

COATUE

The Path to General-Purpose Robots

→ Sri Viswanath, Vibhor Khanna, Yijia Liang, Abhi Srinivas, Zach Cherian

July 2024

Disclaimer

THIS PRESENTATION DOES NOT CONSTITUTE AN OFFER TO SELL OR THE SOLICITATION OF ANY OFFER TO BUY AN INTEREST IN A FUND OR VEHICLE MANAGED BY COATUE MANAGEMENT, L.L.C. (“COATUE”).

ANY SUCH OFFER OR SOLICITATION WILL BE MADE ONLY AT THE TIME A QUALIFIED OFFEREE RECEIVES A CONFIDENTIAL PRIVATE OFFERING MEMORANDUM OR OTHER OFFERING DOCUMENT (“CPOM”) DESCRIBING THE OFFERING AND RELATED SUBSCRIPTION AGREEMENT.

IN THE CASE OF ANY INCONSISTENCY BETWEEN THE DESCRIPTIONS OR TERMS IN THIS PRESENTATION AND THE CPOM, THE CPOM SHALL CONTROL.

COATUE HAS PROVIDED THIS PRESENTATION SOLELY IN CONNECTION WITH ONGOING OR INTENDED DISCUSSIONS WITH THE PERSON TO WHOM IT HAS BEEN DELIVERED. IN THIS REGARD, THE PERFORMANCE FIGURES, AND CERTAIN OTHER INFORMATION INCLUDED IN THIS PRESENTATION, REQUIRE FURTHER EXPLANATION AND MUST BE DISCUSSED WITH YOUR COATUE REPRESENTATIVES. ACCORDINGLY, PROSPECTIVE INVESTORS SHOULD NOT RELY ON THE INFORMATION IN THIS PRESENTATION ABSENT SUCH DISCUSSIONS.

NO SECURITIES OR SERVICES SHALL BE OFFERED OR SOLD IN ANY JURISDICTION IN WHICH SUCH OFFER, SOLICITATION OR SALE WOULD BE UNLAWFUL UNTIL THE REQUIREMENTS OF THE LAWS OF SUCH JURISDICTION HAVE BEEN SATISFIED. WHILE ALL THE INFORMATION PREPARED IN THIS PRESENTATION IS BELIEVED TO BE ACCURATE, COATUE MAKES NO EXPRESS WARRANTY AS TO THE COMPLETENESS OR ACCURACY NOR CAN IT ACCEPT RESPONSIBILITY FOR ERRORS, APPEARING IN THE PRESENTATION. NEITHER COATUE NOR ITS AFFILIATES ASSUMES ANY DUTY TO UPDATE THE INFORMATION CONTAINED HEREIN FOR SUBSEQUENT CHANGES OF ANY KIND AND THERE IS NO ASSURANCE THAT THE POLICIES, STRATEGIES OR APPROACHES DISCUSSED HEREIN WILL NOT CHANGE.

ANY PROJECTIONS, MARKET OUTLOOKS OR ESTIMATES IN THIS PRESENTATION ARE FORWARD-LOOKING STATEMENTS AND ARE BASED UPON CERTAIN ASSUMPTIONS. OTHER EVENTS WHICH WERE NOT TAKEN INTO ACCOUNT MAY OCCUR AND MAY SIGNIFICANTLY AFFECT INVESTMENT RETURNS OR PERFORMANCE.

ANY PROJECTIONS, OUTLOOKS OR ASSUMPTIONS SHOULD NOT BE CONSTRUED TO BE INDICATIVE OF THE ACTUAL EVENTS WHICH WILL OCCUR. HISTORICAL RETURNS ARE NOT PREDICTIVE OF FUTURE RESULTS.

THE INFORMATION PROVIDED HEREIN, INCLUDING, WITHOUT LIMITATION, INVESTMENT STRATEGIES, INVESTMENT RESTRICTIONS AND PARAMETERS, PROCEDURES, POLICIES, AND INVESTMENT AND OTHER PERSONNEL MAY BE CHANGED, MODIFIED, TERMINATED OR SUPPLEMENTED AT ANY TIME, WITHOUT NOTICE.

THIS PRESENTATION IS CONFIDENTIAL AND NOT INTENDED FOR PUBLIC USE OR DISTRIBUTION. THIS PRESENTATION HAS NOT BEEN APPROVED BY THE U.S. SECURITIES AND EXCHANGE COMMISSION OR ANY OTHER FEDERAL OR STATE REGULATOR.

YOU SHOULD CAREFULLY READ THE IMPORTANT DISCLOSURES IN THE APPENDIX.

Key Topics

→ **1. Past & Present: Where is Robotics Today?**

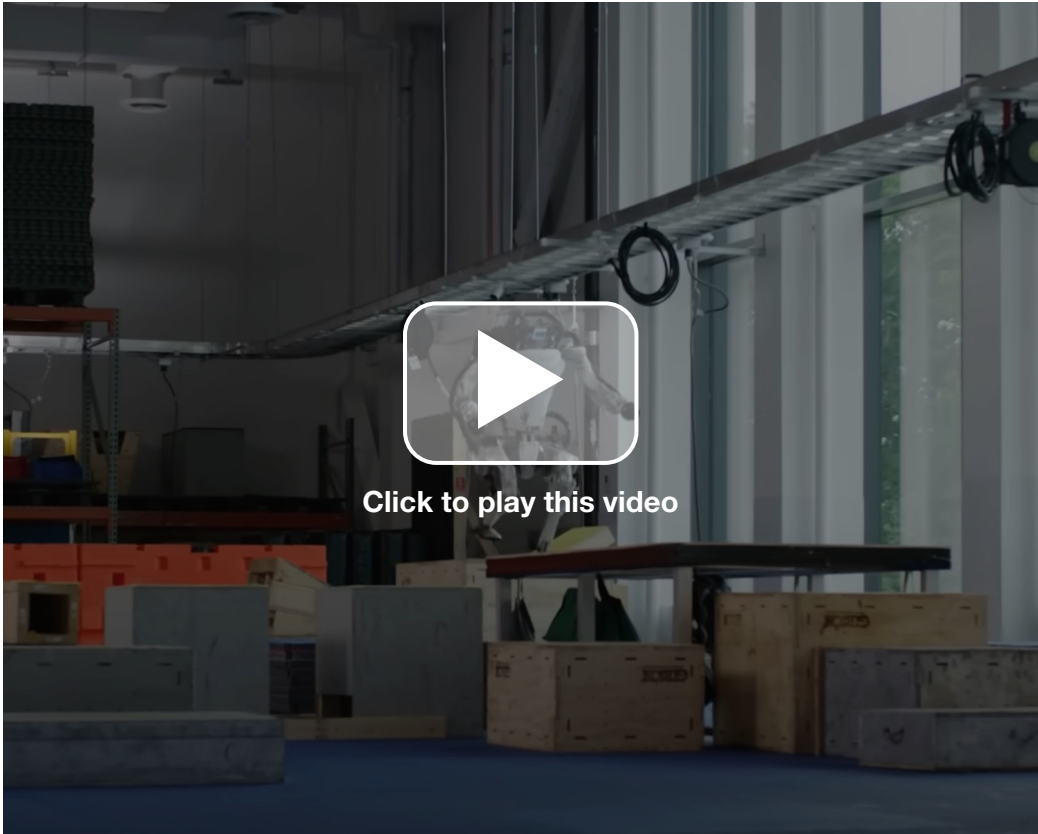
→ 2. The Dawn of a New Era: General-Purpose Robots

→ 3. When is the ChatGPT Moment for Robotics?

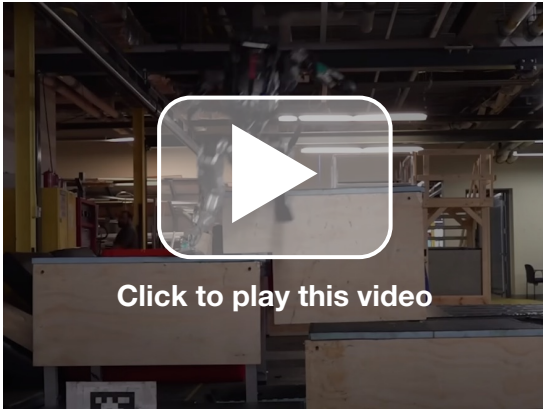
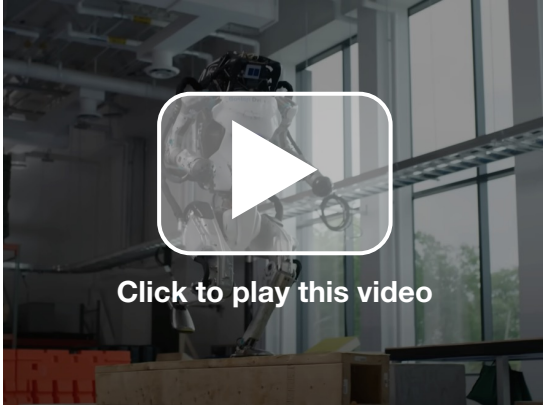
→ 4. Future: A Thriving Robotics Ecosystem

The 'curse' of robotics today: demos are not always reality

Robots get it right for a demo...



...after failing many times!



Robots have been in the field for decades

1961

First industrial robot,
delivered to GM

20 humans

Equivalent estimated
output of “Unimate”
robot in factory welding



Home robots have been around 50+ years for niche use cases

1958

First automatic pool cleaner developed



2014

Grillbot automated grill cleaner announced



2002

Roomba vacuum cleaner launched



2020

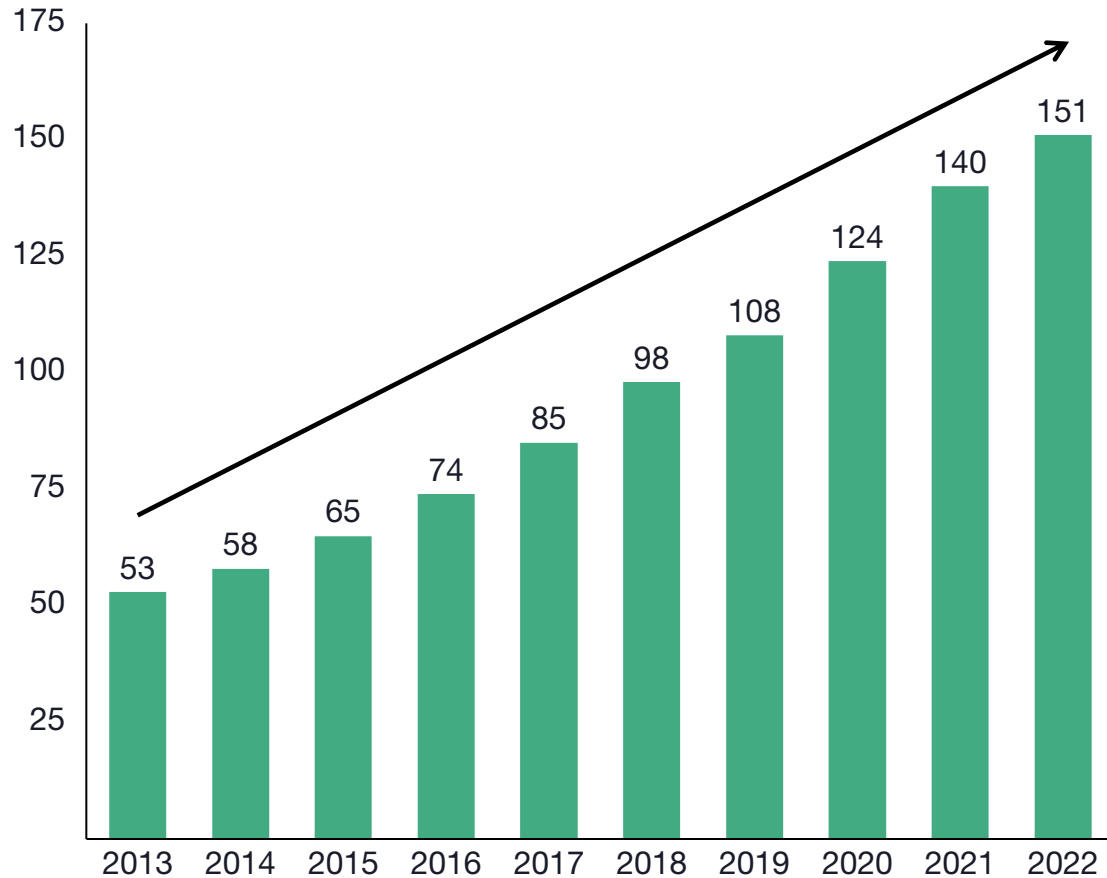
Unitree A1 robot dog launched



Robotics adoption has been linear historically

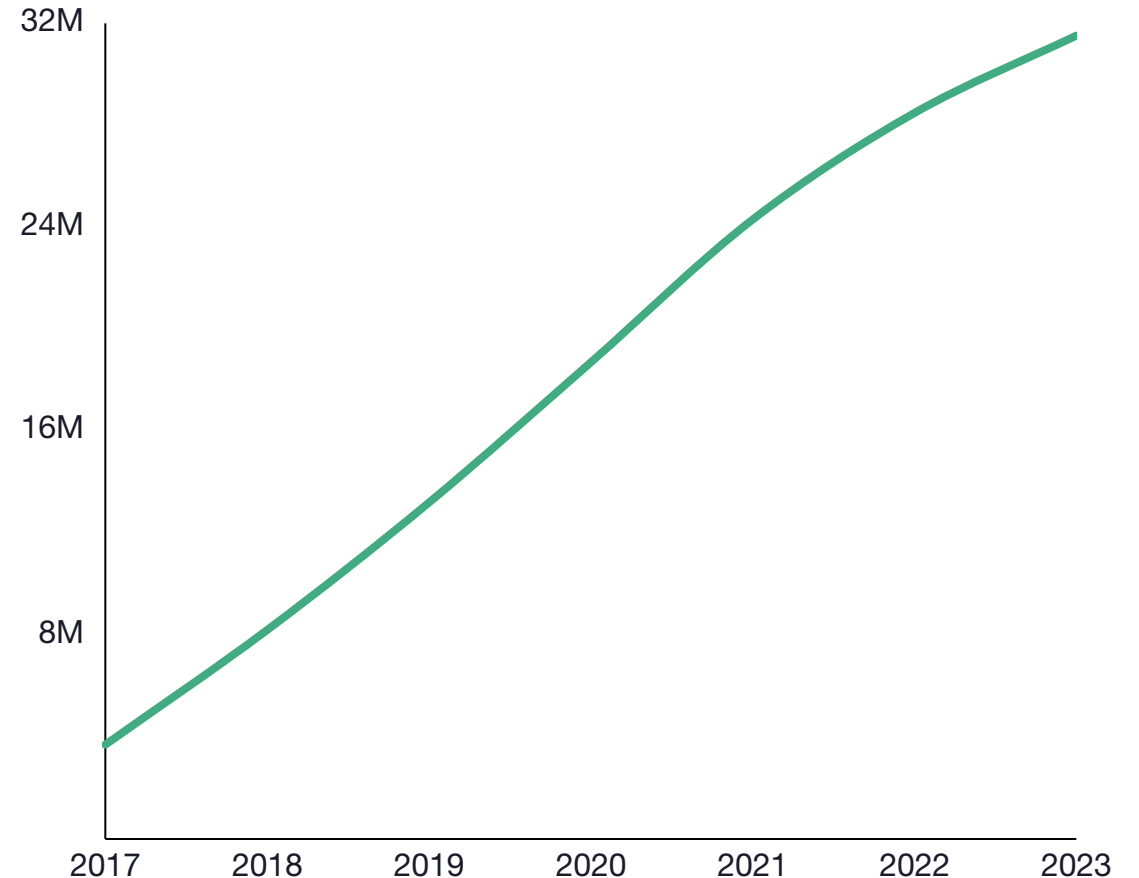
Industrial Robots

Industrial robots per 10,000 manufacturing FTE



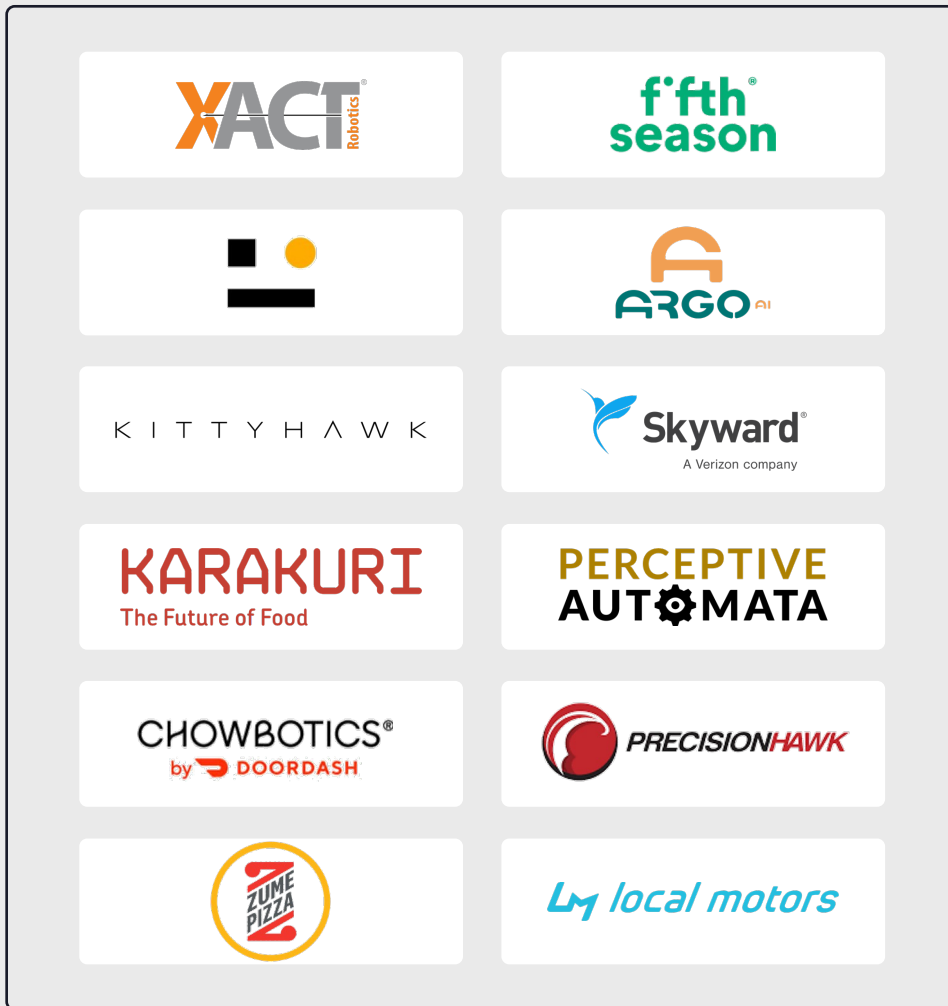
Home Robots

iRobot cumulative shipments



Many robotics startups struggled with commercialization and cost

Examples of robotics projects that wound down operations in 2022-2023



Possible factors that led to failure

1

Struggled to bring useful robot to market

2

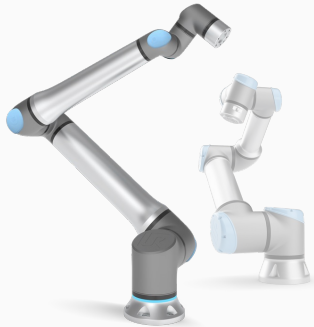
Difficulty finding early adopters in core segments

3

Tough unit economics given high upfront CapEx

Robot hardware has been rapidly developing across form factors

Collaborative & Traditional Industrial



1M+

Shipped in 2021-2022

Autonomous Mobile



120K+

Shipped in 2022

Drones



1M+

Drone deliveries in 2023

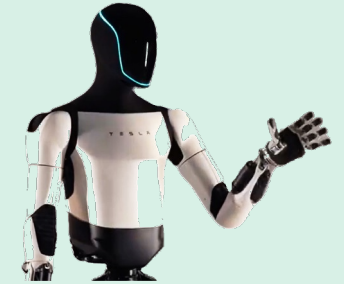
Quadrupeds



\$3K

Quadruped robot
starting price in 2024

Humanoids



20+

Companies building
humanoid robots from
2013 - present

We believe the path to general-purpose robotics is AI

→ Available now

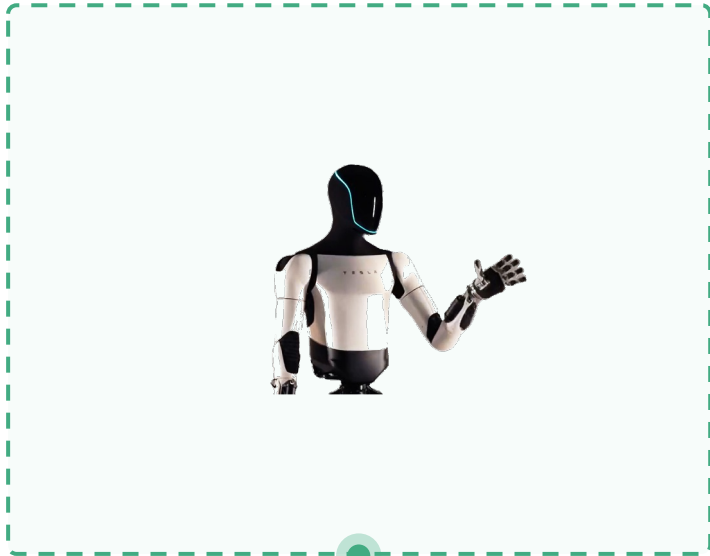
Single-Purpose Robots



Pre-programmed for specific tasks

→ Coming soon

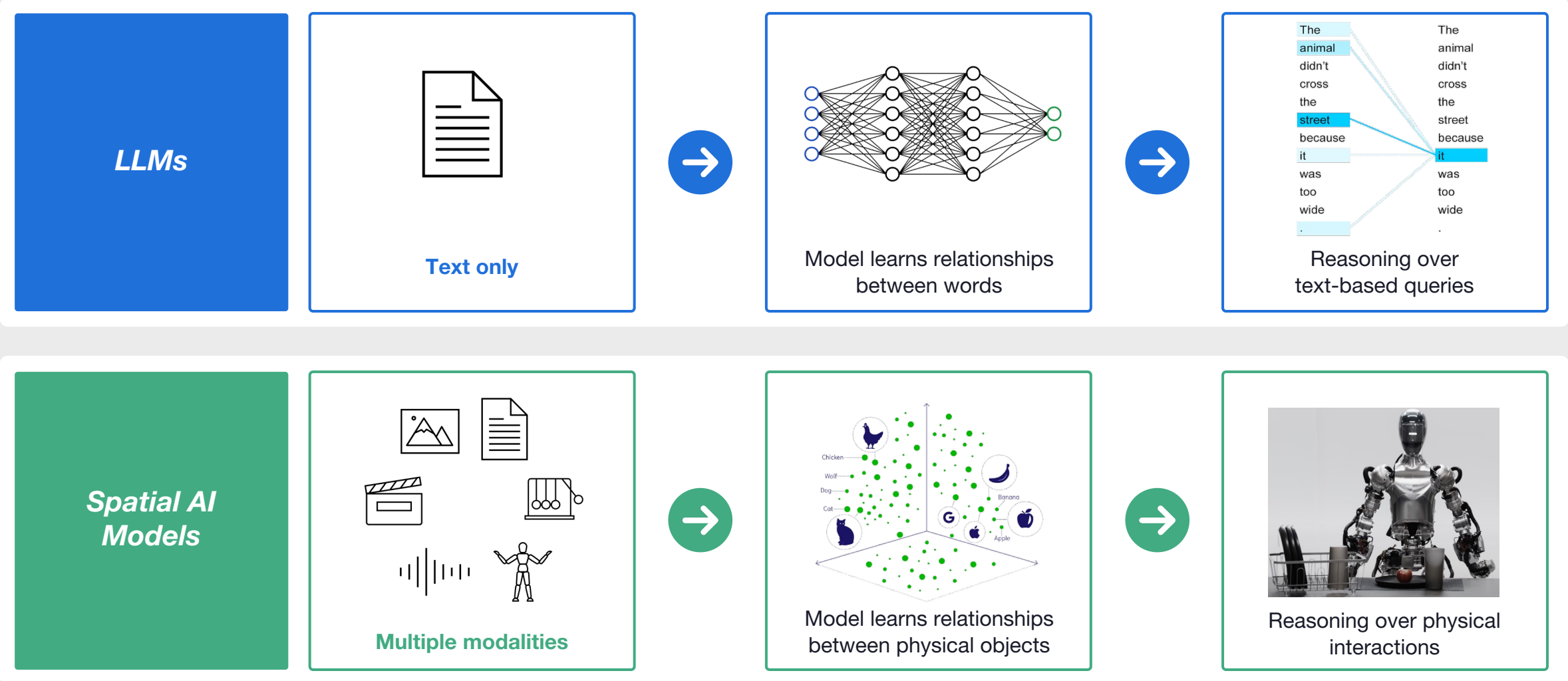
General-Purpose Robots



Adaptive learning for many tasks and situations

We expect spatial AI models to accelerate generalizability

→ As LLMs enable language reasoning, spatial AI models enable physical world reasoning



Key Topics

→ 1. Past & Present: Where is Robotics Today?

→ **2. The Dawn of a New Era: General-Purpose Robots**

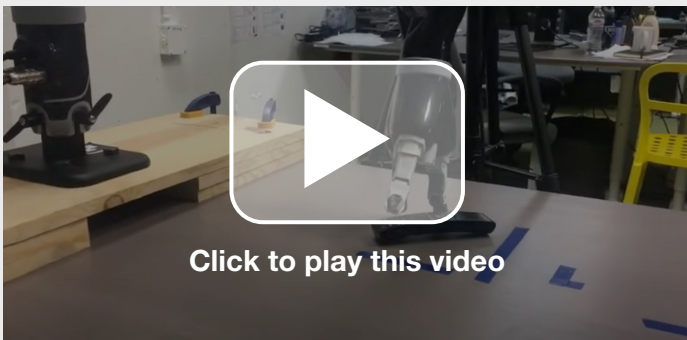
→ 3. When is the ChatGPT Moment for Robotics?

→ 4. Future: A Thriving Robotics Ecosystem

Many tasks that are easy for humans are hard for robots

1

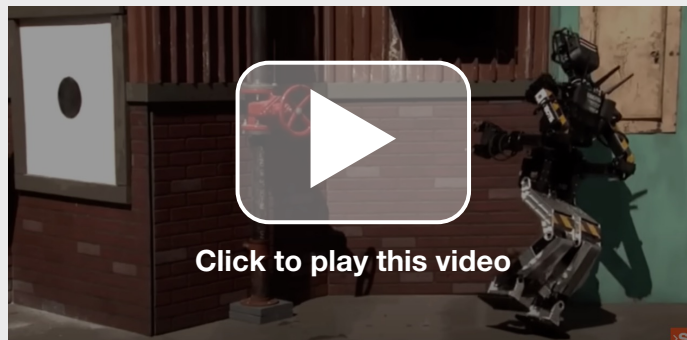
Dexterity



Click to play this video

2

Spatial Awareness



Click to play this video





3

Recovery



Click to play this video

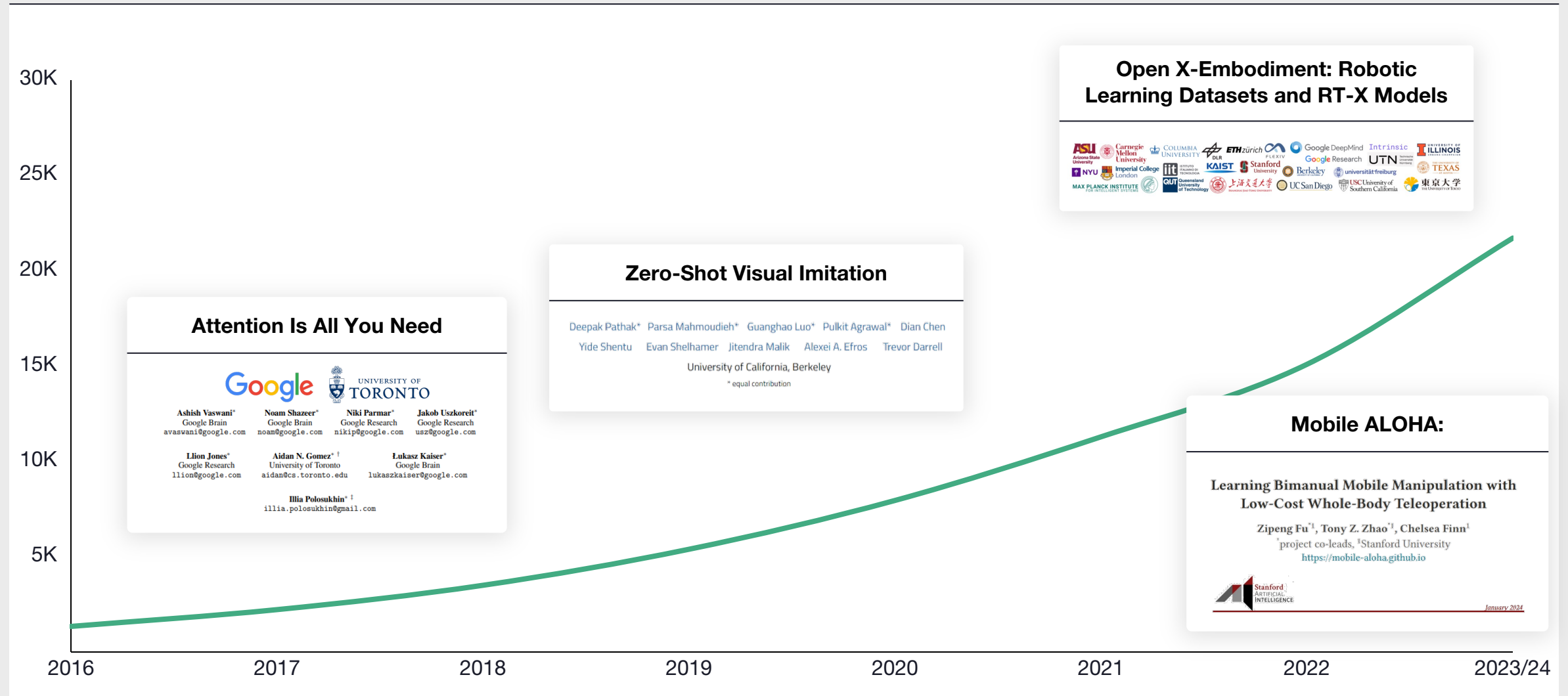
Data scarcity is currently a major bottleneck for robotics AI

Modality	Largest Dataset Size	Example AI Models
Text	15T Tokens	 OpenAI GPT-4
Image	6B Image-Text Pairs	 Midjourney
Video	2.6B Audio/Visual Features	 runway
Robotics	2.4M Episodes	

Not enough for
general-purpose
AI model

Open research has accelerated progress

→ Research publications in robotics, showing select examples



Several data collection approaches are promising: Teleoperation

Teleoperation

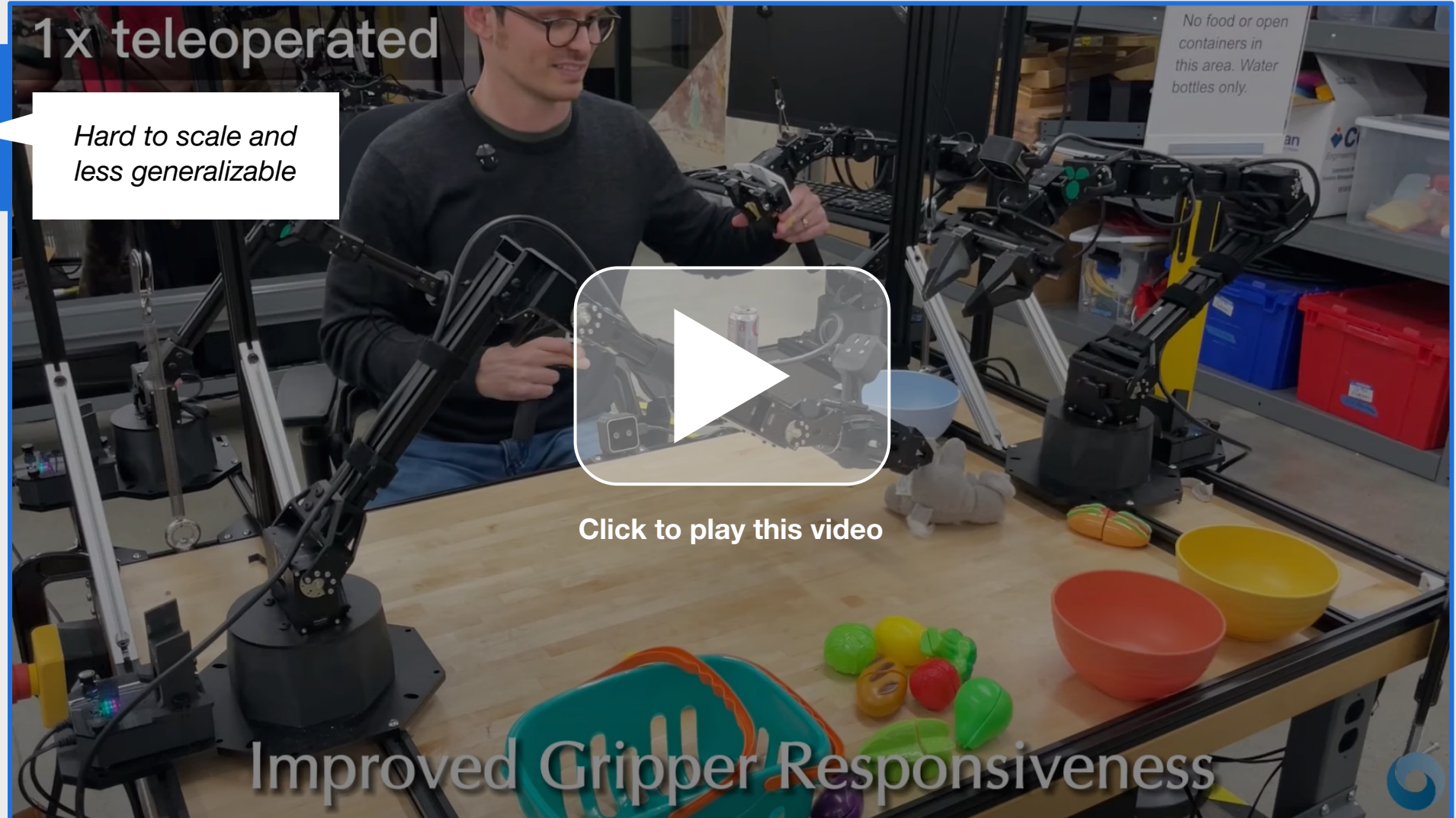
1x teleoperated

Hard to scale and less generalizable

AR Data

Simulation

Video Learning



Improved Gripper Responsiveness

Several data collection approaches are promising: AR Data

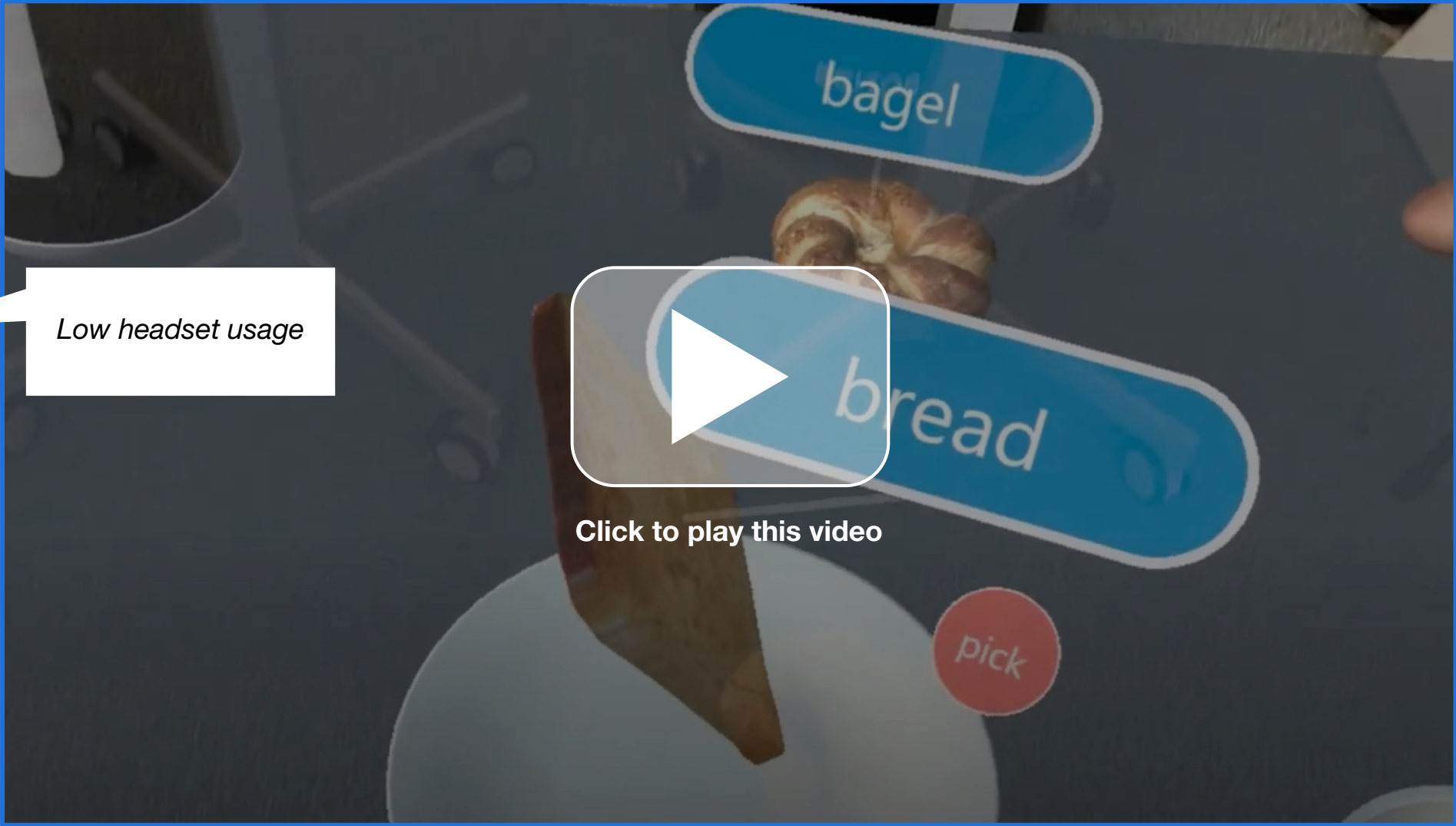
Teleoperation

AR Data

Low headset usage

Simulation

Video Learning



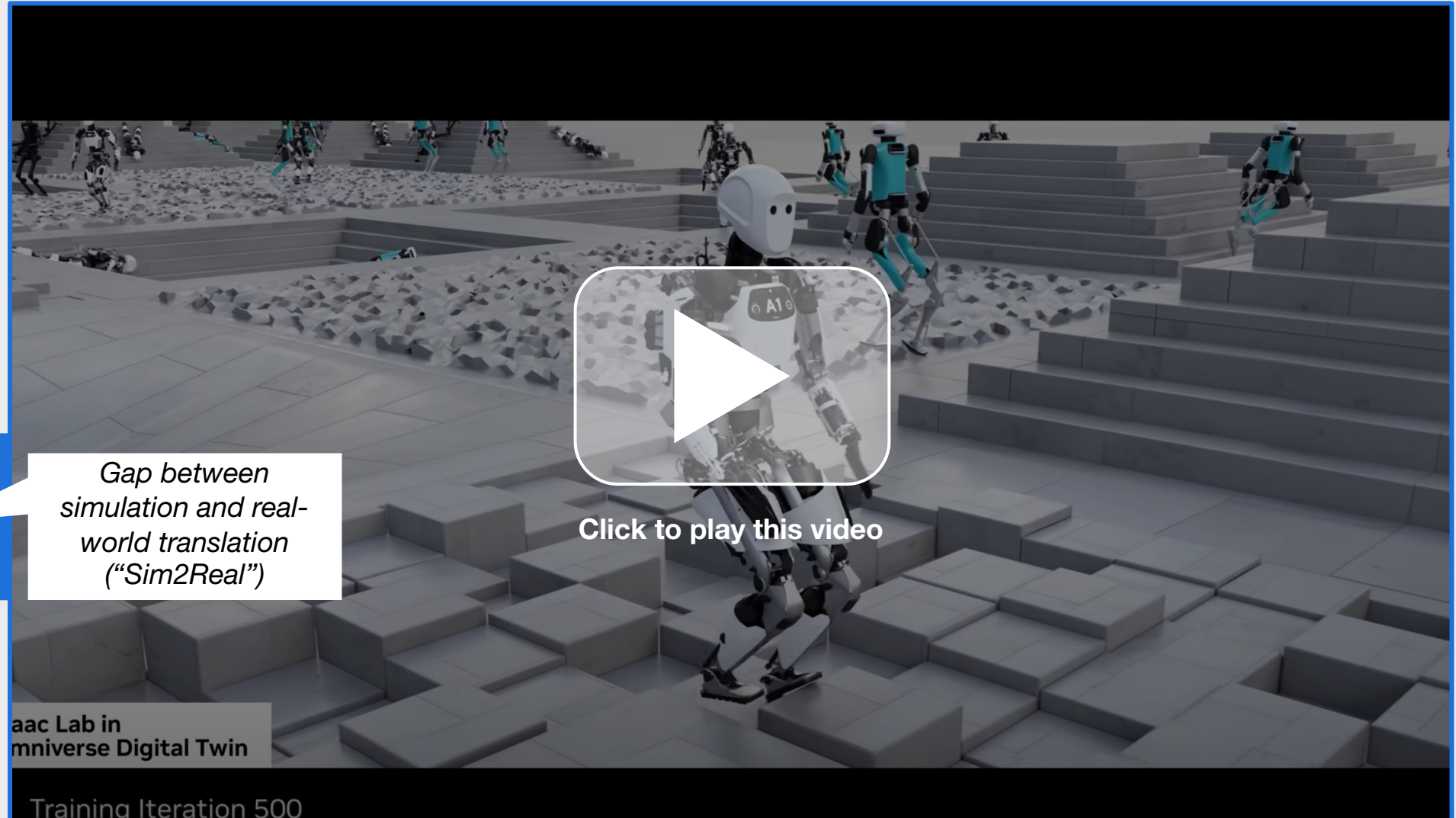
Several data collection approaches are promising: Simulation

Teleoperation

AR Data

Simulation

Video Learning



Gap between simulation and real-world translation ("Sim2Real")

Click to play this video

Several data collection approaches are promising: Video Learning

Teleoperation

AR Data

Simulation

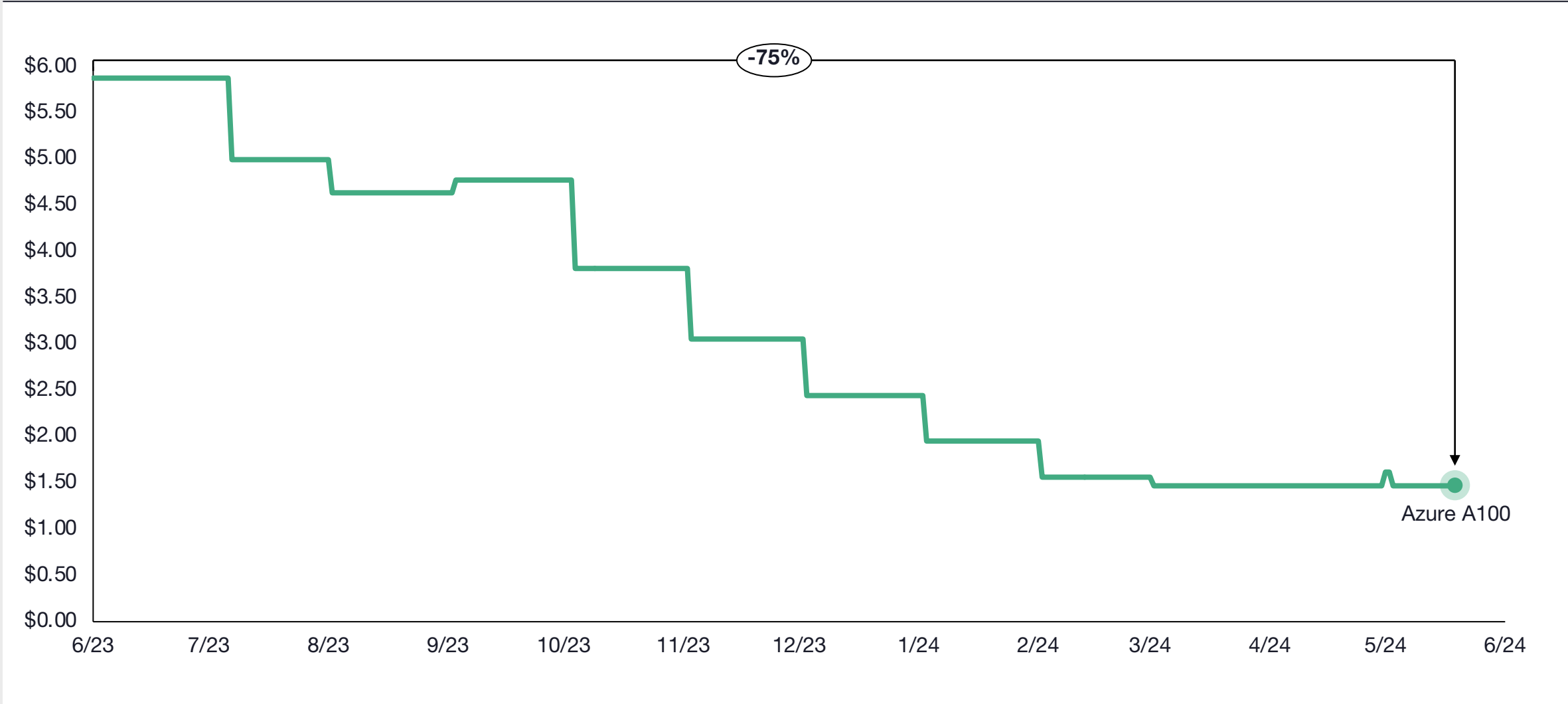
Video Learning



In early research

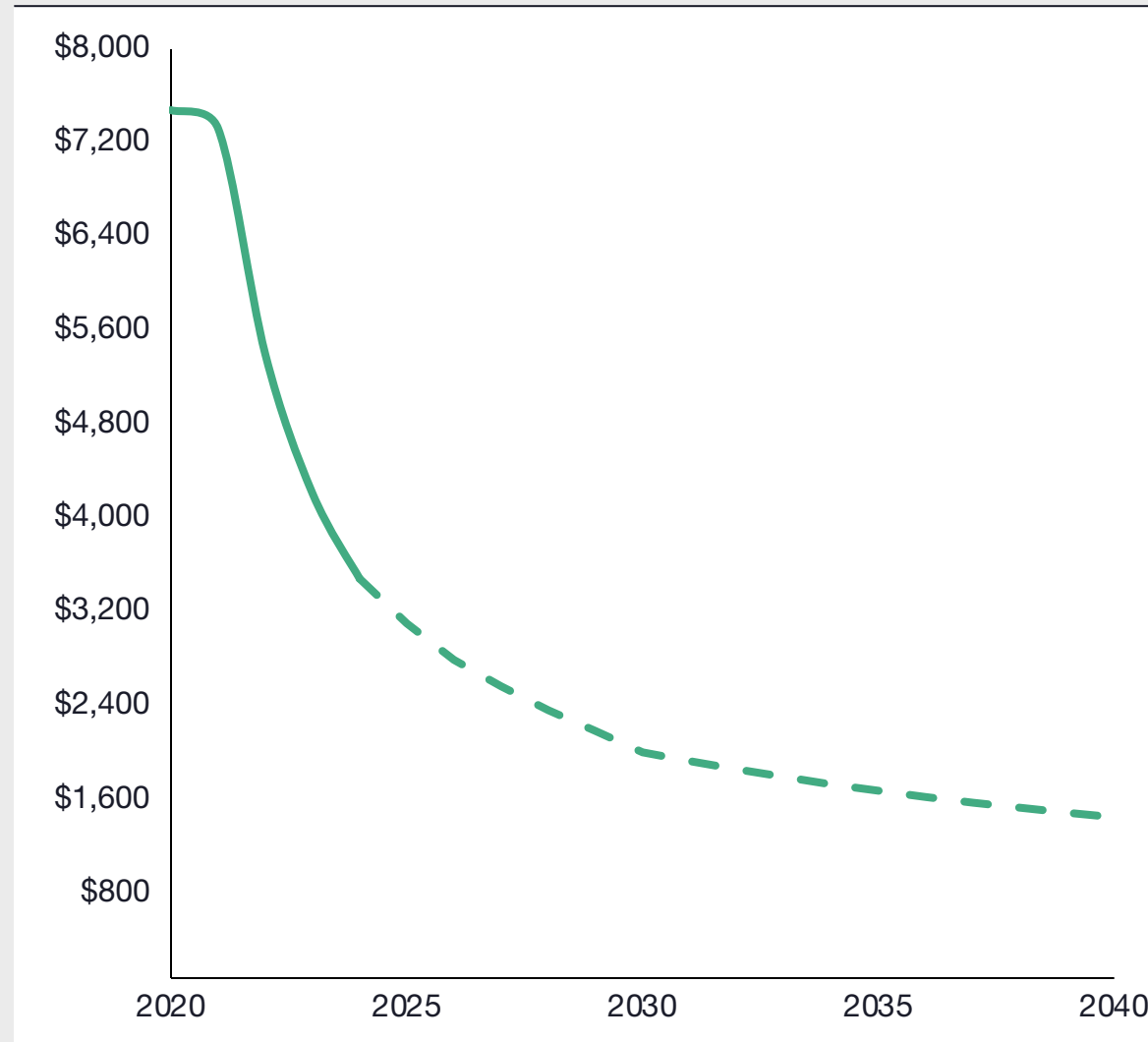
GPU costs have dropped, leading to cheaper model training

→ A100 spot pricing on Azure (\$/hr)

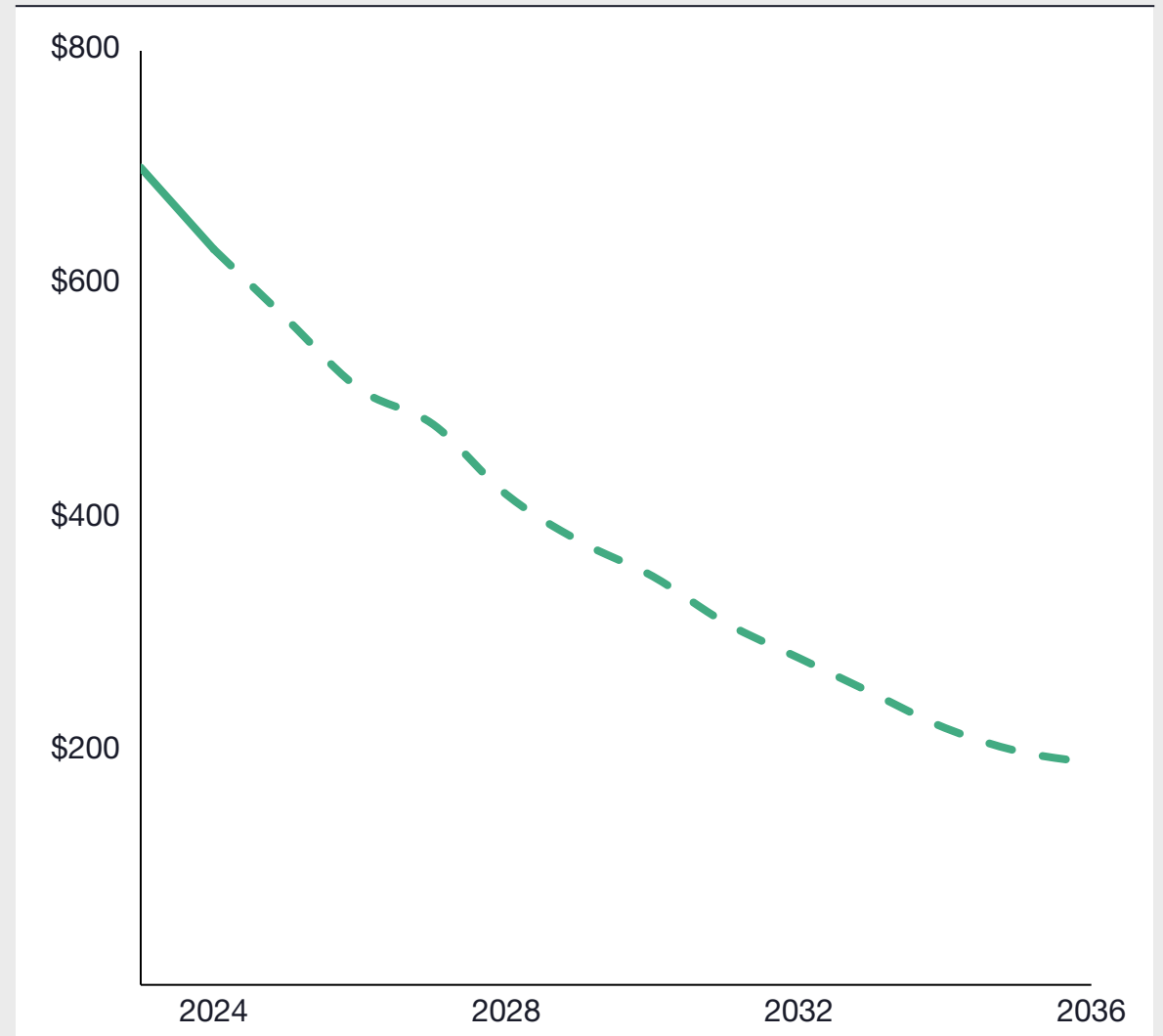


Robot components are expected to get cheaper

→ **L3 LiDAR sensor costs**

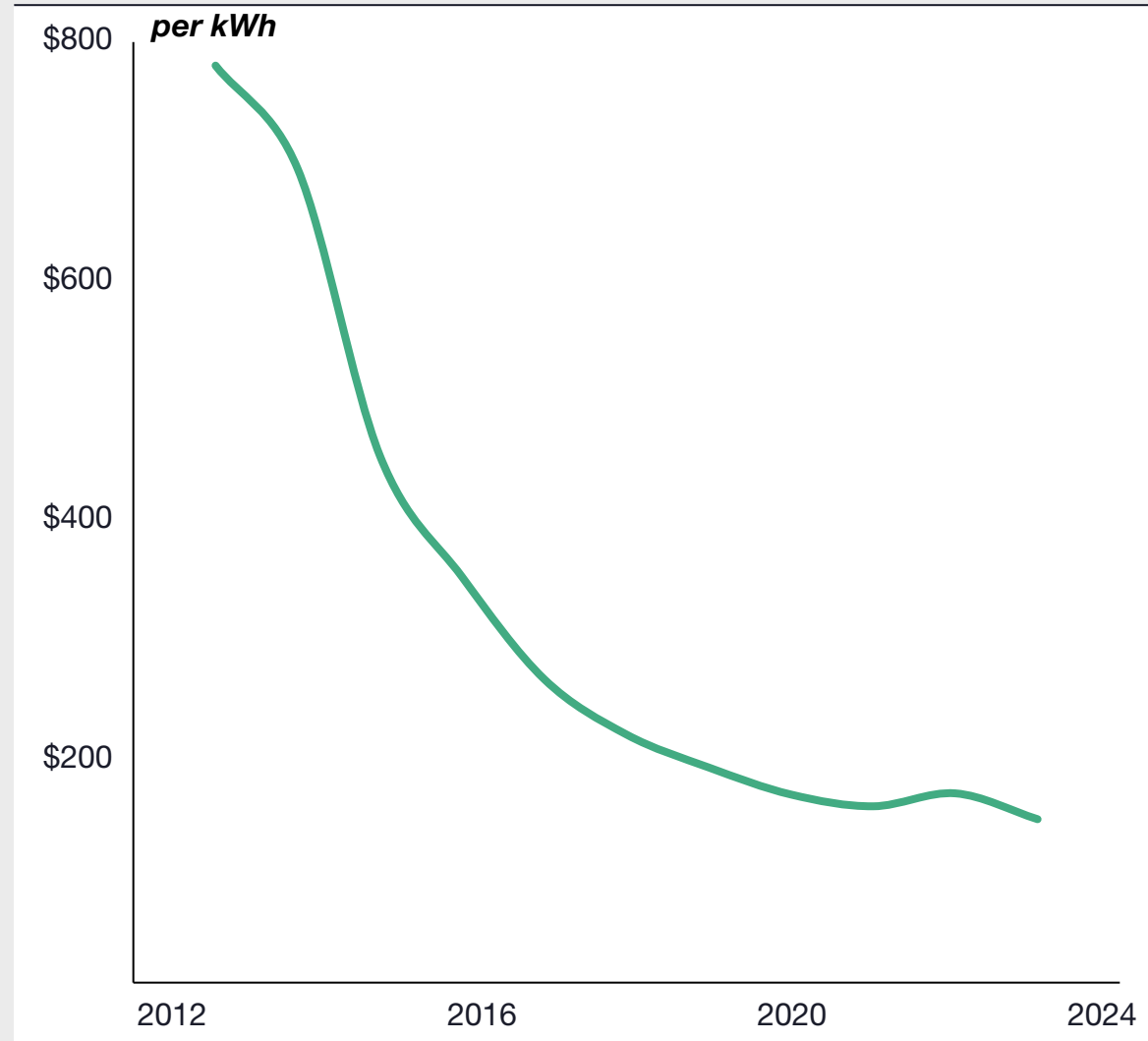


→ **Humanoid coreless motor costs**

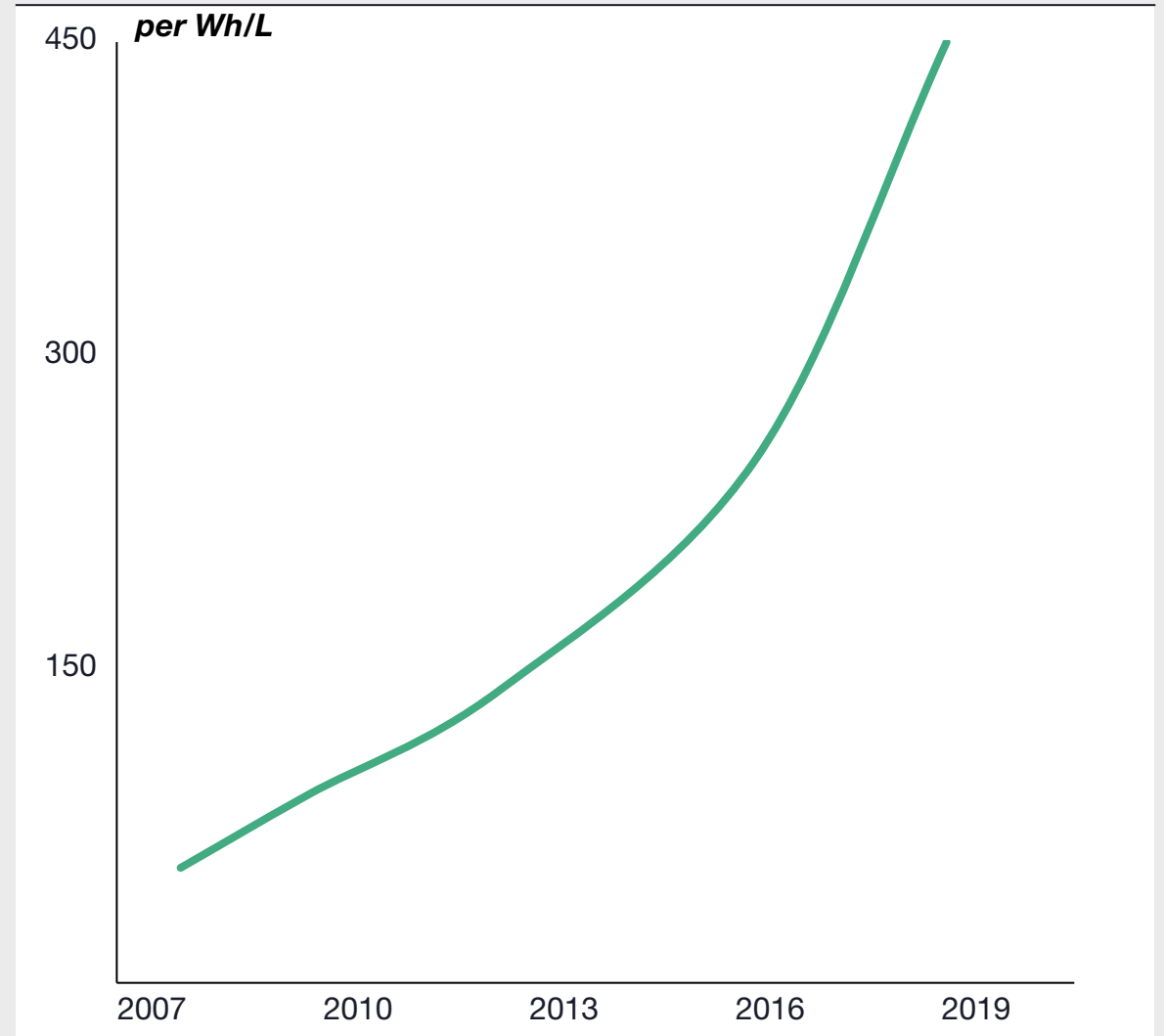


Robot components have gotten better

→ **Battery cost**

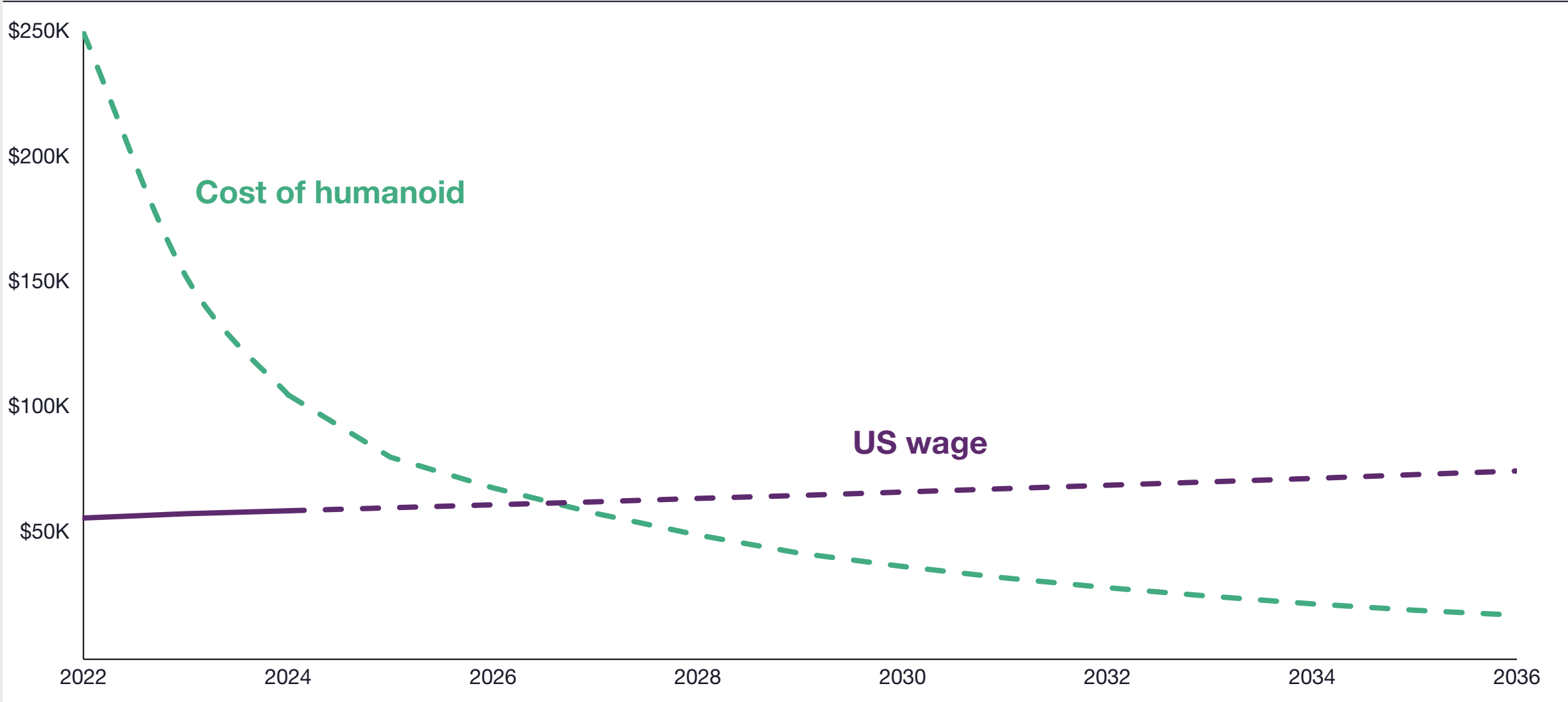


→ **Battery energy density**



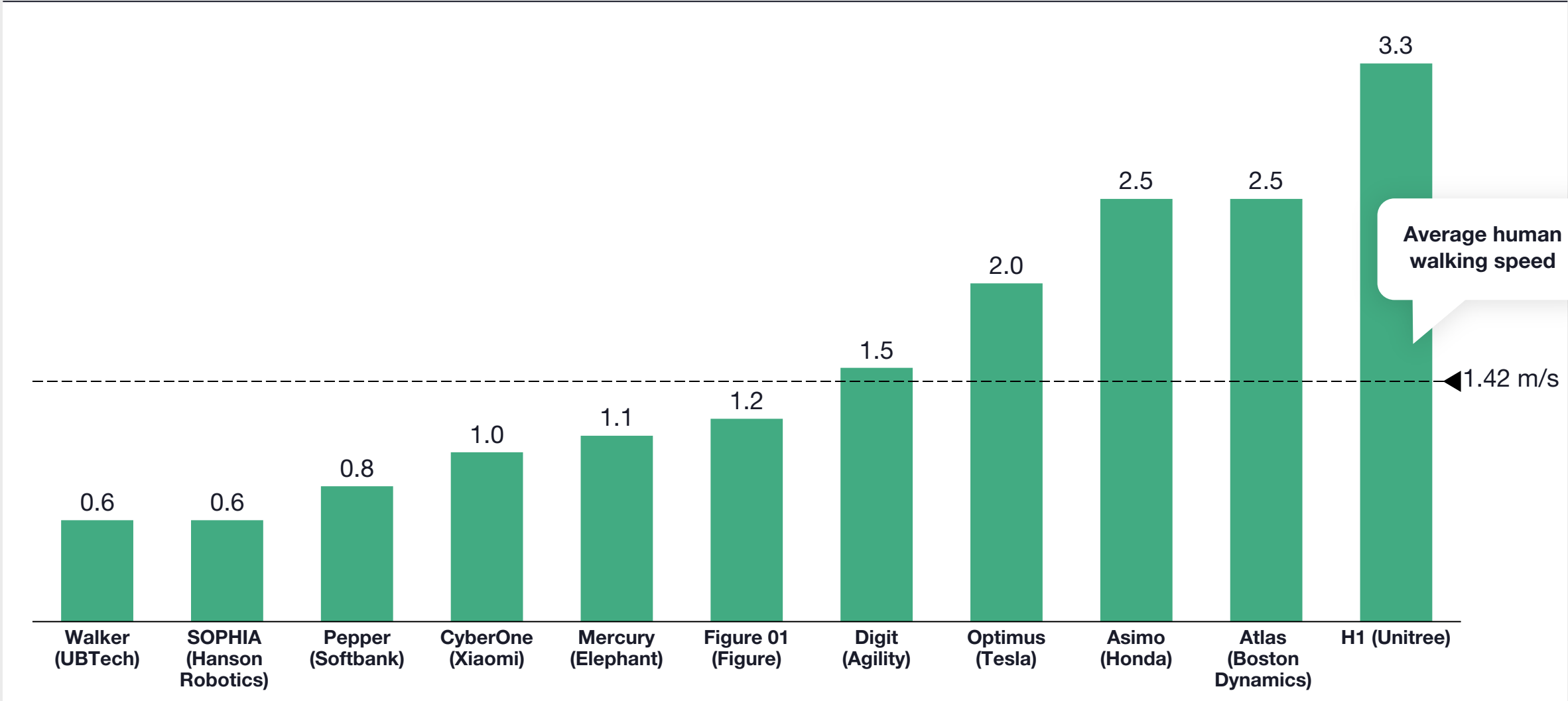
Overall humanoid hardware cost expected to dramatically decrease

→ Humanoid component costs (one-time) vs. Human wage (annual)

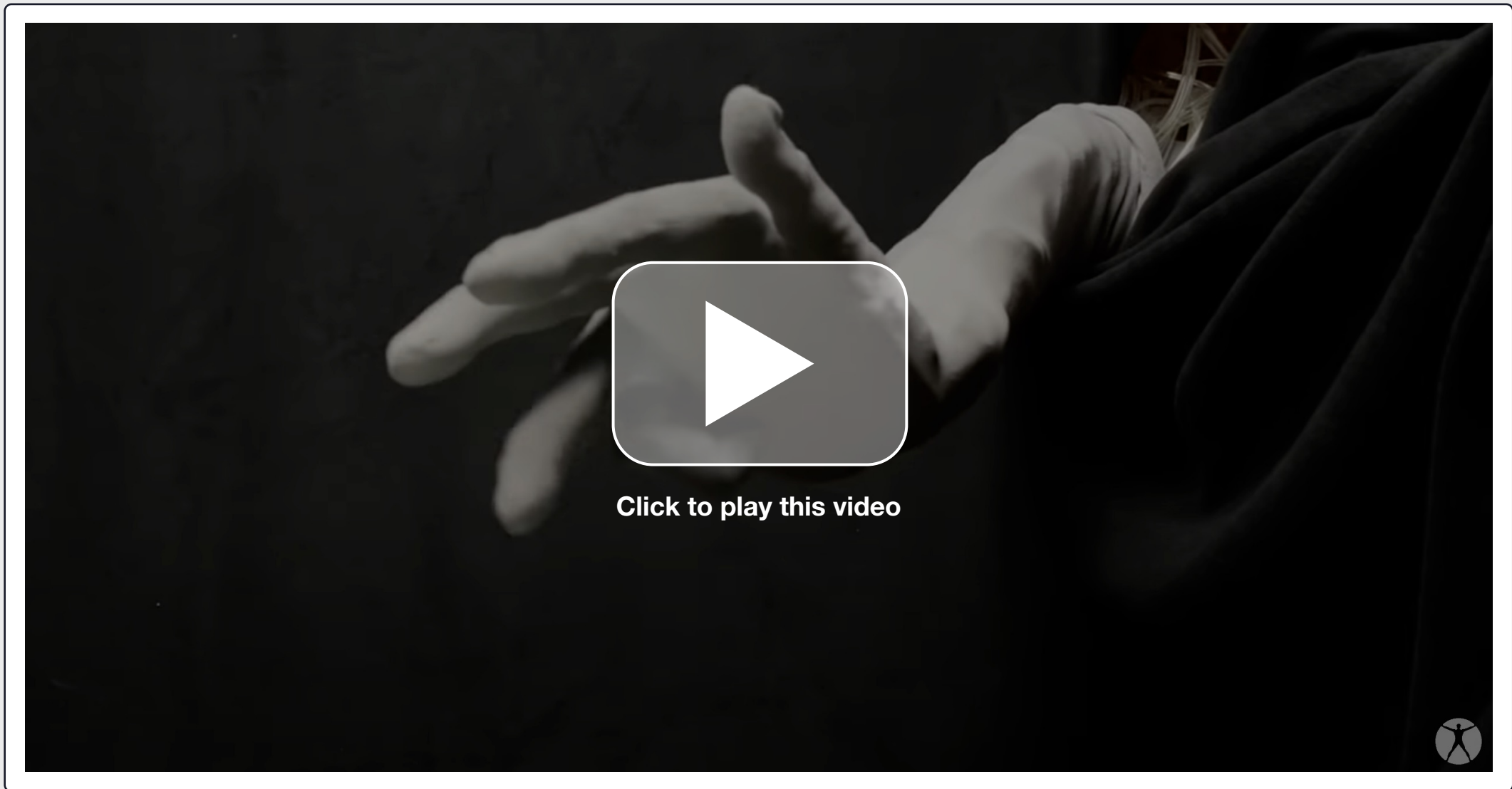


Some humanoids today operate faster than humans

→ Humanoid walking speed

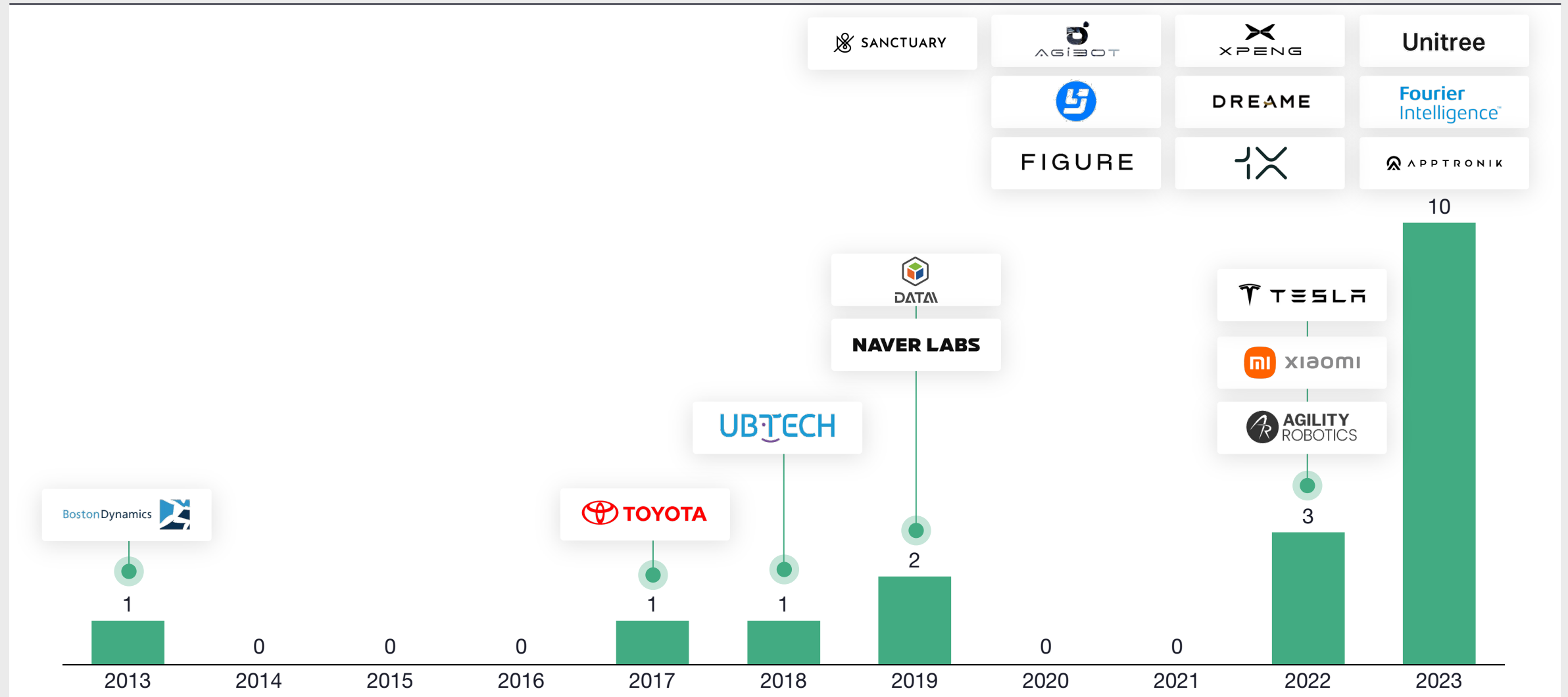


Human-like dexterity is on the way

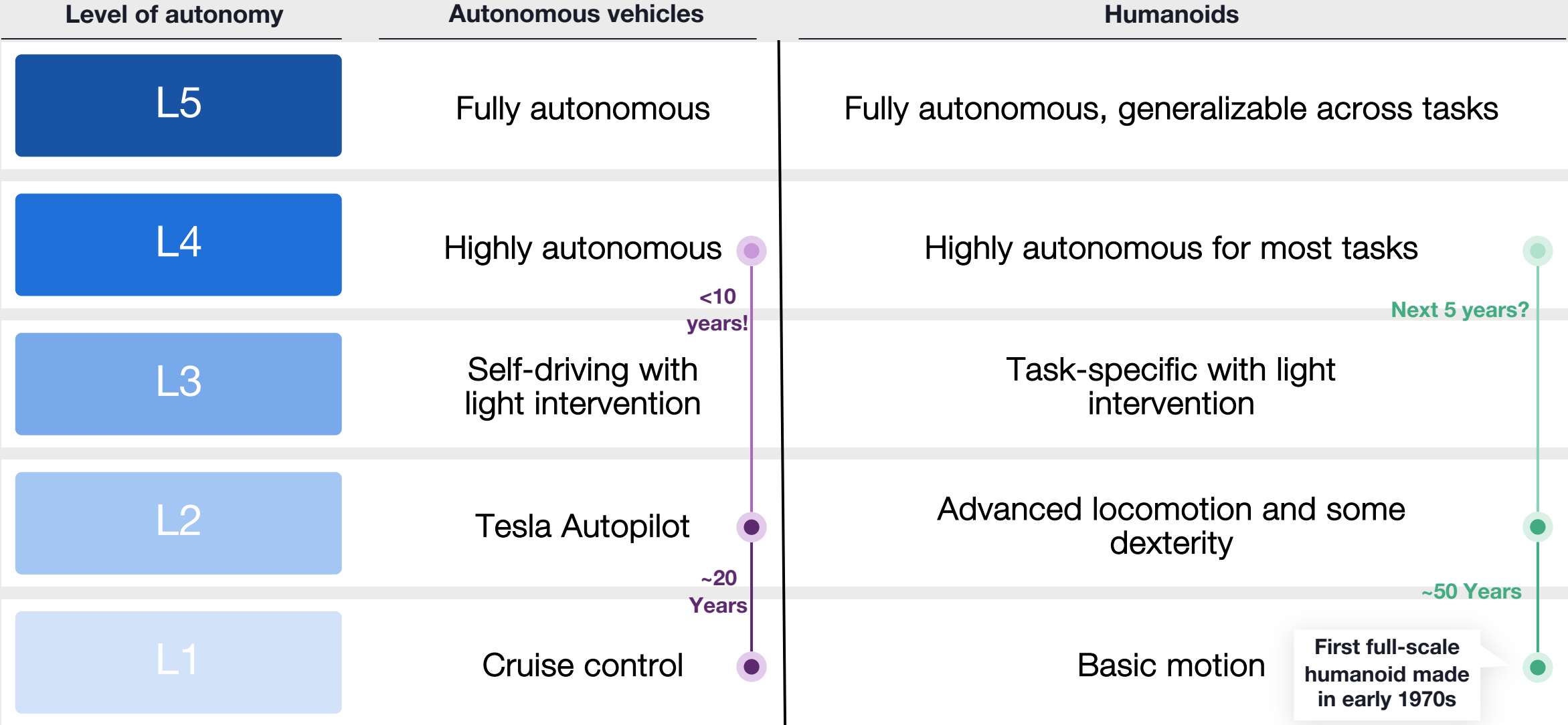


More humanoid initiatives are emerging

→ Select humanoid launches



We expect humanoid autonomy to accelerate as with AVs



We believe hardware robustness will enable extraordinary abilities!



Robots exhibiting increased durability...



...and increasingly able to do more with better hardware



Superhero-level humanoids next?

Key Topics

→ 1. Past & Present: Where is Robotics Today?

→ 2. The Dawn of a New Era: General-Purpose Robots

→ **3. When is the ChatGPT Moment for Robotics?**

→ 4. Future: A Thriving Robotics Ecosystem

The ChatGPT Moment for robotics is coming soon...?

About the ChatGPT moment for robotics

Things might get very interesting in robotics in 2024 and beyond



CONRAD GRAY
JAN 11, 2024

Radical Reads

Robotics' ChatGPT Moment

By Leah Morris, Senior Director, Velocity Program
August 21, 2023

Figure AI say they've had a 'chatGPT moment' with their Humanoid robot.. reveal tomorrow.

January 7, 2024 By Jason Cartwright

TECH

Silicon Valley really, really wants robots to get their ChatGPT moment

Hasan Chowdhury Jan 10, 2024, 5:38 AM PST

Share Save

ARTIFICIAL INTELLIGENCE

Is robotics about to have its own ChatGPT moment?

Researchers are using generative AI and other techniques to teach robots new skills—including tasks they could perform in homes.

By Melissa Heikkilä

April 11, 2024



Brett Adcock
@adcock_brett

we just had an AI breakthrough in our lab
robotics is about to have its ChatGPT moment
and that moment is happening tomorrow
4:17 PM · Jan 6, 2024 · 2.4M Views


01-19-2024 | FAST COMPANY EXECUTIVE BOARD

Robotics needs its ChatGPT moment

The right user-centric approach can skyrocket robotics from a niche spectacle to an everyday utility.

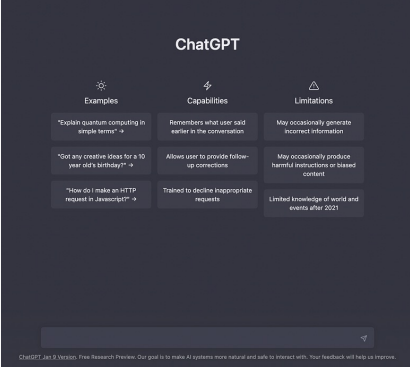
Three big “WOW!” Moments in technology in the last 20 years

iPhone




2007

ChatGPT & LLMs



2022

Autonomous Vehicles



2024

Robotics



Coming soon

These characteristics often help create a “WOW!” moment in tech

Virality & Adoption



Rapidly goes mainstream via word-of-mouth

Use Cases



Exciting use cases from day one

Cost






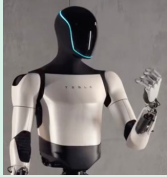
















Price point accessible to majority

Ecosystem



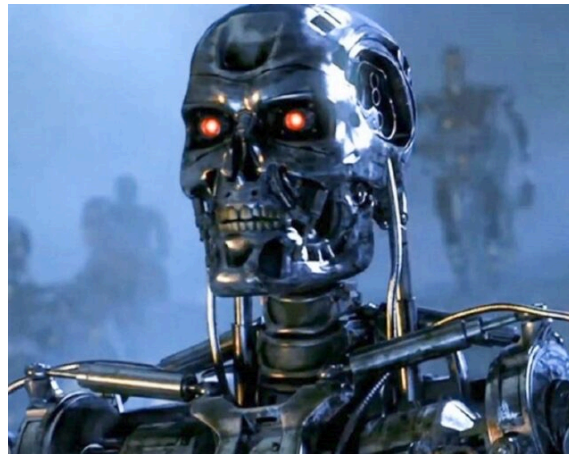
Thriving developer community

Prediction: Robot Moment won't look like ChatGPT Moment

	2007  iPhone	2022  ChatGPT ChatGPT & LLMs	2024  Waymo	Coming soon  Robotics
Scorecard				
Adoption & Virality				 <i>Physical limitations to adoption</i>
Use Cases				 <i>Potential across many tasks</i>
Cost				 <i>Costs still high</i>
Ecosystem				 <i>Nascent ecosystem</i>

From seeing to experiencing, then owning robots

→ In-movie robots



Meant to entertain you

Fictional and fun!

→ Out-of-home robots



**Built into
customer experience**

*Robot in coffee shop fully
handles customers*




→ In-home robots



Direct ownership

*Consumer owns
multi-task robot at home*

Coatue View: How human(oids) might grow up

	1 year	3 years	5 years	15 years
 <p>Newborn Capabilities</p>	<i>Walking</i>	<i>Speaking</i>	<i>Writing</i>	<i>Driving</i>
 <p>In-Home Humanoid Capabilities</p>	Humanoid cleaner	Humanoid chef	Humanoid concierge	Humanoid nanny
 <p>Out-of-Home Humanoid Capabilities</p>	Humanoid warehouses	Humanoid stores	Humanoid firefighter	Humanoid surgeon

Key Topics

→ 1. Past & Present: Where is Robotics Today?

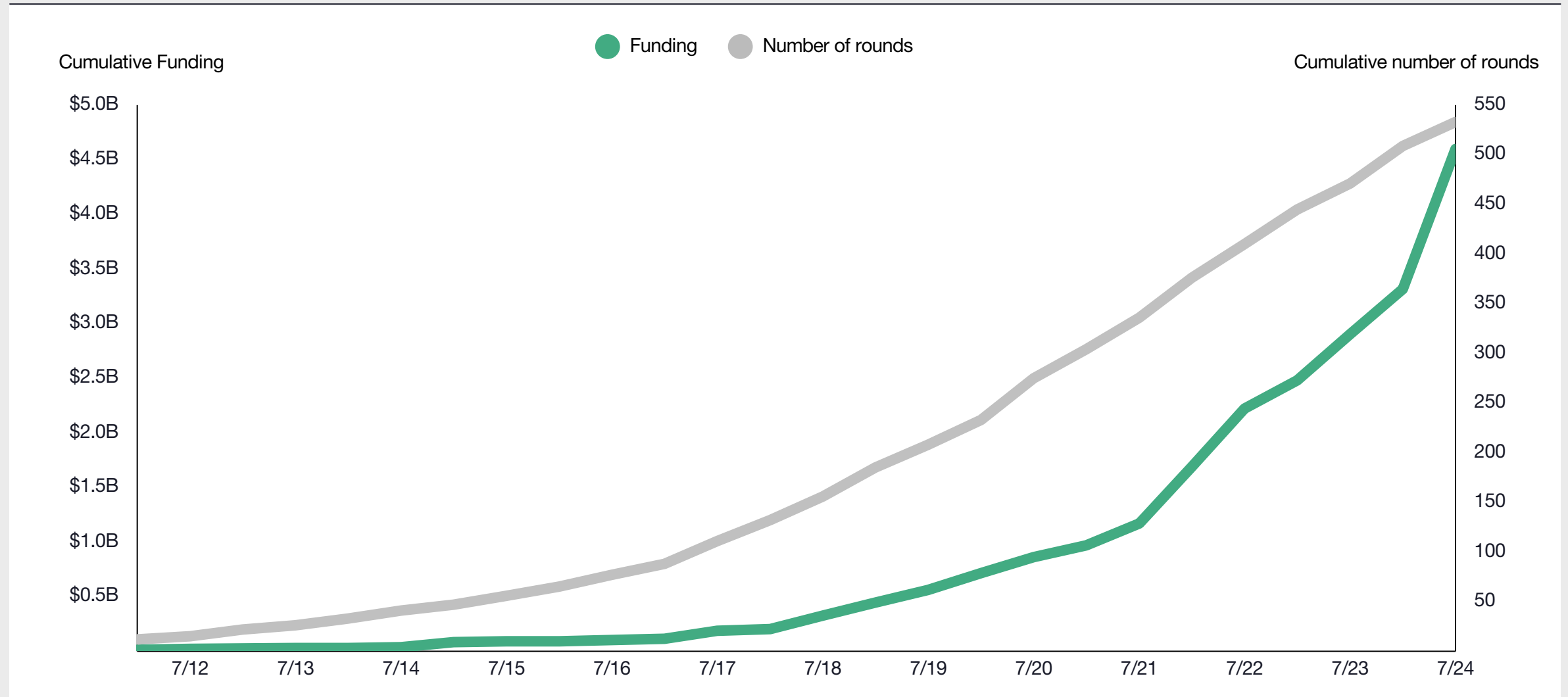
→ 2. The Dawn of a New Era: General-Purpose Robots

→ 3. When is the ChatGPT Moment for Robotics?



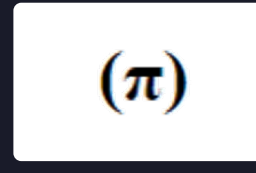
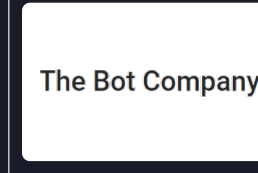







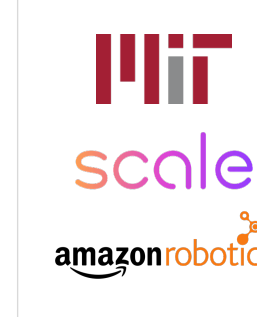


→ 4. Future: A Thriving Robotics Ecosystem

Funding for AI robotics startups has inflected

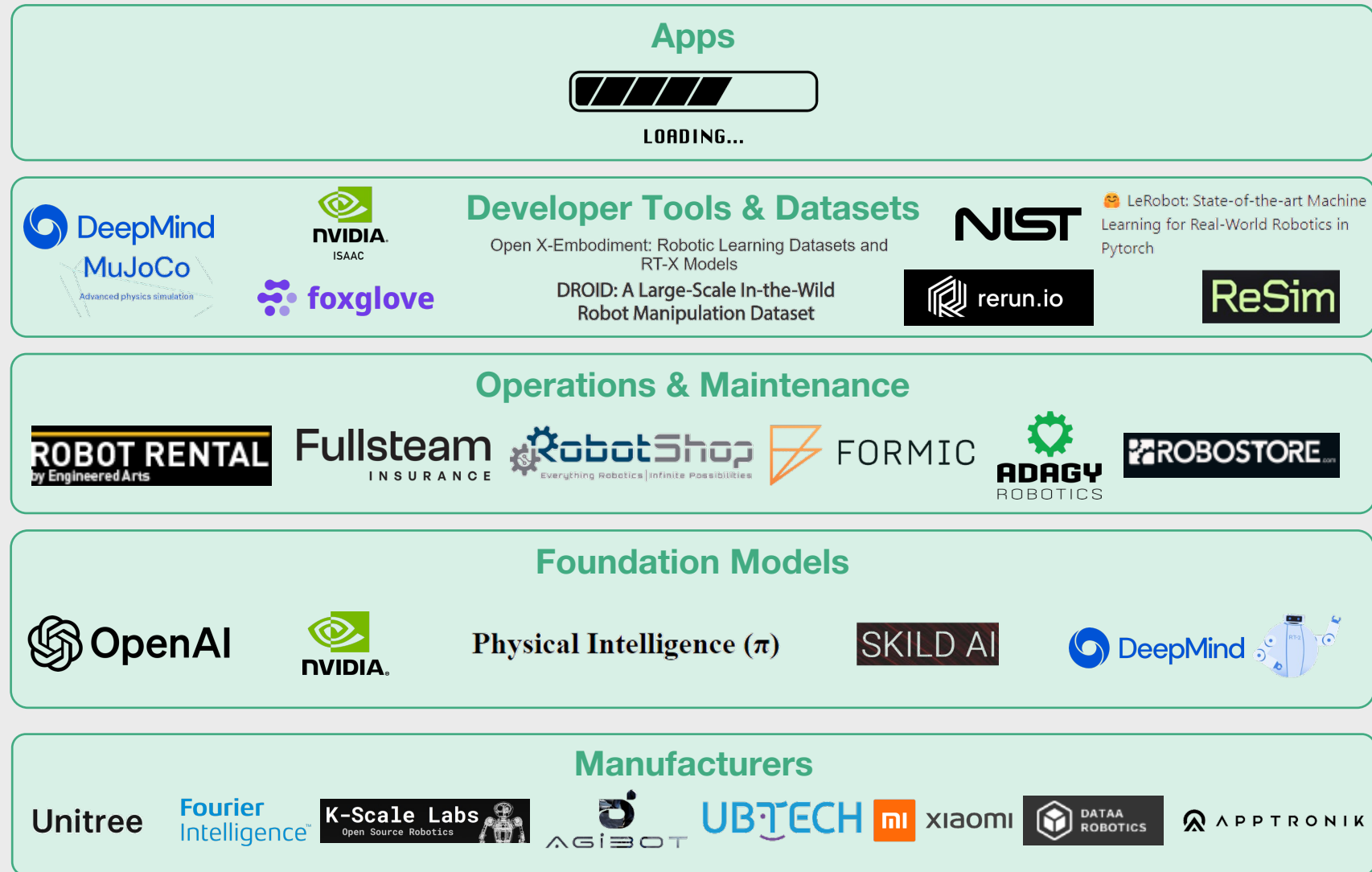
→ Investors pouring capital into next-gen robotics startups



Leading talent is starting robotics companies

Company							
Robot Type	Humanoid	Humanoid	Foundation Model	Home Robots	Stealth	Foundation Model	Humanoid
Founders	Brett Adcock	Bernt Bornich	Chelsea Finn Karol Hausman Sergey Levine	Kyle Vogt Paril Jain Luke Holoubek	Brad Porter	Deepak Pathak Abhinav Gupta	Elon Musk Milan Kovac
Funding	\$845M	\$140M	\$70M	\$150M	\$140M	\$300M	N/A
Background							

An ecosystem for AI robots has started to emerge



Robotics rides LLM tailwinds but faces AV-like headwinds

Tailwinds

Headwinds



Talent & Research



Compute



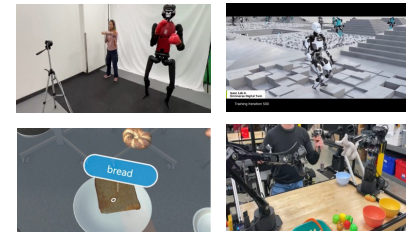
Capital

\$30B+

raised by top AI model companies



Data Scarcity



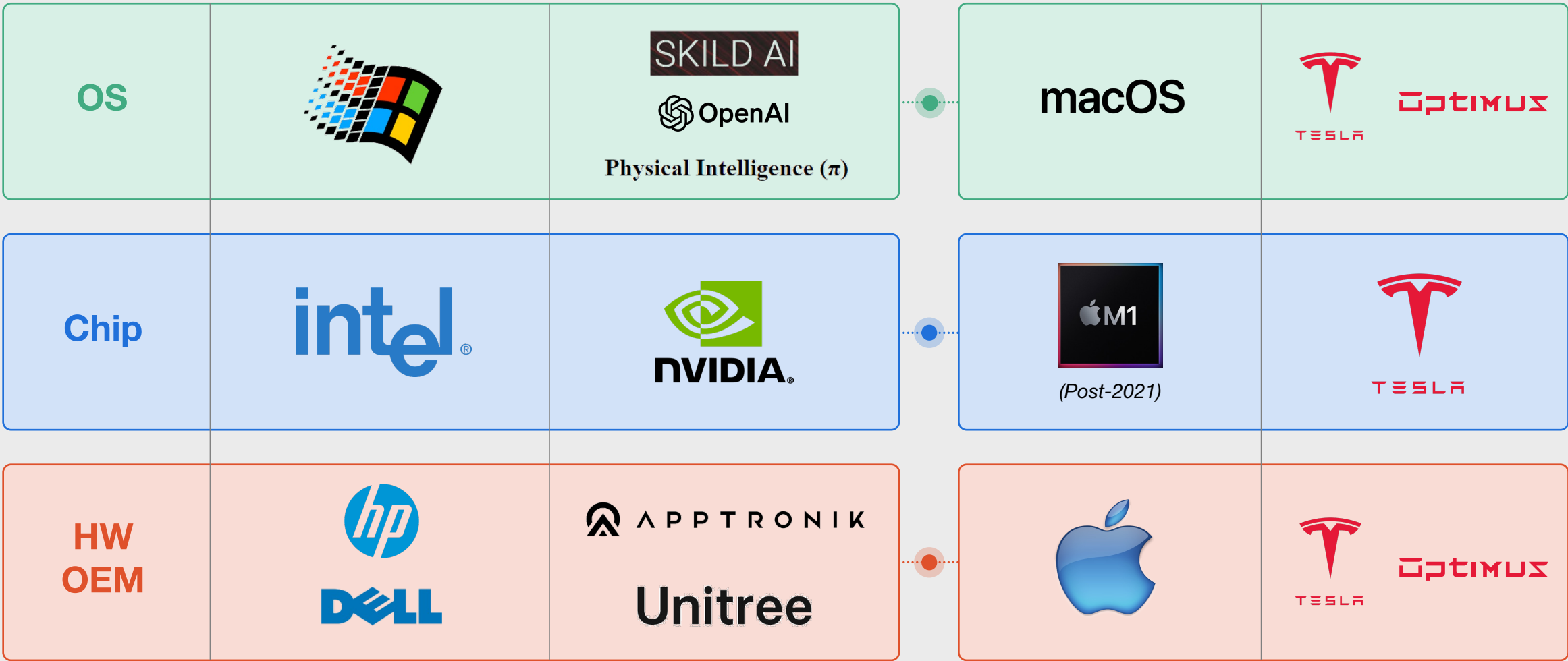
Supply Chain Constraints



Wintel-like partnerships and walled-garden approaches developing

PC Era **Wintel** ↔ AI Robotics **AI+HW OEMs**


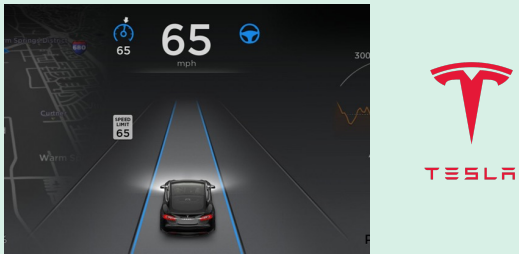
PC Era **Mac** ↔ AI Robotics **Full-Stack**




We expect AI – not hardware – to differentiate humanoids

Undifferentiated Hardware

Software & AI Layer

<p>Cars</p>	 <p>Porsche BMW Infiniti Toyota</p>	
--------------------	--	---

<p>Phones</p>	 <p>iPhone Samsung Xiaomi Oppo</p>	<p>Apple Intelligence</p>
----------------------	---	---------------------------

<p>Robots</p>		<p>OpenAI SKILD AI</p> <p>(π) TESLA ?</p>
----------------------	--	--

Coatue View: Robotics sectors will have different market dynamics

Home



General-purpose
humanoids
Vertical integration

Industrial



Special-purpose,
non-humanoids
Partnership approach

Commercial



Special-purpose
humanoids
Partnership approach

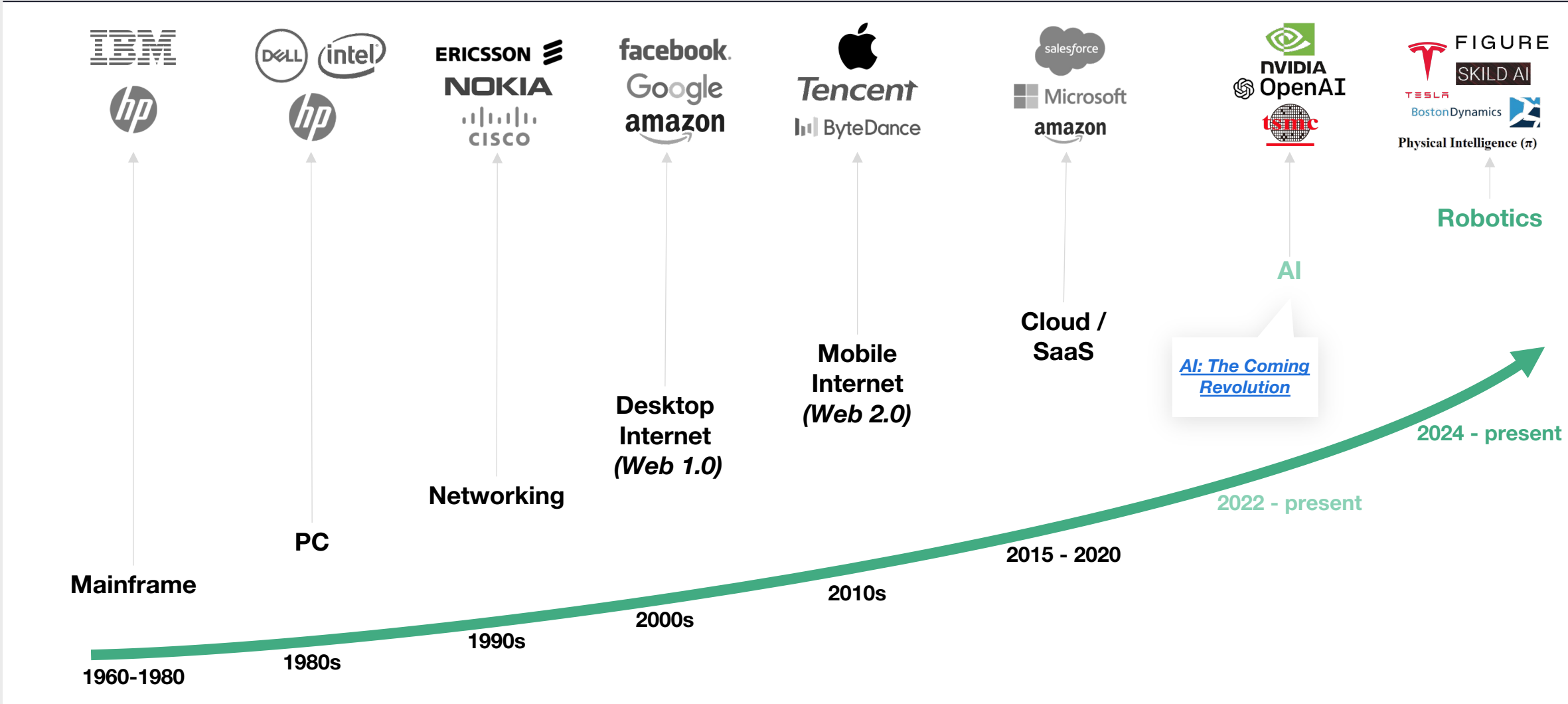
Defense



Special-purpose
superhumanoids
Vertical integration:
2-3 robot primes

We see AI robotics creating the next disruptive platform shift

→ General-purpose robotics has the potential to be one of the biggest waves yet!



Appendix - Disclosures

Coatue Analysis

- **This presentation reflects Coatue’s opinions and analysis on AI and robotics as of the date of this presentation. It does not constitute investment advice or a recommendation to buy or sell any securities.**
- Unless otherwise indicated, any figures and calculations herein are for informational purposes only, computed by Coatue or its advisors and not audited by any third party.
- Since AI and information herein is based on an emerging technology, we expect our views may evolve or shift over time. As such, information herein is subject to change at anytime without notice.
- Although Coatue believes that the data expressed in this presentation is accurate and reasonable, actual results could differ materially from those projected or assumed, and such projections are subject to change, and are subject to inherent risks and uncertainties. Neither Coatue nor its affiliates or advisors guarantees the accuracy or completeness of the information. Accordingly, neither Coatue nor any of its affiliates, advisors or employees shall be liable to you or anyone else for any loss or damages from use of the information contained in this presentation.

Artificial Intelligence (AI)

- This presentation contains forward-looking predictions regarding AI and its potential impacts and opportunities, all of which are subject to a number of factors and uncertainties. Any characterization of AI herein is the opinion of Coatue, is subject to change, and should not be relied upon in making an investment decision. Given that AI is an emerging technology, assessing the future trajectory of the AI industry is inherently challenging, and Coatue’s views on its success or failure can be subjective and based on incomplete information, limited perspectives, or speculative assumptions. See also the disclosures regarding forward-looking statements.
- Companies herein are not intended to highlight or represent the Coatue portfolio, but rather the broader AI theme, which by nature may include Coatue investments. To the extent Coatue portfolio companies or investments are included herein, Coatue makes no suggestion or guarantee regarding the future outcomes or performance of such companies.
- Even if Coatue’s characterizations and opinions regarding the AI trend were to prove accurate, there is no suggestion or guarantee that Coatue will be able to identify and invest in opportunities presented by AI. The AI industry is multifaceted, encompassing various technologies, applications, and market dynamics. Its complexity makes it susceptible to unpredictable developments, including breakthrough innovations, disruptive technologies, or unexpected challenges.

Forward-looking Statements & Projections

- This presentation contains forecasts, projections and other forward-looking statements, including (but not limited to) the occurrence or outcome of anticipated events, estimates, future performance and adaption of AI. Due to various risks and uncertainties, actual events, results of these events may differ materially from those reflected or contemplated in such forward-looking statements. There is no guarantee that such forecasts, projections or forward-looking statements will occur and therefore should not be relied upon.
- Projections are forward-looking statements and actual results may differ materially from those presented herein. Projections are inherently unreliable as they are based on estimates and assumptions about events and conditions that have not yet occurred and any of which may prove to be incorrect. No assurance, representation or warranty is made that any of the projections will occur. Coatue makes no assurance, representation or warranty as to the accuracy or reasonableness of the projections or estimates.

Companies and Trends

- The companies referenced herein are included for informational purposes only. The information herein does not constitute investment advice or a recommendation to buy or sell any securities. The companies do not necessarily represent stocks or investments that Coatue owned or owns. In addition, the trends identified and discussed in this presentation reflect the opinions of Coatue. The trends discussed do not reflect the entire universe and could be impacted by market factors, changes in laws and other factors.
- No third-party firm or company names, brands or logos used in this presentation are Coatue’s trademarks or registered trademarks, and they remain the property of their respective holders and not Coatue. The inclusion of any third-party firm and/or company names, brands and/or logos does not imply any affiliation with these firms or companies. None of these firms or companies has endorsed the investment opportunity described herein, Coatue, any affiliates of Coatue, or Coatue’s personnel.

Third Party Information & Market Data

- Market data and industry information used throughout this memorandum is based on market and industry data and forecasts that Coatue has derived from publicly available information, various industry publications, other published industry sources and Coatue’s knowledge of the industry and the good faith estimates of Coatue management. Coatue also relied, to the extent available, upon our review of independent industry surveys and publications, and other publicly available information prepared by a number of sources. All of the market data and industry information used herein involves a number of assumptions and limitations, and you are cautioned not to give undue weight to such estimates.
- Certain estimates or projections in this presentation have been provided or primarily sourced by third parties and have not been independently verified or audited by Coatue. While we believe the sources providing company information are generally reliable, Coatue makes no representation as to the accuracy or reliability of such information.