CSE 573:
Artificial Intelligence

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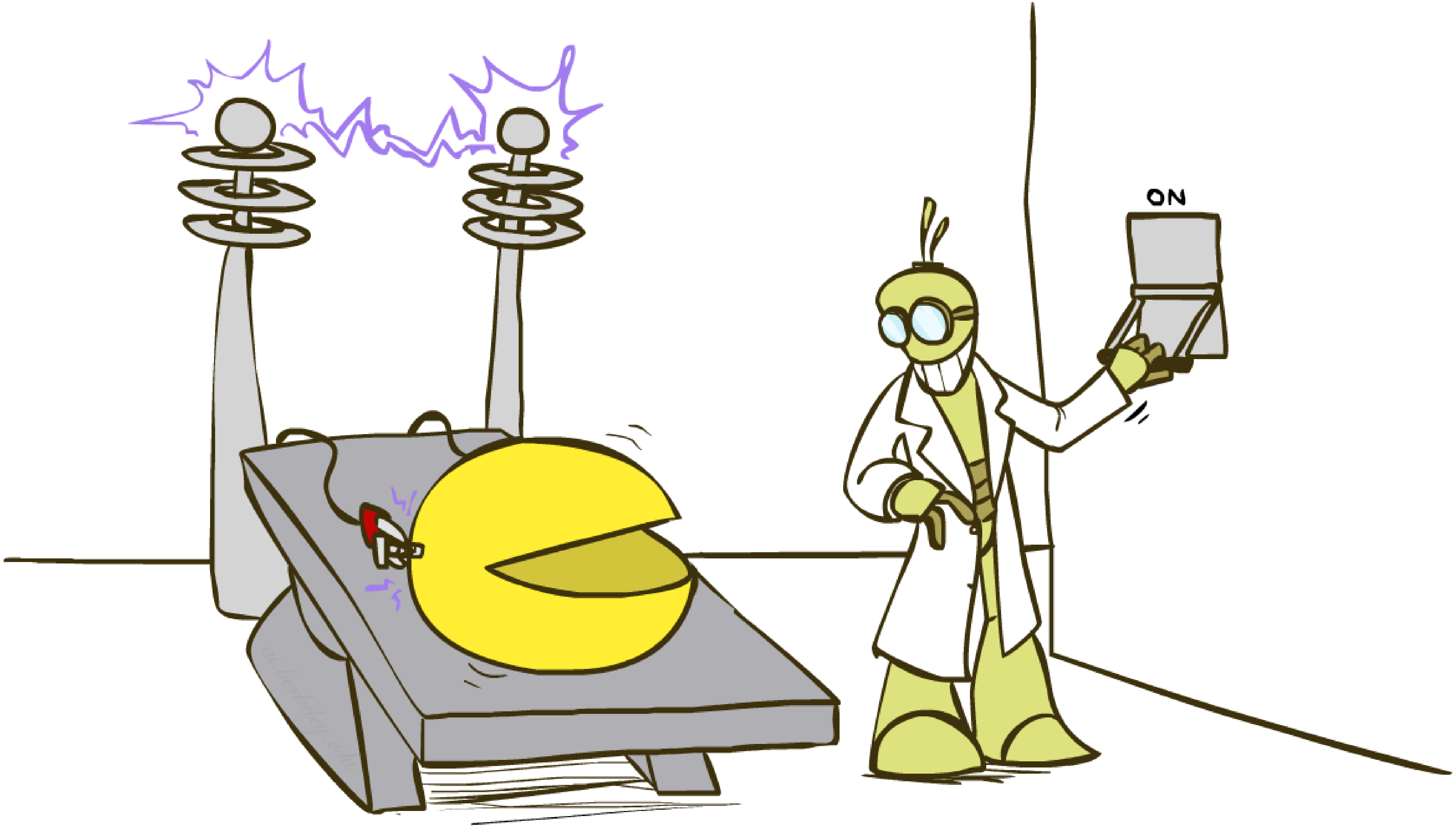
slides adapted from
Dan Klein, Pieter Abbeel ai.berkeley.edu
And Dan Weld, Luke Zettlemoyer

ai.berkeley.edu

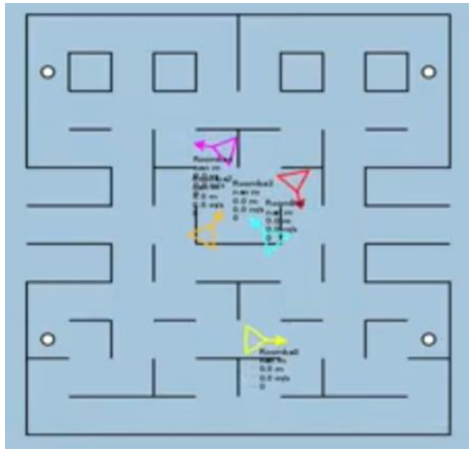
Topics in This Course

- Part I: Intelligence from Computation
  - Fast search
  - Adversarial and uncertain search
- Part II: Reasoning under Uncertainty
  - Decision theory: Reinforcement Learning, Markov Decision Processes
  - Machine learning
  - Graphical Models - Bayes Nets; HMMs
- Throughout: Applications
  - Natural language, vision, robotics, games, …

Pac-Man Beyond the Game!



Pacman: Beyond Simulation?



ROOMBA PACMAN

Students at Colorado University: http://pacman.elstonj.com

Research Frontiers

- Deep Unsupervised Learning
- AI for Science
- AI and Ethics

Also:

- Unsupervised Deep Reinforcement Learning
- Human-in-the-loop Reinforcement Learning
- …

Research Frontiers

- ***Deep Unsupervised Learning***
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Deep Unsupervised Learning

- Key hypothesis:

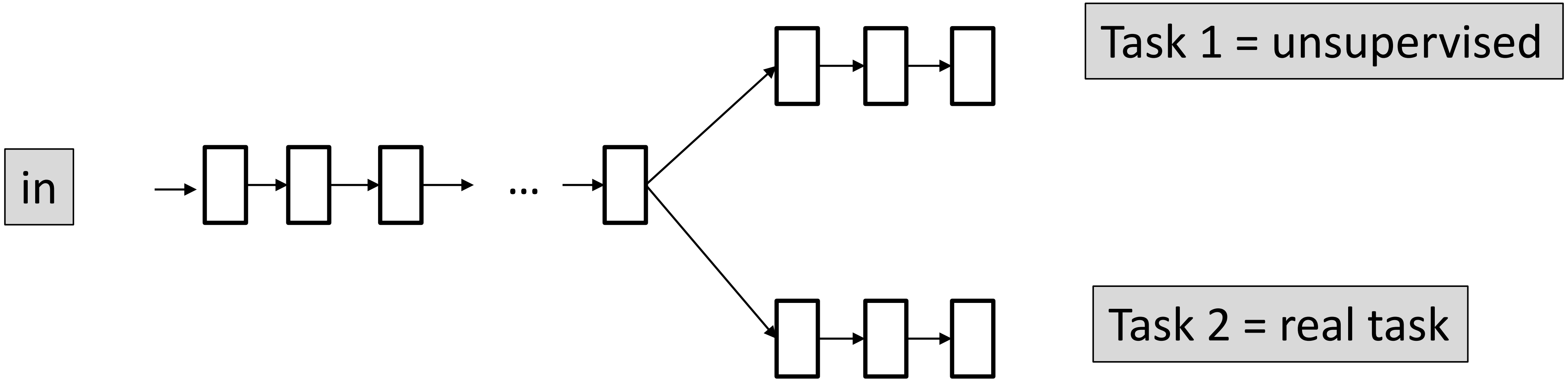
Task 1

  - IF neural network smart enough to predict:
    - Next frame in video
    - Next word in sentence
    - Generate realistic images
    - ``Translate'' images
    - …

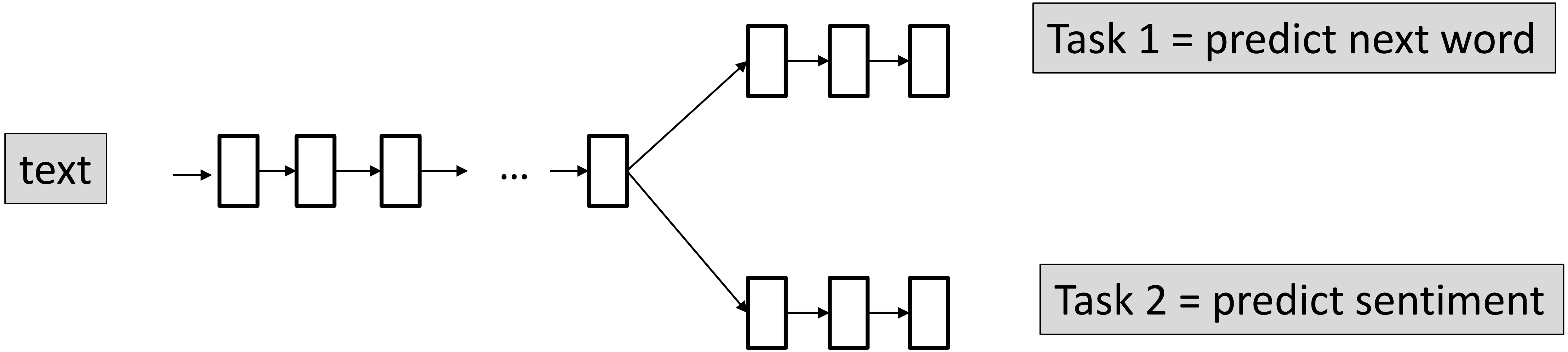
Task 2

  - THEN same neural network is ready to do Deep Supervised Learning from very small data-set

Transfer from Unsupervised Learning



Example Setting



text

Task 1 = predict next word

Task 2 = predict sentiment

Text Generati ’s GPT-2)

SYSTEM PROMPT (HUMAN-WRITTEN)

In a shocking fi
remote, previou
surprising to the
English.

MODEL COMPLETION (MACHINE-WRITTEN, 10 TRIES)

The scientist nam
Ovid’s Unicorn. Th
previously unknown

Now, after almost tw
odd phenomenon is fi

Dr. Jorge Pérez, an ev
La Paz, and several co
Mountains when they fou
or humans. Pérez noticed
a natural fountain, surr
snow.

Pérez and the others then
the time we reached the top
with some crystals on top,”

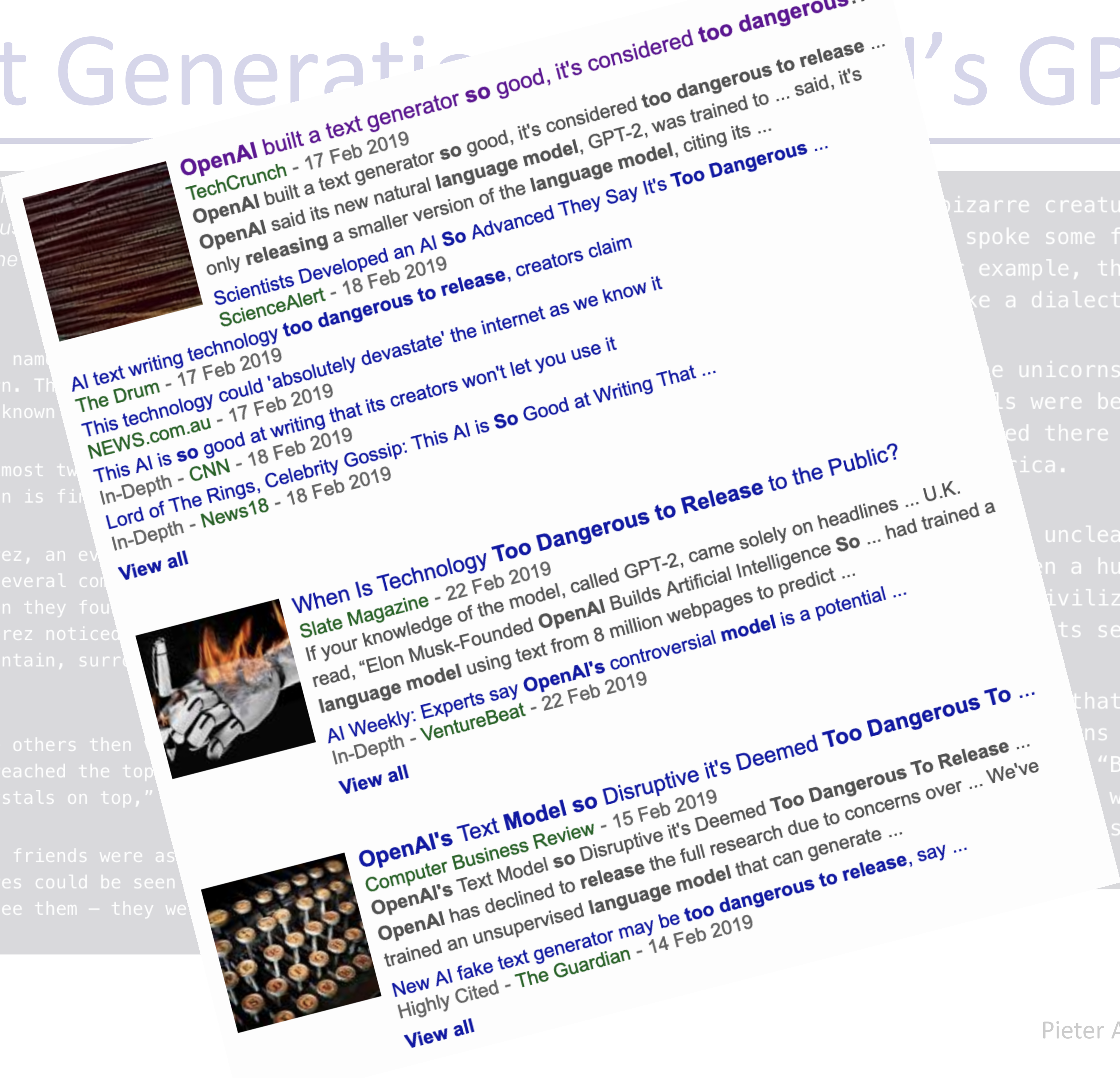
Pérez and his friends were as
These creatures could be seen
too much to see them – they we
horns.

bizarre creatures the scientists discovered
spoke some fairly regular English. Pérez
example, that they have a common
ke a dialect or dialectic.”

e unicorns may have originated in
ls were believed to be descendants of a
ed there before the arrival of humans
ica.

unclear, some believe that perhaps
n a human and a unicorn met each
ivilization. According to Pérez,
ts seem to be quite common.”

that it is likely that the only
ns are indeed the descendants of
“But they seem to be able to
which I believe is a sign of
social organization,” said the



OpenAI built a text generator so good, it's considered too dangerous ...
TechCrunch - 17 Feb 2019
OpenAI built a text generator so good, it's considered too dangerous to release ... OpenAI said its new natural language model, GPT-2, was trained to ... said, it's only releasing a smaller version of the language model, citing its ...

Scientists Developed an AI So Advanced They Say It's Too Dangerous ...
ScienceAlert - 18 Feb 2019

AI text writing technology too dangerous to release, creators claim
The Drum - 17 Feb 2019

This technology could 'absolutely devastate' the internet as we know it
NEWS.com.au - 17 Feb 2019

This AI is so good at writing that its creators won't let you use it
In-Depth - CNN - 18 Feb 2019

Lord of The Rings, Celebrity Gossip: This AI is So Good at Writing That ...
In-Depth - News18 - 18 Feb 2019

View all

When Is Technology Too Dangerous to Release to the Public?
Slate Magazine - 22 Feb 2019
If your knowledge of the model, called GPT-2, came solely on headlines ... U.K. read, “Elon Musk-Founded OpenAI Builds Artificial Intelligence So ... had trained a language model using text from 8 million webpages to predict ...

AI Weekly: Experts say OpenAI's controversial model is a potential ...
In-Depth - VentureBeat - 22 Feb 2019

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OpenAI's Text Model so Disruptive it's Deemed Too Dangerous To ...
Computer Business Review - 15 Feb 2019
OpenAI's Text Model so Disruptive it's Deemed Too Dangerous To Release ... OpenAI has declined to release the full research due to concerns over ... We've trained an unsupervised language model that can generate ...

New AI fake text generator may be too dangerous to release, say ...
Highly Cited - The Guardian - 14 Feb 2019

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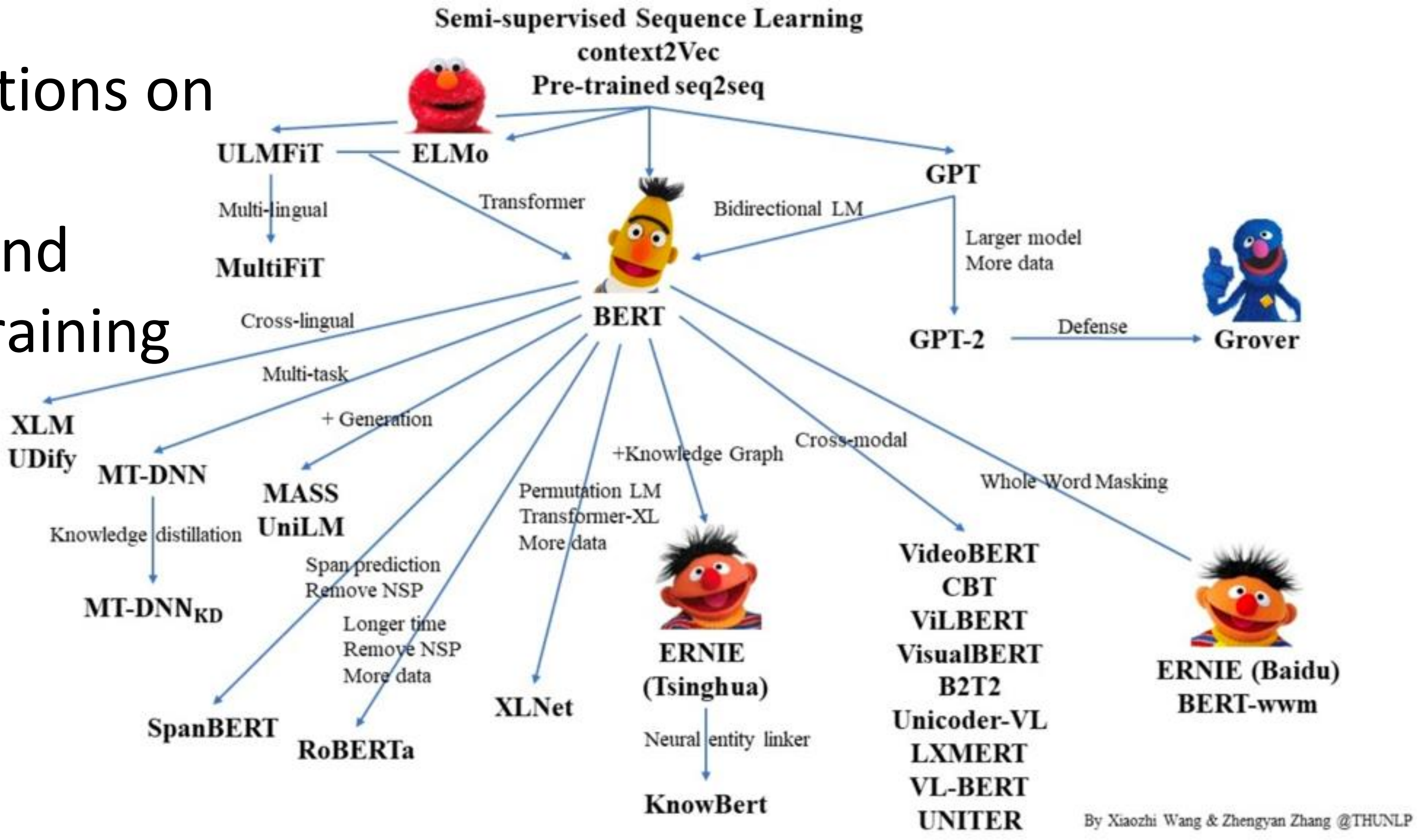
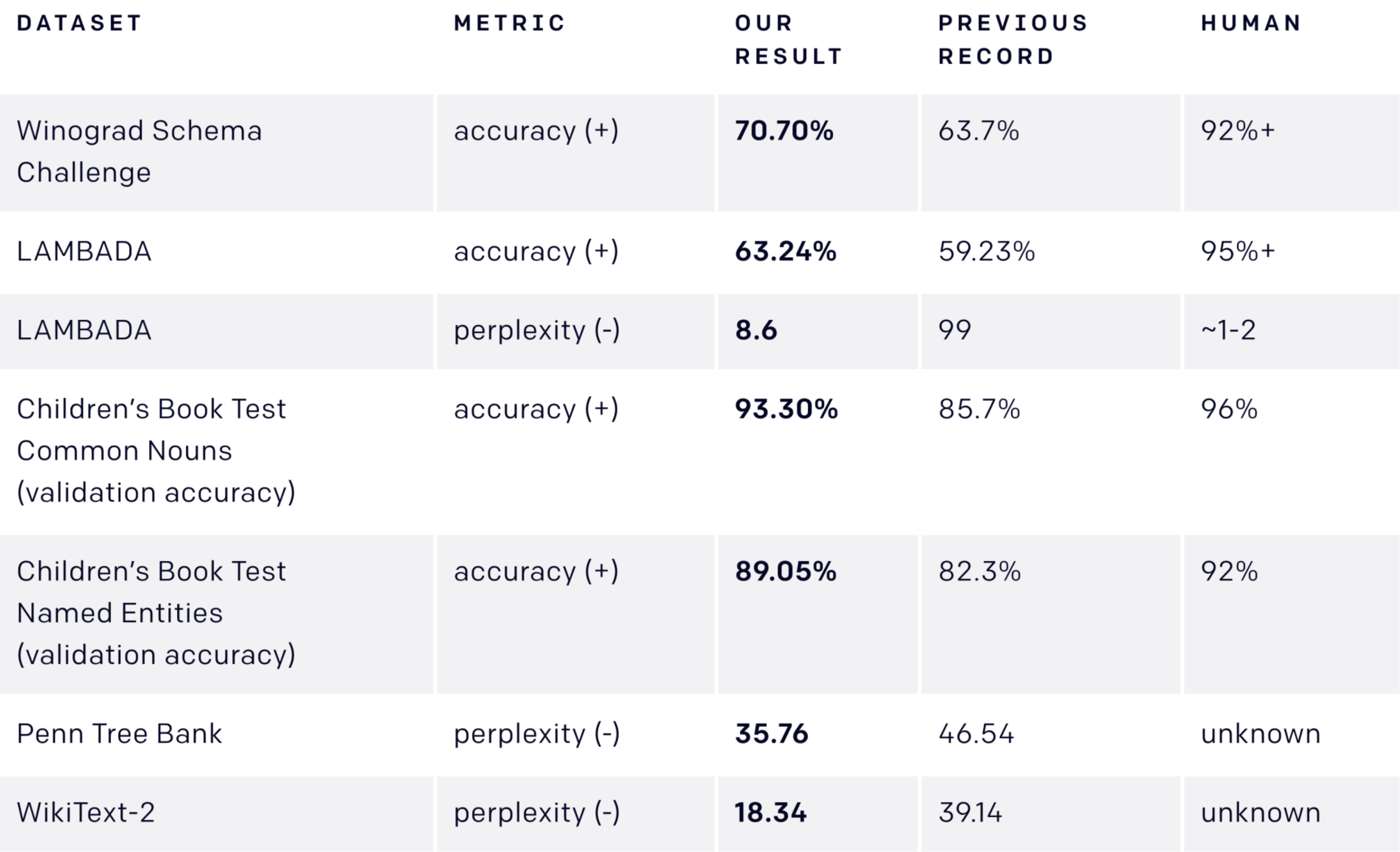
[Radford et al, 2019]

BERT and Family

Different Variations on Transformer architectures and different pre-training tasks

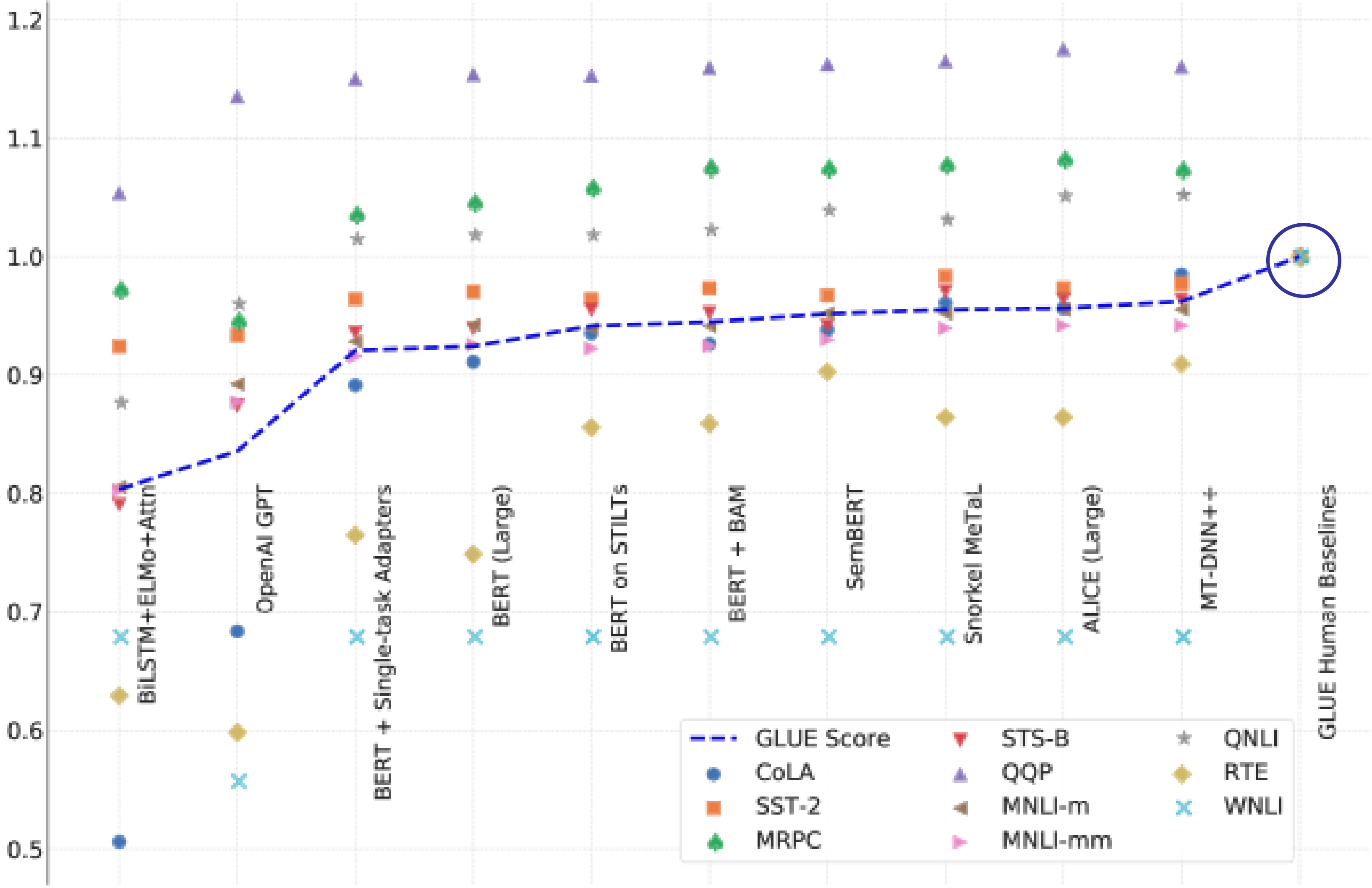


Benchmarks



DATASET	METRIC	OUR RESULT	PREVIOUS RECORD	HUMAN
Winograd Schema Challenge	accuracy (+)	**70.70%**	63.7%	92%+
LAMBADA	accuracy (+)	**63.24%**	59.23%	95%+
LAMBADA	perplexity (-)	**8.6**	99	~1-2
Children's Book Test Common Nouns (validation accuracy)	accuracy (+)	**93.30%**	85.7%	96%
Children's Book Test Named Entities (validation accuracy)	accuracy (+)	**89.05%**	82.3%	92%
Penn Tree Bank	perplexity (-)	**35.76**	46.54	unknown
WikiText-2	perplexity (-)	**18.34**	39.14	unknown

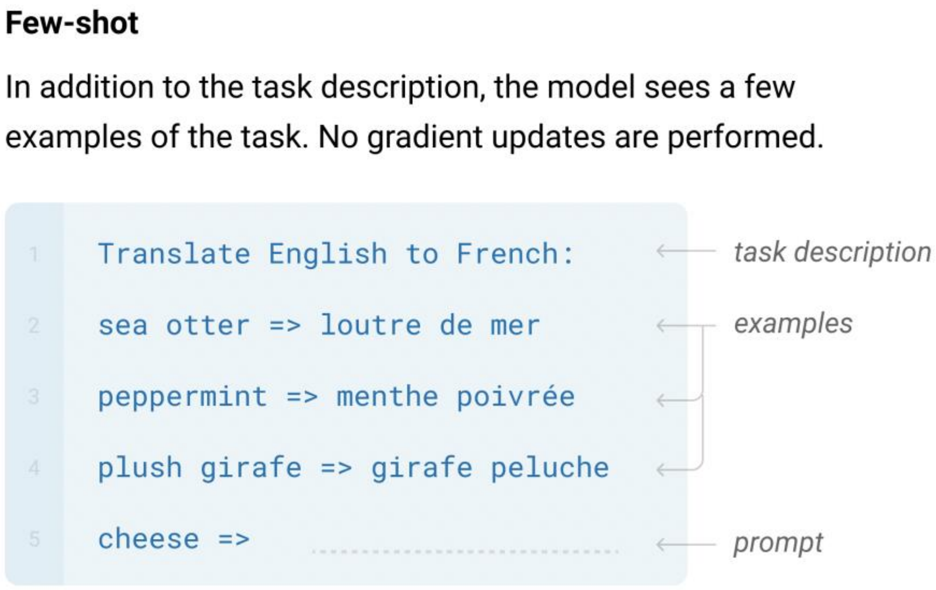
Pretrained Models (BERT) on GLUE Benchmarks



Human Performance on GLUE

Massive Pre-trained models are few-shot learners! (GPT-3)

175B GPT-3 can work without fine-tuning, when it is shown sample **demonstrations** for a task:



Few-shot

In addition to the task description, the model sees a few examples of the task. No gradient updates are performed.

```
Translate English to French:
sea otter => loutre de mer
peppermint => menthe poivrée
plush girafe => girafe peluche
cheese =>
```

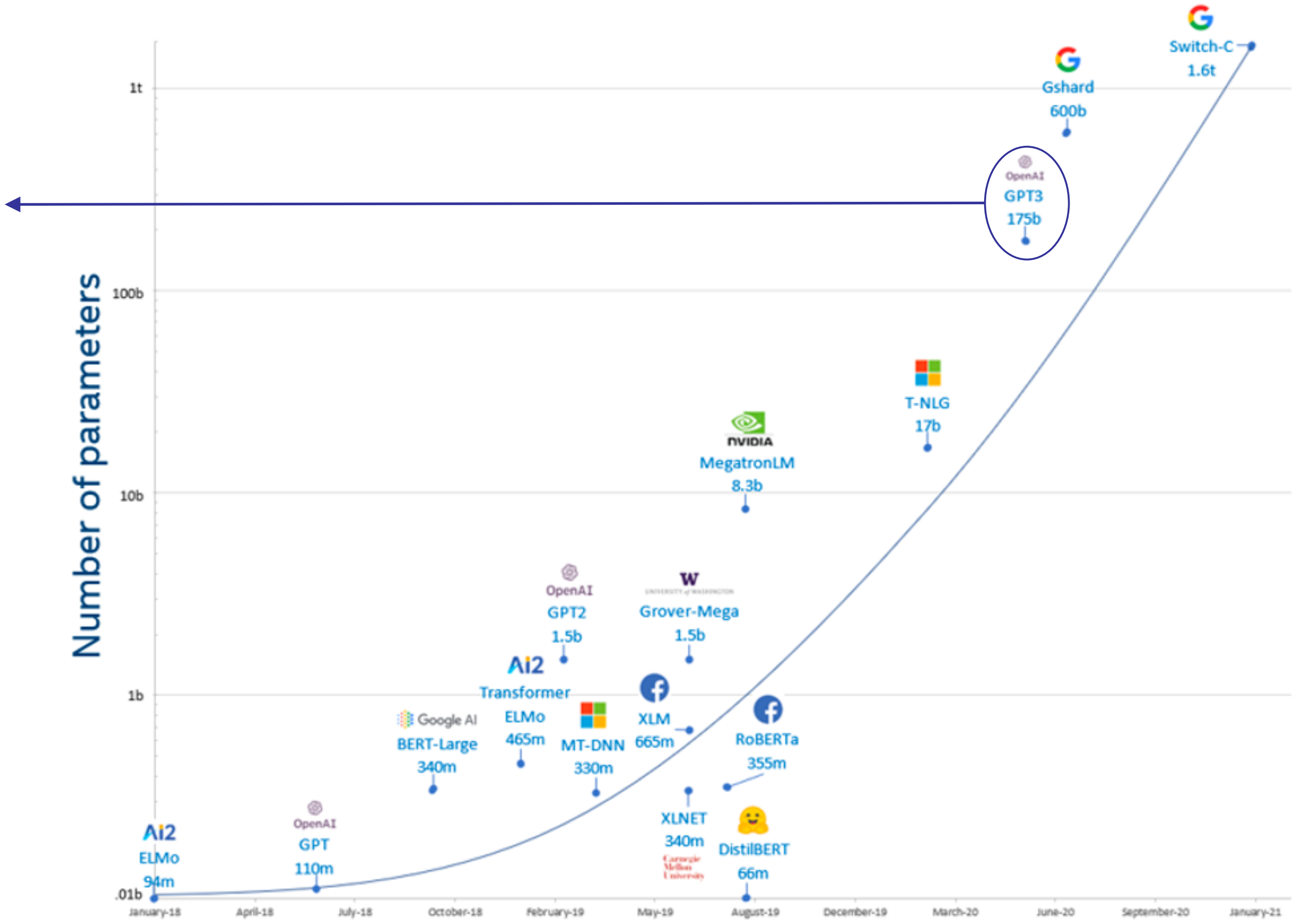
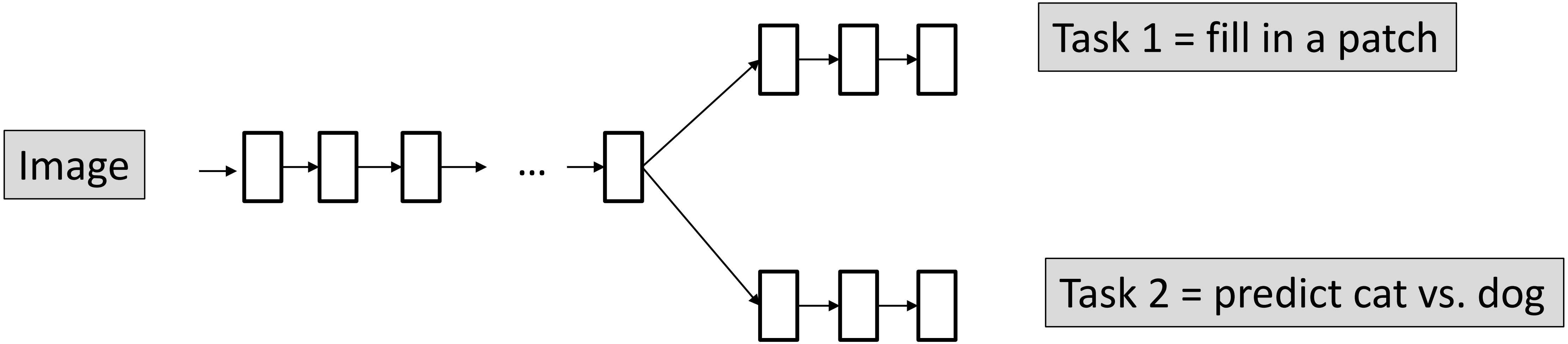
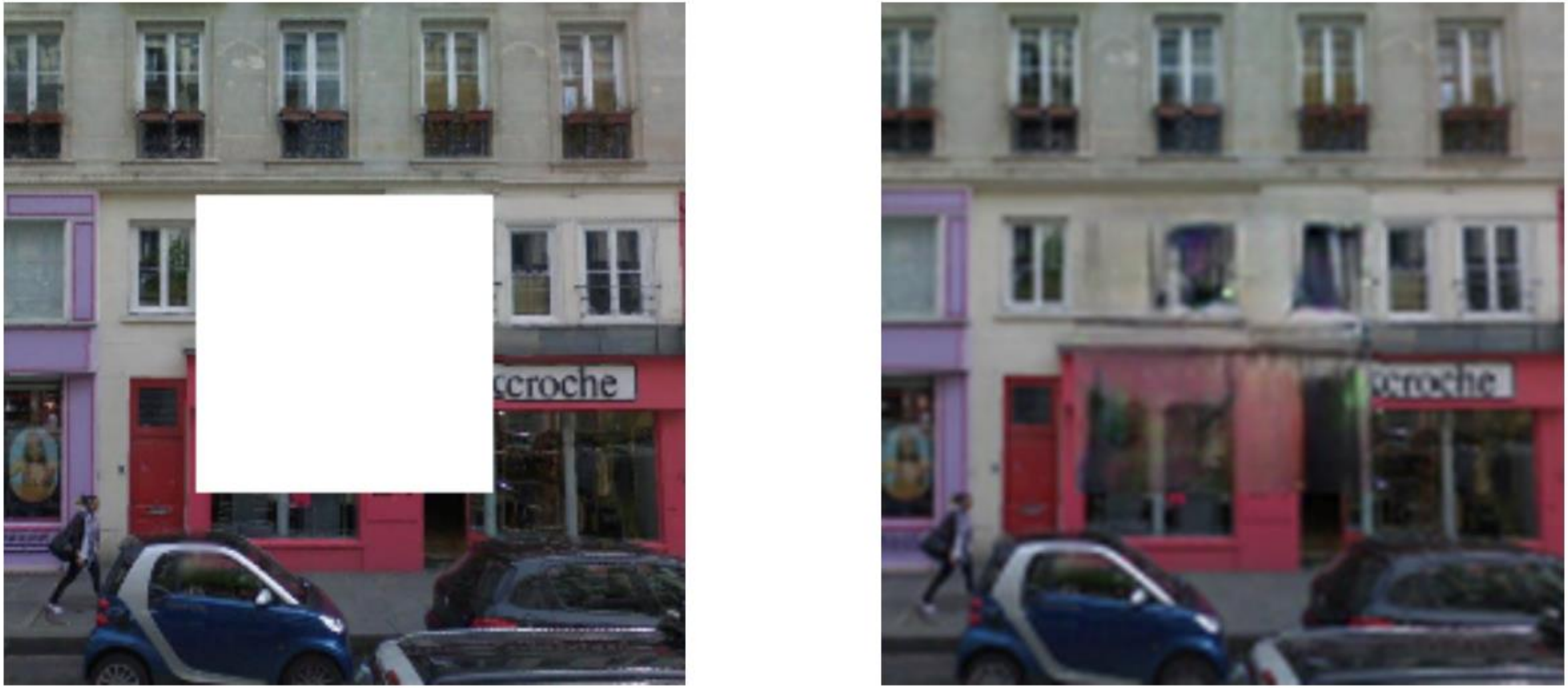


Figure 1: Exponential growth of number of parameters in DL models

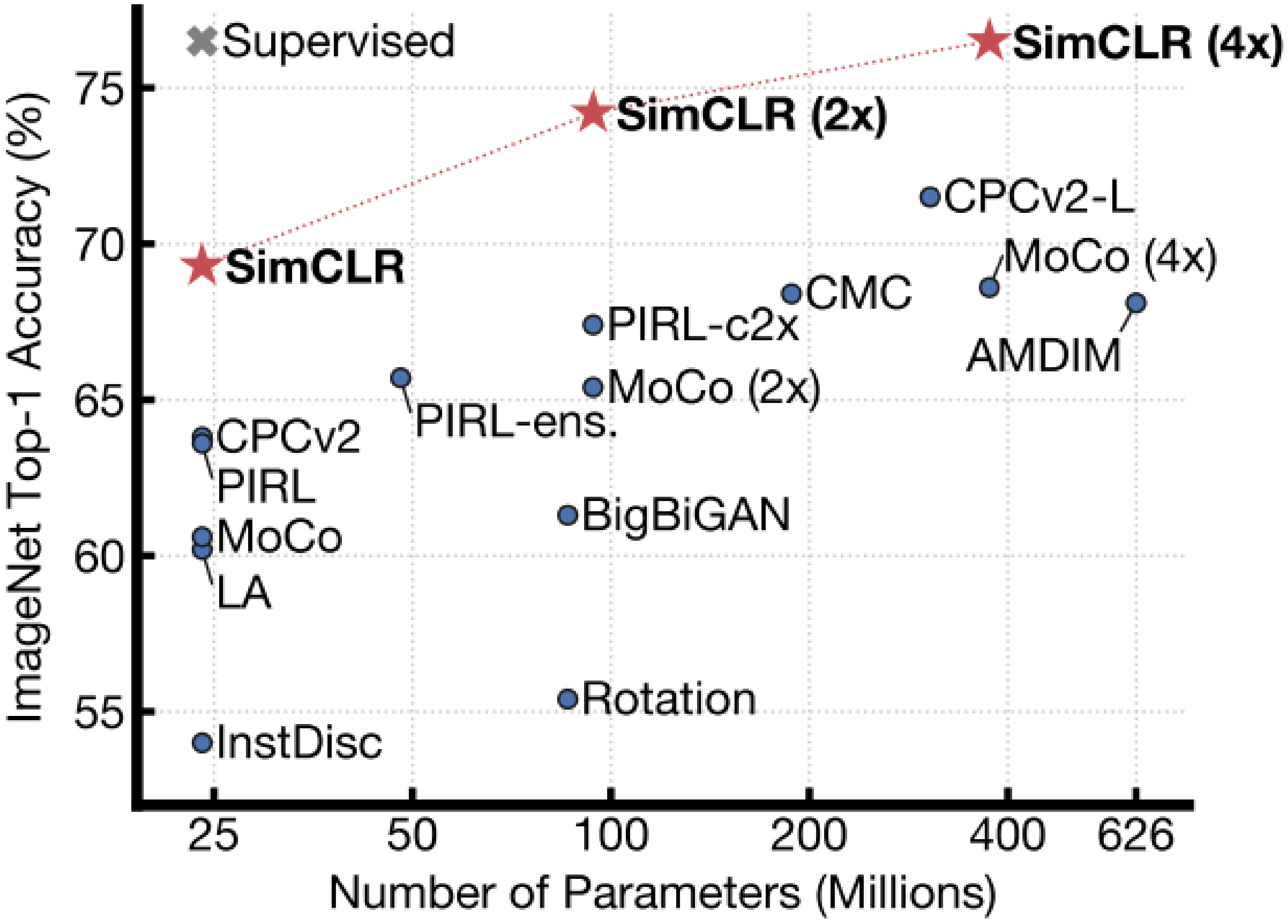
Unsupervised Learning in Vision



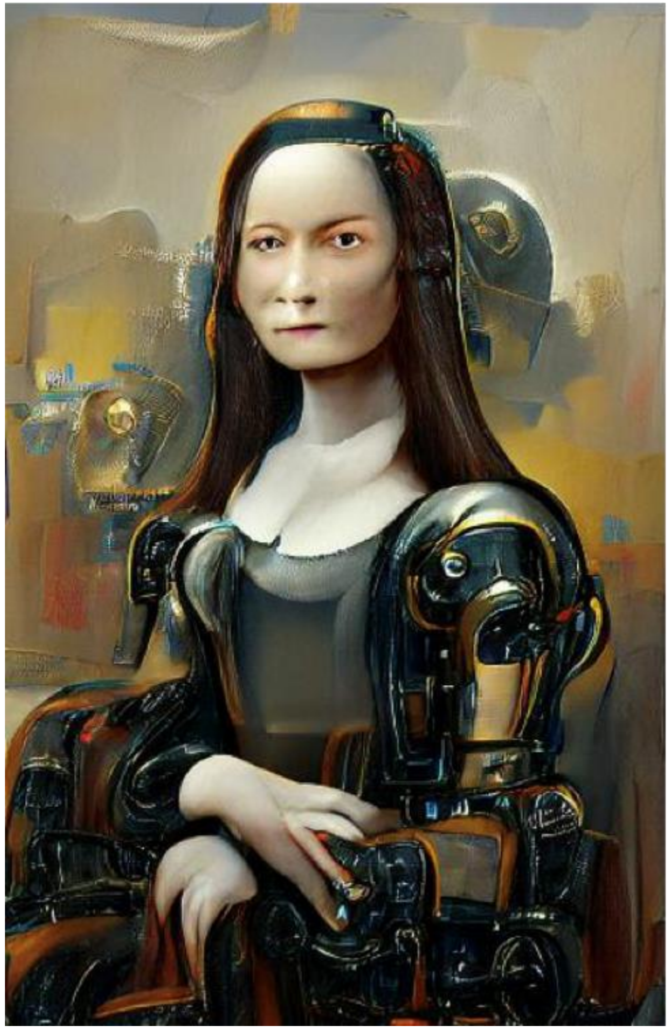
Predict Missing Patch



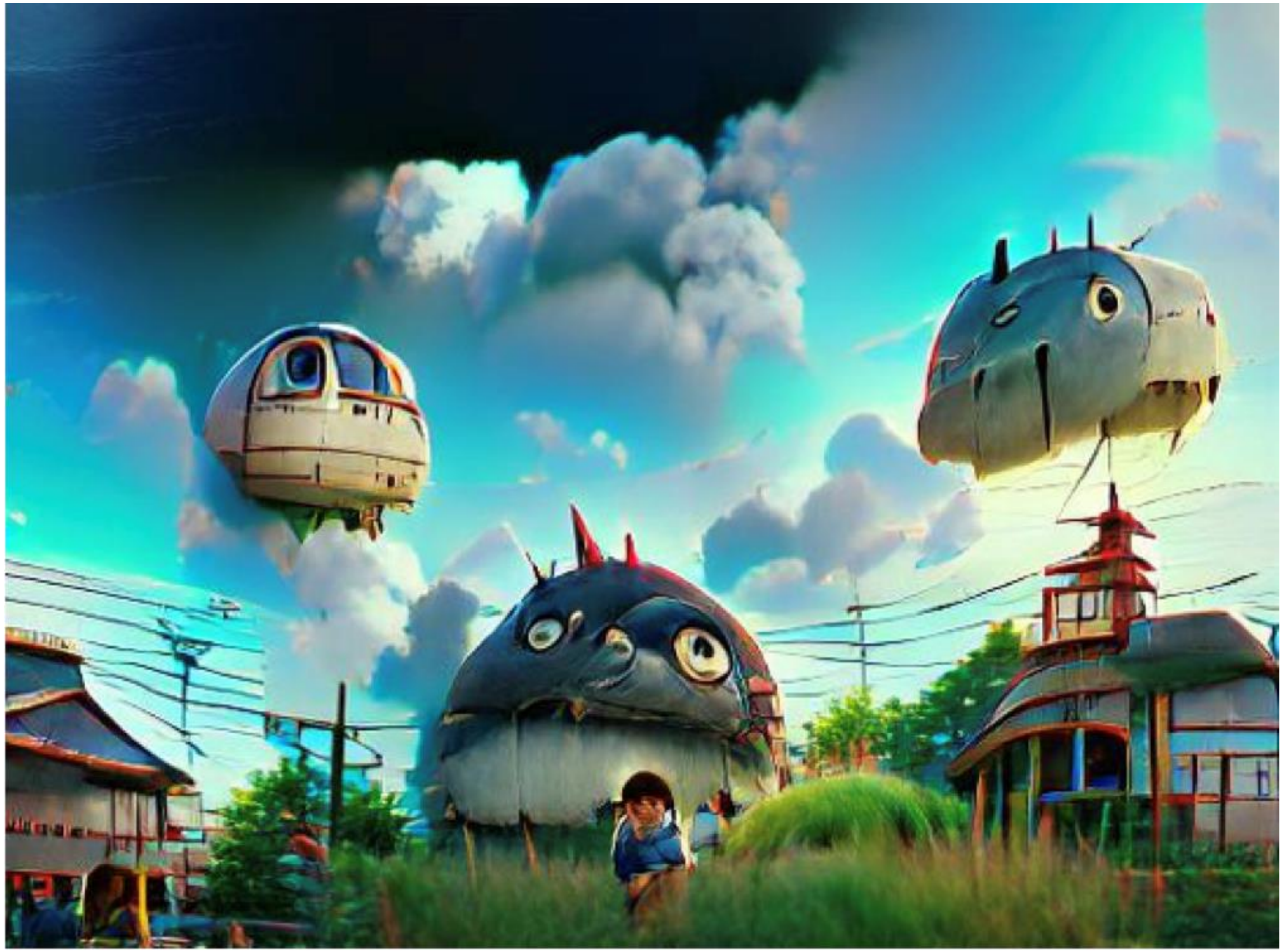
SimCLR + linear classifier



AI for Art Creation

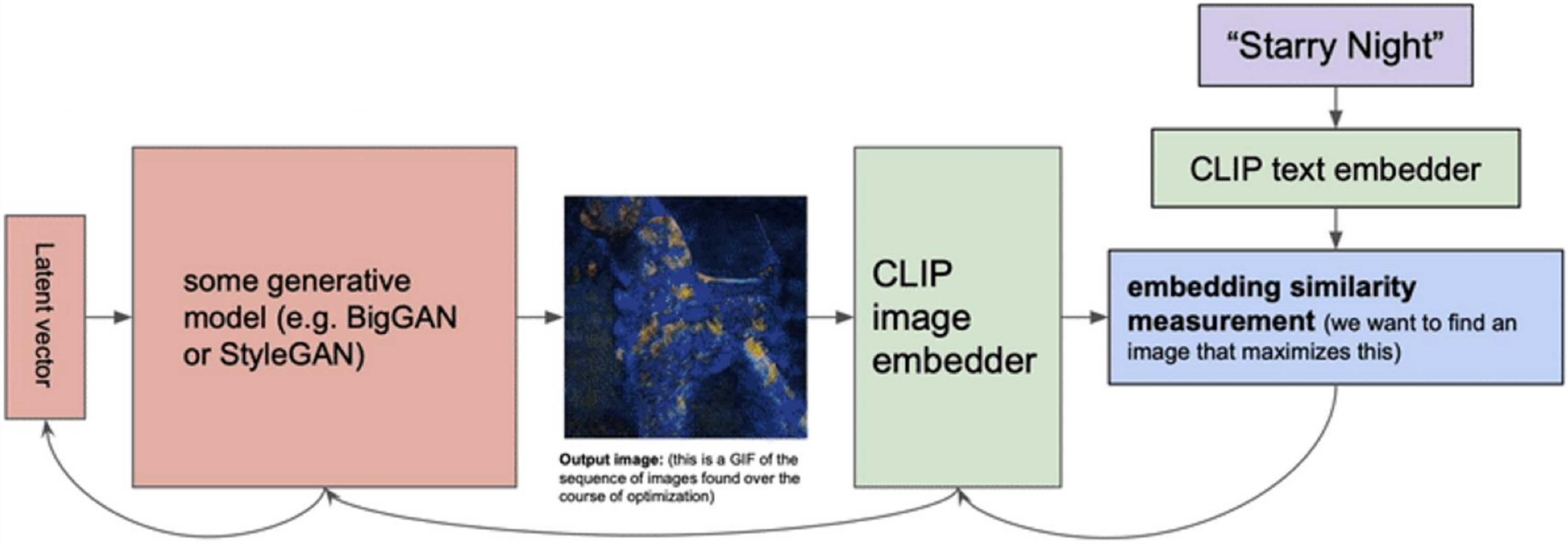


humanoid robot Mona Lisa
artstationHQ



studio ghibli trending on artstation | vary

Text-Guided Image Generation



Latent vector

some generative model (e.g. BigGAN or StyleGAN)

Output image: (this is a GIF of the sequence of images found over the course of optimization)

CLIP image embedder

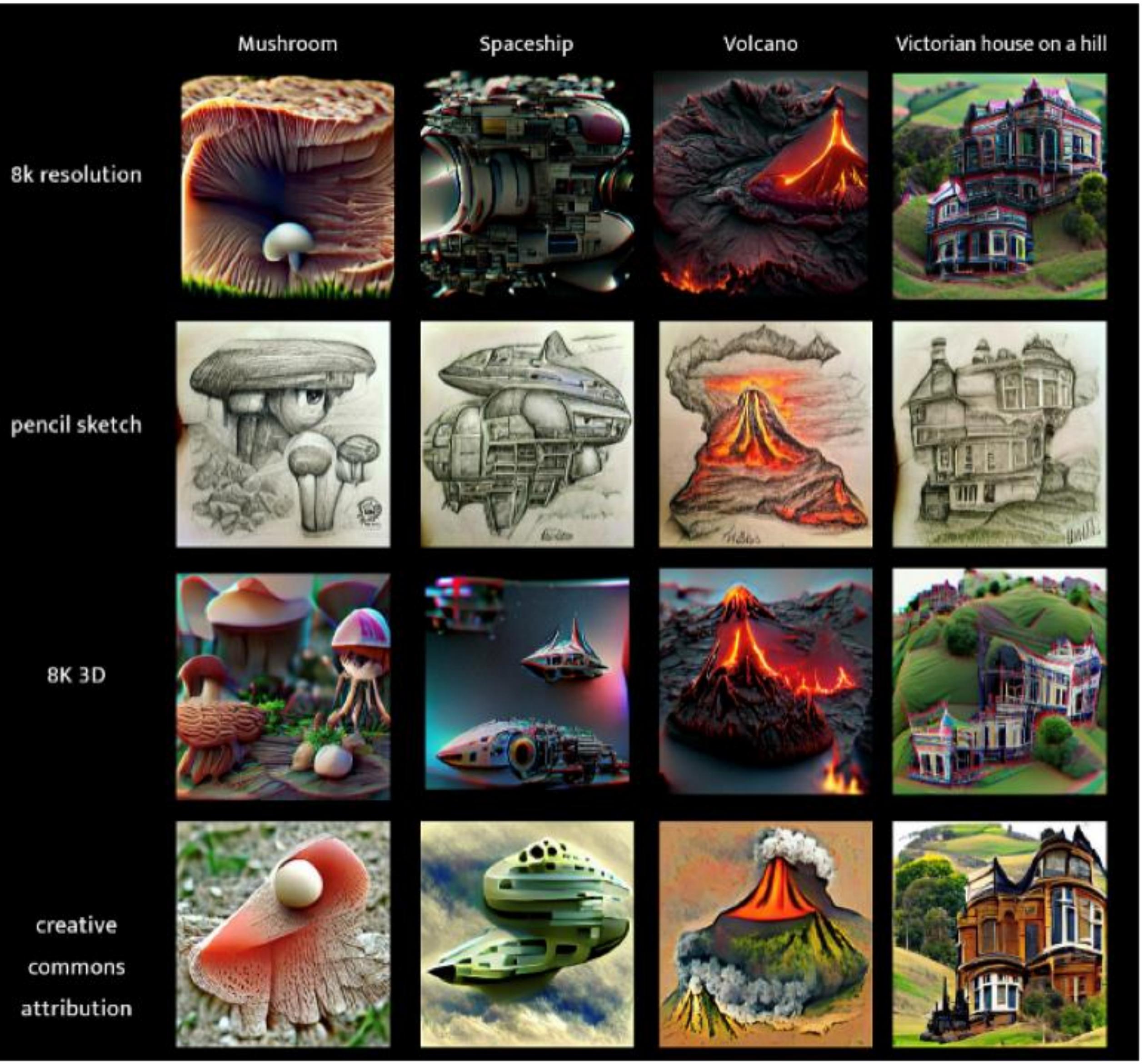
"Starry Night"

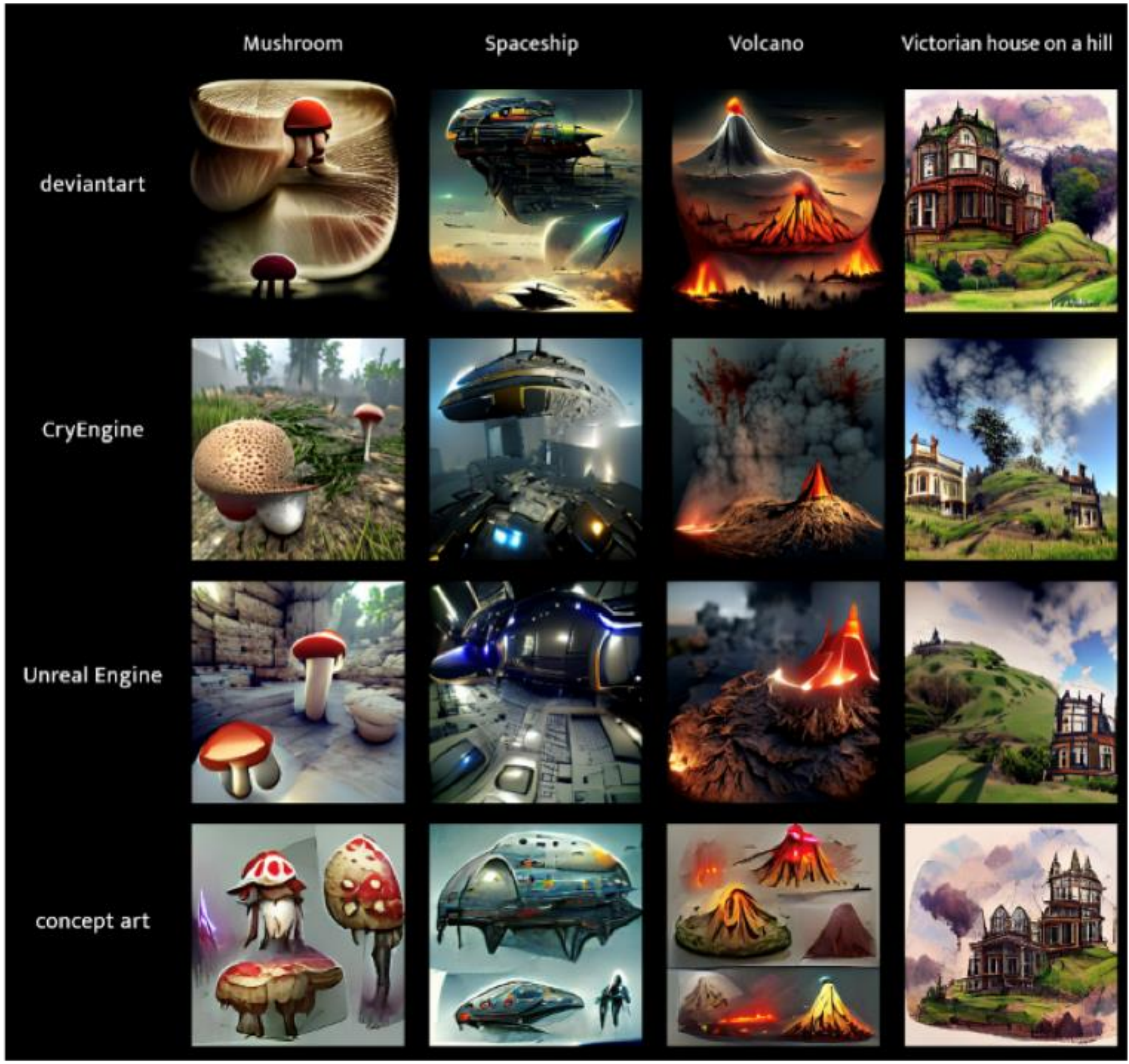
CLIP text embedder

embedding similarity measurement (we want to find an image that maximizes this)

via Charlie Snell

Examples (CLIP + VQGAN)





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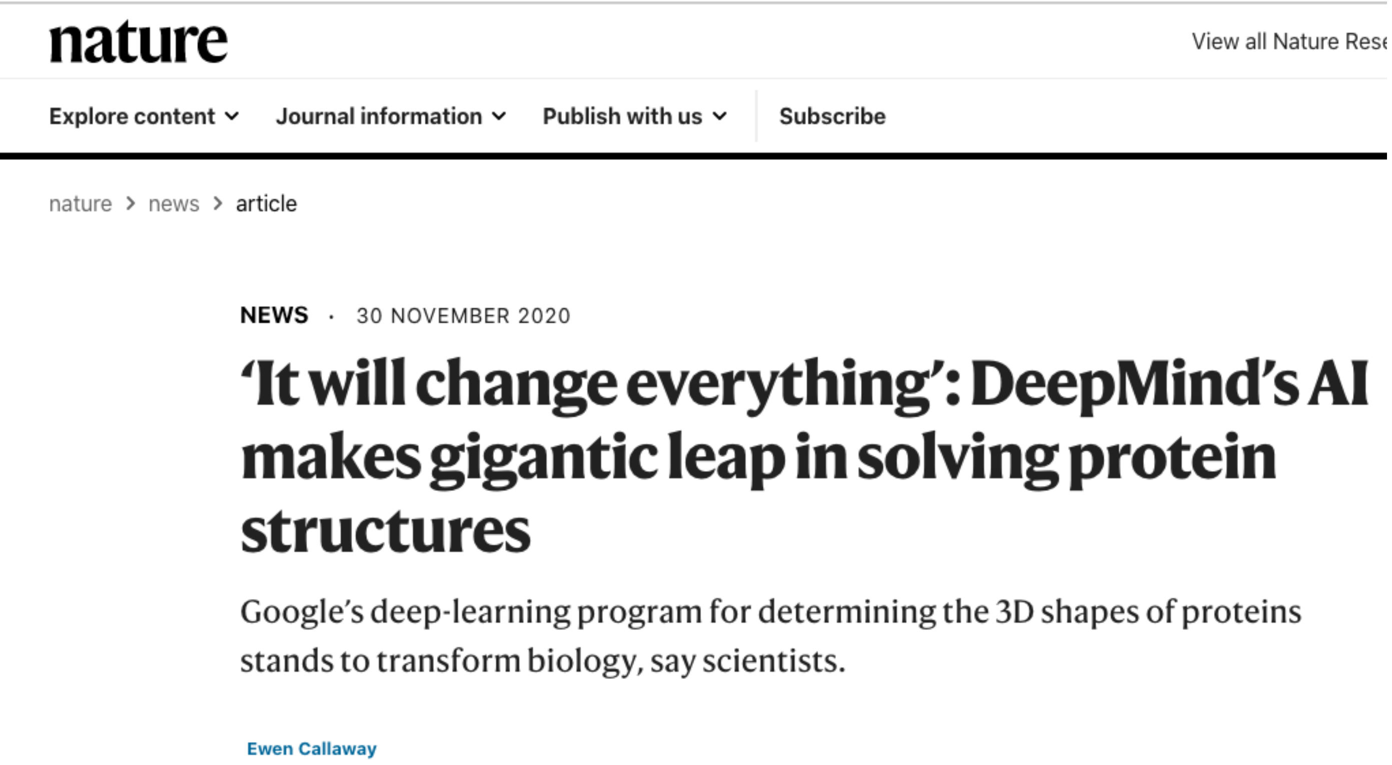


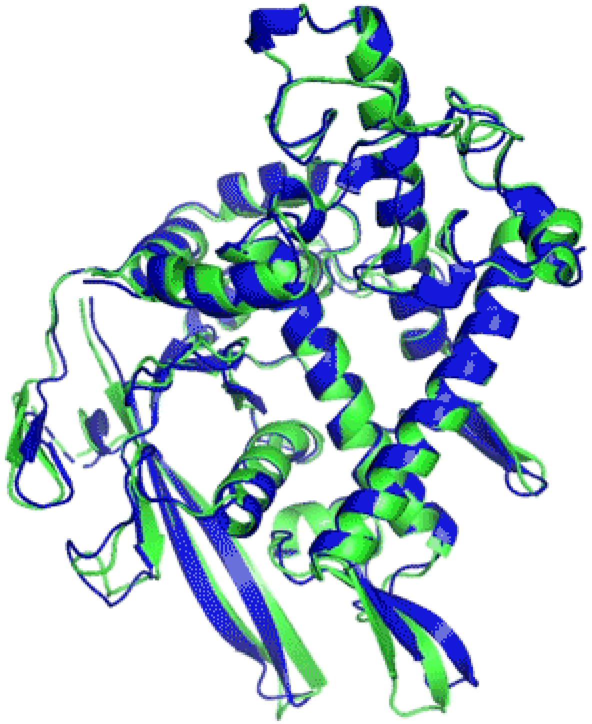
NEWS · 30 NOVEMBER 2020

‘It will change everything’: DeepMind’s AI makes gigantic leap in solving protein structures

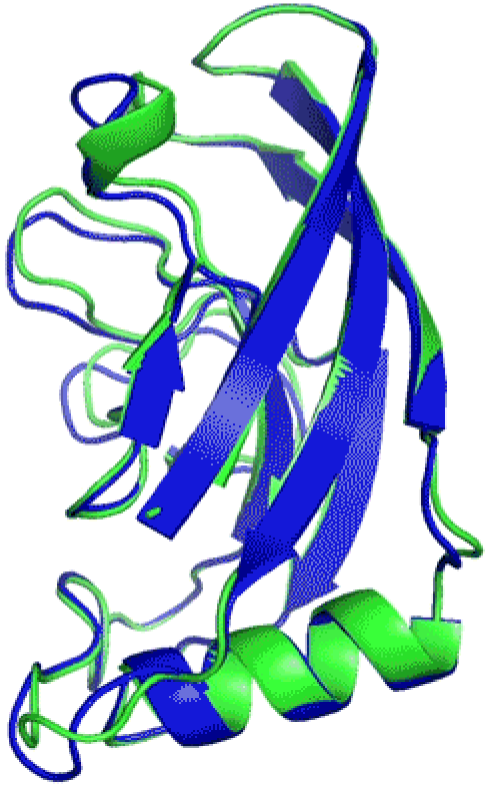
Google’s deep-learning program for determining the 3D shapes of proteins stands to transform biology, say scientists.

Ewen Callaway

A protein’s function is determined by its 3D shape. Credit: DeepMind



T1037 / 6vr4
90.7 GDT
(RNA polymerase domain)

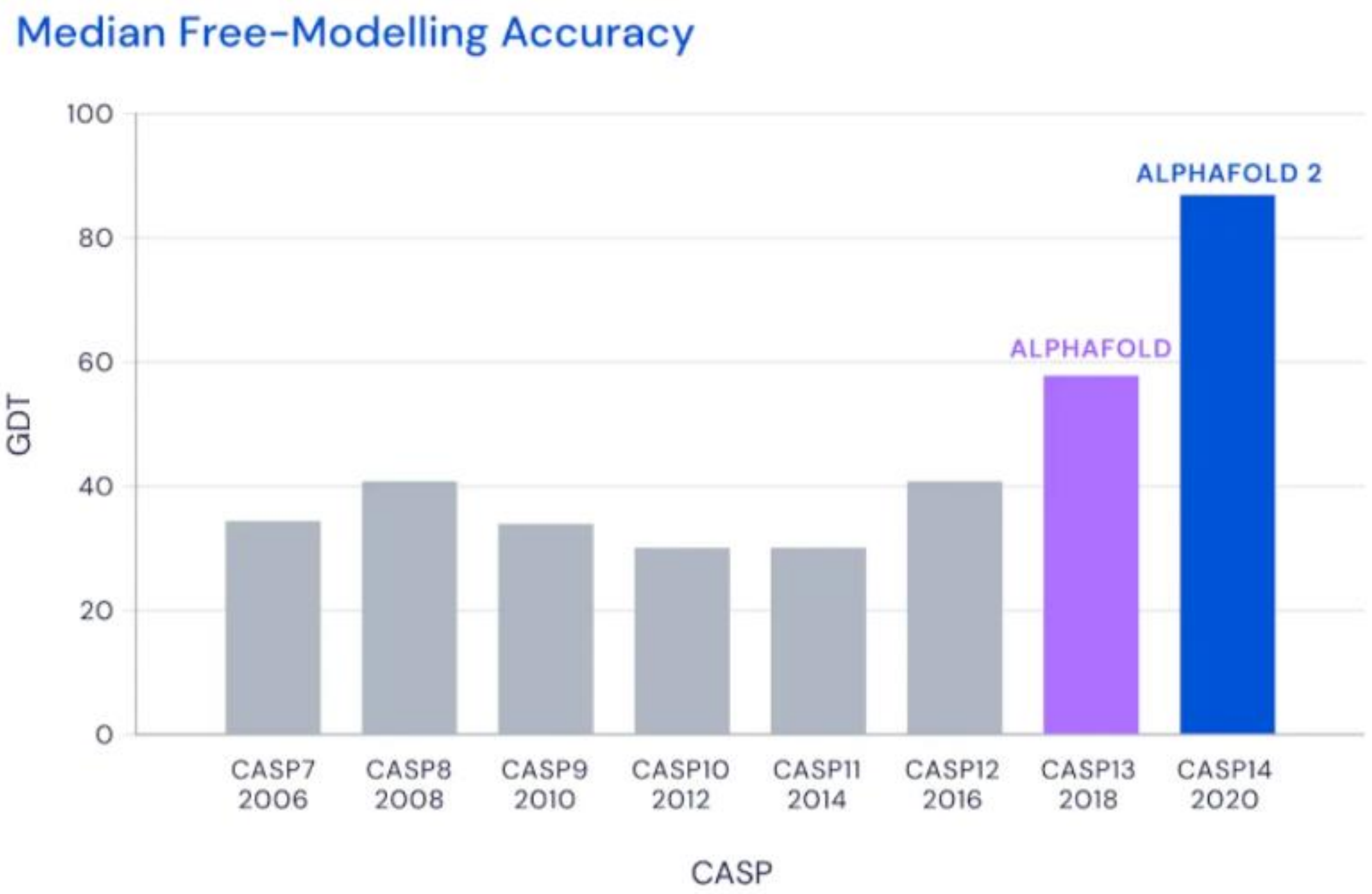


T1049 / 6y4f
93.3 GDT
(adhesin tip)

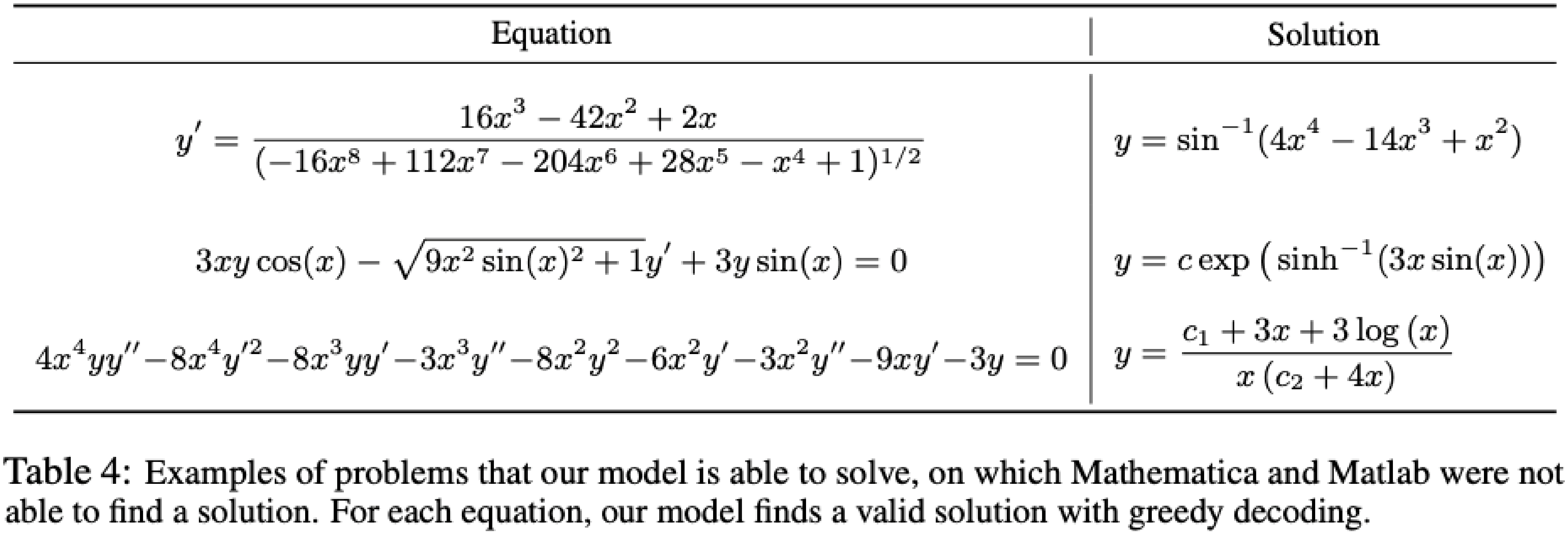
🟢 Experimental result

🔵 Computational prediction

CASP 2020 Competition



Symbolic Math: Integrals and ODEs

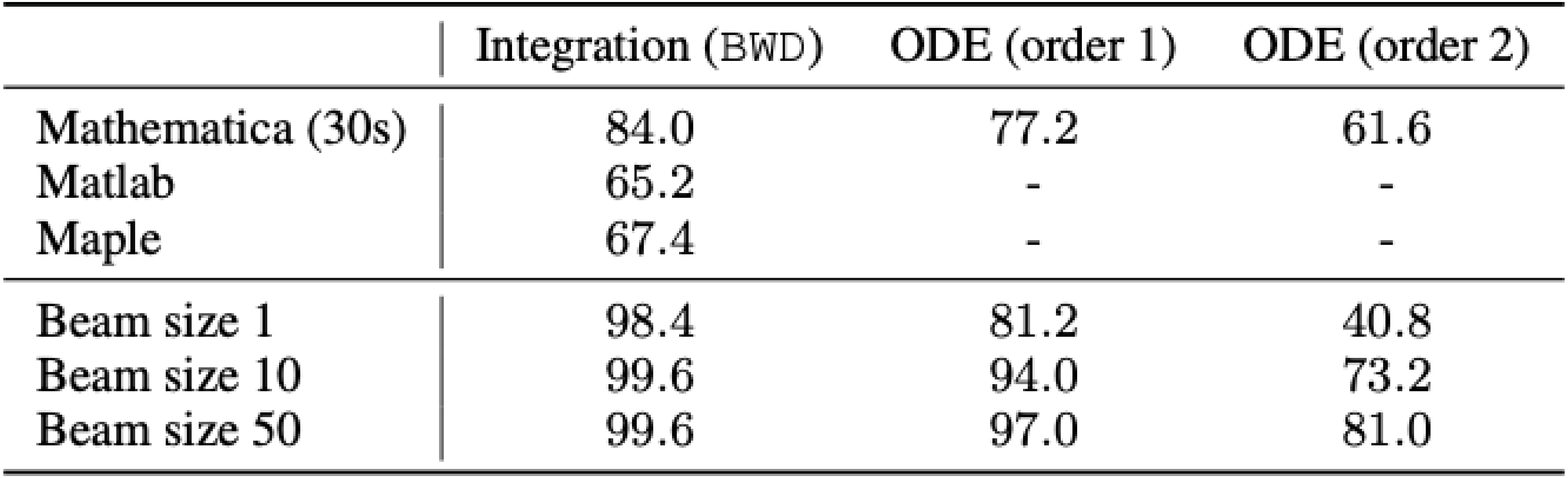


Equation	Solution
$y' = \frac{16x^3 - 42x^2 + 2x}{(-16x^8 + 112x^7 - 204x^6 + 28x^5 - x^4 + 1)^{1/2}}$	$y = \sin^{-1}(4x^4 - 14x^3 + x^2)$
$3xy\cos(x) - \sqrt{9x^2\sin(x)^2 + 1}y' + 3y\sin(x) = 0$	$y = c\exp\left(\sinh^{-1}(3x\sin(x))\right)$
$4x^4yy'' - 8x^4y'^2 - 8x^3yy' - 3x^3y'' - 8x^2y^2 - 6x^2y' - 3x^2y'' - 9xy' - 3y = 0$	$y = \frac{c_1 + 3x + 3\log(x)}{x(c_2 + 4x)}$

Table 4: Examples of problems that our model is able to solve, on which Mathematica and Matlab were not able to find a solution. For each equation, our model finds a valid solution with greedy decoding.

[Lample and Charton, ICLR 2020]

Symbolic Math: Integrals and ODEs



	Integration (BWD)	ODE (order 1)	ODE (order 2)
Mathematica (30s)	84.0	77.2	61.6
Matlab	65.2	-	-
Maple	67.4	-	-
Beam size 1	98.4	81.2	40.8
Beam size 10	99.6	94.0	73.2
Beam size 50	99.6	97.0	81.0

[Lample and Charton, ICLR 2020]

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AI Ethics Ever More Important

- Why?
  - AI is making decisions, at scale
  - Any kind of issues (e.g. bias or malignant use) could significantly affect *people*
- Many open questions:
  - Who is responsible?
  - How to diagnose and prevent?

Some Key AI Ethics Topics

- Disinformation
- Bias and fairness
- Privacy and surveillance
- Metrics
- Algorithmic colonialism

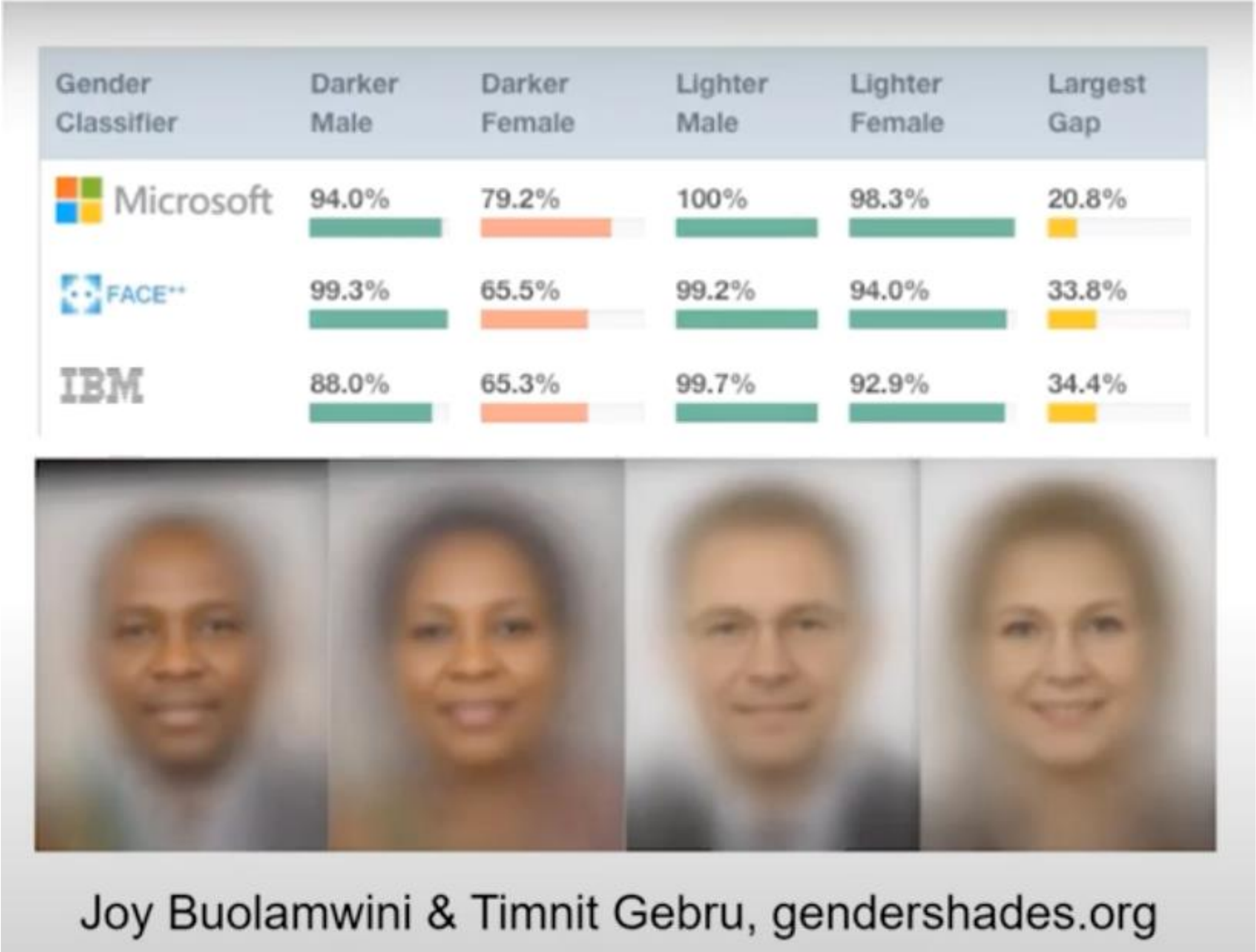
Source: Rachel Thomas (@math_rachel)

Disinformation can be aided by AI generated text

Prompt: Recycling is good for the world, no, you could not be more wrong.

GPT-2: Recycling is NOT good for the world. It is bad for the environment, it is bad for our health, and it is bad for our economy. I’m not kidding. Recycling is not good for the environment. It is destructive to the earth and it is a major contributor to global warming. Recycling is not good for our health. It contributes to obesity and diseases like heart disease and cancer. Recycling is bad for our economy. It increases the cost of a product, and in turn, the price of everything that is made with that product. Recycling is not good for our nation. We pay a tremendous price for the privilege of having the world’s most advanced and efficient recycling system. Recycling is a huge, colossal waste of time, energy, money, and resources.

Bias and Fairness – Gender Shades



Gender Classifier	Darker Male	Darker Female	Lighter Male	Lighter Female	Largest Gap
Microsoft	94.0%	79.2%	100%	98.3%	20.8%
FACE++	99.3%	65.5%	99.2%	94.0%	33.8%
IBM	88.0%	65.3%	99.7%	92.9%	34.4%

Joy Buolamwini & Timnit Gebru, gendershades.org

Source: Rachel Thomas (@math_rachel)

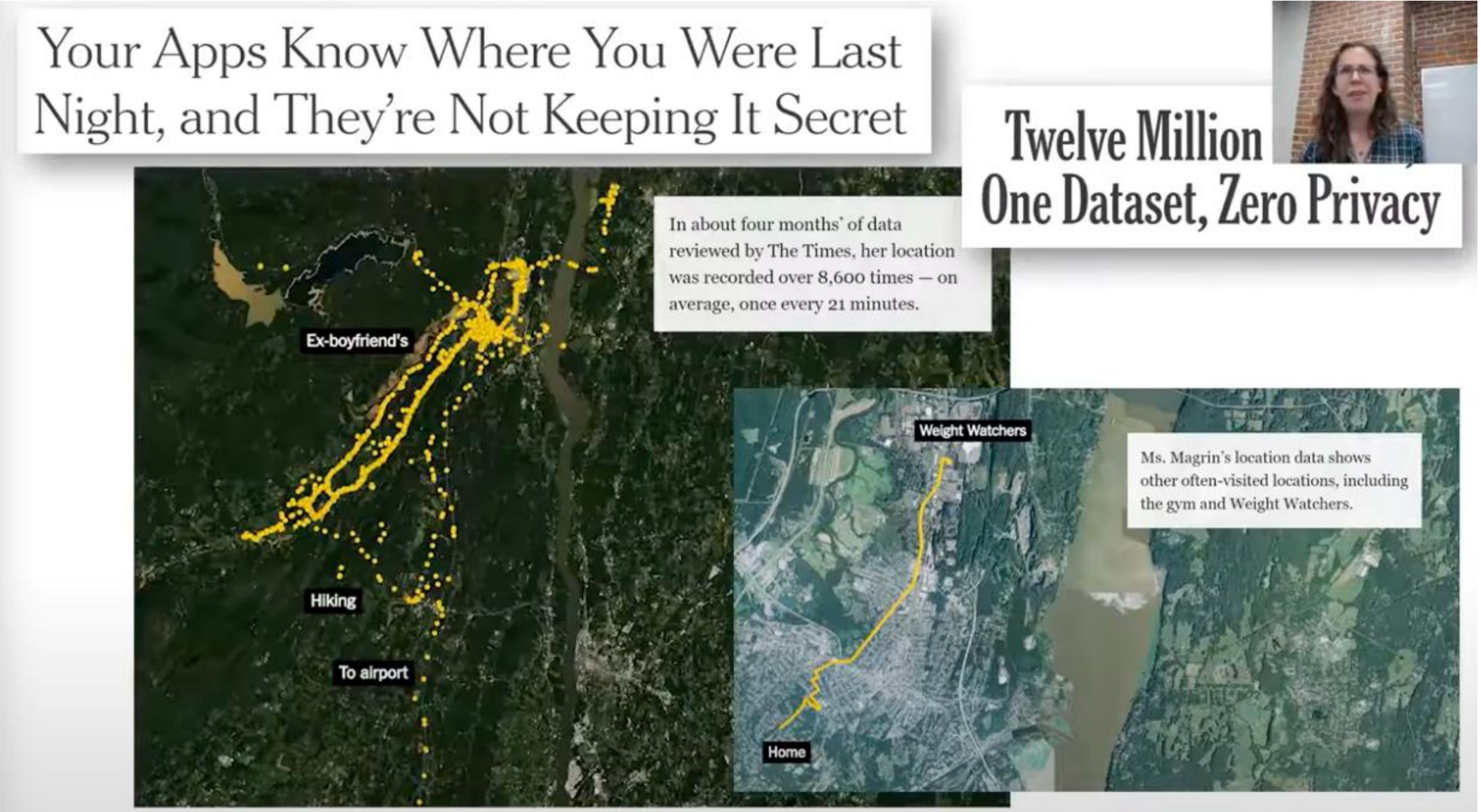
Bias and Fairness

Algorithms are used differently than human decision makers

- People are more likely to assume algorithms are objective or error-free
- Algorithms are more likely to be implemented with no appeals process
- Algorithms are often used at scale
- Algorithmic systems are cheap

Source: Rachel Thomas (@math_rachel)

Privacy and Surveillance



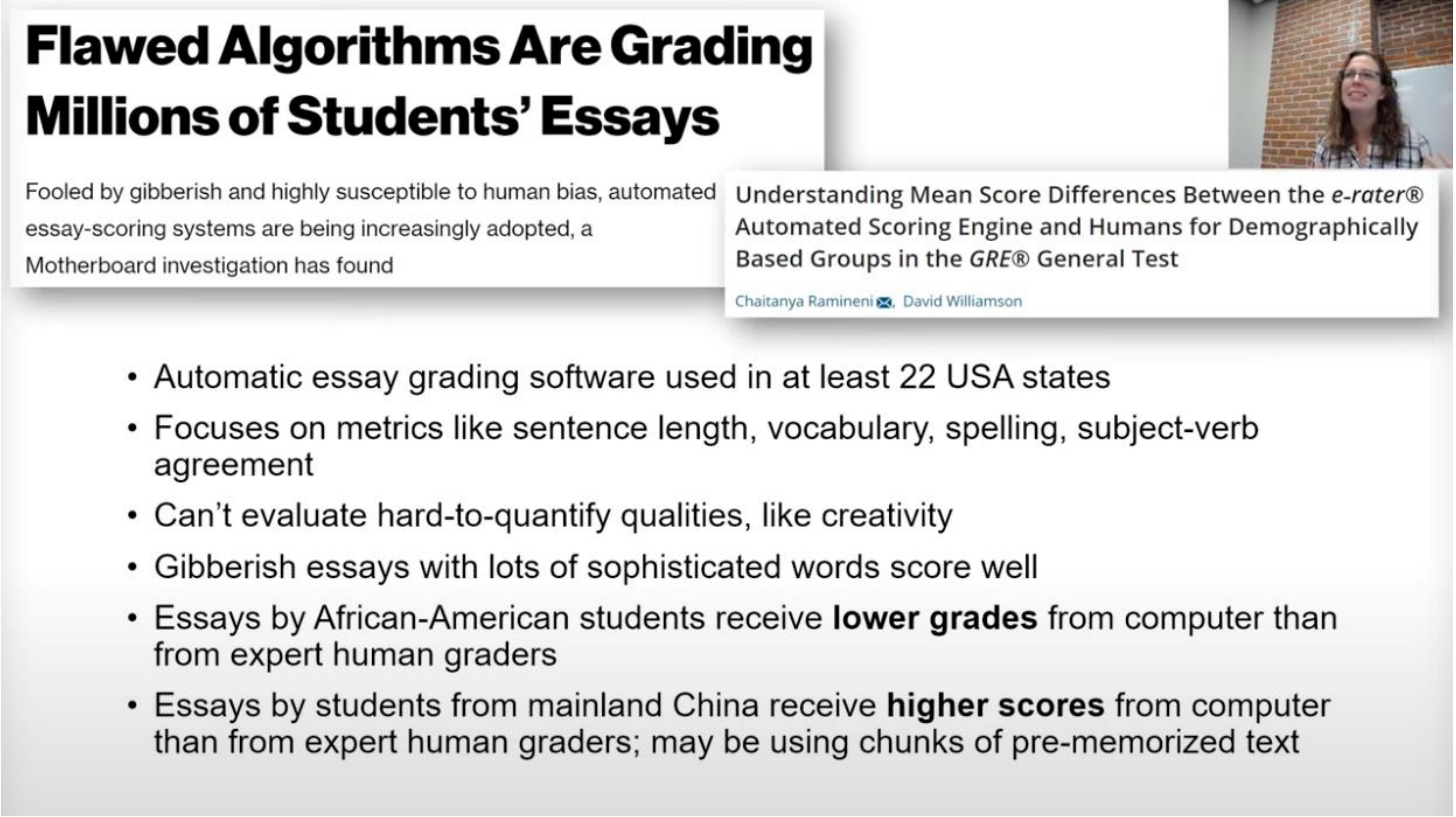
Your Apps Know Where You Were Last Night, and They're Not Keeping It Secret

Twelve Million Phones, One Dataset, Zero Privacy

In about four months' of data reviewed by The Times, her location was recorded over 8,600 times — on average, once every 21 minutes.

Ms. Magrin's location data shows other often-visited locations, including the gym and Weight Watchers.

Source: Rachel Thomas (@math_rachel)



Flawed Algorithms Are Grading Millions of Students' Essays

Fooled by gibberish and highly susceptible to human bias, automated essay-scoring systems are being increasingly adopted, a Motherboard investigation has found

Understanding Mean Score Differences Between the *e-rater*® Automated Scoring Engine and Humans for Demographically Based Groups in the *GRE*® General Test

Chaitanya Ramineni, David Williamson

- Automatic essay grading software used in at least 22 USA states
- Focuses on metrics like sentence length, vocabulary, spelling, subject-verb agreement
- Can't evaluate hard-to-quantify qualities, like creativity
- Gibberish essays with lots of sophisticated words score well
- Essays by African-American students receive **lower grades** from computer than from expert human graders
- Essays by students from mainland China receive **higher scores** from computer than from expert human graders; may be using chunks of pre-memorized text

Source: Rachel Thomas (@math_rachel)

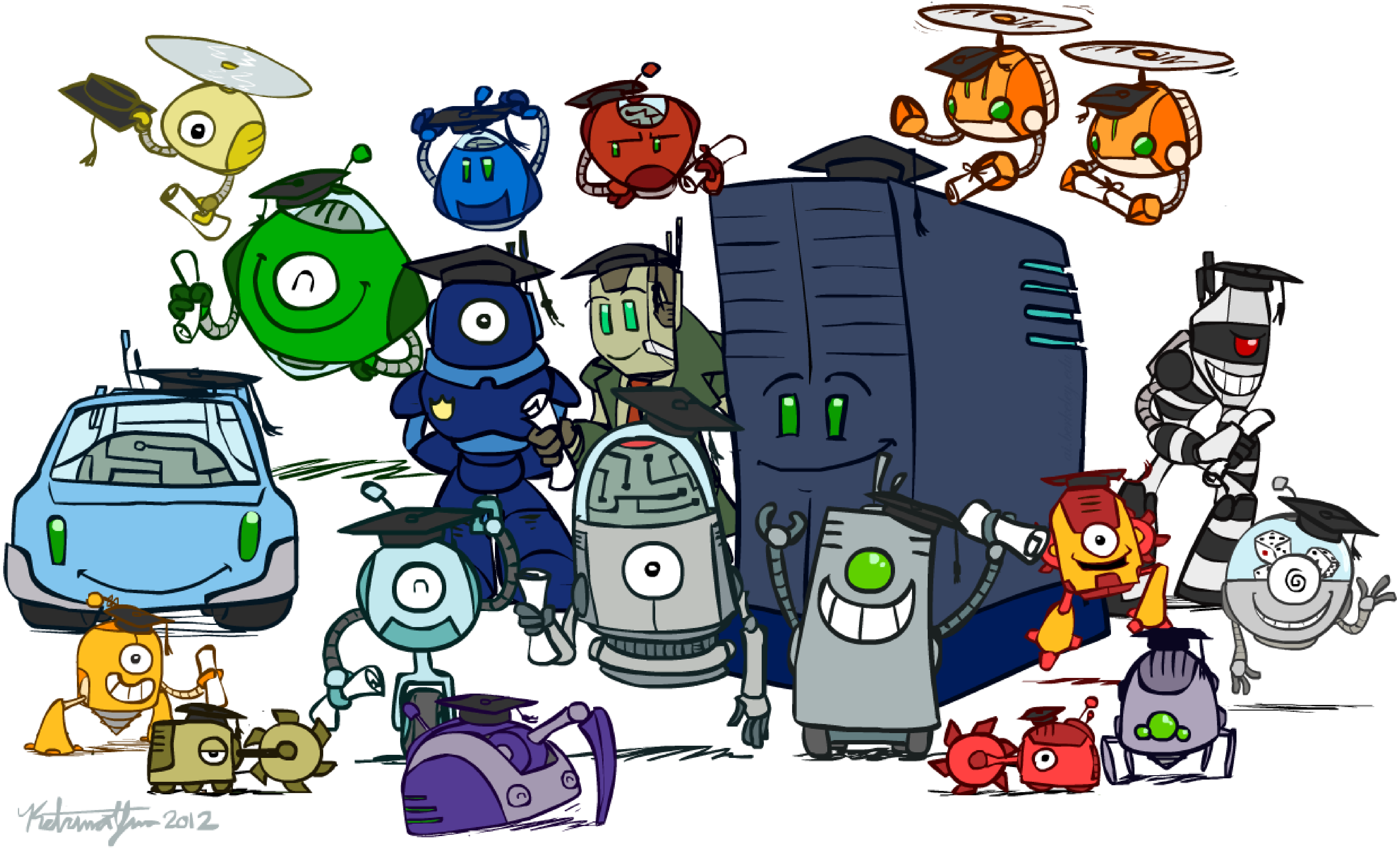
Where to Go Next?

Where to go next?

- Congratulations, you've seen the basics of modern AI
  - … and done some amazing work putting it to use!
- How to continue:
  - Machine learning:
  - Data Science:
  - Data / Ethics:
  - Probability:
  - Optimization:
  - Computer vision:
  - Reinforcement Learning:
  - Robotics:
  - NLP:
  - … and more; ask if you're interested

That’s It!

- Help us out with some course evaluations
- Have a great spring break


2012