



OpenAI

Progress towards the OpenAI mission

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OpenAI's mission

OpenAI's mission is to ensure that artificial general intelligence (AGI) — by which we mean highly autonomous systems that outperform humans at most economically valuable work — benefits all of humanity.

— The OpenAI Charter

Technical progress from OpenAI

OpenAI Five

Dota



Dota is hard

Partial observability

120 heroes (we integrated 18)

20,000 actions per game, massive action space

Pros dedicate their lives to the game, 10K+ hrs of deliberate practice

Dota is popular

Largest professional scene

Annual prize pool of \$40M+

Dota



Our approach

Very large scale reinforcement learning

millennia of practice

LSTM policy = honeybee brain

Self play

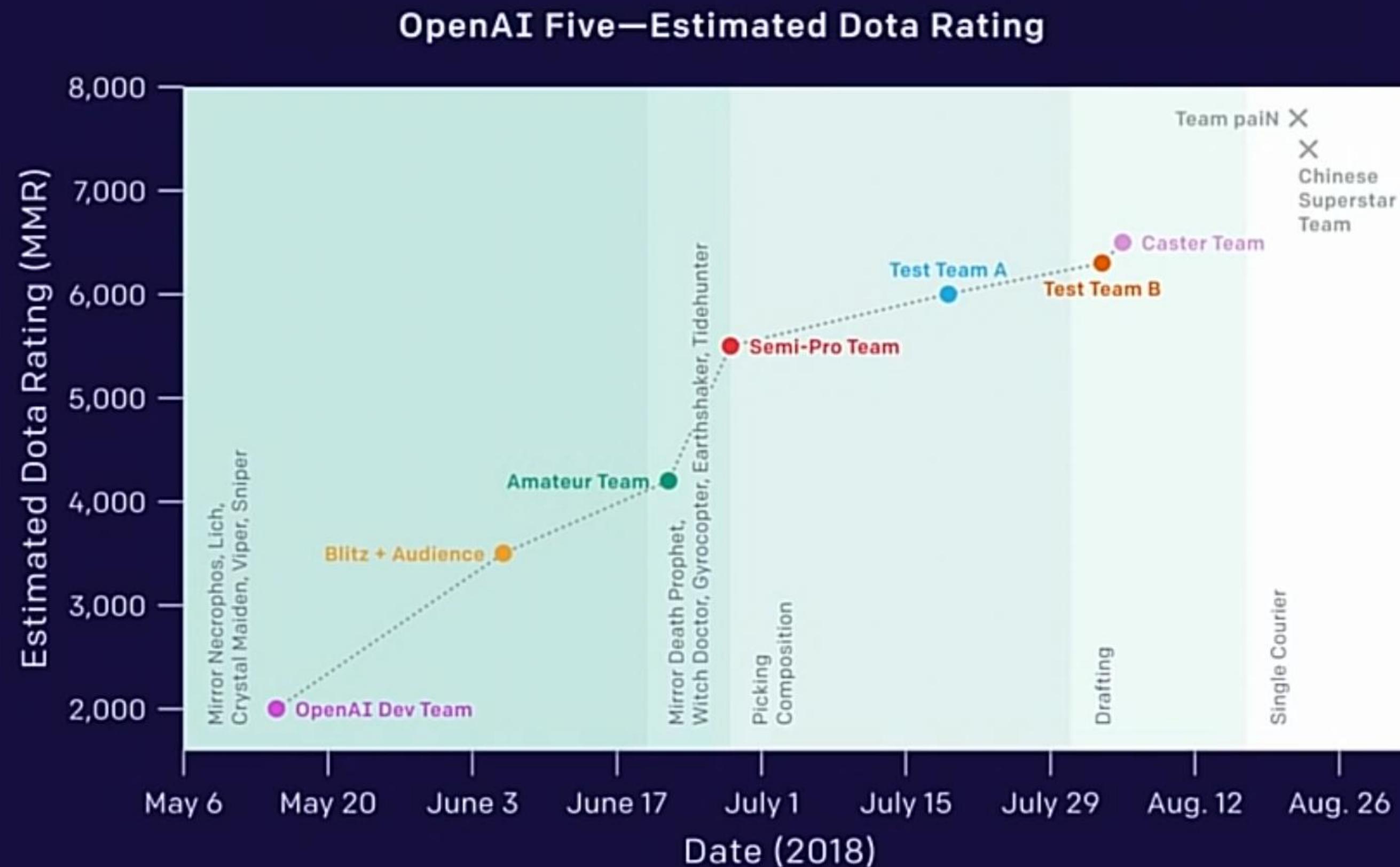
Reward shaping

Reinforcement learning (RL) actually works!

Nearly all RL experts believed that RL can't solve tasks as hard as Dota

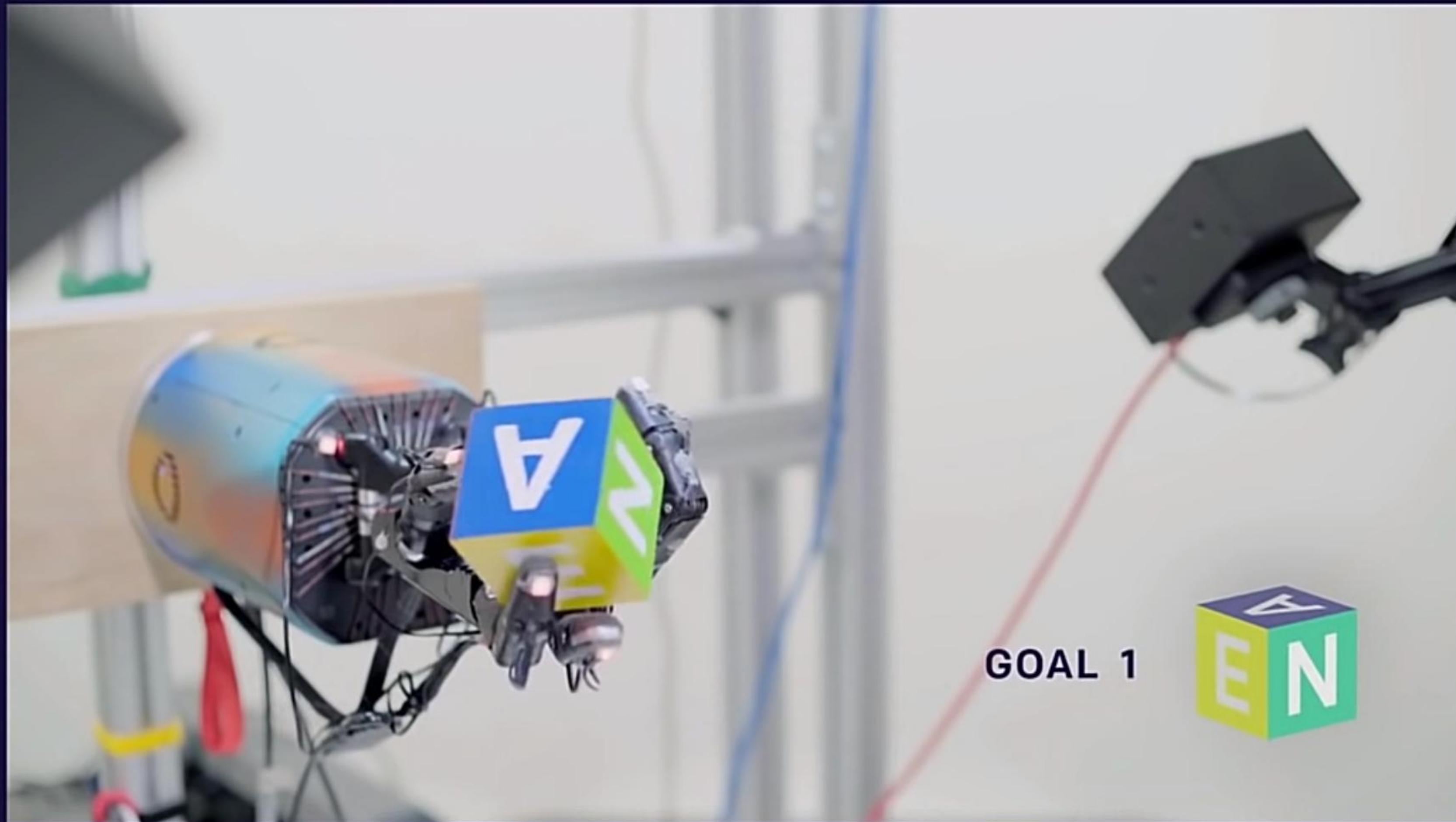
Horizon too long

Results

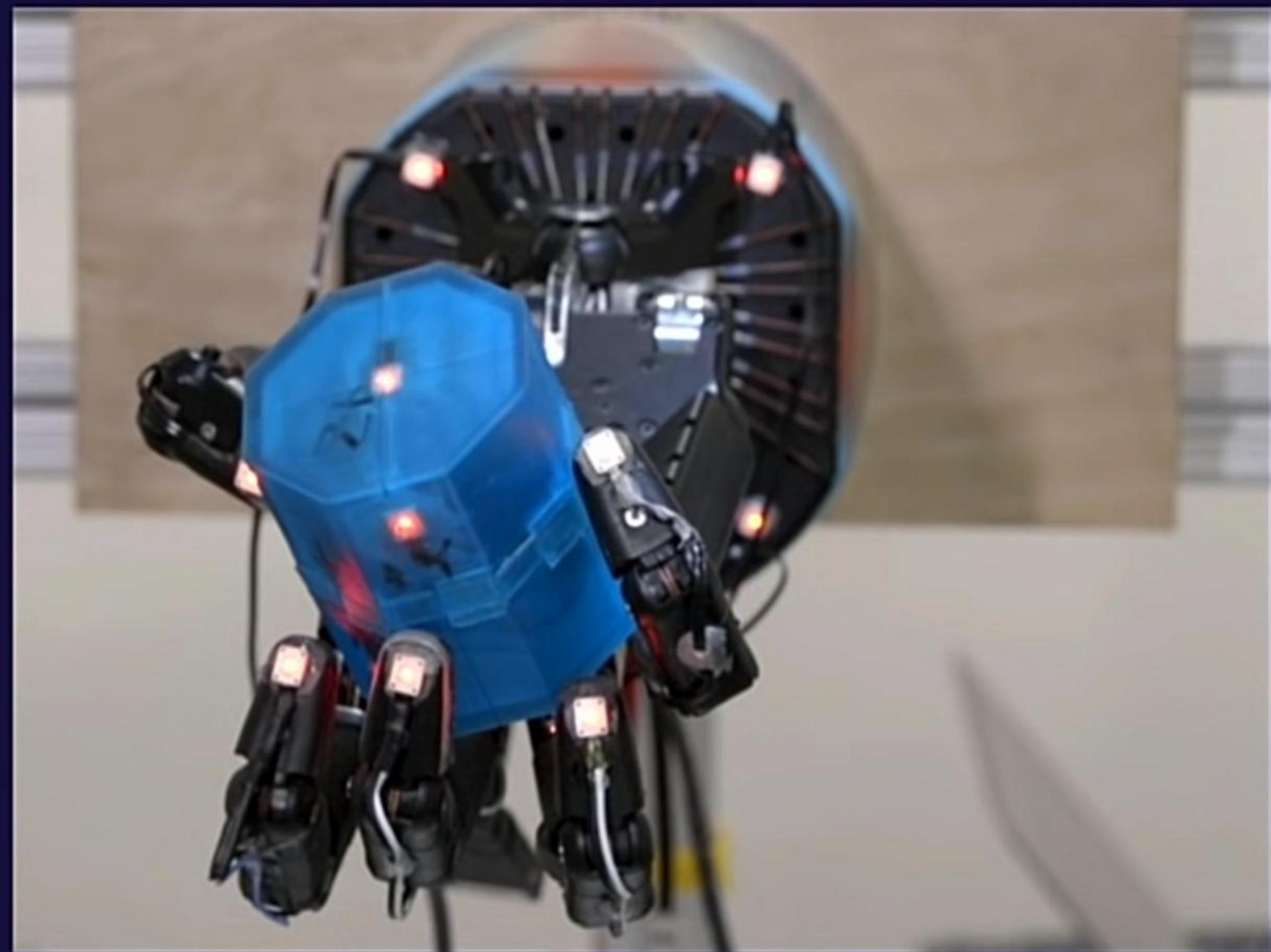


Dactyl

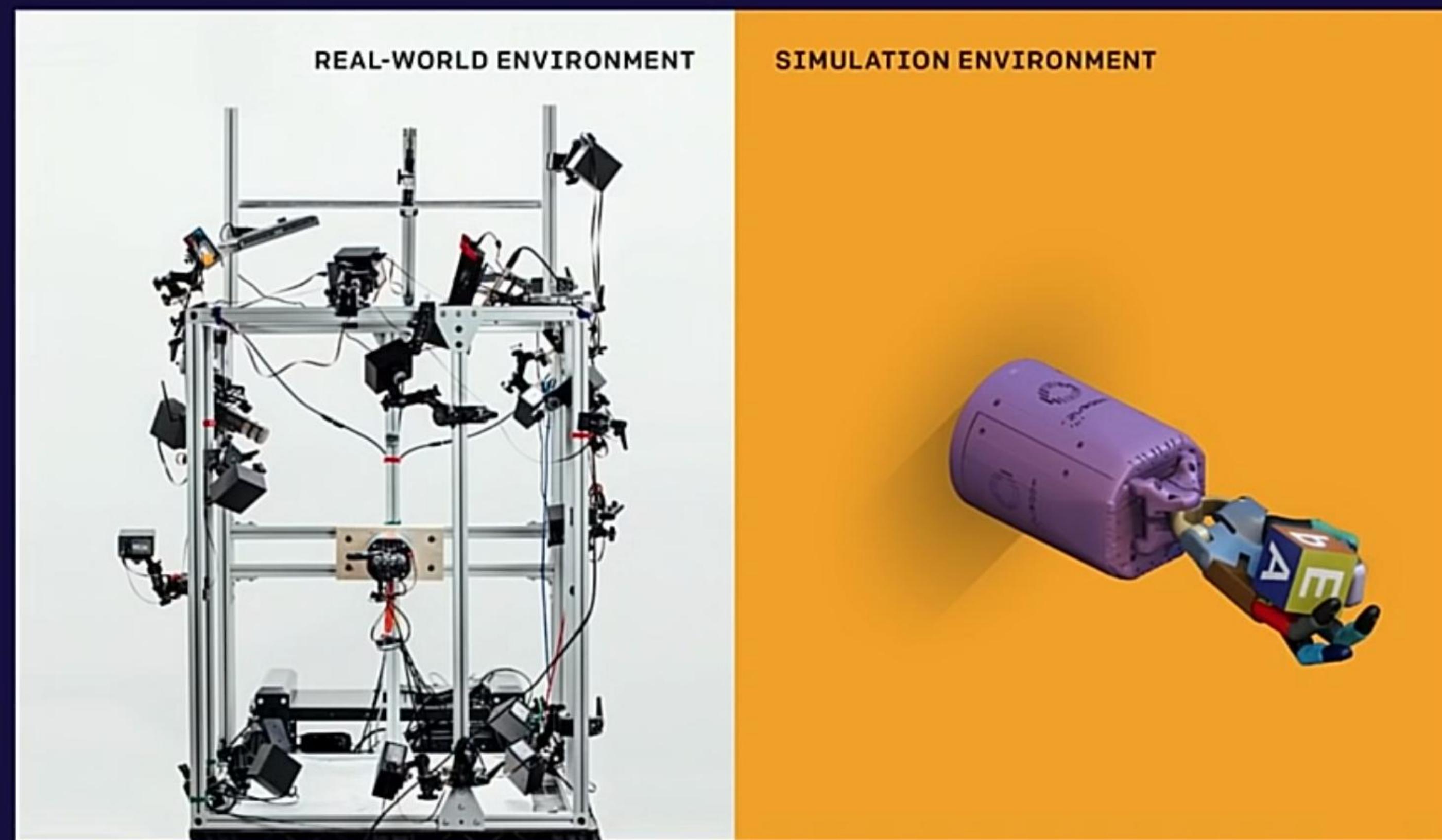
Dexterity



Diverse objects



Strategy: Sim 2 Real



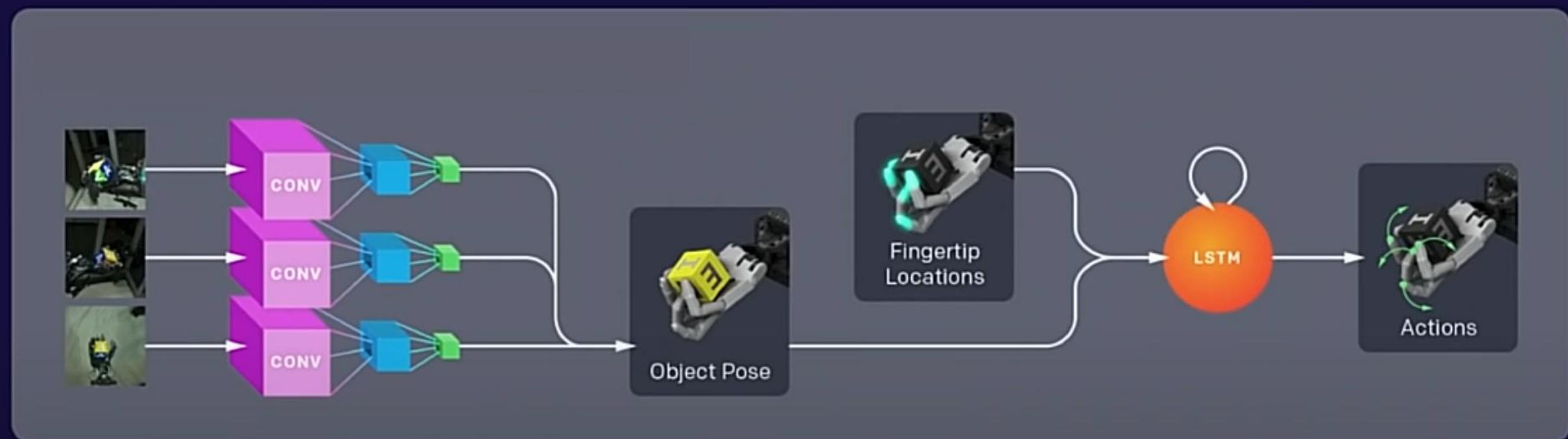
Domain randomization

Train in simulation: randomize perception and physics



Domain randomization

Transfer to the Real World



Curiosity-based exploration

Core idea

Novel states = reward

Fix all bugs

Very hard to do

Montezuma's Revenge

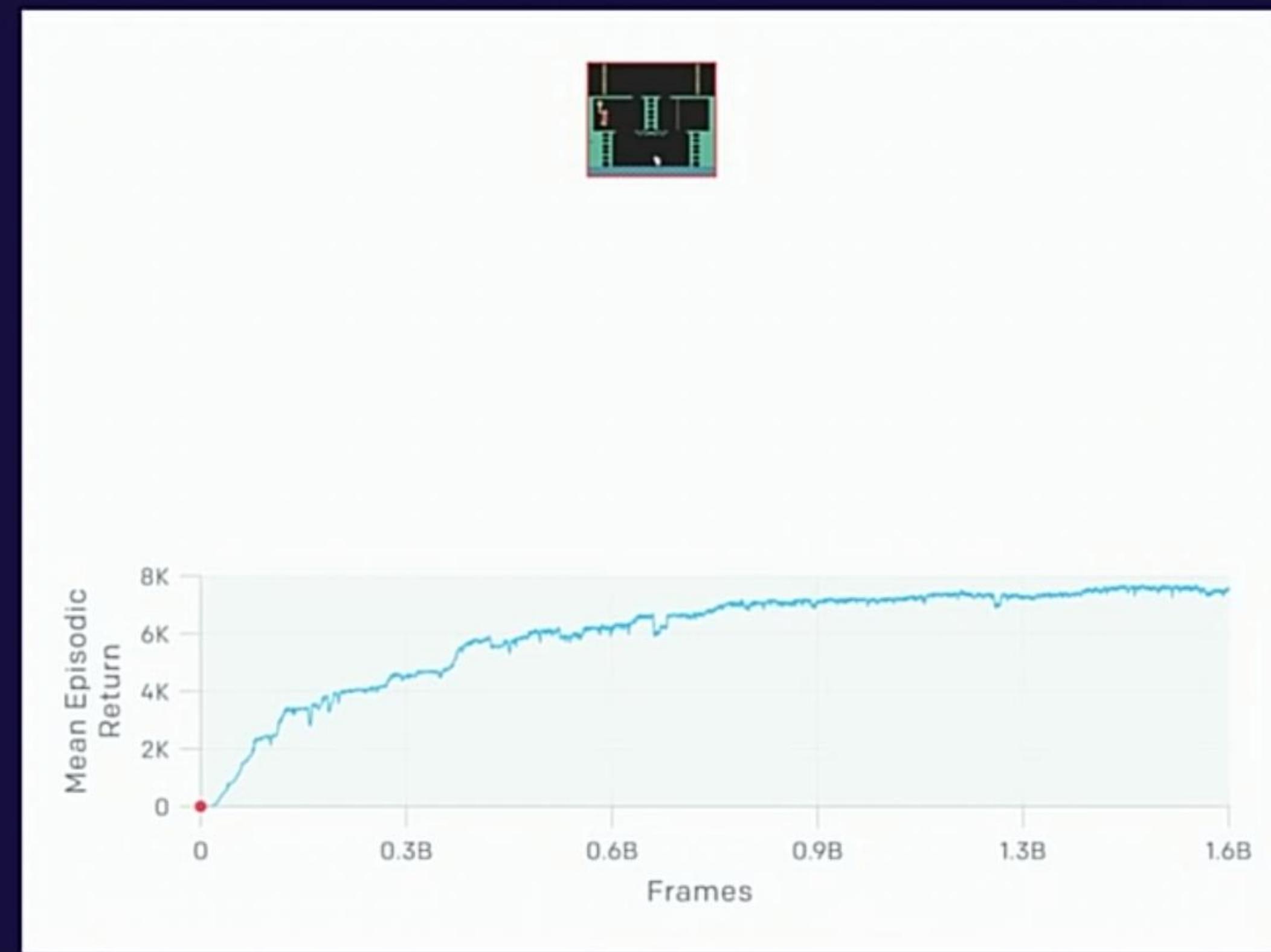


Our agent trained with RND shows a wide range of capabilities:

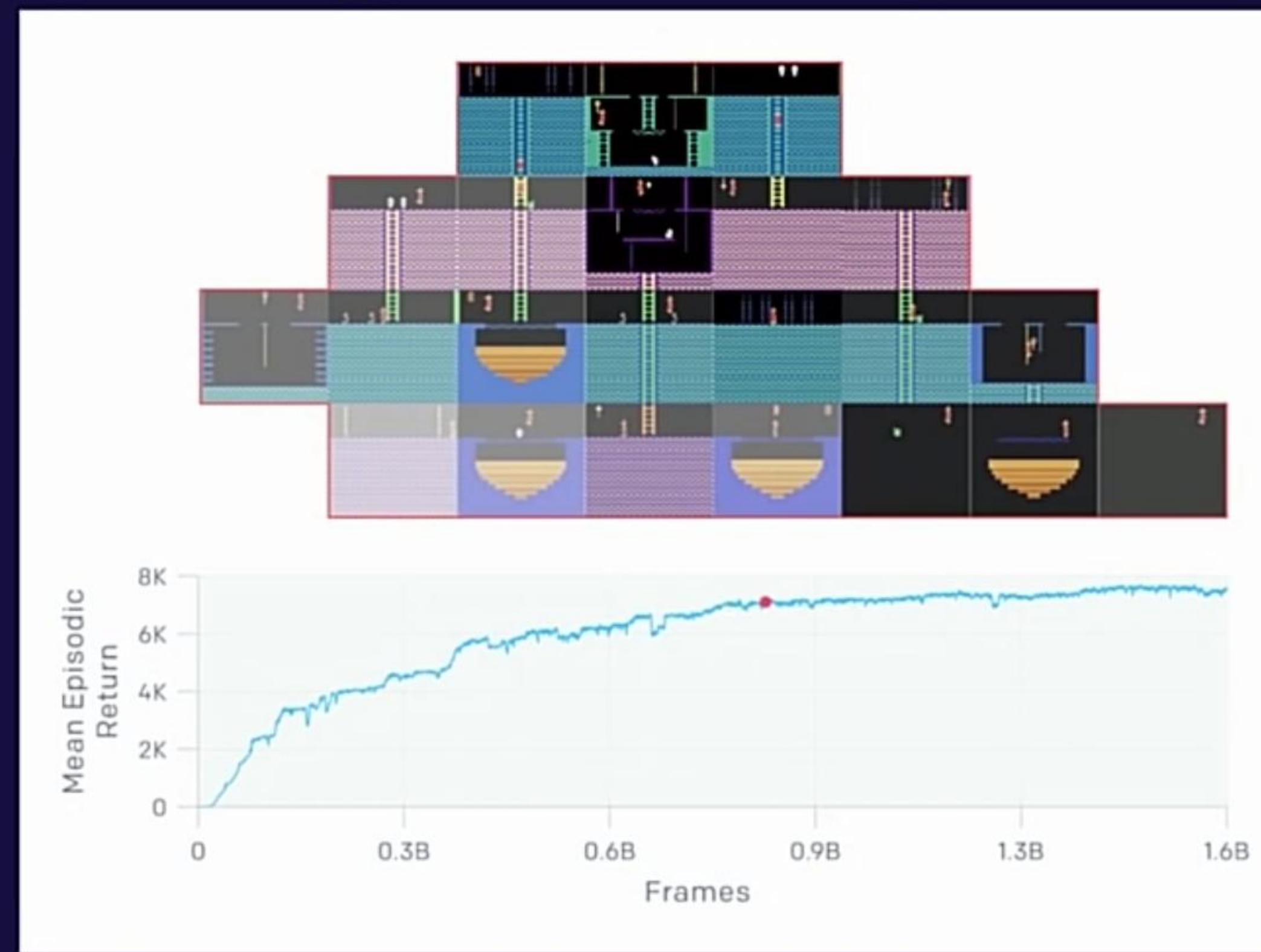
Montezuma's Revenge

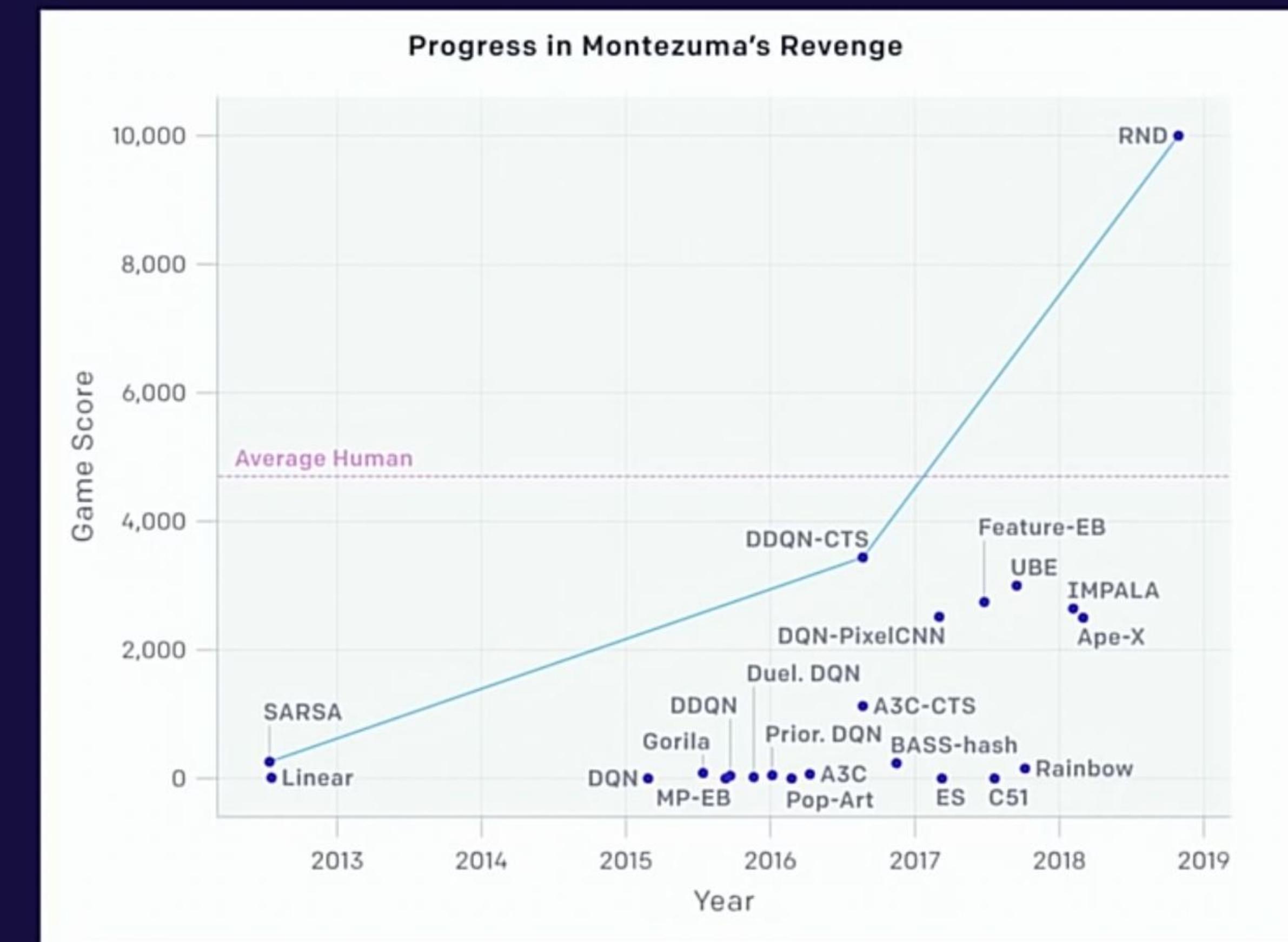


Montezuma's Revenge



Montezuma's Revenge

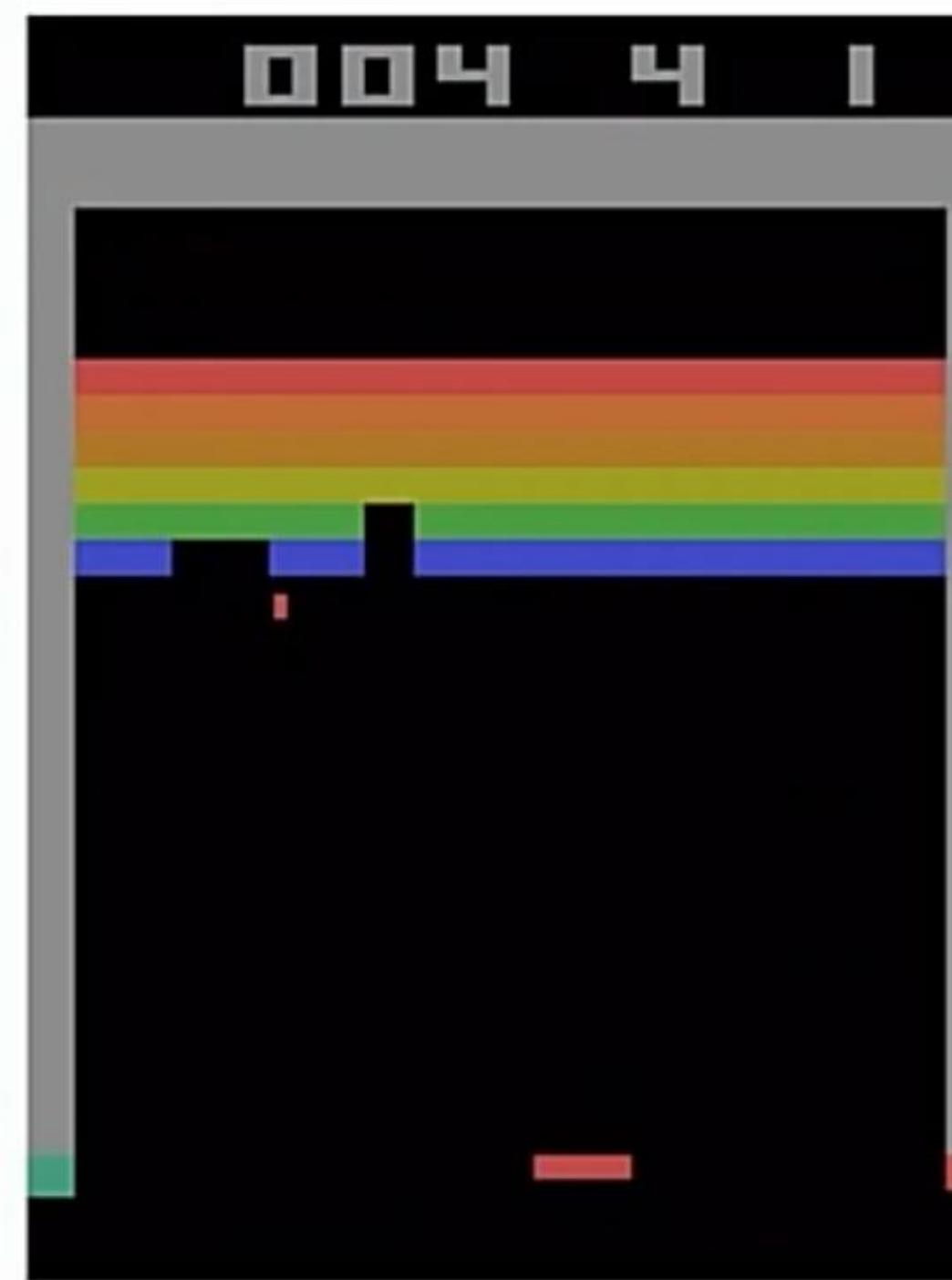




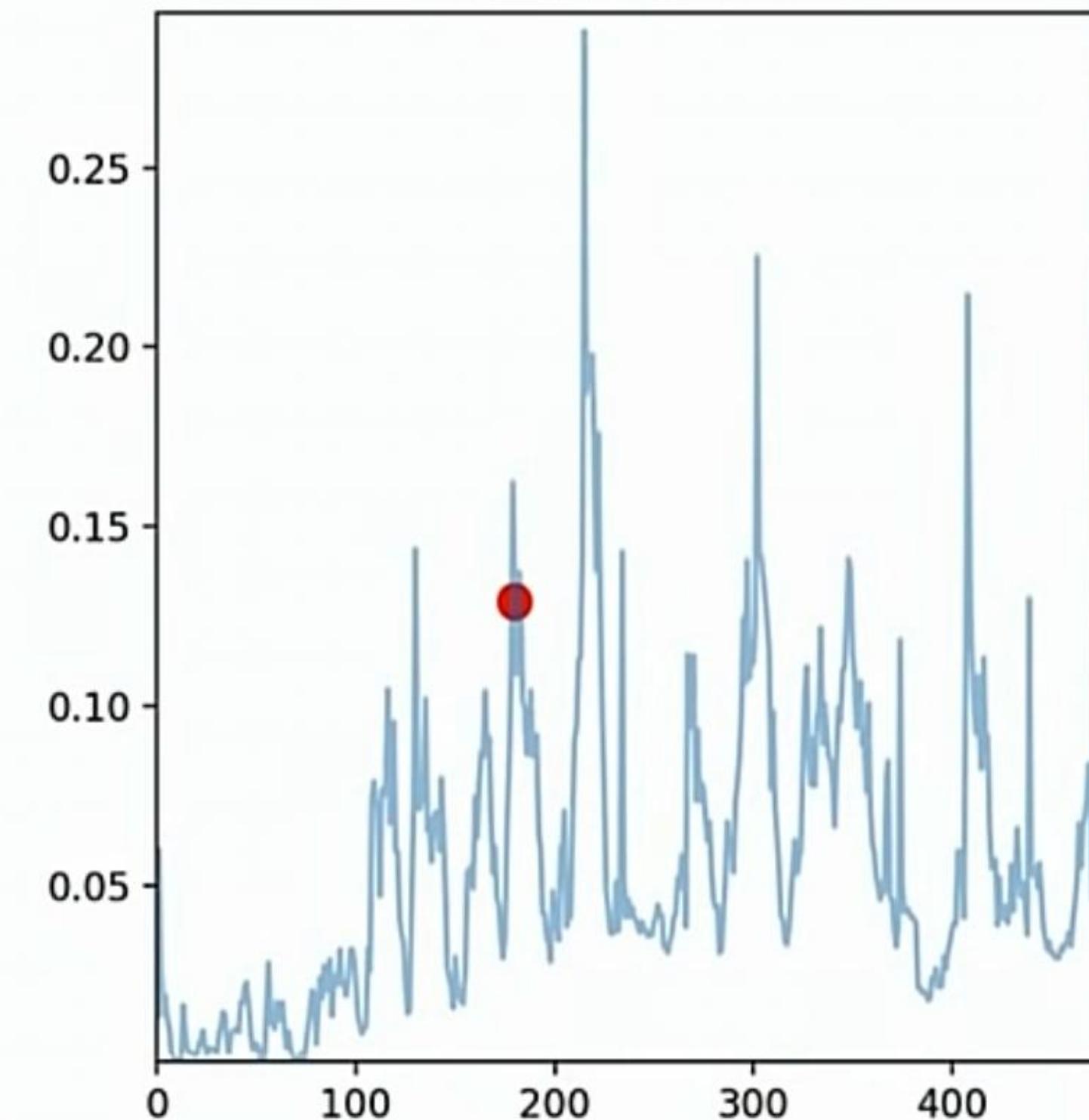
Mario



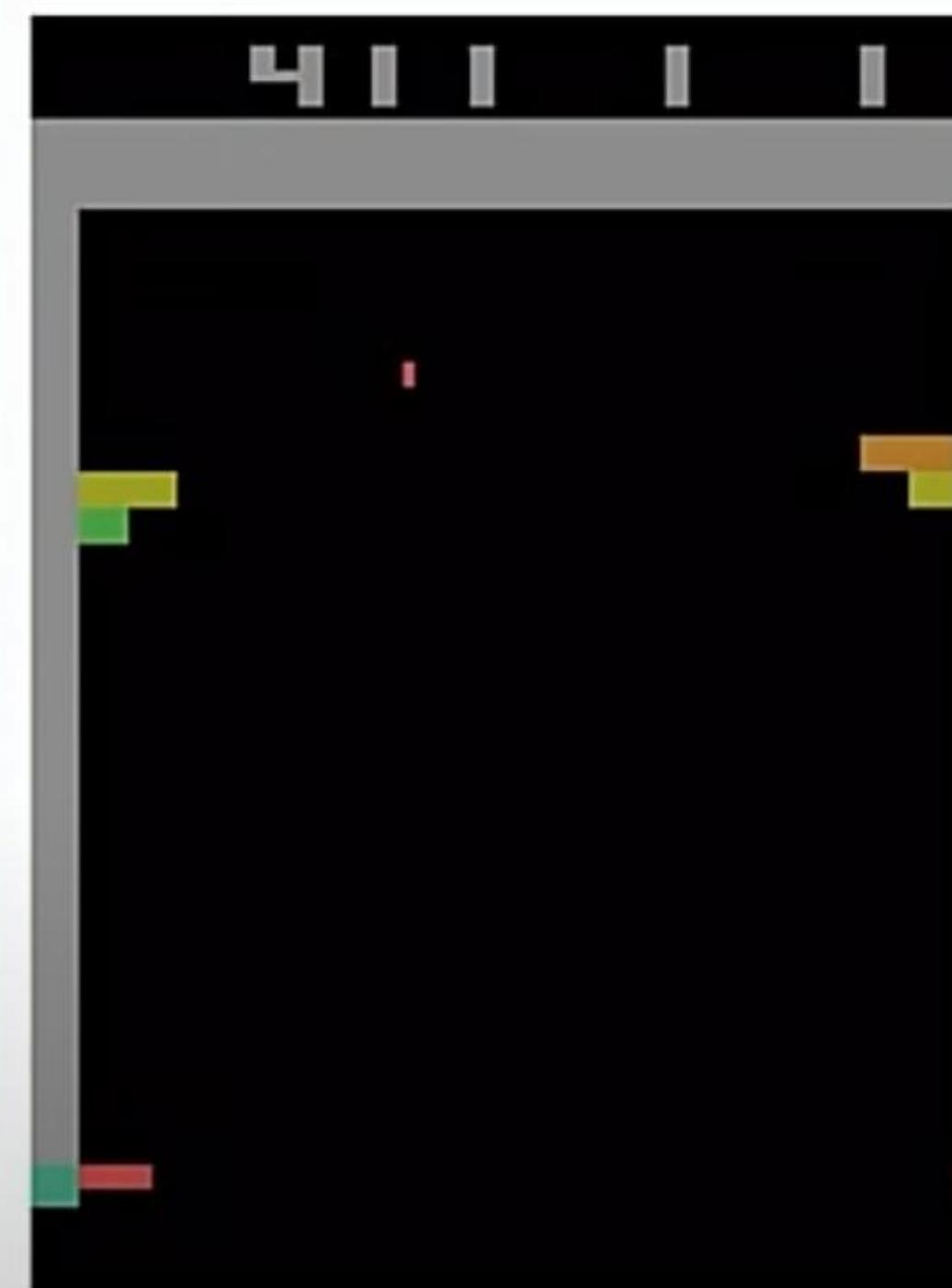
Curiosity early in training



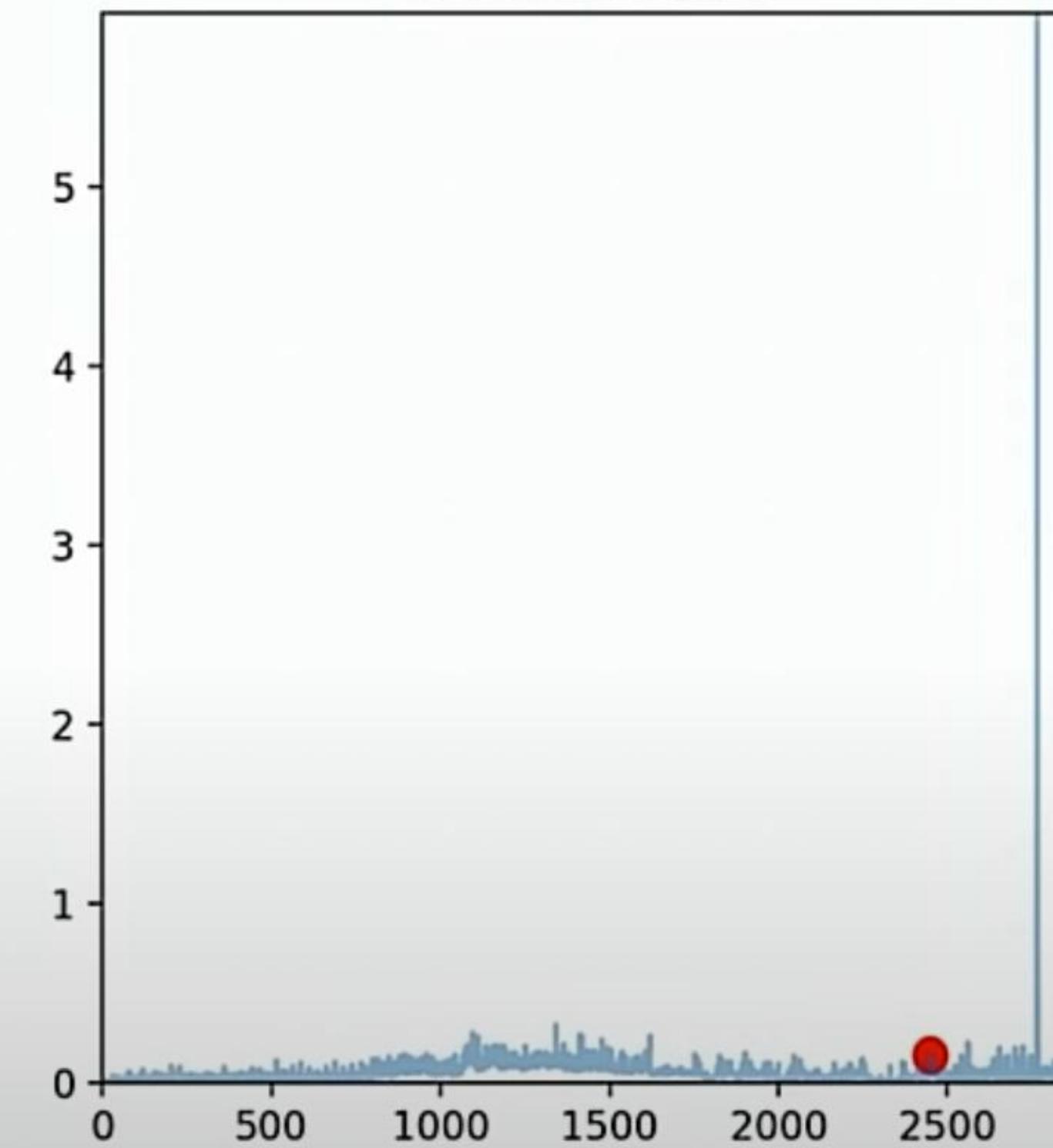
Intrinsic reward



Curiosity late in training



Intrinsic reward



The OpenAI Mission

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Impact of AGI

Generate massive wealth

Potential to end poverty, achieve material abundance

Impact of AGI

Generate massive wealth

Potential to end poverty, achieve material abundance

Generate science and technology

cure disease, extend life, superhuman healthcare

mitigate global warming, clean the oceans, etc

massively improve education and psychological well being

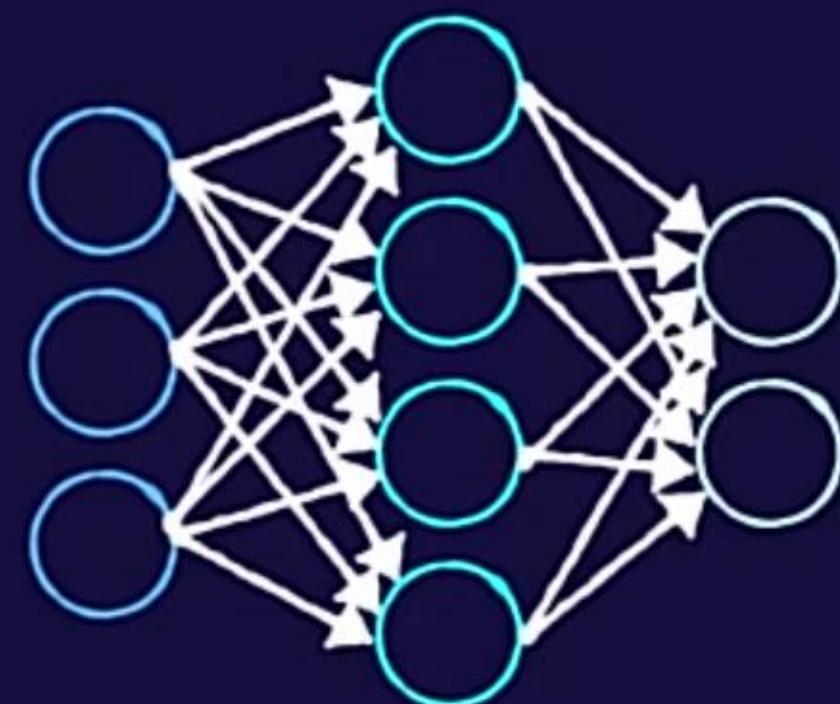
Why is OpenAI's mission relevant today?

We review progress in the field over the past 6 years

Our conclusion: near term AGI should be taken as a serious possibility

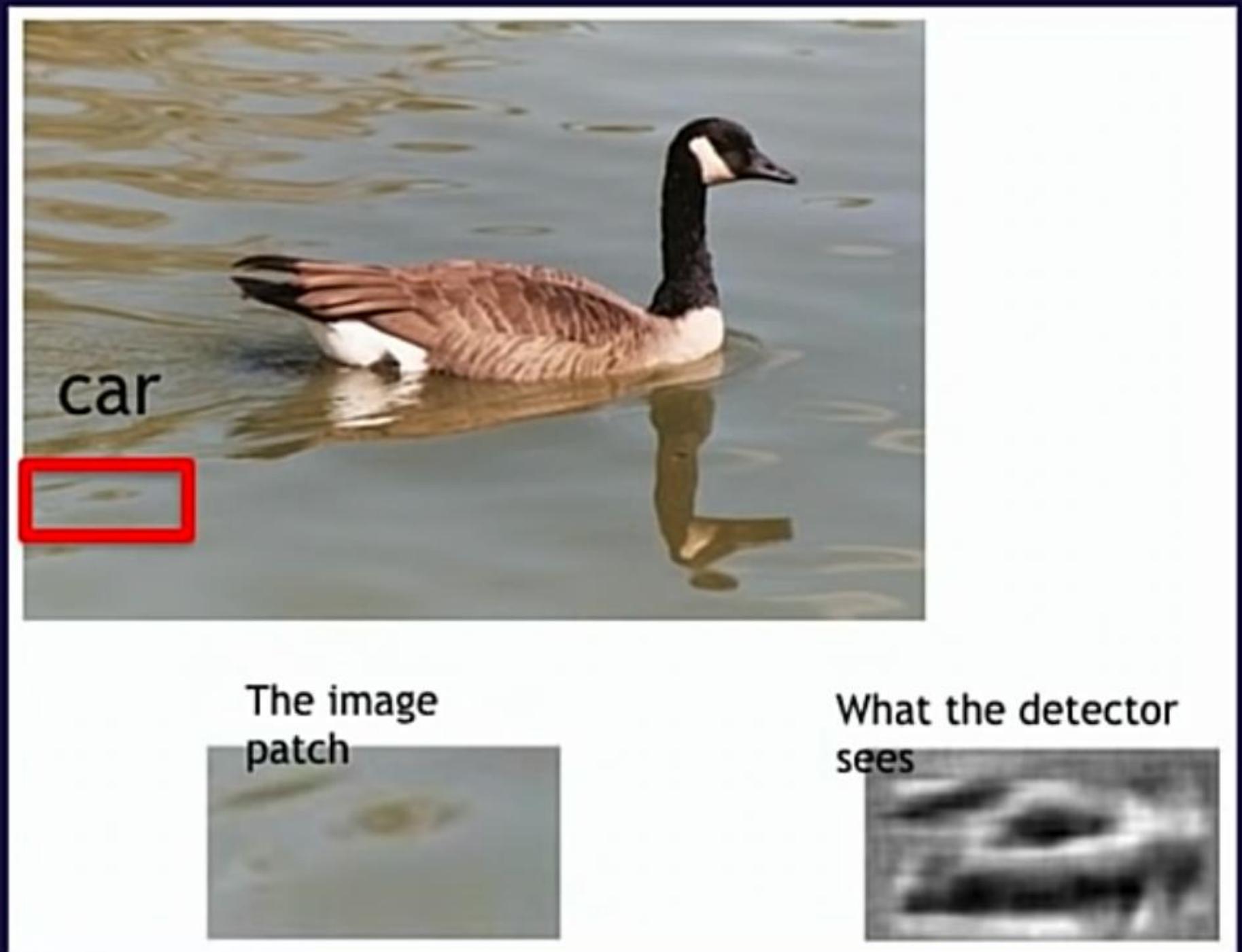
Deep Learning at the root of it all

During the past 6 years, deep learning repeatedly and rapidly broke through “insurmountable” barriers



A multilayered Perceptron
trainable with backpropagation

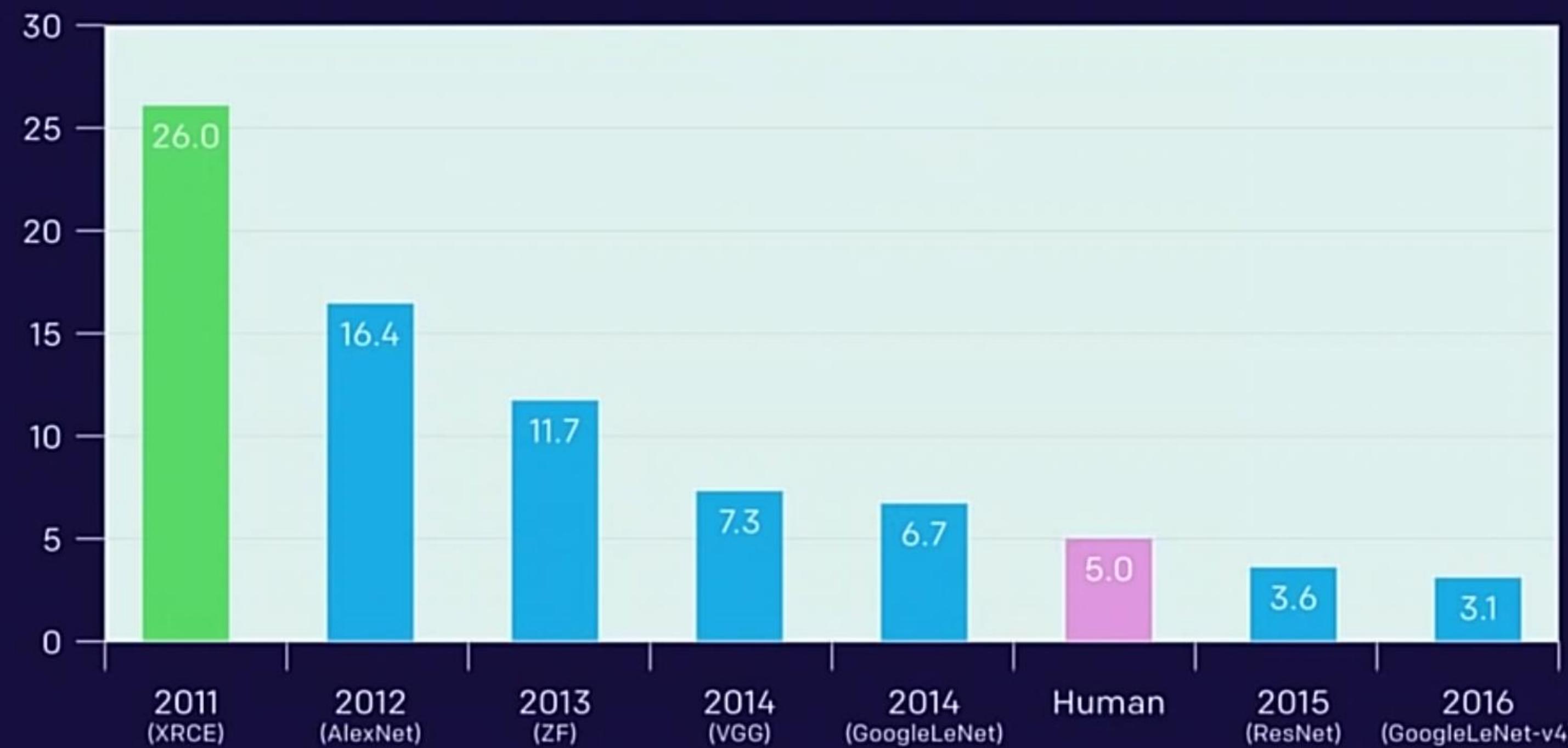
Vision (2012-2016)



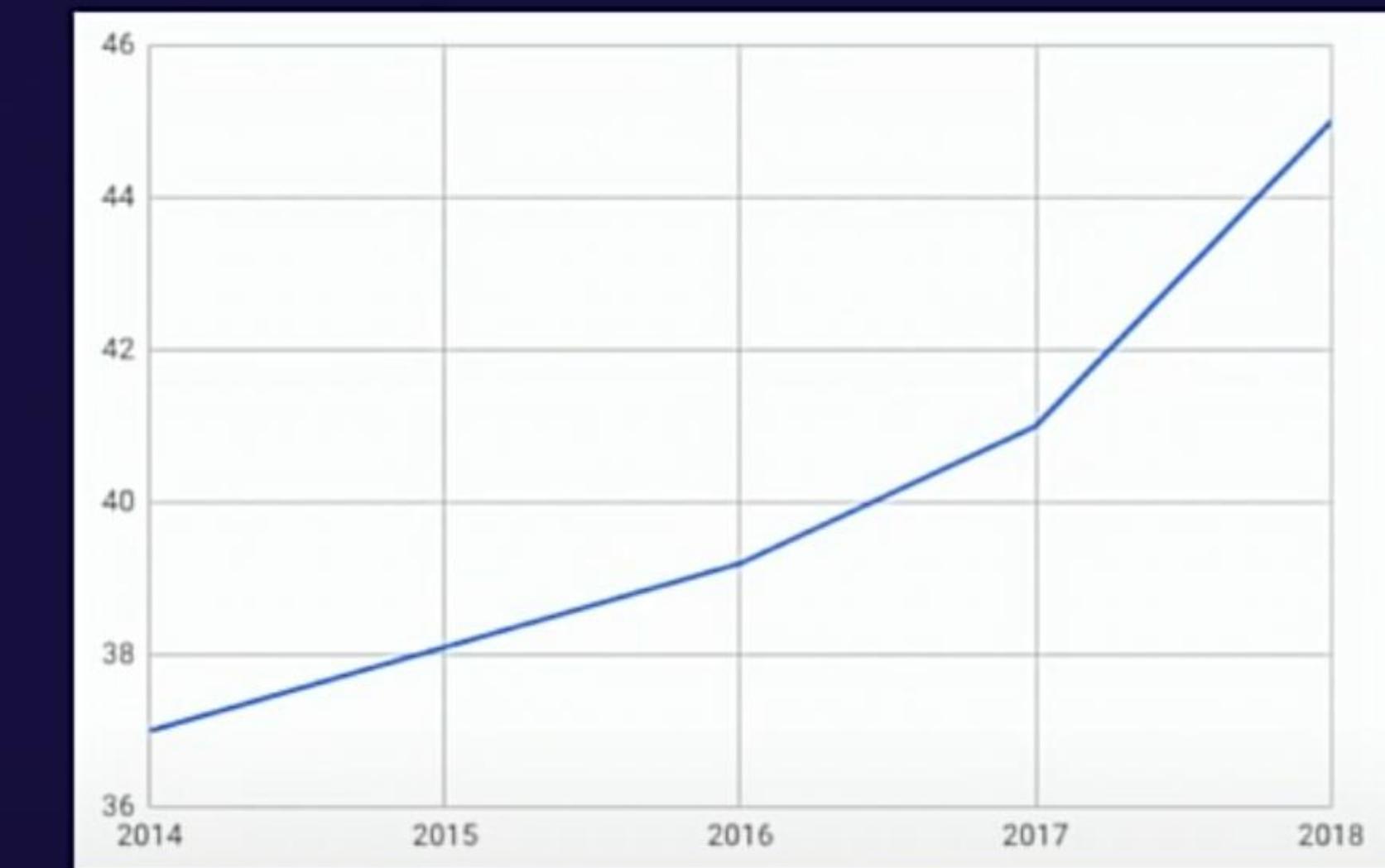
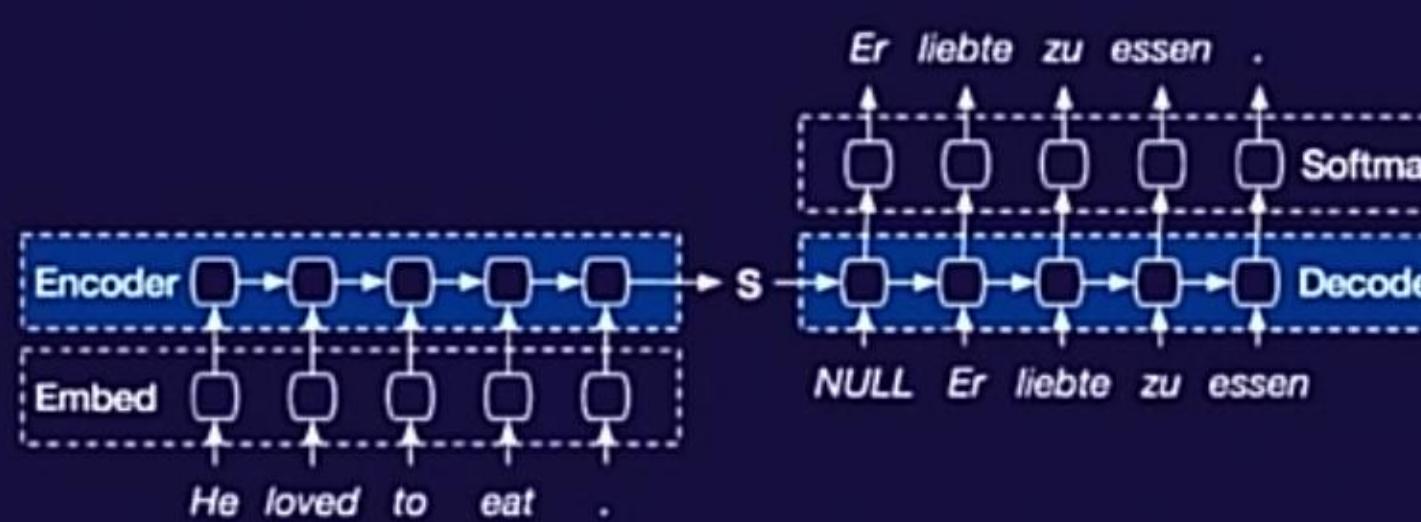
HOG feature (2005)—image by Antonio Torrabla

Vision (2012-2016)

ImageNet Classification Error (Top 5)



Translation (2014-2018)



BLEU score on EN to FR translation on the WMT dataset

Image generation (2014-2018)

GANs over the years: 2014

Goodfellow et al, 2014

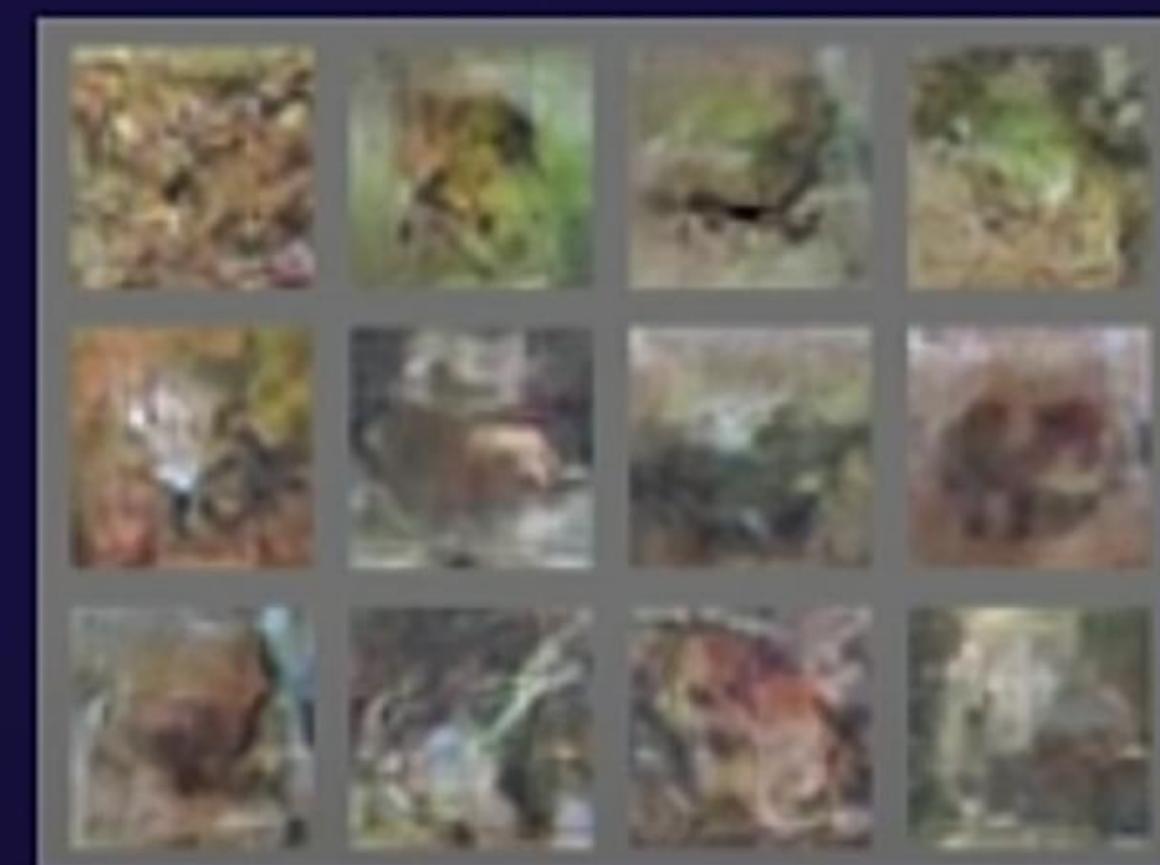


Image generation (2014-2018)

GANs over the years: 2015

Radford et al, 2015

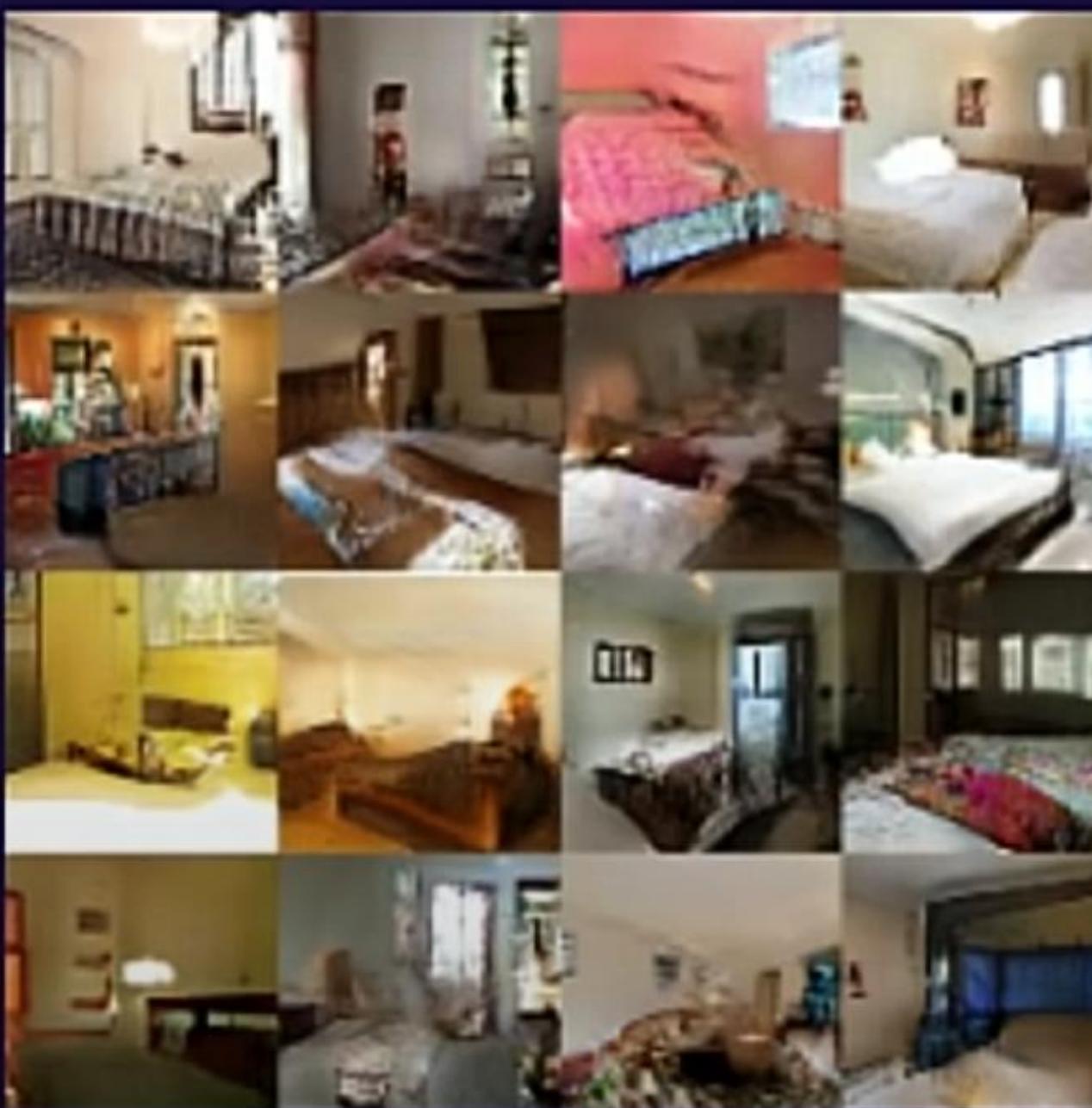


Image generation (2014-2018)

GANs over the years: 2017

Karras et al, 2017



Image generation (2014-2018)

GANs over the years: 2018

Brock et al, 2018



Reinforcement Learning (2013-2018)

DQN (2013)

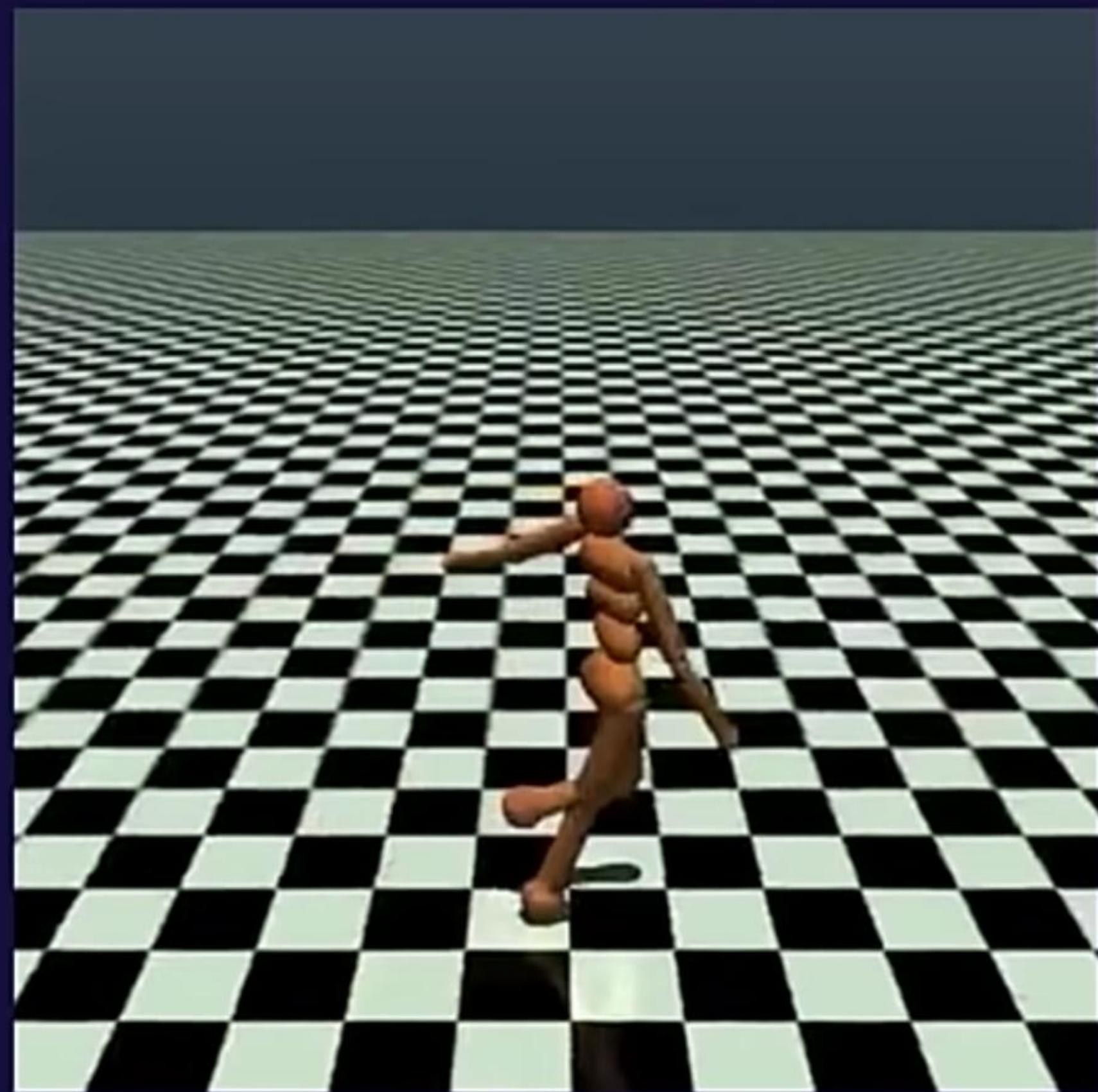


Mnih et al, 2013

Reinforcement Learning (2013-2018)

TRPO (2015)

Schulman et al, 2015



Reinforcement Learning (2013-2018)

AlphaGo (2016)

Silver et al, 2016



Reinforcement Learning (2013-2018)

OpenAI Five (2018)

Very large scale: +100,000 CPU cores, +1000 GPUs

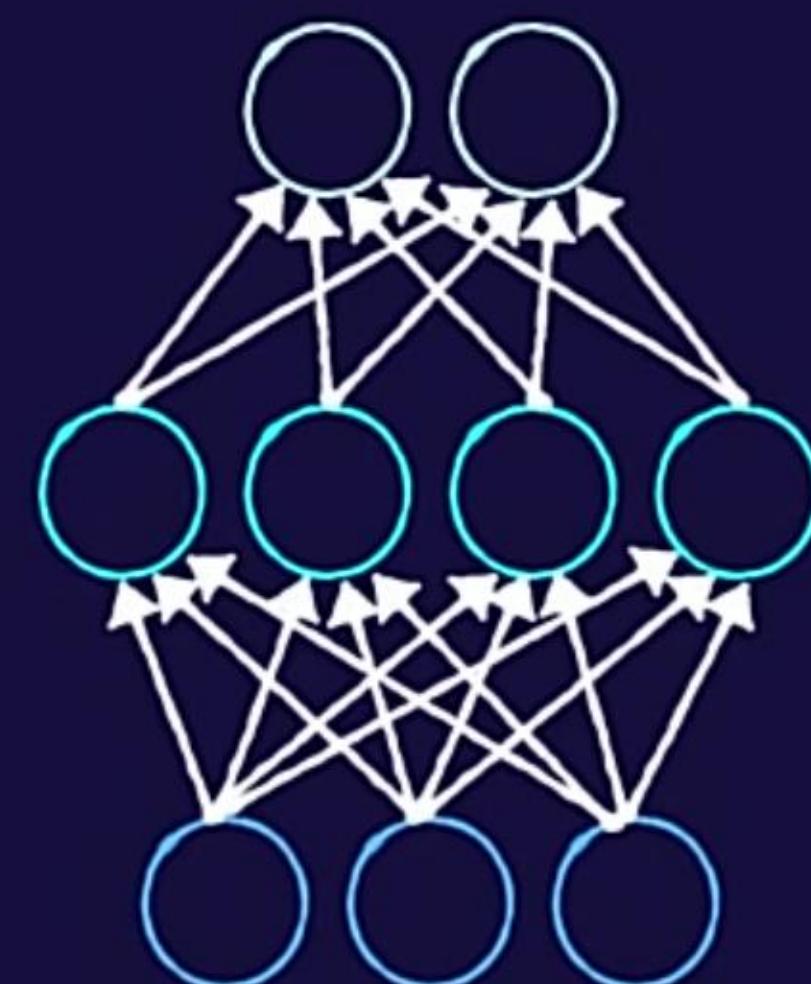


Compute grows rapidly

Neural networks can usefully consume all available compute

Neural networks are extremely parallelizable

300,000x increase in neural net compute used for the largest neural net experiments over the past 6 years





Formidable challenges remain

Unsupervised learning

Robust classification

Reasoning

Abstraction

???

We've been breaking through barriers for 6 years

Will this trend continue, or will it stop?

And if so, when?

THIS TALK'S GOAL IS TO PRESENT EVIDENCE THAT:

While highly uncertain,
near-term AGI should be taken
as a serious possibility.

Means proactively thinking about risks:

Machines pursuing goals misspecified by
their operator

Malicious humans subverting deployed systems

Out-of-control economy that grows without resulting
in improvements to human lives

