

# Next Generation AI: Transitioning to the Continuous, Self-Learning Enterprise

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Domino Data Lab





# Let your data science team use the tools they love.

And bring them together in an enterprise-strength platform, that enables them to spend more time solving critical business problems.

[Learn More](#)Bristol Myers Squibb<sup>®</sup>[Read Our Customer Stories »](#)[dominodatalab.com](http://dominodatalab.com)

## System-of-Record for Enterprise Data Science Teams



### Accelerate Research

Get self-serve access to the latest tools and scalable compute. Reuse past work and iterate more efficiently.

[Learn More »](#)

The screenshot shows the Domino platform's user interface. At the top, there's a navigation bar with tabs for 'Run' (selected), 'Jobs Timeline', 'Logs', 'Results', 'Details', 'Comments', and 'Resource Usage'. Below the navigation is a search bar and a download button for a file named 'results/AUC\_ACC\_exponential\_5.png'. The main area features a 'Jobs Timeline' section with a graph showing AUC values over time, and a table below it listing job details like 'paramSearch.py -n 25 --loss exp' with an AUC of 0.947. The bottom of the screenshot includes a footer with the text '5-fold CV ROC Curve and Metrics: Loss = exponential, N\_Estimators = 5'.



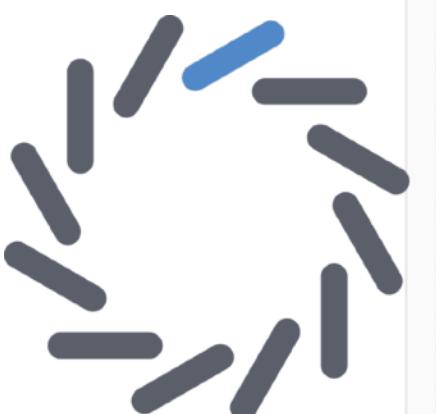
### Centralize Infrastructure

Manage the availability of powerful data science resources in a secure and governed system-of-record.

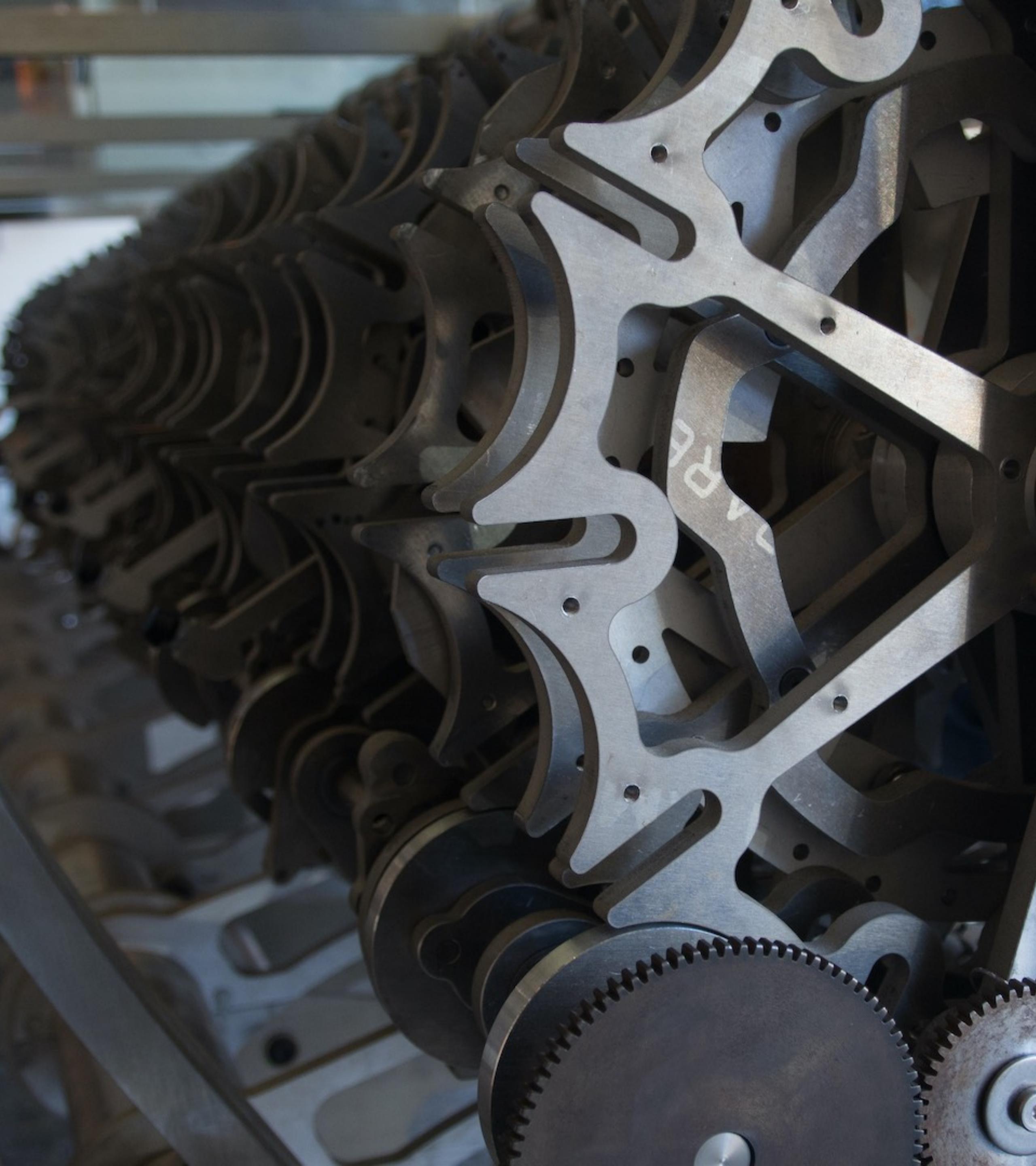
[Learn More »](#)

### Deploy and Monitor Models

Expedite model consumption with apps, APIs, and more – and ensure their



DOMINO



# Outline

- The Promise of AI
- AI in the Enterprise
  - The Past
  - The Present
  - The Future
- Conclusions



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# The Promise of AI



@deanwampler

# The Promise of AI

- Natural Language Processing
- Reinforcement Learning
- New applications of Deep Learning
- What Our Phones Are Telling Us...



# Natural Language Processing



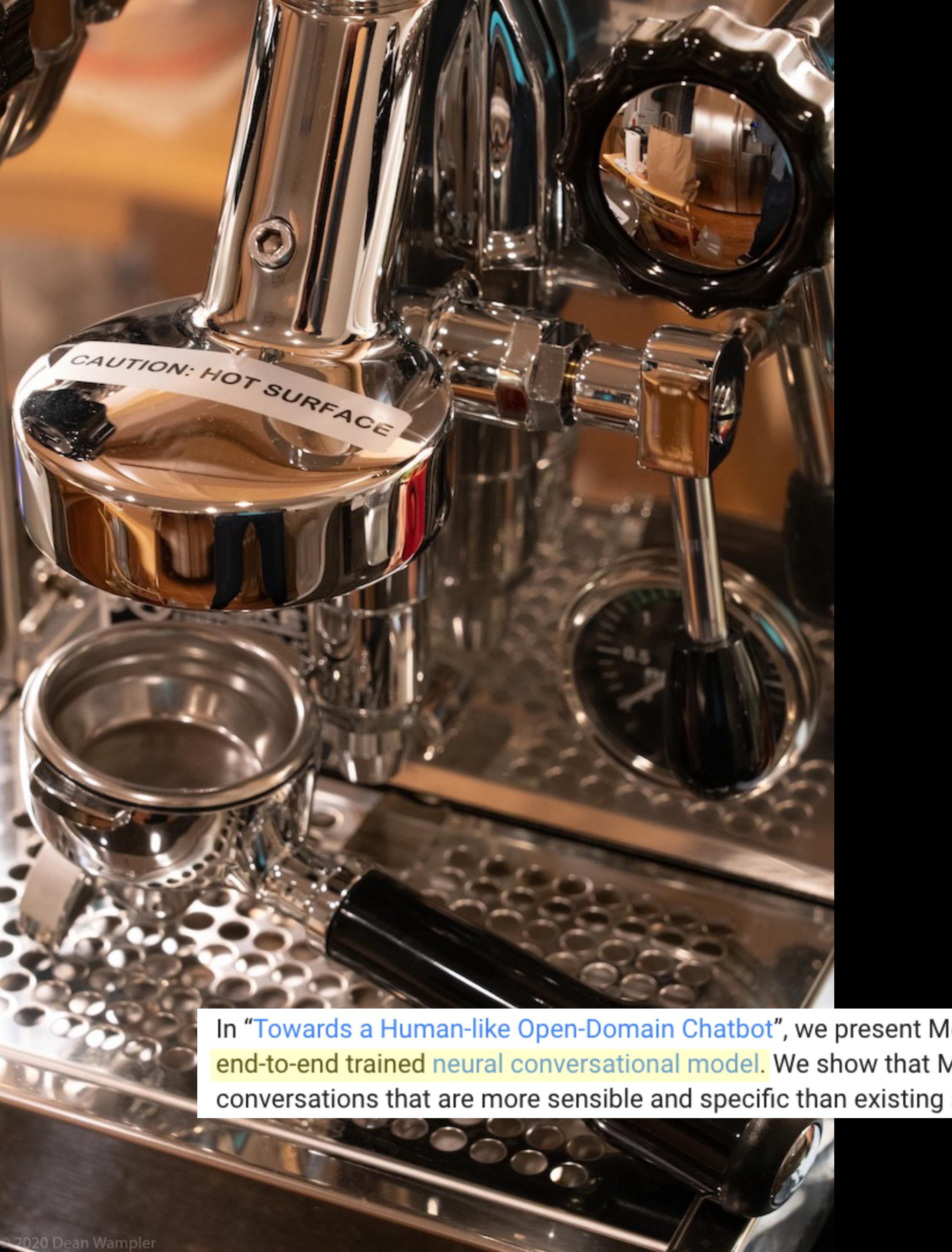
# Applications

- Summarization
- Dialogues
- Naturalistic text to speech
- Translation
- Sentiment Analysis
- Fraud & Veracity Analysis
- Question Answering & Search



# Summarization

- Legal documents
- Research papers
- News
- ...



In “[Towards a Human-like Open-Domain Chatbot](#)”, we present Meena, a **2.6 billion parameter end-to-end trained neural conversational model**. We show that Meena can conduct conversations that are more sensible and specific than existing state-of-the-art chatbots.

- # Dialogs
- Chatbots
  - Human-computer dialogs

The screenshot shows a web browser displaying a Google AI Blog post. The title is "Towards a Conversational Agent that Can Chat About... Anything". The date is Tuesday, January 28, 2020. The post discusses the creation of Meena, a 2.6 billion parameter end-to-end trained neural conversational model. It highlights that while modern chatbots are highly specialized, Meena can handle a wide variety of topics. The post includes several paragraphs of text, some of which are highlighted in yellow. A red box at the bottom right of the post area points to the same text as the quote in the image above. The sidebar on the right includes a search bar, labels, archive, feed, and social media links for Twitter and Google AI.

Google AI Blog  
The latest news from Google AI

## Towards a Conversational Agent that Can Chat About... Anything

Tuesday, January 28, 2020

Posted by Daniel Adiwardana, Senior Research Engineer, and Thang Luong, Senior Research Scientist, Google Research, Brain Team

Modern conversational agents (chatbots) tend to be highly specialized – they perform well as long as users don't stray too far from their expected usage. To better handle a wide variety of conversational topics, open-domain dialog research explores a complementary approach

Meena is a conversational agent that is specialized but can still chat about virtually anything a search problem, such as a conversational agent could lead to further humanizing computer interactions, improving interactive movie and videogame characters.

There is a critical flaw – they often don't make sense. They with what has been said so far, or lack common sense and basic knowledge about the world. Moreover, chatbots often give responses that are not specific to the current context. For example, “I don't know,” is a sensible response to any question, but it's not specific. Current chatbots do this much more often than people because it covers many possible user inputs.

In “[Towards a Human-like Open-Domain Chatbot](#)”, we present Meena, a 2.6 billion parameter end-to-end trained neural conversational model. We show that Meena can conduct conversations that are more sensible and specific than existing state-of-the-art chatbots. Such improvements are

A close-up photograph of a high-end espresso machine. The machine is made of polished stainless steel, reflecting the warm lighting of the environment. A black leather strap is wrapped around one of the handles. A small, rectangular white sticker with the text "CAUTION: HOT SURFACE" in black capital letters is attached to the side of the machine. In the background, a digital timer or clock is visible on the machine's control panel.

# Naturalistic text to speech

- Needed for dialog generation



# Translation

- Domain-specific languages
  - Medicine
  - Air traffic control
  - ...
  - “Rare” languages

A close-up photograph of a high-end espresso machine. The machine is made of polished stainless steel, reflecting the warm lighting of the environment. A black leather strap is wrapped around one of the handles. A small white sticker with the text "CAUTION: HOT SURFACE" is attached to the side of the machine. The background is blurred, showing a wooden counter and some equipment in a coffee shop setting.

# Sentiment Analysis

- Customer support
- Social media
- Public relations



# Fraud & Veracity Analysis

- “Fake news”
- Better SPAM, Phishing, etc.  
detection and mitigation.

The screenshot shows a PDF document titled "Fake News Detection on Social Media: A Data Mining Perspective" by Kai Shu, Amy Sliva, Suhang Wang, Jiliang Tang, and Huan Liu. The document is from the KDD conference. The abstract discusses the use of social media for news consumption and the challenges of detecting fake news. The authors are from Arizona State University, Charles River Analytics, and Michigan State University.

**Abstract**  
Social media for news consumption is a double-edged sword. On the one hand, its low cost, easy access, and rapid dissemination of information lead people to seek out and consume news from social media. On the other hand, it enables the

Kai Shu<sup>†</sup>, Amy Sliva<sup>‡</sup>, Suhang Wang<sup>†</sup>, Jiliang Tang<sup>‡</sup>, and Huan Liu<sup>†</sup>  
<sup>†</sup>Computer Science & Engineering, Arizona State University, Tempe, AZ, USA  
<sup>‡</sup>Charles River Analytics, Cambridge, MA, USA  
<sup>‡</sup>Computer Science & Engineering, Michigan State University, East Lansing, MI, USA  
<sup>†</sup>{kai.shu,suhang.wang,huan.liu}@asu.edu,  
<sup>‡</sup>asliva@cra.com, <sup>‡</sup>tangjili@msu.edu



# Question Answering & Search

- Customer support
- More advanced, targeted search results
- Support natural language queries
- Search legal docs, research papers, patents, ...



# Images and Videos...

- Many of these same techniques and applications apply to image and video applications, too.

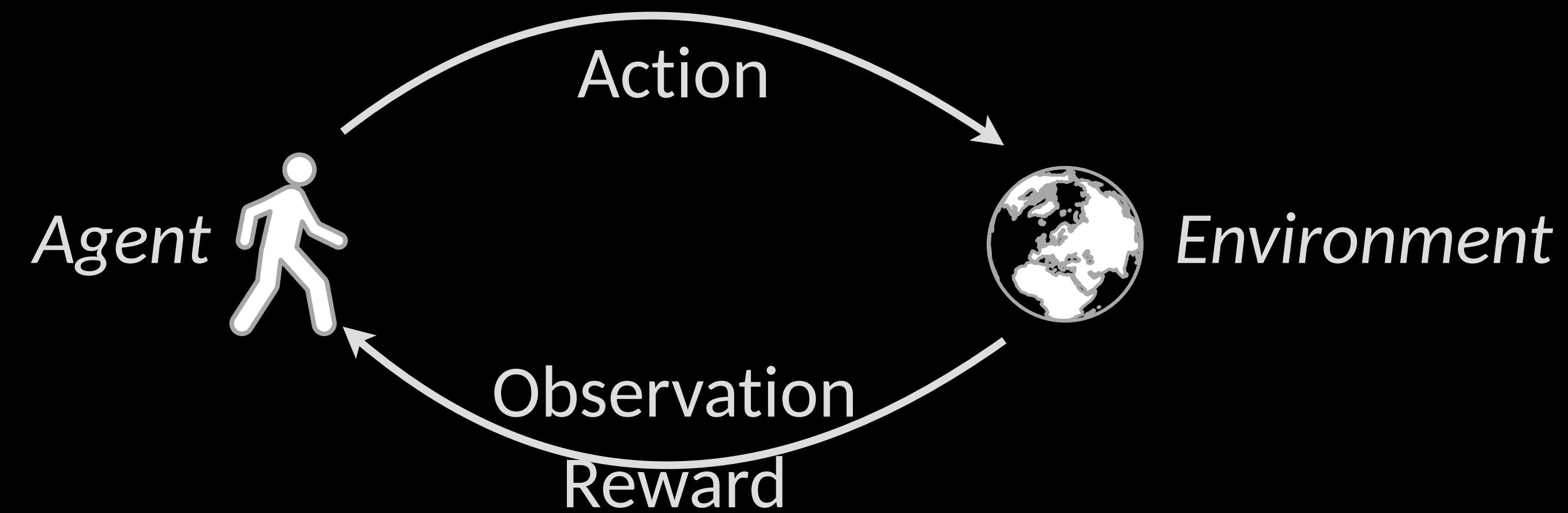


# Reinforcement Learning



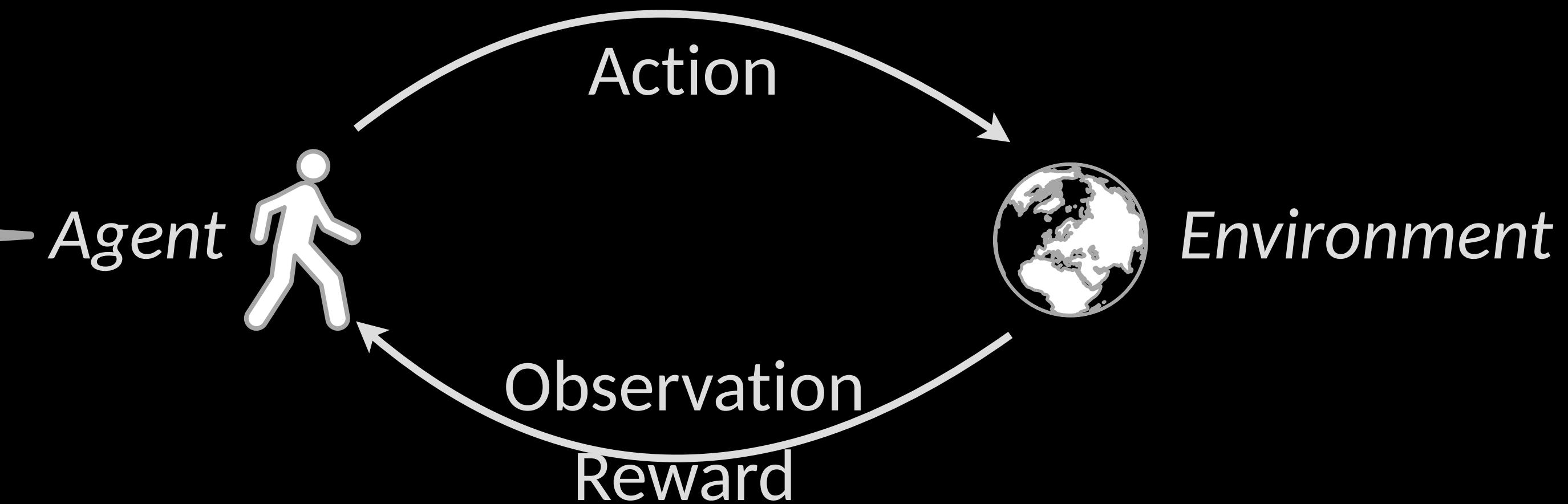
# What Is RL?

- An agent observes an environment, takes a sequence of actions
- Goal: maximize the cumulative reward



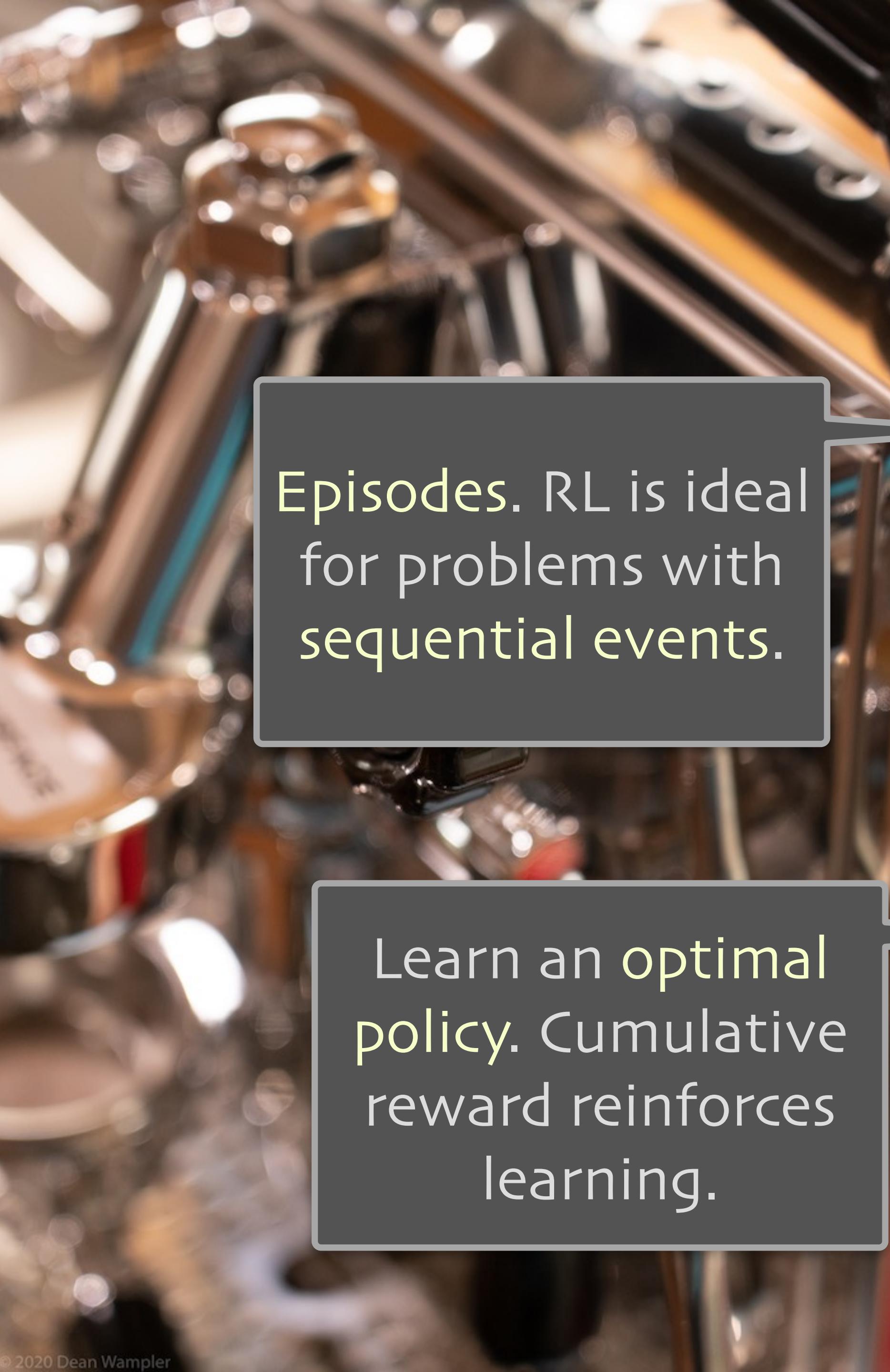
# What Is RL?

- An agent observes an environment, takes a sequence of actions
- Goal: maximize the cumulative reward



Episodes. RL is ideal for problems with sequential events.

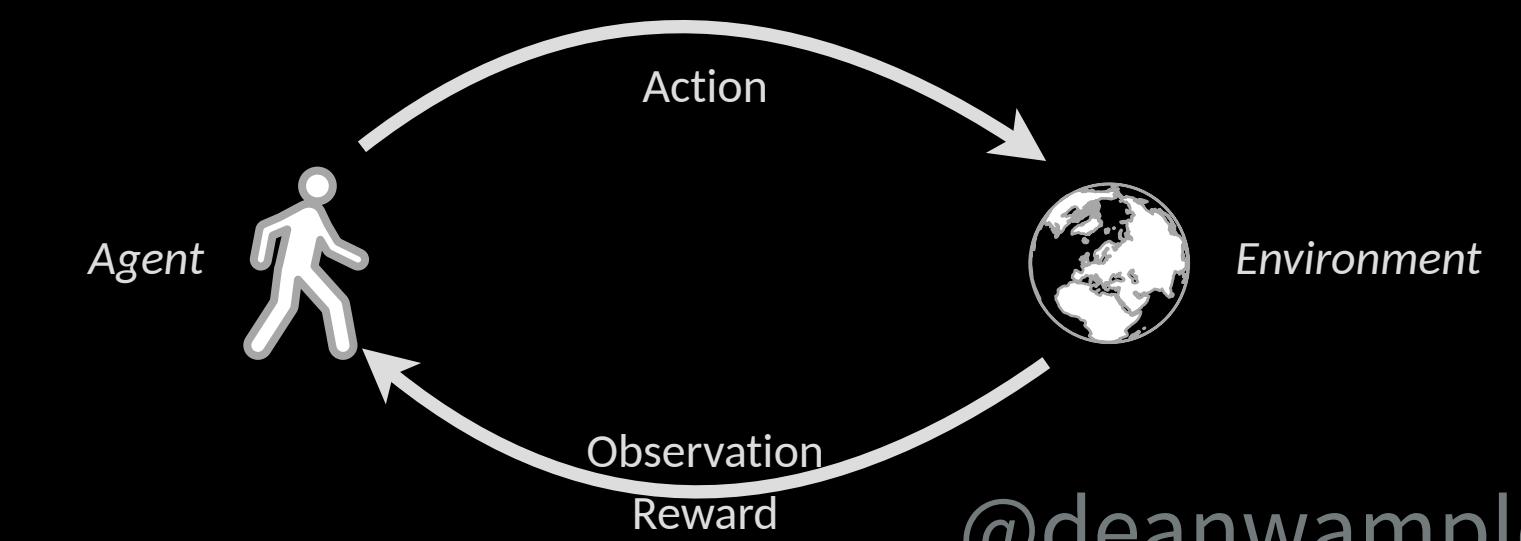
Learn an optimal policy. Cumulative reward reinforces learning.





# Applications

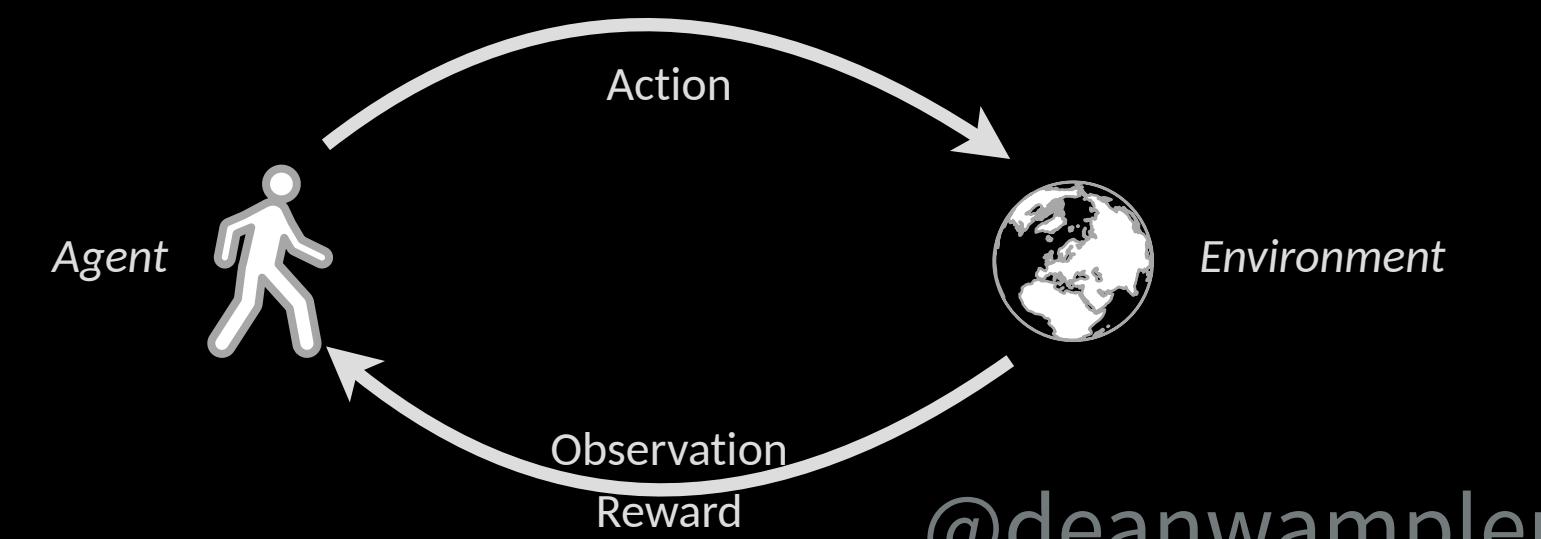
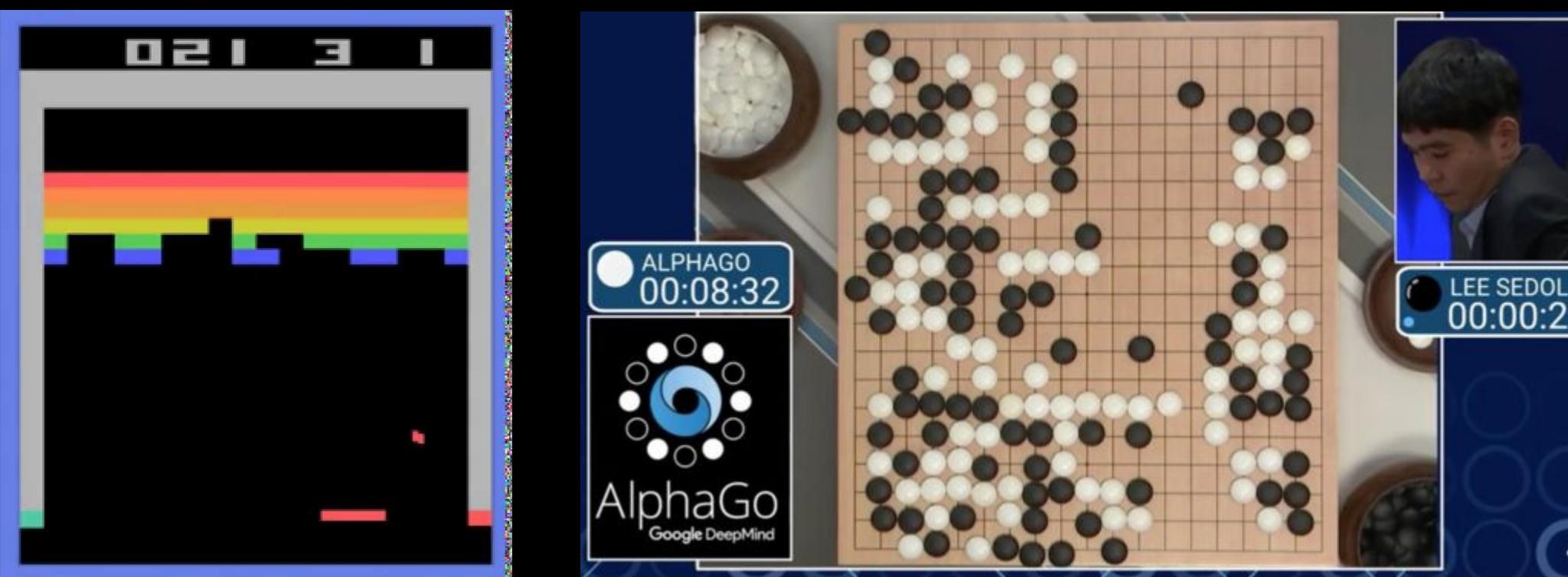
- Games
- Robots & Autonomous Vehicles
- Process Modeling & Automation
- System Optimization
- Advertising & Recommendation
- Markets





# Games

- World's best expert game play in:

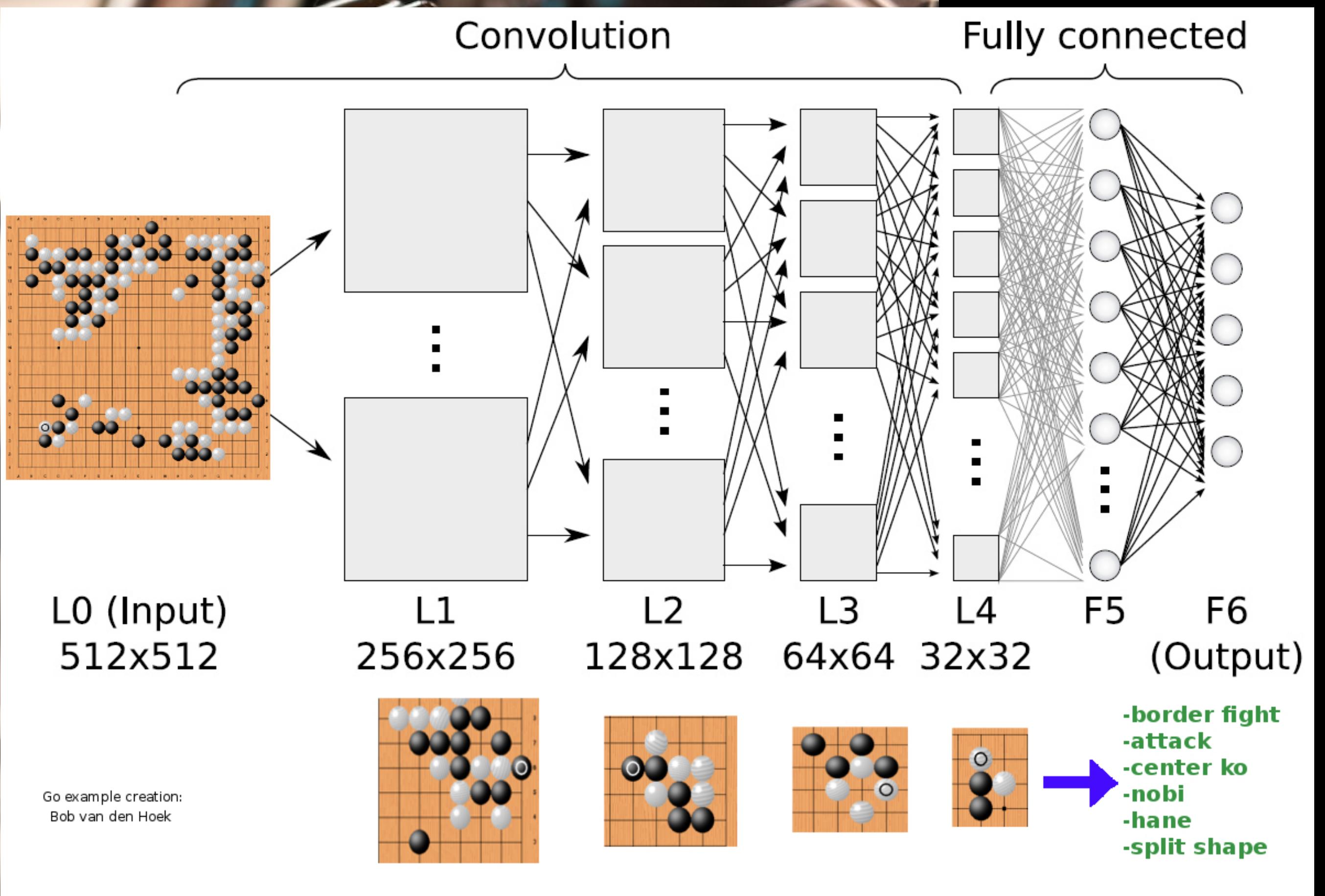


<https://www.geekwire.com/2016/alphago-ai-program-wins-1-million-prize-go-showdown-champion-lee-sedol/>

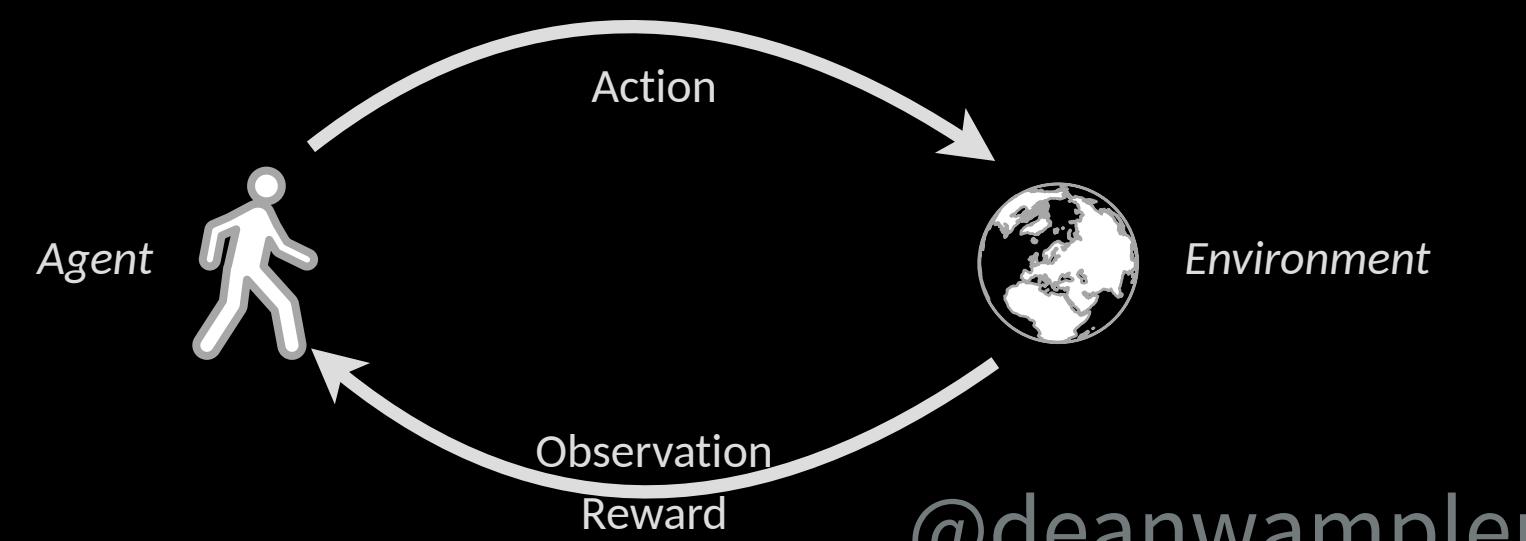
<https://towardsdatascience.com/tutorial-double-deep-q-learning-with-dueling-network-architectures-4c1b3fb7f756>



# Games



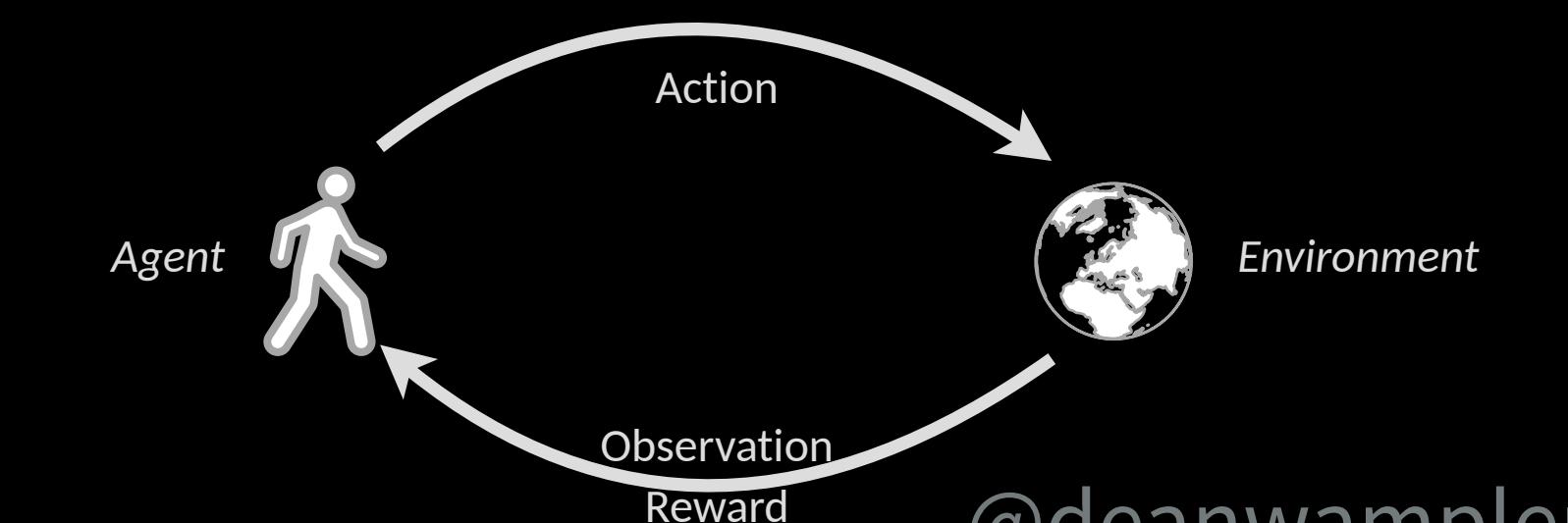
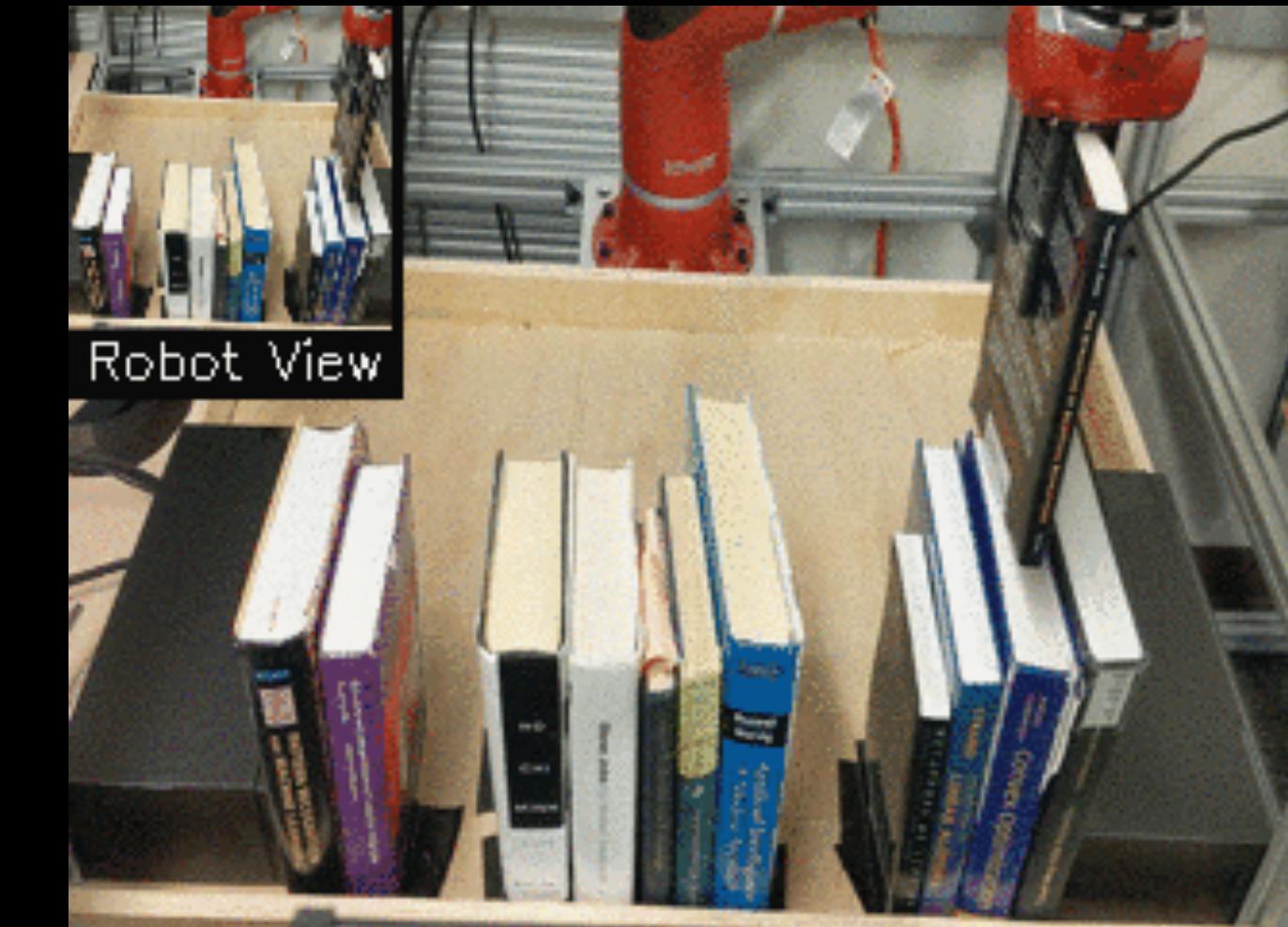
- AlphaGo
- Observations: board state
- Actions: place stones
- Rewards:
  - 1 if you win
  - 0 otherwise



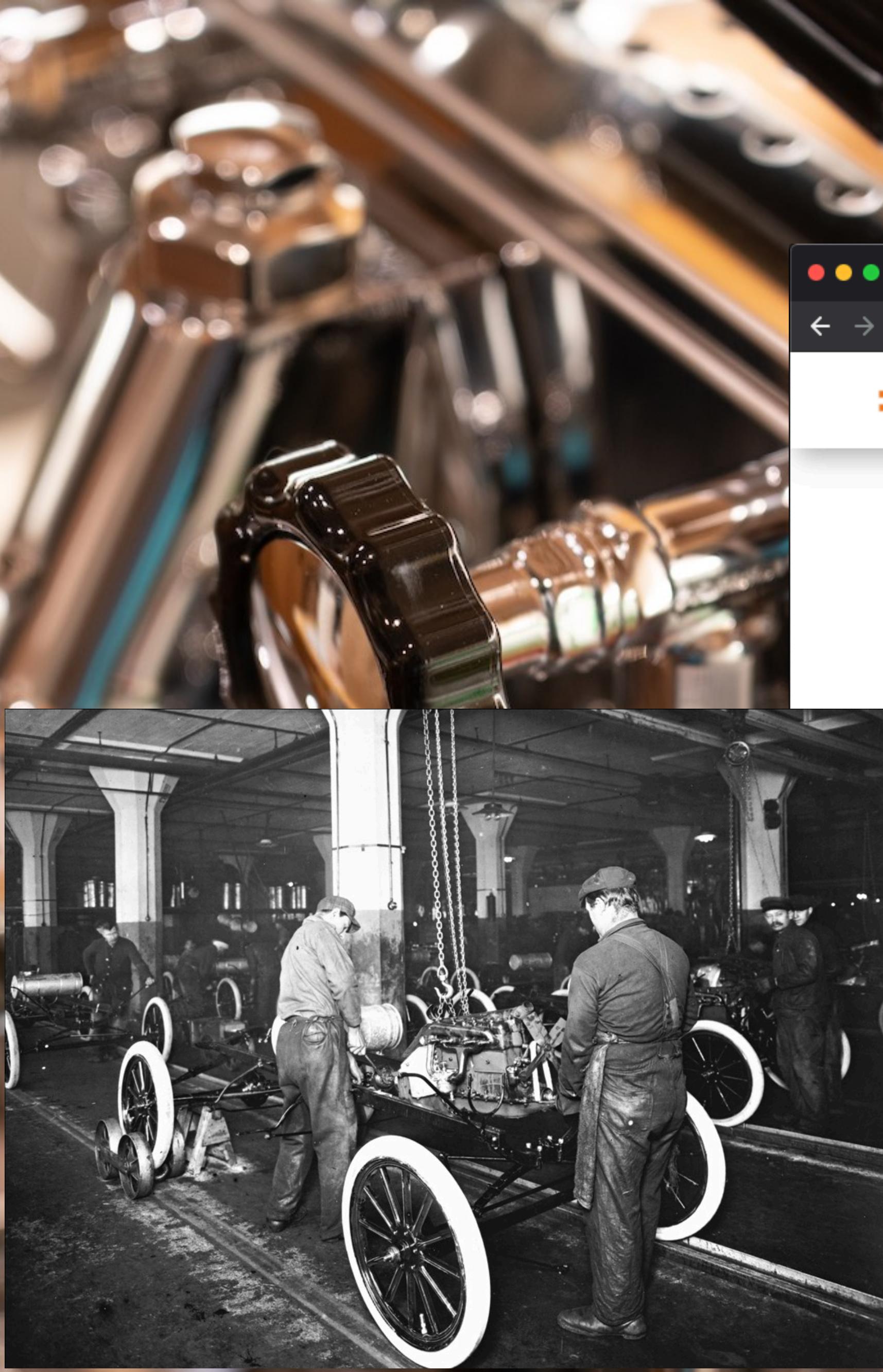


# Robotics & Autonomous Vehicles

- Start with simulators, work up to real machines.



# Process Modeling & Automation



Simulation Optimization | Add / x +

pathmind.com

Products Services Industries Resources Company SIGN IN REQUEST DEMO

## Recent Updates

Engineering Group: Manufacturing Optimization with AI Minimizes Factory Flow Bottlenecks

Oct 30, 2020 | Customer Success

Summary Engineering Group, a global engineering firm and technology consultancy with a strong practice in simulation, worked with Pathmind to apply reinforcement learning to intelligently route heavy industrial parts over a complex assembly line in...

Engineering Group: Using AI to Maximize Factory Output with Better Order Sequencing

Oct 29, 2020 | Customer Success

Summary Engineering Group, a global engineering firm and technology consultancy with a strong practice in simulation, worked with Pathmind to apply reinforcement learning to maximize factory output by making smarter decisions about order...

Princeton Consultants: Using AI to Maximize Efficiency of Machine Scheduling

Oct 13, 2020 | Customer Success

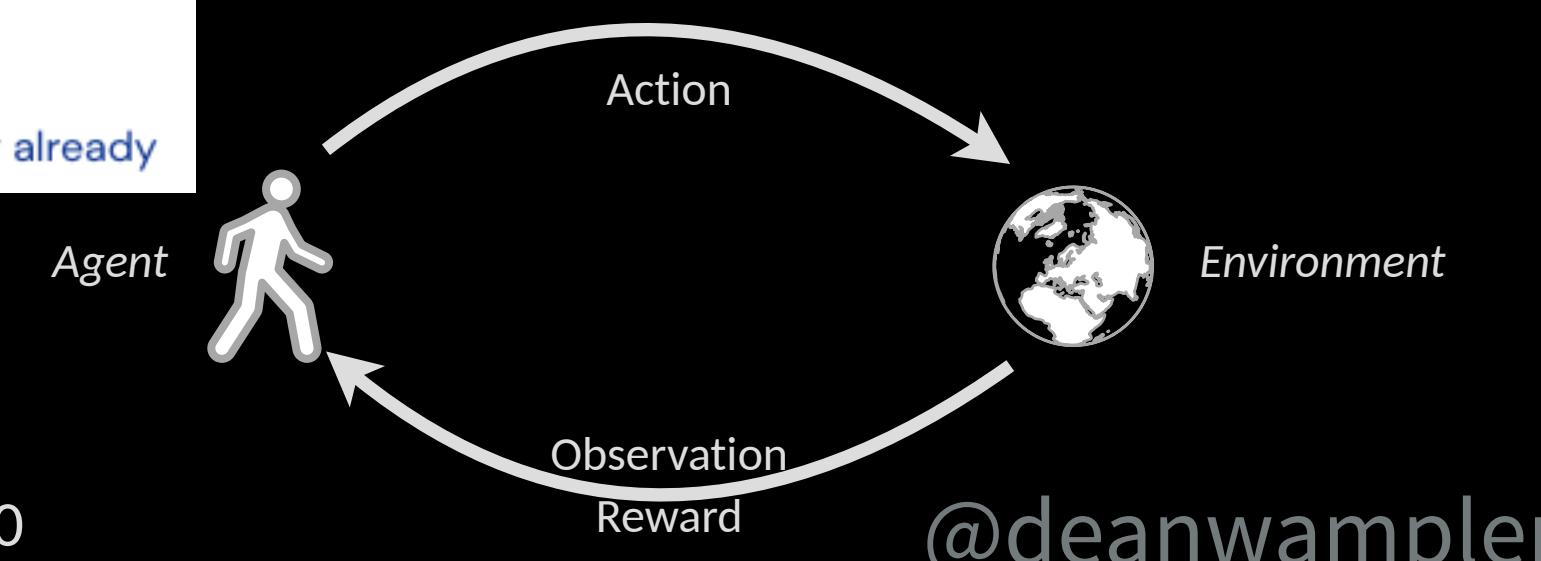
Summary Princeton Consultants, a simulation consulting firm, serves a manufacturing client with a hard machine scheduling problem. Its optimizer had difficulty scheduling machines for new types of items that needed to be processed; it was not able...



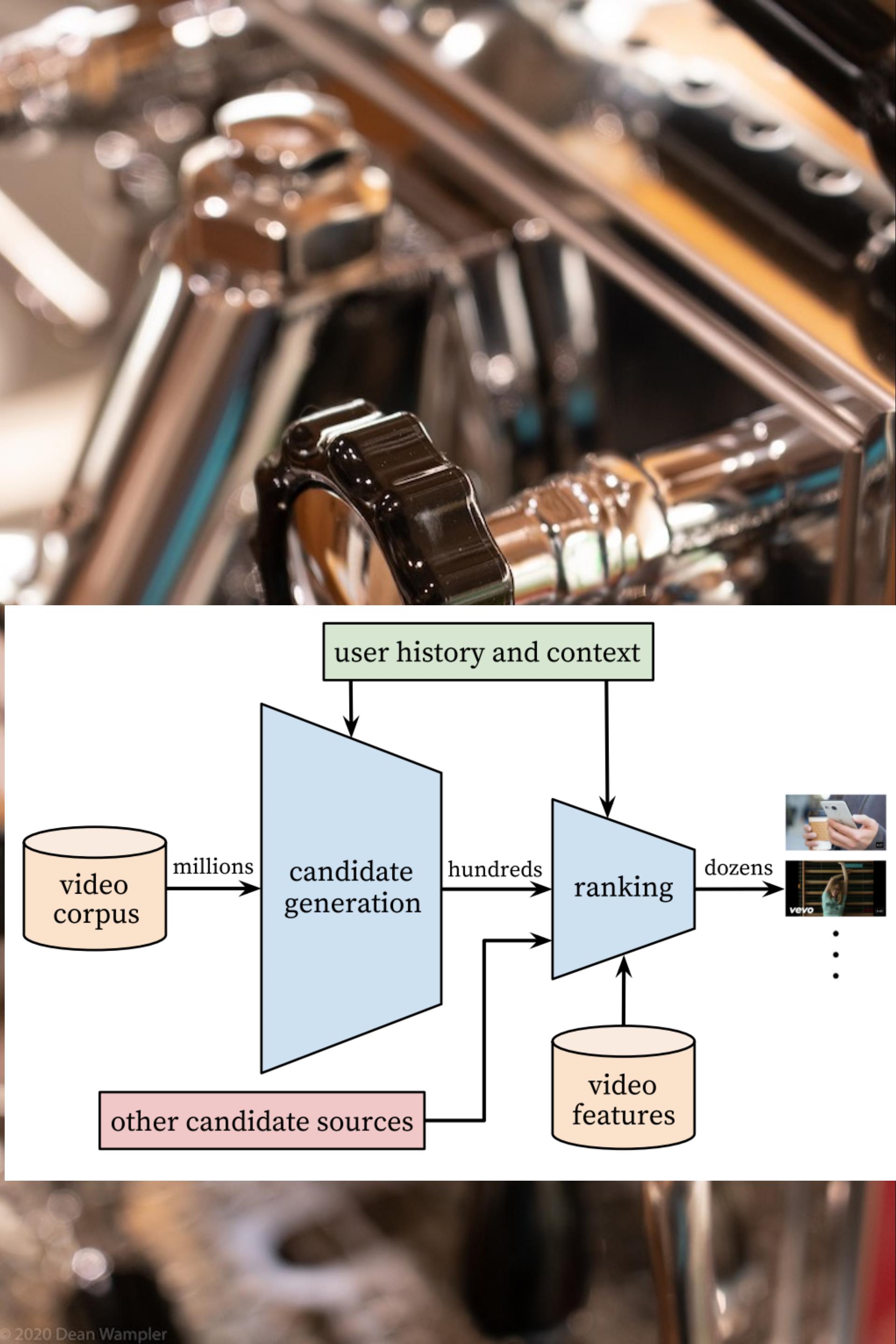
# System Optimization

The screenshot shows a web browser displaying a DeepMind blog post. The URL in the address bar is [deepmind.com/blog/article/deepmind-ai-reduces-google-data-centre-cooling-bill-40](https://deepmind.com/blog/article/deepmind-ai-reduces-google-data-centre-cooling-bill-40). The page title is "DeepMind" followed by "Blog" and "DeepMind AI Reduces Google Data Centre Cooling Bill by 40%". On the left, there's a sidebar with links for "About", "Research", "Impact", "Blog", "Safety & Ethics", and "Careers". The main content features a large image of a data center with many colorful pipes and machinery. A pink banner at the top of the content area says "BLOG POST RESEARCH". Below the banner, the title is repeated: "DeepMind AI Reduces Google Data Centre Cooling Bill by 40%". There are social sharing icons for Twitter, Facebook, and LinkedIn. A small text box at the bottom right of the content area says "From smartphone assistants to image recognition and translation, machine learning already".

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

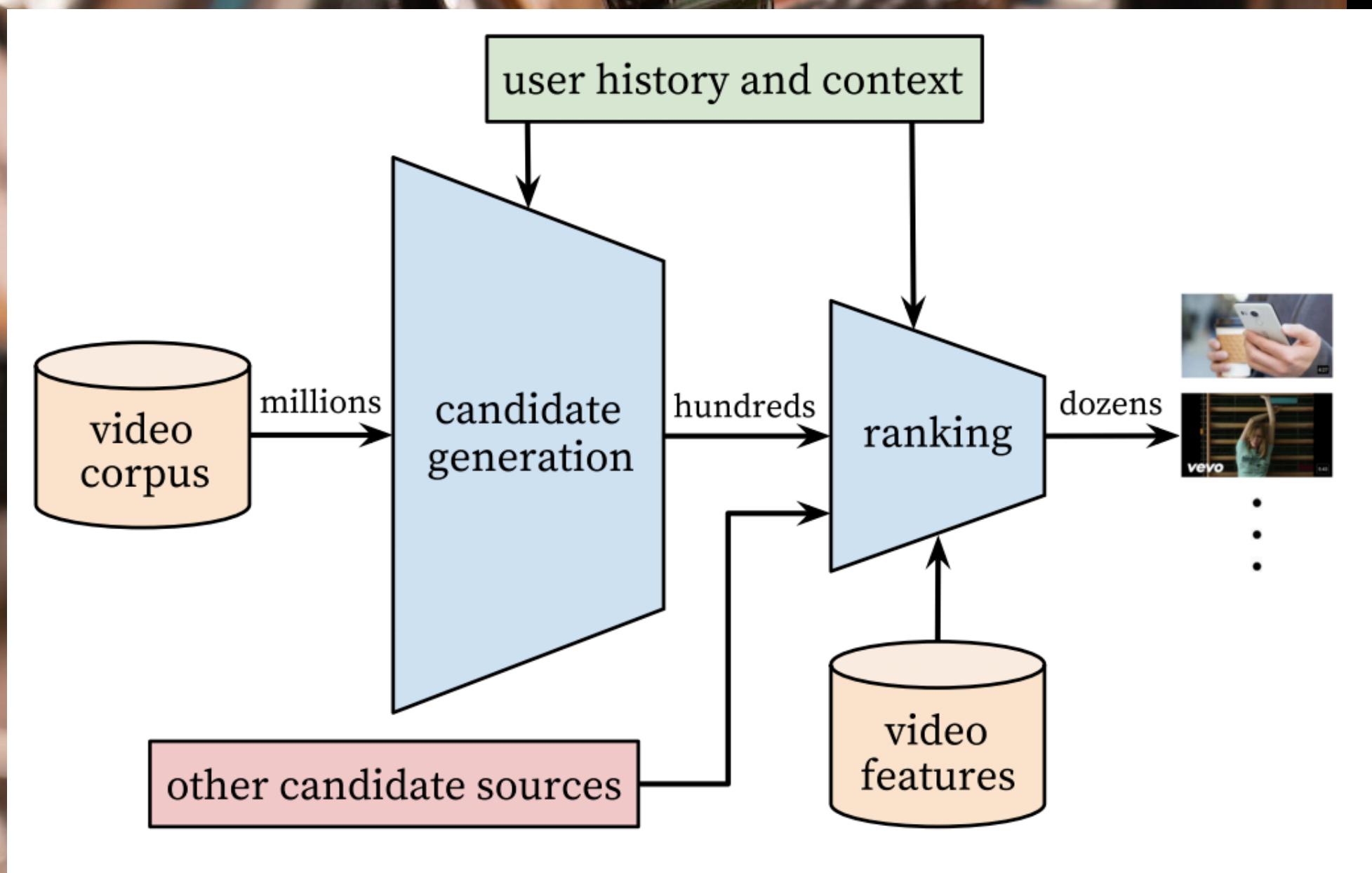


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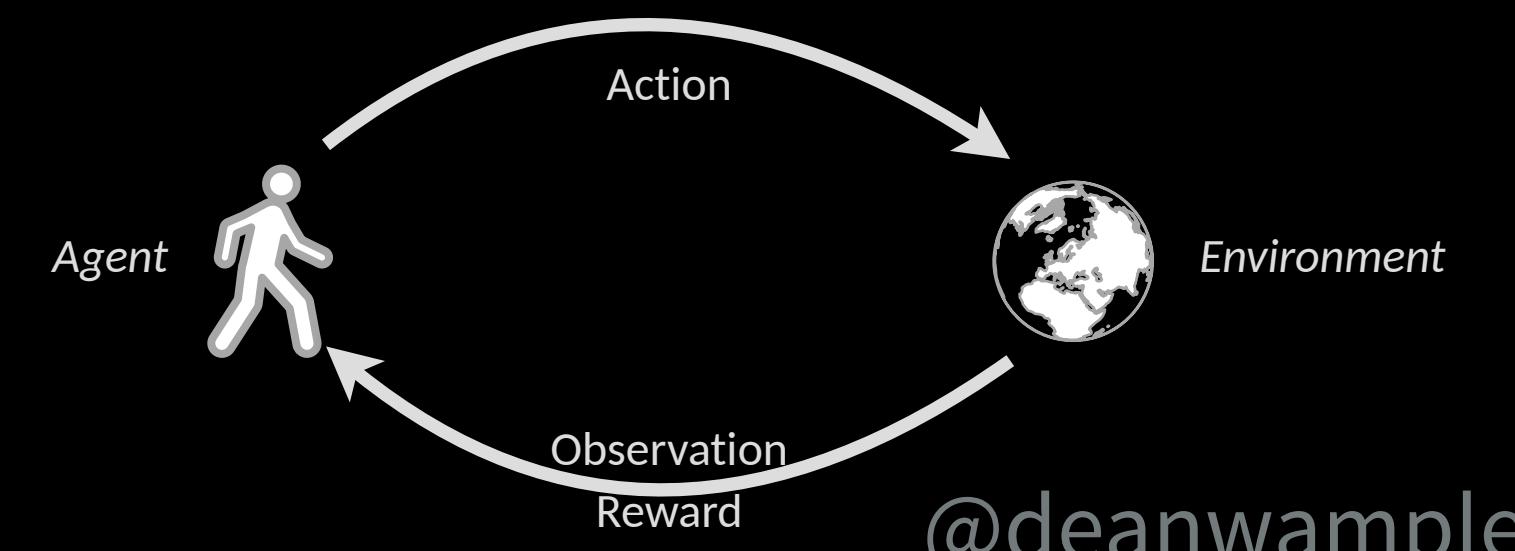


# Advertising & Recommendation

- A “mature” problem, yet RL is providing a new approach.
- Better modeling of evolving preferences.
- Better scalability than collaborative filtering, etc.



<https://research.google/pubs/pub45530/>

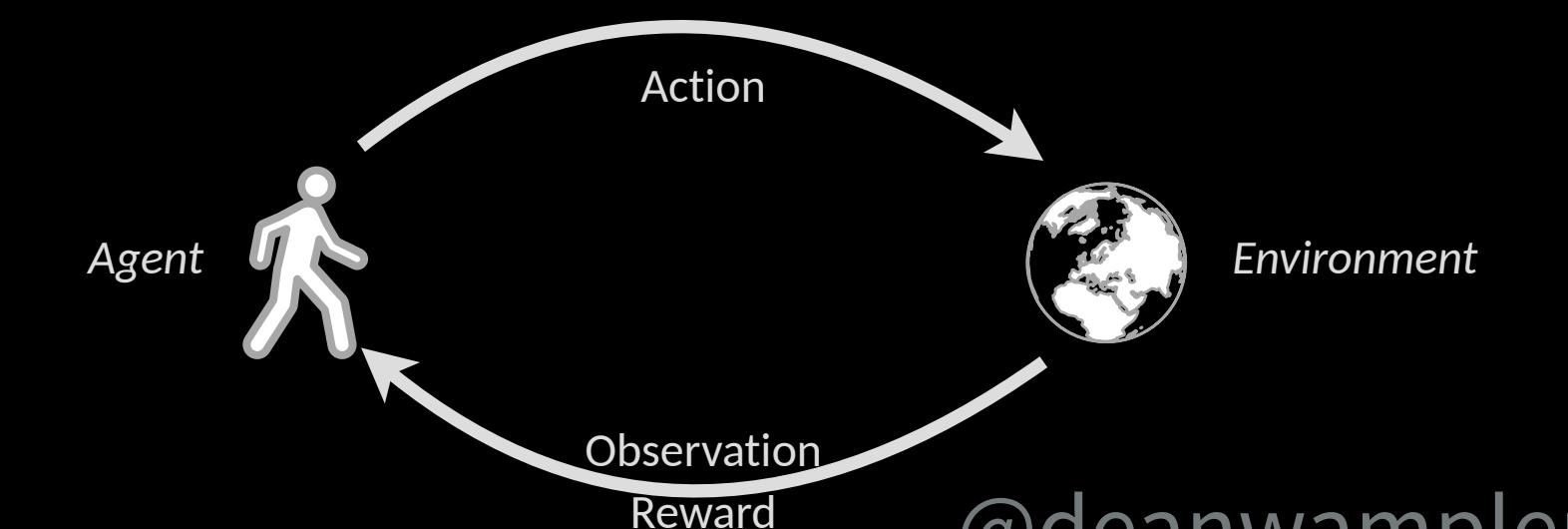


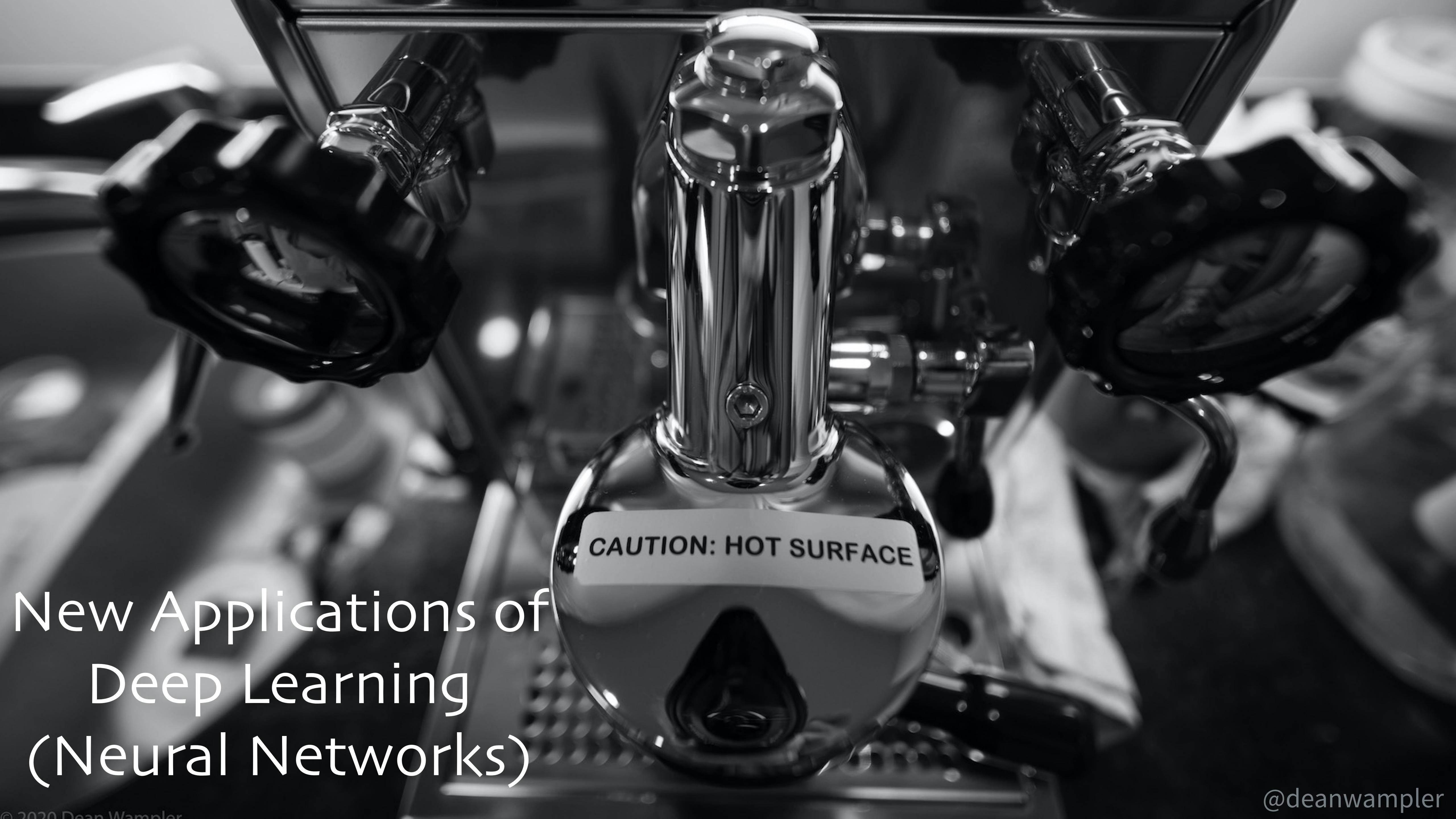
@deanwampler



# Markets

- Inherently time-ordered
- Lots of different “signals”
- Contextual, multi-armed bandits



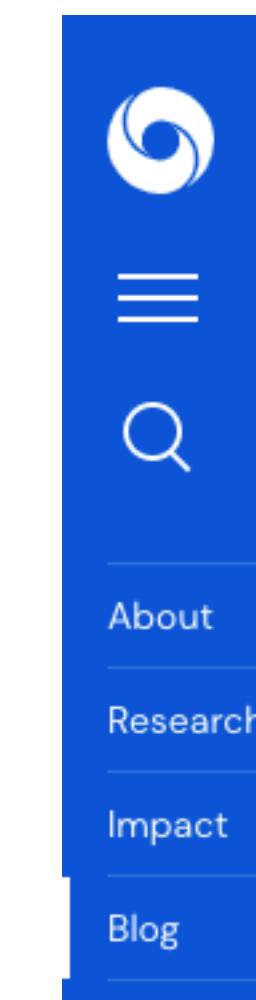


# New Applications of Deep Learning (Neural Networks)

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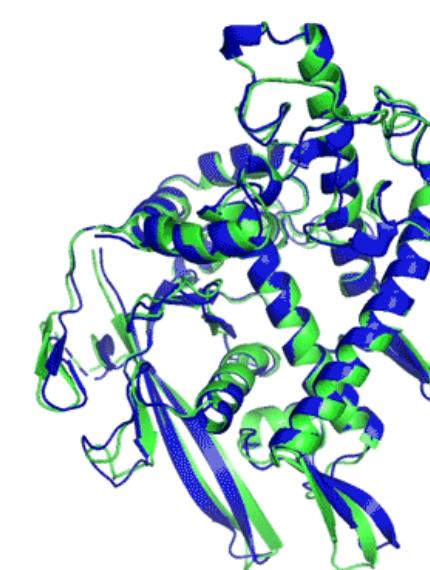


# Biology, Medicine

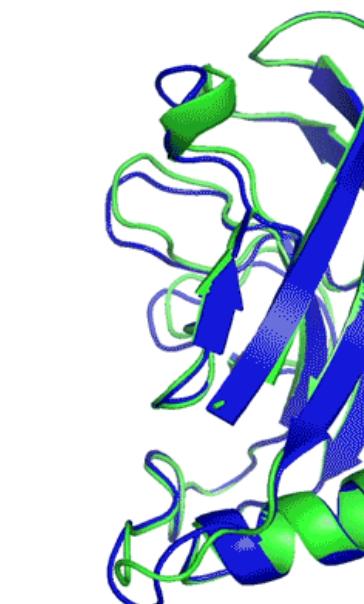


30 NOV 2020

## AlphaFold: a solution to a 50-year-old grand challenge in biology



T1037 / 6vr4  
90.7 GDT  
(RNA polymerase domain)



T1049 / 6y4f  
93.3 GDT  
(adhesin tip)

- Experimental result
- Computational prediction



# Biology, Medicine

**nature reviews cancer**

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[nature](#) > [nature reviews cancer](#) > [perspectives](#) > [article](#)

Perspective | Published: 17 May 2018

OPINION

## Artificial intelligence in radiology

Ahmed Hosny, Chintan Parmar, John Quackenbush, Lawrence H. Schwartz &  
Hugo J. W. L. Aerts 

[Nature Reviews Cancer 18](#), 500–510(2018) | [Cite this article](#)

**15k** Accesses | **317** Citations | **311** Altmetric | [Metrics](#)

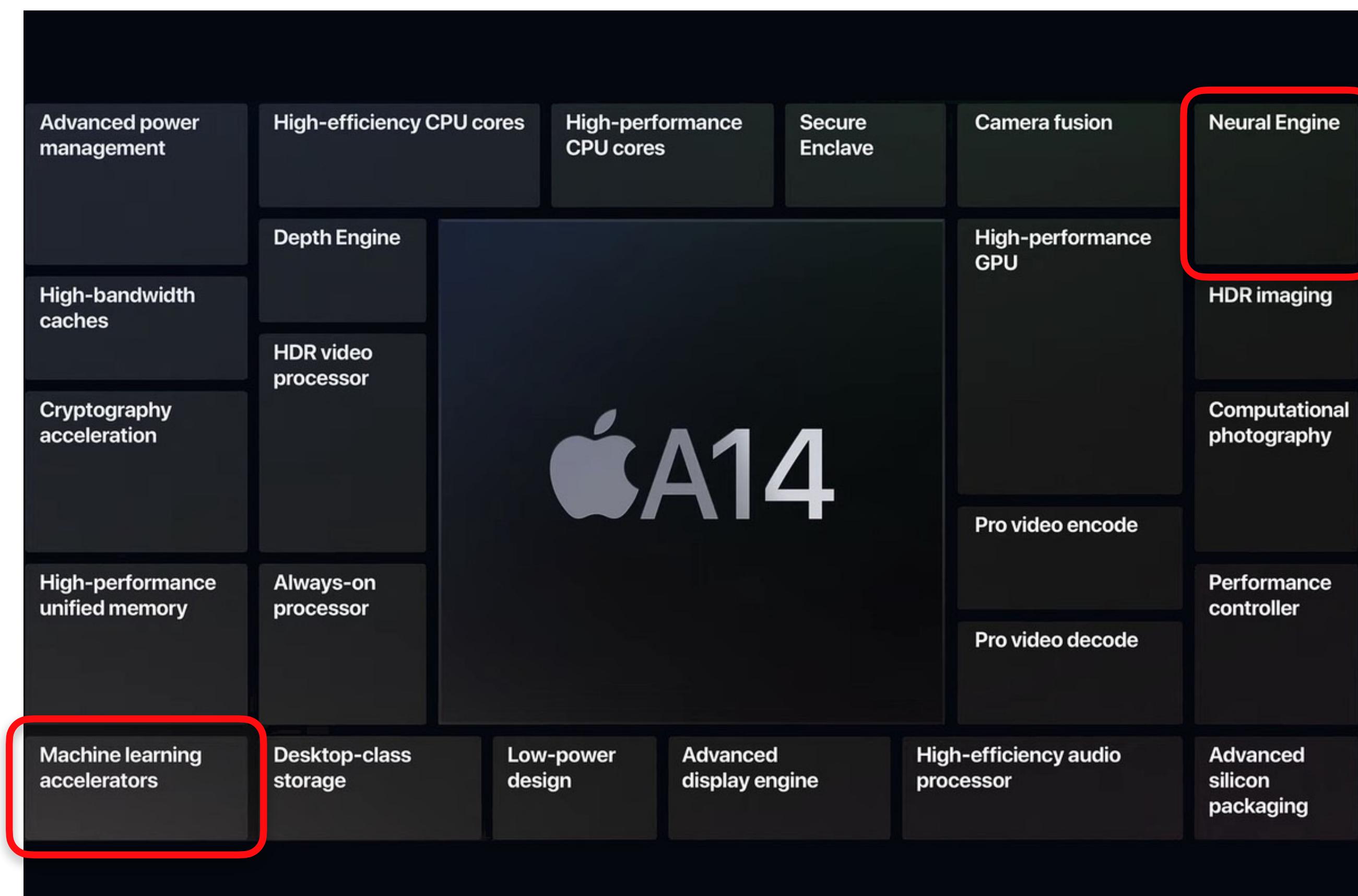
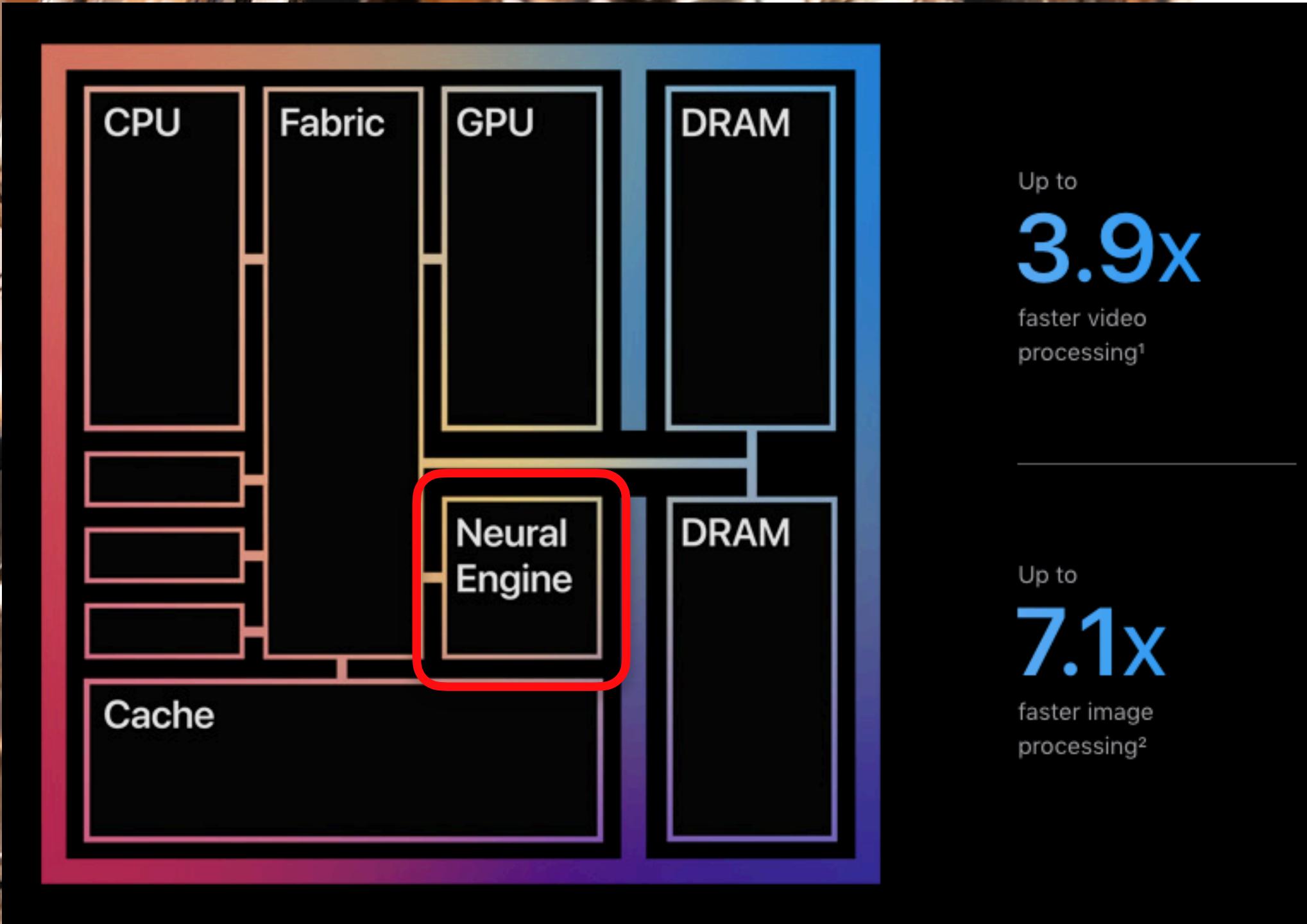
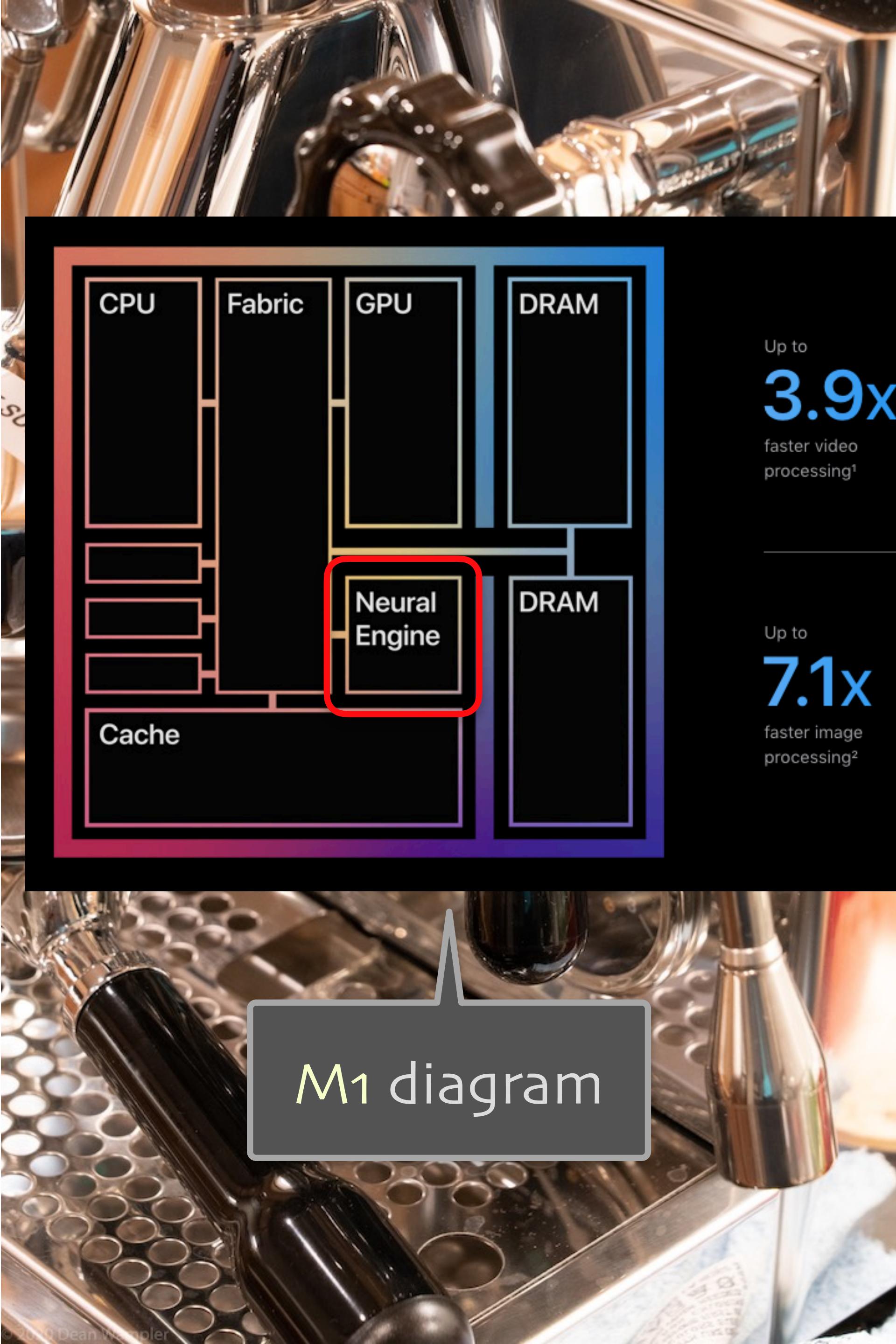
### Abstract

Artificial intelligence (AI) algorithms, particularly deep learning, have demonstrated remarkable progress in image-recognition tasks. Methods ranging from convolutional neural networks to variational autoencoders have found myriad applications in the medical image analysis field, propelling it forward at a rapid pace. Historically, in radiology practice, trained physicians visually assessed medical images for the detection



What Our Phones  
Are Telling Us...

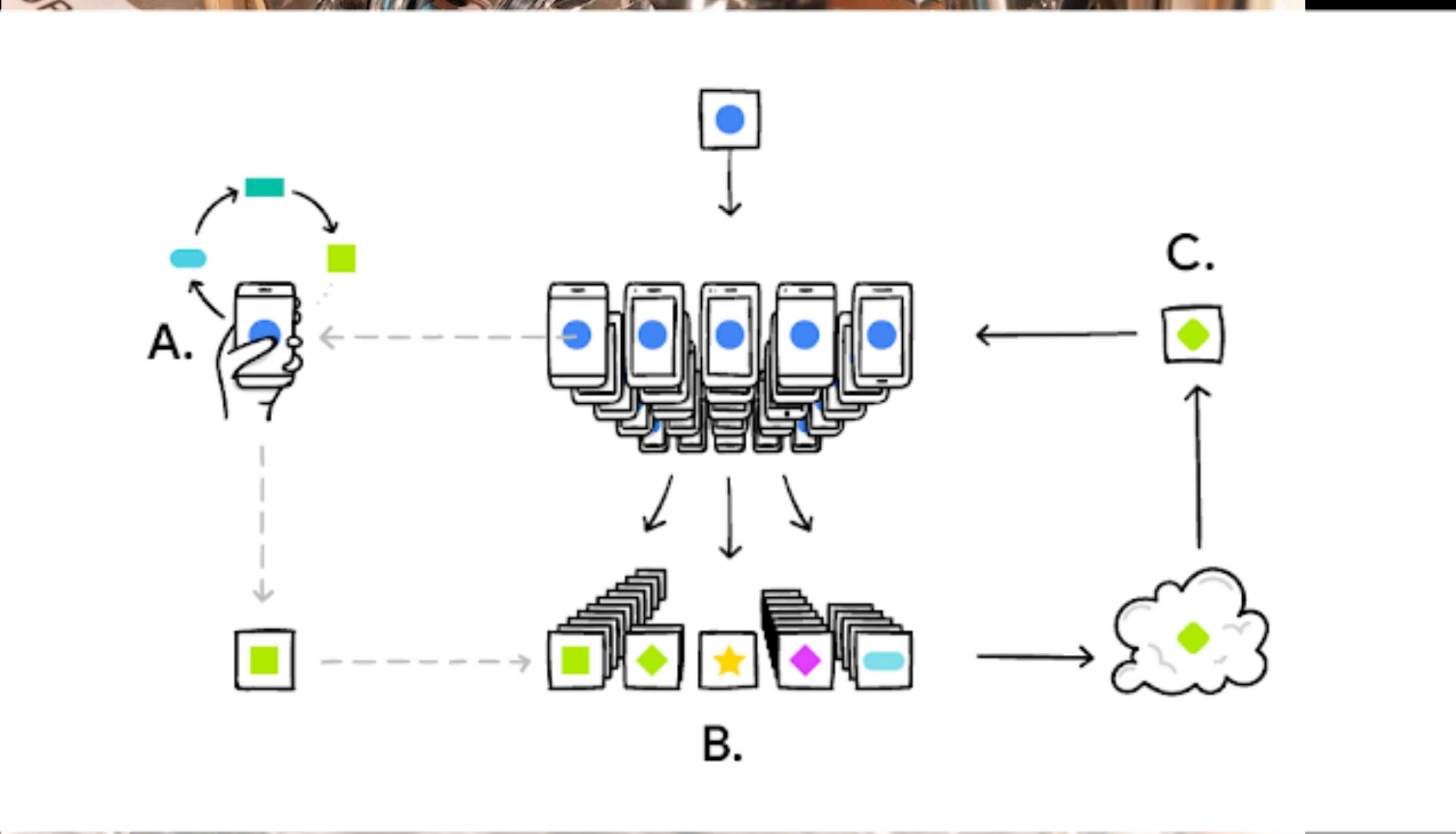
# Apple Silicon





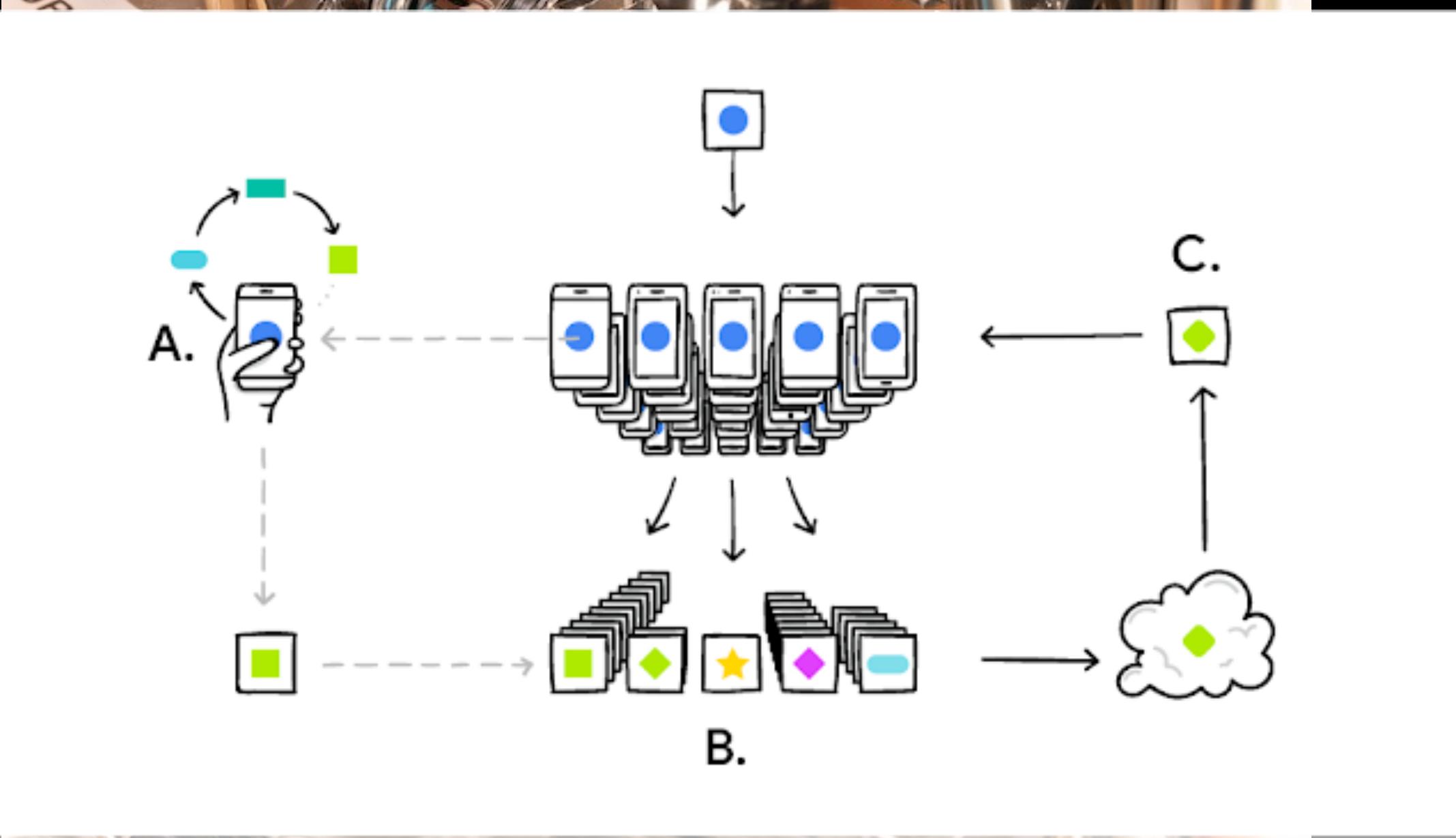
# Applications that Exploit ML/AI

- Unlocking: finger and face ID
- Predictive typing
- Voice assist - Siri
- Health monitoring
- Security (beyond passwords...)
- Recommendations
- ...
- Probably most apps will use it in one way or another, eventually!



# Technologies that Make this Possible

- Federated Learning
  - A. Your local usage trains a model
  - B. Model updates from many users are aggregated to form a consensus update
  - C. Updated model propagated to all users.
  - D. Repeat...

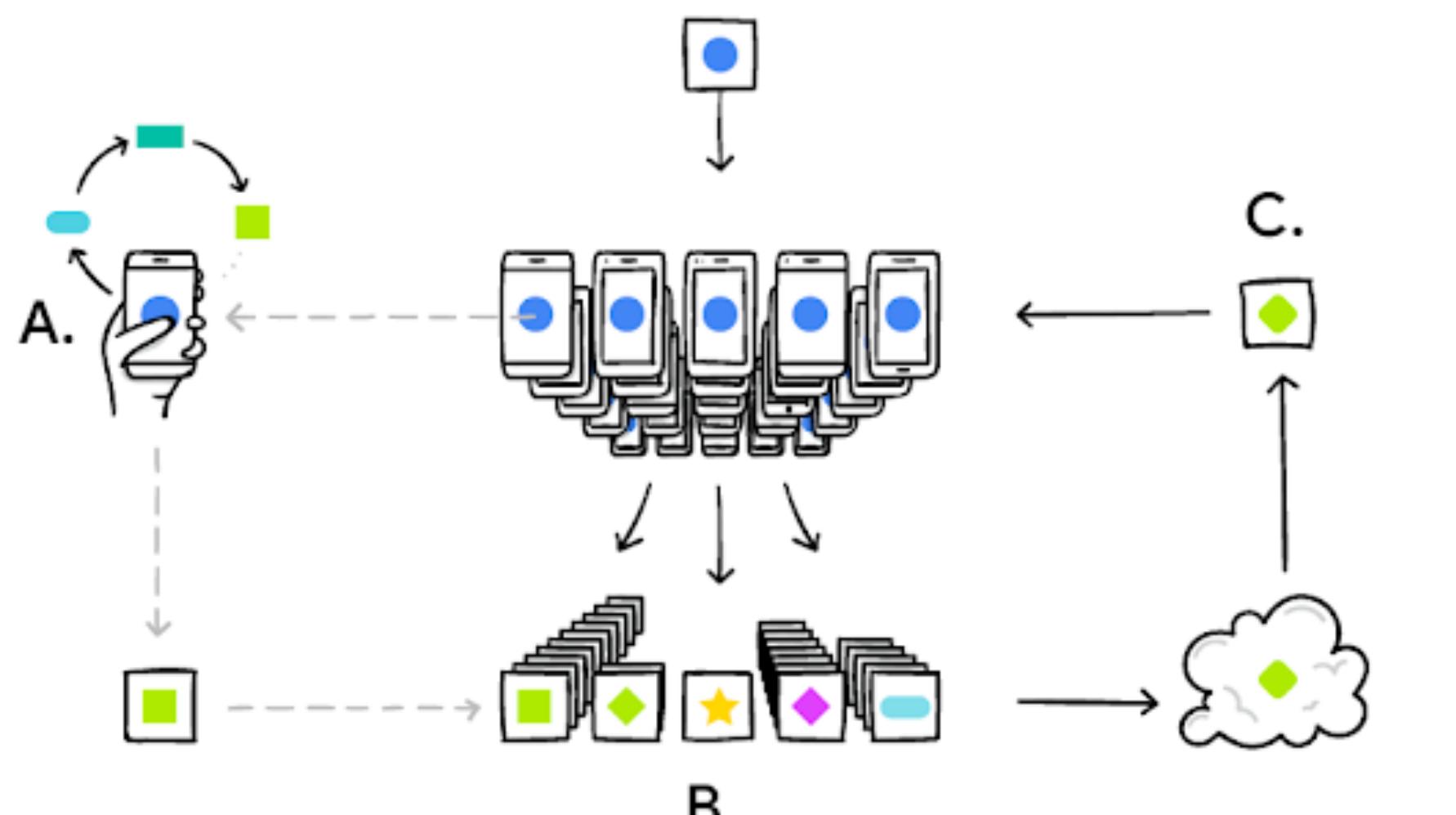


# Technologies that Make this Possible

- Federated Learning Advantages
  - Your private data stays local
  - Local model is fine tuned for you
  - No central data storage required
  - Central processing is minimized
  - Instead, all our phones do most of the training



# Technologies that Make this Possible

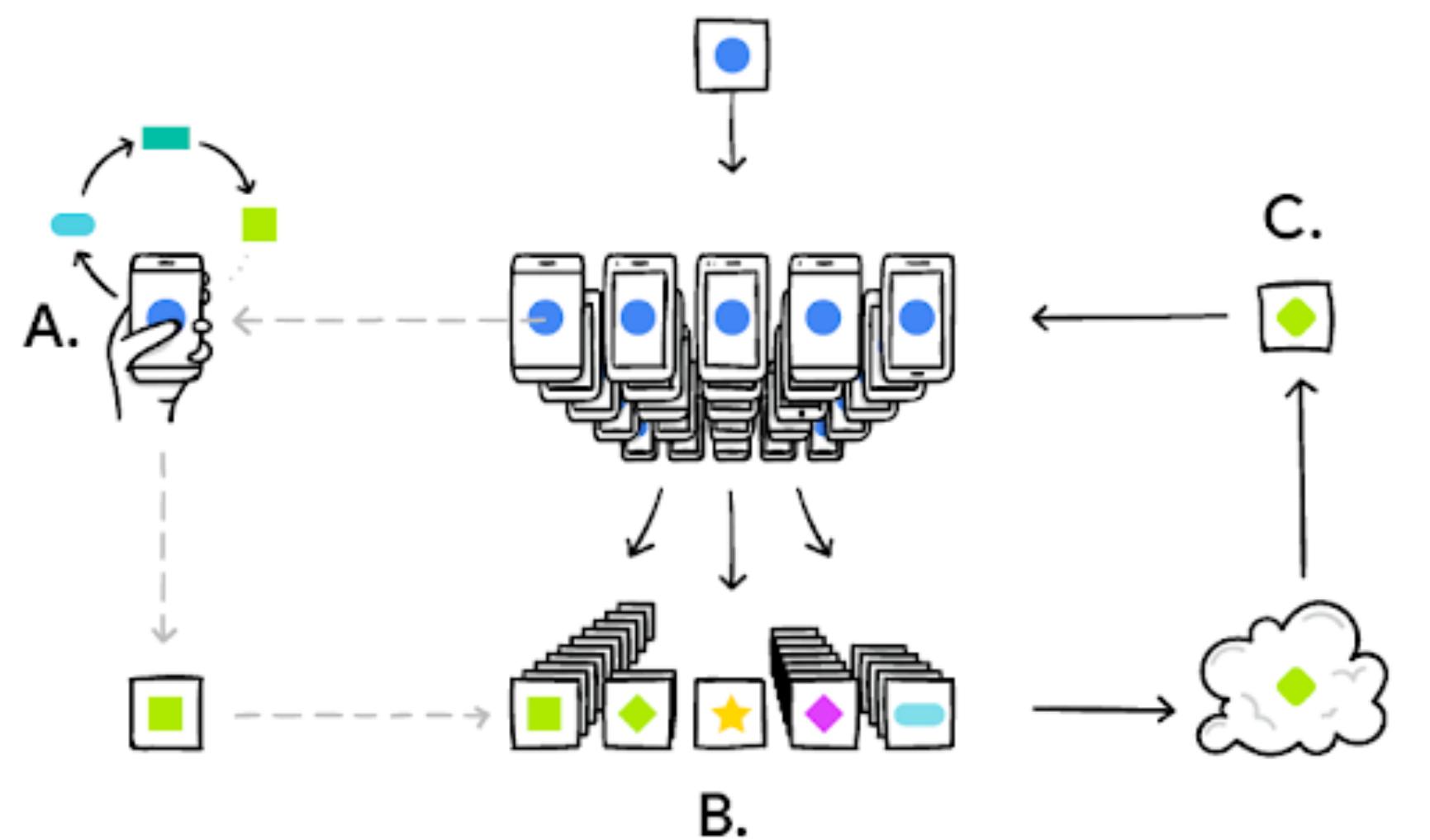


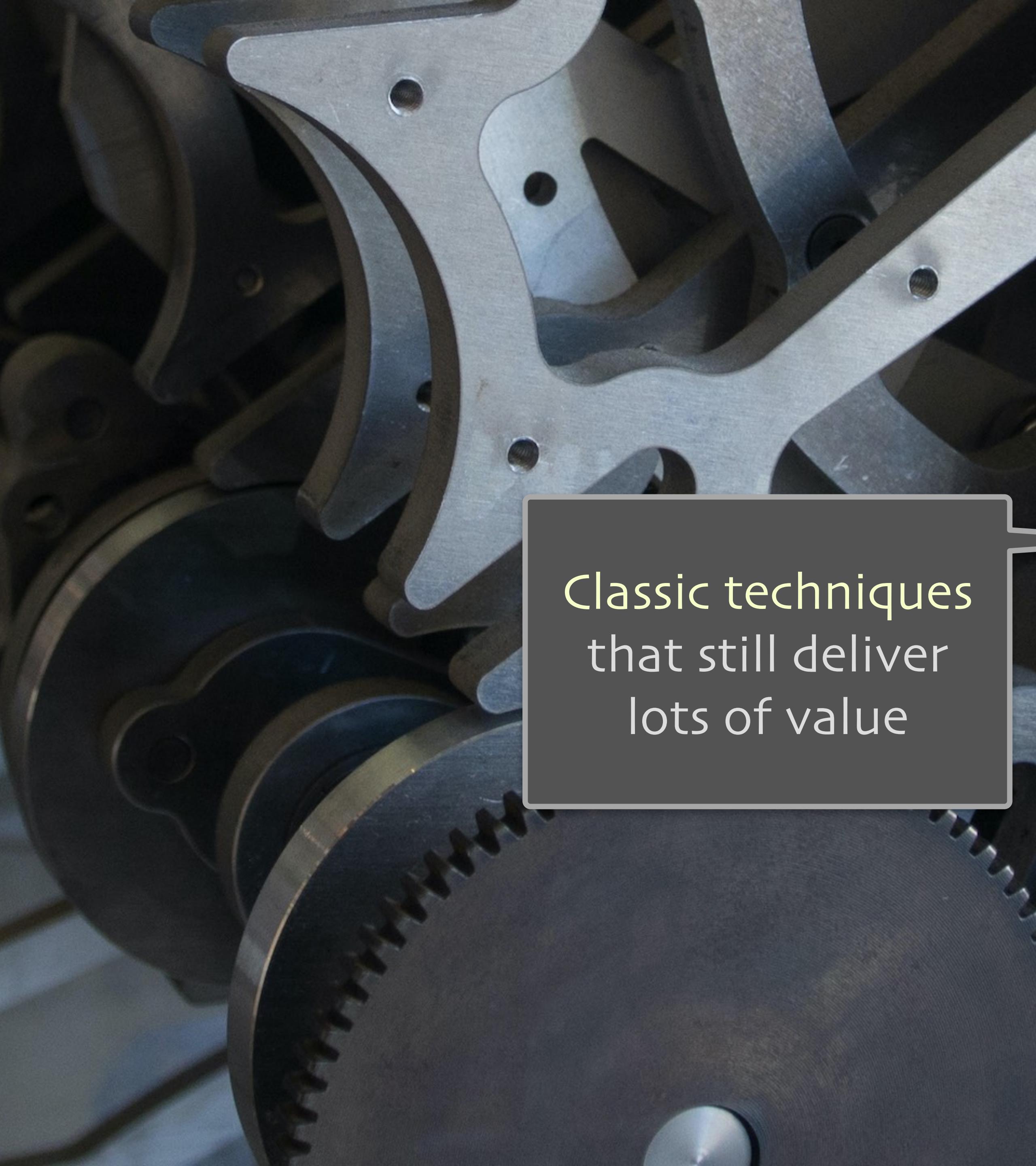
- Differential Privacy
- “Differential” - If I run a query without your record, then with your record, what can I learn about you from the difference??
- Introduce “noise” into the data so that:
  - Private data is obscured
  - Introduced error is bounded



# Enterprise Applications?

- What services would your customers reject now, but accept if you offered the services using Federated Learning & Differential Privacy??





Classic techniques  
that still deliver  
lots of value

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# Statistical Inference

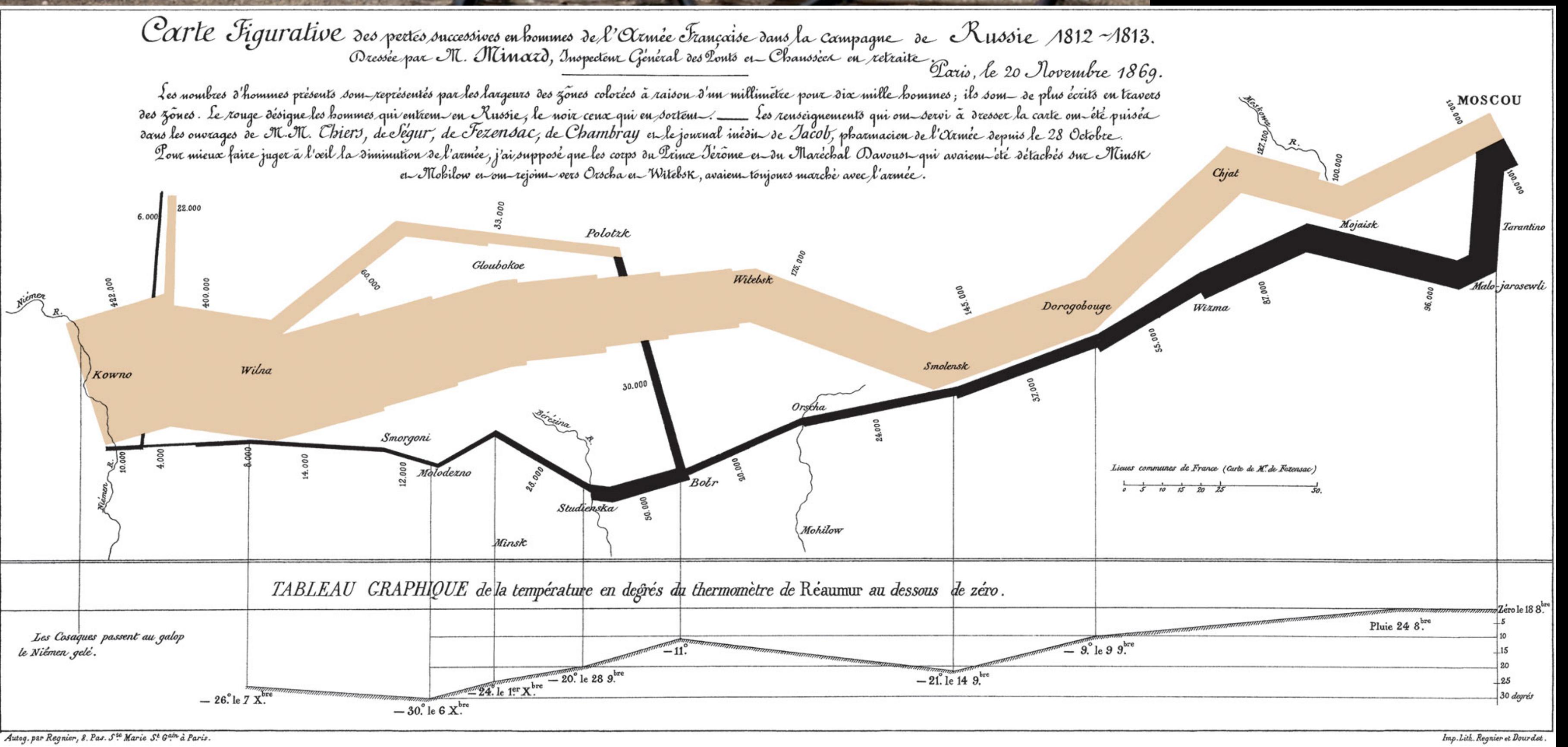
- Al Kindi (801-873):
    - On Deciphering Cryptographic Messages
    - Creator of cryptanalysis
    - Earliest known use of statistical inference

<https://en.wikipedia.org/wiki/Al-Kindi>





<https://datavizblog.com/2013/05/26/dataviz-history-charles-minards-flow-map-of-napoleons-russian-campaign-of-1812-part-5/>



# Visualization

- Charles Minard's visualization of Napoleon's Russia Campaign (drawn 1861)



# Visualization

- “On the Mode of Communication of Cholera”; by John Snow (1854)

[https://en.wikipedia.org/wiki/1854\\_Broad\\_Street\\_cholera\\_outbreak](https://en.wikipedia.org/wiki/1854_Broad_Street_cholera_outbreak)



# Neural Nets

- 1943 - McCulloch and Pitts - single layer
- ...
- Le Cun, et al.  
(1989-1990)

## Handwritten Zip Code Recognition with Multilayer Networks

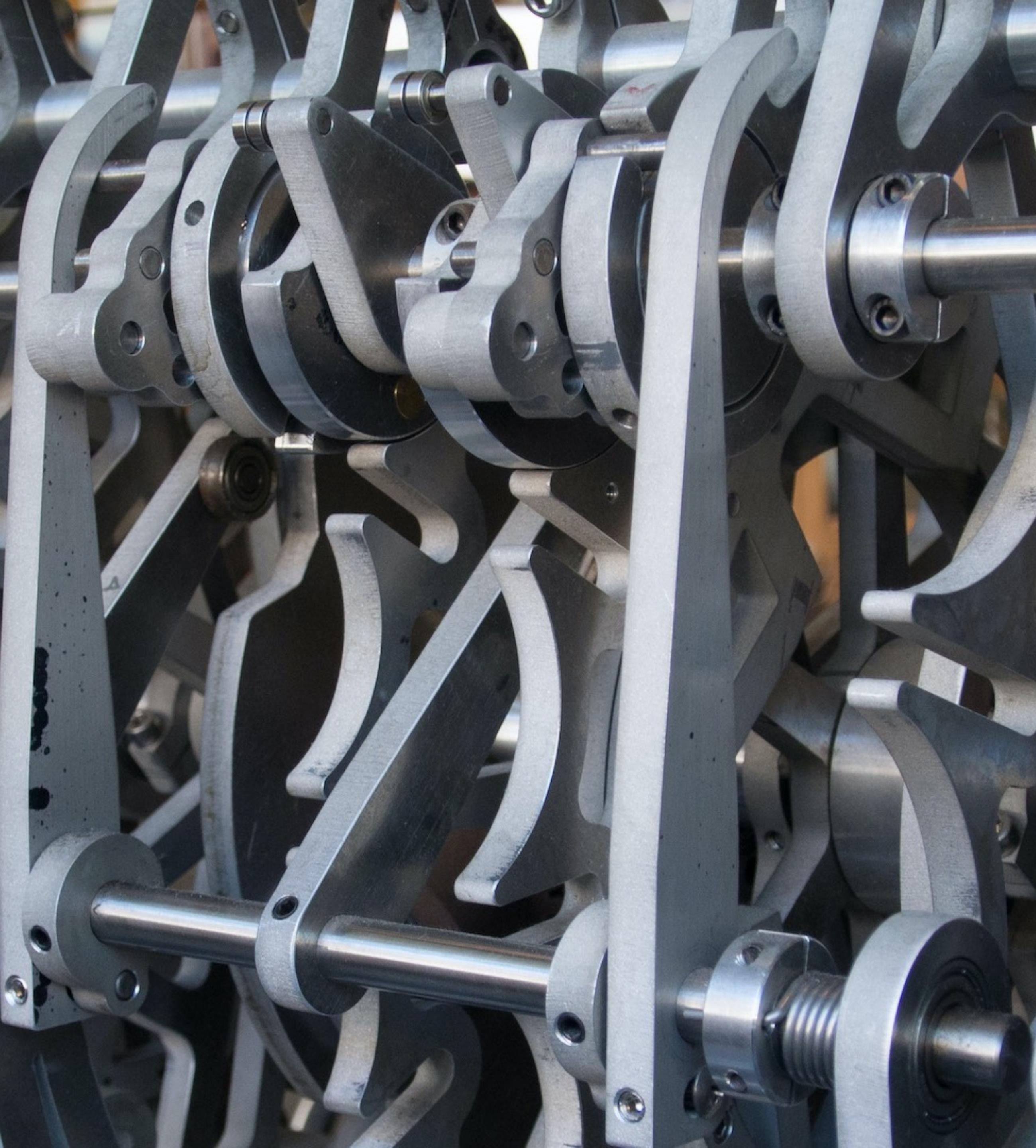
**Y. Le Cun, O. Matan, B. Boser, J. S. Denker, D. Henderson,  
R. E. Howard, W. Hubbard, L. D. Jackel and H. S. Baird**  
AT&T Bell Laboratories, Holmdel, N.J. 07733

A zip code

### Abstract

We present an application of backpropagation networks to handwritten zip

only be obtained by designing a network architecture that contains a certain amount of *a priori* knowledge about the problem. The basic design



# Outline

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A photograph of the Chicago Riverwalk. In the foreground, there's a body of water with a small boat. The middle ground shows a paved walkway with trees and a bridge. In the background, the iconic Marina City towers are visible, along with other skyscrapers under a clear blue sky.

All the current capabilities of the  
Promise of AI section are  
available now, but they are hard  
to build and use.



# Data Science vs. Data Engineering



# Data Science vs. Data Engineering

- A cultural and technical divide



Data Science toolbox

Software Engineering toolbox

@deanwampler

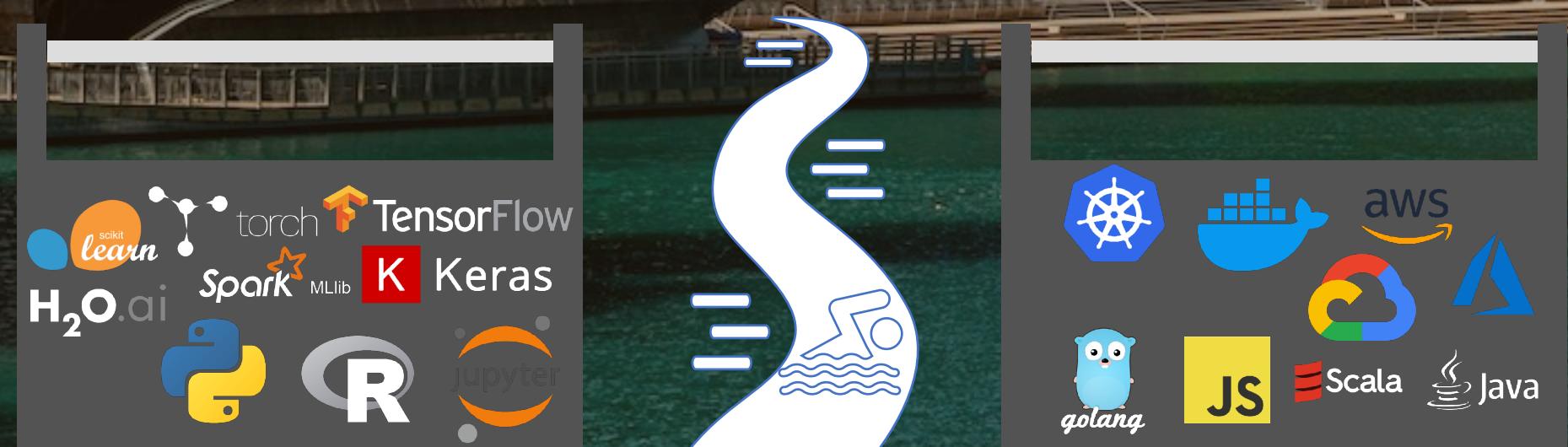
# Data Scientists

- Comfortable with uncertainty
- Less process oriented
  - Iterative, experimental

# Data Engineers

- Uncomfortable with uncertainty
- Process oriented
  - Agile Manifesto
    - ... which does not mention data!

<https://derwen.ai/s/6fqt>



@deanwampler

# Bridging the Divide



## Data Scientists

- Embrace control and repeatability

## Data Engineers

- DevOps → ModelOps

# Bridging the Divide

## Data Scientists

- Embrace control and repeatability

## Data Engineers

- DevOps → ModelOps

Model: An algorithm that makes a prediction or recommendation or prescribes some action based on a probabilistic assessment. Data scientists make models.

<https://www.dominodatalab.com/blog/model-management-and-the-era-of-the-model-driven-business/>



# ModelOps

“ModelOps is a principled approach to operationalizing a model in apps. ModelOps synchronizes cadences between the application and model pipelines. ... you can optimize your data science and AI investments using data, models, and resources from edge to core to cloud.”

<https://www.ibm.com/cloud/machine-learning/modelops>

# ModelOps

And if you look at the most successful companies in the world, you'll find models at the heart of their business driving that success.

- Example: Netflix recommendation model
  - Drives subscriber engagement, retention, and operational efficiency.
  - Their recommendation model is worth more than \$1B per year (2016).

# ModelOps

And if you look at the most successful companies in the world, you'll find models at the heart of their business driving that success.

- Example: Coca-Cola
  - Optimizes orange juice production, ...
- Example: Stitch Fix and Trunk Club
  - Clothing recommendations for customers

# ModelOps

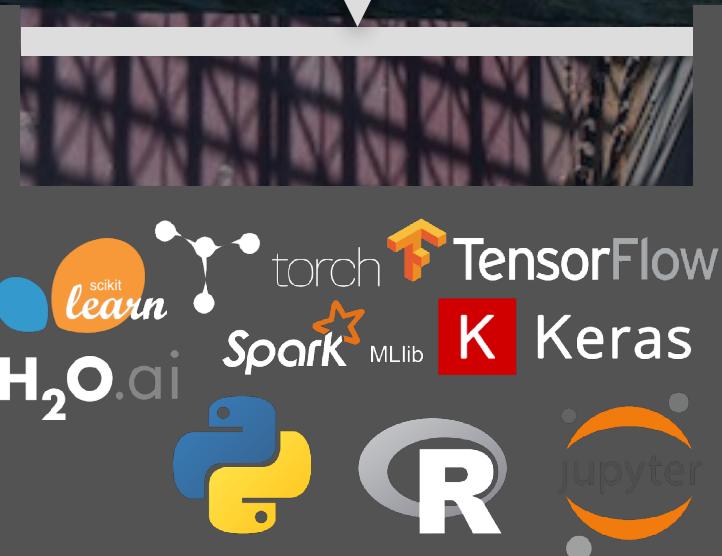
And if you look at the most successful companies in the world, you'll find models at the heart of their business driving that success.

- Example: Insurance companies
  - Actuarial models (very old technique...)
  - Now using models to make automated damage estimates from accident photos, reducing dependence on claims adjusters.

# ModelOps



Data



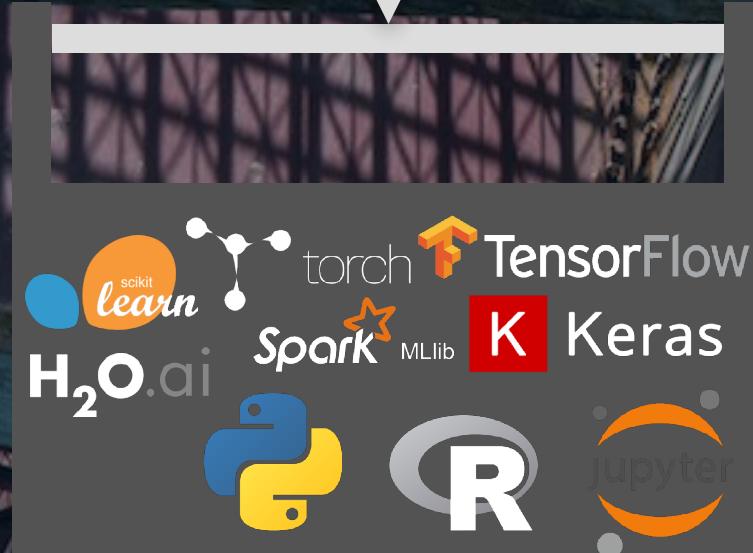
Model Development

Research  
new models

# ModelOps



Data



Model Development

Model CI/CD Pipeline

Research  
new models

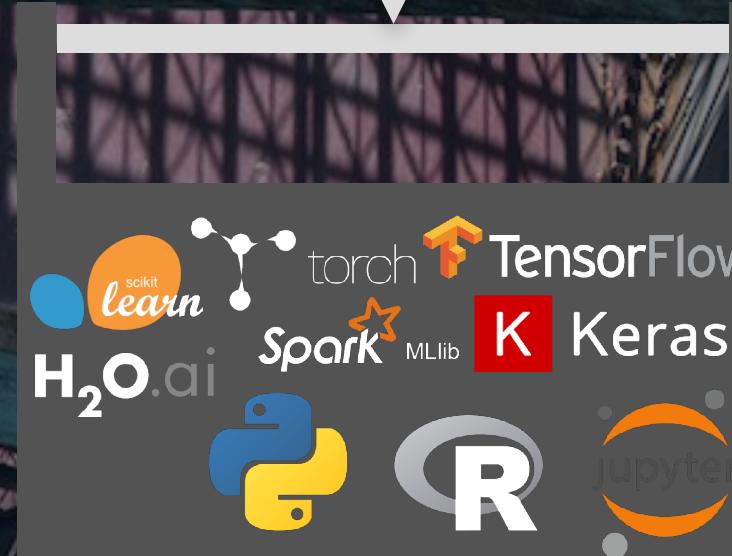
Versioning, traceability,  
reproducibility, automation



# ModelOps

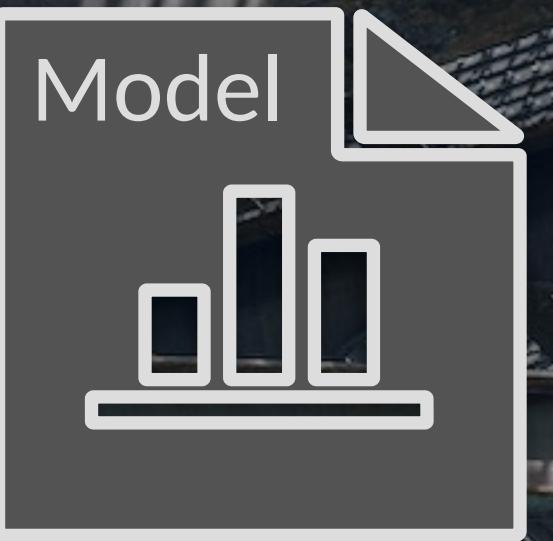


Data



Model Development

Model CI/CD Pipeline

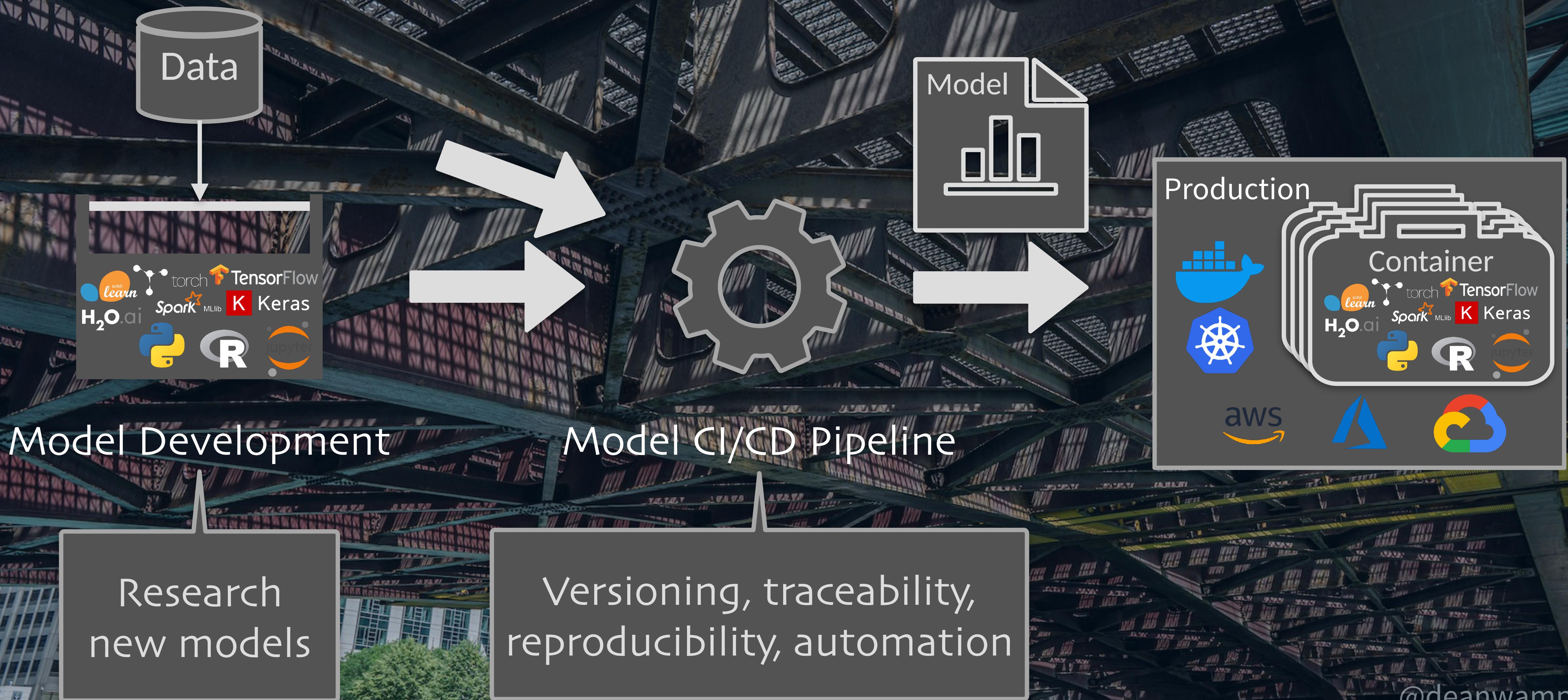


Model

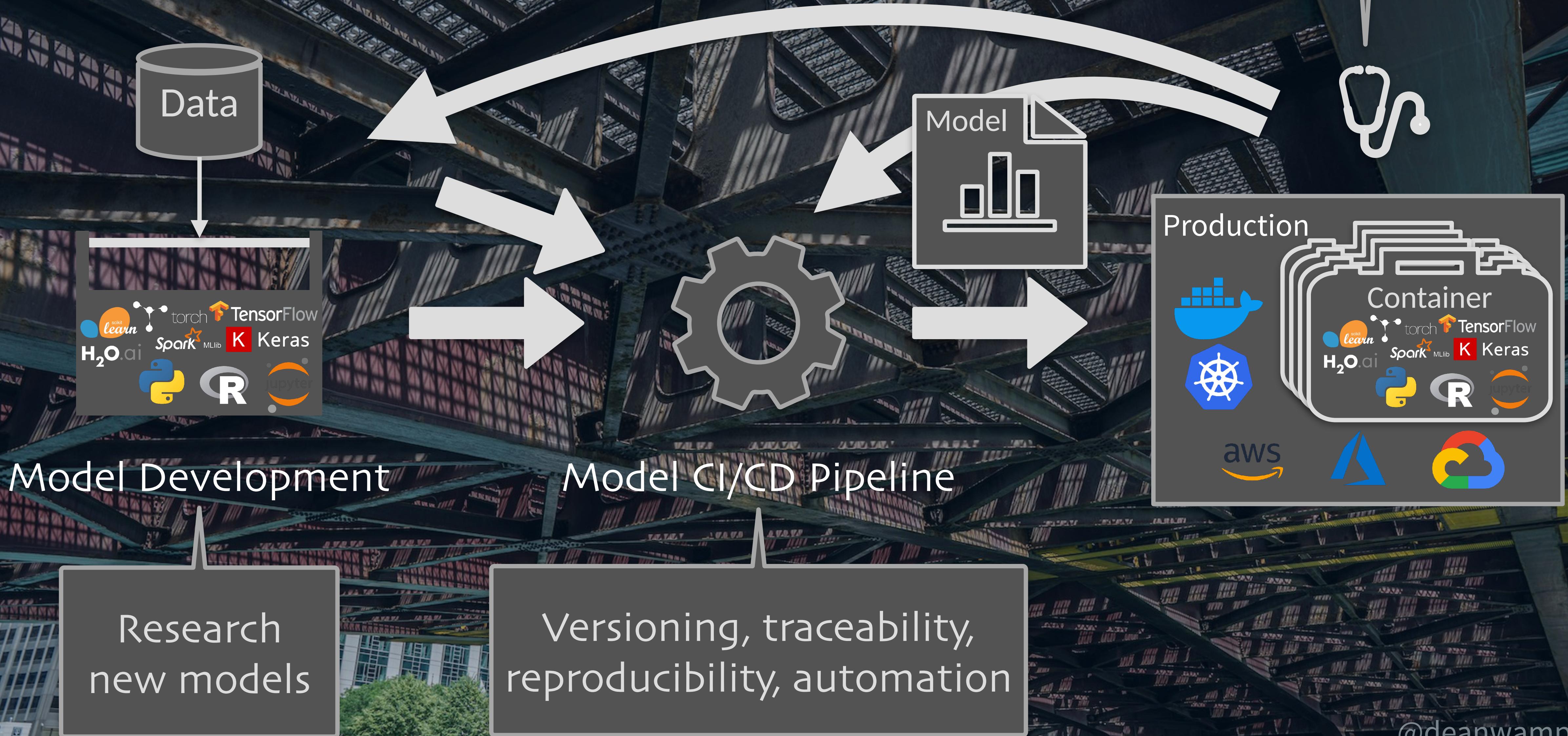
Research  
new models

Versioning, traceability,  
reproducibility, automation

# ModelOps

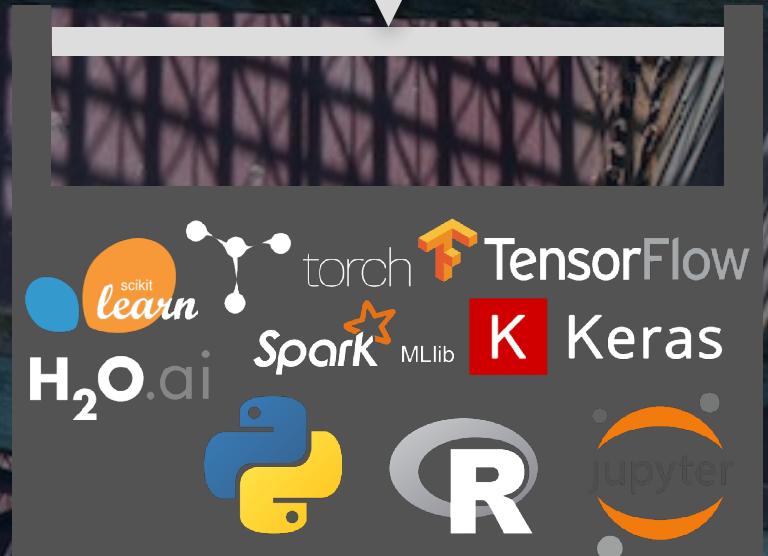


# ModelOps



# ModelOps

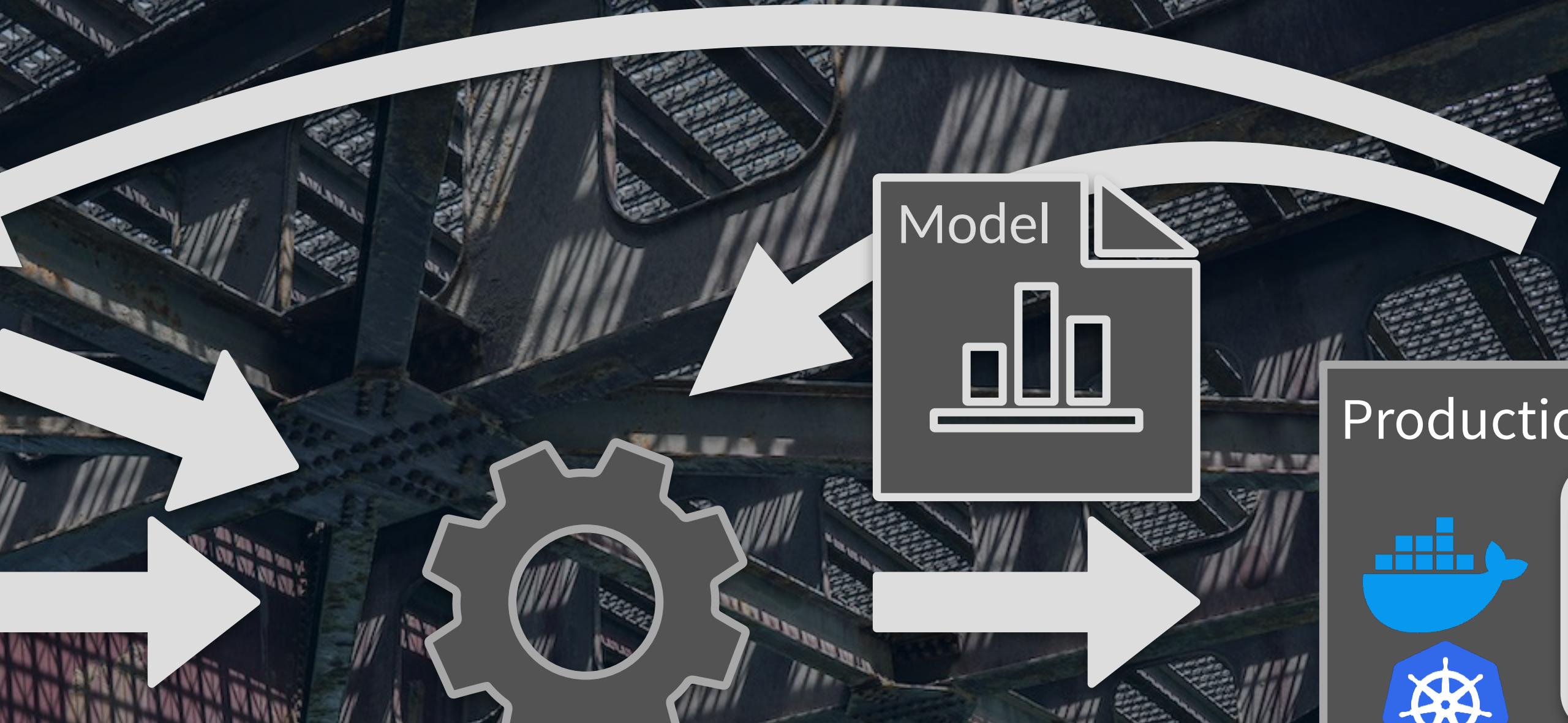
Data and Model Governance



Model Development

Versioning, traceability,  
reproducibility, automation

Research  
new models



Production



Monitor



# ModelOps

Monitor

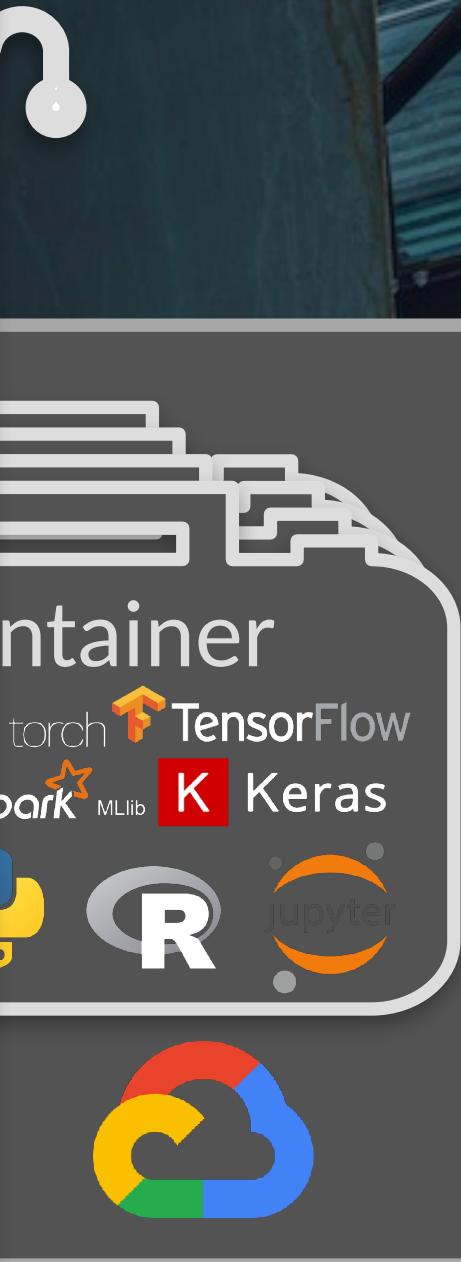
This is shown as a batch process, but expect these processes to evolve into streaming pipelines, with continuous training.

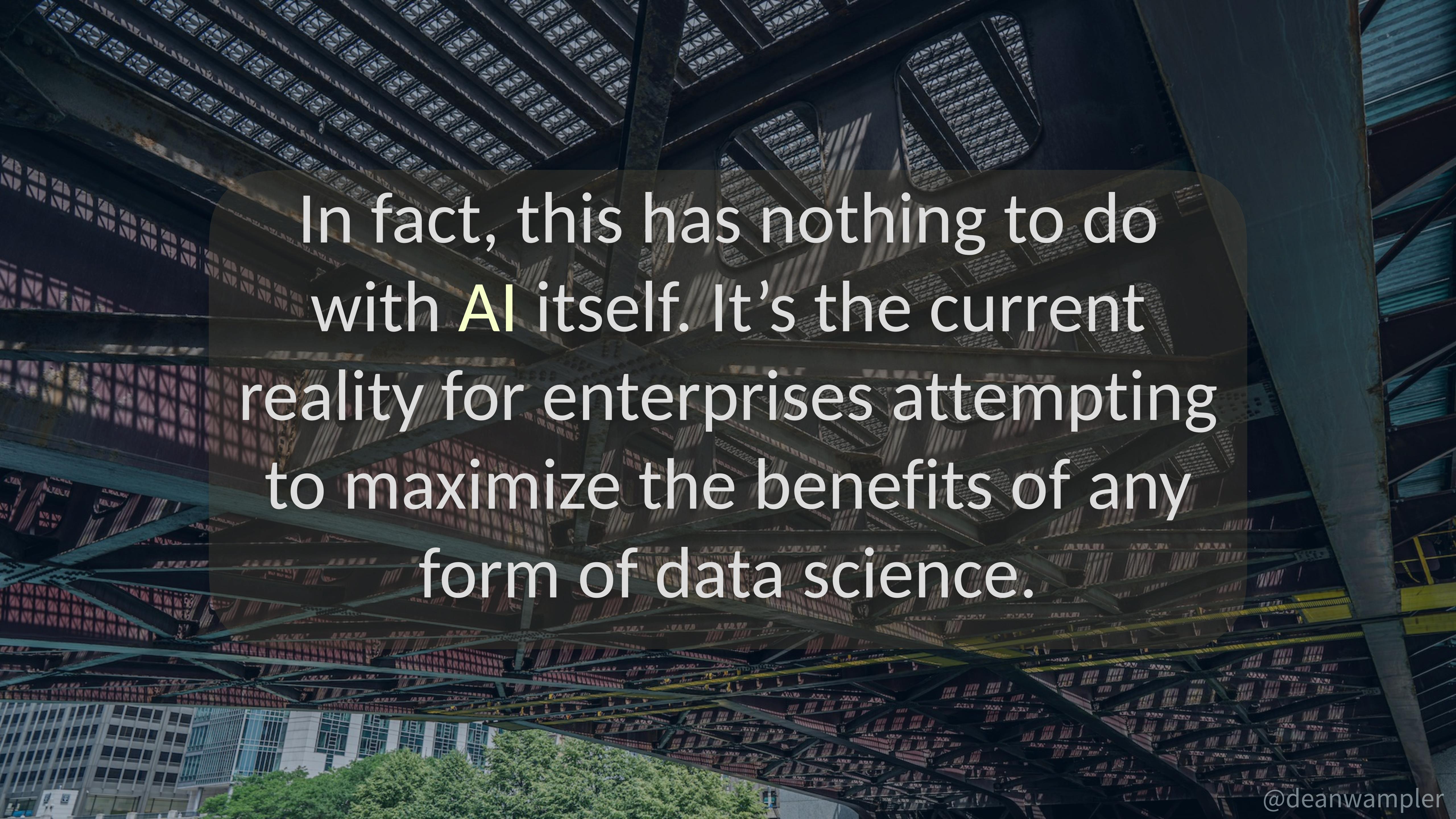
Mode

R

new models

reproducibility, automation



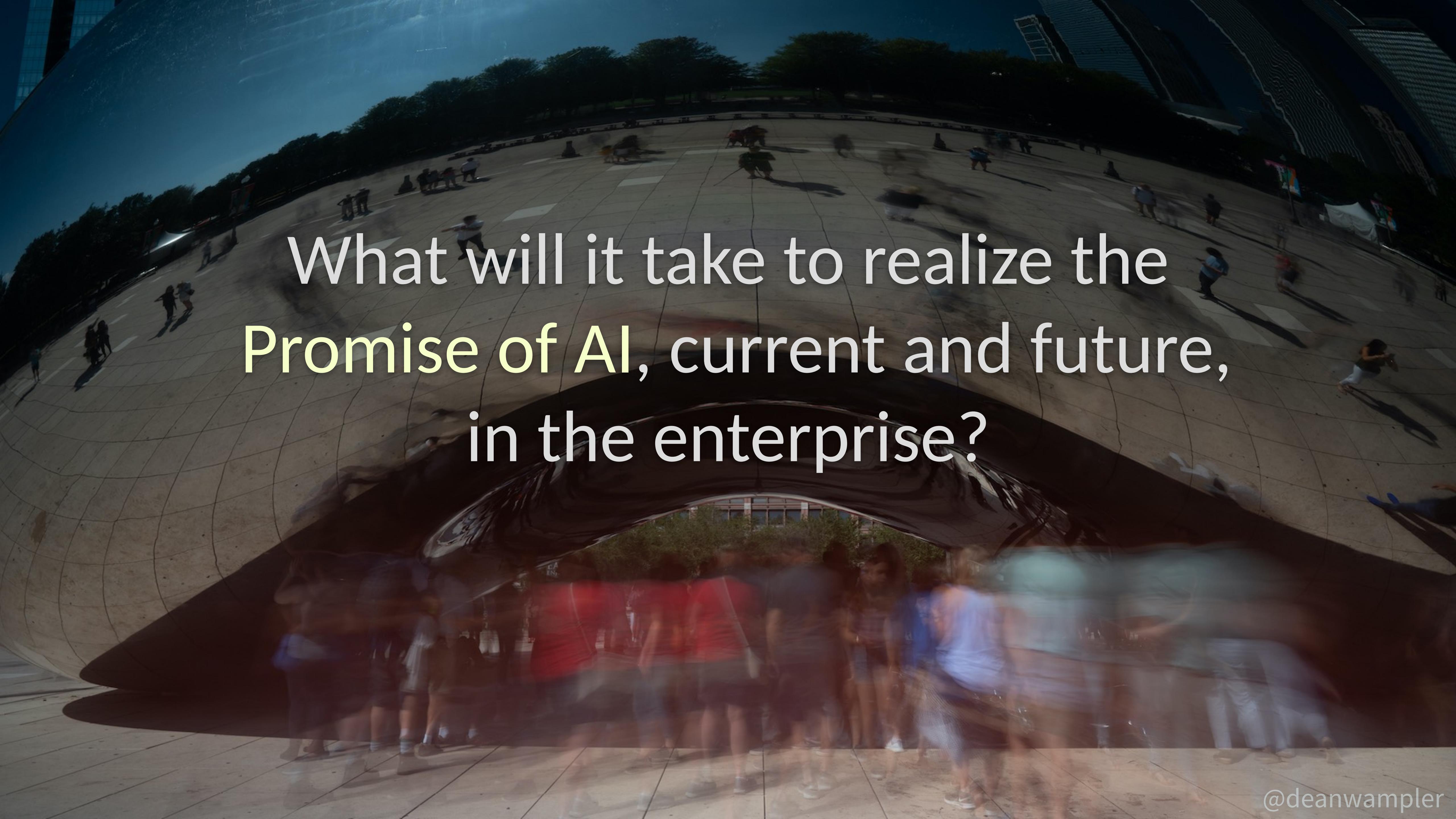


In fact, this has nothing to do  
with AI itself. It's the current  
reality for enterprises attempting  
to maximize the benefits of any  
form of data science.



# Outline

- The Promise of AI
- AI in the Enterprise
  - The Past
  - The Present
  - The Future
- Conclusions



What will it take to realize the  
Promise of AI, current and future,  
in the enterprise?



# AI in the Enterprise

- Fully adopting:
  - Natural Language Processing
  - Reinforcement Learning
  - Ubiquitous AI in Applications



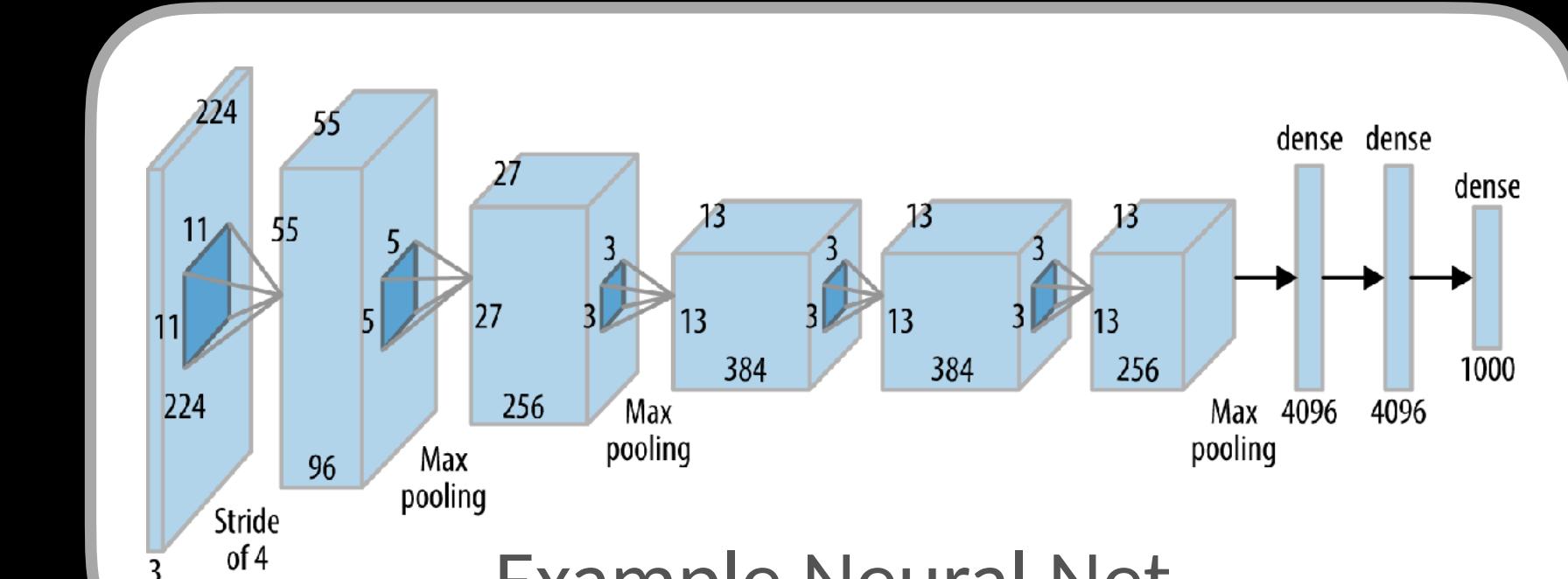
# Along the way...

- Infrastructure Changes
  - Cloud
  - Scaling computation
  - Diff. Privacy & Fed. Learning
- Software Development

“The largest version GPT-3 175B or ‘GPT-3’ has 175 B Parameters, 96 attention layers and 3.2 M batch size.”

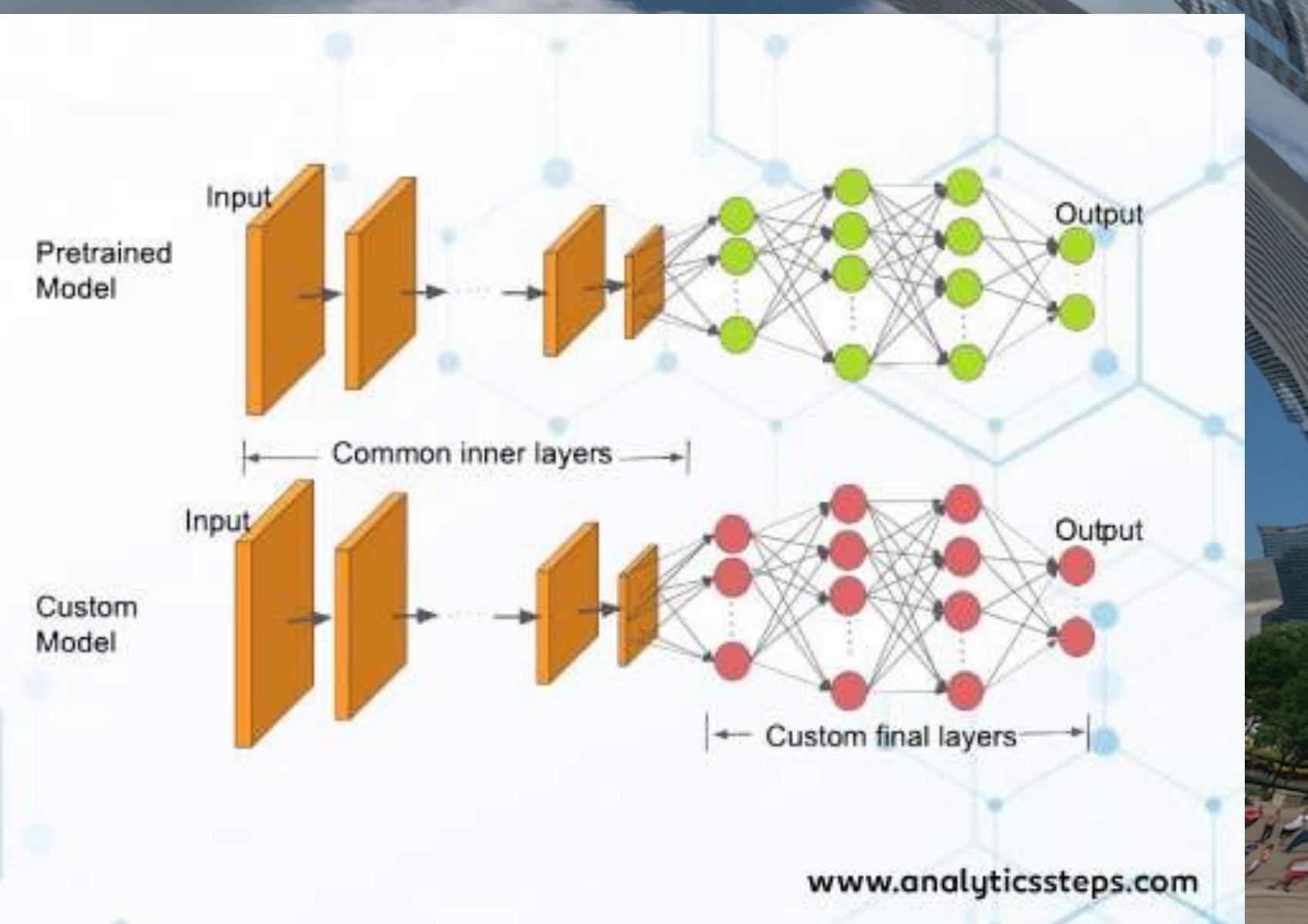
# Transfer Learning

- NLP: The world's largest neural networks



Example Neural Net

# Transfer Learning



<https://analyticssteps.com/blogs/how-transfer-learning-done-neural-networks-and-convolutional-neural-networks>

# Transfer Learning

- Fortunately, you can start with a trained model and further refine it for your problem.



# Reinforcement Learning

- While “classic” RL uses a simulator, you can also train on historical (“offline”) data.
- Use when a good simulator doesn’t exist or is too hard to create.

<https://arxiv.org/abs/2005.01643>

@deanwampler



# Infrastructure

- Model training, especially NNs, is very expensive.
  - Burst to the cloud
  - Or have lots of in-house compute available!



# Infrastructure

- A hybrid-cloud model balances:
- Security & regulatory benefits of on-premise cluster
- Burst of resources when you need them.



# Infrastructure

- But, don't forget the cost of moving data between on-premise clusters and the cloud!



# Infrastructure

- Leverage federated learning and differential privacy.
- Offload some computation!
- Meet data privacy objectives.

<https://openmined.org/>

@deanwampler

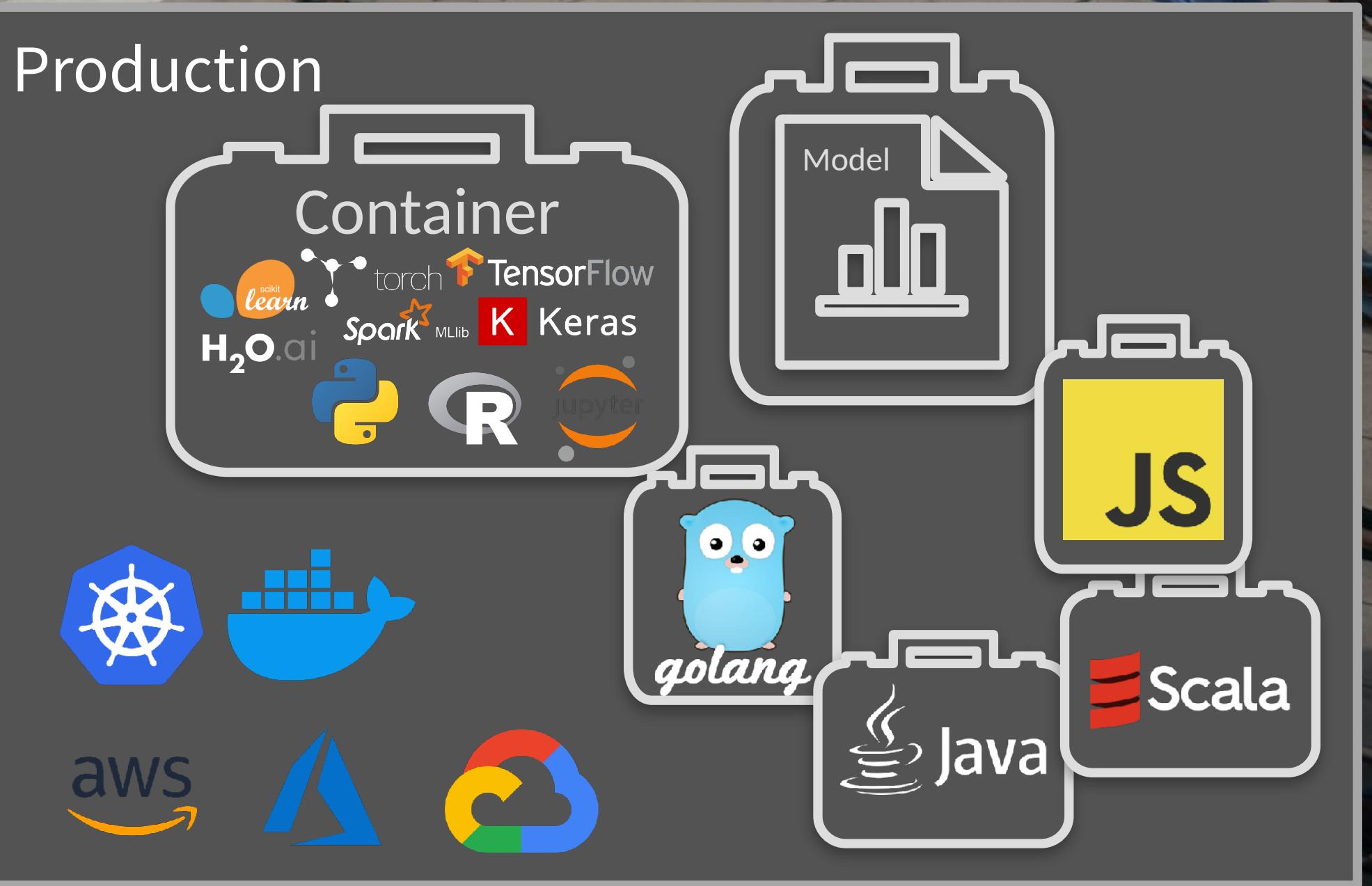


# Software Development Impacts

- Ubiquitous AI requires:
  - Heterogeneous tools
  - Batch and stream data processing
- Statistical & probabilistic thinking

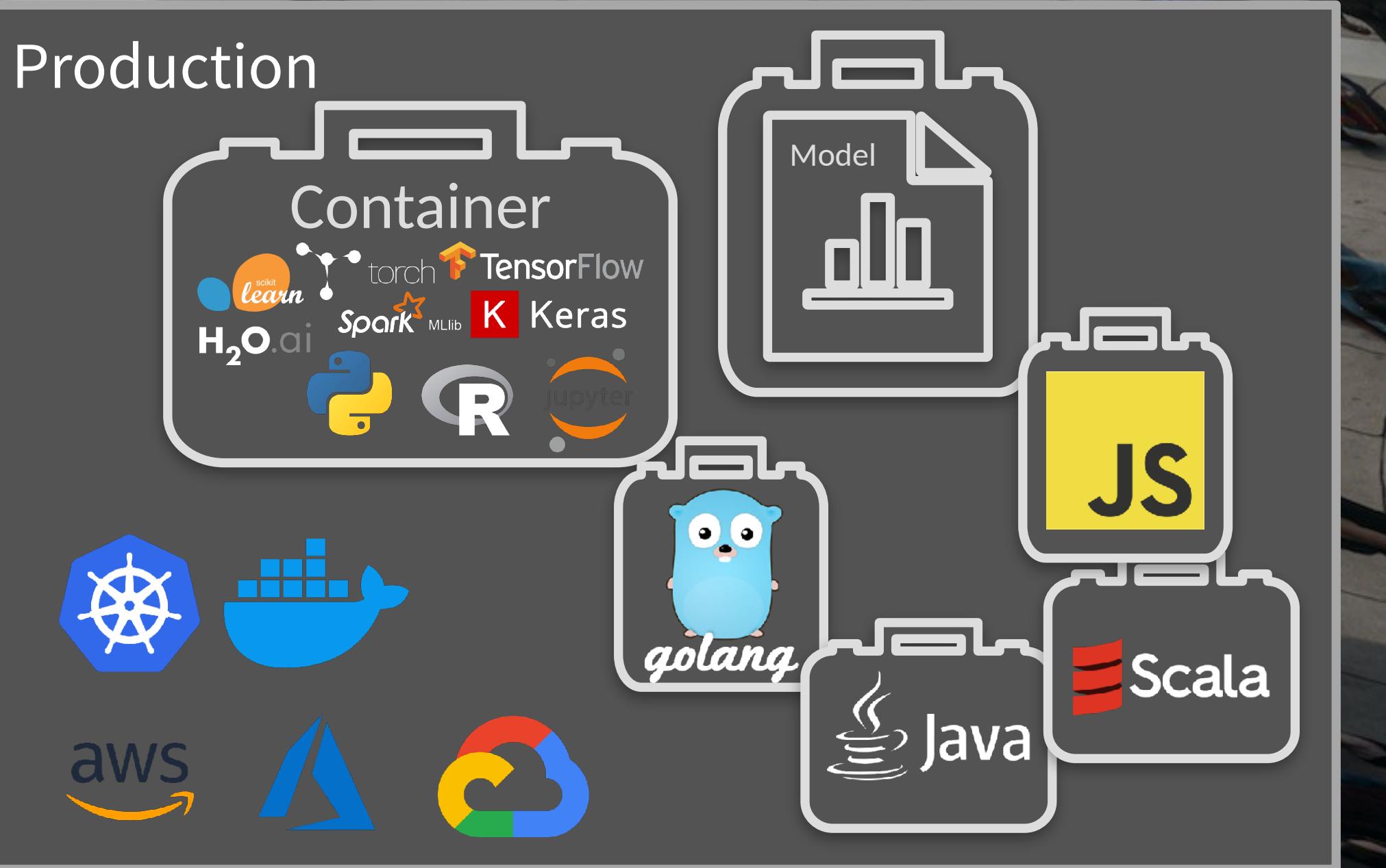
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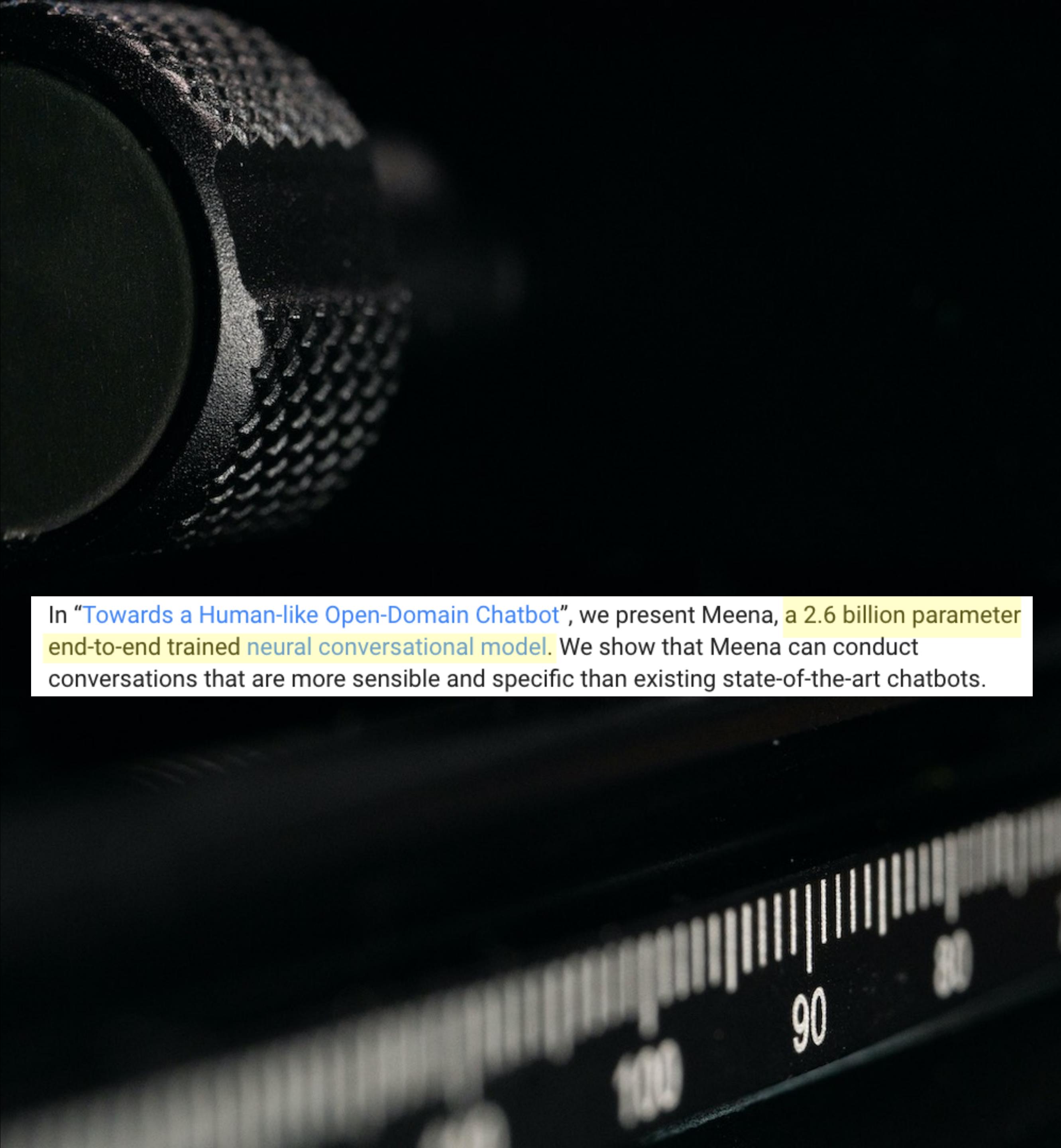


# Outline

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We can expect AI to become ubiquitous in the coming years, providing competitive advantages to enterprises that learn how to use it.



# AI's Promise

- Natural Language Processing has become very capable, with wide applications

In "Towards a Human-like Open-Domain Chatbot", we present Meena, a 2.6 billion parameter end-to-end trained neural conversational model. We show that Meena can conduct conversations that are more sensible and specific than existing state-of-the-art chatbots.

# AI's Promise



- Reinforcement Learning is being applied to many enterprise problems where sequential activity is central.



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Perspective | Published: 17 May 2018

OPINION

## Artificial intelligence in radiology

Ahmed Hosny, Chintan Parmar, John Quackenbush, Lawrence H. Schwartz & Hugo J. W. L. Aerts✉

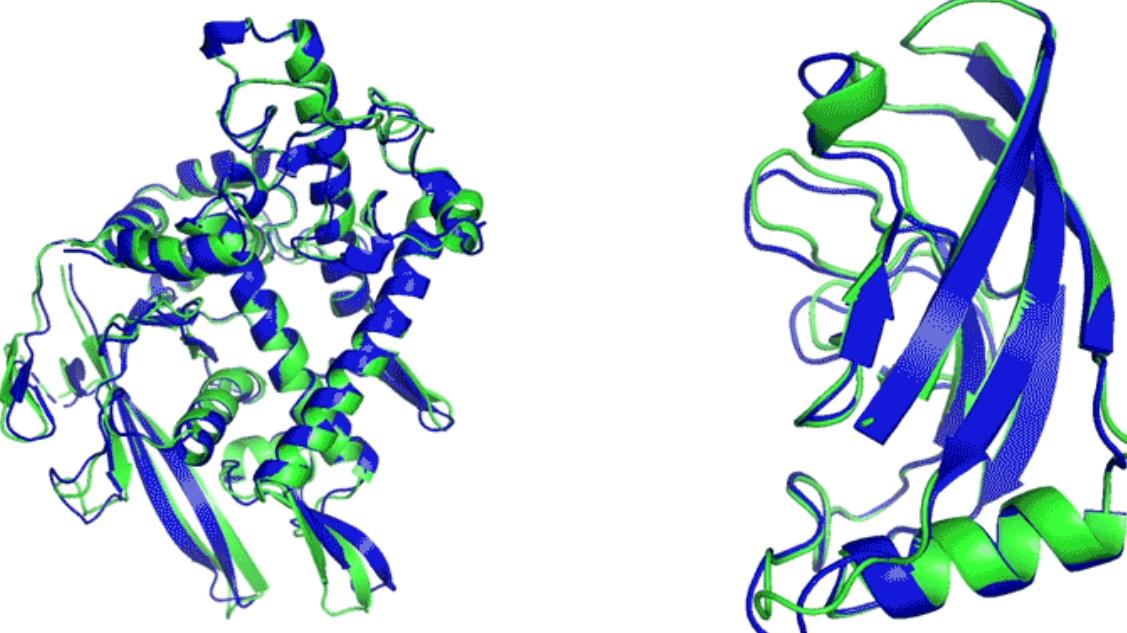
*Nature Reviews Cancer* 18, 500–510(2018) | Cite this article

15k Accesses | 317 Citations | 311 Altmetric | Metrics

### Abstract

Artificial intelligence (AI) algorithms, particularly deep learning, have

ognition tasks. Methods  
rialization autoencoders  
age analysis field,  
in radiology practice,  
ges for the detection

  
**T1037 / 6vr4**  
90.7 GDT  
(RNA polymerase domain)  
**T1049 / 6y4f**  
93.3 GDT  
(adhesin tip)

● Experimental result  
● Computational prediction

# AI's Promise

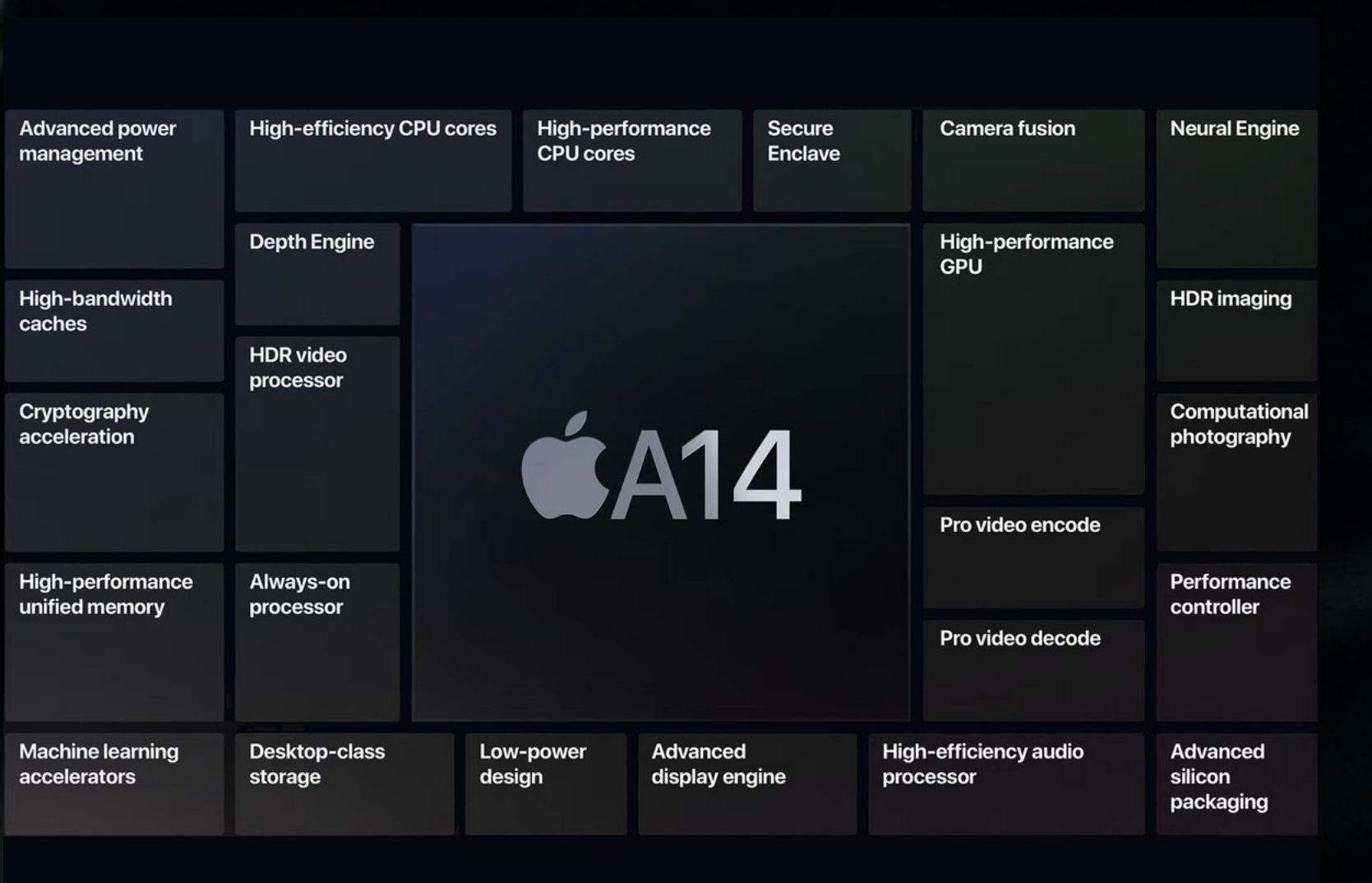
- New sciences and industries are benefiting from AI





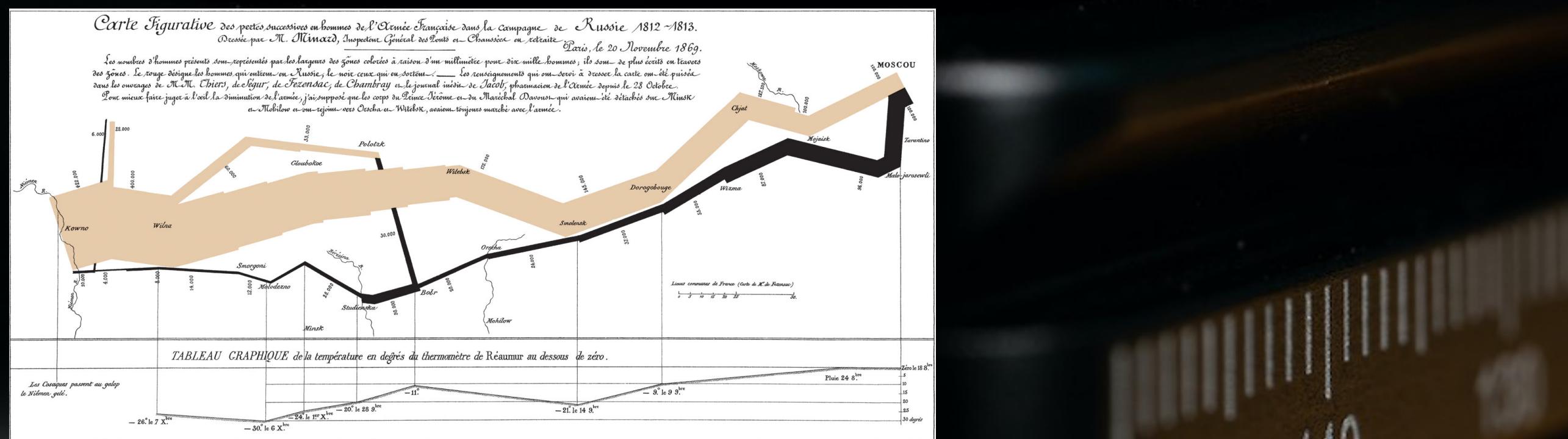
# AI's Promise

- Mobile phones are showing us how AI is enabling new system features and enhancing capabilities in applications



# The Past

- Traditional data science tools still provide important benefits:
    - Proven Maturity
    - Explainability
    - Cheap to use!



ذات الوجهين، والدبر، يصفه بالكلام الفاسد، اعترض سرطان على دبره، فما بالمرأة  
غير مبالاة؟، بينما يصفه بـ «جاف من طفل»، وـ «شائبة طفولة»، بالمثل الطفولية، ويصفه بالابطال  
ـ «ناس اعتصموا بـ ابطالهم»، واصحاحه في المثل ان «اعتصم بالآمن»، «اعمل الله وسفله»؛  
ـ «لطف ورحمة»، «رسد عالمي»، «الصلوة صدمة للليل»، «اصناعه»، «والرسالة للخوارج»، «بعض  
ـ «الاجحاف»، «البراء»، «الناء»، «الرمح»، «ذكر وابنته»، «والركض بعد السرور»، «الساق»، «الرثى»،  
ـ «مسير الاماكن»، «ولما تملىء رملة»، «التعز وفتحه»، «وللمهم»، «رسائر»، «صاري»، «لكل المحب»، «بيه»،  
ـ «اسم»، «السماع»، «البراء»، «الناء»، «الرمح»، «وعسل»، «الظرف»، «الصبر»، «الدبر»، «الفسر»، «م

لسم الله الرحمن الرحيم . وصَلَّى اللهُ عَلَيْهِ وَسَلَّمَ وَسَلَّمَ وَبَرَّأَهُ وَبَرَّأَهُ  
رسانه الرسالة بعمور سبعينيالدرر استسلام العرش الراي امسار  
فهذا مجموعه فتاوى ورقائق علماء المشرق والغرب وكتاباته موجوده في الخليل الاستسلم مدارس  
الكل العجماء والبصراء والشافعية وجمهور الفقهاء . فالكتابه الاول يصرح ببيان اسرار النجاح الفطحي  
عن طريق اسلوب دراية قيم العرش وعذاب طلاق الشياخ السوسي ورسوله العفتى الاعظم  
الاسفاذ . وسورة رواياته ورواياته وخطبته وكتاباته . وفيه اقسام ادلة احكامه اقسامها المعاشر

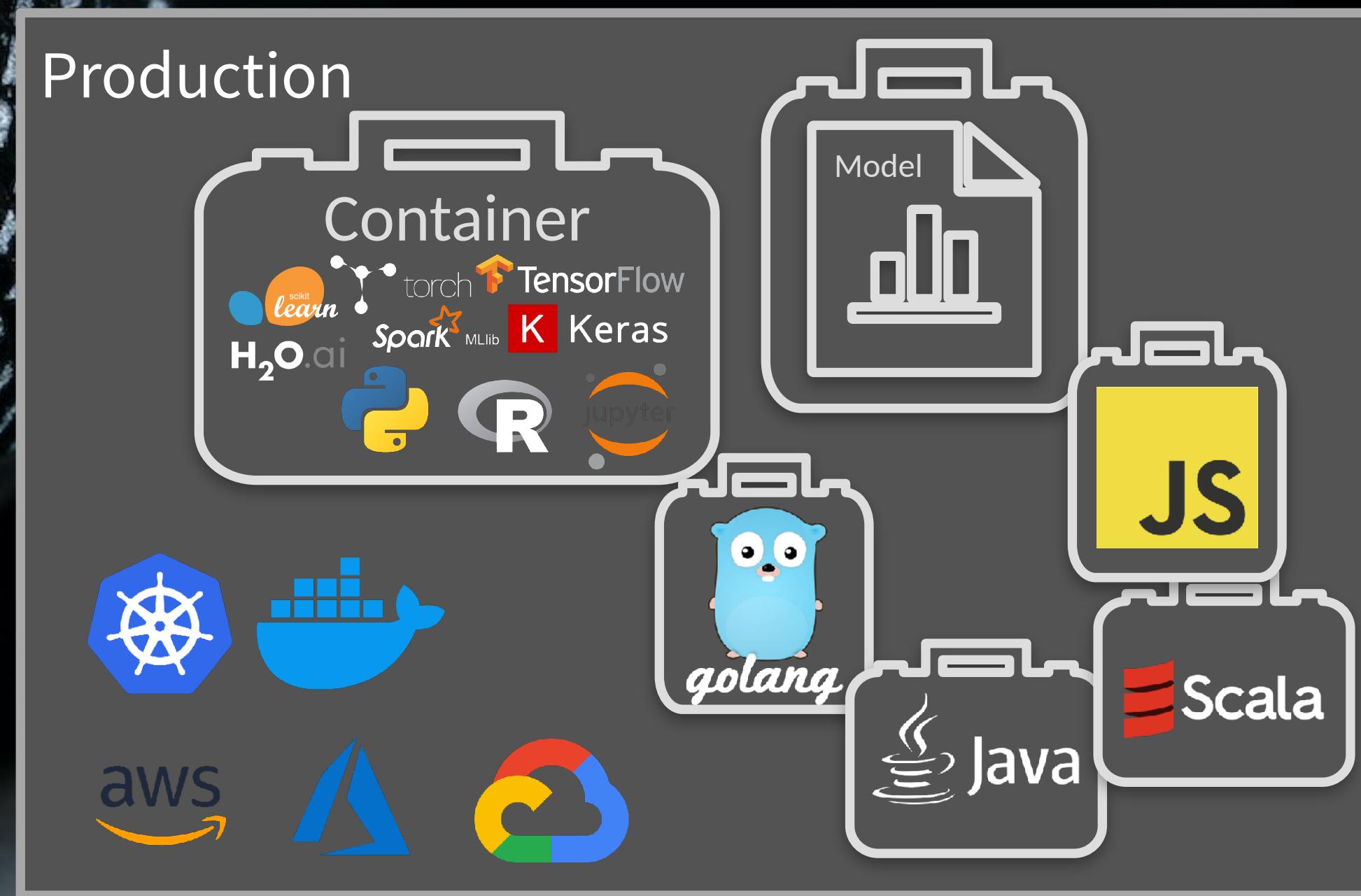
# The Present

- We have to bridge the divide between data science and data engineering now.
- Or AI won't be an option.



# The Future

- To fully benefit, we need to embrace:
  - Scalable compute
  - Hybrid cloud
  - Kubernetes & containers
  - New SW design and implementation tools and techniques



# Questions?

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