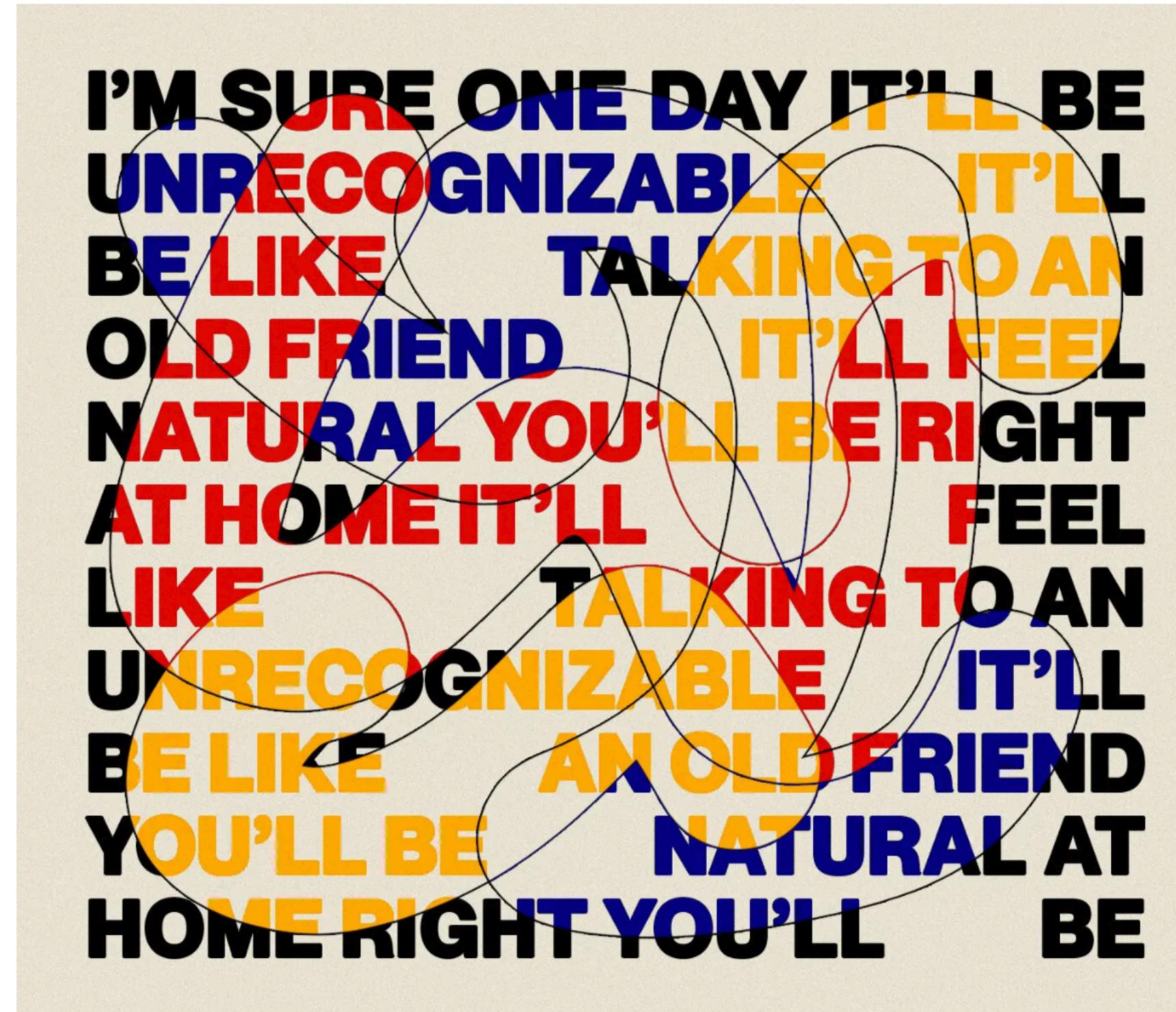
<https://www.nature.com/articles/d41586-021-03593-1>



Knot theorists proved the correctness of a mathematical formula about knots after using machine learning to guess what the formula should be.

<https://www.nature.com/articles/d41586-021-03593-1>

A Robot Wrote This Book Review



Elliot Ulm

By [Kevin Roose](#)

Nov. 21, 2021

THE AGE OF AI

And Our Human Future

By Henry A. Kissinger, Eric Schmidt and Daniel Hattenlocher

One of the great promises of technology is that it can do the work that humans find too boring or arduous.

In the 19th and 20th centuries, factory machines relieved us of repetitive manual labor and backbreaking farm work. In this century, artificial intelligence has taken care of a few more tasks — curating Spotify playlists, selecting the next YouTube video, vacuuming the floor and so on — but many more mind-numbing activities remain ripe for the picking. The experts promise us that someday, all of our least favorite chores — including complex cognitive ones, like interviewing job candidates or managing global supply chains — will be outsourced to machines.

But that day has not yet arrived. Or has it?

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MENU



Jackson Institute establishes Schmidt Program on Artificial Intelligence, Emerging Technologies, and National Power

December 8, 2021 | by Yale Jackson

By Kevin Roose

Nov. 21, 2021

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<https://jackson.yale.edu/news/schmidt-program/>

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search

MENU



Jackson Institute establishes Schmidt Program on Artificial Intelligence, Emerging Technologies, and National Power

December 8, 2021 | by Yale Jackson

<https://jackson.yale.edu/news/schmidt-program/>

OpenAI's GPT-3 language model writes:

Kissinger, Schmidt and Hüttenlocher are not afraid to explore the darkest side of AI, either. They are clear-eyed about the ways that AI could enable dictators to monitor their citizens and manipulate information to incite people to commit violence.

Although AI is already making our lives better in many ways, Kissinger, Schmidt and Hüttenlocher caution that it will take us as a species many years to create a system as powerful as we deserve. They wisely suggest that we not lose sight of the values we want to instill in this new machine intelligence.

A.I. Is Mastering Language. Should We Trust What It Says?

OpenAI's GPT-3 and other neural nets can now write original prose with mind-boggling fluency — a development that could have profound implications for the future.

*k i n d
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language, conversation. AI convincing rely
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<https://www.nytimes.com/2022/04/15/magazine/ai-language.html>

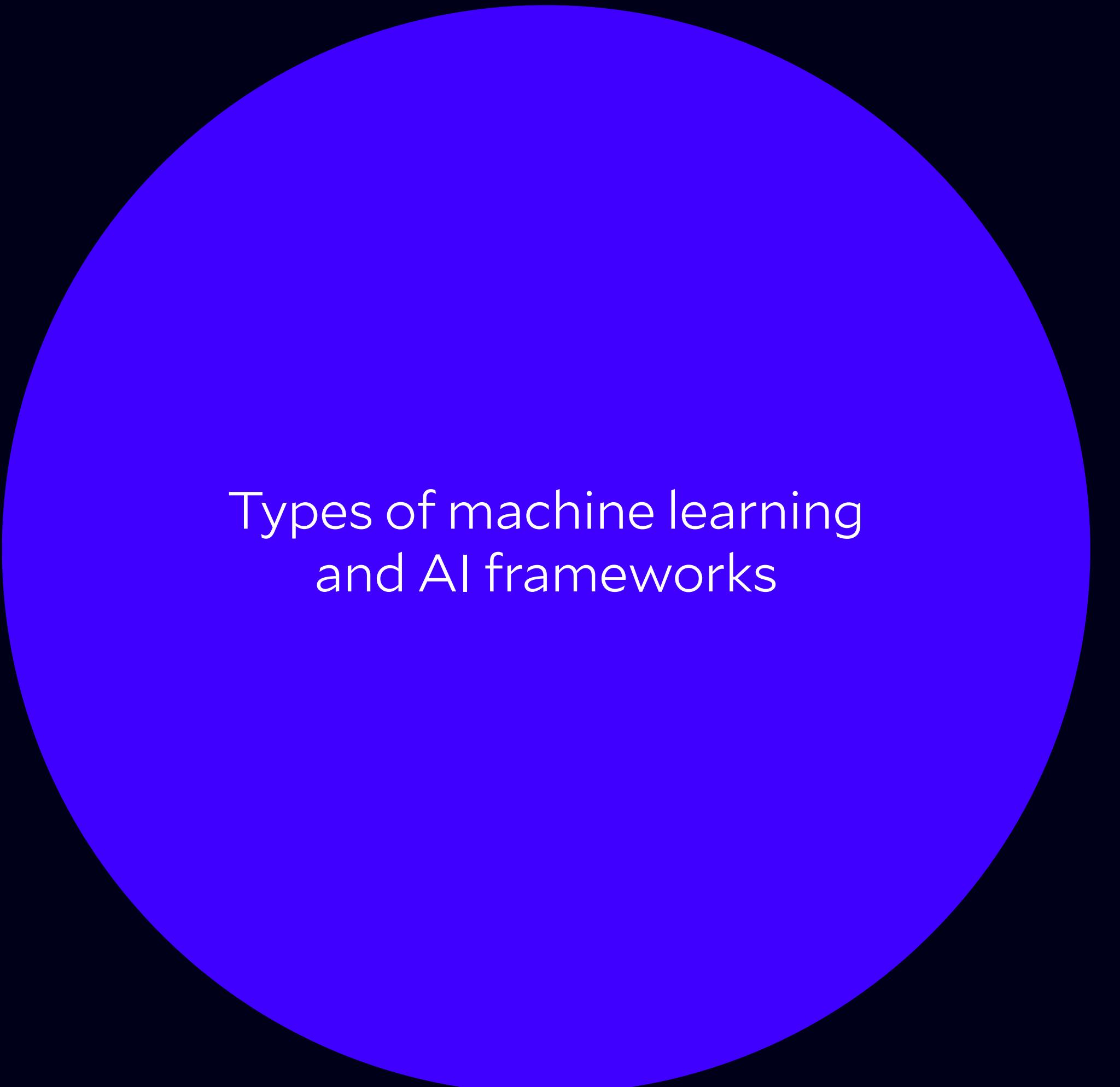
[GPT-3 demo]

What is machine learning?

The science of algorithms and computational models
that make predictions and improve with experience

ML vs AI

- Machine learning focuses on making predictions and inferences from data
- AI combines ML components into a larger system that includes a decision making component
- *An AI system exhibits a behavior, as a result of the collective decisions that are made*



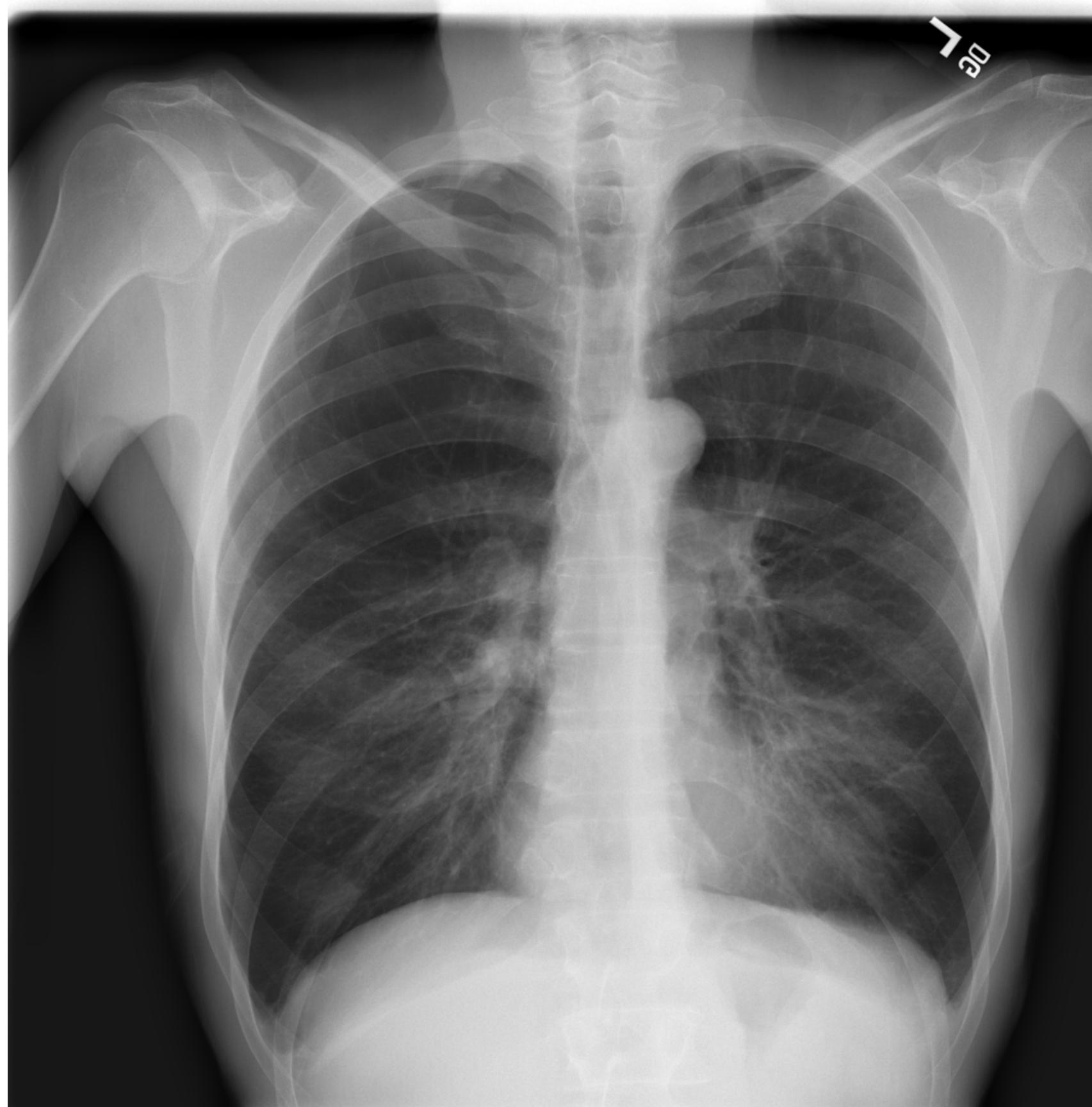
Types of machine learning
and AI frameworks

Supervised and unsupervised
Latent variable models
Deep learning
Reinforcement learning

Types of machine learning

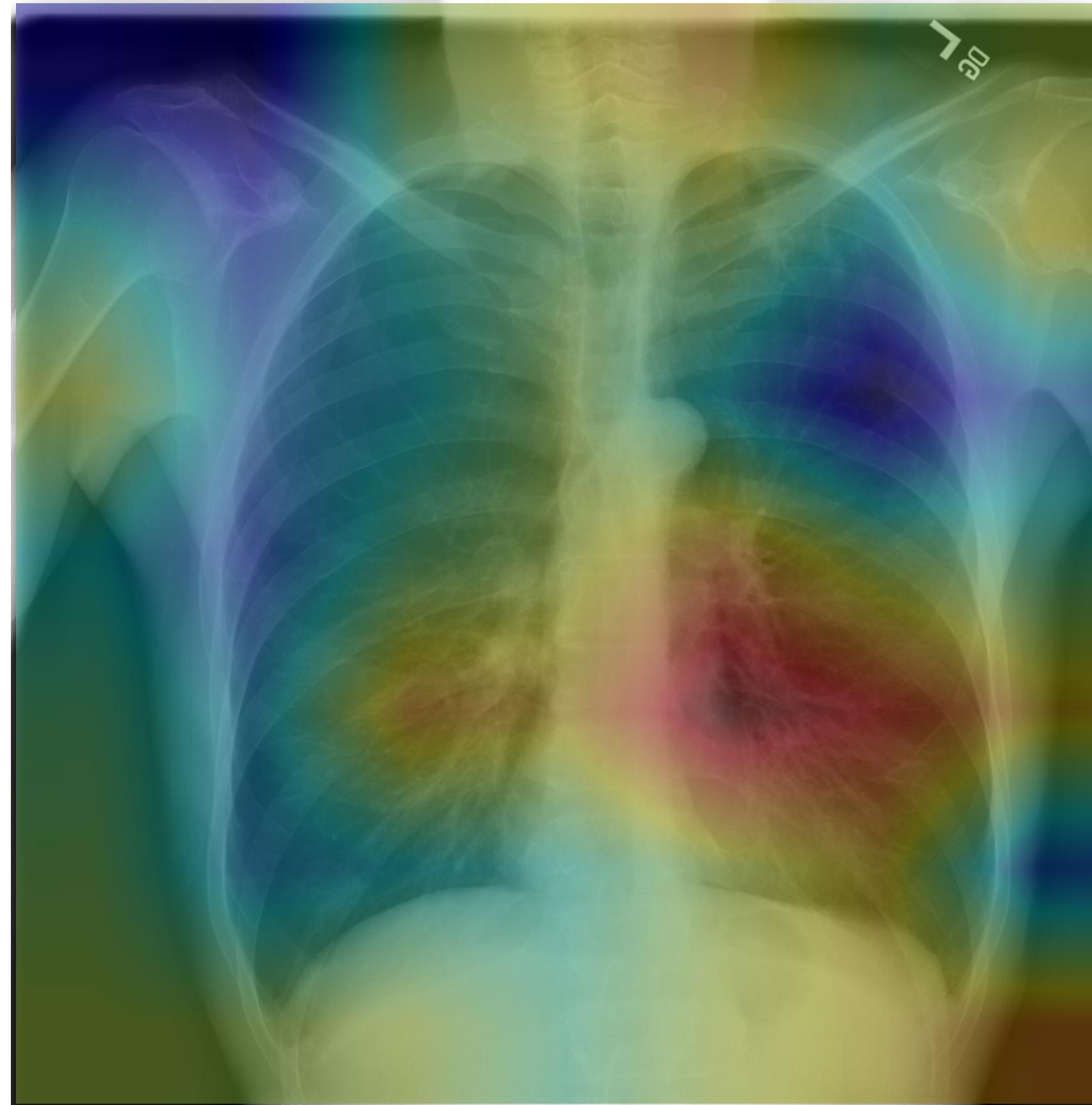
- Supervised learning: Large database of example predictions is given to the computer. Algorithm learns a prediction rule
- Unsupervised learning: Large dataset is provided, without “labels.” Algorithm discovers patterns and features of the data

Supervised learning: Example



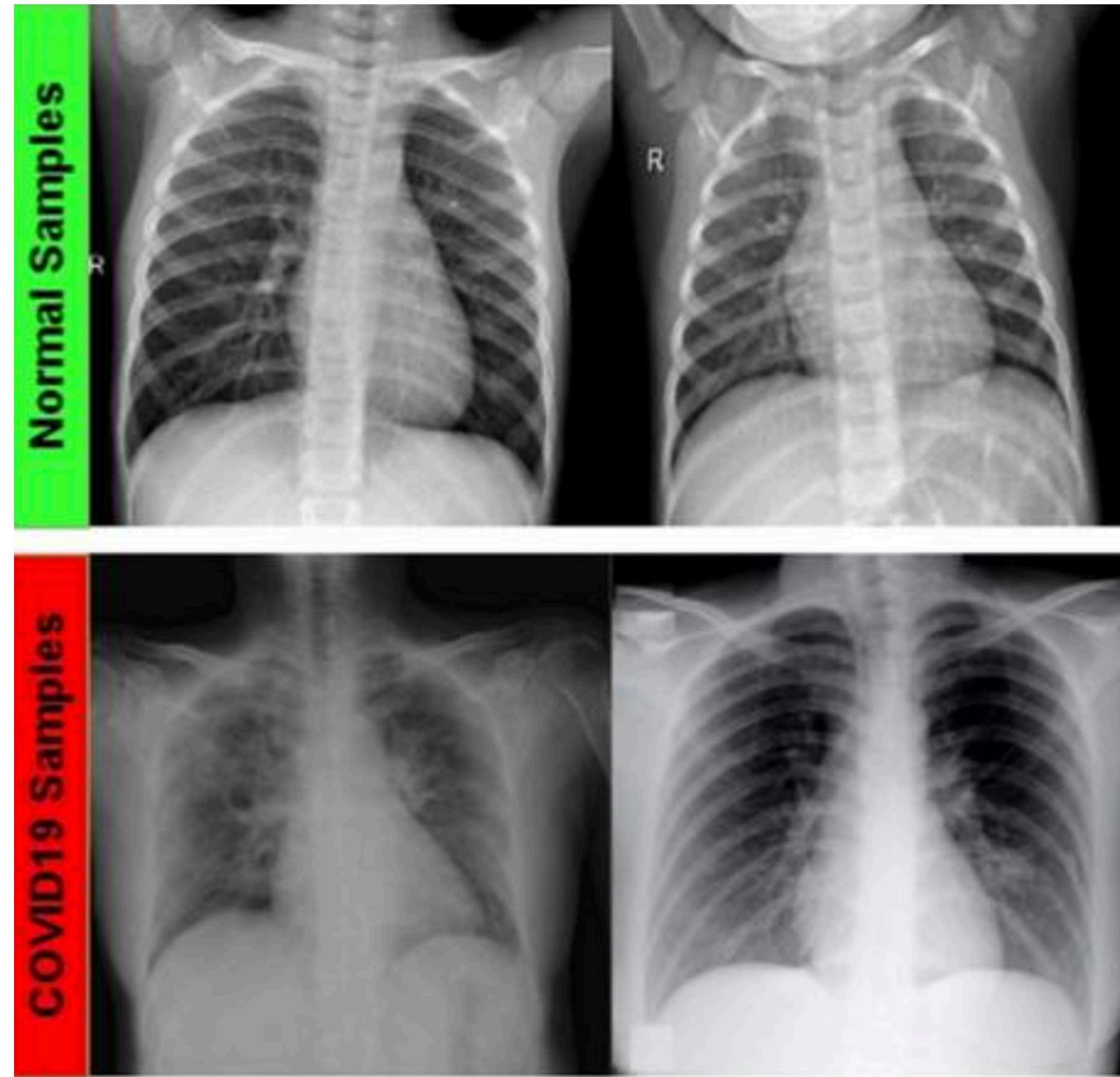
A large neural network analyzes chest X-ray images for pneumonia, with heat map showing affected regions.

Supervised learning: Example



A large neural network analyzes chest X-ray images for pneumonia, with heat map showing affected regions.

Supervised learning: Example



A large neural network analyzes chest X-ray images for **COVID-19**, with heat map showing affected regions.

Supervised learning: Example

Journal List > Nature Public Health Emergency Collection > PMC7679792

Nature Public Health Emergency Collection

Nature Public Health Emergency Collection

Public Health Emergency COVID-19 Initiative

Soft comput. 2020 Nov 21 : 1–16.
doi: [10.1007/s00500-020-05424-3](https://doi.org/10.1007/s00500-020-05424-3) [Epub ahead of print]

PMCID: [PMC7679792](#)
PMID: [33250662](#)

COVID-CheXNet: hybrid deep learning framework for identifying COVID-19 virus in chest X-rays images

Alaa S. Al-Waisy,¹ Shumoos Al-Fahdawi,² Mazin Abed Mohammed,³ Karrar Hameed Abdulkareem,⁴ Salama A. Mostafa,⁵ Mashael S. Maashi,⁶ Muhammad Arif,⁷ and Begonya Garcia-Zapirain⁸

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This article has been cited by other articles in PMC.

Abstract

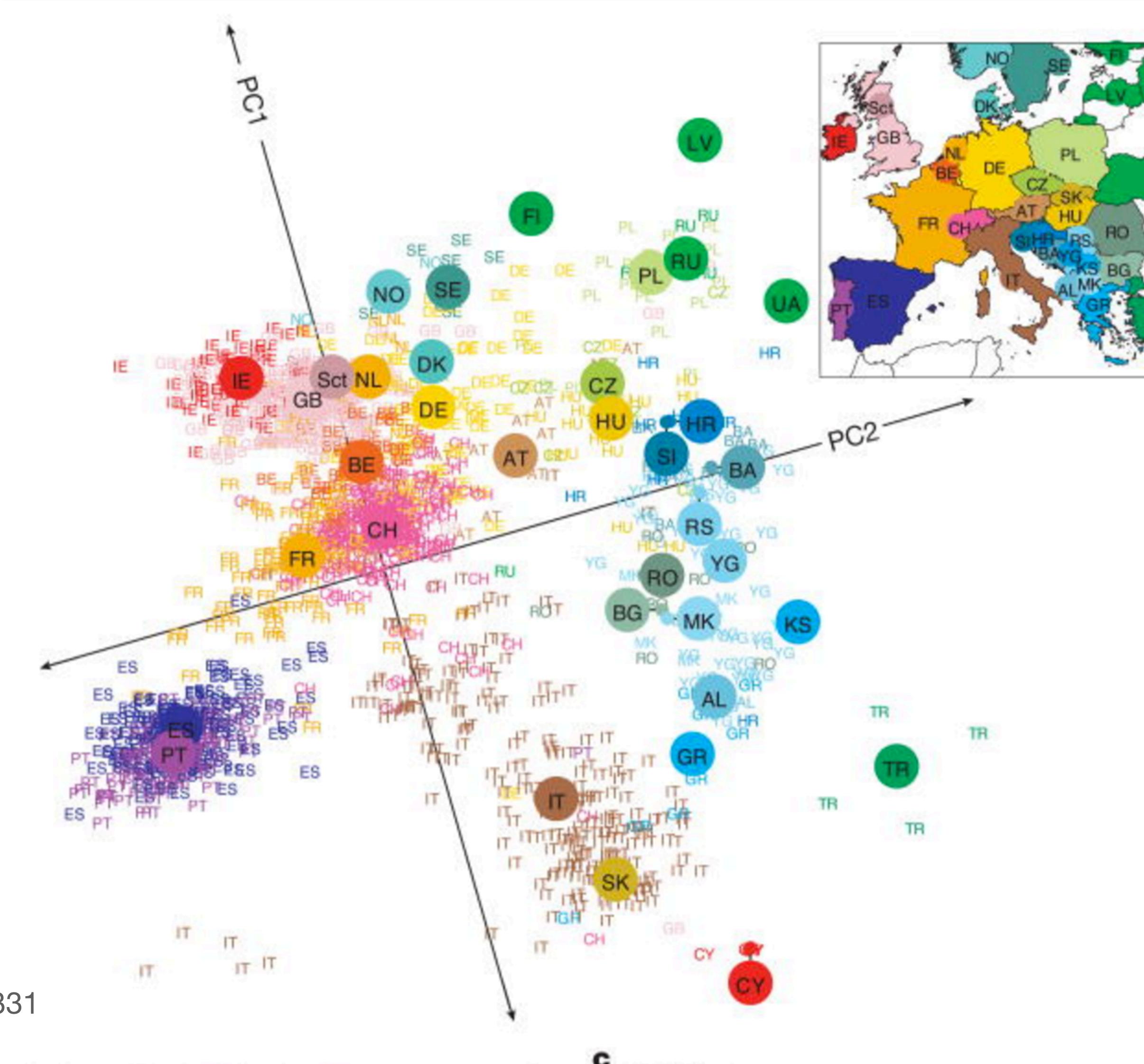
Go to:

The outbreaks of Coronavirus (COVID-19) epidemic have increased the pressure on healthcare and medical systems worldwide. The timely diagnosis of infected patients is a critical step to limit the spread of the COVID-19 epidemic. The chest radiography imaging has shown to be an effective screening technique

A large neural network analyzes chest X-ray images for **COVID-19**, with heat map showing affected regions.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7679792/>

Classical methods: PCA and clustering



<https://www.nature.com/articles/nature07331>

Modern methods: Generative models with latent variables

- Unsupervised learning algorithms learn to “synthesize” realistic data from a large collection of examples
- Text, images, music, art, genomes...

Exploring the UN General Debates with Dynamic Topic Models



Luke Lefebure

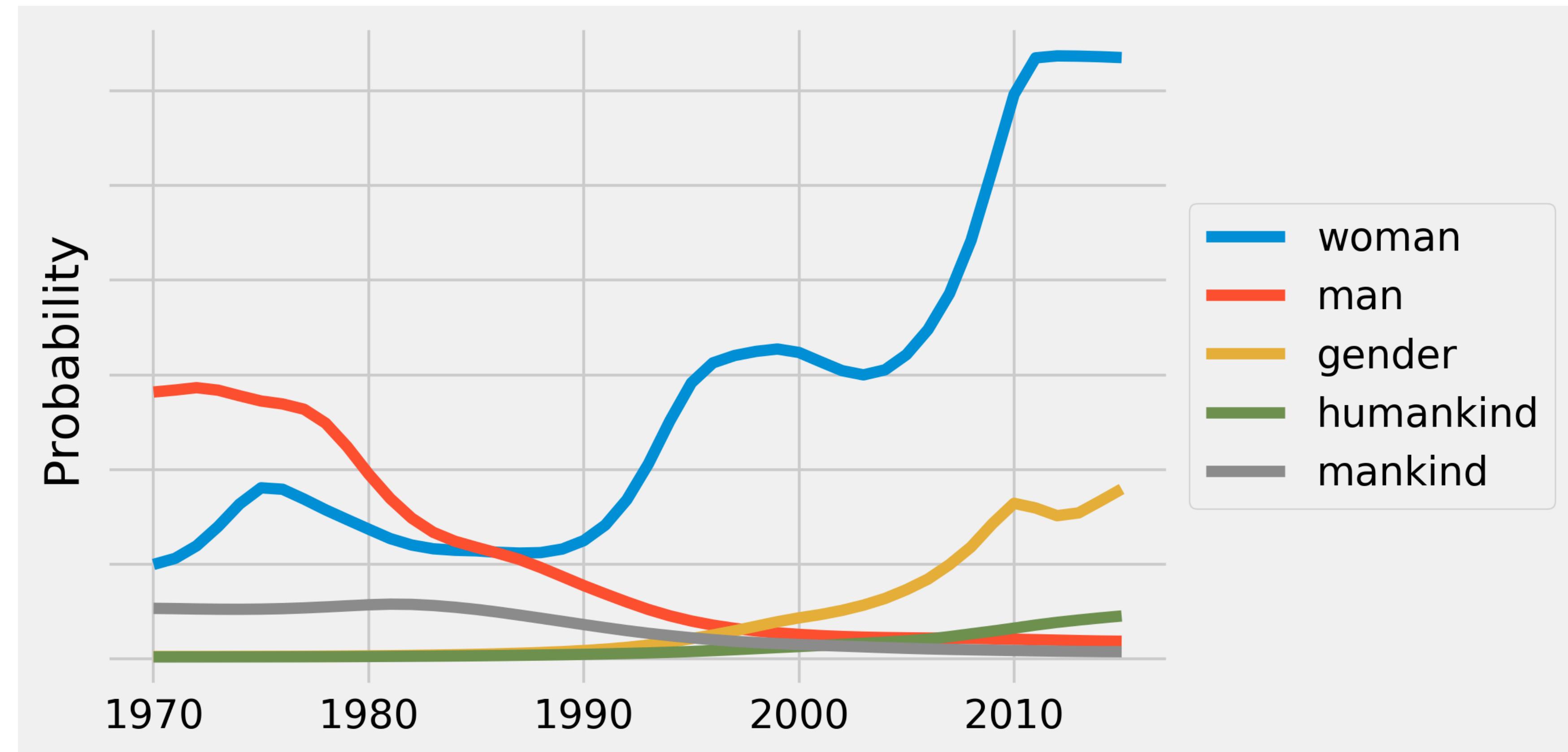
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Oct 17, 2018 · 11 min read

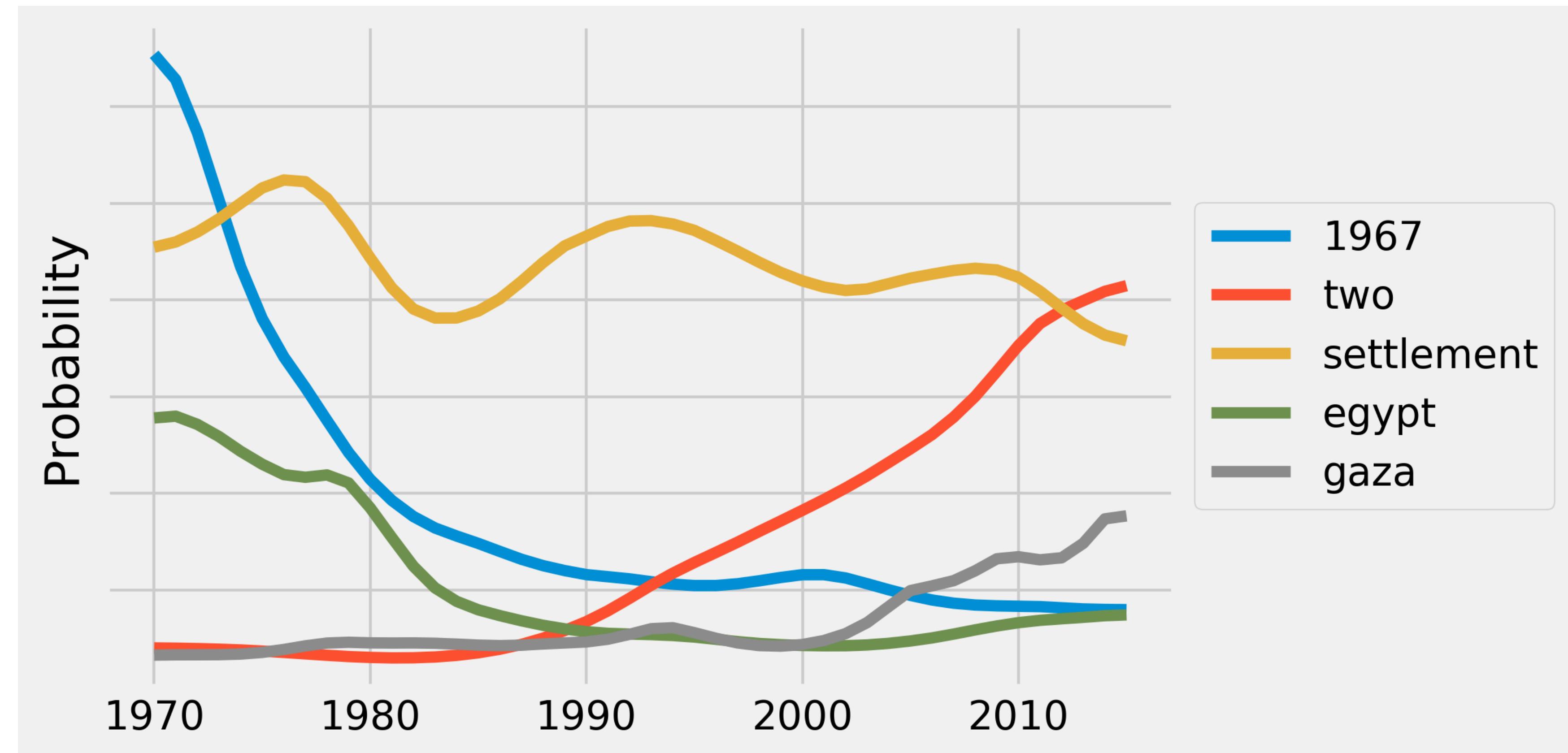


Credit: [Vladislav Klapin](#) on [Unsplash](#)

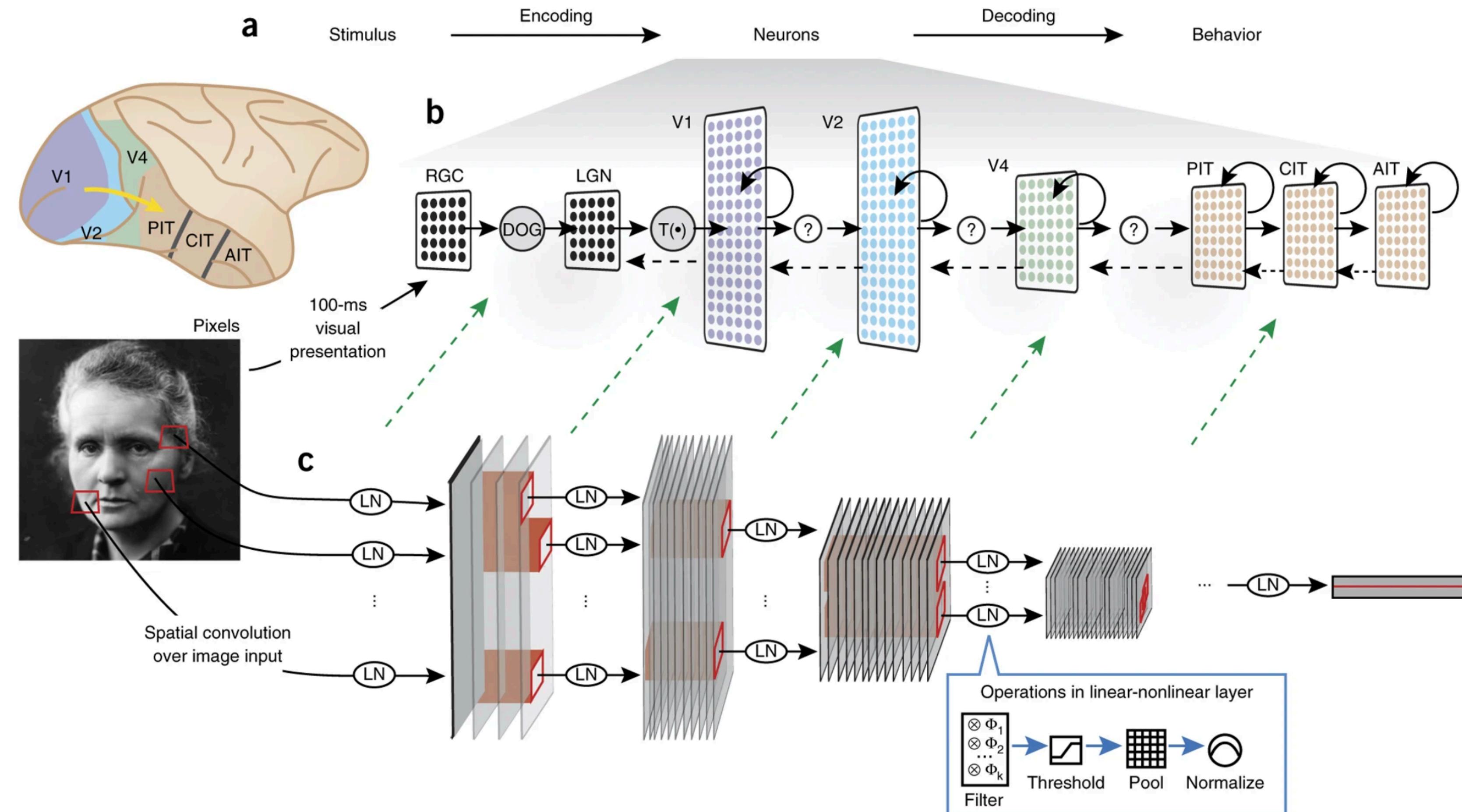
Latent topic: Human rights



Latent topic: Middle East peace



Convolutional neural networks



<https://www.nature.com/articles/nn.4244>



Designed to Deceive: Do These People Look Real to You?

By Kashmir Hill and Jeremy White

Nov. 21, 2020

<https://www.nytimes.com/interactive/2020/11/21/science/artificial-intelligence-fake-people-faces.html>



BLOG POST
RESEARCH

17 JUN 2016

Deep Reinforcement Learning

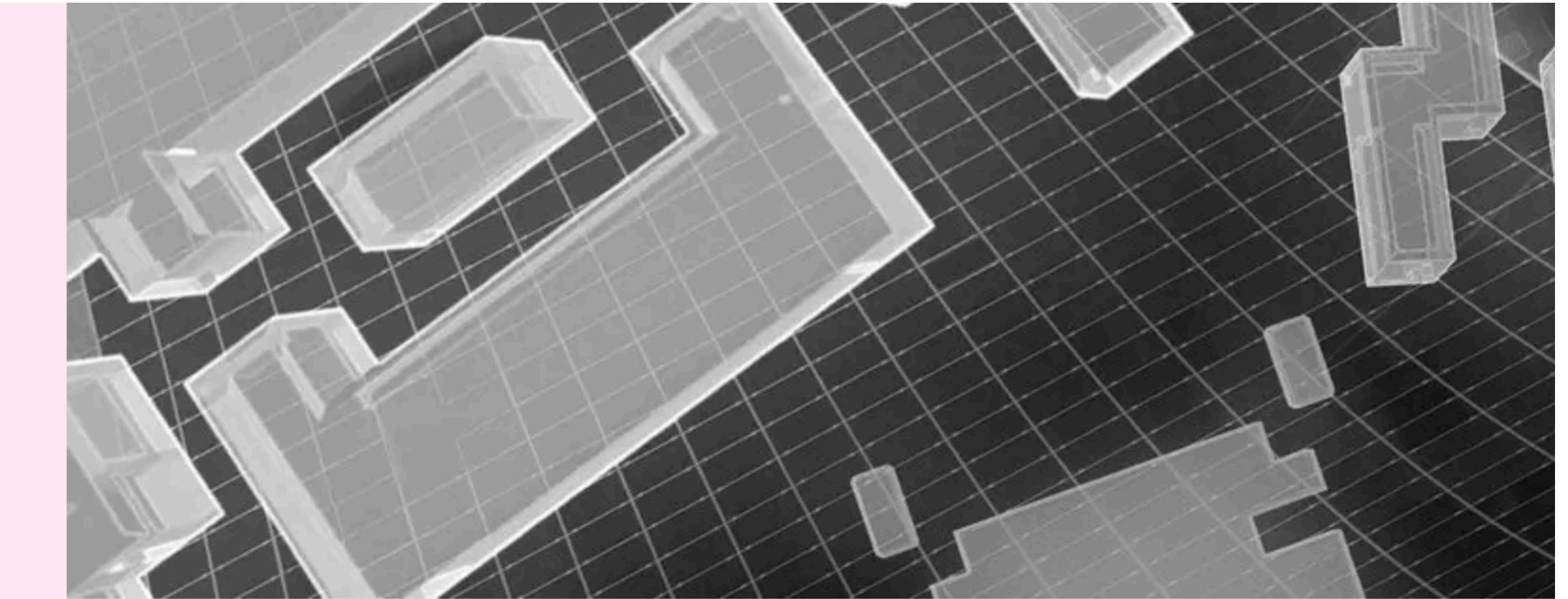
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AUTHORS

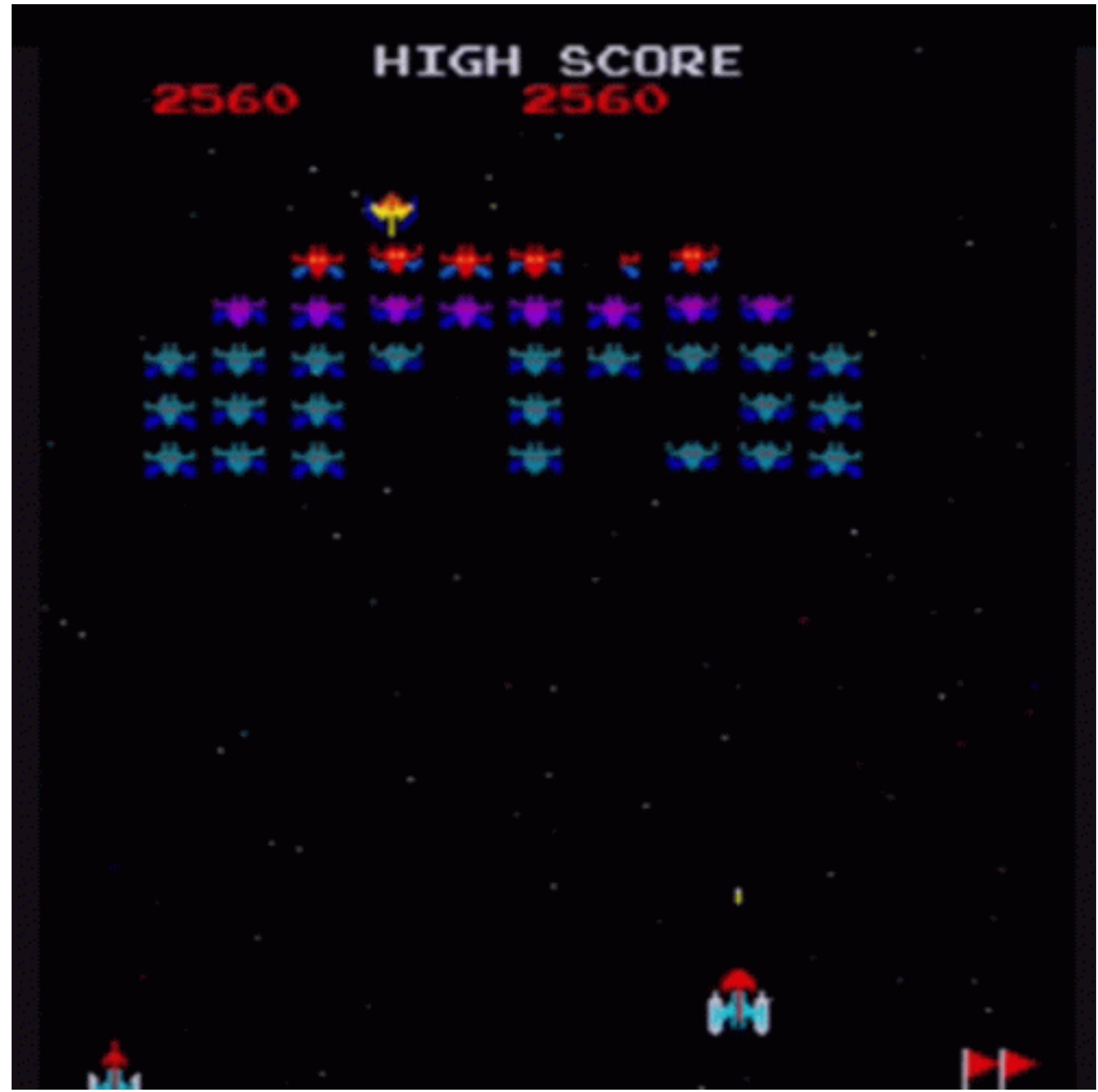


David Silver

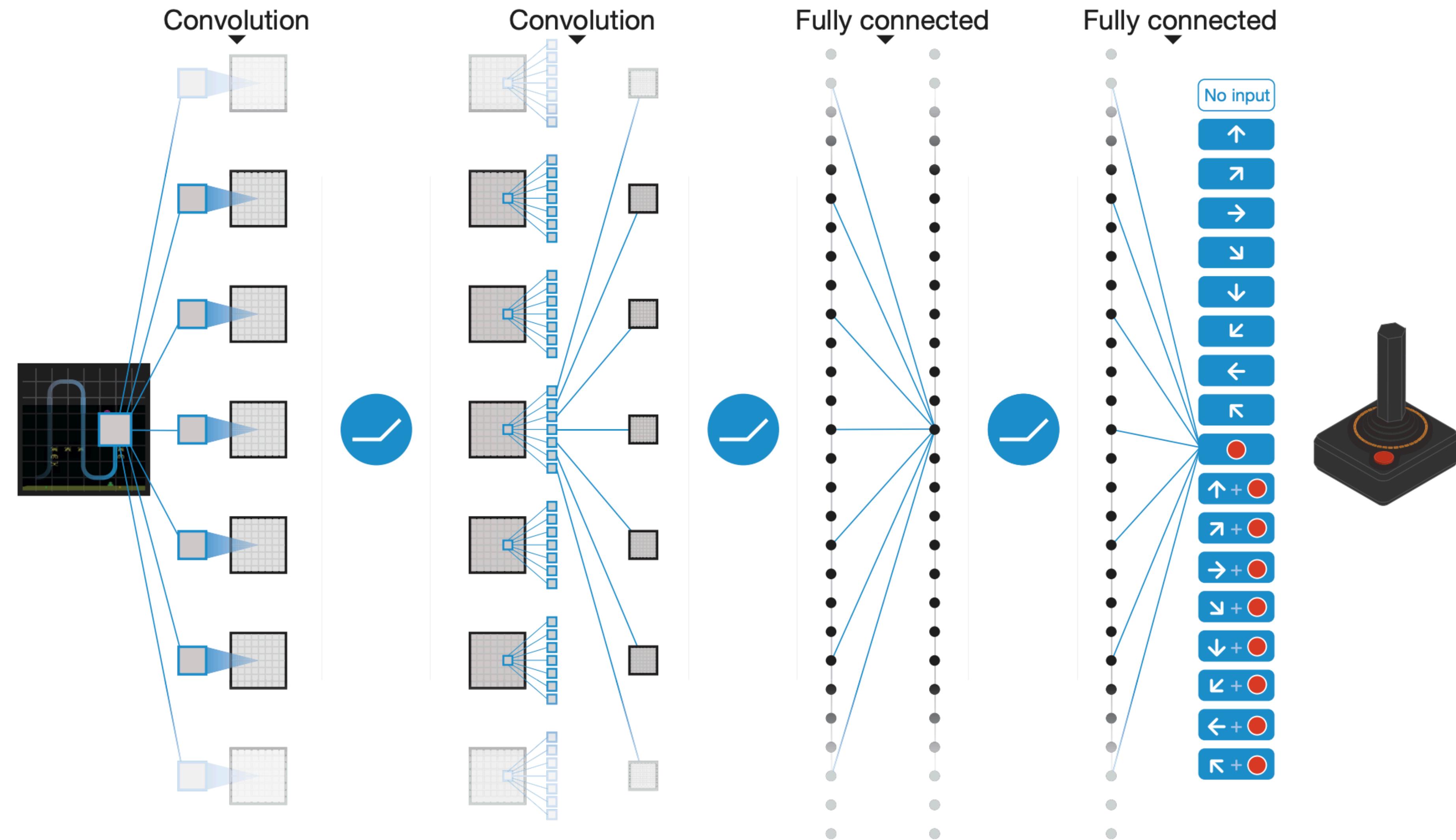


Humans excel at solving a wide variety of challenging problems, from low-level motor control through to high-level cognitive tasks. Our goal at DeepMind is to create artificial agents that can achieve a similar level of performance and generality. Like a human, our agents learn for themselves to achieve successful strategies that lead to the greatest long-term rewards. This paradigm of learning by trial-and-error, solely from rewards or punishments, is known as reinforcement learning (RL). Also like a human, our agents construct and learn their own knowledge directly from raw inputs, such as vision, without any hand-engineered features or domain heuristics. This is achieved by deep learning of neural

<https://deepmind.com/blog/article/deep-reinforcement-learning>



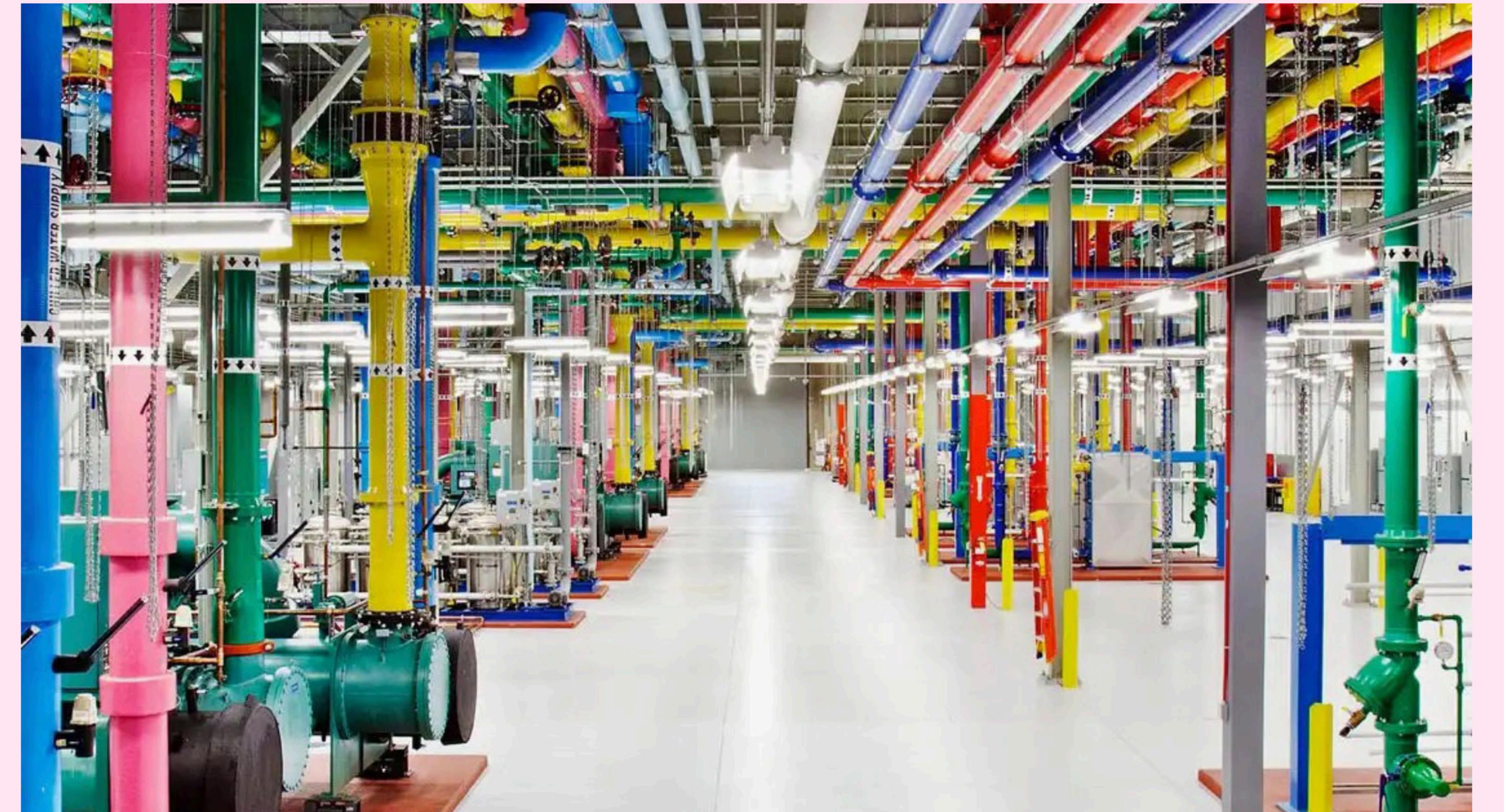






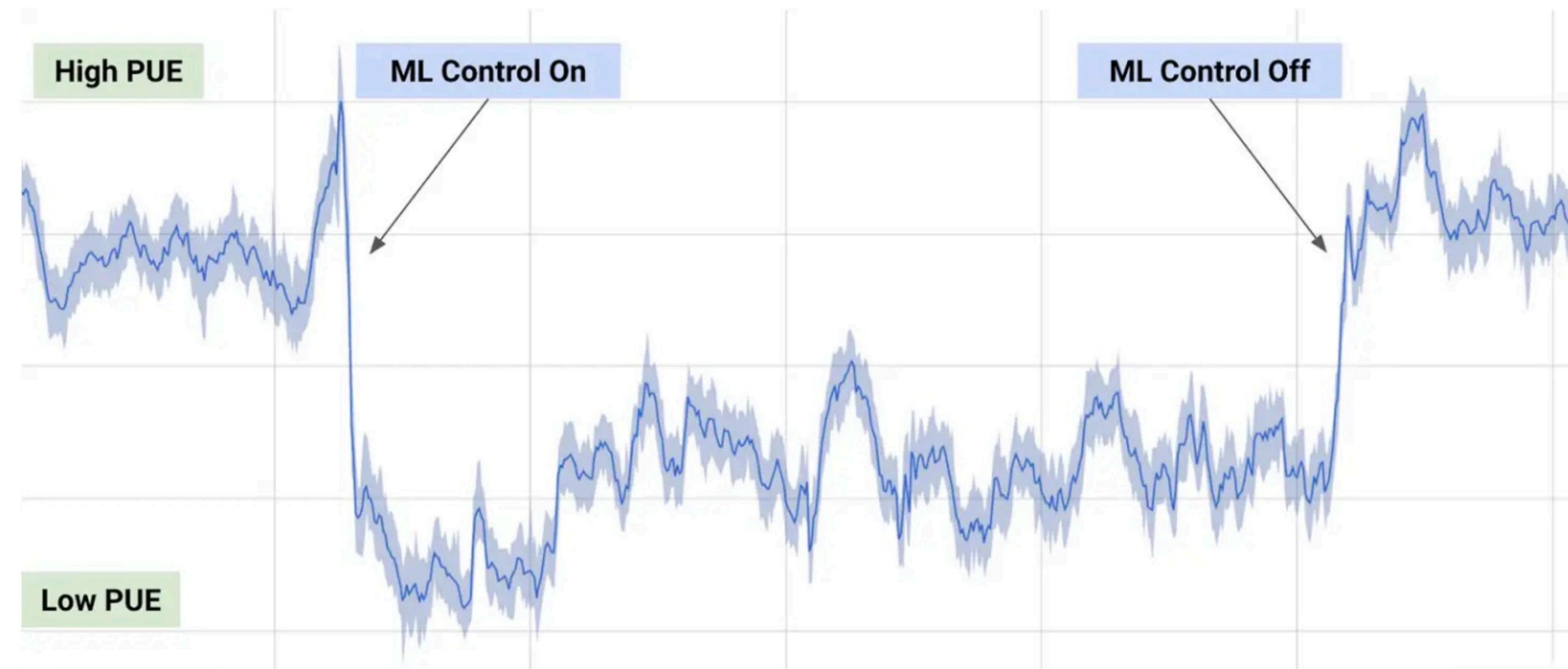
DeepMind AI Reduces Google Data Centre Cooling Bill by 40%

July 20, 2016



<https://www.deepmind.com/blog/deepmind-ai-reduces-google-data-centre-cooling-bill-by-40>

We tested our model by deploying on a live data centre. The graph below shows a typical day of testing, including when we turned the machine learning recommendations on, and when we turned them off.



When does learning take place?

The Bellman equation tells us:

Learning takes place when expectations are violated. The receipt of the reward does not itself cause changes.

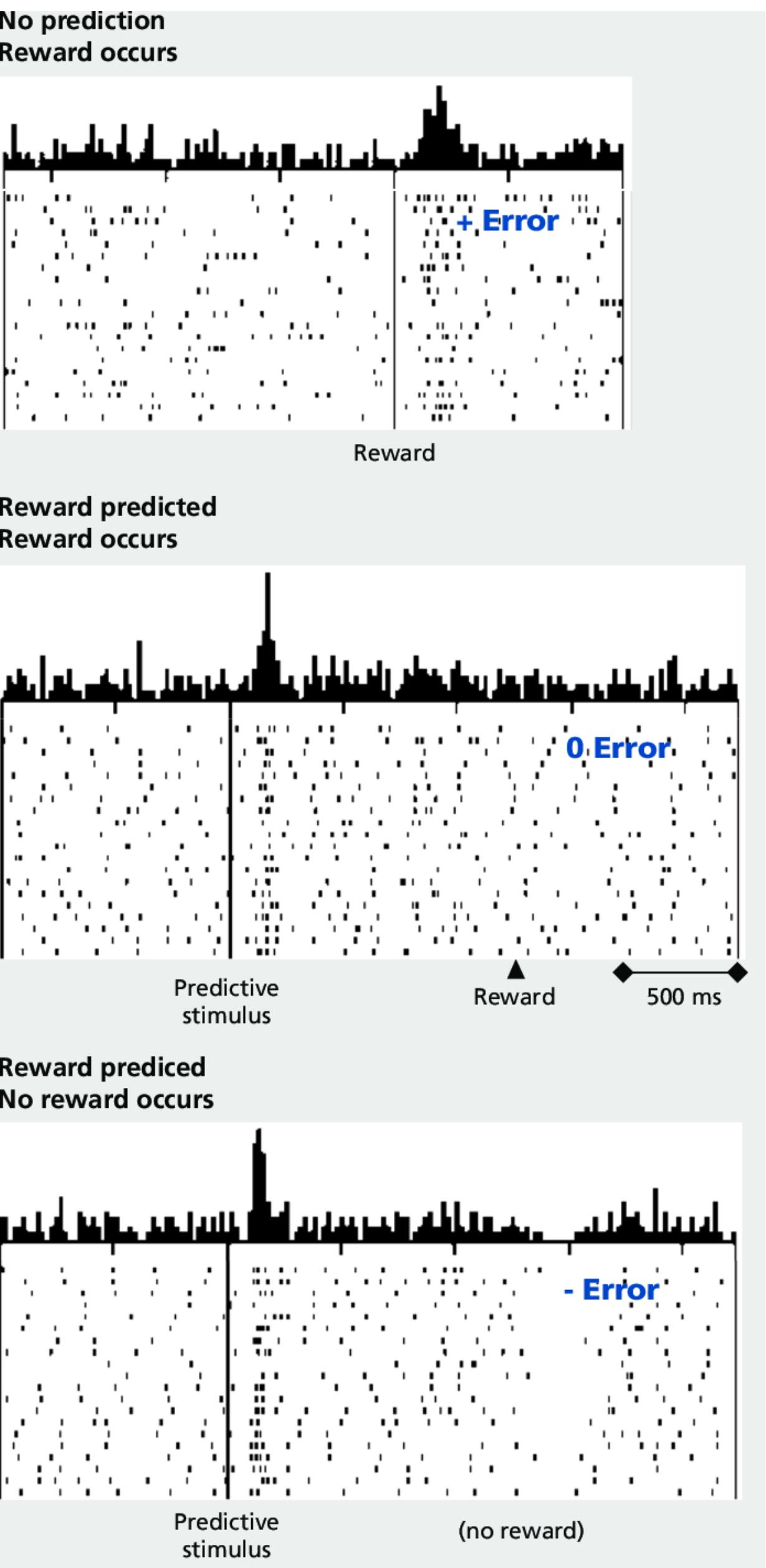
A Neural Substrate of Prediction and Reward

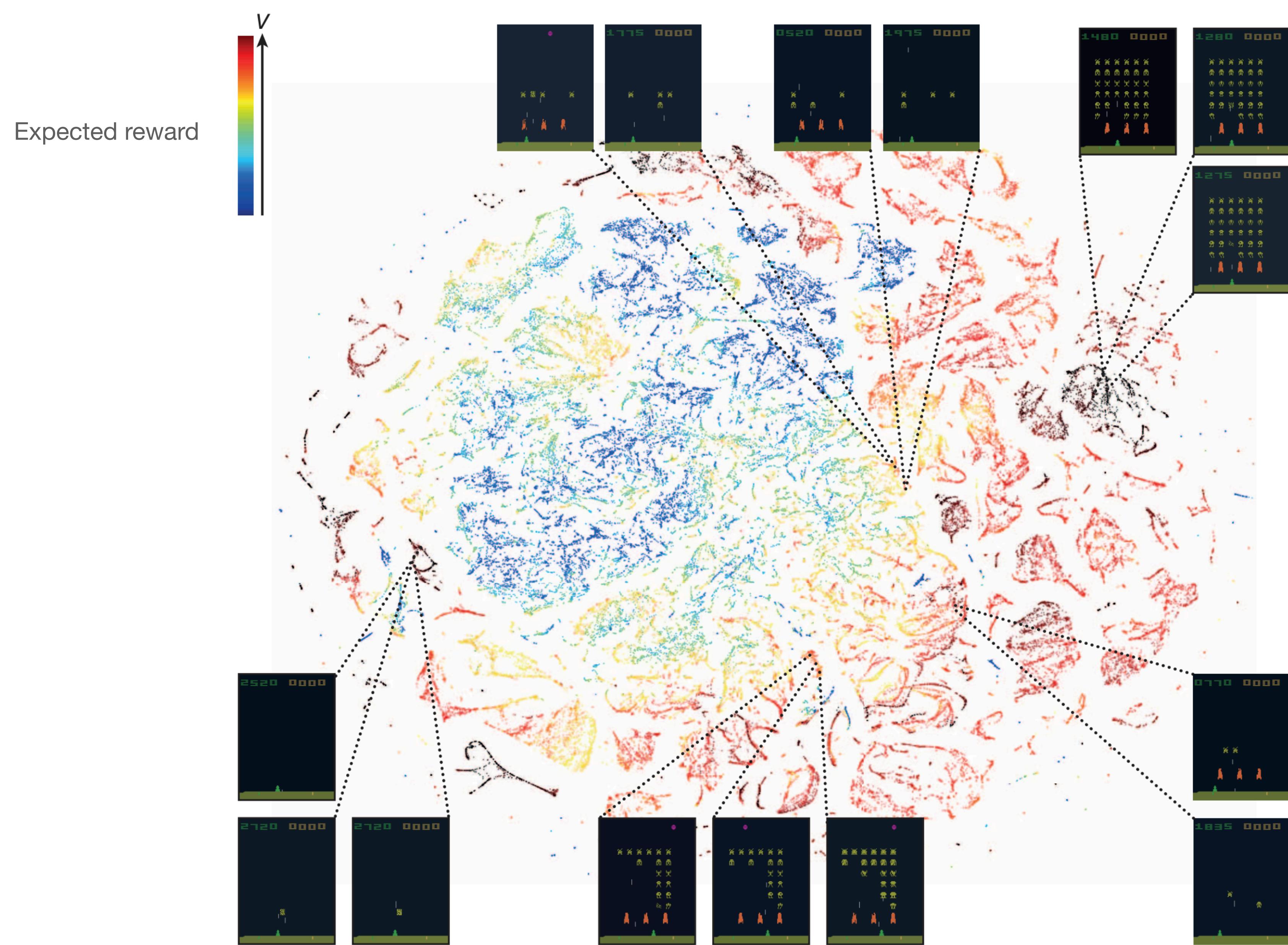
Wolfram Schultz, Peter Dayan, P. Read Montague*

The capacity to predict future events permits a creature to detect, model, and manipulate the causal structure of its interactions with its environment. Behavioral experiments suggest that learning is driven by changes in the expectations about future salient events such as rewards and punishments. Physiological work has recently complemented these studies by identifying dopaminergic neurons in the primate whose fluctuating output apparently signals changes or errors in the predictions of future salient and rewarding events. Taken together, these findings can be understood through quantitative theories of adaptive optimizing control.

Science 1997

Firings of dopamine neurons





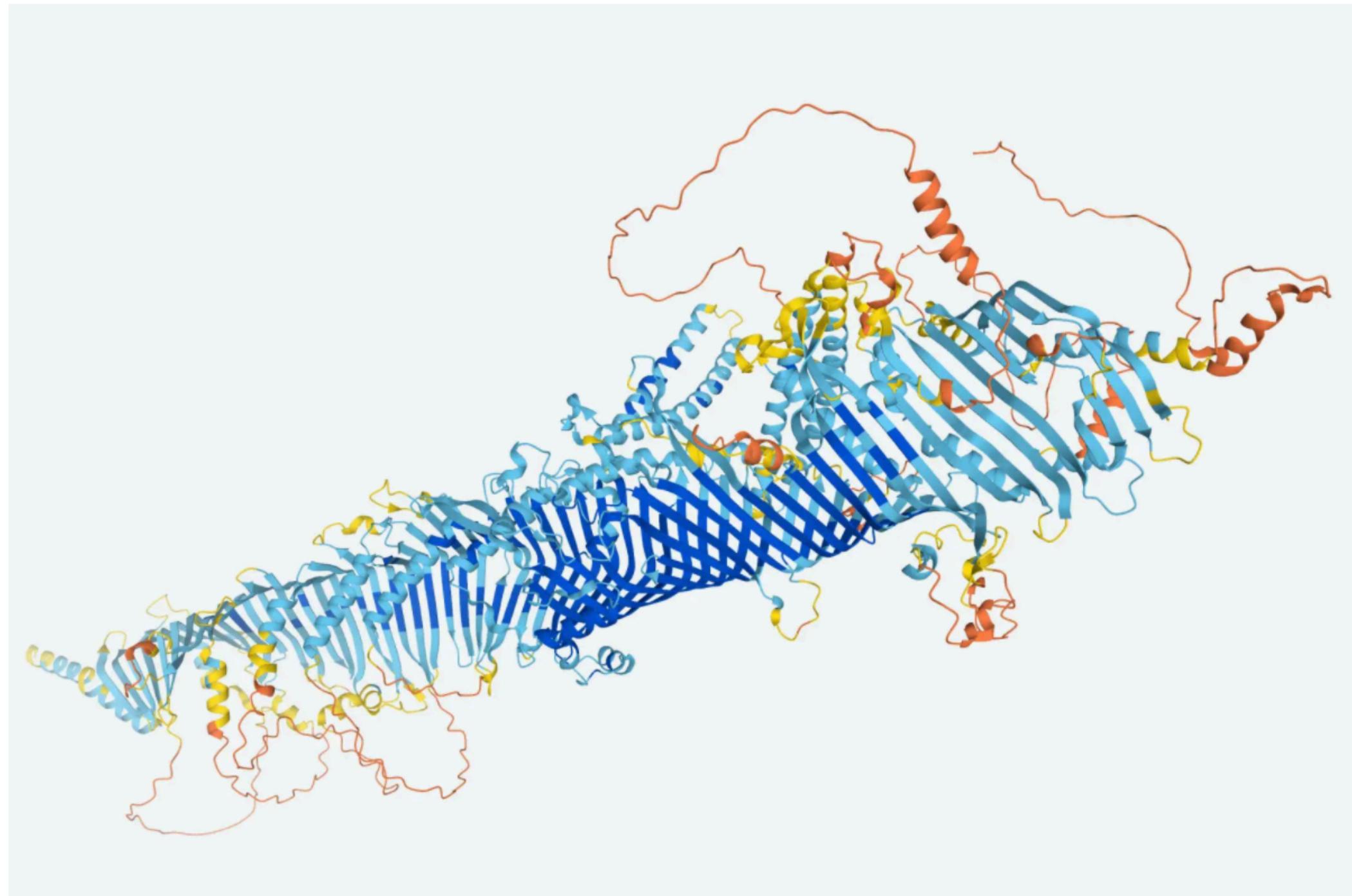


Opportunities and risks

Prospects for science and health
Ethics and safe AI
The next frontier
Wu Tsai Institute at Yale

A.I. Predicts the Shapes of Molecules to Come

DeepMind has given 3-D structure to 350,000 proteins, including every one made by humans, promising a boon for medicine and drug design.



AI for protein folding

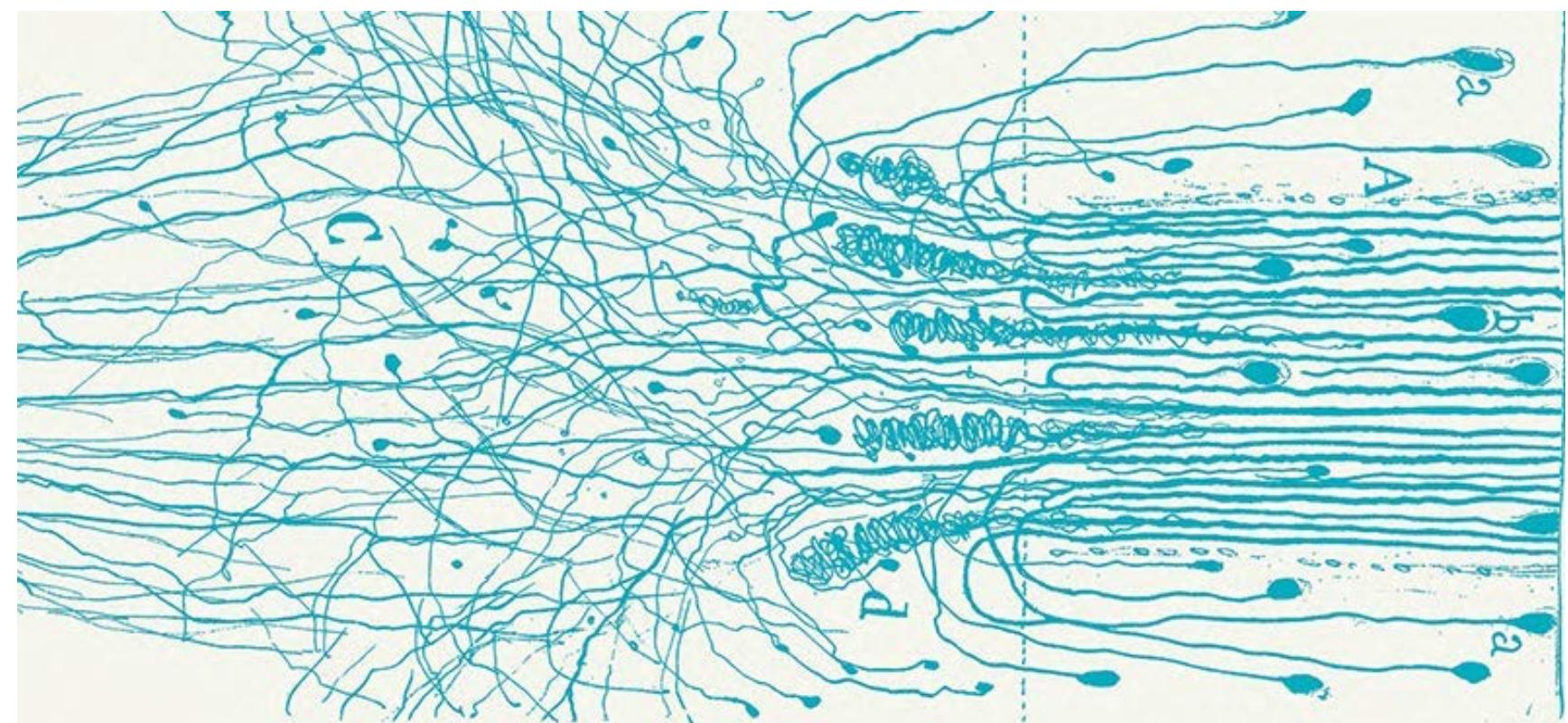
- Deep neural networks used to predict properties of protein, including distances between pairs of amino acids, and angles between chemical bonds
- “From scratch,” not using templates of known proteins
- Highly interdisciplinary, large team at DeepMind
- Published database of structures for 350,000 proteins

Recurring themes

- Breakthroughs across data types and problems
- Unexpected impact on different areas of inquiry
- Methods and code are open and shared
- New models of collaborative research

Prescription for new ML areas

- Combine hard-won domain insights and data with state-of-the-art ML approaches
- Target a bold, concrete, transformative subproblem
- Work together in teams

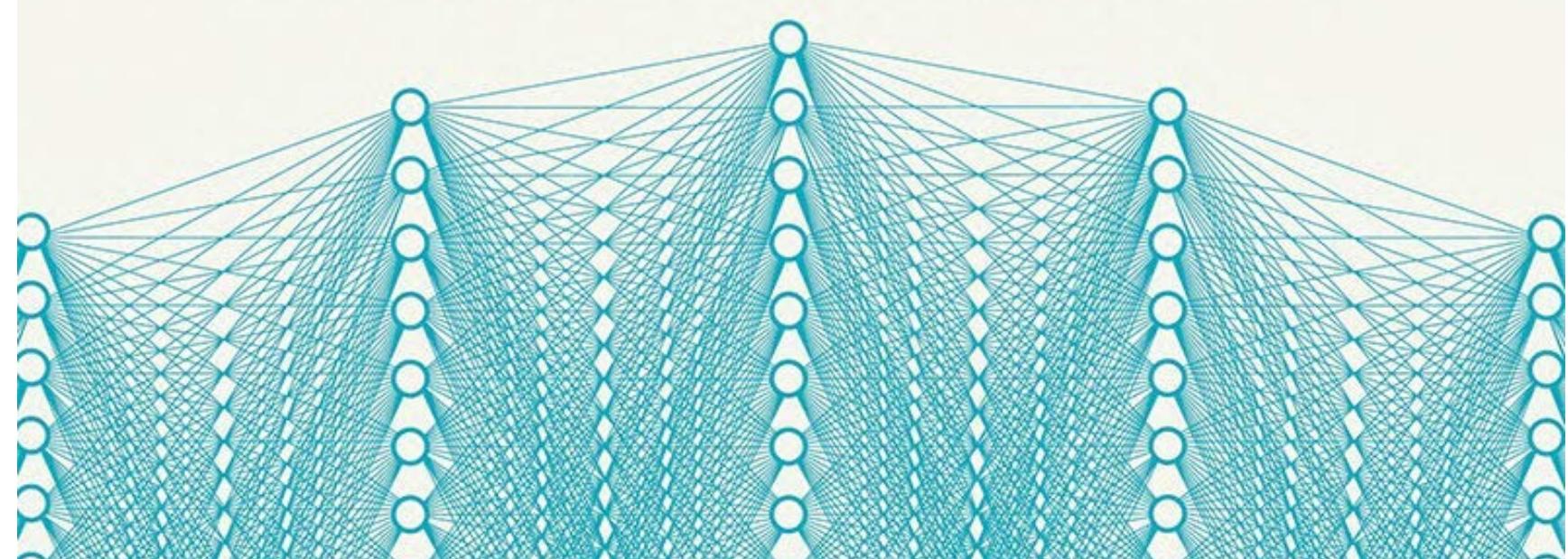


THE ALIGNMENT PROBLEM

Machine Learning and Human Values

BRIAN CHRISTIAN

Best-Selling Author, *Algorithms to Live By*



The Ezra Klein Show



1 hr 16 min

PLAY ►



Is A.I. the Problem? Or Are We?

The Ezra Klein Show

Society & Culture

[Listen on Apple Podcasts ↗](#)



If you talk to many of the people working on the cutting edge of artificial intelligence research, you'll hear that we are on the cusp of a technology that will be far more transformative than simply computers and the internet, one that could bring about a new industrial revolution and usher in a utopia — or perhaps pose the greatest threat in our species's history.

Others, of course, will tell you those folks are nuts.

Yale:

```
[ 0.78310001, 0.51717001, -0.38207 , -0.23722 , -0.31615999, 0.30805001, 0.76389998, 0.064106 , -0.74913001,  
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, 0.72409999, 0.50796002, -0.37845999, -0.13008 , -0.13808 , 0.098928 , 0.16215999, 0.16293 ]
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$\phi(\text{scientist}) - \phi(\text{woman}) + \phi(\text{man})$:

geologist
engineer
astronomer
mathematician
science

$\phi(\text{scientist}) - \phi(\text{man}) + \phi(\text{woman})$:

anthropologist
sociologist
psychologist
geneticist
biochemist

$\phi(\text{smart}) - \phi(\text{girl}) + \phi(\text{boy}):$

wise
better
guy
kind
good
kid

$\phi(\text{smart}) - \phi(\text{boy}) + \phi(\text{girl}):$

sexy
pretty
incredibly
cute
exciting
funny

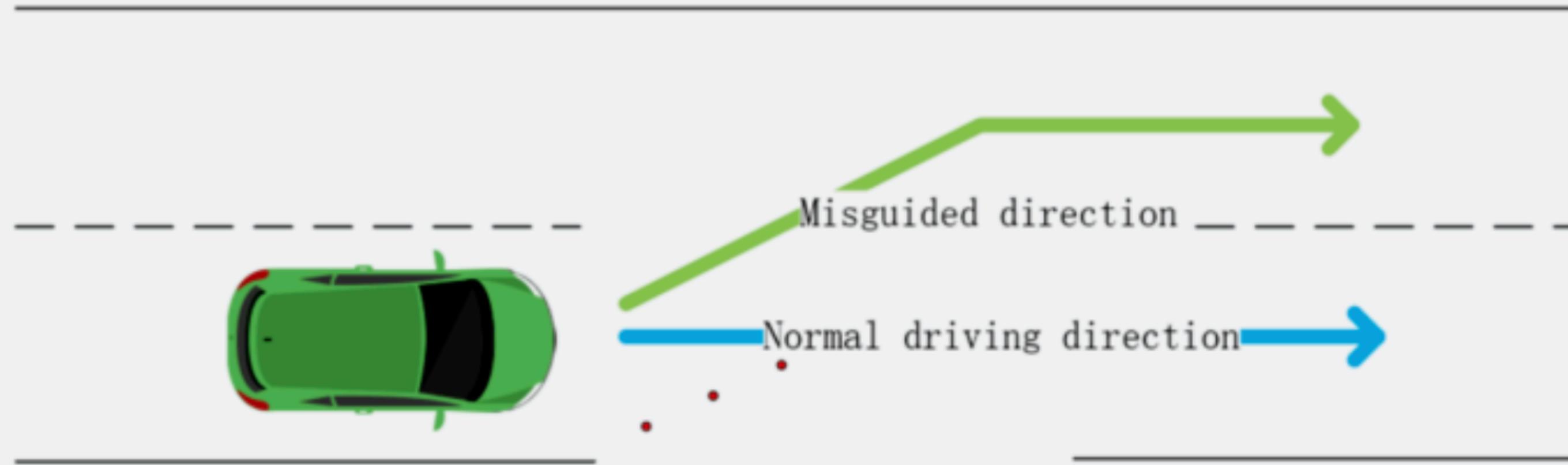
TESLA AUTOPILOT —

Researchers trick Tesla Autopilot into steering into oncoming traffic

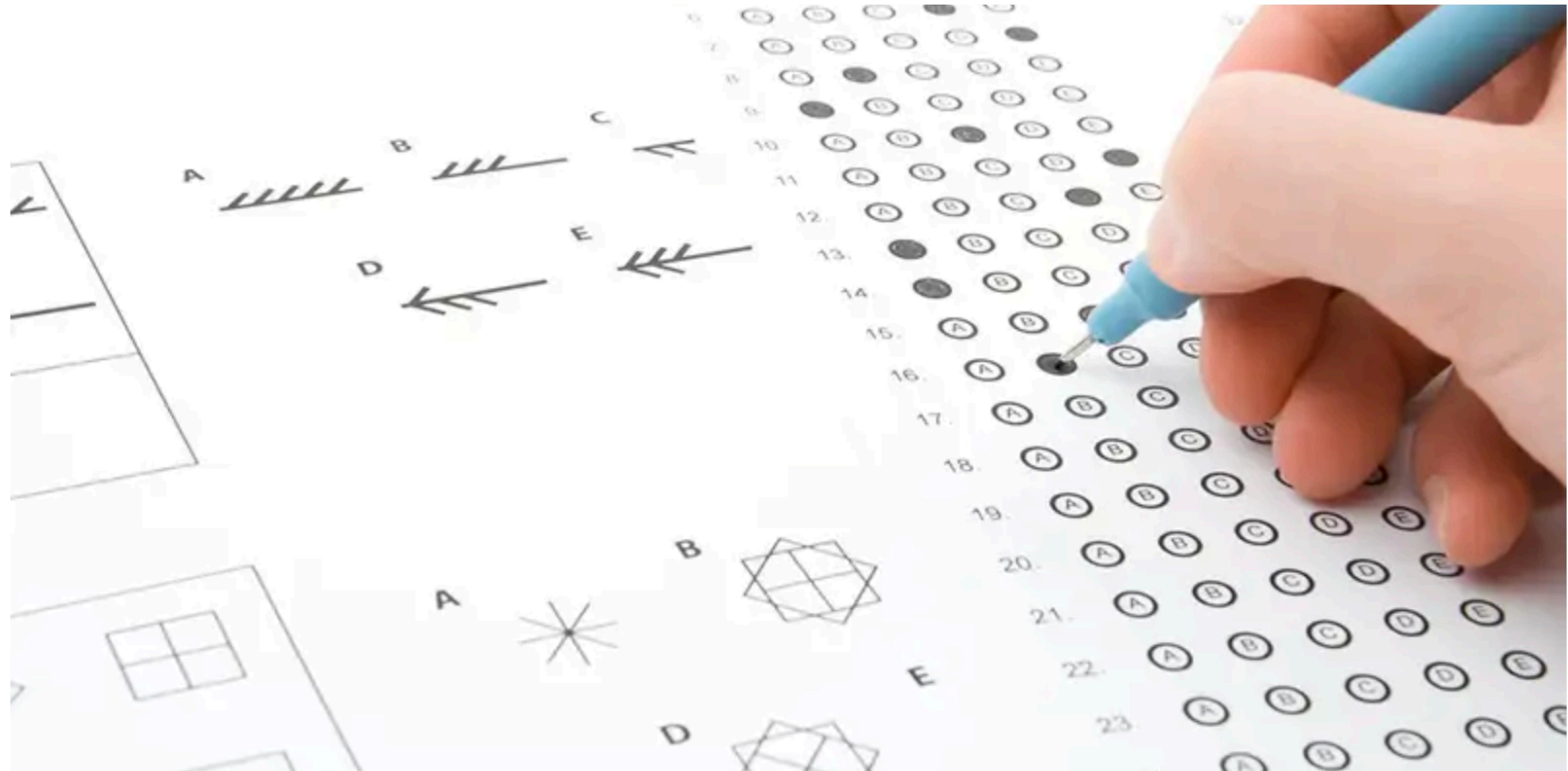
Stickers that are invisible to drivers and fool autopilot.

DAN GOODIN - 4/1/2019, 8:50 PM

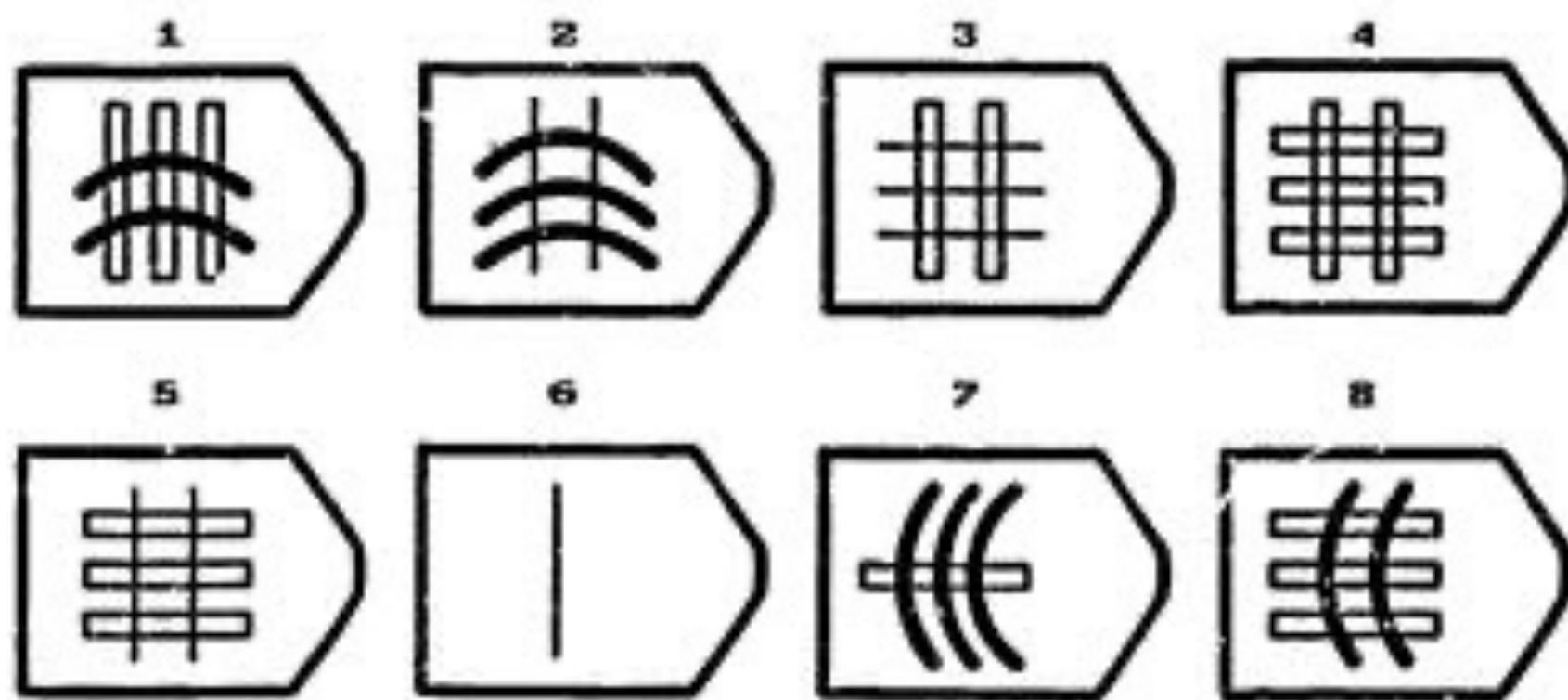
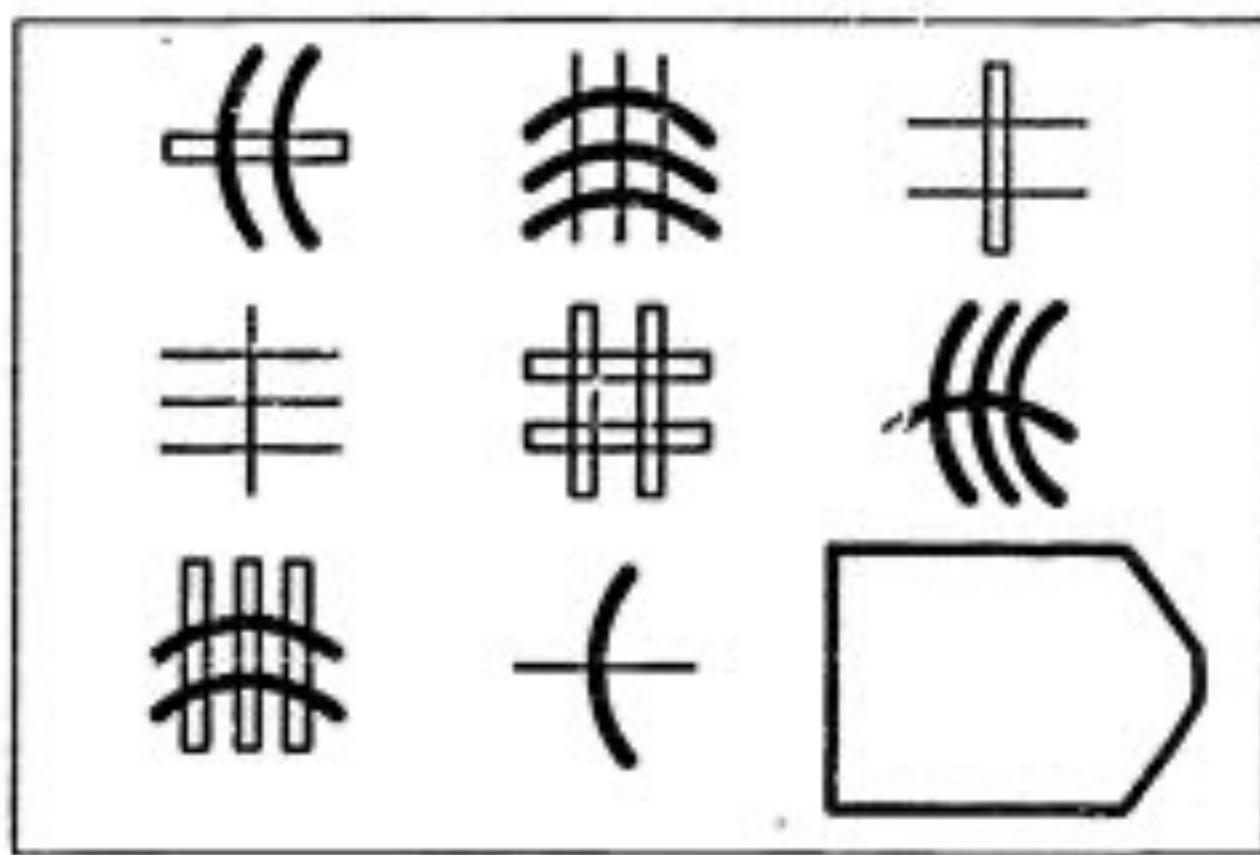
 Keen Security Lab



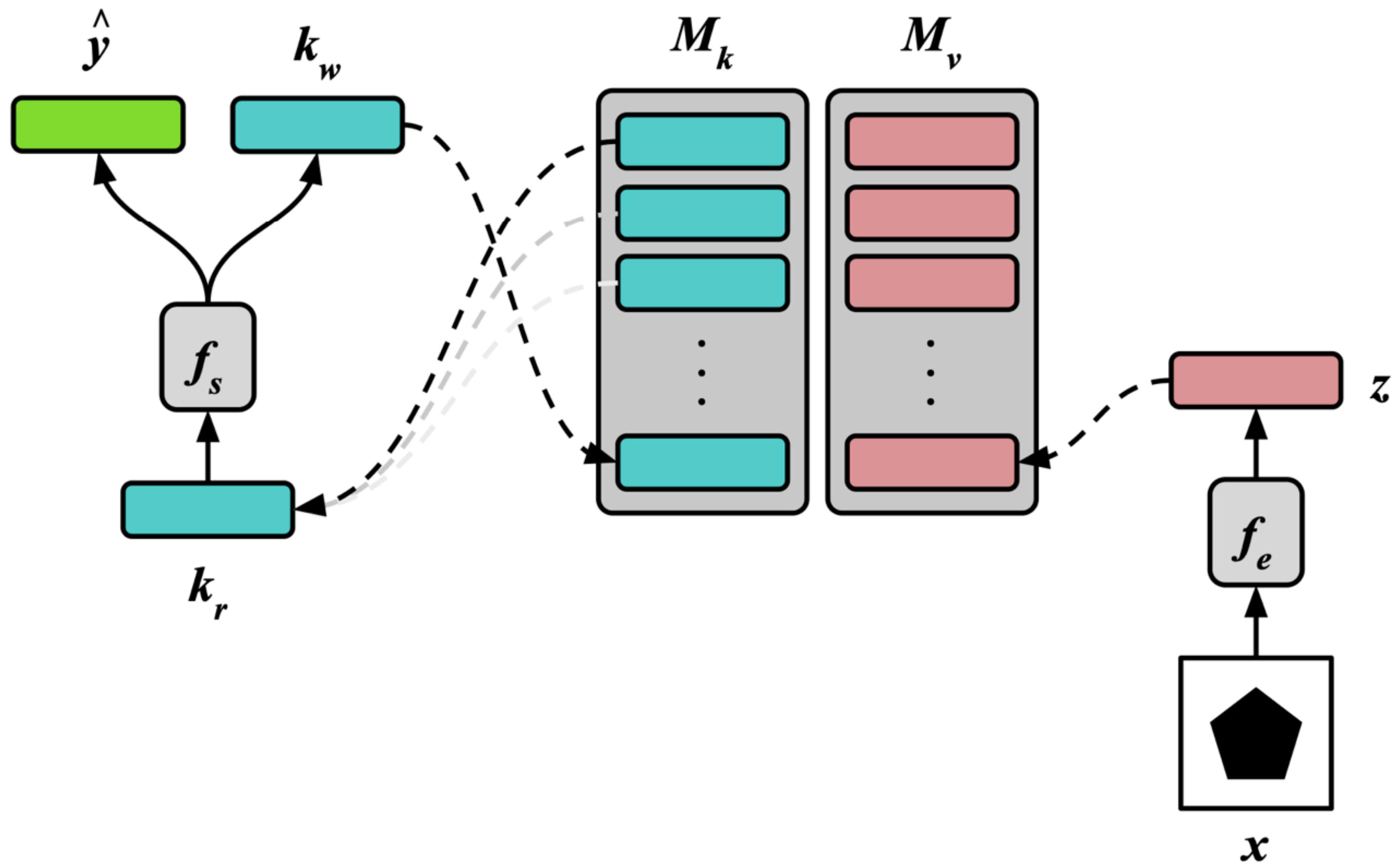
What's next?



What's next?



What's next?



What is machine learning?

Examples in daily life
Examples in science
Connection with AI

Supervised and unsupervised
Latent variable models
Deep learning
Reinforcement learning

Types of machine learning and AI frameworks

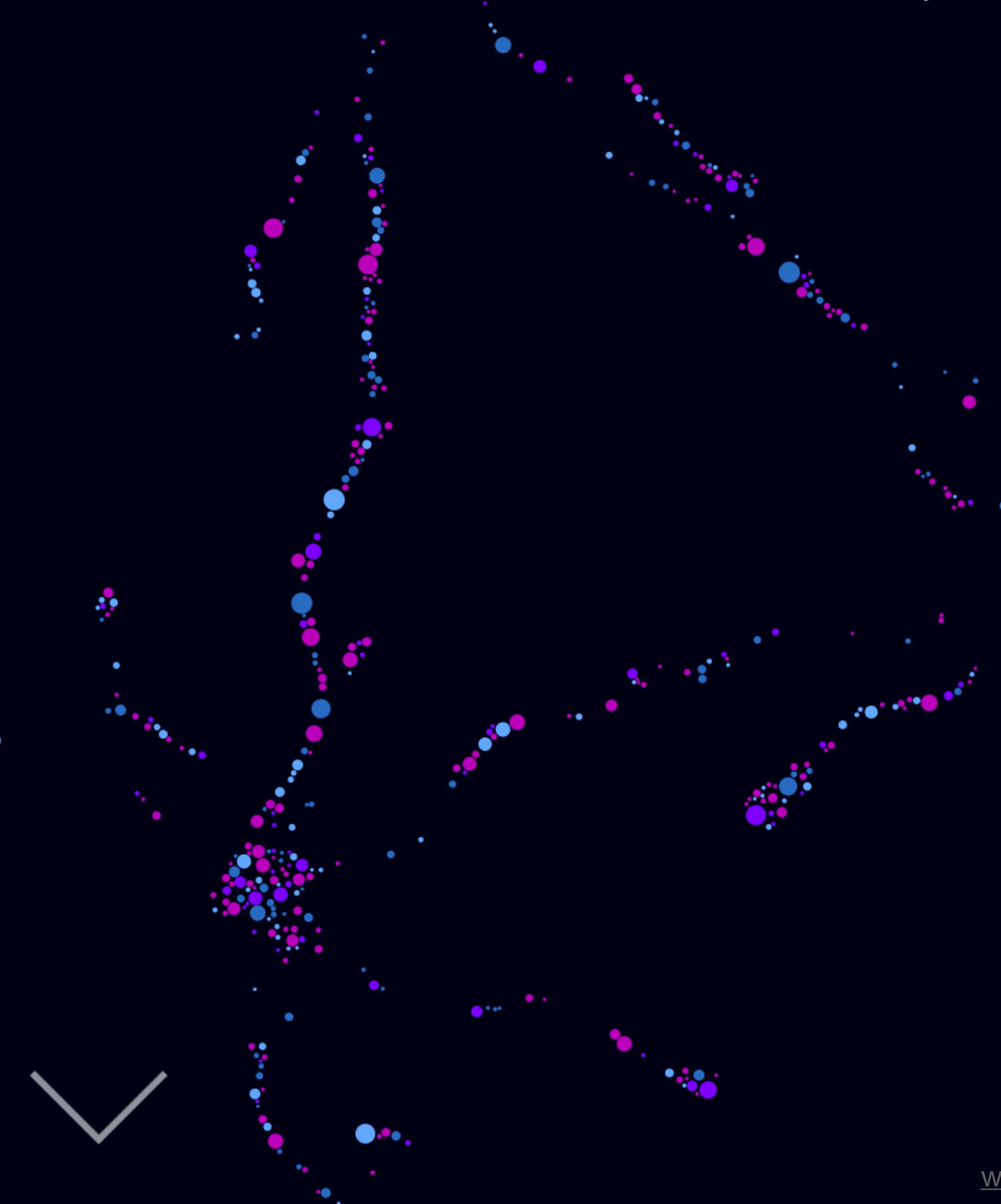
Risks and opportunities

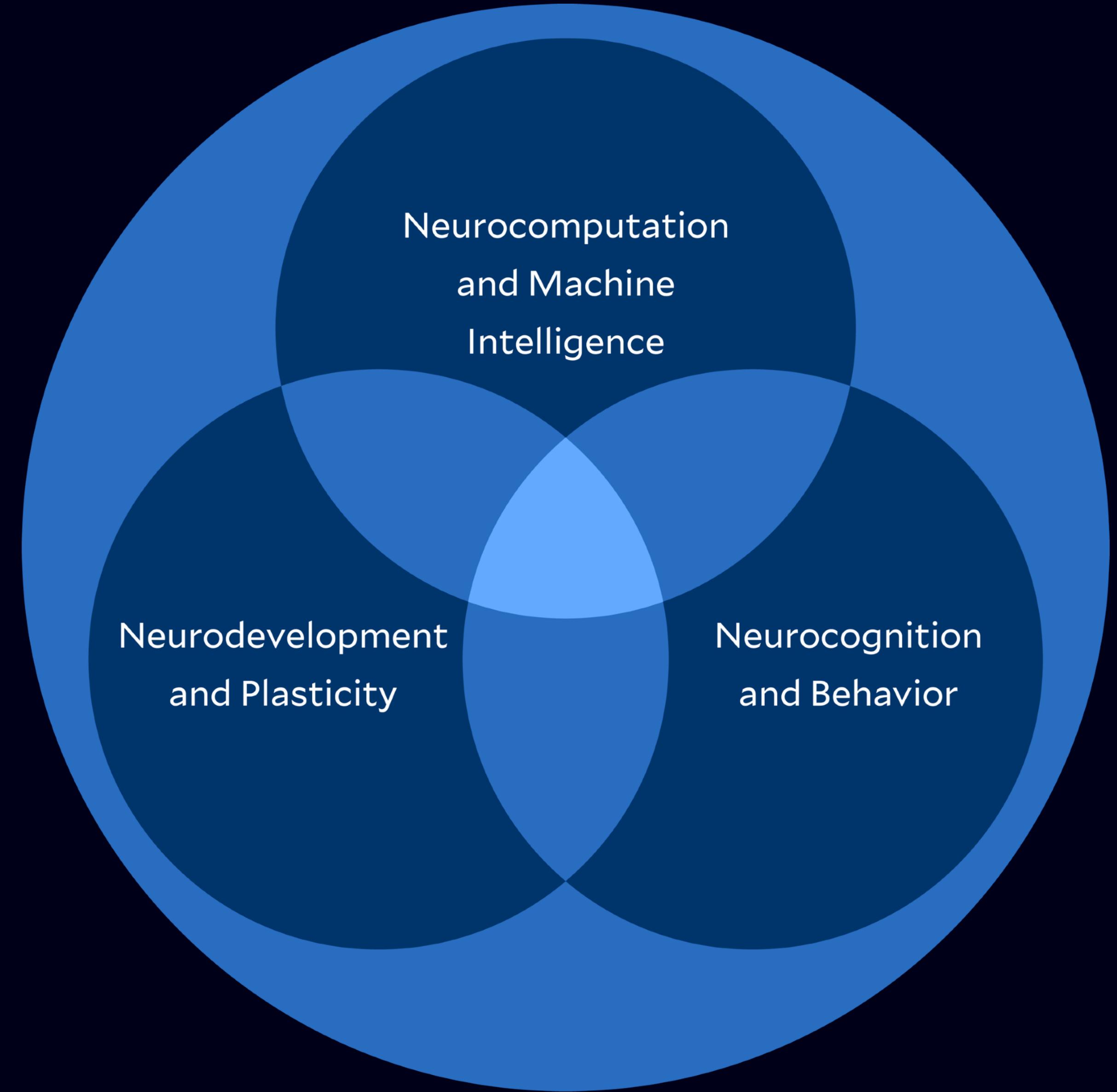
Prospects for science and health
Ethics and safe AI
The next frontier

To know, together.

Our goal is to understand human cognition.

COGNITION :: COGNOSCERE ::
CO [TOGETHER] + GNOSCERE [TO KNOW]





Thank you!